Table of Contents
URS Calculations

MSE Wingwall Design Summary URS-1
Laboratory Summary of Consolidated Undrained Tests..... URS-2
Field Curves for Consolidation Tests URS-3
Global Stability Cross Sections..... URS-10
Test Embankment Back Calculation URS-12
Driveability Analysis..... URS-26
Lateral Analysis of Unstrapped Abutment URS-111

Structure S1 – Ramp A over I-95
- **Plan and Elevation ..... URS S1-2**
- **MSE Wingwalls: Bearing Capacity, Sliding, Overturning, Eccentricity & Settlement**
  - **Abutment A Wingwalls..... URS S1-4**
  - **Abutment A Front Face..... URS S1-14**
  - **Abutment B Front Face and Wingwalls..... URS S1-21**
- **Global Stability ..... URS S1-28**
- **Axial Capacity of Open Ended Pipe Piles ..... URS S1-33**
- **Lateral Analysis of Open Ended Pipe Piles ..... URS S1-65**

Structure S2– Ramp A over SR 7
- **Plan and Elevation ..... URS S2-2**
- **MSE Wingwalls: Bearing Capacity, Sliding, Overturning, Eccentricity & Settlement**
  - **Abutment A Front Face and Wingwalls..... URS S2-4**
  - **Abutment B Wingwalls..... URS S2-8**
  - **Abutment B Front Face..... URS S2-13**
- **Global Stability ..... URS S2-17**
- **Axial Capacity of Open Ended Pipe Piles ..... URS S2-23**
- **Lateral Analysis of Open Ended Pipe Piles ..... URS S2-54**

Structure S3– Ramp B over SR 7
- **Plan and Elevation ..... URS S3-2**
- **MSE Wingwalls: Bearing Capacity, Sliding, Overturning, Eccentricity & Settlement**
  - **Abutment A Front Face and Wingwalls..... URS S3-4**
  - **Abutment B Wingwalls..... URS S3-8**
  - **Abutment B Front Face and Wingwall..... URS S3-12**
- **Global Stability ..... URS S3-16**
- **Axial Capacity of Open Ended Pipe Piles ..... URS S3-23**
- **Lateral Analysis of Open Ended Pipe Piles ..... URS S3-42**

Structure S4– Ramp C over SR 7

Plan and Elevation ..... URS S4-2

MSE Wingwalls: Bearing Capacity, Sliding, Overturning, Eccentricity & Settlement

Abutment A Front Face and Wingwalls ..... URS S4-4

Abutment B Wingwalls ..... URS S4-8

Abutment B Front Face and Wingwall ..... URS S4-12

Global Stability ..... URS S4-16

Axial Capacity of Open Ended Pipe Piles ..... URS S4-23

Lateral Analysis of Open Ended Pipe Piles ..... URS S4-42

SR 1 / I-95 Interchange
MSE Wingwall Design Summary

References:

1. AASHTO LRFD Bridge Design Specification, Customary U.S. Units, 4th Edition 2007, with 2008 Interim.
2. Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines, FHWA-NHI-00-043, 2000.
3. Das, Braja. "Principles of Geotechnical Engineering." 4th Edition, 1998.
4. Schmertmann Settlement Analysis Spreadsheet. Source Virginia Tech.

Design:

1. Bearing capacity, sliding, overturning, eccentricity, settlement and global stability are based on AASHTO (Ref. 1).
2. For back to back walls a "wedge influence factor" was introduced, based on FHWA (Ref. 2), to account for the reduction in lateral force due to horizontal earth pressure.
3. Design was based on in-progress TS&L plans and cross sections, dated Nov. 2008.

Other Notes:

1. For each wall four cases were analyzed.
    a. "Stage 1" Short-Term: The wall was built to the maximum possible height assuming a fully undrained and unconsolidated condition. This was assumed to conservatively estimate the short term condition.
    b. "Stage 1" Long-Term: The wall was checked assuming a fully drained, fully consolidated case to very stability.
    c. Full-Height Short-Term: As described in the text of the FFR a quarantine period occurs after completion of Stage 1 to allow pore water to dissipate and consolidation to occur. For the short-term case the soil properties assumed were from the consolidated, undrained laboratory data.
    d. Full-Height-Term: Similar to the short term case, but uses soil parameters at fully drained, fully consolidated case to represent the long-term condition.

Interchange Reconstruction: Delaware Route 1 and Interstate I-95
Consolidated Undrained Test Summary

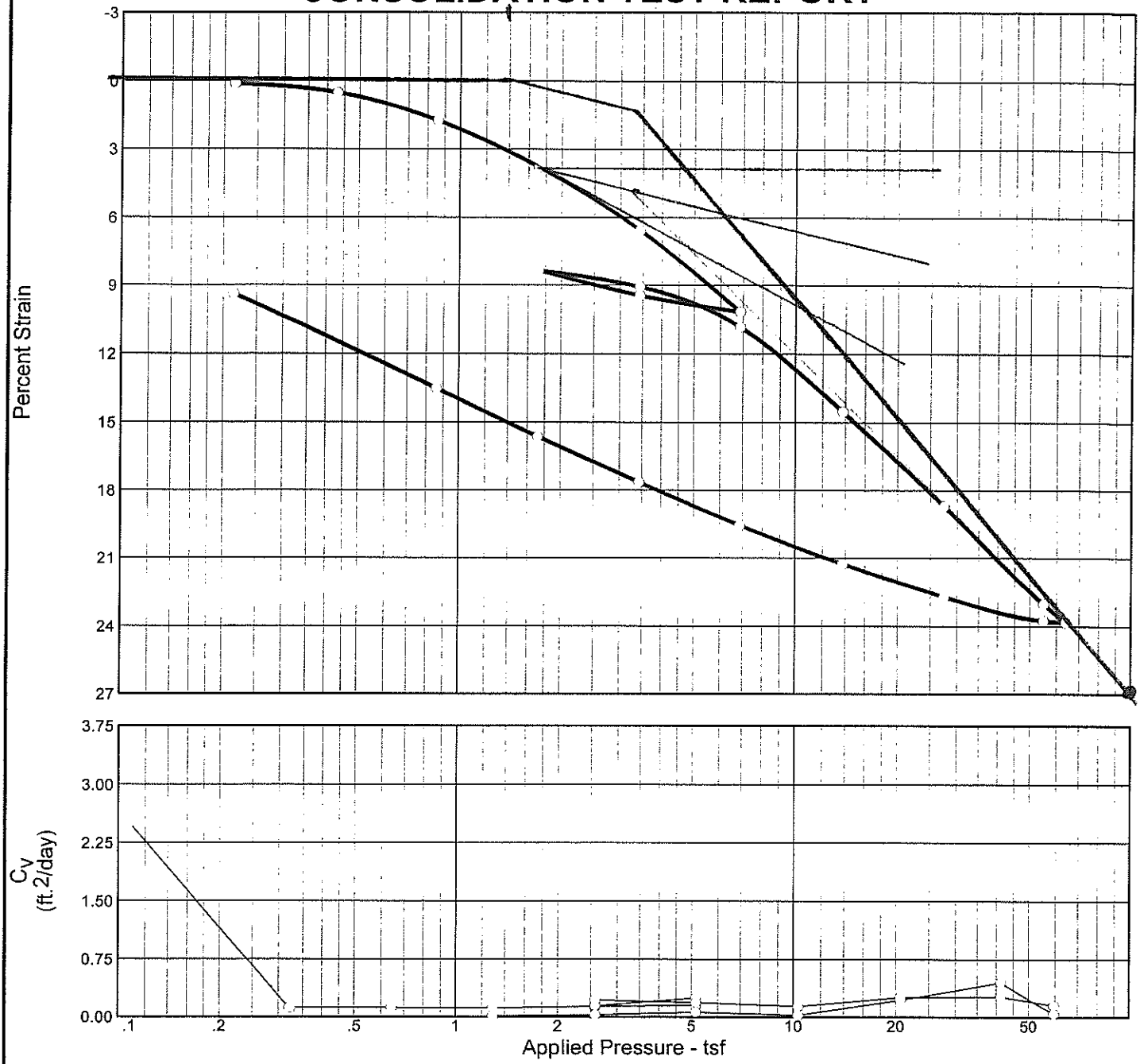
	Total		Effective					
	c (ksf)	phi	c' (ksf)	phi'	LL	PI	% Fines	USCS
IRW-9	1.76	11.74	1.63	18.17	39	19	99.5	CL
IRW-19	0.43	7.5	0.57	8.28	49	27	81	CL
IRW-23	1.07	5.28	1.08	7.62	48	24	99	CL
IRW-27	0.55	14.83	0.5	24.62	43	23	90	CL
IRW-32	1.82	14.76	1.58	23	57	30	97	CH
IRW-33A	0.93	5.23	0.66	17.18	55	34		CH
IRW-42	0.63	9.63	0.68	13.78	42	20		CL
IRW-44	1.14	4.31	4.31	8.83	56	28	99	CH
IRW-49	0	45.45	0.53	36.32	21	2	69	ML
IRW-51	0.52	10.14	0.55	15.84	48	27	98	CL
IRW-52	0.21	20.71	0.35	30.45	34	18	86	CL
IRW-53	1.52	7.44	1.58	9.74	51	24	96	CH
IRW-64	0.7	12.23	0.57	20.94	35	15	93	CL
Average	**0.87**	**13.0**	**1.12**	**18.1**				
Average w/o IRW-49	**0.94**	**10.3**	**1.17**	**16.5**				

IRW-49 excluded because test results considered not representative of strata

Field Curves for Consolidation Tests

$p_o = 1.4$

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Swell %	e_o
111.3 %	34.7 %	92.0	53.4	25.3	2.729	1.01	1.78	0.25	0.09			0.851

MATERIAL DESCRIPTION	USCS	AASHTO
Saturated red and gray clay.	CH	A-7-6(30

Project No. 28-090-03 **Client:**

Project: S.R. 1/I-95 Interchange

Source: URS # 4 **Sample No.:** U-1 **Elev./Depth:** 22.0

Remarks:

CONSOLIDATION TEST REPORT

Delaware Department of Transportation
Materials and Research Laboratory

Figure

URS-4

URS

Job SR1/I-95 Interchange | Project No. | Page ___ of ___
Description Consolidation Properties | Computed by JPK | Sheet ___ of ___ | Date
Checked by | Date
Reference

Test @ URS-4 U-1 @ 22 ft

$e_0 = 0.851$

$0.42\, e_0 = 0.357$

$\Delta e = 0.851 - 0.357$

$= 0.494$

$\varepsilon = \frac{\Delta e}{1+e_0} = \frac{0.494}{1+0.851} = 0.267$ or 26.7%

$RR = \frac{\Delta \varepsilon}{\log \frac{\sigma_f}{\sigma}} = \frac{0.105 - 0.084}{\log \frac{6.88}{1.72}} = 0.0349$

$C_r = RR(1+e_0)$

$= 0.0349(1+0.851)$

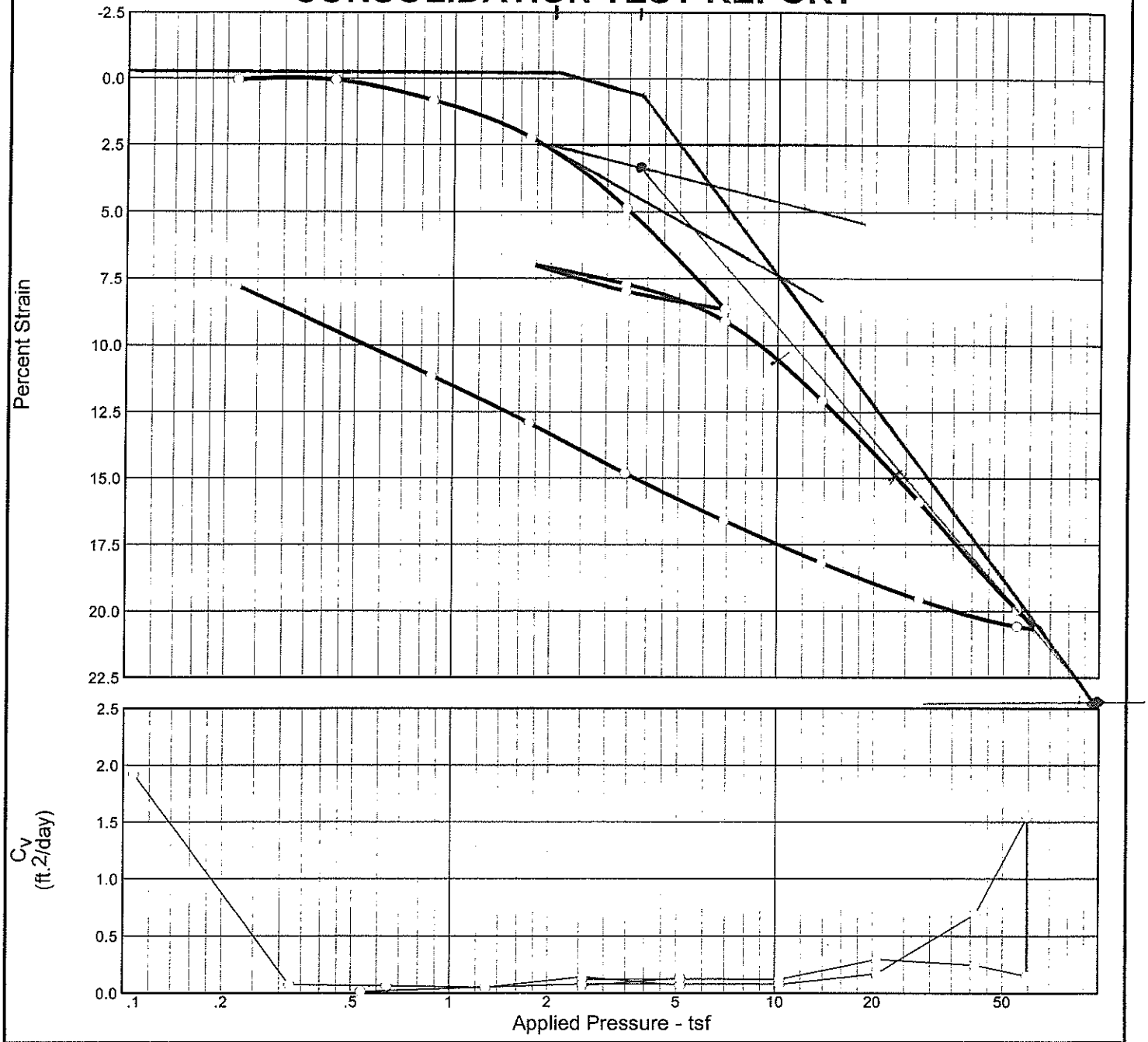
$= 0.0646$

$CR = \frac{0.27 - 0.01}{\log \frac{100}{3.48}} = 0.178$

$C_c = CR(1+e_0)$

$= 0.178(1+0.851) = 0.329$

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Swell %	e_o
115.4 %	26.1 %	104.9	40.4	18.0	2.711	1.19	2.59	0.20	0.07			0.614

MATERIAL DESCRIPTION	USCS	AASHTO
Saturated gray and red clay w/trace of fine sand.	CL	A-6(20)

Project No. 28-090-03 **Client:**

Project: S.R. 1/I-95 Interchange

Source: URS # 3 **Sample No.:** U-1 **Elev./Depth:** 35.0

Remarks:

CONSOLIDATION TEST REPORT

Delaware Department of Transportation
Materials and Research Laboratory

Figure

URS

Job SR 11 I-95 Interchange | Project No. | Page ___ of ___
Description Consolidation Properties | Computed by JPK | Sheet ___ of ___ | Date
Checked by | Date
Reference

Test @ URS-3 U-1 @ 35 ft

$e_o = 0.614$

$0.42\, e_o = 0.258$

$\Delta e = 0.614 - 0.258 = 0.356$

$\varepsilon = \frac{\Delta e}{1+e_o} = \frac{0.356}{1+0.614} = 0.221$ or 22.1%

$RR = \frac{\Delta \varepsilon}{\log \frac{\sigma_f}{\sigma}} = \frac{0.089 - 0.07}{\log \frac{6.88}{1.72}} = 0.0316$

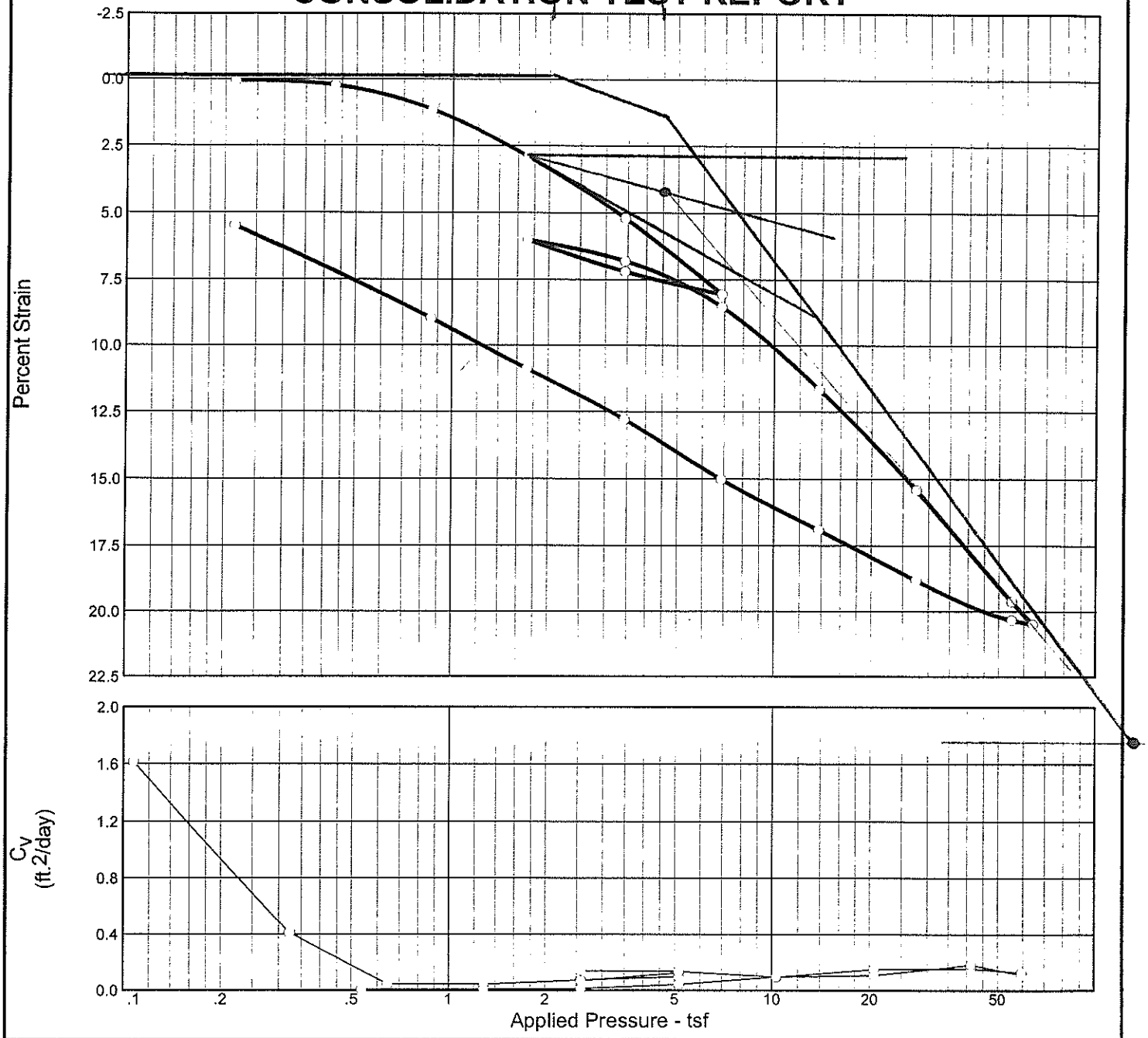
$C_r = RR(1+e_o) = 0.0316(1+0.614) = 0.051$

$CR = \frac{0.221 - 0.007}{\log \frac{100}{3.8}} = 0.151$

$C_c = CR(1+e_o) = 0.151(1+0.614) = 0.244$

po=2.1 tsf pc=4.5 tsf JTR

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Swell %	e_o
113.4 %	34.5 %	90.3	55.2	25.6	2.582	1.27	2.01	0.23	0.09			0.786

MATERIAL DESCRIPTION	USCS	AASHTO
Saturated gray and red clay w/trace of fine to coarse sand.	MH	A-7-5(29

Project No. 28-090-03 **Client:**

Project: S.R. 1/I-95 Interchange

Source: URS # 5 **Sample No.:** U-1 **Elev./Depth:** 35.5

Remarks:

CONSOLIDATION TEST REPORT

Delaware Department of Transportation
Materials and Research Laboratory

Figure

URS

Job SR 1 / I-95 Interchange
Description Consolidation Properties

Project No.
Computed by JPK
Checked by

Page ____ of ____
Sheet ____ of ____
Date
Date

Reference

Test @ URS-5 4-1 @ 35.5 ft

$e_o = 0.786$

$0.42 e_o = 0.33$

$\Delta e = 0.786 - 0.33 = 0.456$

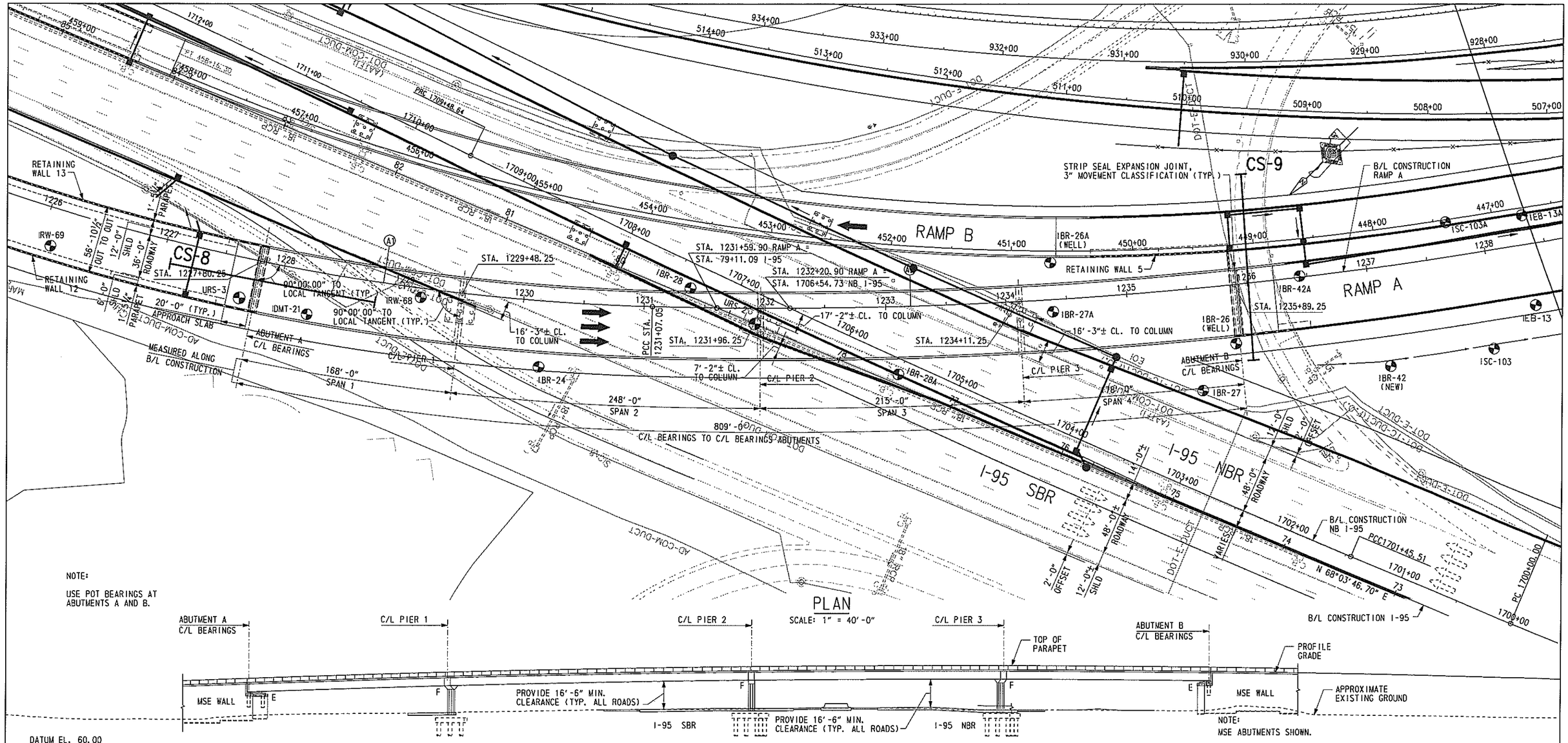
$\varepsilon = \frac{\Delta e}{1+e_o} = \frac{0.456}{1+0.786} = 0.255$ or 25.5%

$RR = \frac{\Delta \varepsilon}{\log \frac{\sigma_f}{\sigma}} = \frac{0.083 - 0.06}{\log \frac{6.88}{1.72}} = 0.0382$

$C_r = RR(1+e_o)$
$= 0.0382(1+0.786) = 0.0682$

$CR = \frac{0.225 - 0.0125}{\log \frac{90}{4.5}} = 0.1633$

$C_c = CR(1+e_o) = 0.1633(1+0.786) = 0.292$



PLAN

SCALE: 1" = 40'-0"

ELEVATION

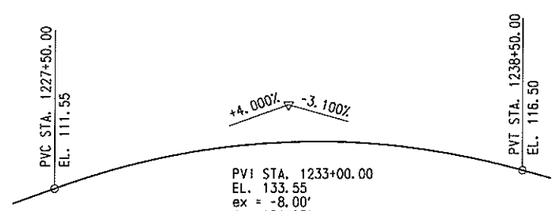
SCALE: 1" = 40'-0"

B/L CONSTR. RAMP A CURVE A1 DATA

PI STA. 1226+68.24
Δ = 27°44'07.64" LT
Dc = 3°05'49.45"
R = 1,850.0000'
T = 456.72'
L = 895.54'

B/L CONSTR. RAMP A CURVE A2 DATA

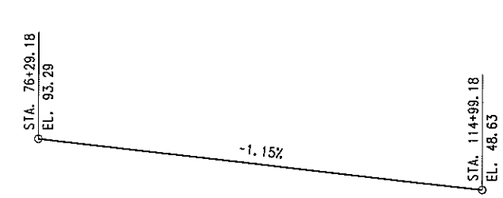
PI STA. 1238+52.84
Δ = 22°47'31.72" LT
Dc = 1°32'54.72"
R = 3,700.0000'
T = 745.79'
L = 1,471.85'



PVI STA. 1233+00.00
EL. 133.55
ex = -8.00'
K = 154.93'
VC=1,100 FT.
>60 MPH.

RAMP A - VERTICAL CURVE DATA

NOT TO SCALE



I-95 PROFILE

NOT TO SCALE

INFORMATION SUPPLIED FROM DELAWARE TURNPIKE CONTRACT NO. 7003.
ELEVATIONS ARE GIVEN APPROXIMATELY 40' LEFT OF BASELINE

URS-10

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

SCALE 0 40 80 120 FEET

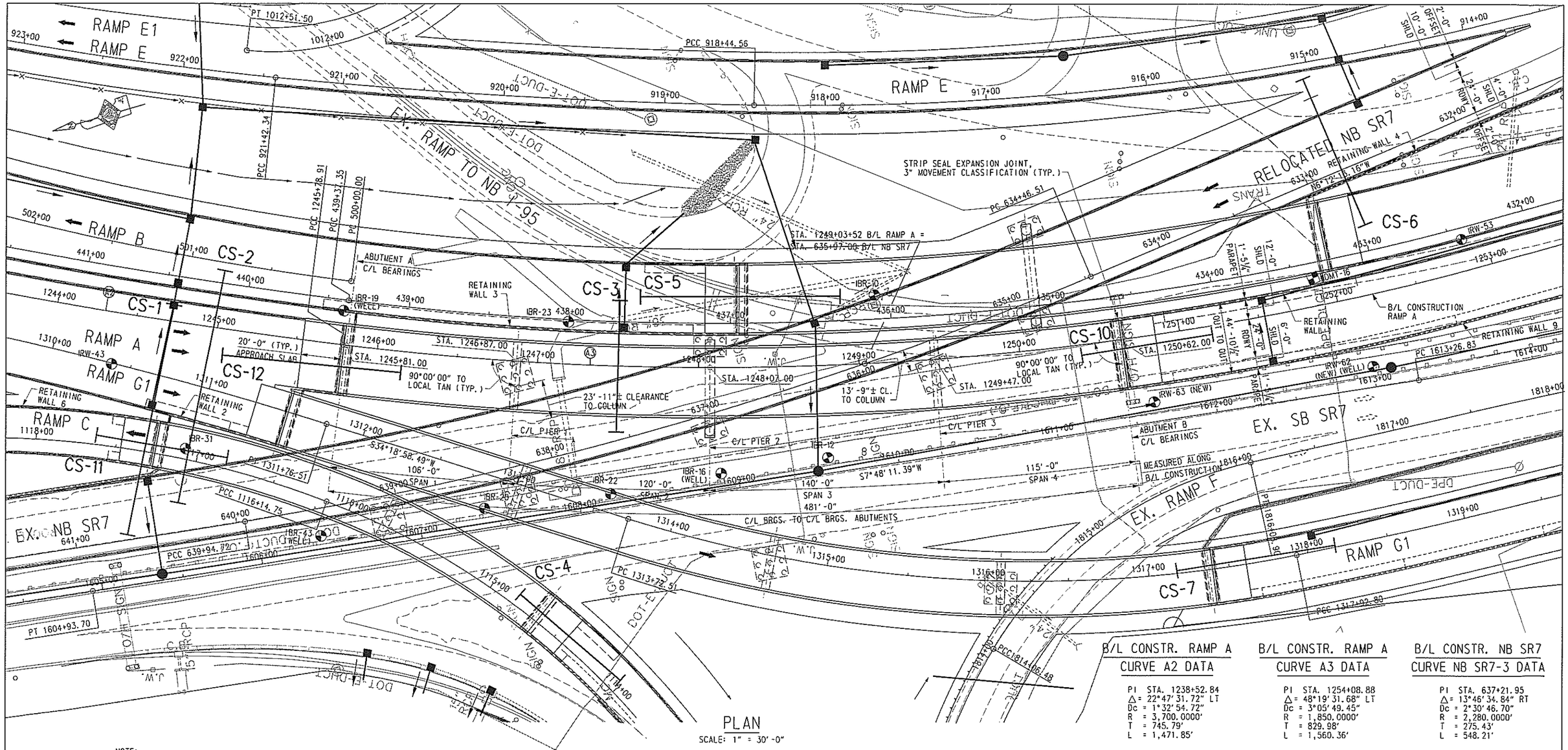
SR1/I-95 INTERCHANGE

CONTRACT	BRIDGE NO.	
28-090-03	DESIGNED BY: R. F. KIRCHNER	URS
COUNTY		
NEW CASTLE	CHECKED BY:	

GLOBAL STABILITY CROSS SECTIONS FOR S1

SHEET NO.	TOTAL SHTS.
S1-1	3

Rodriguez_V8_01 Feb 10, 2009 o:\20832687-XM\CAD\Bridge\FileRemovedFromBridge\pet01CrossSect.dgn



NOTE:

USE POT BEARINGS AT ABUTMENTS A AND B AND PIERS.

B/L CONSTR. RAMP A CURVE A2 DATA

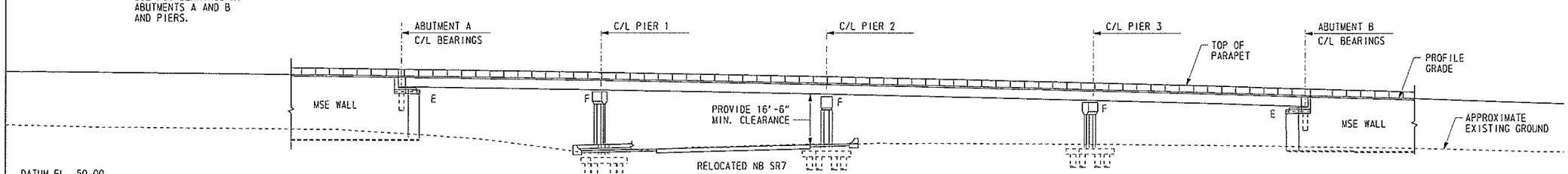
PI STA. 1238+52.84
Δ = 22°47'31.72" LT
Dc = 1°32'54.72"
R = 3,700.0000'
T = 745.79'
L = 1,471.85'

B/L CONSTR. RAMP A CURVE A3 DATA

PI STA. 1254+08.88
Δ = 48°19'31.68" LT
Dc = 3°05'49.45"
R = 1,850.0000'
T = 829.98'
L = 1,560.36'

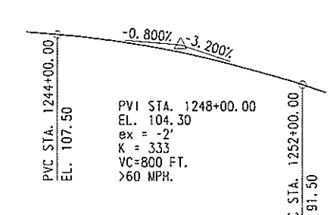
B/L CONSTR. NB SR7 CURVE NB SR7-3 DATA

PI STA. 637+21.95
Δ = 13°46'34.84" RT
Dc = 2°30'46.70"
R = 2,280.0000'
T = 275.43'
L = 548.21'



ELEVATION
SCALE: 1" = 30'-0"

NOTE:
MSE ABUTMENTS SHOWN



RAMP A PROFILE
NOT TO SCALE

URS-11

DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS	SCALE 0 30 60 90 FEET	SR1/I-95 INTERCHANGE	CONTRACT 28-090-03	BRIDGE NO.	GLOBAL STABILITY CROSS SECTIONS S2 THRU S5	SHEET NO. S2-1
				COUNTY NEW CASTLE	DESIGNED BY: R. F. KIRCHNER URS		TOTAL SHTS. 7
					CHECKED BY:		

Rodriguez_V8_01 Feb 10, 2009 o:\20832687-XM\CAD\Bridge\FileRemovedFromBridge\pe20CrossSec1.dgn

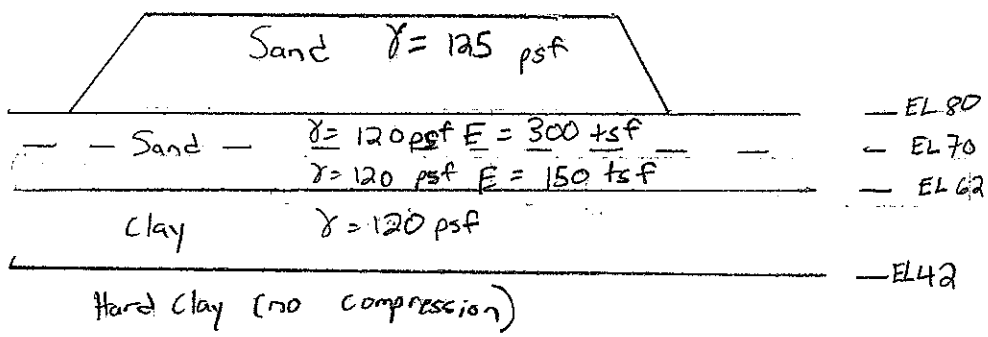
Test Embankment Back Calculation

URS

Job I-95 / SR 1 Interchange | Project No. | Page ___ of ___
Description Test Embankment Settlement | Computed by JPK | Sheet ___ of ___ | Date 11/17/08
Checked by | Date
Reference

Total Settlement @ SP-1 = 1.5 in
Total Settlement @ SP-2 = 1.8 in
Total Settlement @ SP-3 = 2.5 in
Total Settlement @ SP-4 = 1.3 in
Total Settlement @ SP-5 = 2.3 in
Total Settlement @ SP-6 = 3.5 in
Avg. Total Settlement = 2.15 in = S_T
Borings in proximity: ISC-118, IEB-13B, IEB-13A — See attached profile

Assumed Soil Profile



Immediate Settlement of Sand Layer = S_1 = 0.5 inches
(See attached)

Consolidation Settlement of Clay Layer: $S_{2A} = S_T - S_1$
$= 2.15 - 0.5$
$= 1.65$ in

$\Delta\sigma = 29\text{ ft}(125\text{ psf}) = 3{,}625\text{ psf} = 1.813\text{ tsf}$
$\sigma_o = 120\text{ psf}(18\text{ ft}) + 125\text{ psf}(10\text{ ft}) = 3410\text{ psf} = 1.705\text{ tsf}$

$e_o = \frac{(0.454 + 0.447 + 0.505 + 0.554)}{4} = 0.49$ (avg. from consols)

$C_r = \frac{(0.017 + 0.023 + 0.015 + 0.029)}{4} = 0.02$ (avg. from consols)

URS

Page ____ of ____

Job SR 1 / I-95 Interchange | Project No. ____ | Sheet ____ of ____

Description Test Embankment Settlement | Computed by JPK | Date 11/18/08

Checked by ____ | Date ____

Reference

$$\sigma_c = \frac{(2.5\ tsf + 3.0\ tsf + 3.5\ tsf + 2.2\ tsf)}{4} = 2.8\ tsf$$

$$C_c = \frac{(0.051 + 0.071 + 0.064 + 0.15)}{4} = 0.084$$

$$S_{2B} = \frac{C_r H}{1+e_o} \log \frac{\sigma_c}{\sigma_o} + \frac{C_c H}{1+e_o} \log \frac{\sigma_o + \Delta\sigma}{\sigma_c}$$

$$= \frac{0.02\,(20\,ft)}{1+0.49} \log \frac{2.8\ tsf}{1.705\ tsf} + \frac{0.084\,(20\,ft)}{1+0.49} \log \frac{1.705\ tsf + 1.813\ tsf}{2.8\ tsf}$$

$$= 0.1696\ ft$$

$$S_{2B} = 2.04\ in$$

Calculated Consolidation Settlement, $S_{2B} = 2.04\,in$, is comparable to average measured movement of settlement plates (less the calculated sand contribution), $S_{2A} = 1.65\,in$, given the consolidation is still ongoing.

Project Name: SR 1/I-95 Interchange
Project Location: Newark, Delaware - Test Embankment Sand Settlement
Project Number: 20832687 00000
Calculations By: JPK
Date: 11/17/2008

Input Global Data		
Footing Width, B	75.0	feet
Elevation of Ground Surface	80.0	feet
Elevation of Base of Footing	80.0	feet
Elevation of Water Table	30.0	feet
Unit Weight of Water, γ_w	62.4	pcf
Net Bearing Pressure, ΔP	3625	psf
Soil Unit Weight Above Footing Base	125	pcf
Settlement Calculated at end of construction and at time t	1	years

Input Layer Data				
Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_t (pcf)
1	80.0	70.0	300	120
2	70.0	65.0	150	120
3	65.0	62.0	150	120
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Note: The depth of the water table must be a layer boundary.

Compute Global Values for Axisymmetrical Case		
σ'_{vo} at Elevation	80.0	0 psf
Elev. of I_{zp}		42.5 feet
σ'_{vp} at elevation	42.5	4500 psf
I_{zp}		0.590
C_1		1.00
C_2		1.20

Computed Axisymmetrical Layer Information

Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_T (pcf)	Δz (ft)	Elev. Of Center of Layer (ft)	I_z	ε	ΔH (inches)
1	80	70	300	120	10	75	0.17	0.10%	0.12
2	70	65	150	120	5	67.5	0.26	0.32%	0.19
3	65	62	150	120	3	63.5	0.32	0.38%	0.14
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

Immediate Settlement			0.4 inches
Settlement After	1	year	0.5 inches

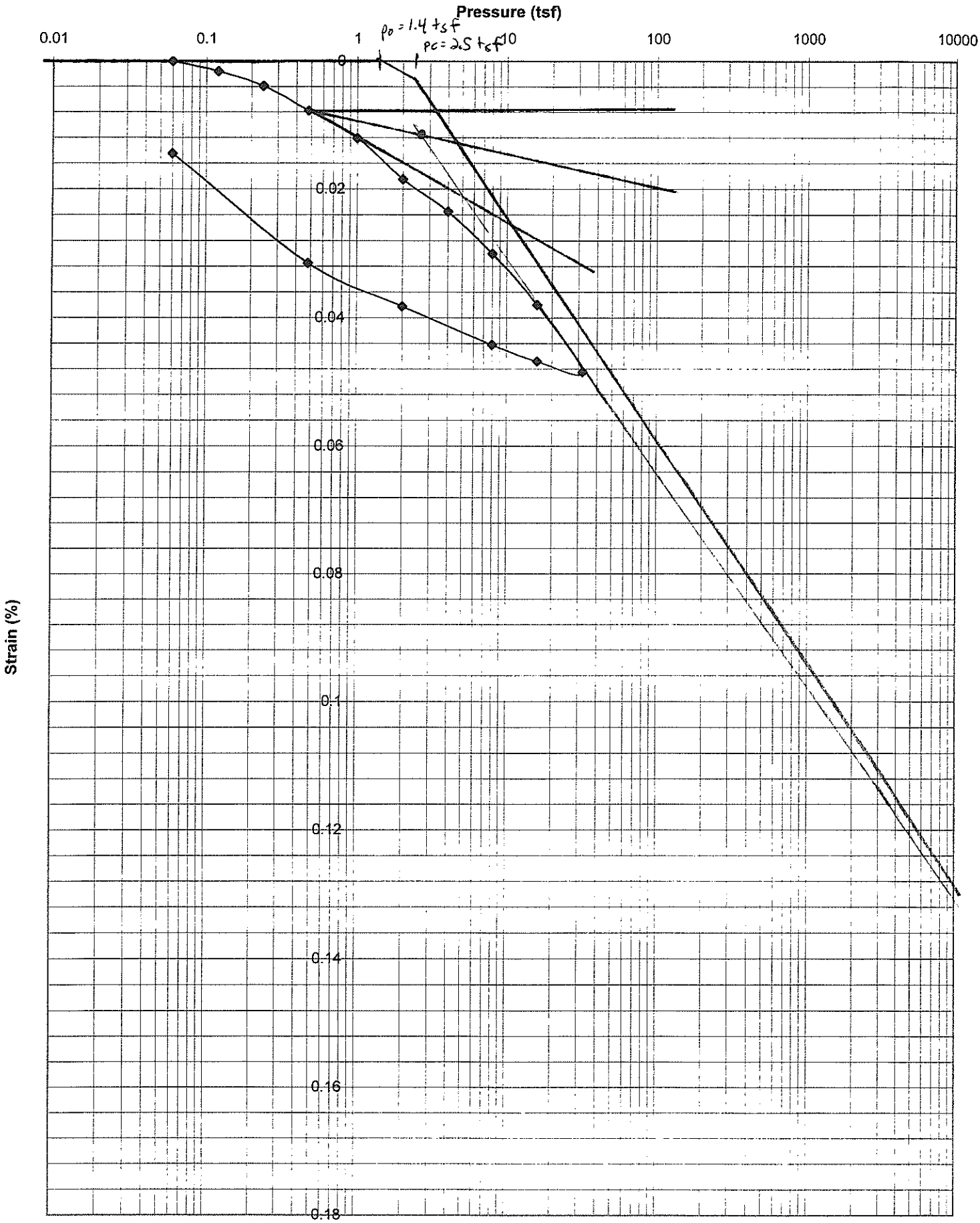
Compute Global Values for Plane Strain Case			
σ'_{vo} at Elevation	80	0	psf
Elev. of I_{zp}		5	feet
σ'_{vp} at elevation	5	9000	psf
I_{zp}		0.563	
C_1		1.00	
C_2		1.20	

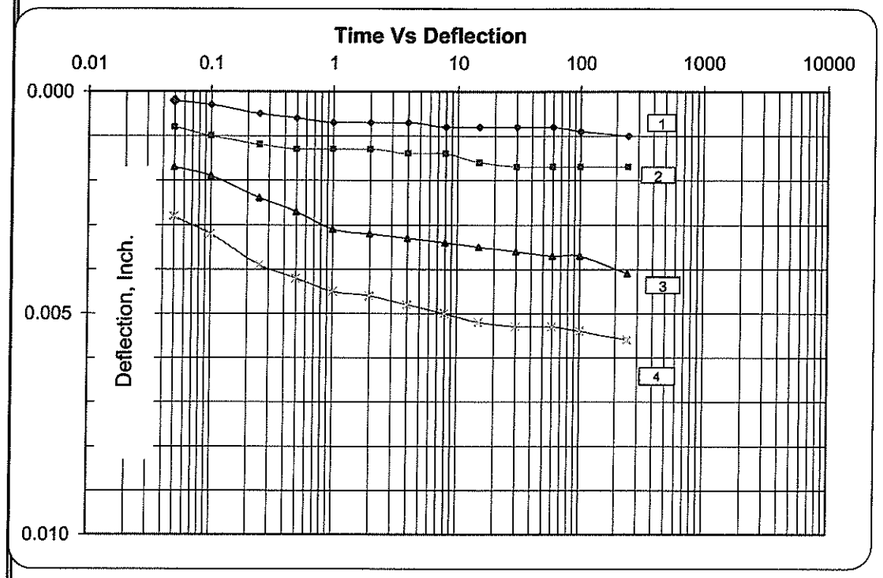
Computed Plane Strain Layer Information

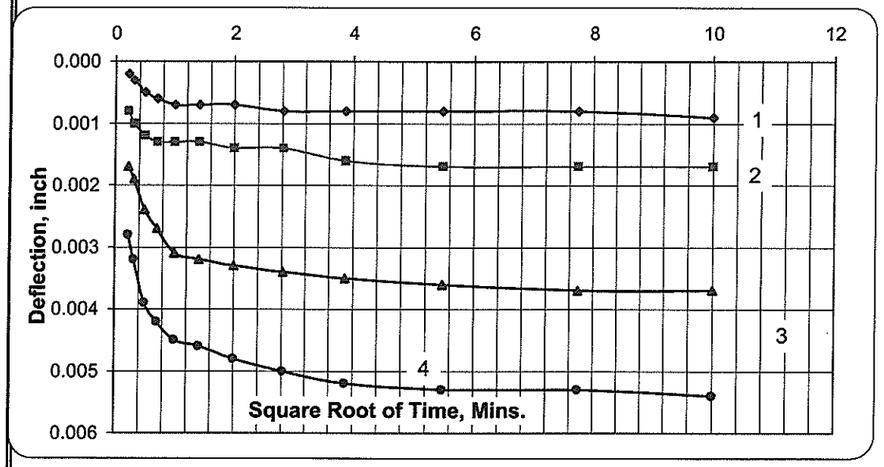
Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_T (pcf)	Δz (ft)	Elev. Of Center of Layer (ft)	I_z	ε	ΔH (inches)
1	80	70	300	120	10	75	0.22	0.14%	0.16
2	70	65	150	120	5	67.5	0.26	0.31%	0.19
3	65	62	150	120	3	63.5	0.28	0.34%	0.12
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

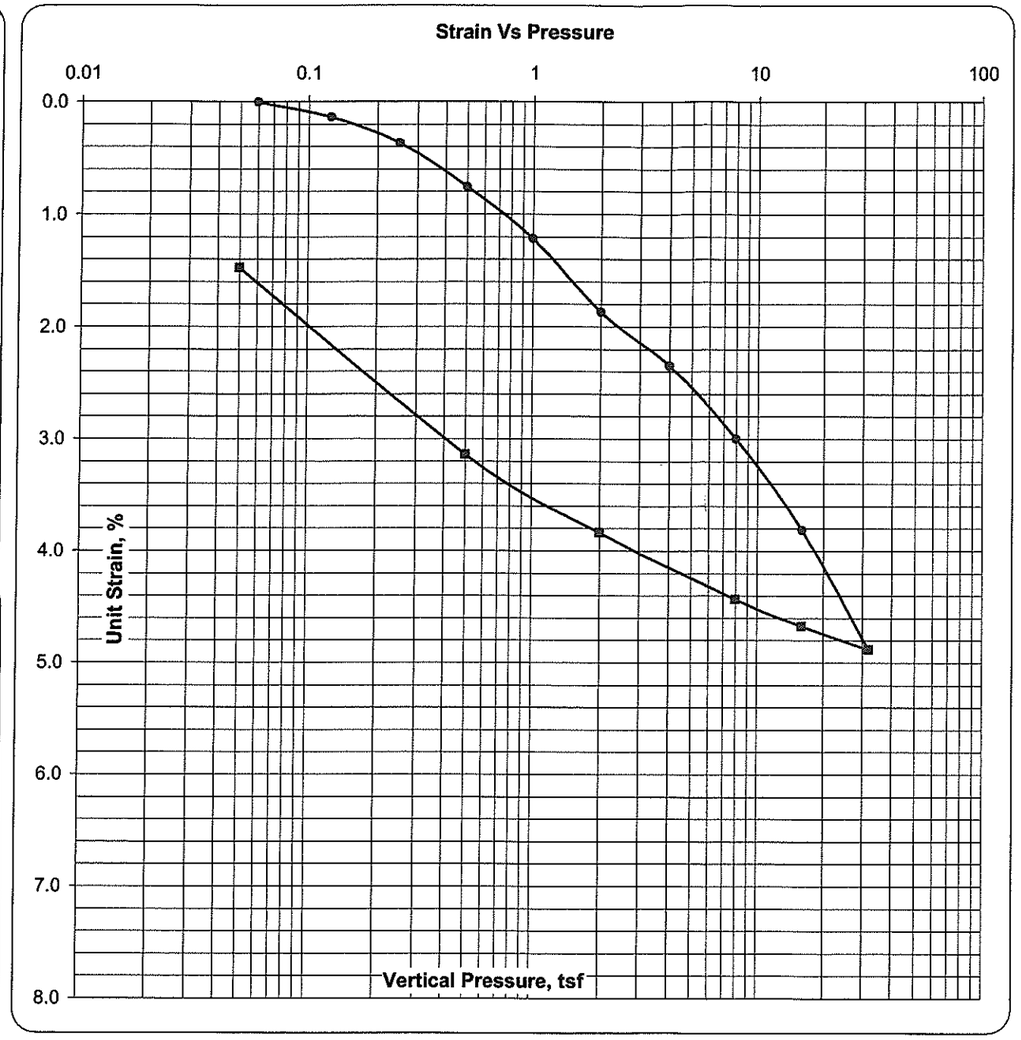
Immediate Settlement			0.5 inches
Settlement After	1	year	0.6 inches

Boring IE-13B, Tube T-2









One-Dimensional Consolidation Test (ASTMD-2435)

Curve No.	Pressure Increment From ,tsf	To,tsf	Coeff. Of Consolidation Cv, ft^2/day
1	0.5	1	2.47
2	1	2	5.27
3	2	4	5.12
4	4	8	6.87
5	8	16	6.68
6	16	32	3.45
7			
8			
10			

Description of Specimen:	Brown-gray Mottled silty clay		
Nat.Water Content (%)	15.5	(From Trims.)	
Liquid Limit (%)	28	(From Trims.)	
Plastic Limit (%)	17	(From Trims.)	
Plastic Index (%)	11	(From Trims.)	
Specific Gravity(assumed)	2.7	(From Trims.)	
Test Specimen Properties			
Diameter,inch.	2.490		
Initial And Final Thickness, inch.	0.860	0.857	
Initial And Final Water Content (%)	16.1	16.2	
Initial And Final Void Ratio	0.454	0.449	
Initial And Final Saturation (%)	95.8	97.8	* Unit Strain Basis
Unit Dry Weight (pcf)	115.9		

Consolidation Properties (Unit Strain Basis)	
Compression Ratio (Cc') *	
Recompression Ratio (Cr')*	
Swelling Ratio (Cs')*	
Preconsolidation Stress, Pc (tsf)*	
Existing Overburden Stress, Po (tsf)*	

Project No	19996251
Project Name	RKK I-95 Delaware TP Improve
Boring No.	IEB-13B
Sample No.	T-2
Depth, ft.	32.0-34.0
Tested By	rmm
Reviewed By	enm
Date	07-May-05
File No.	19996251C-1

URS Corporation M:\projects\2003\03059_deltrnpk\Geotech\ASSIGN. NO 3 - SR 1 INTERCHANGE\Lab Testing\URS Testing\[19996251c-1.xls]C-1

$e_o = 0.454$

$0.42 e_o = 0.191$

$\Delta e = 0.454 - 0.191$
$= 0.263$

$\varepsilon = \frac{\Delta e}{1+e_o} = \frac{0.263}{1+0.454}$
$= 0.18$ or
18%

$RR = \frac{\Delta \varepsilon}{\log\left(\frac{\sigma_f}{\sigma}\right)}$

$RR = \frac{0.049 - 0.015}{\log\left(\frac{32}{0.05}\right)}$

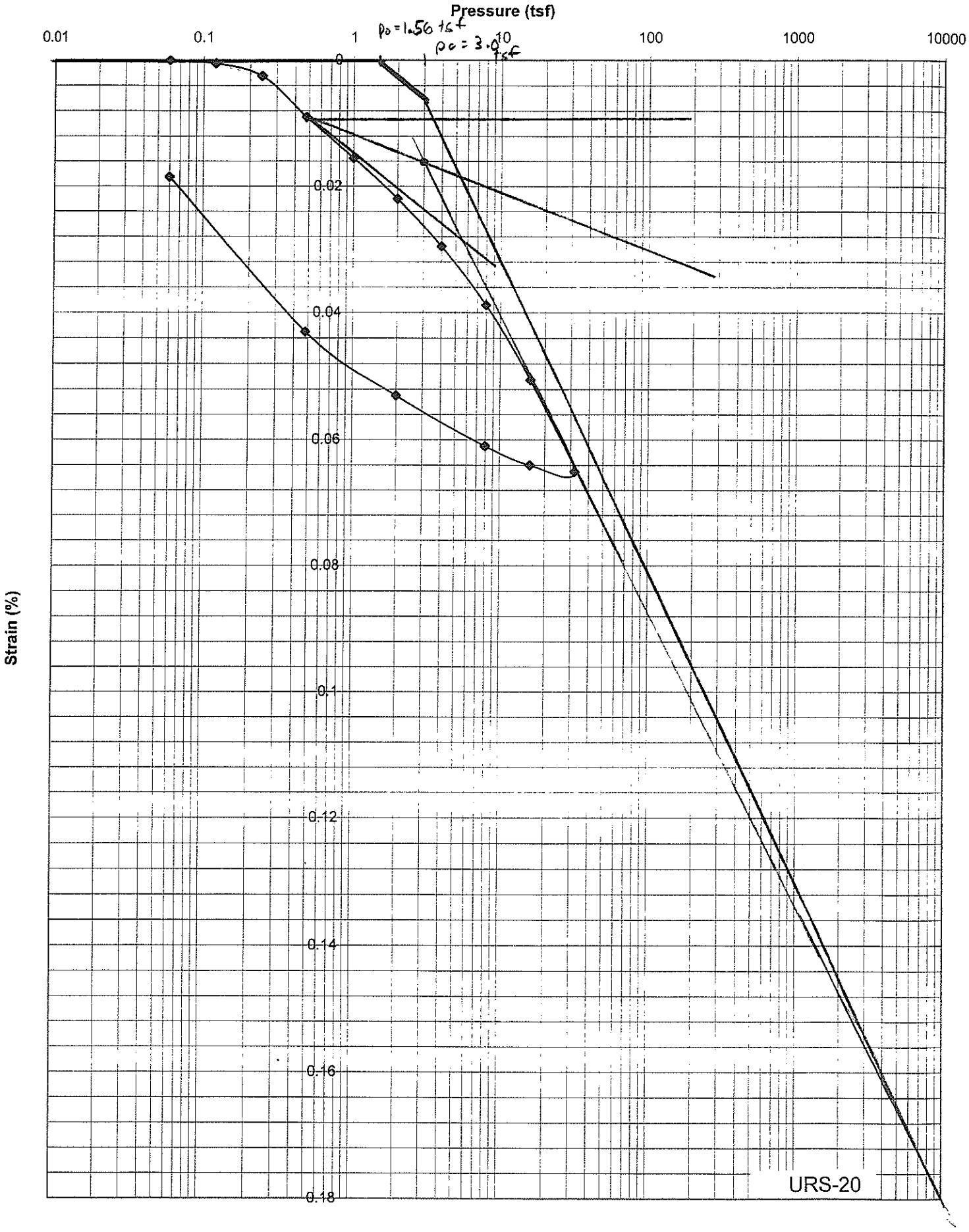
$RR = 0.012$

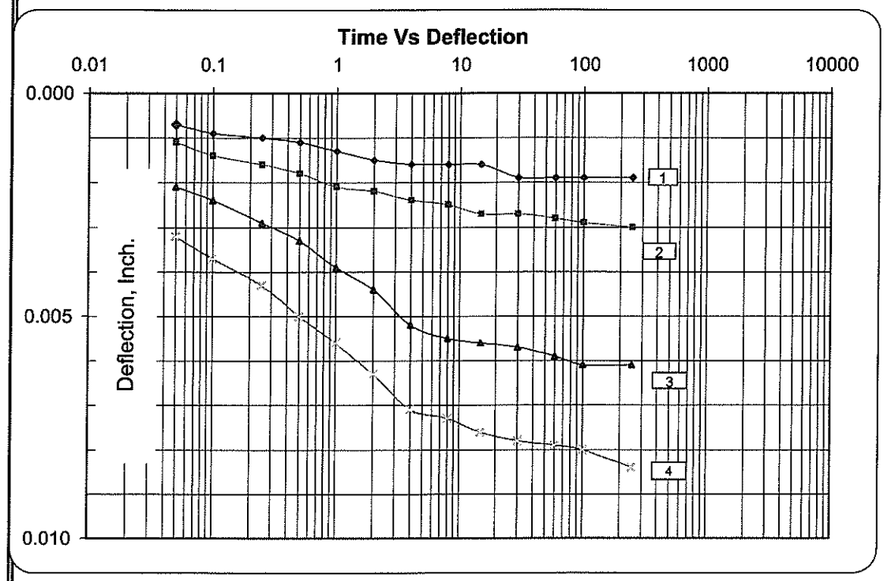
$C_r = RR(1+e_o)$
$= 0.012(1+0.454)$
$C_r = 0.017$

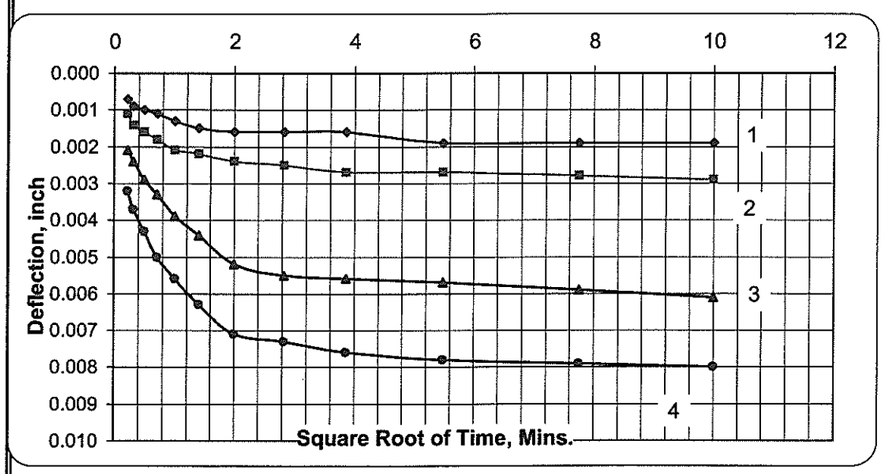
$CR = \frac{0.128 - 0.002}{\log \frac{10{,}000}{2.5}}$
$= 0.035$

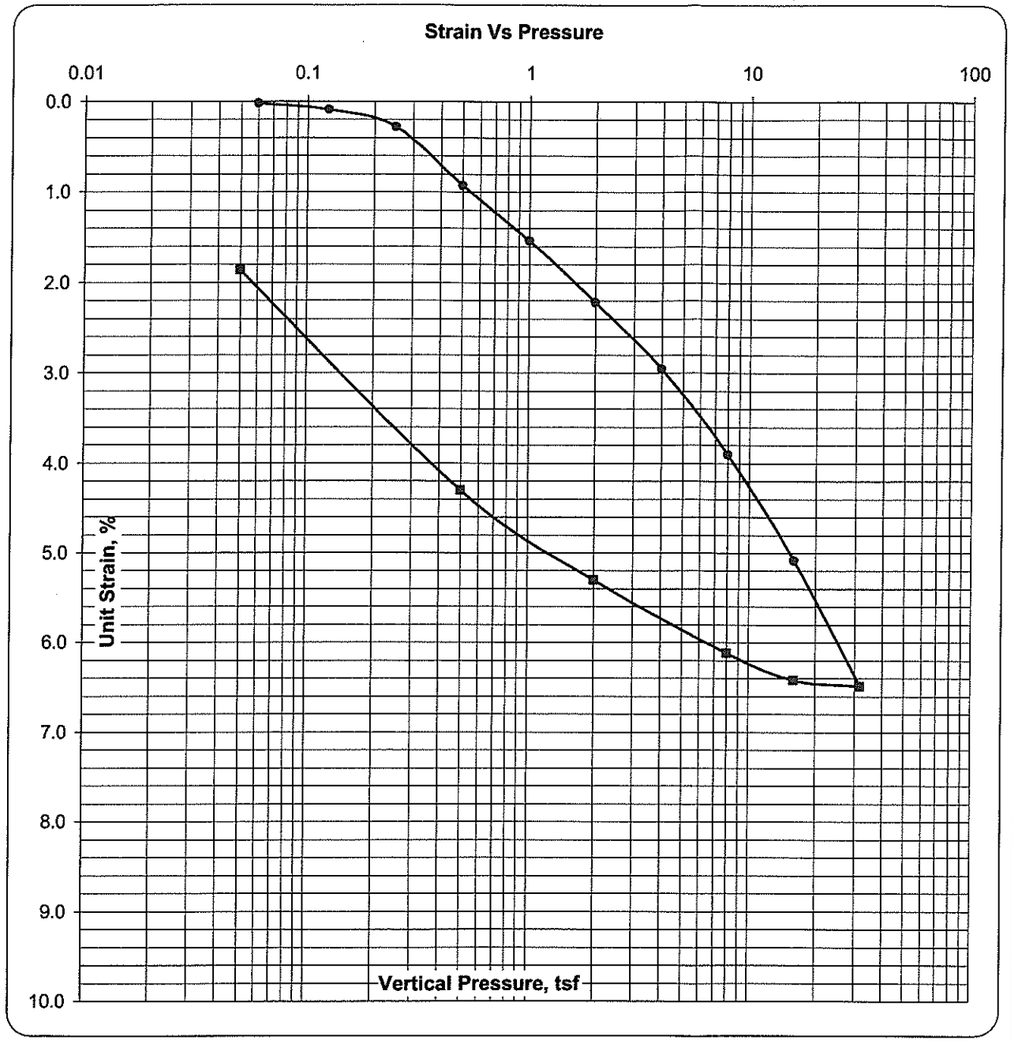
$C_c = CR(1+e_o)$
$= 0.051$

Boring IE-13B, Tube T-3









One-Dimensional Consolidation Test (ASTMD-2435)

Curve No.	Pressure Increment From ,tsf	To,tsf	Coeff. Of Consolidation Cv, ft^2/day
1	0.5	1	2.22
2	1	2	4.99
3	2	4	1.59
4	4	8	3.58
5	8	16	2.58
6	16	32	1.67
7			
8			
10			

Description of Specimen:	Light gray silty clay			
Nat.Water Content (%)	15.2	(From Trims.)	**Consolidation Properties (Unit Strain Basis)**	
Liquid Limit (%)	27	(From Trims.)	Compression Ratio (Cc') *	
Plastic Limit (%)	14	(From Trims.)	Recompression Ratio (Cr')*	
Plastic Index (%)	13	(From Trims.)	Swelling Ratio (Cs')*	
Specific Gravity(assumed)	2.71	(From Trims.)	Preconsolidation Stress, Pc (tsf)*	
Test Specimen Properties			Existing Overburden Stress, Po (tsf)*	
Diameter,inch.	2.490			
Initial And Final Thickness, inch.	0.860	0.852		
Initial And Final Water Content (%)	15.7	15.4		
Initial And Final Void Ratio	0.447	0.434		
Initial And Final Saturation (%)	95.4	96.0	* Unit Strain Basis	
Unit Dry Weight (pcf)	116.9			

Project No	19996251
Project Name	RKK
	I-95 Delaware TP Improve
Boring No.	IEB-13B
Sample No.	T-3
Depth, ft.	38.0-40.0
Tested By	rmm
Reviewed By	enm
Date	07-May-05
File No.	19996251C-2

URS Corporation M:\projects\2003\03059_deltrnpk\Geotech\ASSIGN. NO 3 - SR 1 INTERCHANGE\Lab Testing\URS Testing\[19996251c-2.xls]C-1

$e_o = 0.447$

$0.42 e_o = 0.188$

$\Delta e = 0.447 - 0.18$
$= 0.259$

$\varepsilon = \frac{\Delta e}{1+e_o} = \frac{0.259}{1+0.447}$
$= 17.9\%$

$RR = \frac{\Delta \varepsilon}{\log\left(\frac{\sigma_f}{\sigma}\right)}$

$RR = \frac{0.065 - 0.0}{\log\left(\frac{32}{0.5}\right)}$

$RR = 0.016$

$C_r = RR(1+e_o)$

$C_r = 0.023$

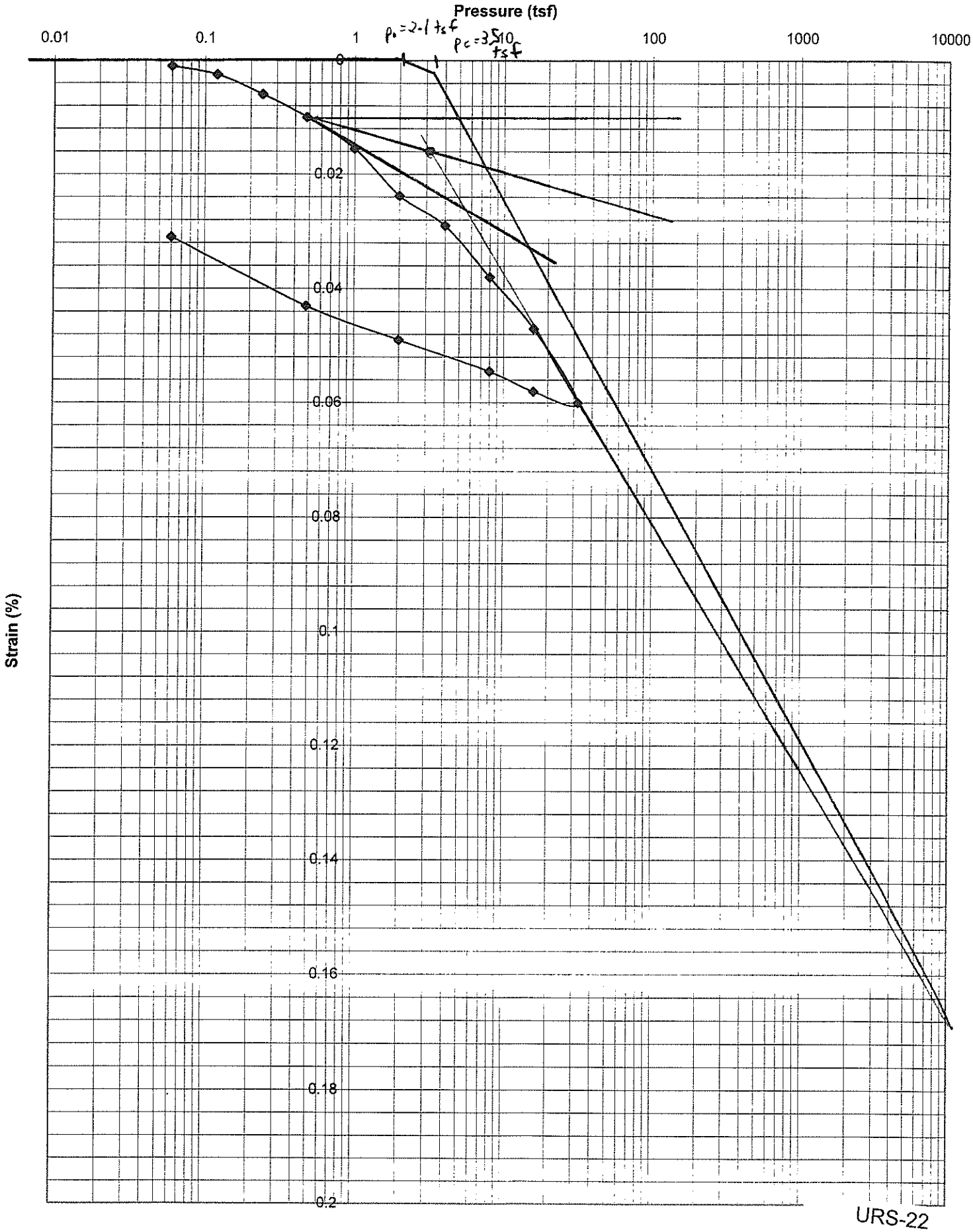
$CR = \frac{0.18 - 0.006}{\log \frac{10{,}000}{3.0}}$

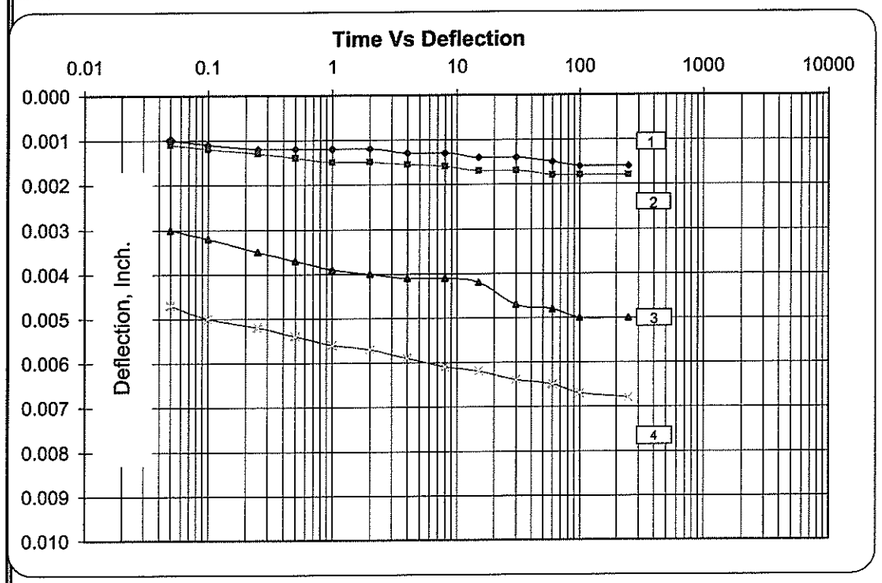
$= 0.049$

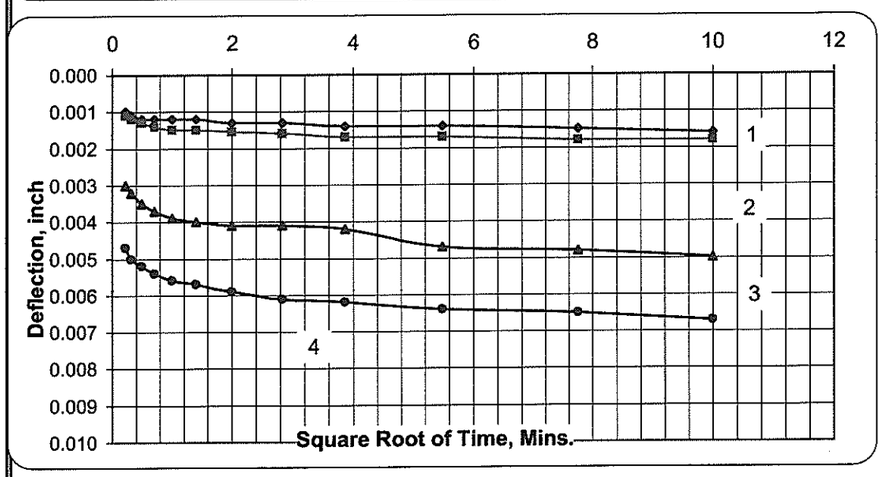
$C_c = CR(1+e_o)$

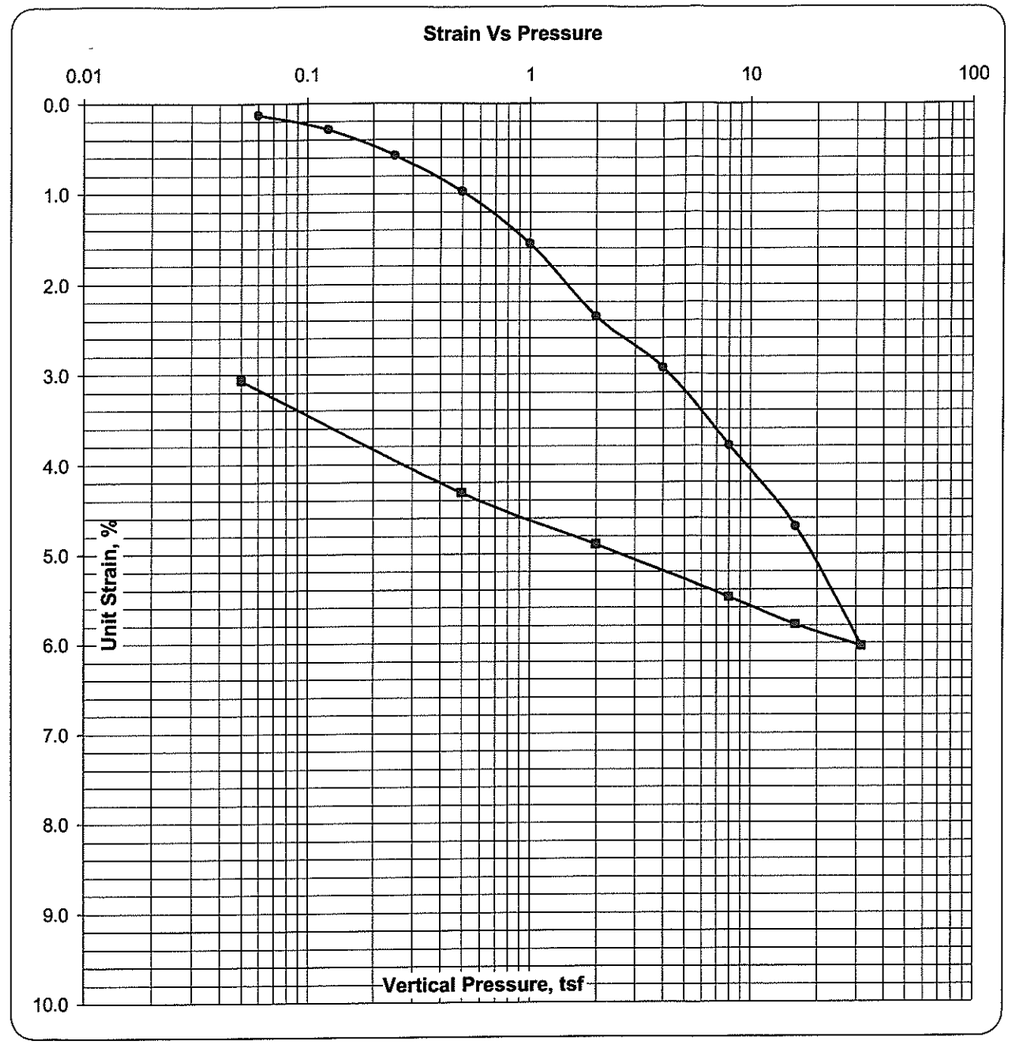
$= 0.071$

Boring IE-13B, Tube T-4









One-Dimensional Consolidation Test (ASTMD-2435)

Curve No.	Pressure Increment From ,tsf	To,tsf	Coeff. Of Consolidation Cv, Ft^2/day
1	0.5	1	1.46
2	1	2	1.20
3	2	4	1.38
4	4	8	0.34
5	8	16	1.76
6			
7			
8			
10			

Description of Specimen:	Light gray silty sand		
Nat.Water Content (%)	22.1	(From Trims.)	
Liquid Limit (%)	N.P	(From Trims.)	
Plastic Limit (%)		(From Trims.)	
Plastic Index (%)		(From Trims.)	
Specific Gravity(assumed)	2.51	(From Trims.)	
Test Specimen Properties			
Diameter,inch.	2.490		
Initial And Final Thickness, inch.	0.870	0.870	
Initial And Final Water Content (%)	21.4	20.3	
Initial And Final Void Ratio	0.505	0.505	
Initial And Final Saturation (%)	106.1	100.6	* Unit Strain Basis
Unit Dry Weight (pcf)	104.1		

Consolidation Properties (Unit Strain Basis)	
Compression Ratio (Cc') *	
Recompression Ratio (Cr')*	
Swelling Ratio (Cs')*	
Preconsolidation Stress, Pc (tsf)*	
Existing Overburden Stress, Po (tsf)*	

Project No	19996251
Project Name	RKK
	I-95 Delaware TP Improve
Boring No.	IEB-13B
Sample No.	T-4
Depth, ft.	58.0-60.0
Tested By	rmm
Reviewed By	enm
Date	07-May-05
File No.	19996251C-3

URS Corporation M:\projects\2003\03059_deltrnpk\Geotech\ASSIGN. NO 3 - SR 1 INTERCHANGE\Lab Testing\URS Testing\[19996251c-3.xls]C-1

$e_o = 0.505$

$0.42 e_o = 0.212$

$\Delta e = 0.505 - 0.212 = 0.293$

$\varepsilon = \frac{\Delta e}{1+e_o} = \frac{0.293}{1+0.505} = 19.5\%$

$RR = \frac{\Delta \varepsilon}{\log\left(\frac{\sigma_f}{\sigma}\right)}$

$RR = \frac{0.06 - 0.031}{\log \frac{32}{0.5}}$

$RR = 0.010$

$C_r = RR(1+e_o) = 0.015$

$CR = \frac{0.166 - 0.002}{\log \frac{10{,}1000}{3.5}} = 0.042$

$C_c = CR(1+e_o) = 0.064$

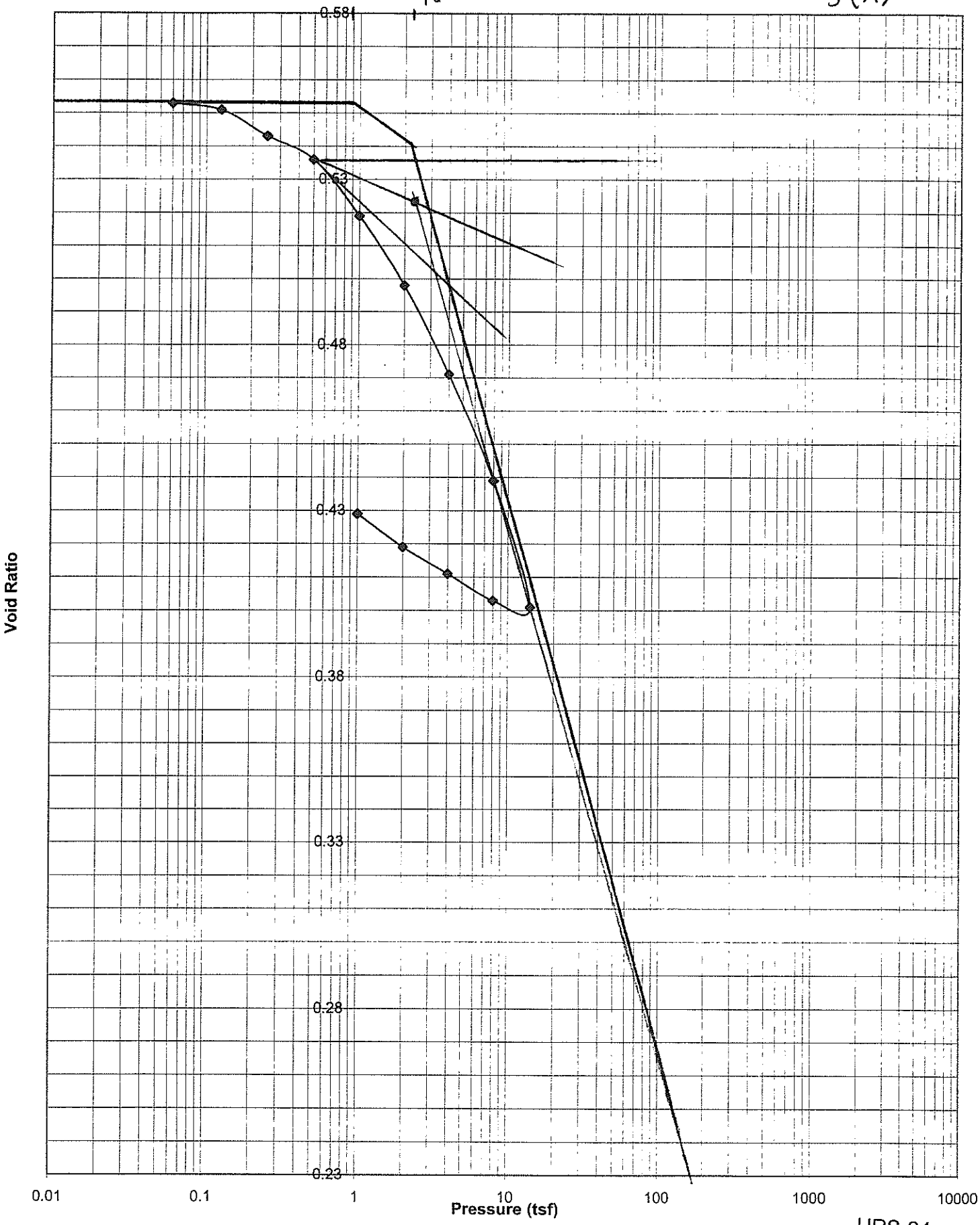
$C_c = \frac{\quad}{\log \frac{180}{2.2}} = 0.15$

$C_r = \frac{0.0429 - 0.403}{\log (8/1)} = 0.02$

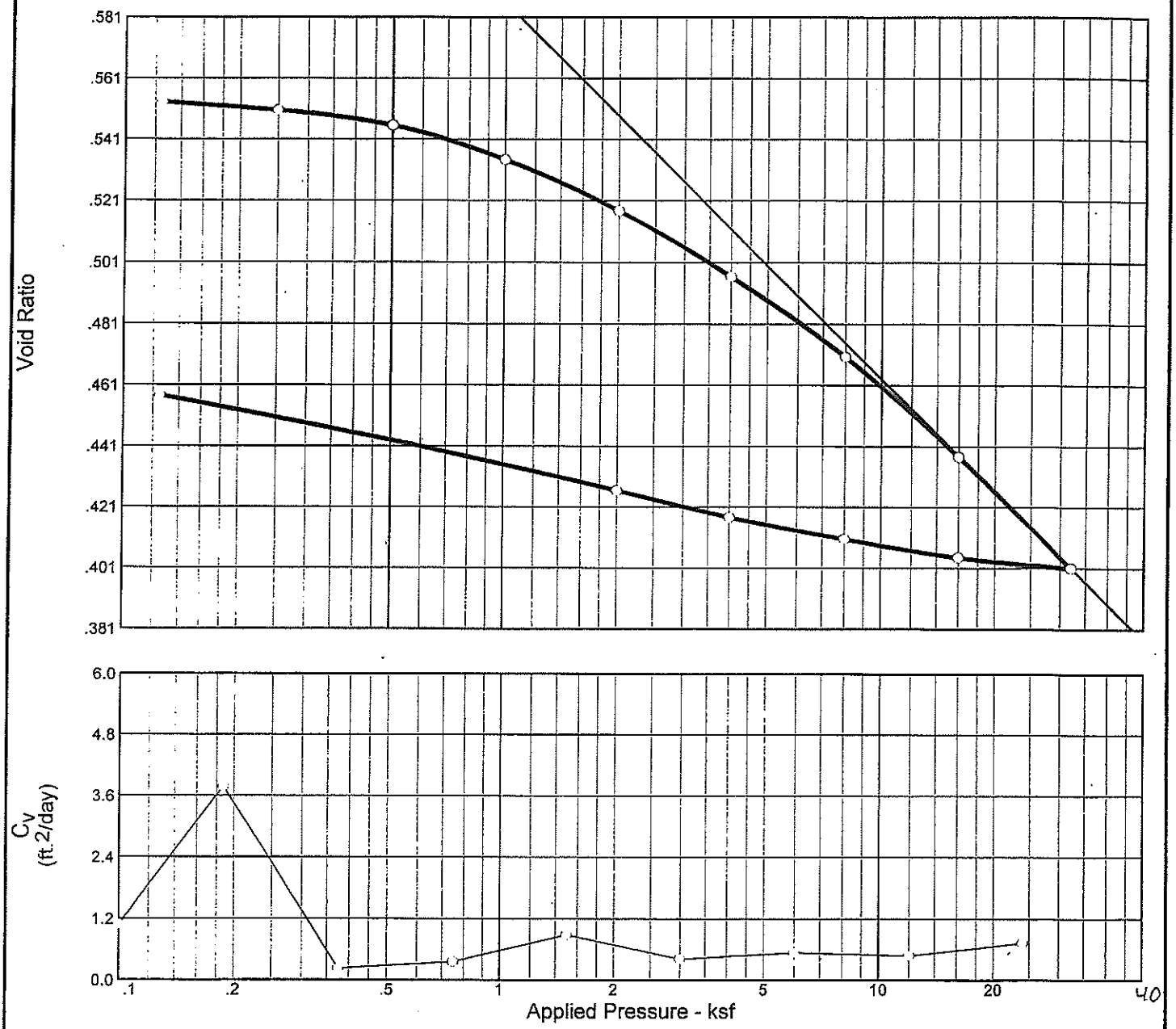
Boring IE-13A, Tube T-1

$p_o = 0.9$ tsf

$p_c = 2.2$ tsf



CONSOLIDATION TEST REPORT (ASTM D2435)



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
88.4 %	17.7 %	66.0	33	14	2.772		2.51	0.12	0.02	0.554

MATERIAL DESCRIPTION	USCS	AASHTO
Brown LEAN CLAY with SAND.	CL	

Project No. 14678 **Client:** RUMMELL,KLEPPER & KAHL. LLC

Project: DELAWARE TURNPIKE IMPROVEMENTS -Interchange
RK & K Job No. 103-059

Location: IEB-13A,T-1@ 15.0'-17.0'

Remarks:
Undisturbed Sample

CONSOLIDATION TEST REPORT (ASTM D2435)

The Robert B. Balter Company

Driveability

DelDOT SR1 / I-95 Interchange
Driveability of Pipe Pile

17-Dec-08

Proposed Pile	Location	Foundation	Max. Factored Pile Load, kip	Required Factored* Capacity, kip	Est. Pile Tip El. Based on Req. Capacity	Trial Hammer Energy	Wall thickness, inch	Pile Driveable to elev.	Blows / ft	Note
24 Inch Pipe Pile	Ramp A Over I-95	Abut A	375	577	10	90 ft-k	0.5	-7	118 ±	30 ksi steel OK
30 Inch Pipe Pile	Ramp A Over SR 7	Pier 1	680	1046	-9	165 ft-k	0.625	-15	119 ±	Requires 50 ksi steel
36 Inch Pipe Pile	Ramp A Over I-95	Pier 1	835	1285	10	165 ft-k	0.625	-20	126 ±	Requires 50 ksi steel

* 0.65 Resistance factor. Required capacity factor = 1.54

URS

Page ____ of ____

Job ____ Project No. ____ Sheet ____ of ____

Description ____ Computed by ____ Date ____

____ Checked by ____ Date ____

Reference

DRIVEABILITY

FOR 24" DIAM.

OPEN END PIPE PILE

Filename: Z:\DELDOT\SR1DEC~1\A95UTW1.DVN FOR 24" PIPE PILE DRIVEABILITY

BORING URS-3 **Soil Profile** RAMP A/I95 ABUT A

EL 81

0.0 ft	Sand: Unit Weight 115 -- Friction Angles 30/30 -- Driving Loss 0%
8.3 ft	Clay: Unit Weight 105 -- Undrained Shear Strength 750 -- Driving Loss 0%
16.6 ft	Sand: Unit Weight 120 -- Friction Angles 32/32 -- Driving Loss 0%
24.9 ft	Clay: Unit Weight 115 -- Undrained Shear Strength 2200 -- Driving Loss 0%
33.2 ft	
41.5 ft	
49.8 ft	
58.1 ft	Clay: Unit Weight 120 -- Undrained Shear Strength 2500 -- Driving Loss 0%
66.4 ft	Clay: Unit Weight 125 -- Undrained Shear Strength 4000 -- Driving Loss 0%
74.7 ft	Clay: Unit Weight 130 -- Undrained Shear Strength 6000 -- Driving Loss 0%
83.0 ft (88ft±)	
91.3 ft	Sand: Unit Weight 130 -- Friction Angles 38/38 -- Driving Loss 0%
99.6 ft	Clay: Unit Weight 125 -- Undrained Shear Strength 4000 -- Driving Loss 0%
107.9 ft	Sand: Unit Weight 135 -- Friction Angles 42/42 -- Driving Loss 0%
116.2 ft	Clay: Unit Weight 130 -- Undrained Shear Strength 4200 -- Driving Loss 0%
124.5 ft	

- DRIVEABLE WITH 90 ft-K (eg. DELMAG D44) HAMMER
- OK WITH 36 Ks STEEL
- DRIVEABLE TO EL-7±

FOR 24"φ PIPE PILE DRIVEABILITY

½" WALL (0.5")

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A95UTW1.DVN
Project Name: Ramp A/I95 Abut A
Project Date: 12/11/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 URS-3 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 24.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	6.00 ft
	- Driving/Restrike	6.00 ft
	- Ultimate:	6.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	12.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
2	Cohesive	7.00 ft	0.00%	105.00 pcf	750.00 psf	T-79 Steel
3	Cohesionless	12.00 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund
4	Cohesive	26.00 ft	0.00%	115.00 pcf	2200.00 psf	T-79 Steel
5	Cohesive	8.00 ft	0.00%	120.00 pcf	2500.00 psf	T-79 Steel
6	Cohesive	12.00 ft	0.00%	125.00 pcf	4000.00 psf	T-79 Steel
7	Cohesive	13.00 ft	0.00%	130.00 pcf	6000.00 psf	T-79 Steel
8	Cohesionless	7.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund
9	Cohesive	7.00 ft	0.00%	125.00 pcf	4000.00 psf	T-79 Steel
10	Cohesionless	12.00 ft	0.00%	135.00 pcf	42.0/42.0	Nordlund
11	Cohesive	8.50 ft	0.00%	130.00 pcf	4200.00 psf	T-79 Steel

A95UTW1-1

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.57 psf	23.94	N/A	0.00 Kips
5.99 ft	Cohesionless	344.42 psf	23.94	N/A	6.42 Kips
6.01 ft	Cohesionless	690.26 psf	23.94	N/A	6.46 Kips
11.99 ft	Cohesionless	847.54 psf	23.94	N/A	22.22 Kips
12.01 ft	Cohesive	N/A	N/A	622.50 psf	22.29 Kips
18.99 ft	Cohesive	N/A	N/A	622.50 psf	49.59 Kips
19.01 ft	Cohesionless	1304.09 psf	25.54	N/A	49.69 Kips
28.01 ft	Cohesionless	1563.29 psf	25.54	N/A	106.28 Kips
30.99 ft	Cohesionless	1649.11 psf	25.54	N/A	129.15 Kips
31.01 ft	Cohesive	N/A	N/A	1204.41 psf	129.30 Kips
40.01 ft	Cohesive	N/A	N/A	1273.41 psf	201.32 Kips
49.01 ft	Cohesive	N/A	N/A	1342.41 psf	281.14 Kips
56.99 ft	Cohesive	N/A	N/A	1403.59 psf	358.44 Kips
57.01 ft	Cohesive	N/A	N/A	1323.84 psf	358.62 Kips
64.99 ft	Cohesive	N/A	N/A	1393.66 psf	428.50 Kips
65.01 ft	Cohesive	N/A	N/A	1137.58 psf	428.66 Kips
74.01 ft	Cohesive	N/A	N/A	1211.08 psf	497.15 Kips
76.99 ft	Cohesive	N/A	N/A	1235.42 psf	521.66 Kips
77.01 ft	Cohesive	N/A	N/A	1235.58 psf	521.83 Kips
86.01 ft	Cohesive	N/A	N/A	1260.00 psf	593.08 Kips
89.99 ft	Cohesive	N/A	N/A	1260.00 psf	624.59 Kips
90.01 ft	Cohesionless	5453.74 psf	30.32	N/A	625.13 Kips
96.99 ft	Cohesionless	5689.66 psf	30.32	N/A	965.43 Kips
97.01 ft	Cohesive	N/A	N/A	1260.00 psf	966.02 Kips
103.99 ft	Cohesive	N/A	N/A	1260.00 psf	1021.28 Kips
104.01 ft	Cohesionless	6365.16 psf	33.52	N/A	1022.06 Kips
113.01 ft	Cohesionless	6691.86 psf	33.52	N/A	1683.34 Kips
115.99 ft	Cohesionless	6800.04 psf	33.52	N/A	1916.53 Kips
116.01 ft	Cohesive	N/A	N/A	1260.00 psf	1917.40 Kips
124.49 ft	Cohesive	N/A	N/A	1260.00 psf	1984.53 Kips

A95UTW1-5

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.15 psf	30.00	41.85 Kips	0.06 Kips
5.99 ft	Cohesionless	688.85 psf	30.00	41.85 Kips	37.66 Kips
6.01 ft	Cohesionless	690.53 psf	30.00	41.85 Kips	37.75 Kips
11.99 ft	Cohesionless	1005.07 psf	30.00	41.85 Kips	41.85 Kips
12.01 ft	Cohesive	N/A	N/A	N/A	21.21 Kips
18.99 ft	Cohesive	N/A	N/A	N/A	21.21 Kips
19.01 ft	Cohesionless	1304.38 psf	40.40	103.67 Kips	103.57 Kips
28.01 ft	Cohesionless	1822.78 psf	40.40	103.67 Kips	103.67 Kips
30.99 ft	Cohesionless	1994.42 psf	40.40	103.67 Kips	103.67 Kips
31.01 ft	Cohesive	N/A	N/A	N/A	62.20 Kips
40.01 ft	Cohesive	N/A	N/A	N/A	62.20 Kips
49.01 ft	Cohesive	N/A	N/A	N/A	62.20 Kips
56.99 ft	Cohesive	N/A	N/A	N/A	62.20 Kips
57.01 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
64.99 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
65.01 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
74.01 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
76.99 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
77.01 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
86.01 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
89.99 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
90.01 ft	Cohesionless	5454.08 psf	110.40	843.83 Kips	843.83 Kips
96.99 ft	Cohesionless	5925.92 psf	110.40	843.83 Kips	843.83 Kips
97.01 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
103.99 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
104.01 ft	Cohesionless	6365.53 psf	244.00	1861.58 Kips	1861.58 Kips
113.01 ft	Cohesionless	7018.93 psf	244.00	1861.58 Kips	1861.58 Kips
115.99 ft	Cohesionless	7235.27 psf	244.00	1861.58 Kips	1861.58 Kips
116.01 ft	Cohesive	N/A	N/A	N/A	118.75 Kips
124.49 ft	Cohesive	N/A	N/A	N/A	118.75 Kips

A95UTW1-6

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.06 Kips	0.06 Kips
5.99 ft	6.42 Kips	37.66 Kips	44.07 Kips
6.01 ft	6.46 Kips	37.75 Kips	44.20 Kips
11.99 ft	22.22 Kips	41.85 Kips	64.07 Kips
12.01 ft	22.29 Kips	21.21 Kips	43.50 Kips
18.99 ft	49.59 Kips	21.21 Kips	70.80 Kips
19.01 ft	49.69 Kips	103.57 Kips	153.26 Kips
28.01 ft	106.28 Kips	103.67 Kips	209.95 Kips
30.99 ft	129.15 Kips	103.67 Kips	232.82 Kips
31.01 ft	129.30 Kips	62.20 Kips	191.51 Kips
40.01 ft	201.32 Kips	62.20 Kips	263.52 Kips
49.01 ft	281.14 Kips	62.20 Kips	343.34 Kips
56.99 ft	358.44 Kips	62.20 Kips	420.64 Kips
57.01 ft	358.62 Kips	70.69 Kips	429.30 Kips
64.99 ft	428.50 Kips	70.69 Kips	499.19 Kips
65.01 ft	428.66 Kips	113.10 Kips	541.76 Kips
74.01 ft	497.15 Kips	113.10 Kips	610.25 Kips
76.99 ft	521.66 Kips	113.10 Kips	634.76 Kips
77.01 ft	521.83 Kips	169.65 Kips	691.47 Kips
86.01 ft	593.08 Kips	169.65 Kips	762.72 Kips
89.99 ft	624.59 Kips	169.65 Kips	794.23 Kips
90.01 ft	625.13 Kips	843.83 Kips	1468.96 Kips
96.99 ft	965.43 Kips	843.83 Kips	1809.27 Kips
97.01 ft	966.02 Kips	113.10 Kips	1079.12 Kips
103.99 ft	1021.28 Kips	113.10 Kips	1134.38 Kips
104.01 ft	1022.06 Kips	1861.58 Kips	2883.64 Kips
113.01 ft	1683.34 Kips	1861.58 Kips	3544.92 Kips
115.99 ft	1916.53 Kips	1861.58 Kips	3778.11 Kips
116.01 ft	1917.40 Kips	118.75 Kips	2036.15 Kips
124.49 ft	1984.53 Kips	118.75 Kips	2103.29 Kips

A95UTW1-7

A/I95 Abut A A-95UTAW
URS Corporation

WEAP INPUT FOR A-95UTA1

Based on closed end.

12/11/2008
GRLWEAP(TM) Version 2005

Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
10.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
15.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
25.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
32.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
40.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
50.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
55.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
60.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
70.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
75.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
80.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
85.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
89.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
91.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00
92.00	92.00	0.00	9.05	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	0.00	0.06	0.100	0.200	0.050	0.150	1.000	0.000	0.000
5.99	0.34	37.66	0.100	0.200	0.050	0.150	1.000	0.000	0.000
6.01	0.34	37.75	0.100	0.200	0.050	0.150	1.000	0.000	0.000
11.99	0.50	41.85	0.100	0.200	0.050	0.150	1.000	0.000	0.000
12.01	0.62	21.21	0.100	0.200	0.200	0.150	1.000	0.000	0.000
18.99	0.62	21.21	0.100	0.200	0.200	0.150	1.000	0.000	0.000
19.01	0.83	103.57	0.100	0.200	0.050	0.150	1.000	0.000	0.000
28.01	1.17	103.67	0.100	0.200	0.050	0.150	1.000	0.000	0.000
30.99	1.28	103.67	0.100	0.200	0.050	0.150	1.000	0.000	0.000
31.01	1.20	62.20	0.100	0.200	0.200	0.150	1.000	0.000	0.000
40.01	1.27	62.20	0.100	0.200	0.200	0.150	1.000	0.000	0.000
49.01	1.34	62.20	0.100	0.200	0.200	0.150	1.000	0.000	0.000
56.99	1.40	62.20	0.100	0.200	0.200	0.150	1.000	0.000	0.000
57.01	1.32	70.69	0.100	0.200	0.200	0.150	1.000	0.000	0.000
64.99	1.39	70.69	0.100	0.200	0.200	0.150	1.000	0.000	0.000
65.01	1.14	113.10	0.100	0.200	0.200	0.150	1.000	0.000	0.000
74.01	1.21	113.10	0.100	0.200	0.200	0.150	1.000	0.000	0.000
76.99	1.24	113.10	0.100	0.200	0.200	0.150	1.000	0.000	0.000
77.01	1.24	169.65	0.100	0.200	0.200	0.150	1.000	0.000	0.000
86.01	1.26	169.65	0.100	0.200	0.200	0.150	1.000	0.000	0.000
89.99	1.26	169.65	0.100	0.200	0.200	0.150	1.000	0.000	0.000
90.01	7.44	843.83	0.100	0.200	0.050	0.150	1.000	0.000	0.000
96.99	8.08	843.83	0.100	0.200	0.050	0.150	1.000	0.000	0.000

URS-34

KERVISE FACTORED LOAD = 577 KIPS
HAMMER EFFICIENCY = 90 ft-k

URS Corporation
A/I95 Abut A 24" A-95UTA3 DelMAG D44

Dec 11 2008
GRLWEAP(TM) Version 2005

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
10.0	23.9	20.6	3.3	1.6	8.369	-1.830	3.12	40.5
15.0	44.5	42.8	1.7	2.0	12.248	-2.711	3.55	45.1
25.0	115.3	106.8	8.5	4.3	17.498	-2.524	4.28	42.9
32.0	176.3	171.3	5.1	7.0	19.653	-1.842	4.66	40.1
40.0	254.2	249.1	5.1	12.9	21.899	-2.172	5.21	37.5
50.0	357.2	352.1	5.1	20.6	23.837	-1.203	5.76	35.9
55.0	410.9	405.8	5.1	25.0	24.615	-1.034	5.99	36.3
60.0	464.9	459.1	5.8	30.6	25.321	-1.097	6.21	36.5
70.0	567.7	558.4	9.2	45.6	26.594	-2.070	6.62	37.5
75.0	614.7	605.5	9.2	55.9	26.965	-1.914	6.76	37.5
80.0	667.9	654.0	13.8	70.9	27.455	-1.400	6.91	37.6
85.0	717.1	703.3	13.8	92.1	27.704	-1.631	7.04	37.4
89.0	756.8	743.0	13.8	117.8	27.974	-2.051	7.11	37.2
91.0	880.5	811.7	68.8	377.8	28.268	-0.462	7.23	37.3
92.0	940.0	871.1	68.8	1258.6	28.382	-0.439	7.27	37.4

Total Continuous Driving Time 81.00 minutes; Total Number of Blows 3680

FOR ABUTS. 24" PILE DRIVEABILITY

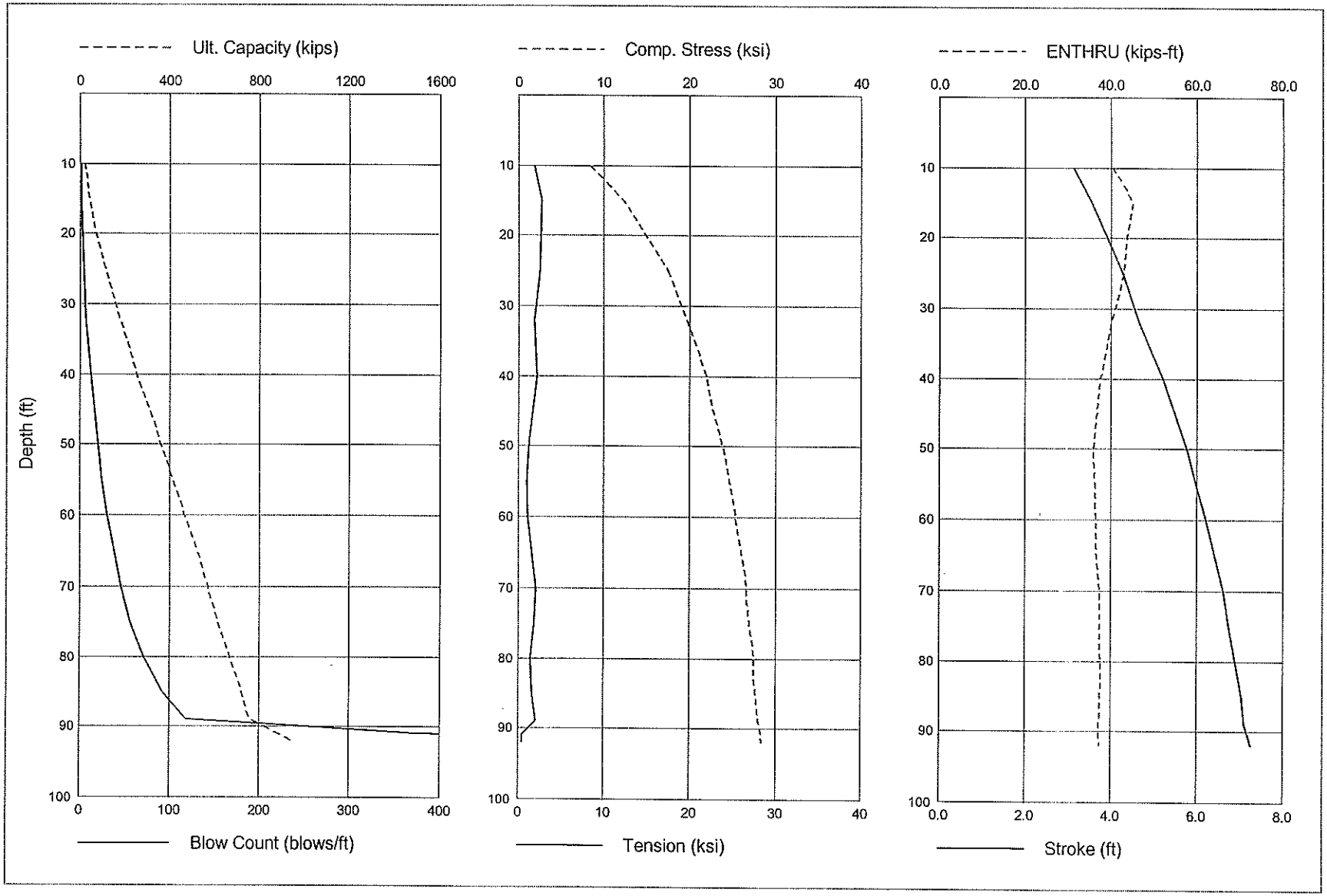
URS Corporation

Dec 11 2008

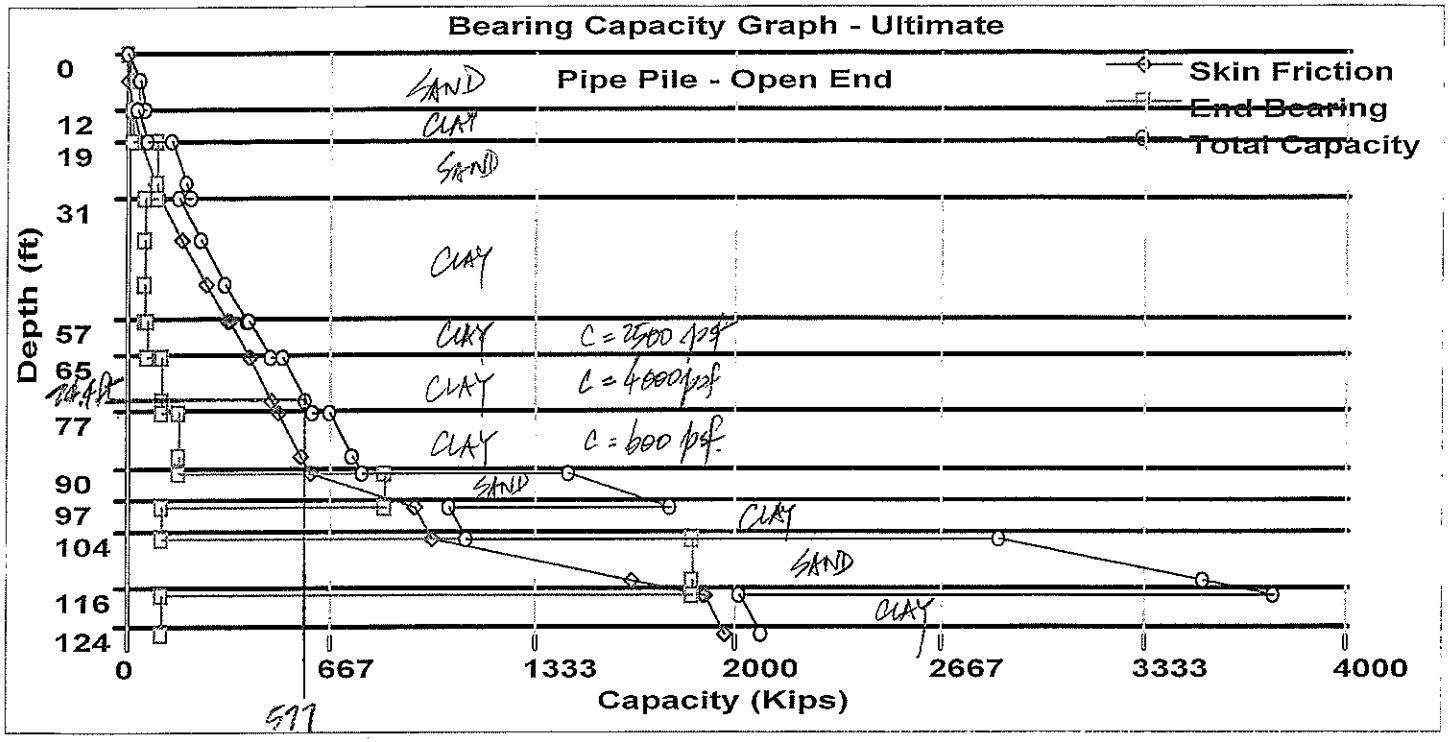
A/I95 Abut A 24" A-95UTA3 DelMAG D44

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

GRLWEAP(TM) Version 2005



Filename: Z:\DELDOT\SR1DEC~1\A-95UTA.DVN



GRLWEAP - Version 2005
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.
Copyright (c) 1998-2005, Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

Input File: Z:\DELDOT\SR1 DEC-08\A-95UTA3.GWI
Hammer File: D:\Program Files\PDI\GRLWEAP 2005\HAMMER2003.GW
Hammer File Version: 2003 (10/24/2008)

Input File Contents

A/I95 Abut A 24" A-95UTA3 DelMAG D44

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEx
-100	0	21	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.000

Pile g	Hammer g	Toe Area	Pile Size	Pile Type
32.170	32.170	36.910	24.000	Unknown

W Cp	A Cp	E Cp	T Cp	CoR	ROut	StCp
3.800	370.000	408.0	4.000	0.800	0.010	0.0

A Cu	E Cu	T Cu	CoR	ROut	StCu
0.000	0.0	0.000	0.000	0.000	0.0

LPle	APle	EPle	WPle	Peri	Strg	CoR	ROut
92.000	36.910	29000.000	492.000	6.280	0.000	0.850	0.010

Manufac	Hmr Name	HmrType	No Seg-s
DELMAG	D 44	1	4

Ram Wt	Ram L	Ram Dia	MaxStrk	RtdStrk	Efficy
9.50	104.01	21.63	9.52	9.49	0.80

IB. Wt	IB. L	IB.Dia	IB CoR	IB RO
2.42	26.83	21.64	0.900	0.010

CompStrk	A Chamber	V Chamber	C Delay	C Duratn	Exp Coeff	VolCStart	Vol CEnd
12.88	367.56	429.60	0.001	0.002	1.250	0.00	0.00

P atm	P1	P2	P3	P4	P5
14.70	1200.00	1080.00	972.00	875.00	972.00

Stroke	Effic.	Pressure	R-Weight	T-Delay	Exp-Coeff	Eps-Str	Total-AW
9.4900	0.8000	1200.0000	0.0000	0.0000	0.0000	0.0100	0.0000

Qs	Qt	Js	Jt	Qx	Jx	Rati	Dept
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Research Soil Model: Atoe, Plug, Gap, Q-fac

0.000	0.000	0.000	0.000

Research Soil Model: RD-skn: m, d, toe: m, d

0.000	0.000	0.000	0.000

Res. Distribution

Dpth	Rskn	Rtoe	Qs	Qt	Js	Jt	SU F	LimD	SU T
0.01	0.00	0.01	0.10	0.20	0.05	0.15	1.00	0.00	0.00
5.99	0.43	3.07	0.10	0.20	0.05	0.15	1.00	0.00	0.00
6.01	0.43	3.08	0.10	0.20	0.05	0.15	1.00	0.00	0.00
11.99	0.63	3.41	0.10	0.20	0.05	0.15	1.00	0.00	0.00
12.01	0.78	1.73	0.10	0.20	0.20	0.15	1.00	0.00	0.00
18.99	0.78	1.73	0.10	0.20	0.20	0.15	1.00	0.00	0.00
19.01	1.04	8.45	0.10	0.20	0.05	0.15	1.00	0.00	0.00
28.01	1.46	8.46	0.10	0.20	0.05	0.15	1.00	0.00	0.00
30.99	1.60	8.46	0.10	0.20	0.05	0.15	1.00	0.00	0.00
31.01	1.50	5.08	0.10	0.20	0.20	0.15	1.00	0.00	0.00
40.01	1.59	5.08	0.10	0.20	0.20	0.15	1.00	0.00	0.00
49.01	1.68	5.08	0.10	0.20	0.20	0.15	1.00	0.00	0.00
56.99	1.75	5.08	0.10	0.20	0.20	0.15	1.00	0.00	0.00
57.01	1.65	5.77	0.10	0.20	0.20	0.15	1.00	0.00	0.00
64.99	1.74	5.77	0.10	0.20	0.20	0.15	1.00	0.00	0.00
65.01	1.43	9.23	0.10	0.20	0.20	0.15	1.00	0.00	0.00
74.01	1.51	9.23	0.10	0.20	0.20	0.15	1.00	0.00	0.00
76.99	1.55	9.23	0.10	0.20	0.20	0.15	1.00	0.00	0.00
77.01	1.55	13.84	0.10	0.20	0.20	0.15	1.00	0.00	0.00
86.01	1.58	13.84	0.10	0.20	0.20	0.15	1.00	0.00	0.00
89.99	1.58	13.84	0.10	0.20	0.20	0.15	1.00	0.00	0.00
90.01	9.30	68.85	0.10	0.20	0.05	0.15	1.00	0.00	0.00
96.99	10.10	68.85	0.10	0.20	0.05	0.15	1.00	0.00	0.00

Gain/Loss factors: shaft and toe

1.00000	0.00000	0.00000	0.00000	0.00000
1.00000	0.00000	0.00000	0.00000	0.00000

Dpth	L	Wait	Strk	Pmx%	Eff.	Stff	CoR
10.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
15.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
25.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
32.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
40.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
50.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
55.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
60.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
70.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
75.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
80.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
85.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
89.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
91.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
92.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2005
English Units

A/I95 Abut A 24" A-95UTA3 DelMAG D44

Hammer Model: D 44 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	2.375				
2	2.375	409813.0	1.000	0.0100	
3	2.375	409813.0	1.000	0.0100	
4	2.375	409813.0	1.000	0.0100	
Imp Block	2.420	201791.8	0.900	0.0100	
Helmet	3.800	37740.0	0.800	0.0100	16.9
Combined Pile Top		27147.6			

HAMMER OPTIONS:

Hammer File ID No.	21	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	9.50	Ram Length	(inch)	104.01
Maximum Stroke	(ft)	9.52			
Rated Stroke	(ft)	9.49	Efficiency		0.800
Maximum Pressure	(psi)	1200.00	Actual Pressure	(psi)	1200.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	21.63			
Combustion Delay	(s)	0.00100	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	370.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	408.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	4.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		1.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	37740.0	Stiffness	(kips/in)	0.0

URS-41

Depth (ft) 10.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 23.9

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	0.0	0.050	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	2.6	0.050	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	7.4	0.050	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	10.5	0.050	0.100	92.00	6.3	36.9
Toe						3.3	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:
Uniform pile Pile Segments: Automatic
No. of Slacks/Splices 0 Pile Damping (%) 1
Pile Damping Fact.(k/ft/s) 1.296

Driveability Analysis
Soil Damping Option Smith
Max No Analysis Iterations 0 Time Increment/Critical 160
Output Time Interval 1 Analysis Time-Input (ms) 0
Output Level: Normal
Gravity Mass, Pile, Hammer: 32.170 32.170 32.170
Output Segment Generation: Automatic

Depth ft	Stroke ft	Pressure Ratio	Efficy
10.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
23.9	1.6	3.12	3.13	-1.83	13	34	8.37	1	6	40.5	66.9

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 15.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 44.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	0.8	0.050	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	5.2	0.050	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	9.3	0.050	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	11.7	0.050	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	15.8	0.189	0.100	92.00	6.3	36.9
Toe						1.7	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
	ft	ft	Ratio
15.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
44.5	2.0	3.55	3.57	-2.71	5	16	12.25	1	2	45.1	62.7

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 25.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 115.3

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	0.9	0.050	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	5.4	0.050	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	9.4	0.050	0.100	75.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	11.8	0.050	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	16.0	0.195	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	21.6	0.069	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	25.6	0.050	0.100	92.00	6.3	36.9
Toe						8.5	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
25.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
115.3	4.3	4.28	4.25	-2.52	3	13	17.50	17	5	42.9	57.3

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 32.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 176.3

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	6.3	36.9
19	0.414	27148.	0.000	0.000	1.00	1.3	0.050	0.100	62.43	6.3	36.9
20	0.414	27148.	0.000	0.000	1.00	6.0	0.050	0.100	65.71	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	9.8	0.050	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	12.3	0.067	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	75.57	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	22.7	0.055	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	26.1	0.050	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	29.2	0.050	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	31.7	0.095	0.100	92.00	6.3	36.9
Toe						5.1	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

URS-45

Depth ft	Stroke ft	Pressure Ratio	Efficy
32.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
176.3	7.0	4.66	4.64	-1.84	4	15	19.65	20	6	40.1	54.7

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 40.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 254.2

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	6.3	36.9
16	0.414	27148.	0.000	0.000	1.00	0.1	0.050	0.100	52.57	6.3	36.9
17	0.414	27148.	0.000	0.000	1.00	3.3	0.050	0.100	55.86	6.3	36.9
18	0.414	27148.	0.000	0.000	1.00	8.0	0.050	0.100	59.14	6.3	36.9
19	0.414	27148.	0.000	0.000	1.00	10.8	0.050	0.100	62.43	6.3	36.9
20	0.414	27148.	0.000	0.000	1.00	14.4	0.138	0.100	65.71	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	18.4	0.130	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	24.3	0.050	0.100	75.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	27.4	0.050	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	30.6	0.050	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	31.6	0.160	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	31.8	0.200	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	32.5	0.200	0.100	92.00	6.3	36.9
Toe						5.1	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
40.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
254.2	12.9	5.21	5.24	-2.17	17	42	21.90	18	6	37.5	51.5

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 50.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 357.2

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	6.3	36.9
13	0.414	27148.	0.000	0.000	1.00	0.1	0.050	0.100	42.71	6.3	36.9
14	0.414	27148.	0.000	0.000	1.00	3.5	0.050	0.100	46.00	6.3	36.9
15	0.414	27148.	0.000	0.000	1.00	8.1	0.050	0.100	49.29	6.3	36.9
16	0.414	27148.	0.000	0.000	1.00	10.9	0.050	0.100	52.57	6.3	36.9
17	0.414	27148.	0.000	0.000	1.00	14.5	0.144	0.100	55.86	6.3	36.9
18	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	59.14	6.3	36.9
19	0.414	27148.	0.000	0.000	1.00	18.7	0.123	0.100	62.43	6.3	36.9
20	0.414	27148.	0.000	0.000	1.00	24.4	0.050	0.100	65.71	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	27.6	0.050	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	30.7	0.050	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	31.5	0.166	0.100	75.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	31.8	0.200	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	32.5	0.200	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	33.2	0.200	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	33.9	0.200	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	34.5	0.200	0.100	92.00	6.3	36.9
Toe						5.1	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
50.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
357.2	20.6	5.76	5.74	-1.20	12	40	23.84	15	5	35.9	49.1

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 55.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 410.9

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	6.3	36.9
12	0.414	27148.	0.000	0.000	1.00	1.3	0.050	0.100	39.43	6.3	36.9
13	0.414	27148.	0.000	0.000	1.00	6.0	0.050	0.100	42.71	6.3	36.9
14	0.414	27148.	0.000	0.000	1.00	9.8	0.050	0.100	46.00	6.3	36.9
15	0.414	27148.	0.000	0.000	1.00	12.3	0.067	0.100	49.29	6.3	36.9
16	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	52.57	6.3	36.9
18	0.414	27148.	0.000	0.000	1.00	22.7	0.055	0.100	59.14	6.3	36.9
19	0.414	27148.	0.000	0.000	1.00	26.1	0.050	0.100	62.43	6.3	36.9
20	0.414	27148.	0.000	0.000	1.00	29.2	0.050	0.100	65.71	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	31.7	0.095	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	31.5	0.200	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	32.2	0.200	0.100	75.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	32.9	0.200	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	33.5	0.200	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	34.2	0.200	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	34.9	0.200	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	35.5	0.200	0.100	92.00	6.3	36.9
Toe						5.1	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
55.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
410.9	25.0	5.99	5.97	-1.03	14	33	24.62	13	4	36.3	48.2

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 60.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 464.9

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	6.3	36.9
10	0.414	27148.	0.000	0.000	1.00	0.2	0.050	0.100	32.86	6.3	36.9
11	0.414	27148.	0.000	0.000	1.00	3.7	0.050	0.100	36.14	6.3	36.9
12	0.414	27148.	0.000	0.000	1.00	8.3	0.050	0.100	39.43	6.3	36.9
13	0.414	27148.	0.000	0.000	1.00	11.0	0.050	0.100	42.71	6.3	36.9
14	0.414	27148.	0.000	0.000	1.00	14.7	0.150	0.100	46.00	6.3	36.9
15	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	49.29	6.3	36.9
16	0.414	27148.	0.000	0.000	1.00	19.0	0.116	0.100	52.57	6.3	36.9
17	0.414	27148.	0.000	0.000	1.00	24.5	0.050	0.100	55.86	6.3	36.9
18	0.414	27148.	0.000	0.000	1.00	27.7	0.050	0.100	59.14	6.3	36.9
19	0.414	27148.	0.000	0.000	1.00	30.9	0.050	0.100	62.43	6.3	36.9
20	0.414	27148.	0.000	0.000	1.00	31.5	0.173	0.100	65.71	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	31.8	0.200	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	32.5	0.200	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	33.2	0.200	0.100	75.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	33.9	0.200	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	34.6	0.200	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	35.2	0.200	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	35.8	0.200	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	34.5	0.200	0.100	92.00	6.3	36.9
Toe						5.8	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
60.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
464.9	30.6	6.21	6.21	-1.10	12	26	25.32	14	5	36.5	47.3

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 70.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 567.7

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	6.3	36.9
7	0.414	27148.	0.000	0.000	1.00	0.2	0.050	0.100	23.00	6.3	36.9
8	0.414	27148.	0.000	0.000	1.00	3.9	0.050	0.100	26.29	6.3	36.9
9	0.414	27148.	0.000	0.000	1.00	8.5	0.050	0.100	29.57	6.3	36.9
10	0.414	27148.	0.000	0.000	1.00	11.1	0.050	0.100	32.86	6.3	36.9
11	0.414	27148.	0.000	0.000	1.00	14.9	0.156	0.100	36.14	6.3	36.9
12	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	39.43	6.3	36.9
13	0.414	27148.	0.000	0.000	1.00	19.3	0.110	0.100	42.71	6.3	36.9
14	0.414	27148.	0.000	0.000	1.00	24.7	0.050	0.100	46.00	6.3	36.9
15	0.414	27148.	0.000	0.000	1.00	27.8	0.050	0.100	49.29	6.3	36.9
16	0.414	27148.	0.000	0.000	1.00	31.0	0.050	0.100	52.57	6.3	36.9
17	0.414	27148.	0.000	0.000	1.00	31.4	0.180	0.100	55.86	6.3	36.9
18	0.414	27148.	0.000	0.000	1.00	31.9	0.200	0.100	59.14	6.3	36.9
19	0.414	27148.	0.000	0.000	1.00	32.6	0.200	0.100	62.43	6.3	36.9
20	0.414	27148.	0.000	0.000	1.00	33.2	0.200	0.100	65.71	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	33.9	0.200	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	34.6	0.200	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	35.2	0.200	0.100	75.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	35.8	0.200	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	34.5	0.200	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	35.2	0.200	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	32.6	0.200	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	30.1	0.200	0.100	92.00	6.3	36.9
Toe						9.2	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

URS-50

Depth ft	Stroke ft	Pressure Ratio	Efficy
70.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
567.7	45.6	6.62	6.59	-2.07	9	24	26.59	11	4	37.5	45.9

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 75.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 614.7

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	6.3	36.9
6	0.414	27148.	0.000	0.000	1.00	1.7	0.050	0.100	19.71	6.3	36.9
7	0.414	27148.	0.000	0.000	1.00	6.4	0.050	0.100	23.00	6.3	36.9
8	0.414	27148.	0.000	0.000	1.00	10.0	0.050	0.100	26.29	6.3	36.9
9	0.414	27148.	0.000	0.000	1.00	12.8	0.083	0.100	29.57	6.3	36.9
10	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	32.86	6.3	36.9
11	0.414	27148.	0.000	0.000	1.00	16.3	0.191	0.100	36.14	6.3	36.9
12	0.414	27148.	0.000	0.000	1.00	23.2	0.050	0.100	39.43	6.3	36.9
13	0.414	27148.	0.000	0.000	1.00	26.3	0.050	0.100	42.71	6.3	36.9
14	0.414	27148.	0.000	0.000	1.00	29.5	0.050	0.100	46.00	6.3	36.9
15	0.414	27148.	0.000	0.000	1.00	31.7	0.108	0.100	49.29	6.3	36.9
16	0.414	27148.	0.000	0.000	1.00	31.6	0.200	0.100	52.57	6.3	36.9
17	0.414	27148.	0.000	0.000	1.00	32.2	0.200	0.100	55.86	6.3	36.9
18	0.414	27148.	0.000	0.000	1.00	32.9	0.200	0.100	59.14	6.3	36.9
19	0.414	27148.	0.000	0.000	1.00	33.6	0.200	0.100	62.43	6.3	36.9
20	0.414	27148.	0.000	0.000	1.00	34.3	0.200	0.100	65.71	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	34.9	0.200	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	35.5	0.200	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	35.1	0.200	0.100	75.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	34.8	0.200	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	35.3	0.200	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	29.8	0.200	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	30.4	0.200	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	31.1	0.200	0.100	92.00	6.3	36.9
Toe						9.2	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
75.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
614.7	55.9	6.76	6.75	-1.91	8	24	26.96	7	3	37.5	45.4

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 80.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 667.9

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	6.3	36.9
4	0.414	27148.	0.000	0.000	1.00	0.3	0.050	0.100	13.14	6.3	36.9
5	0.414	27148.	0.000	0.000	1.00	4.1	0.050	0.100	16.43	6.3	36.9
6	0.414	27148.	0.000	0.000	1.00	8.6	0.050	0.100	19.71	6.3	36.9
7	0.414	27148.	0.000	0.000	1.00	11.2	0.050	0.100	23.00	6.3	36.9
8	0.414	27148.	0.000	0.000	1.00	15.0	0.162	0.100	26.29	6.3	36.9
9	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	29.57	6.3	36.9
10	0.414	27148.	0.000	0.000	1.00	19.6	0.104	0.100	32.86	6.3	36.9
11	0.414	27148.	0.000	0.000	1.00	24.8	0.050	0.100	36.14	6.3	36.9
12	0.414	27148.	0.000	0.000	1.00	28.0	0.050	0.100	39.43	6.3	36.9
13	0.414	27148.	0.000	0.000	1.00	31.2	0.050	0.100	42.71	6.3	36.9
14	0.414	27148.	0.000	0.000	1.00	31.4	0.186	0.100	46.00	6.3	36.9
15	0.414	27148.	0.000	0.000	1.00	31.9	0.200	0.100	49.29	6.3	36.9
16	0.414	27148.	0.000	0.000	1.00	32.6	0.200	0.100	52.57	6.3	36.9
17	0.414	27148.	0.000	0.000	1.00	33.3	0.200	0.100	55.86	6.3	36.9
18	0.414	27148.	0.000	0.000	1.00	33.9	0.200	0.100	59.14	6.3	36.9
19	0.414	27148.	0.000	0.000	1.00	34.6	0.200	0.100	62.43	6.3	36.9
20	0.414	27148.	0.000	0.000	1.00	35.2	0.200	0.100	65.71	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	35.8	0.200	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	34.4	0.200	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	35.2	0.200	0.100	75.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	32.3	0.200	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	30.1	0.200	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	30.7	0.200	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	31.5	0.200	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	32.1	0.200	0.100	92.00	6.3	36.9
Toe						13.8	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
80.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
667.9	70.9	6.91	6.92	-1.40	7	44	27.46	8	3	37.6	44.9

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 85.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 717.1

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	6.3	36.9
3	0.414	27148.	0.000	0.000	1.00	1.8	0.050	0.100	9.86	6.3	36.9
4	0.414	27148.	0.000	0.000	1.00	6.7	0.050	0.100	13.14	6.3	36.9
5	0.414	27148.	0.000	0.000	1.00	10.1	0.050	0.100	16.43	6.3	36.9
6	0.414	27148.	0.000	0.000	1.00	13.0	0.090	0.100	19.71	6.3	36.9
7	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	23.00	6.3	36.9
8	0.414	27148.	0.000	0.000	1.00	16.6	0.183	0.100	26.29	6.3	36.9
9	0.414	27148.	0.000	0.000	1.00	23.3	0.050	0.100	29.57	6.3	36.9
10	0.414	27148.	0.000	0.000	1.00	26.5	0.050	0.100	32.86	6.3	36.9
11	0.414	27148.	0.000	0.000	1.00	29.6	0.050	0.100	36.14	6.3	36.9
12	0.414	27148.	0.000	0.000	1.00	31.7	0.114	0.100	39.43	6.3	36.9
13	0.414	27148.	0.000	0.000	1.00	31.6	0.200	0.100	42.71	6.3	36.9
14	0.414	27148.	0.000	0.000	1.00	32.3	0.200	0.100	46.00	6.3	36.9
15	0.414	27148.	0.000	0.000	1.00	32.9	0.200	0.100	49.29	6.3	36.9
16	0.414	27148.	0.000	0.000	1.00	33.6	0.200	0.100	52.57	6.3	36.9
17	0.414	27148.	0.000	0.000	1.00	34.3	0.200	0.100	55.86	6.3	36.9
18	0.414	27148.	0.000	0.000	1.00	34.9	0.200	0.100	59.14	6.3	36.9
19	0.414	27148.	0.000	0.000	1.00	35.5	0.200	0.100	62.43	6.3	36.9
20	0.414	27148.	0.000	0.000	1.00	35.1	0.200	0.100	65.71	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	34.8	0.200	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	35.0	0.200	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	29.9	0.200	0.100	75.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	30.5	0.200	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	31.1	0.200	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	31.9	0.200	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	32.2	0.200	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	32.4	0.200	0.100	92.00	6.3	36.9
Toe						13.8	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
85.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
717.1	92.1	7.04	7.04	-1.63	27	8	27.70	4	2	37.4	44.5

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 89.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 756.8

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	0.0	0.050	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	2.8	0.050	0.100	6.57	6.3	36.9
3	0.414	27148.	0.000	0.000	1.00	7.6	0.050	0.100	9.86	6.3	36.9
4	0.414	27148.	0.000	0.000	1.00	10.6	0.050	0.100	13.14	6.3	36.9
5	0.414	27148.	0.000	0.000	1.00	14.0	0.125	0.100	16.43	6.3	36.9
6	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	19.71	6.3	36.9
7	0.414	27148.	0.000	0.000	1.00	17.9	0.144	0.100	23.00	6.3	36.9
8	0.414	27148.	0.000	0.000	1.00	24.0	0.050	0.100	26.29	6.3	36.9
9	0.414	27148.	0.000	0.000	1.00	27.2	0.050	0.100	29.57	6.3	36.9
10	0.414	27148.	0.000	0.000	1.00	30.3	0.050	0.100	32.86	6.3	36.9
11	0.414	27148.	0.000	0.000	1.00	31.6	0.146	0.100	36.14	6.3	36.9
12	0.414	27148.	0.000	0.000	1.00	31.7	0.200	0.100	39.43	6.3	36.9
13	0.414	27148.	0.000	0.000	1.00	32.4	0.200	0.100	42.71	6.3	36.9
14	0.414	27148.	0.000	0.000	1.00	33.1	0.200	0.100	46.00	6.3	36.9
15	0.414	27148.	0.000	0.000	1.00	33.8	0.200	0.100	49.29	6.3	36.9
16	0.414	27148.	0.000	0.000	1.00	34.4	0.200	0.100	52.57	6.3	36.9
17	0.414	27148.	0.000	0.000	1.00	35.1	0.200	0.100	55.86	6.3	36.9
18	0.414	27148.	0.000	0.000	1.00	35.7	0.200	0.100	59.14	6.3	36.9
19	0.414	27148.	0.000	0.000	1.00	34.8	0.200	0.100	62.43	6.3	36.9
20	0.414	27148.	0.000	0.000	1.00	35.0	0.200	0.100	65.71	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	33.8	0.200	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	30.0	0.200	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	30.6	0.200	0.100	75.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	31.2	0.200	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	32.0	0.200	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	32.2	0.200	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	32.5	0.200	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	32.6	0.200	0.100	92.00	6.3	36.9
Toe						13.8	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
89.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
756.8	117.8	7.11	7.11	-2.05	27	8	27.97	5	3	37.2	44.3

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 91.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 880.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	1.2	0.050	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	5.8	0.050	0.100	6.57	6.3	36.9
3	0.414	27148.	0.000	0.000	1.00	9.7	0.050	0.100	9.86	6.3	36.9
4	0.414	27148.	0.000	0.000	1.00	12.1	0.059	0.100	13.14	6.3	36.9
5	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	16.43	6.3	36.9
7	0.414	27148.	0.000	0.000	1.00	22.3	0.059	0.100	23.00	6.3	36.9
8	0.414	27148.	0.000	0.000	1.00	25.9	0.050	0.100	26.29	6.3	36.9
9	0.414	27148.	0.000	0.000	1.00	29.1	0.050	0.100	29.57	6.3	36.9
10	0.414	27148.	0.000	0.000	1.00	31.6	0.088	0.100	32.86	6.3	36.9
11	0.414	27148.	0.000	0.000	1.00	31.5	0.200	0.100	36.14	6.3	36.9
12	0.414	27148.	0.000	0.000	1.00	32.1	0.200	0.100	39.43	6.3	36.9
13	0.414	27148.	0.000	0.000	1.00	32.8	0.200	0.100	42.71	6.3	36.9
14	0.414	27148.	0.000	0.000	1.00	33.5	0.200	0.100	46.00	6.3	36.9
15	0.414	27148.	0.000	0.000	1.00	34.2	0.200	0.100	49.29	6.3	36.9
16	0.414	27148.	0.000	0.000	1.00	34.8	0.200	0.100	52.57	6.3	36.9
17	0.414	27148.	0.000	0.000	1.00	35.4	0.200	0.100	55.86	6.3	36.9
18	0.414	27148.	0.000	0.000	1.00	35.3	0.200	0.100	59.14	6.3	36.9
19	0.414	27148.	0.000	0.000	1.00	34.7	0.200	0.100	62.43	6.3	36.9
20	0.414	27148.	0.000	0.000	1.00	35.5	0.200	0.100	65.71	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	30.3	0.200	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	30.4	0.200	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	31.0	0.200	0.100	75.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	31.7	0.200	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	32.2	0.200	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	32.4	0.200	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	32.6	0.200	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	81.4	0.092	0.100	92.00	6.3	36.9
Toe						68.8	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
91.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
880.5	377.8	7.23	7.23	-0.46	3	38	28.27	5	3	37.3	43.9

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 92.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 36.910 Pile Type Unknown
Pile Size (inch) 24.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8
92.0	36.91	29000.	492.0	6.3	0.000	16524.	64.8

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 940.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.414	27148.	0.010	0.000	0.85	2.4	0.050	0.100	3.29	6.3	36.9
2	0.414	27148.	0.000	0.000	1.00	7.3	0.050	0.100	6.57	6.3	36.9
3	0.414	27148.	0.000	0.000	1.00	10.4	0.050	0.100	9.86	6.3	36.9
4	0.414	27148.	0.000	0.000	1.00	13.6	0.112	0.100	13.14	6.3	36.9
5	0.414	27148.	0.000	0.000	1.00	16.1	0.200	0.100	16.43	6.3	36.9
6	0.414	27148.	0.000	0.000	1.00	17.3	0.159	0.100	19.71	6.3	36.9
7	0.414	27148.	0.000	0.000	1.00	23.7	0.050	0.100	23.00	6.3	36.9
8	0.414	27148.	0.000	0.000	1.00	26.9	0.050	0.100	26.29	6.3	36.9
9	0.414	27148.	0.000	0.000	1.00	30.1	0.050	0.100	29.57	6.3	36.9
10	0.414	27148.	0.000	0.000	1.00	31.7	0.133	0.100	32.86	6.3	36.9
11	0.414	27148.	0.000	0.000	1.00	31.7	0.200	0.100	36.14	6.3	36.9
12	0.414	27148.	0.000	0.000	1.00	32.3	0.200	0.100	39.43	6.3	36.9
13	0.414	27148.	0.000	0.000	1.00	33.0	0.200	0.100	42.71	6.3	36.9
14	0.414	27148.	0.000	0.000	1.00	33.7	0.200	0.100	46.00	6.3	36.9
15	0.414	27148.	0.000	0.000	1.00	34.4	0.200	0.100	49.29	6.3	36.9
16	0.414	27148.	0.000	0.000	1.00	35.0	0.200	0.100	52.57	6.3	36.9
17	0.414	27148.	0.000	0.000	1.00	35.6	0.200	0.100	55.86	6.3	36.9
18	0.414	27148.	0.000	0.000	1.00	34.9	0.200	0.100	59.14	6.3	36.9
19	0.414	27148.	0.000	0.000	1.00	34.9	0.200	0.100	62.43	6.3	36.9
20	0.414	27148.	0.000	0.000	1.00	34.3	0.200	0.100	65.71	6.3	36.9
21	0.414	27148.	0.000	0.000	1.00	29.9	0.200	0.100	69.00	6.3	36.9
22	0.414	27148.	0.000	0.000	1.00	30.5	0.200	0.100	72.29	6.3	36.9
23	0.414	27148.	0.000	0.000	1.00	31.2	0.200	0.100	75.57	6.3	36.9
24	0.414	27148.	0.000	0.000	1.00	31.9	0.200	0.100	78.86	6.3	36.9
25	0.414	27148.	0.000	0.000	1.00	32.2	0.200	0.100	82.14	6.3	36.9
26	0.414	27148.	0.000	0.000	1.00	32.4	0.200	0.100	85.43	6.3	36.9
27	0.414	27148.	0.000	0.000	1.00	32.6	0.200	0.100	88.71	6.3	36.9
28	0.414	27148.	0.000	0.000	1.00	131.0	0.065	0.100	92.00	6.3	36.9
Toe						68.8	0.150	0.200			

11.602 kips total unreduced pile weight (g= 32.17 ft/s2)
11.602 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
92.00	9.49	1.00	0.800

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
940.0	1258.6	7.27	7.28	-0.44	3	38	28.38	4	2	37.4	43.8

A/I95 Abut A 24" A-95UTA3 DelMAG D44 12/11/2008
URS Corporation GRLWEAP(TM) Version 2005

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 1.000 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
10.0	23.9	20.6	3.3	1.6	8.369	-1.830	3.12	40.5
15.0	44.5	42.8	1.7	2.0	12.248	-2.711	3.55	45.1
25.0	115.3	106.8	8.5	4.3	17.498	-2.524	4.28	42.9
32.0	176.3	171.3	5.1	7.0	19.653	-1.842	4.66	40.1
40.0	254.2	249.1	5.1	12.9	21.899	-2.172	5.21	37.5
50.0	357.2	352.1	5.1	20.6	23.837	-1.203	5.76	35.9
55.0	410.9	405.8	5.1	25.0	24.615	-1.034	5.99	36.3
60.0	464.9	459.1	5.8	30.6	25.321	-1.097	6.21	36.5
70.0	567.7	558.4	9.2	45.6	26.594	-2.070	6.62	37.5
75.0	614.7	605.5	9.2	55.9	26.965	-1.914	6.76	37.5
80.0	667.9	654.0	13.8	70.9	27.455	-1.400	6.91	37.6
85.0	717.1	703.3	13.8	92.1	27.704	-1.631	7.04	37.4
89.0	756.8	743.0	13.8	117.8	27.974	-2.051	7.11	37.2
91.0	880.5	811.7	68.8	377.8	28.268	-0.462	7.23	37.3
92.0	940.0	871.1	68.8	1258.6	28.382	-0.439	7.27	37.4

Total Driving Time 81 minutes; Total No. of Blows 3680

Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
10.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
15.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
25.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
32.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
40.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
50.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
55.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
60.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
70.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
75.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
80.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
85.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
89.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
91.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00
92.00	92.00	0.00	9.49	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	0.00	0.01	0.100	0.200	0.050	0.150	1.000	0.000	0.000
5.99	0.43	3.07	0.100	0.200	0.050	0.150	1.000	0.000	0.000
6.01	0.43	3.08	0.100	0.200	0.050	0.150	1.000	0.000	0.000
11.99	0.63	3.41	0.100	0.200	0.050	0.150	1.000	0.000	0.000
12.01	0.78	1.73	0.100	0.200	0.200	0.150	1.000	0.000	0.000
18.99	0.78	1.73	0.100	0.200	0.200	0.150	1.000	0.000	0.000
19.01	1.04	8.45	0.100	0.200	0.050	0.150	1.000	0.000	0.000
28.01	1.46	8.46	0.100	0.200	0.050	0.150	1.000	0.000	0.000
30.99	1.60	8.46	0.100	0.200	0.050	0.150	1.000	0.000	0.000
31.01	1.50	5.08	0.100	0.200	0.200	0.150	1.000	0.000	0.000
40.01	1.59	5.08	0.100	0.200	0.200	0.150	1.000	0.000	0.000
49.01	1.68	5.08	0.100	0.200	0.200	0.150	1.000	0.000	0.000
56.99	1.75	5.08	0.100	0.200	0.200	0.150	1.000	0.000	0.000
57.01	1.65	5.77	0.100	0.200	0.200	0.150	1.000	0.000	0.000
64.99	1.74	5.77	0.100	0.200	0.200	0.150	1.000	0.000	0.000
65.01	1.43	9.23	0.100	0.200	0.200	0.150	1.000	0.000	0.000
74.01	1.51	9.23	0.100	0.200	0.200	0.150	1.000	0.000	0.000
76.99	1.55	9.23	0.100	0.200	0.200	0.150	1.000	0.000	0.000
77.01	1.55	13.84	0.100	0.200	0.200	0.150	1.000	0.000	0.000
86.01	1.58	13.84	0.100	0.200	0.200	0.150	1.000	0.000	0.000
89.99	1.58	13.84	0.100	0.200	0.200	0.150	1.000	0.000	0.000
90.01	9.30	68.85	0.100	0.200	0.050	0.150	1.000	0.000	0.000
96.99	10.10	68.85	0.100	0.200	0.050	0.150	1.000	0.000	0.000

URS

Page ____ of ____

Job ____ Project No. ____ Sheet ____ of ____

Description ____ Computed by ____ Date ____

____ Checked by ____ Date ____

Reference

DRIVEABILITY

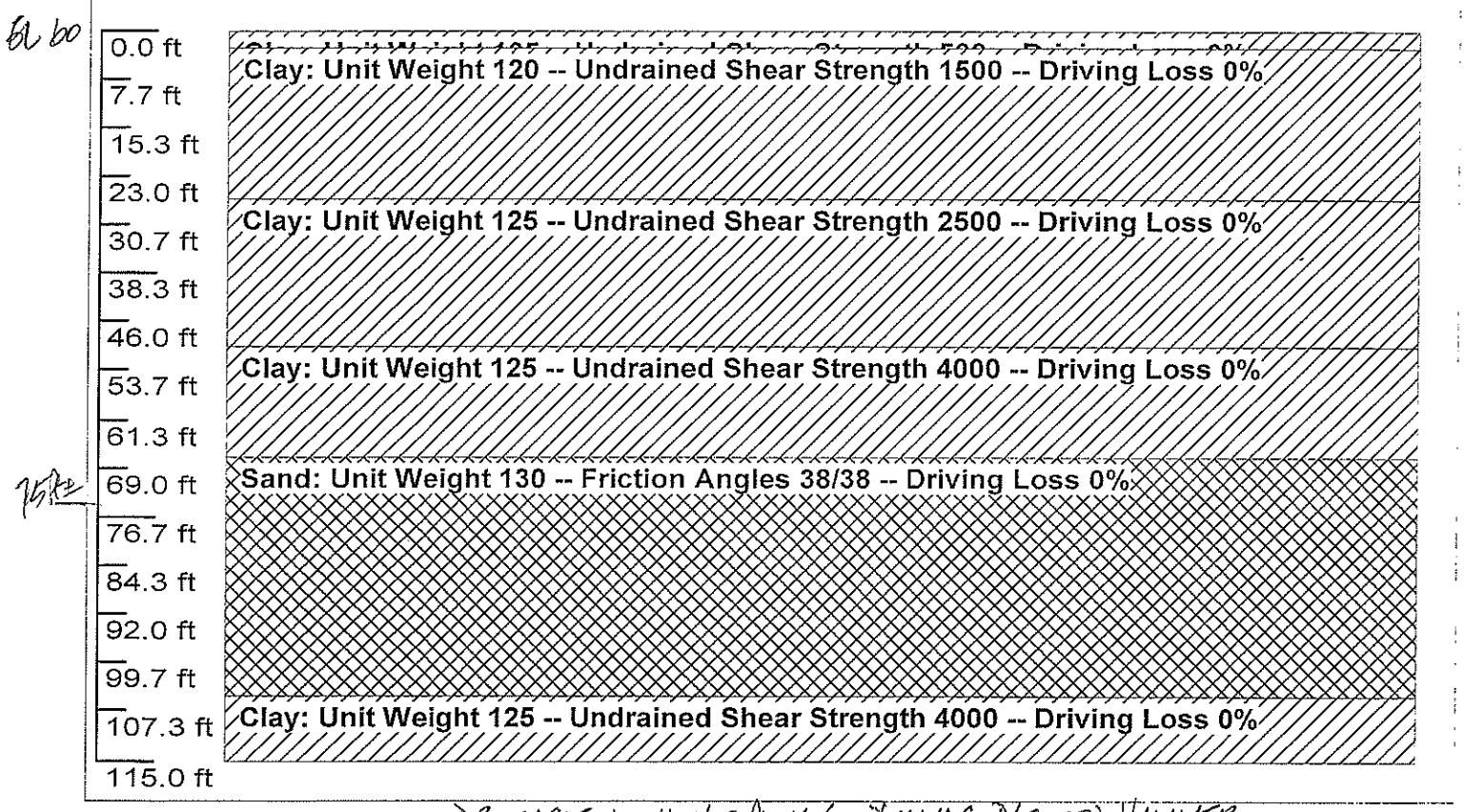
FOR 30" DIAM.

OPEN END PIPE PILE

Filename: Z:\DELDOT\SR1DEC~1\A-R7P1AW.DVN

FOR 30" PIPE PILE DRIVERABILITY

BORING IBR-33 **Soil Profile** RAMP A/SR7 PIER 1



- DRIVEABLE WITH 165 A-K (eg DELMAG D62-22) HAMMER
- PILE MAY NEED TO BE DRIVEN TO REFUSAL (PIER 3, RAMP A/SR7) FOR CAPACITY
- REQUIRES 50 KSI STEEL
- DRIVEABLE TO EL. -15±

FOR 30" ϕ PIPE PILE DRIVERABILITY

5/8" WALL (0.625")

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A-R7P1AW.DVN
Project Name: Ramp A / SR7 Pier 1 Project Date: 12/05/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-23 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 30.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.00 ft	0.00%	105.00 pcf	500.00 psf	T-79 Steel
2	Cohesive	23.50 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
3	Cohesive	23.50 ft	0.00%	125.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	17.50 ft	0.00%	125.00 pcf	4000.00 psf	T-79 Steel
5	Cohesionless	37.50 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund
6	Cohesive	10.00 ft	0.00%	125.00 pcf	4000.00 psf	T-79 Steel

A-R7P1AW - 1

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	410.00 psf	0.03 Kips
2.99 ft	Cohesive	N/A	N/A	410.00 psf	9.63 Kips
3.01 ft	Cohesive	N/A	N/A	1060.00 psf	9.74 Kips
12.01 ft	Cohesive	N/A	N/A	1060.00 psf	84.67 Kips
21.01 ft	Cohesive	N/A	N/A	1060.00 psf	159.60 Kips
26.49 ft	Cohesive	N/A	N/A	1064.67 psf	206.08 Kips
26.51 ft	Cohesive	N/A	N/A	1010.57 psf	206.25 Kips
35.51 ft	Cohesive	N/A	N/A	1073.57 psf	282.14 Kips
44.51 ft	Cohesive	N/A	N/A	1136.57 psf	366.94 Kips
49.99 ft	Cohesive	N/A	N/A	1174.93 psf	422.93 Kips
50.01 ft	Cohesive	N/A	N/A	933.40 psf	423.11 Kips
59.01 ft	Cohesive	N/A	N/A	992.20 psf	493.25 Kips
67.49 ft	Cohesive	N/A	N/A	1047.60 psf	566.94 Kips
67.51 ft	Cohesionless	4048.34 psf	30.32	N/A	567.50 Kips
76.51 ft	Cohesionless	4352.54 psf	30.32	N/A	1014.67 Kips
85.51 ft	Cohesionless	4656.74 psf	30.32	N/A	1524.35 Kips
94.51 ft	Cohesionless	4960.94 psf	30.32	N/A	2096.52 Kips
103.51 ft	Cohesionless	5265.14 psf	30.32	N/A	2731.20 Kips
104.99 ft	Cohesionless	5315.16 psf	30.32	N/A	2841.55 Kips
105.01 ft	Cohesive	N/A	N/A	1260.00 psf	2842.40 Kips
114.01 ft	Cohesive	N/A	N/A	1260.00 psf	2931.47 Kips
114.99 ft	Cohesive	N/A	N/A	1260.00 psf	2941.17 Kips

ARTRIAW-5

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	22.09 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	22.09 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
12.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
21.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
26.49 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
26.51 ft	Cohesive	N/A	N/A	N/A	110.45 Kips
35.51 ft	Cohesive	N/A	N/A	N/A	110.45 Kips
44.51 ft	Cohesive	N/A	N/A	N/A	110.45 Kips
49.99 ft	Cohesive	N/A	N/A	N/A	110.45 Kips
50.01 ft	Cohesive	N/A	N/A	N/A	176.71 Kips
59.01 ft	Cohesive	N/A	N/A	N/A	176.71 Kips
67.49 ft	Cohesive	N/A	N/A	N/A	176.71 Kips
67.51 ft	Cohesionless	4048.68 psf	110.40	1318.49 Kips	1318.49 Kips
76.51 ft	Cohesionless	4657.08 psf	110.40	1318.49 Kips	1318.49 Kips
85.51 ft	Cohesionless	5265.48 psf	110.40	1318.49 Kips	1318.49 Kips
94.51 ft	Cohesionless	5873.88 psf	110.40	1318.49 Kips	1318.49 Kips
103.51 ft	Cohesionless	6482.28 psf	110.40	1318.49 Kips	1318.49 Kips
104.99 ft	Cohesionless	6582.32 psf	110.40	1318.49 Kips	1318.49 Kips
105.01 ft	Cohesive	N/A	N/A	N/A	176.71 Kips
114.01 ft	Cohesive	N/A	N/A	N/A	176.71 Kips
114.99 ft	Cohesive	N/A	N/A	N/A	176.71 Kips

A-R7R1AW-6

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.03 Kips	22.09 Kips	22.12 Kips
2.99 ft	9.63 Kips	22.09 Kips	31.72 Kips
3.01 ft	9.74 Kips	66.27 Kips	76.01 Kips
12.01 ft	84.67 Kips	66.27 Kips	150.94 Kips
21.01 ft	159.60 Kips	66.27 Kips	225.87 Kips
26.49 ft	206.08 Kips	66.27 Kips	272.35 Kips
26.51 ft	206.25 Kips	110.45 Kips	316.70 Kips
35.51 ft	282.14 Kips	110.45 Kips	392.59 Kips
44.51 ft	366.94 Kips	110.45 Kips	477.38 Kips
49.99 ft	422.93 Kips	110.45 Kips	533.38 Kips
50.01 ft	423.11 Kips	176.71 Kips	599.83 Kips
59.01 ft	493.25 Kips	176.71 Kips	669.96 Kips
67.49 ft	566.94 Kips	176.71 Kips	743.66 Kips
67.51 ft	567.50 Kips	1318.49 Kips	1885.98 Kips
76.51 ft	1014.67 Kips	1318.49 Kips	2333.16 Kips
85.51 ft	1524.35 Kips	1318.49 Kips	2842.83 Kips
94.51 ft	2096.52 Kips	1318.49 Kips	3415.01 Kips
103.51 ft	2731.20 Kips	1318.49 Kips	4049.69 Kips
104.99 ft	2841.55 Kips	1318.49 Kips	4160.04 Kips
105.01 ft	2842.40 Kips	176.71 Kips	3019.12 Kips
114.01 ft	2931.47 Kips	176.71 Kips	3108.18 Kips
114.99 ft	2941.17 Kips	176.71 Kips	3117.88 Kips

A-RTRIAW-7

Rp A/SR7 Pier 1 Delmag
URS Corporation

12/12/2008
GRLWEAP(TM) Version 2005

FOR WEAP INPUT FROM RESULTS OF DRIVEN

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 1.000 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
3.0	31.7	9.6	22.1	1.0	11.584	-2.789	4.22	84.7
3.0	76.1	9.8	66.3	1.7	18.487	-5.885	5.00	82.4
14.8	173.7	107.4	66.3	5.4	24.113	-4.071	6.20	68.8
26.5	271.4	205.1	66.3	9.8	27.818	-1.681	7.07	63.3
26.5	315.9	205.4	110.4	12.0	28.616	-0.453	7.33	62.3
38.2	412.8	302.3	110.4	17.8	30.536	-1.111	7.94	60.2
50.0	517.2	406.8	110.4	26.5	32.021	-0.940	8.42	57.9
50.0	583.8	407.1	176.7	31.6	32.528	0.000	8.59	58.0
58.8	649.7	473.0	176.7	39.0	33.309	0.000	8.84	58.0
67.5	719.5	542.8	176.7	47.8	34.203	0.000	9.16	58.6
67.5	1862.4	543.9	1318.5	9999.0	36.492	-0.933	9.84	64.1
83.7	2713.2	1394.7	1318.5	9999.0	36.126	-1.096	9.73	61.8
100.0	3769.8	2451.3	1318.5	9999.0	35.267	-0.098	9.56	59.5

Refusal occurred; no driving time output possible

Soil Layer Resistance Values

Depth ft	X 1.25	Shaft Res. k/ft2	End Bearing kips	X End Bg	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	0.51	0.41	22.09	1.8	0.100	0.250	0.200	0.150	1.000	0.000	0.000
2.99	0.51	0.41	22.09	1.8	0.100	0.250	0.200	0.150	1.000	0.000	0.000
3.01	1.33	1.06	66.27	5.41	0.100	0.250	0.200	0.150	1.000	0.000	0.000
12.01	1.33	1.06	66.27	5.41	0.100	0.250	0.200	0.150	1.000	0.000	0.000
21.01	1.34	1.06	66.27	5.41	0.100	0.250	0.200	0.150	1.000	0.000	0.000
26.49	1.34	1.07	66.27	5.41	0.100	0.250	0.200	0.150	1.000	0.000	0.000
26.51	1.26	1.01	110.45	9.01	0.100	0.250	0.200	0.150	1.000	0.000	0.000
35.51	1.34	1.07	110.45	9.01	0.100	0.250	0.200	0.150	1.000	0.000	0.000
44.51	1.43	1.14	110.45	9.01	0.100	0.250	0.200	0.150	1.000	0.000	0.000
49.99	1.46	1.17	110.45	9.01	0.100	0.250	0.200	0.150	1.000	0.000	0.000
50.01	1.16	0.93	176.71	14.42	0.100	0.250	0.200	0.150	1.000	0.000	0.000
59.01	1.24	0.99	176.71	14.42	0.100	0.250	0.200	0.150	1.000	0.000	0.000
67.49	1.31	1.05	176.71	14.42	0.100	0.250	0.200	0.150	1.000	0.000	0.000
67.51	7.35	5.88	1318.49	107.59	0.100	0.250	0.050	0.150	1.000	0.000	0.000
76.51	8.46	6.77	1318.49	107.59	0.100	0.250	0.050	0.150	1.000	0.000	0.000
85.51	9.56	7.65	1318.49	107.59	0.100	0.250	0.050	0.150	1.000	0.000	0.000
94.51	10.68	8.54	1318.49	107.59	0.100	0.250	0.050	0.150	1.000	0.000	0.000
103.51	11.78	9.42	1318.49	107.59	0.100	0.250	0.050	0.150	1.000	0.000	0.000

URS-65

RAMP A/SR7 PIER 1
FOR 30" PIPE PILE DRIVEABILITY

URS Corporation
Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1

Dec 12 2008
GRLWEAP(TM) Version 2005

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
15.0	142.7	137.3	5.4	4.1	23.960	-5.391	6.39	78.4
30.0	301.6	292.6	9.0	10.6	29.703	-2.387	7.74	70.3
40.0	406.5	397.5	9.0	15.9	31.507	-1.998	8.32	67.3
55.0	570.4	556.0	14.4	25.3	33.697	-1.729	9.06	66.0
65.0	668.4	654.0	14.4	32.0	34.658	-1.461	9.44	66.9
70.0	934.3	826.7	107.6	58.2	35.672	-1.220	9.88	69.1
73ft ± 72.0	1056.5	948.9	107.6	76.8	36.110	-1.273	10.01	69.9
Load = 1046K 74.0	1182.5	1074.9	107.6	101.8	36.367	-1.230	10.13	70.3
75ft 75.0	1247.0	1139.4	107.6	118.5	36.525	-1.219	10.17	70.5
80.0	1583.9	1476.3	107.6	384.1	36.865	-1.235	10.34	70.6
90.0	2330.7	2223.1	107.6	9999.0	37.131	-0.426	10.50	69.2

Refusal occurred; no driving time output possible

Require 50 ksi Steel

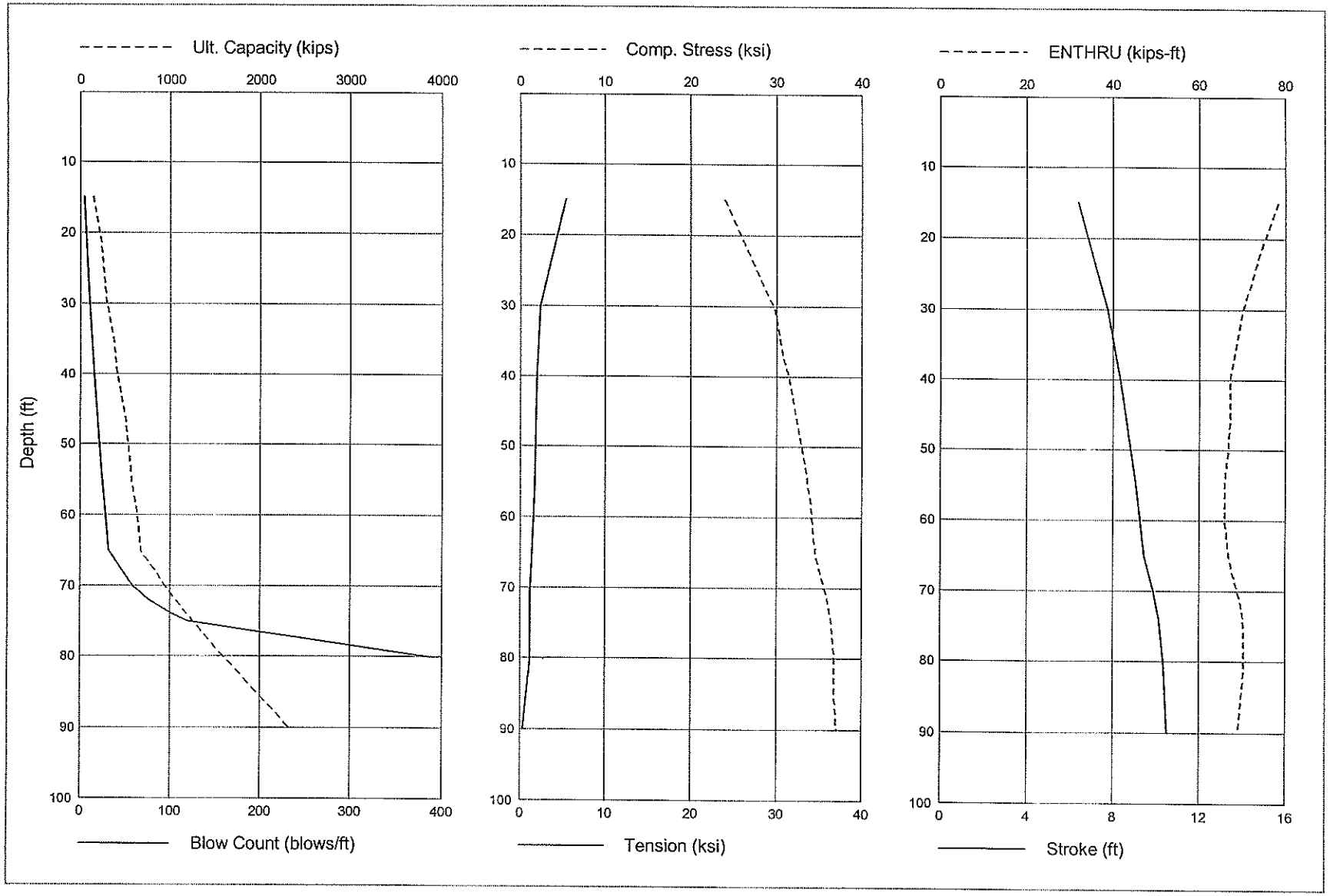
URS Corporation

Dec 12 2008

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

GRLWEAP(TM) Version 2005



GRLWEAP - Version 2005
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.
Copyright (c) 1998-2005, Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

Input File: Z:\DELDOT\SR1 DEC-08\A-R7P1A1.GWI
Hammer File: D:\Program Files\PDI\GRLWEAP 2005\HAMMER2003.GW
Hammer File Version: 2003 (10/24/2008)

Input File Contents

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEx
-100	0	30	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.000

Pile g	Hammer g	Toe Area	Pile Size	Pile Type
32.170	32.170	57.680	30.000	Unknown

W Cp	A Cp	E Cp	T Cp	CoR	ROut	StCp
3.800	415.000	470.0	3.500	0.800	0.010	0.0

A Cu	E Cu	T Cu	CoR	ROut	StCu
0.000	0.0	0.000	0.000	0.000	0.0

LPle	APle	EPle	WPle	Peri	Strg	CoR	ROut
100.000	57.680	29000.000	492.000	7.850	0.000	0.850	0.010

Manufac	Hmr Name	HmrType	No Seg-s
DELMAG	D 62-22	1	5

Ram Wt	Ram L	Ram Dia	MaxStrk	RtdStrk	Efficy
13.66	149.20	21.63	13.26	12.05	0.80

IB. Wt	IB. L	IB.Dia	IB CoR	IB RO
2.83	32.36	21.64	0.900	0.010

CompStrk	A Chamber	V Chamber	C Delay	C Duratn	Exp Coeff	VolCStart	Vol CEnd
22.79	368.30	677.00	0.001	0.001	1.250	0.00	0.00

P atm	P1	P2	P3	P4	P5
14.70	1440.00	1296.00	1166.00	1050.00	0.00

Stroke	Effic.	Pressure	R-Weight	T-Delay	Exp-Coeff	Eps-Str	Total-AW
12.0500	0.8000	1440.0000	0.0000	0.0000	0.0000	0.0100	0.0000

Qs	Qt	Js	Jt	Qx	Jx	Rati	Dept
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Research Soil Model: Atoe, Plug, Gap, Q-fac

0.000	0.000	0.000	0.000

Research Soil Model: RD-skn: m, d, toe: m, d

0.000	0.000	0.000	0.000

Res. Distribution

Dpth	Rskn	Rtoe	Qs	Qt	Js	Jt	SU F	LimD	SU T
0.01	0.51	1.80	0.10	0.25	0.20	0.15	1.00	0.00	0.00
2.99	0.51	1.80	0.10	0.25	0.20	0.15	1.00	0.00	0.00
3.01	1.33	5.41	0.10	0.25	0.20	0.15	1.00	0.00	0.00
12.01	1.33	5.41	0.10	0.25	0.20	0.15	1.00	0.00	0.00
21.01	1.33	5.41	0.10	0.25	0.20	0.15	1.00	0.00	0.00
26.49	1.34	5.41	0.10	0.25	0.20	0.15	1.00	0.00	0.00
26.51	1.26	9.01	0.10	0.25	0.20	0.15	1.00	0.00	0.00
35.51	1.34	9.01	0.10	0.25	0.20	0.15	1.00	0.00	0.00
44.51	1.43	9.01	0.10	0.25	0.20	0.15	1.00	0.00	0.00
49.99	1.46	9.01	0.10	0.25	0.20	0.15	1.00	0.00	0.00
50.01	1.16	14.42	0.10	0.25	0.20	0.15	1.00	0.00	0.00
59.01	1.24	14.42	0.10	0.25	0.20	0.15	1.00	0.00	0.00
67.49	1.31	14.42	0.10	0.25	0.20	0.15	1.00	0.00	0.00
67.51	7.35	107.59	0.10	0.25	0.05	0.15	1.00	0.00	0.00
76.51	8.46	107.59	0.10	0.25	0.05	0.15	1.00	0.00	0.00
85.51	9.58	107.59	0.10	0.25	0.05	0.15	1.00	0.00	0.00
94.51	10.68	107.59	0.10	0.25	0.05	0.15	1.00	0.00	0.00
103.51	11.78	107.59	0.10	0.25	0.05	0.15	1.00	0.00	0.00

URS-69

Gain/Loss factors: shaft and toe

1.00000	0.00000	0.00000	0.00000	0.00000
1.00000	0.00000	0.00000	0.00000	0.00000

Dpth	L	Wait	Strk	Pmx%	Eff.	Stff	CoR
15.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
30.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
40.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
55.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
65.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
70.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
72.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
74.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
75.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
80.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
90.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2005
English Units

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1

Hammer Model: D 62-22 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	2.732				
2	2.732	357110.0	1.000	0.0100	
3	2.732	357110.0	1.000	0.0100	
4	2.732	357110.0	1.000	0.0100	
5	2.732	357110.0	1.000	0.0100	
Imp Block	2.830	171403.4	0.900	0.0100	
Helmet	3.800	55728.6	0.800	0.0100	16.7
Combined Pile Top		41818.0			

HAMMER OPTIONS:

Hammer File ID No.	30	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	13.66	Ram Length	(inch)	149.20
Maximum Stroke	(ft)	13.26			
Rated Stroke	(ft)	12.05	Efficiency		0.800
Maximum Pressure	(psi)	1440.00	Actual Pressure	(psi)	1440.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	21.63			
Combustion Delay	(s)	0.00100	Ignition Duration	(s)	0.00100

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	415.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	470.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	3.50	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		1.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	55728.6	Stiffness	(kips/in)	0.0

URS-71

Depth (ft) 15.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 57.680 Pile Type Unknown
Pile Size (inch) 30.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2
100.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2

Wave Travel Time 2L/c (ms) 12.103

Pile and Soil Model Total Capacity Rut (kips) 142.7

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.657	41818.	0.010	0.000	0.85	0.0	0.000	0.100	3.33	7.8	57.7
2	0.657	41818.	0.000	0.000	1.00	0.0	0.000	0.100	6.67	7.8	57.7
26	0.657	41818.	0.000	0.000	1.00	6.7	0.200	0.100	86.67	7.9	57.7
27	0.657	41818.	0.000	0.000	1.00	26.2	0.200	0.100	90.00	7.9	57.7
28	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	93.33	7.9	57.7
30	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	100.00	7.8	57.7
Toe						5.4	0.150	0.250			

19.707 kips total unreduced pile weight (g= 32.17 ft/s2)
19.707 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:
Uniform pile Pile Segments: Automatic
No. of Slacks/Splices 0 Pile Damping (%) 1
Pile Penetration (ft) 1.80 Pile Damping Fact.(k/ft/s) 2.025
Driveability Analysis
Soil Damping Option Smith
Max No Analysis Iterations 0 Time Increment/Critical 160
Output Time Interval 1 Analysis Time-Input (ms) 0
Output Level: Normal
Gravity Mass, Pile, Hammer: 32.170 32.170 32.170
Output Segment Generation: Automatic

URS-72

Depth ft	Stroke ft	Pressure Ratio	Efficy
15.00	12.05	1.00	0.800

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
142.7	4.1	6.39	6.42	-5.39	6	13	23.96	15	5	78.4	46.5

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 30.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 57.680 Pile Type Unknown
Pile Size (inch) 30.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2
100.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2

Wave Travel Time 2L/c (ms) 12.103

Pile and Soil Model Total Capacity Rut (kips) 301.6

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.657	41818.	0.010	0.000	0.85	0.0	0.000	0.100	3.33	7.8	57.7
2	0.657	41818.	0.000	0.000	1.00	0.0	0.000	0.100	6.67	7.8	57.7
22	0.657	41818.	0.000	0.000	1.00	15.5	0.200	0.100	73.33	7.9	57.7
23	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	76.67	7.9	57.7
28	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	93.33	7.9	57.7
29	0.657	41818.	0.000	0.000	1.00	34.9	0.200	0.100	96.67	7.9	57.7
30	0.657	41818.	0.000	0.000	1.00	33.4	0.200	0.100	100.00	7.8	57.7
Toe						9.0	0.150	0.250			

19.707 kips total unreduced pile weight (g= 32.17 ft/s2)
19.707 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
30.00	12.05	1.00	0.800

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
301.6	10.6	7.74	7.72	-2.39	29	9	29.70	22	6	70.3	42.2

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 40.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 57.680 Pile Type Unknown
Pile Size (inch) 30.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2
100.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2

Wave Travel Time 2L/c (ms) 12.103

Pile and Soil Model Total Capacity Rut (kips) 406.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.657	41818.	0.010	0.000	0.85	0.0	0.000	0.100	3.33	7.8	57.7
2	0.657	41818.	0.000	0.000	1.00	0.0	0.000	0.100	6.67	7.8	57.7
19	0.657	41818.	0.000	0.000	1.00	15.5	0.200	0.100	63.33	7.8	57.7
20	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	66.67	7.8	57.7
25	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	83.33	7.9	57.7
26	0.657	41818.	0.000	0.000	1.00	34.9	0.200	0.100	86.67	7.9	57.7
27	0.657	41818.	0.000	0.000	1.00	33.4	0.200	0.100	90.00	7.9	57.7
28	0.657	41818.	0.000	0.000	1.00	34.2	0.200	0.100	93.33	7.9	57.7
29	0.657	41818.	0.000	0.000	1.00	35.0	0.200	0.100	96.67	7.9	57.7
30	0.657	41818.	0.000	0.000	1.00	35.8	0.200	0.100	100.00	7.8	57.7
Toe						9.0	0.150	0.250			

19.707 kips total unreduced pile weight (g= 32.17 ft/s2)
19.707 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
40.00	12.05	1.00	0.800

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
406.5	15.9	8.32	8.36	-2.00	29	9	31.51	19	6	67.3	40.7

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 55.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 57.680 Pile Type Unknown
Pile Size (inch) 30.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2
100.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2

Wave Travel Time 2L/c (ms) 12.103

Pile and Soil Model Total Capacity Rut (kips) 570.4

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.657	41818.	0.010	0.000	0.85	0.0	0.000	0.100	3.33	7.8	57.7
2	0.657	41818.	0.000	0.000	1.00	0.0	0.000	0.100	6.67	7.8	57.7
14	0.657	41818.	0.000	0.000	1.00	6.7	0.200	0.100	46.67	7.8	57.7
15	0.657	41818.	0.000	0.000	1.00	26.2	0.200	0.100	50.00	7.8	57.7
16	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	53.33	7.8	57.7
20	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	66.67	7.8	57.7
21	0.657	41818.	0.000	0.000	1.00	34.9	0.200	0.100	70.00	7.9	57.7
22	0.657	41818.	0.000	0.000	1.00	34.0	0.200	0.100	73.33	7.9	57.7
23	0.657	41818.	0.000	0.000	1.00	33.8	0.200	0.100	76.67	7.9	57.7
24	0.657	41818.	0.000	0.000	1.00	34.6	0.200	0.100	80.00	7.9	57.7
25	0.657	41818.	0.000	0.000	1.00	35.4	0.200	0.100	83.33	7.9	57.7
26	0.657	41818.	0.000	0.000	1.00	36.2	0.200	0.100	86.67	7.9	57.7
27	0.657	41818.	0.000	0.000	1.00	37.1	0.200	0.100	90.00	7.9	57.7
28	0.657	41818.	0.000	0.000	1.00	37.7	0.200	0.100	93.33	7.9	57.7
29	0.657	41818.	0.000	0.000	1.00	34.3	0.200	0.100	96.67	7.9	57.7
30	0.657	41818.	0.000	0.000	1.00	31.1	0.200	0.100	100.00	7.8	57.7
Toe						14.4	0.150	0.250			

19.707 kips total unreduced pile weight (g= 32.17 ft/s2)
19.707 kips total reduced pile weight (g= 32.17 ft/s2)

URS-75

Depth ft	Stroke ft	Pressure Ratio	Efficy
55.00	12.05	1.00	0.800

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
570.4	25.3	9.06	9.05	-1.73	29	9	33.70	15	5	66.0	39.1

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 65.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 57.680 Pile Type Unknown
Pile Size (inch) 30.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2
100.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2

Wave Travel Time 2L/c (ms) 12.103

Pile and Soil Model Total Capacity Rut (kips) 668.4

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.657	41818.	0.010	0.000	0.85	0.0	0.000	0.100	3.33	7.8	57.7
2	0.657	41818.	0.000	0.000	1.00	0.0	0.000	0.100	6.67	7.8	57.7
11	0.657	41818.	0.000	0.000	1.00	6.7	0.200	0.100	36.67	7.8	57.7
12	0.657	41818.	0.000	0.000	1.00	26.2	0.200	0.100	40.00	7.8	57.7
13	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	43.33	7.8	57.7
17	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	56.67	7.8	57.7
18	0.657	41818.	0.000	0.000	1.00	34.9	0.200	0.100	60.00	7.8	57.7
19	0.657	41818.	0.000	0.000	1.00	34.0	0.200	0.100	63.33	7.8	57.7
20	0.657	41818.	0.000	0.000	1.00	33.8	0.200	0.100	66.67	7.8	57.7
21	0.657	41818.	0.000	0.000	1.00	34.6	0.200	0.100	70.00	7.9	57.7
22	0.657	41818.	0.000	0.000	1.00	35.4	0.200	0.100	73.33	7.9	57.7
23	0.657	41818.	0.000	0.000	1.00	36.2	0.200	0.100	76.67	7.9	57.7
24	0.657	41818.	0.000	0.000	1.00	37.1	0.200	0.100	80.00	7.9	57.7
25	0.657	41818.	0.000	0.000	1.00	37.7	0.200	0.100	83.33	7.9	57.7
26	0.657	41818.	0.000	0.000	1.00	34.3	0.200	0.100	86.67	7.9	57.7
27	0.657	41818.	0.000	0.000	1.00	31.1	0.200	0.100	90.00	7.9	57.7
28	0.657	41818.	0.000	0.000	1.00	31.9	0.200	0.100	93.33	7.9	57.7
29	0.657	41818.	0.000	0.000	1.00	32.7	0.200	0.100	96.67	7.9	57.7
30	0.657	41818.	0.000	0.000	1.00	33.4	0.200	0.100	100.00	7.8	57.7
Toe						14.4	0.150	0.250			

19.707 kips total unreduced pile weight (g= 32.17 ft/s2)
19.707 kips total reduced pile weight (g= 32.17 ft/s2)

URS-76

Depth ft	Stroke ft	Pressure Ratio	Efficy
65.00	12.05	1.00	0.800

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
668.4	32.0	9.44	9.43	-1.46	29	8	34.66	12	4	66.9	38.4

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 70.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 57.680 Pile Type Unknown
Pile Size (inch) 30.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2
100.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2

Wave Travel Time 2L/c (ms) 12.103

Pile and Soil Model Total Capacity Rut (kips) 934.3

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.657	41818.	0.010	0.000	0.85	0.0	0.000	0.100	3.33	7.8	57.7
2	0.657	41818.	0.000	0.000	1.00	0.0	0.000	0.100	6.67	7.8	57.7
10	0.657	41818.	0.000	0.000	1.00	15.5	0.200	0.100	33.33	7.9	57.7
11	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	36.67	7.8	57.7
16	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	53.33	7.8	57.7
17	0.657	41818.	0.000	0.000	1.00	34.9	0.200	0.100	56.67	7.8	57.7
18	0.657	41818.	0.000	0.000	1.00	33.4	0.200	0.100	60.00	7.8	57.7
19	0.657	41818.	0.000	0.000	1.00	34.2	0.200	0.100	63.33	7.8	57.7
20	0.657	41818.	0.000	0.000	1.00	35.0	0.200	0.100	66.67	7.8	57.7
21	0.657	41818.	0.000	0.000	1.00	35.8	0.200	0.100	70.00	7.9	57.7
22	0.657	41818.	0.000	0.000	1.00	36.7	0.200	0.100	73.33	7.9	57.7
23	0.657	41818.	0.000	0.000	1.00	37.5	0.200	0.100	76.67	7.9	57.7
24	0.657	41818.	0.000	0.000	1.00	38.0	0.200	0.100	80.00	7.9	57.7
25	0.657	41818.	0.000	0.000	1.00	30.7	0.200	0.100	83.33	7.9	57.7
26	0.657	41818.	0.000	0.000	1.00	31.5	0.200	0.100	86.67	7.9	57.7
27	0.657	41818.	0.000	0.000	1.00	32.3	0.200	0.100	90.00	7.9	57.7
28	0.657	41818.	0.000	0.000	1.00	33.0	0.200	0.100	93.33	7.9	57.7
29	0.657	41818.	0.000	0.000	1.00	33.7	0.200	0.100	96.67	7.9	57.7
30	0.657	41818.	0.000	0.000	1.00	155.8	0.058	0.100	100.00	7.8	57.7
Toe						107.6	0.150	0.250			

19.707 kips total unreduced pile weight (g= 32.17 ft/s2)
19.707 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
70.00	12.05	1.00	0.800

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
934.3	58.2	9.88	9.86	-1.22	10	46	35.67	11	4	69.1	37.5

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 72.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 57.680 Pile Type Unknown
Pile Size (inch) 30.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2
100.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2

Wave Travel Time 2L/c (ms) 12.103

Pile and Soil Model Total Capacity Rut (kips) 1056.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.657	41818.	0.010	0.000	0.85	0.0	0.000	0.100	3.33	7.8	57.7
2	0.657	41818.	0.000	0.000	1.00	0.0	0.000	0.100	6.67	7.8	57.7
9	0.657	41818.	0.000	0.000	1.00	8.0	0.200	0.100	30.00	7.9	57.7
10	0.657	41818.	0.000	0.000	1.00	28.4	0.200	0.100	33.33	7.9	57.7
11	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	36.67	7.8	57.7
15	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	50.00	7.8	57.7
16	0.657	41818.	0.000	0.000	1.00	34.9	0.200	0.100	53.33	7.8	57.7
17	0.657	41818.	0.000	0.000	1.00	33.9	0.200	0.100	56.67	7.8	57.7
18	0.657	41818.	0.000	0.000	1.00	33.9	0.200	0.100	60.00	7.8	57.7
19	0.657	41818.	0.000	0.000	1.00	34.6	0.200	0.100	63.33	7.8	57.7
20	0.657	41818.	0.000	0.000	1.00	35.5	0.200	0.100	66.67	7.8	57.7
21	0.657	41818.	0.000	0.000	1.00	36.3	0.200	0.100	70.00	7.9	57.7
22	0.657	41818.	0.000	0.000	1.00	37.2	0.200	0.100	73.33	7.9	57.7
23	0.657	41818.	0.000	0.000	1.00	37.8	0.200	0.100	76.67	7.9	57.7
24	0.657	41818.	0.000	0.000	1.00	33.6	0.200	0.100	80.00	7.9	57.7
25	0.657	41818.	0.000	0.000	1.00	31.2	0.200	0.100	83.33	7.9	57.7
26	0.657	41818.	0.000	0.000	1.00	32.0	0.200	0.100	86.67	7.9	57.7
27	0.657	41818.	0.000	0.000	1.00	32.7	0.200	0.100	90.00	7.9	57.7
28	0.657	41818.	0.000	0.000	1.00	33.5	0.200	0.100	93.33	7.9	57.7
29	0.657	41818.	0.000	0.000	1.00	90.1	0.087	0.100	96.67	7.9	57.7
30	0.657	41818.	0.000	0.000	1.00	201.4	0.050	0.100	100.00	7.8	57.7
Toe						107.6	0.150	0.250			

19.707 kips total unreduced pile weight (g= 32.17 ft/s2)
19.707 kips total reduced pile weight (g= 32.17 ft/s2)

URS-78

Depth ft	Stroke ft	Pressure Ratio	Efficy
72.00	12.05	1.00	0.800

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
1056.5	76.8	10.01	9.99	-1.27	9	44	36.11	10	4	69.9	37.3

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 74.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 57.680 Pile Type Unknown
Pile Size (inch) 30.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2
100.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2

Wave Travel Time 2L/c (ms) 12.103

Pile and Soil Model Total Capacity Rut (kips) 1182.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.657	41818.	0.010	0.000	0.85	0.0	0.000	0.100	3.33	7.8	57.7
2	0.657	41818.	0.000	0.000	1.00	0.0	0.000	0.100	6.67	7.8	57.7
8	0.657	41818.	0.000	0.000	1.00	2.6	0.200	0.100	26.67	7.9	57.7
9	0.657	41818.	0.000	0.000	1.00	19.8	0.200	0.100	30.00	7.9	57.7
10	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	33.33	7.9	57.7
15	0.657	41818.	0.000	0.000	1.00	34.9	0.200	0.100	50.00	7.8	57.7
16	0.657	41818.	0.000	0.000	1.00	34.5	0.200	0.100	53.33	7.8	57.7
17	0.657	41818.	0.000	0.000	1.00	33.5	0.200	0.100	56.67	7.8	57.7
18	0.657	41818.	0.000	0.000	1.00	34.3	0.200	0.100	60.00	7.8	57.7
19	0.657	41818.	0.000	0.000	1.00	35.1	0.200	0.100	63.33	7.8	57.7
20	0.657	41818.	0.000	0.000	1.00	36.0	0.200	0.100	66.67	7.8	57.7
21	0.657	41818.	0.000	0.000	1.00	36.8	0.200	0.100	70.00	7.9	57.7
22	0.657	41818.	0.000	0.000	1.00	37.6	0.200	0.100	73.33	7.9	57.7
23	0.657	41818.	0.000	0.000	1.00	36.5	0.200	0.100	76.67	7.9	57.7
24	0.657	41818.	0.000	0.000	1.00	30.9	0.200	0.100	80.00	7.9	57.7
25	0.657	41818.	0.000	0.000	1.00	31.7	0.200	0.100	83.33	7.9	57.7
26	0.657	41818.	0.000	0.000	1.00	32.4	0.200	0.100	86.67	7.9	57.7
27	0.657	41818.	0.000	0.000	1.00	33.2	0.200	0.100	90.00	7.9	57.7
28	0.657	41818.	0.000	0.000	1.00	33.9	0.200	0.100	93.33	7.9	57.7
29	0.657	41818.	0.000	0.000	1.00	189.2	0.052	0.100	96.67	7.9	57.7
30	0.657	41818.	0.000	0.000	1.00	207.9	0.050	0.100	100.00	7.8	57.7
Toe						107.6	0.150	0.250			

19.707 kips total unreduced pile weight (g= 32.17 ft/s2)
19.707 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
74.00	12.05	1.00	0.800

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
1182.5	101.8	10.13	10.11	-1.23	9	43	36.37	9	3	70.3	37.1

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 75.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 57.680 Pile Type Unknown
Pile Size (inch) 30.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2
100.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2

Wave Travel Time 2L/c (ms) 12.103

Pile and Soil Model Total Capacity Rut (kips) 1247.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.657	41818.	0.010	0.000	0.85	0.0	0.000	0.100	3.33	7.8	57.7
2	0.657	41818.	0.000	0.000	1.00	0.0	0.000	0.100	6.67	7.8	57.7
8	0.657	41818.	0.000	0.000	1.00	6.7	0.200	0.100	26.67	7.9	57.7
9	0.657	41818.	0.000	0.000	1.00	26.2	0.200	0.100	30.00	7.9	57.7
10	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	33.33	7.9	57.7
14	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	46.67	7.8	57.7
15	0.657	41818.	0.000	0.000	1.00	34.9	0.200	0.100	50.00	7.8	57.7
16	0.657	41818.	0.000	0.000	1.00	34.0	0.200	0.100	53.33	7.8	57.7
17	0.657	41818.	0.000	0.000	1.00	33.8	0.200	0.100	56.67	7.8	57.7
18	0.657	41818.	0.000	0.000	1.00	34.6	0.200	0.100	60.00	7.8	57.7
19	0.657	41818.	0.000	0.000	1.00	35.4	0.200	0.100	63.33	7.8	57.7
20	0.657	41818.	0.000	0.000	1.00	36.2	0.200	0.100	66.67	7.8	57.7
21	0.657	41818.	0.000	0.000	1.00	37.1	0.200	0.100	70.00	7.9	57.7
22	0.657	41818.	0.000	0.000	1.00	37.7	0.200	0.100	73.33	7.9	57.7
23	0.657	41818.	0.000	0.000	1.00	34.3	0.200	0.100	76.67	7.9	57.7
24	0.657	41818.	0.000	0.000	1.00	31.1	0.200	0.100	80.00	7.9	57.7
25	0.657	41818.	0.000	0.000	1.00	31.9	0.200	0.100	83.33	7.9	57.7
26	0.657	41818.	0.000	0.000	1.00	32.7	0.200	0.100	86.67	7.9	57.7
27	0.657	41818.	0.000	0.000	1.00	33.4	0.200	0.100	90.00	7.9	57.7
28	0.657	41818.	0.000	0.000	1.00	73.9	0.102	0.100	93.33	7.9	57.7
29	0.657	41818.	0.000	0.000	1.00	200.4	0.050	0.100	96.67	7.9	57.7
30	0.657	41818.	0.000	0.000	1.00	211.1	0.050	0.100	100.00	7.8	57.7
Toe						107.6	0.150	0.250			

19.707 kips total unreduced pile weight (g= 32.17 ft/s2)
19.707 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
75.00	12.05	1.00	0.800

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
1247.0	118.5	10.17	10.15	-1.22	9	42	36.52	9	4	70.5	37.0

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 80.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 57.680 Pile Type Unknown
Pile Size (inch) 30.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2
100.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2

Wave Travel Time 2L/c (ms) 12.103

Pile and Soil Model Total Capacity Rut (kips) 1583.9

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.657	41818.	0.010	0.000	0.85	0.0	0.000	0.100	3.33	7.8	57.7
2	0.657	41818.	0.000	0.000	1.00	0.0	0.000	0.100	6.67	7.8	57.7
7	0.657	41818.	0.000	0.000	1.00	15.5	0.200	0.100	23.33	7.9	57.7
8	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	26.67	7.9	57.7
13	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	43.33	7.8	57.7
14	0.657	41818.	0.000	0.000	1.00	34.9	0.200	0.100	46.67	7.8	57.7
15	0.657	41818.	0.000	0.000	1.00	33.4	0.200	0.100	50.00	7.8	57.7
16	0.657	41818.	0.000	0.000	1.00	34.2	0.200	0.100	53.33	7.8	57.7
17	0.657	41818.	0.000	0.000	1.00	35.0	0.200	0.100	56.67	7.8	57.7
18	0.657	41818.	0.000	0.000	1.00	35.8	0.200	0.100	60.00	7.8	57.7
19	0.657	41818.	0.000	0.000	1.00	36.7	0.200	0.100	63.33	7.8	57.7
20	0.657	41818.	0.000	0.000	1.00	37.5	0.200	0.100	66.67	7.8	57.7
21	0.657	41818.	0.000	0.000	1.00	38.0	0.200	0.100	70.00	7.9	57.7
22	0.657	41818.	0.000	0.000	1.00	30.7	0.200	0.100	73.33	7.9	57.7
23	0.657	41818.	0.000	0.000	1.00	31.5	0.200	0.100	76.67	7.9	57.7
24	0.657	41818.	0.000	0.000	1.00	32.3	0.200	0.100	80.00	7.9	57.7
25	0.657	41818.	0.000	0.000	1.00	33.0	0.200	0.100	83.33	7.9	57.7
26	0.657	41818.	0.000	0.000	1.00	33.7	0.200	0.100	86.67	7.9	57.7
27	0.657	41818.	0.000	0.000	1.00	155.8	0.058	0.100	90.00	7.9	57.7
28	0.657	41818.	0.000	0.000	1.00	205.7	0.050	0.100	93.33	7.9	57.7
29	0.657	41818.	0.000	0.000	1.00	216.5	0.050	0.100	96.67	7.9	57.7
30	0.657	41818.	0.000	0.000	1.00	227.3	0.050	0.100	100.00	7.8	57.7
Toe						107.6	0.150	0.250			

19.707 kips total unreduced pile weight (g= 32.17 ft/s2)
19.707 kips total reduced pile weight (g= 32.17 ft/s2)

URS-81

Depth ft	Stroke ft	Pressure Ratio	Efficy
80.00	12.05	1.00	0.800

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
1583.9	384.1	10.34	10.31	-1.23	7	39	36.86	7	3	70.6	36.7

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 90.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 57.680 Pile Type Unknown
Pile Size (inch) 30.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2
100.0	57.68	29000.	492.0	7.8	0.000	16524.	101.2

Wave Travel Time 2L/c (ms) 12.103

Pile and Soil Model Total Capacity Rut (kips) 2330.7

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.657	41818.	0.010	0.000	0.85	0.0	0.000	0.100	3.33	7.8	57.7
2	0.657	41818.	0.000	0.000	1.00	0.0	0.000	0.100	6.67	7.8	57.7
4	0.657	41818.	0.000	0.000	1.00	15.5	0.200	0.100	13.33	7.8	57.7
5	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	16.67	7.8	57.7
10	0.657	41818.	0.000	0.000	1.00	34.8	0.200	0.100	33.33	7.9	57.7
11	0.657	41818.	0.000	0.000	1.00	34.9	0.200	0.100	36.67	7.8	57.7
12	0.657	41818.	0.000	0.000	1.00	33.4	0.200	0.100	40.00	7.8	57.7
13	0.657	41818.	0.000	0.000	1.00	34.2	0.200	0.100	43.33	7.8	57.7
14	0.657	41818.	0.000	0.000	1.00	35.0	0.200	0.100	46.67	7.8	57.7
15	0.657	41818.	0.000	0.000	1.00	35.8	0.200	0.100	50.00	7.8	57.7
16	0.657	41818.	0.000	0.000	1.00	36.7	0.200	0.100	53.33	7.8	57.7
17	0.657	41818.	0.000	0.000	1.00	37.5	0.200	0.100	56.67	7.8	57.7
18	0.657	41818.	0.000	0.000	1.00	38.0	0.200	0.100	60.00	7.8	57.7
19	0.657	41818.	0.000	0.000	1.00	30.7	0.200	0.100	63.33	7.8	57.7
20	0.657	41818.	0.000	0.000	1.00	31.5	0.200	0.100	66.67	7.8	57.7
21	0.657	41818.	0.000	0.000	1.00	32.3	0.200	0.100	70.00	7.9	57.7
22	0.657	41818.	0.000	0.000	1.00	33.0	0.200	0.100	73.33	7.9	57.7
23	0.657	41818.	0.000	0.000	1.00	33.7	0.200	0.100	76.67	7.9	57.7
24	0.657	41818.	0.000	0.000	1.00	155.8	0.058	0.100	80.00	7.9	57.7
25	0.657	41818.	0.000	0.000	1.00	205.7	0.050	0.100	83.33	7.9	57.7
26	0.657	41818.	0.000	0.000	1.00	216.5	0.050	0.100	86.67	7.9	57.7
27	0.657	41818.	0.000	0.000	1.00	227.3	0.050	0.100	90.00	7.9	57.7
28	0.657	41818.	0.000	0.000	1.00	238.2	0.050	0.100	93.33	7.9	57.7
29	0.657	41818.	0.000	0.000	1.00	249.0	0.050	0.100	96.67	7.9	57.7
30	0.657	41818.	0.000	0.000	1.00	259.7	0.050	0.100	100.00	7.8	57.7
Toe						107.6	0.150	0.250			

19.707 kips total unreduced pile weight (g= 32.17 ft/s2)
19.707 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
90.00	12.05	1.00	0.800

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
2330.7	9999.0	10.50	10.48	-0.43	4	35	37.13	4	2	69.2	36.5

Ramp A/SR7 Pier1 Delmag D62-22 A-R7P1A1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 1.000 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
15.0	142.7	137.3	5.4	4.1	23.960	-5.391	6.39	78.4
30.0	301.6	292.6	9.0	10.6	29.703	-2.387	7.74	70.3
40.0	406.5	397.5	9.0	15.9	31.507	-1.998	8.32	67.3
55.0	570.4	556.0	14.4	25.3	33.697	-1.729	9.06	66.0
65.0	668.4	654.0	14.4	32.0	34.658	-1.461	9.44	66.9
70.0	934.3	826.7	107.6	58.2	35.672	-1.220	9.88	69.1
72.0	1056.5	948.9	107.6	76.8	36.110	-1.273	10.01	69.9
74.0	1182.5	1074.9	107.6	101.8	36.367	-1.230	10.13	70.3
75.0	1247.0	1139.4	107.6	118.5	36.525	-1.219	10.17	70.5
80.0	1583.9	1476.3	107.6	384.1	36.865	-1.235	10.34	70.6
90.0	2330.7	2223.1	107.6	9999.0	37.131	-0.426	10.50	69.2

Refusal occurred; no driving time output possible

Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
15.00	100.00	0.00	12.05	1.00	0.80	1.00	1.00
30.00	100.00	0.00	12.05	1.00	0.80	1.00	1.00
40.00	100.00	0.00	12.05	1.00	0.80	1.00	1.00
55.00	100.00	0.00	12.05	1.00	0.80	1.00	1.00
65.00	100.00	0.00	12.05	1.00	0.80	1.00	1.00
70.00	100.00	0.00	12.05	1.00	0.80	1.00	1.00
72.00	100.00	0.00	12.05	1.00	0.80	1.00	1.00
74.00	100.00	0.00	12.05	1.00	0.80	1.00	1.00
75.00	100.00	0.00	12.05	1.00	0.80	1.00	1.00
80.00	100.00	0.00	12.05	1.00	0.80	1.00	1.00
90.00	100.00	0.00	12.05	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	0.51	1.80	0.100	0.250	0.200	0.150	1.000	0.000	0.000
2.99	0.51	1.80	0.100	0.250	0.200	0.150	1.000	0.000	0.000
3.01	1.33	5.41	0.100	0.250	0.200	0.150	1.000	0.000	0.000
12.01	1.33	5.41	0.100	0.250	0.200	0.150	1.000	0.000	0.000
21.01	1.33	5.41	0.100	0.250	0.200	0.150	1.000	0.000	0.000
26.49	1.34	5.41	0.100	0.250	0.200	0.150	1.000	0.000	0.000
26.51	1.26	9.01	0.100	0.250	0.200	0.150	1.000	0.000	0.000
35.51	1.34	9.01	0.100	0.250	0.200	0.150	1.000	0.000	0.000
44.51	1.43	9.01	0.100	0.250	0.200	0.150	1.000	0.000	0.000
49.99	1.46	9.01	0.100	0.250	0.200	0.150	1.000	0.000	0.000
50.01	1.16	14.42	0.100	0.250	0.200	0.150	1.000	0.000	0.000
59.01	1.24	14.42	0.100	0.250	0.200	0.150	1.000	0.000	0.000
67.49	1.31	14.42	0.100	0.250	0.200	0.150	1.000	0.000	0.000
67.51	7.35	107.59	0.100	0.250	0.050	0.150	1.000	0.000	0.000
76.51	8.46	107.59	0.100	0.250	0.050	0.150	1.000	0.000	0.000
85.51	9.58	107.59	0.100	0.250	0.050	0.150	1.000	0.000	0.000
94.51	10.68	107.59	0.100	0.250	0.050	0.150	1.000	0.000	0.000
103.51	11.78	107.59	0.100	0.250	0.050	0.150	1.000	0.000	0.000

URS

Page ____ of ____

Job ____ Project No. ____ Sheet ____ of ____

Description ____ Computed by ____ Date ____

____ Checked by ____ Date ____

Reference

DRIVEABILITY

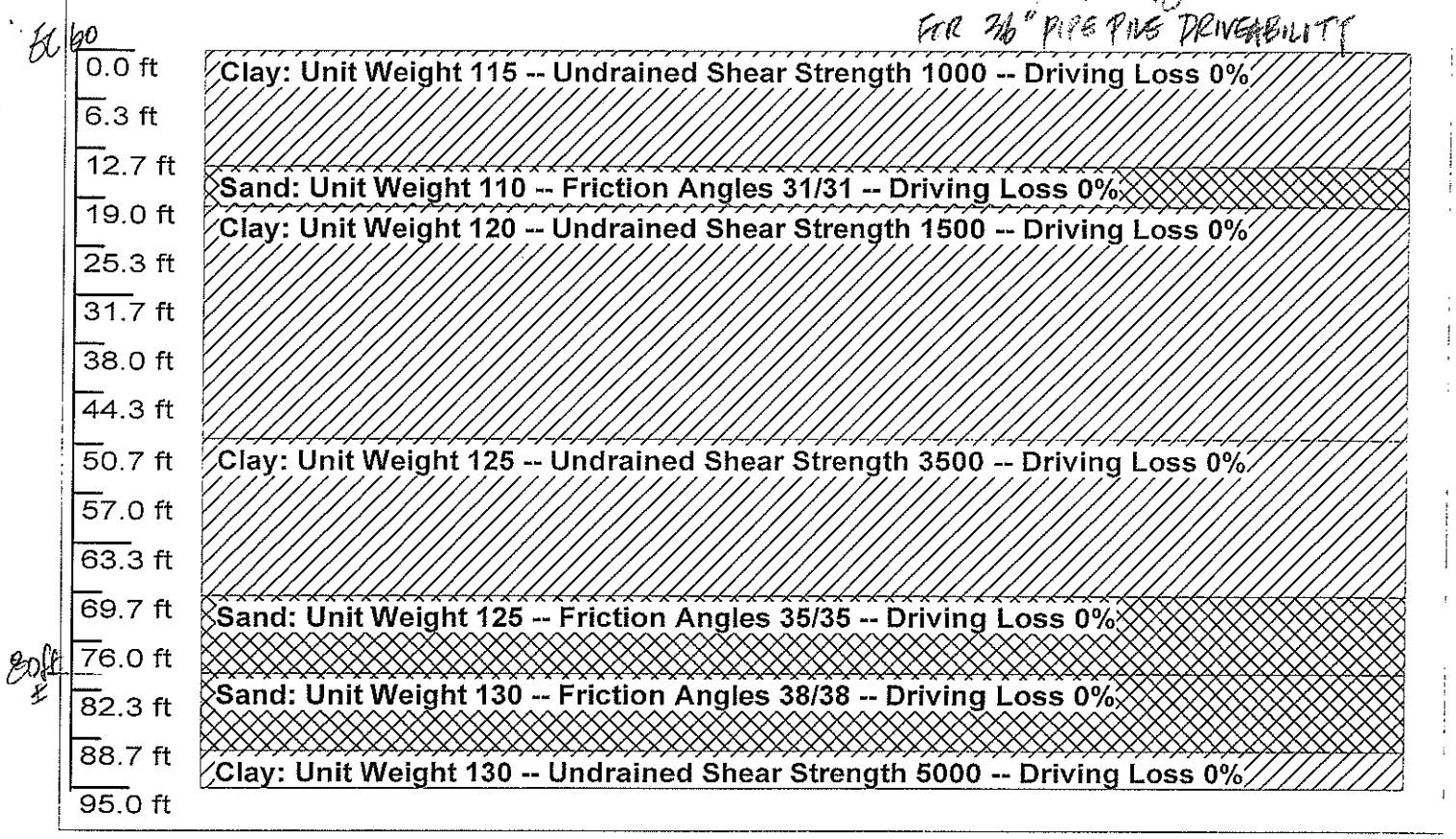
FOR 36" DIAM.

OPEN END PIPE PILE

Filename: Z:\DELDOT\SR1DEC~1\A-95P1B.DVN Ramp A / I95 Pier 1 (B)

Soil Profile

BORING IRW-68
FOR 36" PIPE PILE DRIVEABILITY



- REQUIRES 165 ft-K (eg DELMAG D62-22) HAMMER
- REQUIRES 50 Ksi steel (EVEN WITH INCREASING WALL FROM 0.625 INCH TO 0.75 INCH)
- DRIVEABLE TO 80± FT OR EL. -20±

FOR 36"Φ PIPE PILE DRIVEABILITY

5/8" WALL (0.625")

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A-95P1BW.DVN
Project Name: Ramp A / I95 Pier 1
Project Date: 12/12/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IRW-68 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft
Diameter of Pile: 36.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	15.00 ft	0.00%	115.00 pcf	1000.00 psf	T-79 Steel
2	Cohesionless	5.00 ft	0.00%	110.00 pcf	31.0/31.0	Nordlund
3	Cohesive	30.00 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
4	Cohesive	20.00 ft	0.00%	125.00 pcf	3500.00 psf	T-79 Steel
5	Cohesionless	10.00 ft	0.00%	125.00 pcf	35.0/35.0	Nordlund
6	Cohesionless	10.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund
7	Cohesive	5.00 ft	0.00%	130.00 pcf	5000.00 psf	T-79 Steel

A-95P1BW-1

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	800.00 psf	0.08 Kips
9.01 ft	Cohesive	N/A	N/A	800.00 psf	67.93 Kips
14.99 ft	Cohesive	N/A	N/A	800.00 psf	113.02 Kips
15.01 ft	Cohesionless	789.24 psf	24.74	N/A	113.14 Kips
19.99 ft	Cohesionless	907.76 psf	24.74	N/A	139.38 Kips
20.01 ft	Cohesive	N/A	N/A	1060.00 psf	139.54 Kips
29.01 ft	Cohesive	N/A	N/A	1060.00 psf	229.45 Kips
38.01 ft	Cohesive	N/A	N/A	1080.92 psf	322.92 Kips
47.01 ft	Cohesive	N/A	N/A	1104.42 psf	420.59 Kips
49.99 ft	Cohesive	N/A	N/A	1112.20 psf	453.80 Kips
50.01 ft	Cohesive	N/A	N/A	878.94 psf	454.00 Kips
59.01 ft	Cohesive	N/A	N/A	927.94 psf	532.71 Kips
68.01 ft	Cohesive	N/A	N/A	976.94 psf	619.74 Kips
69.99 ft	Cohesive	N/A	N/A	987.72 psf	640.00 Kips
70.01 ft	Cohesionless	4007.31 psf	27.93	N/A	640.47 Kips
79.01 ft	Cohesionless	4289.01 psf	27.93	N/A	992.21 Kips
79.99 ft	Cohesionless	4319.69 psf	27.93	N/A	1033.30 Kips
80.01 ft	Cohesionless	4633.34 psf	30.32	N/A	1034.39 Kips
89.01 ft	Cohesionless	4937.54 psf	30.32	N/A	1673.79 Kips
89.99 ft	Cohesionless	4970.66 psf	30.32	N/A	1748.17 Kips
90.01 ft	Cohesive	N/A	N/A	1096.72 psf	1749.04 Kips
94.99 ft	Cohesive	N/A	N/A	1123.83 psf	1801.79 Kips

A-95PIBW-5

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	63.62 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	63.62 Kips
14.99 ft	Cohesive	N/A	N/A	N/A	63.62 Kips
15.01 ft	Cohesionless	789.48 psf	35.20	146.07 Kips	118.41 Kips
19.99 ft	Cohesionless	1026.52 psf	35.20	146.07 Kips	146.07 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
29.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
38.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
47.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
49.99 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
50.01 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
59.01 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
68.01 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
69.99 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
70.01 ft	Cohesionless	4007.63 psf	64.00	760.58 Kips	760.58 Kips
79.01 ft	Cohesionless	4571.03 psf	64.00	760.58 Kips	760.58 Kips
79.99 ft	Cohesionless	4632.37 psf	64.00	760.58 Kips	760.58 Kips
80.01 ft	Cohesionless	4633.68 psf	110.40	1898.62 Kips	1898.62 Kips
89.01 ft	Cohesionless	5242.08 psf	110.40	1898.62 Kips	1898.62 Kips
89.99 ft	Cohesionless	5308.32 psf	110.40	1898.62 Kips	1898.62 Kips
90.01 ft	Cohesive	N/A	N/A	N/A	318.09 Kips
94.99 ft	Cohesive	N/A	N/A	N/A	318.09 Kips

A-95P1 BW-6

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.08 Kips	63.62 Kips	63.69 Kips
9.01 ft	67.93 Kips	63.62 Kips	131.55 Kips
14.99 ft	113.02 Kips	63.62 Kips	176.64 Kips
15.01 ft	113.14 Kips	118.41 Kips	231.55 Kips
19.99 ft	139.38 Kips	146.07 Kips	285.45 Kips
20.01 ft	139.54 Kips	95.43 Kips	234.97 Kips
29.01 ft	229.45 Kips	95.43 Kips	324.88 Kips
38.01 ft	322.92 Kips	95.43 Kips	418.34 Kips
47.01 ft	420.59 Kips	95.43 Kips	516.01 Kips
49.99 ft	453.80 Kips	95.43 Kips	549.23 Kips
50.01 ft	454.00 Kips	222.66 Kips	676.66 Kips
59.01 ft	532.71 Kips	222.66 Kips	755.37 Kips
68.01 ft	619.74 Kips	222.66 Kips	842.40 Kips
69.99 ft	640.00 Kips	222.66 Kips	862.66 Kips
70.01 ft	640.47 Kips	760.58 Kips	1401.05 Kips
79.01 ft	992.21 Kips	760.58 Kips	1752.79 Kips
79.99 ft	1033.30 Kips	760.58 Kips	1793.88 Kips
80.01 ft	1034.39 Kips	1898.62 Kips	2933.01 Kips
89.01 ft	1673.79 Kips	1898.62 Kips	3572.41 Kips
89.99 ft	1748.17 Kips	1898.62 Kips	3646.79 Kips
90.01 ft	1749.04 Kips	318.09 Kips	2067.13 Kips
94.99 ft	1801.79 Kips	318.09 Kips	2119.88 Kips

A-95 PIBW-7

FOR WEAP INPUT FROM RESULTS OF DRIVEN

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 1.000 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
7.5	120.1	56.5	63.6	3.0	20.858	-6.420	6.08	81.6
15.0	176.5	112.9	63.6	5.1	23.442	-5.923	6.72	75.6
15.0	231.6	113.1	118.5	7.0	24.813	-4.503	7.16	73.6
17.5	257.5	125.3	132.2	7.9	25.529	-4.299	7.32	72.6
20.0	285.2	139.2	146.0	8.9	26.307	-4.050	7.47	71.8
20.0	235.0	139.5	95.4	6.8	25.344	-5.440	7.16	73.4
35.0	384.9	289.5	95.4	13.9	28.654	-2.403	8.16	67.7
50.0	539.1	443.7	95.4	23.9	31.068	-1.280	8.99	65.2
50.0	666.7	444.1	222.7	34.8	31.655	-0.321	9.25	64.5
60.0	751.9	529.2	222.7	43.3	32.427	0.000	9.54	63.7
70.0	842.2	619.6	222.7	53.2	33.035	0.000	9.78	63.4
70.0	1381.0	620.5	760.6	304.4	33.886	-0.221	10.19	66.6
75.0	1569.9	809.3	760.6	531.6	34.263	-0.524	10.26	65.9
80.0	1772.9	1012.3	760.6	2334.0	34.181	-0.407	10.31	65.3
80.0	2913.1	1014.5	1898.6	9999.0	34.928	-0.521	10.46	66.7
85.0	3257.0	1358.4	1898.6	9999.0	34.981	-0.481	10.46	66.4
90.0	3625.1	1726.5	1898.6	9999.0	34.723	-0.199	10.53	66.0
90.0	2046.3	1728.2	318.1	1169.3	34.042	-0.173	10.43	64.7
91.0	2056.4	1738.3	318.1	1173.0	34.056	-0.052	10.42	64.2
92.0	2066.9	1748.8	318.1	1158.2	34.269	0.000	10.42	63.8

Refusal occurred; no driving time output possible

Soil Layer Resistance Values

Depth ft	X 1.25	Shaft Res. k/ft2	End Bearing kips	X Rut/Rg	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	1.00	0.80	63.62	4.34	0.100	0.300	0.200	0.150	1.000	0.000	0.000
9.01	1.00	0.80	63.62	4.34	0.100	0.300	0.200	0.150	1.000	0.000	0.000
14.99	1.00	0.80	63.62	4.34	0.100	0.300	0.200	0.150	1.000	0.000	0.000
15.01	0.61	0.49	118.41	8.08	0.100	0.300	0.050	0.150	1.000	0.000	0.000
19.99	0.77	0.63	146.07	9.97	0.100	0.300	0.050	0.150	1.000	0.000	0.000
20.01	1.33	1.06	95.43	6.51	0.100	0.300	0.200	0.150	1.000	0.000	0.000
29.01	1.33	1.06	95.43	6.51	0.100	0.300	0.200	0.150	1.000	0.000	0.000
38.01	1.35	1.08	95.43	6.51	0.100	0.300	0.200	0.150	1.000	0.000	0.000
47.01	1.38	1.10	95.43	6.51	0.100	0.300	0.200	0.150	1.000	0.000	0.000
49.99	1.39	1.11	95.43	6.51	0.100	0.300	0.200	0.150	1.000	0.000	0.000
50.01	1.10	0.88	222.66	15.19	0.100	0.300	0.200	0.150	1.000	0.000	0.000
59.01	1.16	0.93	222.66	15.19	0.100	0.300	0.200	0.150	1.000	0.000	0.000
68.01	1.23	0.98	222.66	15.19	0.100	0.300	0.200	0.150	1.000	0.000	0.000
69.99	1.24	0.99	222.66	15.19	0.100	0.300	0.200	0.150	1.000	0.000	0.000
70.01	4.84	3.87	760.58	51.9	0.100	0.300	0.050	0.150	1.000	0.000	0.000
79.01	5.53	4.42	760.58	51.9	0.100	0.300	0.050	0.150	1.000	0.000	0.000
79.99	5.60	4.48	760.58	51.9	0.100	0.300	0.050	0.150	1.000	0.000	0.000
80.01	8.84	7.07	1898.62	129.5	0.100	0.300	0.050	0.150	1.000	0.000	0.000
89.01	10.00	8.00	1898.62	129.5	0.100	0.300	0.050	0.150	1.000	0.000	0.000
89.99	10.13	8.10	1898.62	129.5	0.100	0.300	0.050	0.150	1.000	0.000	0.000
90.01	1.38	1.10	318.09	21.7	0.100	0.300	0.200	0.150	1.000	0.000	0.000
94.99	1.40	1.12	318.09	21.7	0.100	0.300	0.200	0.150	1.000	0.000	0.000

URS Corporation
Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1

Dec 12 2008
GRLWEAP(TM) Version 2005

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
0								
10.0	98.5	94.2	4.3	2.5	20.881	-7.347	6.00	82.8
17.0	162.3	153.4	8.8	4.6	23.556	-7.070	6.67	75.9
40.0	432.6	426.1	6.5	16.6	29.894	-3.187	8.47	65.5
60.0	677.4	662.2	15.2	33.6	32.553	-2.907	9.52	62.7
72.0	920.3	868.4	51.9	51.9	34.162	-0.983	10.09	64.6
75.0	1064.7	1012.8	51.9	64.5	34.281	-0.597	10.18	64.6
78.0	1215.5	1163.6	51.9	82.2	34.355	-0.913	10.27	64.5
81.0	1481.2	1351.6	129.6	149.1	34.464	-0.548	10.41	64.8
82.0	1566.3	1436.7	129.6	181.4	34.787	-0.604	10.45	65.0
88.0	2102.3	1972.7	129.6	1320.2	34.591	-0.411	10.53	65.4
91.0	2195.8	2174.1	21.7	789.9	34.598	-1.509	10.55	64.5

Total Continuous Driving Time 268.00 minutes; Total Number of Blows 9873

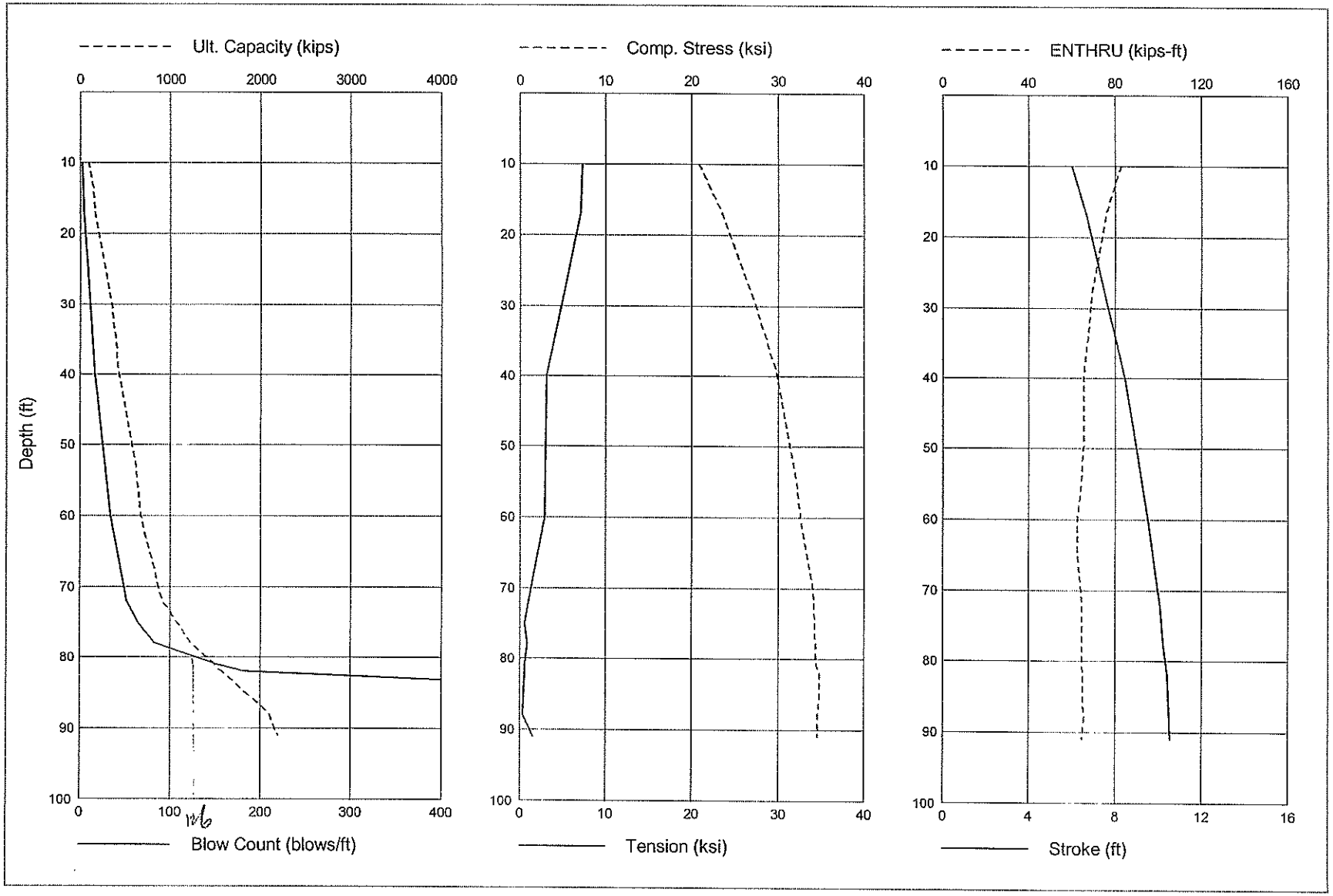
URS Corporation

Dec 12 2008

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

GRLWEAP(TM) Version 2005



GRLWEAP - Version 2005
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.
Copyright (c) 1998-2005, Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

Input File: Z:\DELDOT\SR1 DEC-08\A-95P1B1.GWI
Hammer File: D:\Program Files\PDI\GRLWEAP 2005\HAMMER2003.GW
Hammer File Version: 2003 (10/24/2008)

Input File Contents

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEx
-100	0	30	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0.000

Pile g	Hammer g	Toe Area	Pile Size	Pile Type
32.170	32.170	69.460	36.000	Unknown

W Cp	A Cp	E Cp	T Cp	CoR	ROut	StCp
3.800	415.000	417.0	3.500	0.800	0.010	0.0

A Cu	E Cu	T Cu	CoR	ROut	StCu
0.000	0.0	0.000	0.000	0.000	0.0

LPle	APle	EPle	WPle	Peri	Strg	CoR	ROut
92.000	69.460	29000.000	492.000	9.420	0.000	0.850	0.010

Manufac	Hmr Name	HmrType	No Seg-s
DELMAG	D 62-22	1	5

Ram Wt	Ram L	Ram Dia	MaxStrk	RtdStrk	Efficy
13.66	149.20	21.63	13.26	12.05	0.80

IB. Wt	IB. L	IB.Dia	IB CoR	IB RO
2.83	32.36	21.64	0.900	0.010

CompStrk	A Chamber	V Chamber	C Delay	C Duratn	Exp Coeff	VolCStart	Vol CEnd
22.79	368.30	677.00	0.001	0.001	1.250	0.00	0.00

P atm	P1	P2	P3	P4	P5
14.70	1440.00	1296.00	1166.00	1050.00	0.00

Stroke	Effic.	Pressure	R-Weight	T-Delay	Exp-Coeff	Eps-Str	Total-AW
12.0500	0.8000	1440.0000	0.0000	0.0000	0.0000	0.0100	0.0000

Qs	Qt	Js	Jt	Qx	Jx	Rati	Dept
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Research Soil Model: Atoe, Plug, Gap, Q-fac

0.000	0.000	0.000	0.000

Research Soil Model: RD-skn: m, d, toe: m, d

0.000	0.000	0.000	0.000

Res. Distribution

Dpth	Rskn	Rtoe	Qs	Qt	Js	Jt	SU F	LimD	SU T
0.01	1.00	4.34	0.10	0.30	0.20	0.15	1.00	0.00	0.00
9.01	1.00	4.34	0.10	0.30	0.20	0.15	1.00	0.00	0.00
14.99	1.00	4.34	0.10	0.30	0.20	0.15	1.00	0.00	0.00
15.01	0.61	8.08	0.10	0.30	0.05	0.15	1.00	0.00	0.00
19.99	0.79	9.97	0.10	0.30	0.05	0.15	1.00	0.00	0.00
20.01	1.33	6.51	0.10	0.30	0.20	0.15	1.00	0.00	0.00
29.01	1.33	6.51	0.10	0.30	0.20	0.15	1.00	0.00	0.00
38.01	1.35	6.51	0.10	0.30	0.20	0.15	1.00	0.00	0.00
47.01	1.38	6.51	0.10	0.30	0.20	0.15	1.00	0.00	0.00
49.99	1.39	6.51	0.10	0.30	0.20	0.15	1.00	0.00	0.00
50.01	1.10	15.19	0.10	0.30	0.20	0.15	1.00	0.00	0.00
59.01	1.16	15.19	0.10	0.30	0.20	0.15	1.00	0.00	0.00
68.01	1.23	15.19	0.10	0.30	0.20	0.15	1.00	0.00	0.00
69.99	1.24	15.19	0.10	0.30	0.20	0.15	1.00	0.00	0.00
70.01	4.84	51.90	0.10	0.30	0.05	0.15	1.00	0.00	0.00
79.01	5.53	51.90	0.10	0.30	0.05	0.15	1.00	0.00	0.00
79.99	5.60	51.90	0.10	0.30	0.05	0.15	1.00	0.00	0.00
80.01	8.84	129.56	0.10	0.30	0.05	0.15	1.00	0.00	0.00
89.01	10.00	129.56	0.10	0.30	0.05	0.15	1.00	0.00	0.00
89.99	10.13	129.56	0.10	0.30	0.05	0.15	1.00	0.00	0.00
90.01	1.38	21.71	0.10	0.30	0.20	0.15	1.00	0.00	0.00
94.99	1.40	21.71	0.10	0.30	0.20	0.15	1.00	0.00	0.00

URS-95

Gain/Loss factors: shaft and toe

1.00000	0.00000	0.00000	0.00000	0.00000
1.00000	0.00000	0.00000	0.00000	0.00000

Dpth	L	Wait	Strk	Pmx%	Eff.	Stff	CoR
10.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
17.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
40.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
60.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
72.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
75.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
78.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
81.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
82.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
88.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
91.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2005
English Units

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1

Hammer Model: D 62-22 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	2.732				
2	2.732	357110.0	1.000	0.0100	
3	2.732	357110.0	1.000	0.0100	
4	2.732	357110.0	1.000	0.0100	
5	2.732	357110.0	1.000	0.0100	
Imp Block	2.830	171403.4	0.900	0.0100	
Helmet	3.800	49444.3	0.800	0.0100	16.7
Combined Pile Top		51088.3			

HAMMER OPTIONS:

Hammer File ID No.	30	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	13.66	Ram Length	(inch)	149.20
Maximum Stroke	(ft)	13.26			
Rated Stroke	(ft)	12.05	Efficiency		0.800
Maximum Pressure	(psi)	1440.00	Actual Pressure	(psi)	1440.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	21.63			
Combustion Delay	(s)	0.00100	Ignition Duration	(s)	0.00100

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	415.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	417.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	3.50	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		1.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	49444.3	Stiffness	(kips/in)	0.0

Depth	(ft)	10.0		
Shaft Gain/Loss Factor		1.000	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	69.460	Pile Type	Unknown
Pile Size	(inch)	36.000		

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9
92.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model — Total Capacity Rut (kips) 98.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.780	51088.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	9.4	69.5
2	0.780	51088.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	9.4	69.5
25	0.780	51088.	0.000	0.000	1.00	1.3	0.200	0.100	82.14	9.4	69.5
26	0.780	51088.	0.000	0.000	1.00	31.0	0.200	0.100	85.43	9.4	69.5
28	0.780	51088.	0.000	0.000	1.00	31.0	0.200	0.100	92.00	9.4	69.5
Toe						4.3	0.150	0.300			

21.834 kips total unreduced pile weight (g= 32.17 ft/s2)
21.834 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
Pile Penetration (ft)	4.34	Pile Damping Fact.(k/ft/s)	2.438
Driveability Analysis			
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Normal			
Gravity Mass, Pile, Hammer:	32.170	32.170 32.170	
Output Segment Generation: Automatic			

URS-98

Depth ft	Stroke ft	Pressure Ratio	Efficy
10.00	12.05	1.00	0.800

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
98.5	2.5	6.00	6.02	-7.35	6	12	20.88	6	3	82.8	48.3

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 17.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 69.460 Pile Type Unknown
Pile Size (inch) 36.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9
92.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 162.3

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.780	51088.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	9.4	69.5
2	0.780	51088.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	9.4	69.5
23	0.780	51088.	0.000	0.000	1.00	5.3	0.200	0.100	75.57	9.4	69.5
24	0.780	51088.	0.000	0.000	1.00	31.0	0.200	0.100	78.86	9.4	69.5
28	0.780	51088.	0.000	0.000	1.00	24.3	0.125	0.100	92.00	9.4	69.5
Toe						8.8	0.150	0.300			

21.834 kips total unreduced pile weight (g= 32.17 ft/s2)
21.834 kips total reduced pile weight (g= 32.17 ft/s2)

URS-99

Depth ft	Stroke ft	Pressure Ratio	Efficy
17.00	12.05	1.00	0.800

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
162.3	4.6	6.67	6.69	-7.07	6	12	23.56	24	7	75.9	45.6

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 40.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 69.460 Pile Type Unknown
Pile Size (inch) 36.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9
92.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 432.6

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.780	51088.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	9.4	69.5
2	0.780	51088.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	9.4	69.5
16	0.780	51088.	0.000	0.000	1.00	5.3	0.200	0.100	52.57	9.4	69.5
17	0.780	51088.	0.000	0.000	1.00	31.0	0.200	0.100	55.86	9.4	69.5
21	0.780	51088.	0.000	0.000	1.00	24.3	0.125	0.100	69.00	9.4	69.5
22	0.780	51088.	0.000	0.000	1.00	24.4	0.072	0.100	72.29	9.4	69.5
23	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	75.57	9.4	69.5
25	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	82.14	9.4	69.5
26	0.780	51088.	0.000	0.000	1.00	41.4	0.200	0.100	85.43	9.4	69.5
27	0.780	51088.	0.000	0.000	1.00	41.6	0.200	0.100	88.71	9.4	69.5
28	0.780	51088.	0.000	0.000	1.00	41.8	0.200	0.100	92.00	9.4	69.5
Toe						6.5	0.150	0.300			

21.834 kips total unreduced pile weight (g= 32.17 ft/s2)
21.834 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
40.00	12.05	1.00	0.800

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
432.6	16.6	8.47	8.51	-3.19	27	8	29.89	17	5	65.5	40.4

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 60.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 69.460 Pile Type Unknown
Pile Size (inch) 36.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9
92.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 677.4

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.780	51088.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	9.4	69.5
2	0.780	51088.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	9.4	69.5
10	0.780	51088.	0.000	0.000	1.00	8.0	0.200	0.100	32.86	9.4	69.5
11	0.780	51088.	0.000	0.000	1.00	31.0	0.200	0.100	36.14	9.4	69.5
15	0.780	51088.	0.000	0.000	1.00	23.4	0.110	0.100	49.29	9.4	69.5
16	0.780	51088.	0.000	0.000	1.00	26.1	0.091	0.100	52.57	9.4	69.5
17	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	55.86	9.4	69.5
19	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	62.43	9.4	69.5
20	0.780	51088.	0.000	0.000	1.00	41.4	0.200	0.100	65.71	9.4	69.5
21	0.780	51088.	0.000	0.000	1.00	41.6	0.200	0.100	69.00	9.4	69.5
22	0.780	51088.	0.000	0.000	1.00	41.9	0.200	0.100	72.29	9.4	69.5
23	0.780	51088.	0.000	0.000	1.00	42.2	0.200	0.100	75.57	9.4	69.5
24	0.780	51088.	0.000	0.000	1.00	42.5	0.200	0.100	78.86	9.4	69.5
25	0.780	51088.	0.000	0.000	1.00	42.5	0.200	0.100	82.14	9.4	69.5
26	0.780	51088.	0.000	0.000	1.00	34.4	0.200	0.100	85.43	9.4	69.5
27	0.780	51088.	0.000	0.000	1.00	35.1	0.200	0.100	88.71	9.4	69.5
28	0.780	51088.	0.000	0.000	1.00	35.8	0.200	0.100	92.00	9.4	69.5
Toe						15.2	0.150	0.300			

21.834 kips total unreduced pile weight (g= 32.17 ft/s2)
21.834 kips total reduced pile weight (g= 32.17 ft/s2)

URS-101

Depth ft	Stroke ft	Pressure Ratio	Efficy
60.00	12.05	1.00	0.800

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
677.4	33.6	9.52	9.51	-2.91	27	8	32.55	11	4	62.7	38.2

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 72.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 69.460 Pile Type Unknown
Pile Size (inch) 36.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9
92.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 920.3

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.780	51088.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	9.4	69.5
2	0.780	51088.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	9.4	69.5
7	0.780	51088.	0.000	0.000	1.00	28.2	0.200	0.100	23.00	9.4	69.5
8	0.780	51088.	0.000	0.000	1.00	31.0	0.200	0.100	26.29	9.4	69.5
11	0.780	51088.	0.000	0.000	1.00	27.0	0.162	0.100	36.14	9.4	69.5
12	0.780	51088.	0.000	0.000	1.00	22.0	0.050	0.100	39.43	9.4	69.5
13	0.780	51088.	0.000	0.000	1.00	38.2	0.183	0.100	42.71	9.4	69.5
14	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	46.00	9.4	69.5
16	0.780	51088.	0.000	0.000	1.00	41.3	0.200	0.100	52.57	9.4	69.5
17	0.780	51088.	0.000	0.000	1.00	41.5	0.200	0.100	55.86	9.4	69.5
18	0.780	51088.	0.000	0.000	1.00	41.8	0.200	0.100	59.14	9.4	69.5
19	0.780	51088.	0.000	0.000	1.00	42.1	0.200	0.100	62.43	9.4	69.5
20	0.780	51088.	0.000	0.000	1.00	42.4	0.200	0.100	65.71	9.4	69.5
21	0.780	51088.	0.000	0.000	1.00	42.7	0.200	0.100	69.00	9.4	69.5
22	0.780	51088.	0.000	0.000	1.00	36.9	0.200	0.100	72.29	9.4	69.5
23	0.780	51088.	0.000	0.000	1.00	34.9	0.200	0.100	75.57	9.4	69.5
24	0.780	51088.	0.000	0.000	1.00	35.5	0.200	0.100	78.86	9.4	69.5
25	0.780	51088.	0.000	0.000	1.00	36.3	0.200	0.100	82.14	9.4	69.5
26	0.780	51088.	0.000	0.000	1.00	37.1	0.200	0.100	85.43	9.4	69.5
27	0.780	51088.	0.000	0.000	1.00	37.8	0.200	0.100	88.71	9.4	69.5
28	0.780	51088.	0.000	0.000	1.00	107.6	0.071	0.100	92.00	9.4	69.5
Toe						51.9	0.150	0.300			

21.834 kips total unreduced pile weight (g= 32.17 ft/s2)
21.834 kips total reduced pile weight (g= 32.17 ft/s2)

URS-102

Depth ft	Stroke ft	Pressure Ratio	Efficy
72.00	12.05	1.00	0.800

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
920.3	51.9	10.09	10.00	-0.98	26	8	34.16	7	3	64.6	37.2

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 75.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 69.460 Pile Type Unknown
Pile Size (inch) 36.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9
92.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 1064.7

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.780	51088.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	9.4	69.5
2	0.780	51088.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	9.4	69.5
6	0.780	51088.	0.000	0.000	1.00	25.5	0.200	0.100	19.71	9.4	69.5
7	0.780	51088.	0.000	0.000	1.00	31.0	0.200	0.100	23.00	9.4	69.5
10	0.780	51088.	0.000	0.000	1.00	27.9	0.173	0.100	32.86	9.4	69.5
11	0.780	51088.	0.000	0.000	1.00	21.7	0.050	0.100	36.14	9.4	69.5
12	0.780	51088.	0.000	0.000	1.00	36.7	0.174	0.100	39.43	9.4	69.5
13	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	42.71	9.4	69.5
15	0.780	51088.	0.000	0.000	1.00	41.3	0.200	0.100	49.29	9.4	69.5
16	0.780	51088.	0.000	0.000	1.00	41.5	0.200	0.100	52.57	9.4	69.5
17	0.780	51088.	0.000	0.000	1.00	41.7	0.200	0.100	55.86	9.4	69.5
18	0.780	51088.	0.000	0.000	1.00	42.0	0.200	0.100	59.14	9.4	69.5
19	0.780	51088.	0.000	0.000	1.00	42.4	0.200	0.100	62.43	9.4	69.5
20	0.780	51088.	0.000	0.000	1.00	42.7	0.200	0.100	65.71	9.4	69.5
21	0.780	51088.	0.000	0.000	1.00	37.7	0.200	0.100	69.00	9.4	69.5
22	0.780	51088.	0.000	0.000	1.00	34.8	0.200	0.100	72.29	9.4	69.5
23	0.780	51088.	0.000	0.000	1.00	35.5	0.200	0.100	75.57	9.4	69.5
24	0.780	51088.	0.000	0.000	1.00	36.2	0.200	0.100	78.86	9.4	69.5
25	0.780	51088.	0.000	0.000	1.00	37.0	0.200	0.100	82.14	9.4	69.5
26	0.780	51088.	0.000	0.000	1.00	37.8	0.200	0.100	85.43	9.4	69.5
27	0.780	51088.	0.000	0.000	1.00	97.5	0.078	0.100	88.71	9.4	69.5
28	0.780	51088.	0.000	0.000	1.00	157.7	0.050	0.100	92.00	9.4	69.5
Toe						51.9	0.150	0.300			

21.834 kips total unreduced pile weight (g= 32.17 ft/s2)
21.834 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
75.00	12.05	1.00	0.800

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
1064.7	64.5	10.18	10.12	-0.60	6	43	34.28	6	3	64.6	37.1

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 78.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 69.460 Pile Type Unknown
Pile Size (inch) 36.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9
92.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 1215.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.780	51088.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	9.4	69.5
2	0.780	51088.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	9.4	69.5
5	0.780	51088.	0.000	0.000	1.00	22.8	0.200	0.100	16.43	9.4	69.5
6	0.780	51088.	0.000	0.000	1.00	31.0	0.200	0.100	19.71	9.4	69.5
9	0.780	51088.	0.000	0.000	1.00	28.9	0.183	0.100	29.57	9.4	69.5
10	0.780	51088.	0.000	0.000	1.00	21.3	0.050	0.100	32.86	9.4	69.5
11	0.780	51088.	0.000	0.000	1.00	35.1	0.165	0.100	36.14	9.4	69.5
12	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	39.43	9.4	69.5
14	0.780	51088.	0.000	0.000	1.00	41.3	0.200	0.100	46.00	9.4	69.5
15	0.780	51088.	0.000	0.000	1.00	41.5	0.200	0.100	49.29	9.4	69.5
16	0.780	51088.	0.000	0.000	1.00	41.7	0.200	0.100	52.57	9.4	69.5
17	0.780	51088.	0.000	0.000	1.00	42.0	0.200	0.100	55.86	9.4	69.5
18	0.780	51088.	0.000	0.000	1.00	42.4	0.200	0.100	59.14	9.4	69.5
19	0.780	51088.	0.000	0.000	1.00	42.7	0.200	0.100	62.43	9.4	69.5
20	0.780	51088.	0.000	0.000	1.00	38.4	0.200	0.100	65.71	9.4	69.5
21	0.780	51088.	0.000	0.000	1.00	34.7	0.200	0.100	69.00	9.4	69.5
22	0.780	51088.	0.000	0.000	1.00	35.4	0.200	0.100	72.29	9.4	69.5
23	0.780	51088.	0.000	0.000	1.00	36.1	0.200	0.100	75.57	9.4	69.5
24	0.780	51088.	0.000	0.000	1.00	36.9	0.200	0.100	78.86	9.4	69.5
25	0.780	51088.	0.000	0.000	1.00	37.7	0.200	0.100	82.14	9.4	69.5
26	0.780	51088.	0.000	0.000	1.00	87.5	0.087	0.100	85.43	9.4	69.5
27	0.780	51088.	0.000	0.000	1.00	157.1	0.050	0.100	88.71	9.4	69.5
28	0.780	51088.	0.000	0.000	1.00	164.9	0.050	0.100	92.00	9.4	69.5
Toe						51.9	0.150	0.300			

21.834 kips total unreduced pile weight (g= 32.17 ft/s2)
21.834 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
78.00	12.05	1.00	0.800

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
1215.5	82.2	10.27	10.20	-0.91	5	43	34.36	5	3	64.5	36.9

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 81.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 69.460 Pile Type Unknown
Pile Size (inch) 36.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9
92.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 1481.2

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.780	51088.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	9.4	69.5
2	0.780	51088.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	9.4	69.5
4	0.780	51088.	0.000	0.000	1.00	20.1	0.200	0.100	13.14	9.4	69.5
5	0.780	51088.	0.000	0.000	1.00	31.0	0.200	0.100	16.43	9.4	69.5
8	0.780	51088.	0.000	0.000	1.00	29.9	0.192	0.100	26.29	9.4	69.5
9	0.780	51088.	0.000	0.000	1.00	21.0	0.050	0.100	29.57	9.4	69.5
10	0.780	51088.	0.000	0.000	1.00	33.6	0.154	0.100	32.86	9.4	69.5
11	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	36.14	9.4	69.5
13	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	42.71	9.4	69.5
14	0.780	51088.	0.000	0.000	1.00	41.5	0.200	0.100	46.00	9.4	69.5
15	0.780	51088.	0.000	0.000	1.00	41.7	0.200	0.100	49.29	9.4	69.5
16	0.780	51088.	0.000	0.000	1.00	42.0	0.200	0.100	52.57	9.4	69.5
17	0.780	51088.	0.000	0.000	1.00	42.3	0.200	0.100	55.86	9.4	69.5
18	0.780	51088.	0.000	0.000	1.00	42.7	0.200	0.100	59.14	9.4	69.5
19	0.780	51088.	0.000	0.000	1.00	39.1	0.200	0.100	62.43	9.4	69.5
20	0.780	51088.	0.000	0.000	1.00	34.7	0.200	0.100	65.71	9.4	69.5
21	0.780	51088.	0.000	0.000	1.00	35.4	0.200	0.100	69.00	9.4	69.5
22	0.780	51088.	0.000	0.000	1.00	36.1	0.200	0.100	72.29	9.4	69.5
23	0.780	51088.	0.000	0.000	1.00	36.8	0.200	0.100	75.57	9.4	69.5
24	0.780	51088.	0.000	0.000	1.00	37.6	0.200	0.100	78.86	9.4	69.5
25	0.780	51088.	0.000	0.000	1.00	77.5	0.099	0.100	82.14	9.4	69.5
26	0.780	51088.	0.000	0.000	1.00	156.4	0.050	0.100	85.43	9.4	69.5
27	0.780	51088.	0.000	0.000	1.00	164.2	0.050	0.100	88.71	9.4	69.5
28	0.780	51088.	0.000	0.000	1.00	202.7	0.050	0.100	92.00	9.4	69.5
Toe						129.6	0.150	0.300			

21.834 kips total unreduced pile weight (g= 32.17 ft/s2)
21.834 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
81.00	12.05	1.00	0.800

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
1481.2	149.1	10.41	10.32	-0.55	4	38	34.46	4	2	64.8	36.7

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 82.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 69.460 Pile Type Unknown
Pile Size (inch) 36.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9
92.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 1566.3

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.780	51088.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	9.4	69.5
2	0.780	51088.	0.000	0.000	1.00	0.0	0.000	0.100	6.57	9.4	69.5
4	0.780	51088.	0.000	0.000	1.00	29.6	0.200	0.100	13.14	9.4	69.5
5	0.780	51088.	0.000	0.000	1.00	31.0	0.200	0.100	16.43	9.4	69.5
8	0.780	51088.	0.000	0.000	1.00	26.5	0.157	0.100	26.29	9.4	69.5
9	0.780	51088.	0.000	0.000	1.00	22.1	0.050	0.100	29.57	9.4	69.5
10	0.780	51088.	0.000	0.000	1.00	39.0	0.188	0.100	32.86	9.4	69.5
11	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	36.14	9.4	69.5
12	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	39.43	9.4	69.5
13	0.780	51088.	0.000	0.000	1.00	41.3	0.200	0.100	42.71	9.4	69.5
14	0.780	51088.	0.000	0.000	1.00	41.5	0.200	0.100	46.00	9.4	69.5
15	0.780	51088.	0.000	0.000	1.00	41.8	0.200	0.100	49.29	9.4	69.5
16	0.780	51088.	0.000	0.000	1.00	42.1	0.200	0.100	52.57	9.4	69.5
17	0.780	51088.	0.000	0.000	1.00	42.4	0.200	0.100	55.86	9.4	69.5
18	0.780	51088.	0.000	0.000	1.00	42.8	0.200	0.100	59.14	9.4	69.5
19	0.780	51088.	0.000	0.000	1.00	36.6	0.200	0.100	62.43	9.4	69.5
20	0.780	51088.	0.000	0.000	1.00	34.9	0.200	0.100	65.71	9.4	69.5
21	0.780	51088.	0.000	0.000	1.00	35.6	0.200	0.100	69.00	9.4	69.5
22	0.780	51088.	0.000	0.000	1.00	36.3	0.200	0.100	72.29	9.4	69.5
23	0.780	51088.	0.000	0.000	1.00	37.1	0.200	0.100	75.57	9.4	69.5
24	0.780	51088.	0.000	0.000	1.00	37.9	0.200	0.100	78.86	9.4	69.5
25	0.780	51088.	0.000	0.000	1.00	112.7	0.068	0.100	82.14	9.4	69.5
26	0.780	51088.	0.000	0.000	1.00	158.8	0.050	0.100	85.43	9.4	69.5
27	0.780	51088.	0.000	0.000	1.00	166.6	0.050	0.100	88.71	9.4	69.5
28	0.780	51088.	0.000	0.000	1.00	236.2	0.050	0.100	92.00	9.4	69.5
Toe						129.6	0.150	0.300			

21.834 kips total unreduced pile weight (g= 32.17 ft/s2)
21.834 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
82.00	12.05	1.00	0.800

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
1566.3	181.4	10.45	10.35	-0.60	4	37	34.79	4	2	65.0	36.6

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 88.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 69.460 Pile Type Unknown
Pile Size (inch) 36.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9
92.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 2102.3

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.780	51088.	0.010	0.000	0.85	0.0	0.000	0.100	3.29	9.4	69.5
2	0.780	51088.	0.000	0.000	1.00	24.2	0.200	0.100	6.57	9.4	69.5
3	0.780	51088.	0.000	0.000	1.00	31.0	0.200	0.100	9.86	9.4	69.5
6	0.780	51088.	0.000	0.000	1.00	28.4	0.178	0.100	19.71	9.4	69.5
7	0.780	51088.	0.000	0.000	1.00	21.5	0.050	0.100	23.00	9.4	69.5
8	0.780	51088.	0.000	0.000	1.00	35.9	0.170	0.100	26.29	9.4	69.5
9	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	29.57	9.4	69.5
11	0.780	51088.	0.000	0.000	1.00	41.3	0.200	0.100	36.14	9.4	69.5
12	0.780	51088.	0.000	0.000	1.00	41.5	0.200	0.100	39.43	9.4	69.5
13	0.780	51088.	0.000	0.000	1.00	41.7	0.200	0.100	42.71	9.4	69.5
14	0.780	51088.	0.000	0.000	1.00	42.0	0.200	0.100	46.00	9.4	69.5
15	0.780	51088.	0.000	0.000	1.00	42.4	0.200	0.100	49.29	9.4	69.5
16	0.780	51088.	0.000	0.000	1.00	42.7	0.200	0.100	52.57	9.4	69.5
17	0.780	51088.	0.000	0.000	1.00	38.0	0.200	0.100	55.86	9.4	69.5
18	0.780	51088.	0.000	0.000	1.00	34.8	0.200	0.100	59.14	9.4	69.5
19	0.780	51088.	0.000	0.000	1.00	35.4	0.200	0.100	62.43	9.4	69.5
20	0.780	51088.	0.000	0.000	1.00	36.2	0.200	0.100	65.71	9.4	69.5
21	0.780	51088.	0.000	0.000	1.00	37.0	0.200	0.100	69.00	9.4	69.5
22	0.780	51088.	0.000	0.000	1.00	37.7	0.200	0.100	72.29	9.4	69.5
23	0.780	51088.	0.000	0.000	1.00	92.5	0.083	0.100	75.57	9.4	69.5
24	0.780	51088.	0.000	0.000	1.00	157.4	0.050	0.100	78.86	9.4	69.5
25	0.780	51088.	0.000	0.000	1.00	165.2	0.050	0.100	82.14	9.4	69.5
26	0.780	51088.	0.000	0.000	1.00	217.0	0.050	0.100	85.43	9.4	69.5
27	0.780	51088.	0.000	0.000	1.00	285.8	0.050	0.100	88.71	9.4	69.5
28	0.780	51088.	0.000	0.000	1.00	298.9	0.050	0.100	92.00	9.4	69.5
Toe						129.6	0.150	0.300			

21.834 kips total unreduced pile weight (g= 32.17 ft/s2)
21.834 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
88.00	12.05	1.00	0.800

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
2102.3	1320.2	10.53	10.43	-0.41	2	34	34.59	2	2	65.4	36.5

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Depth (ft) 91.0
Shaft Gain/Loss Factor 1.000 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 69.460 Pile Type Unknown
Pile Size (inch) 36.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9
92.0	69.46	29000.	492.0	9.4	0.000	16524.	121.9

Wave Travel Time 2L/c (ms) 11.135

Pile and Soil Model Total Capacity Rut (kips) 2195.8

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.780	51088.	0.010	0.000	0.85	21.5	0.200	0.100	3.29	9.4	69.5
2	0.780	51088.	0.000	0.000	1.00	31.0	0.200	0.100	6.57	9.4	69.5
5	0.780	51088.	0.000	0.000	1.00	29.4	0.187	0.100	16.43	9.4	69.5
6	0.780	51088.	0.000	0.000	1.00	21.2	0.050	0.100	19.71	9.4	69.5
7	0.780	51088.	0.000	0.000	1.00	34.3	0.159	0.100	23.00	9.4	69.5
8	0.780	51088.	0.000	0.000	1.00	41.2	0.200	0.100	26.29	9.4	69.5
10	0.780	51088.	0.000	0.000	1.00	41.3	0.200	0.100	32.86	9.4	69.5
11	0.780	51088.	0.000	0.000	1.00	41.5	0.200	0.100	36.14	9.4	69.5
12	0.780	51088.	0.000	0.000	1.00	41.7	0.200	0.100	39.43	9.4	69.5
13	0.780	51088.	0.000	0.000	1.00	42.0	0.200	0.100	42.71	9.4	69.5
14	0.780	51088.	0.000	0.000	1.00	42.3	0.200	0.100	46.00	9.4	69.5
15	0.780	51088.	0.000	0.000	1.00	42.7	0.200	0.100	49.29	9.4	69.5
16	0.780	51088.	0.000	0.000	1.00	38.8	0.200	0.100	52.57	9.4	69.5
17	0.780	51088.	0.000	0.000	1.00	34.7	0.200	0.100	55.86	9.4	69.5
18	0.780	51088.	0.000	0.000	1.00	35.4	0.200	0.100	59.14	9.4	69.5
19	0.780	51088.	0.000	0.000	1.00	36.1	0.200	0.100	62.43	9.4	69.5
20	0.780	51088.	0.000	0.000	1.00	36.9	0.200	0.100	65.71	9.4	69.5
21	0.780	51088.	0.000	0.000	1.00	37.7	0.200	0.100	69.00	9.4	69.5
22	0.780	51088.	0.000	0.000	1.00	82.5	0.093	0.100	72.29	9.4	69.5
23	0.780	51088.	0.000	0.000	1.00	156.7	0.050	0.100	75.57	9.4	69.5
24	0.780	51088.	0.000	0.000	1.00	164.5	0.050	0.100	78.86	9.4	69.5
25	0.780	51088.	0.000	0.000	1.00	207.4	0.050	0.100	82.14	9.4	69.5
26	0.780	51088.	0.000	0.000	1.00	284.7	0.050	0.100	85.43	9.4	69.5
27	0.780	51088.	0.000	0.000	1.00	297.8	0.050	0.100	88.71	9.4	69.5
28	0.780	51088.	0.000	0.000	1.00	227.9	0.059	0.100	92.00	9.4	69.5
Toe						21.7	0.150	0.300			

21.834 kips total unreduced pile weight (g= 32.17 ft/s2)
21.834 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
91.00	12.05	1.00	0.800

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
2195.8	789.9	10.55	10.45	-1.51	28	8	34.60	1	2	64.5	36.5

Ramp A/I95 Pier 1 Delmag D62-22 A-95P1B1 12/12/2008
URS Corporation GRLWEAP(TM) Version 2005

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 1.000 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
10.0	98.5	94.2	4.3	2.5	20.881	-7.347	6.00	82.8
17.0	162.3	153.4	8.8	4.6	23.556	-7.070	6.67	75.9
40.0	432.6	426.1	6.5	16.6	29.894	-3.187	8.47	65.5
60.0	677.4	662.2	15.2	33.6	32.553	-2.907	9.52	62.7
72.0	920.3	868.4	51.9	51.9	34.162	-0.983	10.09	64.6
75.0	1064.7	1012.8	51.9	64.5	34.281	-0.597	10.18	64.6
78.0	1215.5	1163.6	51.9	82.2	34.355	-0.913	10.27	64.5
81.0	1481.2	1351.6	129.6	149.1	34.464	-0.548	10.41	64.8
82.0	1566.3	1436.7	129.6	181.4	34.787	-0.604	10.45	65.0
88.0	2102.3	1972.7	129.6	1320.2	34.591	-0.411	10.53	65.4
91.0	2195.8	2174.1	21.7	789.9	34.598	-1.509	10.55	64.5

Total Driving Time 268 minutes; Total No. of Blows 9873

Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
10.00	92.00	0.00	12.05	1.00	0.80	1.00	1.00
17.00	92.00	0.00	12.05	1.00	0.80	1.00	1.00
40.00	92.00	0.00	12.05	1.00	0.80	1.00	1.00
60.00	92.00	0.00	12.05	1.00	0.80	1.00	1.00
72.00	92.00	0.00	12.05	1.00	0.80	1.00	1.00
75.00	92.00	0.00	12.05	1.00	0.80	1.00	1.00
78.00	92.00	0.00	12.05	1.00	0.80	1.00	1.00
81.00	92.00	0.00	12.05	1.00	0.80	1.00	1.00
82.00	92.00	0.00	12.05	1.00	0.80	1.00	1.00
88.00	92.00	0.00	12.05	1.00	0.80	1.00	1.00
91.00	92.00	0.00	12.05	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	1.00	4.34	0.100	0.300	0.200	0.150	1.000	0.000	0.000
9.01	1.00	4.34	0.100	0.300	0.200	0.150	1.000	0.000	0.000
14.99	1.00	4.34	0.100	0.300	0.200	0.150	1.000	0.000	0.000
15.01	0.61	8.08	0.100	0.300	0.050	0.150	1.000	0.000	0.000
19.99	0.79	9.97	0.100	0.300	0.050	0.150	1.000	0.000	0.000
20.01	1.33	6.51	0.100	0.300	0.200	0.150	1.000	0.000	0.000
29.01	1.33	6.51	0.100	0.300	0.200	0.150	1.000	0.000	0.000
38.01	1.35	6.51	0.100	0.300	0.200	0.150	1.000	0.000	0.000
47.01	1.38	6.51	0.100	0.300	0.200	0.150	1.000	0.000	0.000
49.99	1.39	6.51	0.100	0.300	0.200	0.150	1.000	0.000	0.000
50.01	1.10	15.19	0.100	0.300	0.200	0.150	1.000	0.000	0.000
59.01	1.16	15.19	0.100	0.300	0.200	0.150	1.000	0.000	0.000
68.01	1.23	15.19	0.100	0.300	0.200	0.150	1.000	0.000	0.000
69.99	1.24	15.19	0.100	0.300	0.200	0.150	1.000	0.000	0.000
70.01	4.84	51.90	0.100	0.300	0.050	0.150	1.000	0.000	0.000
79.01	5.53	51.90	0.100	0.300	0.050	0.150	1.000	0.000	0.000
79.99	5.60	51.90	0.100	0.300	0.050	0.150	1.000	0.000	0.000
80.01	8.84	129.56	0.100	0.300	0.050	0.150	1.000	0.000	0.000
89.01	10.00	129.56	0.100	0.300	0.050	0.150	1.000	0.000	0.000
89.99	10.13	129.56	0.100	0.300	0.050	0.150	1.000	0.000	0.000
90.01	1.38	21.71	0.100	0.300	0.200	0.150	1.000	0.000	0.000
94.99	1.40	21.71	0.100	0.300	0.200	0.150	1.000	0.000	0.000

URS-110

Lateral Analysis of Unstrapped Abutment

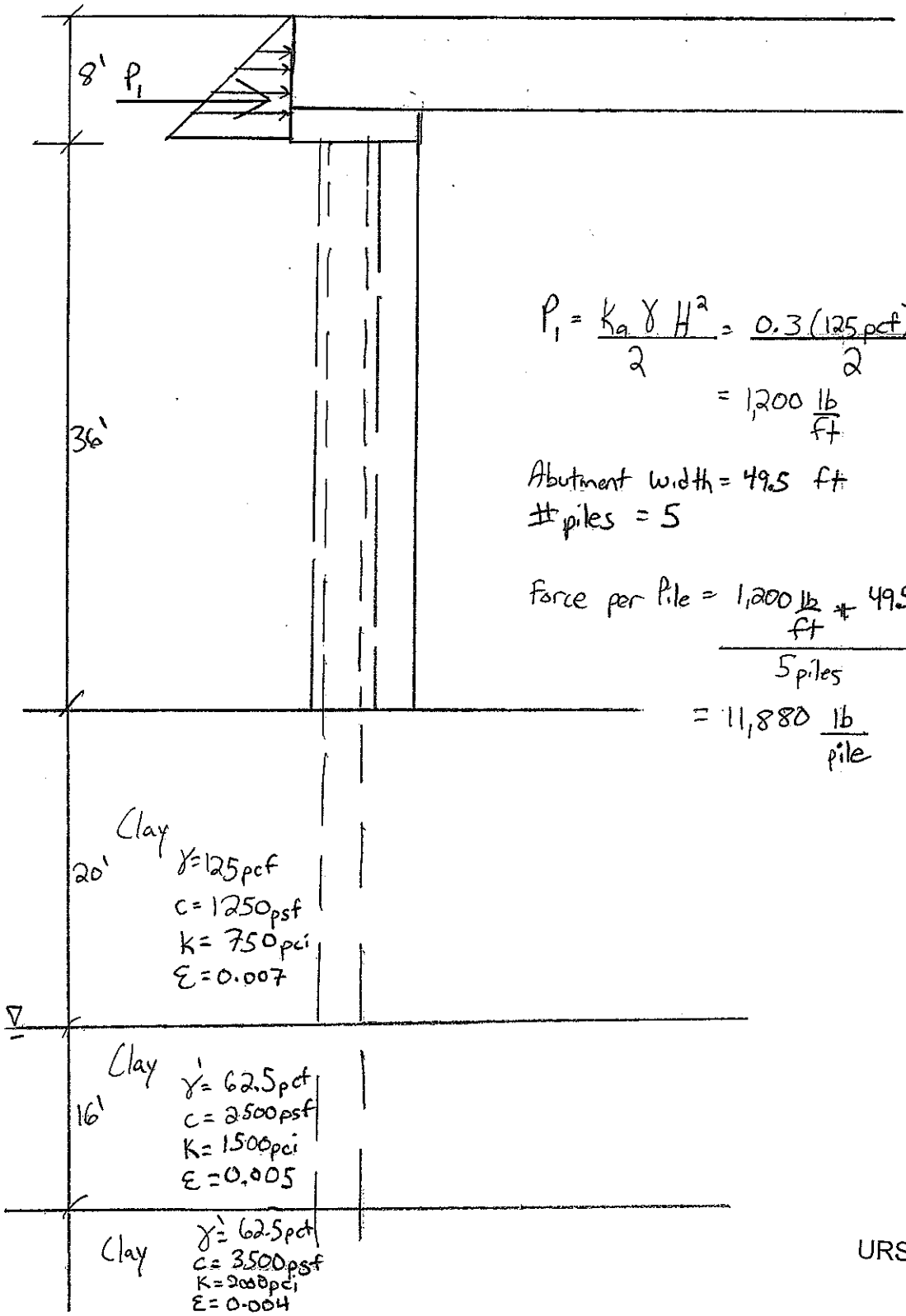
URS

Job SR 1 / I-95 Interchange | Project No. | Page ___ of ___

Description Lateral Deflection of Piles @ Ramp A over SR 7 (unstrapped) | Computed by JPK | Sheet ___ of ___ | Date

Checked by | Date

Reference



$$P_1 = \frac{K_a \gamma H^2}{2} = \frac{0.3(125\,pcf)(8\,ft)^2}{2}$$

$$= 1{,}200 \frac{lb}{ft}$$

Abutment width = 49.5 ft

piles = 5

$$\text{Force per Pile} = \frac{1{,}200 \frac{lb}{ft} * 49.5\,ft}{5\,piles}$$

$$= 11{,}880 \frac{lb}{pile}$$

```
==============================================================================

                LPILE Plus for Windows, Version 4.0 (4.0.8)

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

                  (c) Copyright ENSOFT, Inc., 1985-2003
                        All Rights Reserved

==============================================================================


This program is licensed to:

URS
URS

Path to file locations:      D:\Program Files\Ensoft\LpileP4\
Name of input data file:     RampA24.lpd
Name of output file:         RampA24.lpo
Name of plot output file:    RampA24.lpp
Name of runtime file:        RampA24.lpr


------------------------------------------------------------------------------
                          Time and Date of Analysis
------------------------------------------------------------------------------

               Date:  January  7, 2009     Time:  15:53:45


------------------------------------------------------------------------------
                                Problem Title
------------------------------------------------------------------------------

Ramp A over SR 7 - Abut A w/ 24-inch pipe piles


------------------------------------------------------------------------------
                                Program Options
------------------------------------------------------------------------------

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          150
- Maximum number of iterations allowed =          100
```

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 1100.00 in
Depth of ground surface below top of pile = 432.00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.000	2550.0000	36.9000	30000000.000
2	840.0000	24.000	2550.0000	36.9000	30000000.000

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = 432.000 in
Distance from top of pile to bottom of layer = 672.000 in
p-y subgrade modulus k for top of soil layer = 750.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 750.000 lbs/in**3

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 672.000 in
Distance from top of pile to bottom of layer = 864.000 in
p-y subgrade modulus k for top of soil layer = 1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 1500.000 lbs/in**3

Layer 3 is stiff clay with water-induced erosion
Distance from top of pile to top of layer = 864.000 in
Distance from top of pile to bottom of layer = 1104.000 in
p-y subgrade modulus k for top of soil layer = 2000.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 2000.000 lbs/in**3

(Depth of lowest layer extends 4.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 6 points

Point	Depth X	Eff. Unit Weight

No.	in	lbs/in**3
1	432.00	.07200
2	672.00	.07200
3	672.00	.03600
4	864.00	.03600
5	864.00	.03600
6	1104.00	.03600

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 6 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	432.000	8.50000	.00	.00700	.0
2	672.000	8.50000	.00	.00700	.0
3	672.000	17.00000	.00	.00500	.0
4	864.000	17.00000	.00	.00500	.0
5	864.000	24.00000	.00	.00400	.0
6	1104.000	24.00000	.00	.00400	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 11880.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 245000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 11880.000 lbs
Specified bending moment at pile head = .000 in-lbs
Specified axial load at pile head = 245000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	17.102	0.0000	11880.0000	-.045124	6639.5664	0.0000
7.333	16.771	168193.4449	11880.0000	-.045116	7431.0650	0.0000
14.667	16.440	336357.9219	11880.0000	-.045092	8222.4272	0.0000
22.000	16.110	504464.4682	11880.0000	-.045052	9013.5168	0.0000
29.333	15.780	672484.1308	11880.0000	-.044995	9804.1976	0.0000
36.667	15.450	840387.9718	11880.0000	-.044923	10594.3333	0.0000
44.000	15.121	1.008E+06	11880.0000	-.044834	11383.7879	0.0000
51.333	14.792	1.176E+06	11880.0000	-.044730	12172.4254	0.0000
58.667	14.465	1.343E+06	11880.0000	-.044609	12960.1100	0.0000
66.000	14.138	1.510E+06	11880.0000	-.044472	13746.7060	0.0000
73.333	13.813	1.677E+06	11880.0000	-.044319	14532.0779	0.0000
80.667	13.488	1.844E+06	11880.0000	-.044151	15316.0905	0.0000
88.000	13.165	2.010E+06	11880.0000	-.043966	16098.6088	0.0000
95.333	12.843	2.176E+06	11880.0000	-.043765	16879.4979	0.0000
102.667	12.523	2.342E+06	11880.0000	-.043549	17658.6234	0.0000
110.000	12.205	2.507E+06	11880.0000	-.043316	18435.8512	0.0000
117.333	11.888	2.671E+06	11880.0000	-.043068	19211.0472	0.0000
124.667	11.573	2.836E+06	11880.0000	-.042804	19984.0781	0.0000
132.000	11.260	2.999E+06	11880.0000	-.042525	20754.8106	0.0000
139.333	10.949	3.163E+06	11880.0000	-.042229	21523.1121	0.0000
146.667	10.641	3.325E+06	11880.0000	-.041918	22288.8502	0.0000
154.000	10.334	3.488E+06	11880.0000	-.041592	23051.8930	0.0000
161.333	10.031	3.649E+06	11880.0000	-.041250	23812.1091	0.0000
168.667	9.729	3.810E+06	11880.0000	-.040892	24569.3677	0.0000
176.000	9.431	3.970E+06	11880.0000	-.040519	25323.5381	0.0000
183.333	9.135	4.130E+06	11880.0000	-.040131	26074.4907	0.0000
190.667	8.842	4.289E+06	11880.0000	-.039727	26822.0960	0.0000
198.000	8.552	4.447E+06	11880.0000	-.039309	27566.2252	0.0000
205.333	8.266	4.604E+06	11880.0000	-.038875	28306.7503	0.0000
212.667	7.982	4.761E+06	11880.0000	-.038426	29043.5437	0.0000
220.000	7.702	4.917E+06	11880.0000	-.037962	29776.4784	0.0000
227.333	7.426	5.071E+06	11880.0000	-.037483	30505.4282	0.0000
234.667	7.152	5.226E+06	11880.0000	-.036990	31230.2677	0.0000
242.000	6.883	5.379E+06	11880.0000	-.036482	31950.8719	0.0000
249.333	6.617	5.531E+06	11880.0000	-.035959	32667.1168	0.0000
256.667	6.356	5.682E+06	11880.0000	-.035421	33378.8789	0.0000
264.000	6.098	5.832E+06	11880.0000	-.034869	34086.0357	0.0000
271.333	5.844	5.982E+06	11880.0000	-.034303	34788.4655	0.0000
278.667	5.595	6.130E+06	11880.0000	-.033723	35486.0472	0.0000
286.000	5.350	6.277E+06	11880.0000	-.033128	36178.6607	0.0000
293.333	5.109	6.423E+06	11880.0000	-.032519	36866.1866	0.0000
300.667	4.873	6.568E+06	11880.0000	-.031897	37548.5067	0.0000
308.000	4.641	6.712E+06	11880.0000	-.031260	38225.5033	0.0000
315.333	4.414	6.855E+06	11880.0000	-.030610	38897.0599	0.0000
322.667	4.192	6.996E+06	11880.0000	-.029946	39563.0608	0.0000
330.000	3.975	7.137E+06	11880.0000	-.029268	40223.3913	0.0000
337.333	3.763	7.276E+06	11880.0000	-.028578	40877.9377	0.0000

344.667	3.556	7.413E+06	11880.0000	-.027874	41526.5872	0.0000
352.000	3.354	7.550E+06	11880.0000	-.027156	42169.2281	0.0000
359.333	3.158	7.685E+06	11880.0000	-.026426	42805.7498	0.0000
366.667	2.966	7.819E+06	11880.0000	-.025683	43436.0427	0.0000
374.000	2.781	7.952E+06	11880.0000	-.024927	44059.9980	0.0000
381.333	2.601	8.083E+06	11880.0000	-.024159	44677.5085	0.0000
388.667	2.427	8.213E+06	11880.0000	-.023378	45288.4677	0.0000
396.000	2.258	8.341E+06	11880.0000	-.022584	45892.7704	0.0000
403.333	2.095	8.468E+06	11880.0000	-.021778	46490.3126	0.0000
410.667	1.939	8.594E+06	11880.0000	-.020961	47080.9913	0.0000
418.000	1.788	8.718E+06	11880.0000	-.020131	47664.7048	0.0000
425.333	1.643	8.840E+06	11880.0000	-.019289	48241.3526	0.0000
432.667	1.505	8.961E+06	10326.2483	-.018436	48810.8353	-423.7505
440.000	1.373	9.058E+06	7145.9412	-.017572	49265.8155	-443.6060
447.333	1.247	9.129E+06	3825.9002	-.016701	49601.1900	-461.8597
454.667	1.128	9.174E+06	378.0632	-.015823	49812.2816	-478.4595
462.000	1.015	9.192E+06	-3185.2392	-.014943	49894.8529	-493.3502
469.333	.908812	9.181E+06	-6851.2573	-.014062	49845.1213	-506.4729
476.667	.808915	9.142E+06	-10606.7907	-.013184	49659.7743	-517.7635
484.000	.715444	9.073E+06	-14438.1493	-.012311	49335.9866	-527.1525
491.333	.628351	8.974E+06	-18331.1038	-.011446	48871.4379	-534.5624
498.667	.547568	8.845E+06	-22270.8231	-.010592	48264.3328	-539.9065
506.000	.473002	8.686E+06	-26241.7933	-.009752	47513.4236	-543.0854
513.333	.404542	8.495E+06	-30227.7097	-.008928	46618.0351	-543.9827
520.667	.342054	8.274E+06	-34211.3308	-.008124	45578.0943	-542.4594
528.000	.285382	8.023E+06	-38174.2744	-.007343	44394.1660	-538.3434
535.333	.234351	7.741E+06	-42096.7248	-.006588	43067.4956	-531.4158
542.667	.188761	7.429E+06	-45956.9961	-.005861	41600.0648	-521.3855
550.000	.148394	7.088E+06	-49730.8490	-.005165	39994.6649	-507.8471
557.333	.113010	6.718E+06	-53390.3612	-.004503	38254.9983	-490.2017
564.667	.082348	6.321E+06	-56901.9111	-.003878	36385.8304	-467.4938
572.000	.056130	5.898E+06	-60222.1706	-.003293	34393.2297	-438.0315
579.333	.034058	5.450E+06	-63288.7134	-.002749	32284.9956	-398.2983
586.667	.015817	4.979E+06	-65990.1687	-.002249	30071.5465	-338.4622
594.000	.001076	4.490E+06	-67883.3153	-.001795	27768.4064	-177.8505
601.333	-.010509	3.990E+06	-67351.1414	-.001388	25416.6184	322.9888
608.667	-.019288	3.507E+06	-64751.1539	-.001029	23143.3357	386.0987
616.000	-.025603	3.044E+06	-61775.9577	-7.151E-04	20964.9214	425.3185
623.333	-.029777	2.604E+06	-58555.4672	-4.444E-04	18891.6760	452.9971
630.667	-.032121	2.187E+06	-55159.4553	-2.148E-04	16930.9612	473.1879
638.000	-.032928	1.795E+06	-51643.3334	-2.395E-05	15088.2246	485.7544
645.333	-.032472	1.430E+06	-48087.3241	1.306E-04	13366.9636	484.0663
652.667	-.031012	1.090E+06	-44557.8049	2.514E-04	11767.0475	478.5298
660.000	-.028785	775154.1769	-41080.9618	3.407E-04	10287.3508	469.7001
667.333	-.026014	485844.5474	-37679.5314	4.012E-04	8925.8937	457.9627
674.667	-.022901	221079.4583	-33259.7341	4.351E-04	7679.9403	747.4365
682.000	-.019633	-3528.2304	-27816.3944	4.455E-04	6656.1698	737.1106
689.333	-.016367	-188495.1399	-22468.4819	4.363E-04	7526.6023	721.4110
696.667	-.013234	-334633.7070	-17255.7107	4.112E-04	8214.3133	700.2539
704.000	-.010336	-443056.5403	-12218.7164	3.739E-04	8724.5384	673.4718
711.333	-.007750	-515185.2491	-7399.7614	3.280E-04	9063.9676	640.7886
718.667	-.005525	-552765.0395	-2843.7355	2.768E-04	9240.8136	601.7639
726.000	-.003690	-557888.1022	1400.1639	2.236E-04	9264.9222	555.6632
733.333	-.002246	-533032.7478	5275.0664	1.713E-04	9147.9558	501.1284
740.667	-.001177	-481136.0181	8708.0848	1.227E-04	8903.7359	435.1494
748.000	-4.46E-04	-405755.0566	11580.9632	8.019E-05	8549.0020	348.3629
755.333	-1.05E-06	-311570.0288	13144.4860	4.581E-05	8105.7783	78.0524
762.667	2.25E-04	-213133.8555	12316.1971	2.066E-05	7642.5492	-303.9493
770.000	3.02E-04	-131006.6945	10002.6944	4.161E-06	7256.0685	-327.0059
777.333	2.86E-04	-66442.6231	7620.3859	-5.303E-06	6952.2376	-322.7146
784.667	2.24E-04	-19221.9809	5324.1400	-9.409E-06	6730.0228	-303.5343
792.000	1.48E-04	11678.5716	3207.2876	-9.770E-06	6694.5244	-273.7891
799.333	8.08E-05	27853.3440	1340.9678	-7.875E-06	6770.6410	-235.2072

806.667	3.29E-05	31374.3984	-210.0305	-5.037E-06	6787.2106	-187.7923
814.000	6.97E-06	24790.9948	-1365.1998	-2.344E-06	6756.2299	-127.2539
821.333	-1.51E-06	11359.8920	-1510.3781	-6.118E-07	6693.0247	87.6598
828.667	-2.00E-06	2640.9816	-845.0174	5.929E-08	6651.9945	93.8022
836.000	-6.37E-07	-1033.9096	-241.6518	1.363E-07	6644.4319	70.7521
843.333	-4.29E-10	-903.7342	70.3558	4.345E-08	6643.8193	14.3409
850.667	5.52E-10	-2.1808	61.6494	2.926E-11	6639.5767	-16.7154
858.000	6.70E-16	.4568	.1671	-5.337E-11	6639.5685	-.052527
865.333	-2.31E-10	.2696	-.022506	-1.855E-11	6639.5677	8.278E-04
872.667	-2.72E-10	.1268	-.015877	4.499E-13	6639.5670	9.799E-04
880.000	-2.24E-10	.036735	-.009312	8.290E-12	6639.5666	8.107E-04
887.333	-1.51E-10	-.009768	-.004335	9.582E-12	6639.5664	5.464E-04
894.667	-8.37E-11	-.026884	-.001213	7.826E-12	6639.5665	3.050E-04
902.000	-3.57E-11	-.027592	3.845E-04	5.214E-12	6639.5665	1.308E-04
909.333	-7.19E-12	-.021263	9.609E-04	2.873E-12	6639.5665	2.642E-05
916.667	6.40E-12	-.013509	9.712E-04	1.206E-12	6639.5665	-2.363E-05
924.000	1.05E-11	-.007024	7.419E-04	2.220E-13	6639.5664	-3.889E-05
931.333	9.66E-12	-.002629	4.676E-04	-2.406E-13	6639.5664	-3.592E-05
938.667	6.97E-12	-1.651E-04	2.404E-04	-3.745E-13	6639.5664	-2.603E-05
946.000	4.17E-12	8.990E-04	8.774E-05	-3.394E-13	6639.5664	-1.562E-05
953.333	1.99E-12	.001123	2.974E-06	-2.425E-13	6639.5664	-7.502E-06
960.667	6.11E-13	9.435E-04	-3.299E-05	-1.434E-13	6639.5664	-2.306E-06
968.000	-1.10E-13	6.397E-04	-3.992E-05	-6.753E-14	6639.5664	4.153E-07
975.333	-3.80E-13	3.582E-04	-3.310E-05	-1.970E-14	6639.5664	1.446E-06
982.667	-3.99E-13	1.543E-04	-2.221E-05	4.861E-15	6639.5664	1.523E-06
990.000	-3.09E-13	3.238E-05	-1.229E-05	1.381E-14	6639.5664	1.184E-06
997.333	-1.96E-13	-2.592E-05	-5.179E-06	1.412E-14	6639.5664	7.546E-07
1005.	-1.02E-13	-4.364E-05	-9.736E-07	1.079E-14	6639.5664	3.924E-07
1012.	-3.78E-14	-4.024E-05	1.002E-06	6.766E-15	6639.5664	1.465E-07
1019.	-2.29E-15	-2.896E-05	1.572E-06	3.449E-15	6639.5664	8.927E-09
1027.	1.28E-14	-1.719E-05	1.421E-06	1.237E-15	6639.5664	-5.013E-08
1034.	1.59E-14	-8.115E-06	1.009E-06	2.423E-17	6639.5664	-6.221E-08
1041.	1.32E-14	-2.384E-06	5.911E-07	-4.790E-16	6639.5664	-5.190E-08
1049.	8.83E-15	5.555E-07	2.728E-07	-5.667E-16	6639.5664	-3.490E-08
1056.	4.87E-15	1.619E-06	7.405E-08	-4.625E-16	6639.5664	-1.931E-08
1063.	2.04E-15	1.643E-06	-2.660E-08	-3.061E-16	6639.5664	-8.141E-09
1071.	3.77E-16	1.230E-06	-6.198E-08	-1.684E-16	6639.5664	-1.507E-09
1078.	-4.26E-16	7.349E-07	-6.124E-08	-7.424E-17	6639.5664	1.708E-09
1085.	-7.12E-16	3.318E-07	-4.447E-08	-2.311E-17	6639.5664	2.866E-09
1093.	-7.65E-16	8.281E-08	-2.262E-08	-3.235E-18	6639.5664	3.090E-09
1100.	-7.59E-16	0.0000	0.0000	7.340E-19	6639.5664	3.080E-09

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	17.102	in
Computed slope at pile head	=	-.04512437	
Maximum bending moment	=	9191748.378	lbs-in
Maximum shear force	=	-67883.315	lbs
Depth of maximum bending moment	=	462.000	in
Depth of maximum shear force	=	594.000	in
Number of iterations	=	34	
Number of zero deflection points	=	9	

RampA24.lpo
Summary of Pile-head Response

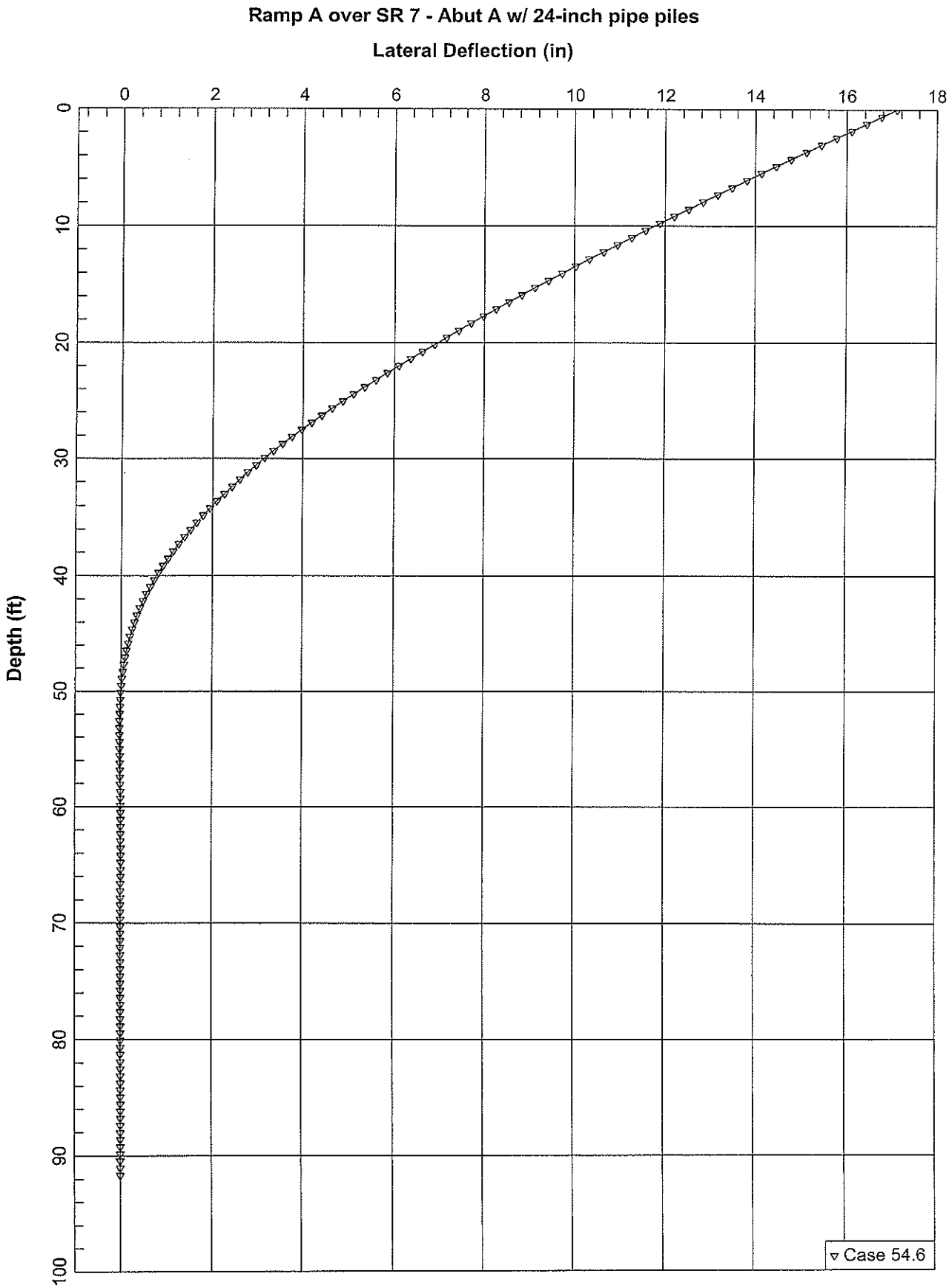
Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

BC Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 11880.000	M= 0.000	245000.0000	17.1022	9.192E+06	-67883.3153

The analysis ended normally.

not OK, must strap


Ramp A over SR 7 - Abut A w/ 24-inch pipe piles
Lateral Deflection (in)
0
2
4
6
8
10
12
14
16
18
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
Case 54.6

Cost Comparison of H Piles vs. Pipe Piles

URS

Job SR-1/I-95 Interchange | Project No. | Page ___ of ___
Description Hpile vs. Pipe Cost Comparison | Computed by JPK | Sheet 1 of 1 | Date 12/18/07
Checked by JCS | Date 01/29/08
Reference

At Pier 2 for I-95 Crossing:

Struct. Comps. by Ray Kirchner

w/ 8 piles max load per pile = 1272 Kips

1) ∴ Load too high for 8 piles

Assume 14 pipe piles

$$\text{Load/pile} = \frac{1272 \text{ Kips } (8 \text{ piles})}{(14 \text{ piles})} = 727 \text{ Kips}$$

See Load Graphs for 12/19/07 memo (Fig. 14)

730 Kips ⇒ 110' long 30" pipe pile

2) ∴ Load too high for 8 piles

Assume 28 H piles

$$\text{Load/pile} = \frac{1272 \text{ Kips } (8 \text{ piles})}{(28 \text{ piles})} = 364 \text{ Kips}$$

See Load Graphs for 12/19/07 memo (Fig. 10)

363 Kips ⇒ 100' long 14x117 Hpile

Pile Cap Cost:

Excavation Size = 43.5 ft * 20 ft * 3 ft $\left(\frac{1 \text{ C.Y.}}{27 \text{ ft}^3}\right)$ = 96.7 C.Y.

Pile Cap Concrete = \$700/C.Y.

Struct. Excav. = \$19/C.Y

Pile Cap Cost = 96.7 C.Y. (\$700/C.Y. + \$19/C.Y) = \$69,503

Total Cost:

30-in pipes: 14 piles * (110 ft) * \$209.30/ft + \$69,503 = \$391,825

HP 14x73 piles: 28 piles * (100 ft) * 155.30/ft + \$69,503 = \$504,343

Price per pound Material
$ 0.90

	lb/foot	$/ft (Material)	$/ft (Labor)	$/ft Total
HP 12 x 53	53.00	47.70	50.00	97.70
HP 14 x 73	73.00	65.70	50.00	115.70
HP 14 x 117	117.00	105.30	50.00	155.30
PP 18 x 0.5	93.45	84.11	50.00	134.11
PP 24 x 0.5	125.50	112.95	50.00	162.95
PP 30 x 0.562	177.00	159.30	50.00	209.30
PP 36 x 0.625	236.30	212.67	50.00	262.67
PP 42 x 0.688	303.00	272.70	50.00	322.70

Drilled Shaft Axial Capacity Analysis

URS

Job: SR-1/I-95 Interchange
Description: Drilled Shaft Feasibility @ I-95 Crossing (Pier 2 Ramp A)

Project No.
Computed by: JPK
Checked by: JES

Page ___ of ___
Sheet 1 of 6
Date 1/28/08
Date 01/29/08
Reference

Generalized Soil Profile

Groundwater Table @ 10 ft deep

Depth Range:	Thickness:			
0 - 10 ft	10 ft	$Sand_A$	$\phi' = 30°$	$\gamma' = 125$ pcf
10 - 25 ft	15 ft	$Sand_B$	$\phi' = 30°$	$\gamma' = 62.5$ pcf
25 - 45 ft	20 ft	$Clay_1$	$S_{u_1} = 1.5$ ksf	$\gamma' = 62.5$ pcf
45 - 65 ft	20 ft	$Clay_2$	$S_{u_2} = 2.5$ ksf	$\gamma' = 62.5$ pcf
65 - 85 ft	20 ft	$Clay_3$	$S_{u_3} = 3.5$ ksf	$\gamma' = 62.5$ pcf
85 - 115 ft	30 ft	$Clay_4$	$S_{u_4} = 5.0$ ksf	$\gamma' = 67.5$ pcf
115 - 165 ft	50 ft	$Clay_5$	$S_{u_5} = 7.5$ ksf	$\gamma' = 67.5$ pcf

Shaft Resistance

Ref. AASHTO LRFD Bridge Design Specifications

$Sand_A$

$\beta_A = 1.5 - 0.135\sqrt{z_A}$ (Eq. 10.8.3.5.2b-2)

$\beta_A = 1.5 - 0.135\sqrt{5} = 1.20$

$q_{sA} = \beta_A \sigma'_{vA}$ (Eq. 10.8.3.5.2b-1)

$= 1.20(5\text{ ft})(125\text{ pcf})$

$= 750$ psf

$= 0.75$ ksf

$R_{sA} = q_{sA} A_{sA}$ (Eq 10.8.3.5-3)

$= 0.75\text{ ksf}(\pi)(9\text{ ft})(10\text{ ft})$

$= 212$ kips

$\phi_{qsA} = 0.55$ (Tab. 10.5.5.2.4-1)

$R_{sA} * \phi_{qsA} = 117$ kips

Sand B

$\beta_B = 1.5 - 0.135\sqrt{Z_B}$
$= 1.5 - 0.135\sqrt{17.5}$
$= 0.94$

$q_{SB} = \beta_B \sigma'_{vB}$
$= 0.94\left[(10\,ft * 125\,pcf) + (7.5\,ft\ 62.5\,pcf)\right]$
$= 1616\ psf$
$= 1.616\ ksf$

$R_{SB} = q_{SB} A_{SB}$
$= 1.616\ ksf\ (\pi)(9\,ft)(15\,ft)$
$= 685\ Kips$

$\phi_{qSB} = 0.55$ (Tab 10.5.5.24-1)

$R_{SB} * \phi_{qSB} = 376.9\ Kips$

URS

Job _____ Project No. _____ Page ___ of ___ Sheet 3 of 6

Description _____ Computed by JPK Date 1/28/08

Checked by [illegible] Date 01/29/08

Reference

Clay$_1$

$\alpha_1 = 0.55$

$q_{s1} = \alpha_1 S_{u1}$
$= 0.55 (1.5 \text{ ksf})$
$q_{s1} = 0.825 \text{ ksf}$

$R_{s1} = q_{s1} A_{s1}$
$= 0.825 \text{ ksf} (\pi)(9 \text{ ft})(20 \text{ ft})$
$R_{s1} = 466.5 \text{ kips}$

$\phi_{qs1} = 0.45$ (Tab. 10.5.5.2.4-1)

$R_{s1} * \phi_{qs1} = 209.9 \text{ kips}$

Clay$_2$

$\alpha_2 = 0.55$

$q_{s2} = \alpha_2 S_{u2}$
$= 0.55 (2.5 \text{ ksf})$
$q_{s2} = 1.375 \text{ ksf}$

$R_{s2} = q_{s2} A_{s2}$
$= 1.375 (\pi)(9 \text{ ft})(20 \text{ ft})$
$R_{s2} = 777.5 \text{ kips}$

$\phi_{qs2} = 0.45$ (Tab. 10.5.5.2.4-1)

$R_{s2} * \phi_{qs2} = 349.9 \text{ kips}$

Clay3

$\alpha_3 = 0.55 - 0.1(S_{u3}/p_a - 1.5)$ (Eq 10.8.35.16-3)

$\alpha_3 = 0.55 - 0.1(3.5/2.12 - 1.5)$

$= 0.535$

$q_{s3} = \alpha_3 S_{u3}$

$= 0.535(3.5 \text{ ksf})$

$q_{s3} = 1.872 \text{ ksf}$

$R_{s3} = q_{s3} A_{s3}$

$= 1.872 \text{ ksf } (\pi)(9 \text{ ft})(20 \text{ ft})$

$= 1058.7 \text{ kips}$

$\phi_{qs3} = 0.45$ (Tab. 10.5.5.2.4-1)

$R_{s3} * \phi_{qs3} = 476.4 \text{ kips}$

Clay4

$\alpha_4 = 0.55 - 0.1(S_{u4}/p_a - 1.5)$

$= 0.464$

$q_{s4} = \alpha_4 S_{u4}$

$= 0.464(5.0 \text{ ksf})$

$= 2.32 \text{ ksf}$

$R_{s4} = q_{s4} A_{s4}$

$= 2.32 \text{ ksf } (\pi)(9 \text{ ft})(30 \text{ ft})$

$= 1968.5 \text{ kips}$

$\phi_{qs4} = 0.45$ (Tab. 10.5.5.2.4-1)

$R_{s4} * \phi_{qs4} = 885.8 \text{ kips}$

Clays

$\alpha_5 = 0.45$ for $S_{u5}/p_A \geq 2.5$, per Eq 10.8.3.5.1b-3

$q_{s5} = \alpha_5 S_{u5}$
$= 0.45 (7.5 \text{ Ksf})$
$= 3.375 \text{ Ksf}$

$R_{s5} = q_{s5} A_{s5}$
$= 3.375 \text{ Ksf} (\pi)(9 \text{ ft})(39 \text{ ft})$ Note: Assumed 39 ft embedment in stratum
$= 3721.6 \text{ Kips}$

$\phi_{qs5} = 0.45$ (Tab. 10.5.5.2.4-1)

$R_{s5} * \phi_{qs5} = 1674.7 \text{ Kips}$

Tip Resistance

Clays

$q_{p5} = N_c S_u$ (Eq. 10.8.3.5.1c-1)
where $N_c = 9$ for $z \geq 22.5$ f per Eq. 10.8.3.5.1c-2

$q_{p5} = 9.0 (7.5 \text{ Ksf})$
$= 67.5 \text{ Ksf}$

$R_{p5} = q_{p5} A_{p5}$
$= 67.5 \text{ Ksf} \frac{(\pi)(9 \text{ ft})^2}{4}$
$= 4,294.2 \text{ Kips}$

$\phi_{qp5} = 0.40$ (Tab. 10.5.5.2.4-1)

$R_{p5} * \phi_{qp5} = 1717.7 \text{ Kips}$

URS

Job _____ Project No. _____ Page ___ of ___ Sheet 6 of 6

Description _____ Computed by JK Date 1/28/08

Checked by ZES Date 01/29/08

Reference

Factored Axial Resistance

$$R_R = (\phi_{qPS} R_{PS}) + (\phi_{qS5} R_{S5}) + (\phi_{qS4} R_{S4}) + (\phi_{qS3} R_{S3}) + (\phi_{qS2} R_{S2}) + (\phi_{qS1} R_{S1}) + (\phi_{qB} R_{SB}) + (\phi_{qSA} R_{SA})$$

$$= 1717.7 + 1674.7 + 885.8 + 476.4 + 349.9 + 209.9 + 376.9 + 117.0$$

$R_R = 5808$ kips > 5800 kips Req'd

Total Shaft Length

$T_L = 10 + 15 + 20 + 20 + 20 + 30 + 39$
$= 154$ ft

per Sec. 10.8.3.5.16
- @ base of shaft 9 ft (1 diam.) does not contribute to shaft resistance

$\therefore T_L = 154$ ft $+ 9$ ft
$= 163$ ft

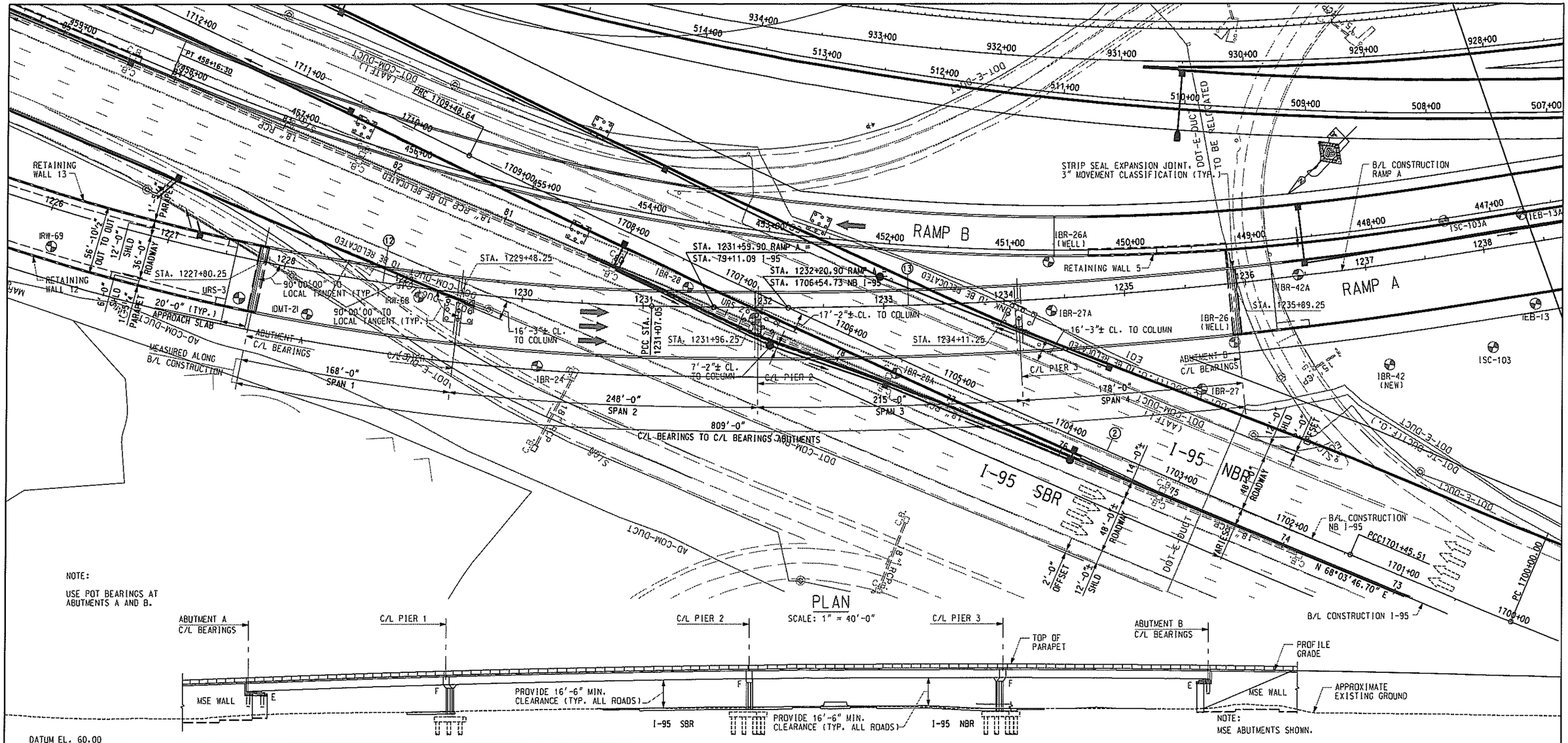
Shaft Cost

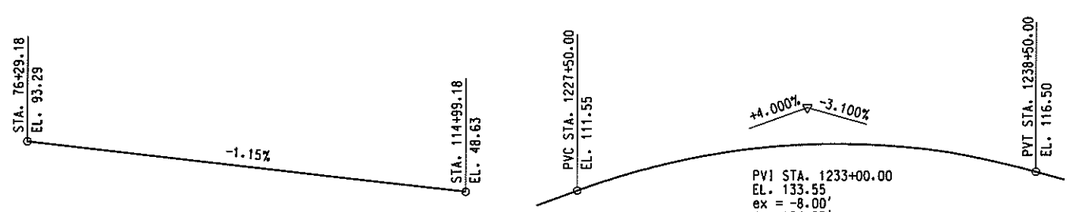
Installed Cost = \$1,200 C.Y. per discussion w/ Contractor on 1-28-08

$$T_c = \frac{\pi (9\text{ft})^2}{4} (163\text{ ft}) \left(\frac{1\text{ C.Y.}}{27\text{ ft}^3}\right) \left(\frac{\$1200}{\text{C.Y.}}\right)$$

$T_c = \$460,872$

Structure S1 – Ramp A over I-95





I-95 PROFILE

NOT TO SCALE

INFORMATION SUPPLIED FROM DELAWARE TURNPIKE CONTRACT NO. 7003.
ELEVATIONS ARE GIVEN APPROXIMATELY 40' LEFT OF BASELINE

RAMP A - VERTICAL CURVE DATA

NOT TO SCALE

B/L CONSTR. RAMP A CURVE 12 DATA

PI STA. 1226+68.24
Δ = 27°44'07.64" LT
Dc = 3°05'49.45"
R = 1,850.0000'
T = 456.72'
L = 895.54'

B/L CONSTR. RAMP A CURVE 13 DATA

PI STA. 1238+52.84
Δ = 22°47'31.72" LT
Dc = 1°32'54.72"
R = 3,700.0000'
T = 745.79'
L = 1,471.85'

B/L CONSTR. I-95 NB CURVE 2 DATA

PI STA. 1705+47.18
Δ = 3°10'24.61" RT
Dc = 0°23'42.52"
R = 14,500.0000'
T = 401.67'
L = 803.13'

URS S1-2

DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS	SCALE 0 40 80 120 FEET	SR1 / I-95 INTERCHANGE	CONTRACT 28-090-03	BRIDGE NO.	RAMP A OVER I-95 PLAN AND ELEVATION
				COUNTY NEW CASTLE	DESIGNED BY: R. F. KIRCHNER URS	
					CHECKED BY:	

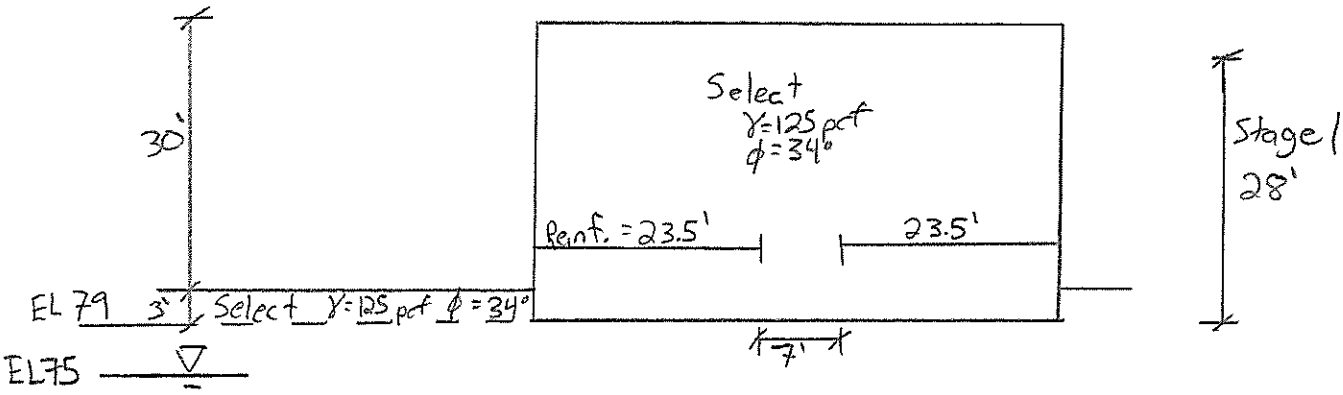
S1-1
SHEET NO. 3
TOTAL SHTS.

Jan 22, 2009 0:\20832687-XM\CAD\Bridge\pal01.dgn
Jason.kotovo

MSE Wingwalls
Bearing Capacity, Sliding, Overturning, Eccentricity, Settlement

URS

Job SR1 / I-95 Interchange | Project No. | Page ___ of ___
Description Ramp A over I-95 | Computed by JPK | Sheet ___ of ___ | Date
Abut A Wingwalls | Checked by | Date
Bearing Capacity, Sliding & Overturning | Reference



Clay
γ=120 pcf

CD	CU	UU @ Stage 1
φ=27°	φ=10.3°	φ=0
c=0	c=940 psf	c=1000
Traffic Surcharge = 250 psf	TS=250 psf	TS=0

Note: For sliding, assumed sand stratum w/ φ=27°

Settlement

Assumptions:
(Same as "Ramp A over I-95, Abut A Face")

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp A over I-95 - Abutment A Wingwalls (Back to Back)
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	30	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	33	feet	
Wall Base Width	B =	23.5	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	30	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	4	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	33	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Weight of Retained Wedge	Wrw	36	k/ft	$= [H_2 \tan(45-\phi 1/2/2) * \gamma 2 * H2/2 + H2 \tan(45-\phi 1/2/2) * H1 * \gamma 1 + H1 * \tan(45-\phi 1/2/2) * \gamma 1 * H1/2] * \frac{1}{100}$
Wedge Influence Factor	WIF =	0.62		see attached spreadsheet calculations
Embedment Soil Properties				Note: see figure on following page
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		$= \tan^2(45+\phi e/2)$
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	11.8	k/ft	as defined by Fig 11.10.5.2-1 $= Wrw * WIF * \tan(45-\phi 1/2/2)$
Coeff. Active Earth Pressure	Ka =	0.283	(dim)	$= \tan^2(45-\phi 1/2/2)$
Horiz F2 Surcharge	F2 =	2.3	k/ft	per Eq 3.11.6.4-1 $= Ka * qs/1000 * H * WIF$
MSE Mass	V1 =	96.9	k/ft	as defined by Fig 11.10.5.2-1 $= \gamma rei/1000 * H * B$
Loading Conditions				
Friction Factor	tan Φf =	0.51	(dim)	$= \tan \phi f$
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horzinontal Load	FHL =	17.8	k/ft	as defined by Fig 11.10.5.2-1 $= F1 * EHLF + F2 * LSLF$
Nominal Sliding Resistance	Rn =	64.0	k/ft	as defined by Fig 10.6.3.4-1 $= \tan \phi f * B/1000 + Df * \gamma e * Kp/1000$
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	64.0	k/ft	$= Rn * \phi t$
Eccentrity, parallel to width	e_B =	1.44	ft	$= \frac{F1 * EHLF * H/3 + F2 * LSLF * H/2}{V1}$
Effective Width	B' =	27.1	ft	$= B - 2e_B$
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	3.57	ksf	$= V1/B'$
Factored Bearing Pressure	Sigv =	5.20	ksf	$= \frac{V1 * MMLF + qs * LSLF * B/1000}{B'}$

Capacity Demand Ratio (CDR)= 3.60
CDR > 1.0, OK
e < 0.25*B, OK

Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	27.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	23.94	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	13.20	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Ny =	14.47	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.43	(dim)	per Table 10.6.3.1.2a-3 $= 1 + B/L * \frac{Nq}{Nc}$
	sq =	1.40	(dim)	per Table 10.6.3.1.2a-3 $= 1 - 0.4\, B/L$
	sy =	0.69	(dim)	per Table 10.6.3.1.2a-3 $= 1 + B/L \tan \phi f$
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwy =	0.51	(dim)	per Table 10.6.3.1.2a-2 $= 0.5 + (1.0 - 0.5) \frac{GWD - Df}{(1.5B + Df) - Df}$
Nominal Bearing Resistance (ksf)	qn =	14.1	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	9.18	ksf	

Capacity Demand Ratio (CDR)= 1.765
CDR > 1.0, OK

Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming quarantine period after Stage 1
Foundation Φ	Φf =	10.3	degrees	
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS-2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Ny =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.23	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.14	(dim)	per Table 10.6.3.1.2a-3
	sy =	0.69	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwy =	0.51	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	11.6	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.52	ksf	

Capacity Demand Ratio (CDR)= 1.445
CDR > 1.0, OK

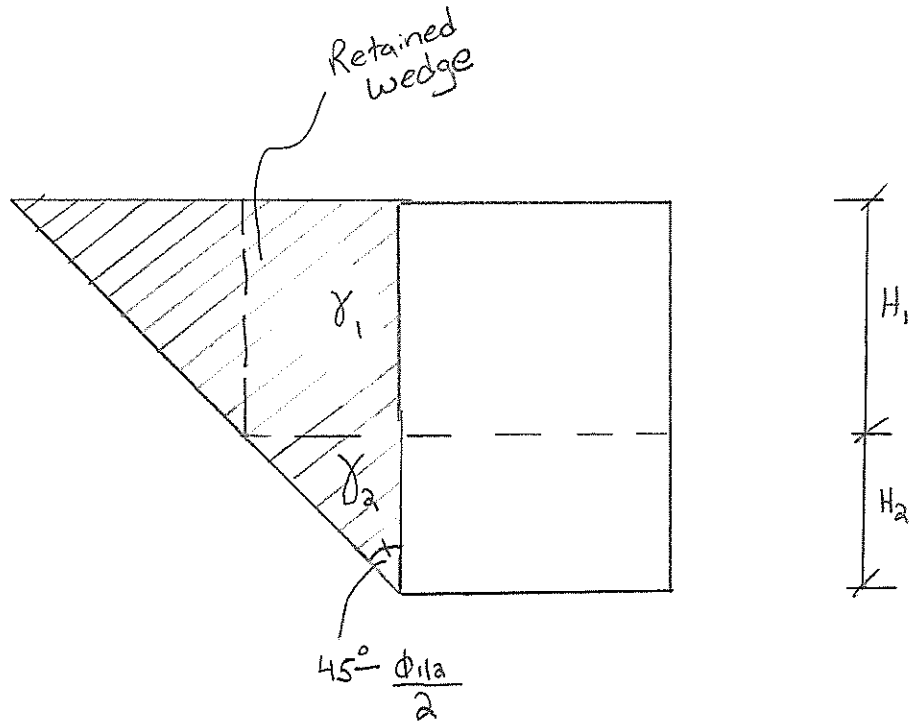
Back to Back Wall Calculations
Ramp A over I-95 - Abutment A Wingwalls (Back to Back)
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

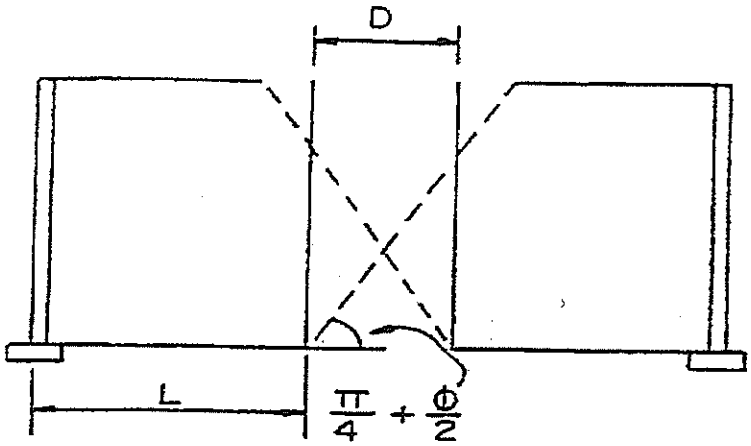
Total Height (Hw+Df)	H =	33	feet	
Wall Base Width	B =	23.5	feet	as defined by Fig 11.10.2-1
Face to Face Distance	F =	54	feet	
Overlap	Lr =	-7	feet	as defined by Fig 50 of FHWA-NHI-00-043 (attached
Wedge Distance at Top of Wall	Dwd=	17.54641	feet	as defined by Fig 50 of FHWA-NHI-00-043
Overlap Distance with No Wedge Influence	Lr' =	9.9	feet	as defined by Sec. 5.4 of FHWA-NHI-00-043
Wedge Influence Factor	WIF =	0.62		as defined by Sec. 5.4 of FHWA-NHI-00-043

Lr = (2*B)-F
Dwd = H*tan(45-Φ1|2 / 2)
Lr' = H*0.3
WIF = (Lr' - Lr) / (Lr'+Dwd)

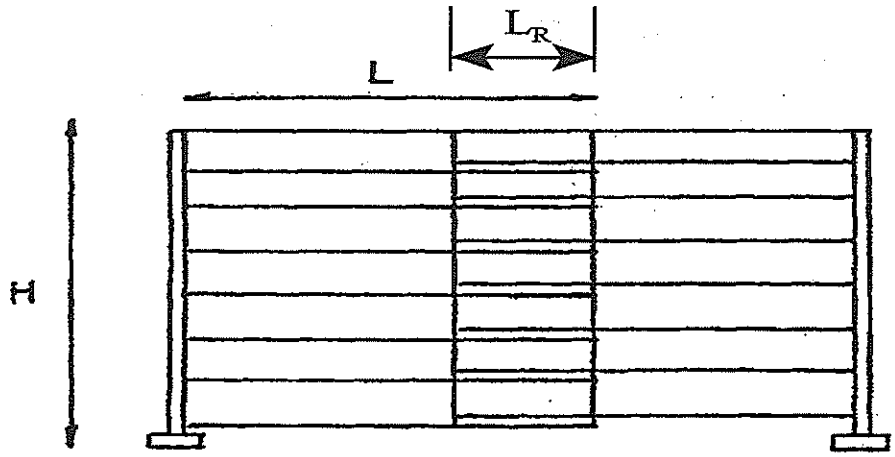
Note: WIF linear interpolation between "full active" case and "zero-active" case

Lr - negative = non-overlapping (but within influence zone)





CASE I



CASE II

source: FHWA-NHI-00-043

Figure 50. Back-to-back wall.

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp A over I-95 - Abutment A Wingwalls (Back to Back)
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	25	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	28	feet	
Wall Base Width	B =	23.5	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	30	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	4	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	28	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Weight of Retained Wedge	Wrw	26	k/ft	
Wedge Influence Factor	WIF =	0.62		see attached spreadsheet calculations
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	8.5	k/ft	as defined by Fig 11.10.5.2-1
Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	82.3	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Friction Factor	tan Φf =	0.51	(dim)	
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horzinontal Load	FHL =	12.8	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	54.3	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	54.3	k/ft	
				Capacity Demand Ratio (CDR)= 4.24
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	1.22	ft	e < 0.25*B, OK
Effective Width	B' =	27.6	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	4.03	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	27.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	23.94	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	13.20	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	14.47	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.43	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.40	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.69	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.51	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	14.1	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	9.18	ksf	
				Capacity Demand Ratio (CDR)= 2.280
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1, quarantine period to follow
Foundation Φ	Φf =	0.0	degrees	
Foundation Cohesion (c)	cf =	1000	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.16	(dim)	per Table 10.6.3.1.2a-3 $= 1 + \frac{B}{5L}$
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.51	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	6.3	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	4.11	ksf	
				Capacity Demand Ratio (CDR)= 1.020
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp A over I-95 - Abutment A Wingwalls
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c'' [3]	
Initial Overburden	3				0.09				1.79				
Sand Stratum 1	5.5				0.18								
I	8	0.614	0.051	0.244	0.39	3.80	0.53	0.80	1.73	1.34	0	1.959624	
Sand Stratum 2	12.5				0.71								
II	12	0.614	0.051	0.244	1.09	3.80	1.49	0.40	1.72	0.62	0	0.890013	
Total Sand Settlement (See Attached Sheets)												1.0	
Footing Width (ft)	23.5										0.00	3.85	in
											TOTAL	3.85	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19 (attached)

Profile described on page URS-S1-4
Lab data on page URS-6

Das (Ref. 3)

where e_O = initial void ratio at volume V_0. Thus, from Eqs. (8.11) through (8.14),

$$\Delta V = SA = \Delta e V_s = \frac{AH}{1 + e_O}\Delta e$$

or

$$S = H\frac{\Delta e}{1 + e_O} \tag{8.15}$$

8.8 CO

For normally consolidated clays that exhibit a linear e–log p relationship (see Figure 8.9),

$$\Delta e = C_c[\log (p_O + \Delta p) - \log p_O] \tag{8.16}$$

where C_c = slope of the e–log p plot and is defined as the compression index. Substitution of Eq. (8.16) into Eq. (8.15) gives

$$\boxed{S = \frac{C_c H}{1 + e_O}\log\left(\frac{p_O + \Delta p}{p_O}\right)} \tag{8.17}$$

For a thicker clay layer, it is more accurate if the layer is divided into a number of sublayers and calculations for settlement are made separately for each sublayer. Thus, the total settlement for the entire layer can be given as

$$S = \sum\left[\frac{C_c H_i}{1 + e_O}\log\left(\frac{p_{O(i)} + \Delta p_{(i)}}{p_{O(i)}}\right)\right]$$

where H_i = thickness of sublayer i
$p_{O(i)}$ = initial average effective overburden pressure for sublayer i
$\Delta p_{(i)}$ = increase of vertical pressure for sublayer i

In overconsolidated clays (see Figure 8.10), for $p_O + \Delta p \leq p_c$, field e–log p variation will be along the line hj, the slope of which will be approximately equal to that for the laboratory rebound curve. The slope of the rebound curve, C_s, is referred to as the *swell index,* so

$$\Delta e = C_s[\log (p_O + \Delta p) - \log p_O] \tag{8.18}$$

From Eqs. (8.15) and (8.18),

$$\boxed{S = \frac{C_s H}{1 + e_O}\log\left(\frac{p_O + \Delta p}{p_O}\right)} \tag{8.19}$$

If $p_O + \Delta p > p_c$, then

$$\boxed{S = \frac{C_s H}{1 + e_O}\log\frac{p_c}{p_O} + \frac{C_c H}{1 + e_O}\log\left(\frac{p_O + \Delta p}{p_c}\right)} \tag{8.20}$$

URS S1-10

Project Name: SR 1/I-95 Interchange
Project Location: Newark, Delaware - Ramp A over I-95 - Abutment A Wingwalls: Sand Settlement
Project Number: 20832687 00000
Calculations By: JPK
Date: 12/30/2008

Input Global Data		
Footing Width, B	33.0	feet
Elevation of Ground Surface	75.0	feet
Elevation of Base of Footing	75.0	feet
Elevation of Water Table	75.0	feet
Unit Weight of Water, γ_w	62.4	pcf
Net Bearing Pressure, ΔP	3580	psf
Soil Unit Weight Above Footing Base	125	pcf
Settlement Calculated at end of construction and at time t	1	years

Input Layer Data				
Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_t (pcf)
1	75.0	69.5	125	125
2	62.5	50.0	400	125
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Es based on SPT values

Note: The depth of the water table must be a layer boundary.

Compute Global Values for Axisymmetrical Case		
σ'_{vo} at Elevation	75.0	0 psf
Elev. of I_{zp}		58.5 feet
σ'_{vp} at elevation	58.5	594.7 psf
I_{zp}		0.745
C_1		1.00
C_2		1.20

Computed Axisymmetrical Layer Information

Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_T (pcf)	Δz (ft)	Elev. Of Center of Layer (ft)	I_z	ε	ΔH (inches)
1	75	69.5	125	125	5.5	72.25	0.21	0.30%	0.20
2	62.5	50	400	125	12.5	56.25	0.68	0.30%	0.45
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

Immediate Settlement			0.7 inches
Settlement After	1	year	0.8 inches

Compute Global Values for Plane Strain Case		
σ'_{vo} at Elevation	75	0 psf
Elev. of I_{zp}		42 feet
σ'_{vp} at elevation	42	1627.6 psf
I_{zp}		0.648
C_1		1.00
C_2		1.20

Computed Plane Strain Layer Information

Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_T (pcf)	Δz (ft)	Elev. Of Center of Layer (ft)	I_z	ε	ΔH (inches)
1	75	69.5	125	125	5.5	72.25	0.24	0.34%	0.22
2	62.5	50	400	125	12.5	56.25	0.45	0.20%	0.31
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

Immediate Settlement			0.5 inches
Settlement After	1	year	0.6 inches

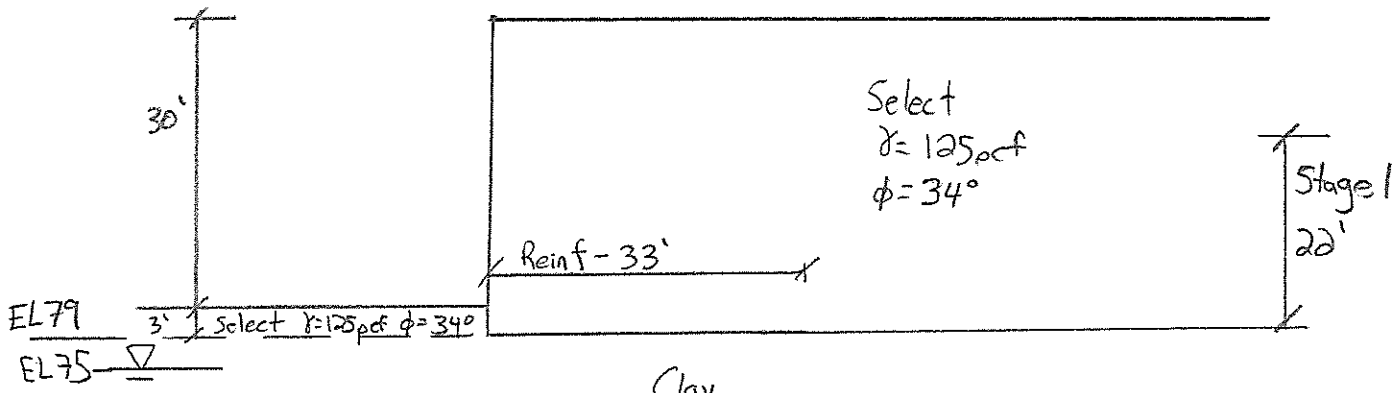
URS

Job SR1 / I-95 Interchange | Project No. | Page ___ of ___ | Sheet ___ of ___

Description Ramp A over I-95 | Computed by JPK | Date

Abut A Face | Checked by | Date

Bearing Capacity, Sliding & Overturning | Reference



Clay
γ = 120 pcf

CD	CU	UU @ Stage 1
φ = 27°	φ = 10.3°	φ = 0
c = 0	c = 940 psf	c = 1000 psf
Traffic Surcharge = 250 psf	TS = 250 psf	TS = 0

Note: For sliding, assumed sand stratum w/ φ = 27°

Settlement

Assumptions:

1) 3 feet of overburden removed to reach bottom of footing
2) Subsurface strata defined by URS-3
3) Elastic settlement of sand layers calculated using Schmertmann method
4) 20 feet of clay layer consolidating (based on test embankment back calculation)
5) Consolidation parameters from URS-3, U-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp A over I-95 - Abutment A Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	30	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	33	feet	
Wall Base Width	B =	33	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	54	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	4	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	33	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Weight of Retained Wedge	Wrw	36	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	19.2	k/ft	as defined by Fig 11.10.5.2-1
Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	2.3	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	136.1	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Friction Factor	tan Φf =	0.51	(dim)	
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horzinontal Load	FHL =	32.9	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	70.7	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	70.7	k/ft	**Capacity Demand Ratio (CDR)= 2.15**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	2.83	ft	**e < 0.25*B, OK**
Effective Width	B' =	27.3	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	4.98	ksf	
Factored Bearing Pressure	Sigv =	7.25	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	27.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	23.94	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	13.20	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	14.47	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.34	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.31	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.76	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.51	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	17.5	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	11.40	ksf	**Capacity Demand Ratio (CDR)= 1.572**
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming quarantine period after Stage 1
Foundation Φ	Φu =	10.3	degrees	
Foundation Cohesion (c)	cu =	940	psf	- Averaged from CU lab data- See Sheet URS-2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.18	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.11	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.76	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.51	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	11.5	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.45	ksf	**Capacity Demand Ratio (CDR)= 1.029**
				CDR > 1.0, OK

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp A over I-95 - Abutment A Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	19	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	22	feet	
Wall Base Width	B =	33	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11 10.2 1)
Total Footing Length (=Length of Wall)	L =	54	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	4	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	22	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Weight of Retained Wedge	Wrw	16	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	8.6	k/ft	as defined by Fig 11.10.5.2-1
Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	90.8	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Friction Factor	tan Φf =	0.51	(dim)	
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horzinontal Load	FHL =	12.8	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	47.6	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	47.6	k/ft	**Capacity Demand Ratio (CDR)= 3.71**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	1.04	ft	**e < 0.25*B, OK**
Effective Width	B' =	30.9	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	3.96	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	27.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	23.94	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	13.20	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	14.47	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.34	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.31	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.76	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.51	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	17.5	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	11.40	ksf	**Capacity Demand Ratio (CDR)= 2.877**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1, quarantine period to follow
Foundation Φ	Φf =	0.0	degrees	
Foundation Cohesion (c)	cf =	1000	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.12	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.51	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	6.1	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	3.99	ksf	**Capacity Demand Ratio (CDR)= 1.008**
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp A over I-95 - Abutment A Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c' [3]	
Initial Overburden	3				0.09				2.49				
Sand Stratum 1	5.5				0.18								
I	8	0.614	0.051	0.244	0.39	3.80	0.38	0.85	2.41	2.02	0	2.399054	
Sand Stratum 2	12.5				0.71								
II	12	0.614	0.051	0.244	1.09	3.80	1.06	0.52	2.29	1.20	0	1.464372	
Total Sand Settlement (See Attached Sheets)												1.0	
Footing Width (ft)	33										0.00	4.86	in
											TOTAL	4.86	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS- S1-14
Lab data on page URS-6

Project Name: SR 1/I-95 Interchange
Project Location: Newark, Delaware - Ramp A over I-95 - Abutment A Face: Sand Settlement
Project Number: 20832687 00000
Calculations By: JPK
Date: 12/30/2008

Input Global Data		
Footing Width, B	33.0	feet
Elevation of Ground Surface	75.0	feet
Elevation of Base of Footing	75.0	feet
Elevation of Water Table	75.0	feet
Unit Weight of Water, γ_w	62.4	pcf
Net Bearing Pressure, ΔP	4980	psf
Soil Unit Weight Above Footing Base	125	pcf
Settlement Calculated at end of construction and at time t	1	years

Input Layer Data				
Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_t (pcf)
1	75.0	69.5	125	125
2	62.5	50.0	400	125
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Es values based on SPT values

Note: The depth of the water table must be a layer boundary.

Compute Global Values for Axisymmetrical Case		
σ'_{vo} at Elevation	75.0	0 psf
Elev. of I_{zp}		58.5 feet
σ'_{vp} at elevation	58.5	594.7 psf
I_{zp}		0.789
C_1		1.00
C_2		1.20

Computed Axisymmetrical Layer Information

Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_T (pcf)	Δz (ft)	Elev. Of Center of Layer (ft)	I_z	ε	ΔH (inches)
1	75	69.5	125	125	5.5	72.25	0.21	0.43%	0.28
2	62.5	50	400	125	12.5	56.25	0.72	0.45%	0.67
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

Immediate Settlement			1.0 inches
Settlement After	1	year	1.1 inches

Compute Global Values for Plane Strain Case		
σ'_{vo} at Elevation	75	0 psf
Elev. of I_{zp}		42 feet
σ'_{vp} at elevation	42	1627.6 psf
I_{zp}		0.675
C_1		1.00
C_2		1.20

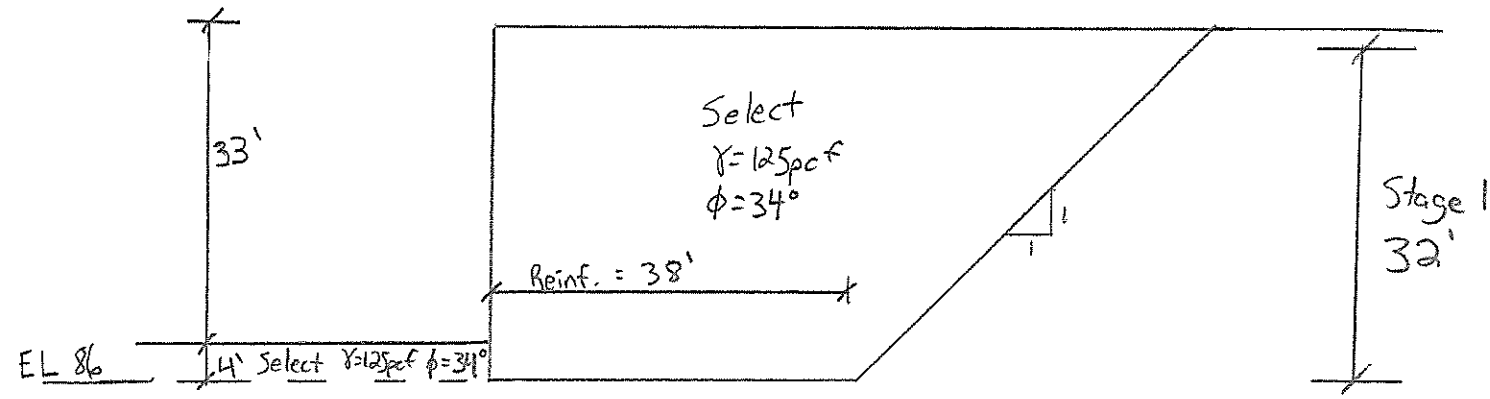
Computed Plane Strain Layer Information

Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_T (pcf)	Δz (ft)	Elev. Of Center of Layer (ft)	I_z	ε	ΔH (inches)
1	75	69.5	125	125	5.5	72.25	0.24	0.48%	0.31
2	62.5	50	400	125	12.5	56.25	0.47	0.29%	0.44
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

Immediate Settlement			0.8 inches
Settlement After	1	year	0.9 inches

URS

Job SR 1 / I-95 Interchange | Project No. | Page ___ of ___
Description Ramp A over I-95 | Computed by JPK | Sheet ___ of ___
Abut B Face & wingwalls | Checked by | Date
Bearing Capacity, Sliding & Overturning | Date | Reference



EL 75 ▽

Clay
γ=120 pcf

CD	CU	UU @ Stage 1
φ=28°	φ= 10.3°	φ=0
c=0	c= 940psf	c= 1500 psf
Traffic Surcharge = 250psf	TS= 250psf	TS=0 psf

Note: For sliding, assumed sand stratum w/ φ=28°

Settlement

Assumptions:

1) 6.5 feet of overburden removed to reach bottom of footing
2) Subsurface strata defined by IBR-26
3) Elastic settlement of sand layer calculated using Schmertmann method
4) 20 feet of clay layer consolidating (based on test embankment back calculation)
5) Consolidation parameters from URS-3, 4-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp A over I-95 - Abutment B Face & Wingwalls
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	33	feet	
Embedment (below grade)	Df =	4	feet	
Total Height (Hw+Df)	H =	37	feet	
Wall Base Width	B =	38	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	55	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	11	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	37	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Weight of Retained Wedge	Wrw	45	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	24.2	k/ft	as defined by Fig 11.10.5.2-1
Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	2.6	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	175.8	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Friction Factor	tan Φf =	0.53	(dim)	
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horzinontal Load	FHL =	40.9	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	95.2	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	95.2	k/ft	**Capacity Demand Ratio (CDR)= 2.33**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	3.03	ft	**e < 0.25*B, OK**
Effective Width	B' =	31.9	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	5.50	ksf	
Factored Bearing Pressure	Sigv =	7.95	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	28.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	25.80	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	14.72	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Ny =	16.72	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.39	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.37	(dim)	per Table 10.6.3.1.2a-3
	sy =	0.72	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwy =	0.56	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	25.5	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	16.61	ksf	**Capacity Demand Ratio (CDR)= 2.089**
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming
Foundation Φ	Φf =	10.3	degrees	quarantine period after Stage 1
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS-2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Ny =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.21	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.13	(dim)	per Table 10.6.3.1.2a-3
	sy =	0.72	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwy =	0.56	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	12.2	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.98	ksf	**Capacity Demand Ratio (CDR)= 1.001**
				CDR > 1.0, OK

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp A over I-95 - Abutment B Face & Wingwalls
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	28	feet	
Embedment (below grade)	Df =	4	feet	
Total Height (Hw+Df)	H =	32	feet	
Wall Base Width	B =	38	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	55	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	11	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	32	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Weight of Retained Wedge	Wrw	34	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	18.1	k/ft	as defined by Fig 11.10.5.2-1
Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	152.0	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Friction Factor	tan Φf =	0.53	(dim)	
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horzinontal Load	FHL =	27.1	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	82.6	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	82.6	k/ft	**Capacity Demand Ratio (CDR)= 3.04**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	1.90	ft	**e < 0.25*B, OK**
Effective Width	B' =	34.2	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	6.00	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	28.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	25.80	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	14.72	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	16.72	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.39	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.37	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.72	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.56	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	25.5	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	16.61	ksf	**Capacity Demand Ratio (CDR)= 2.767**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1,
Foundation Φ	Φf =	0.0	degrees	quarantine period to follow
Foundation Cohesion (c)	cf =	1500	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.14	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.56	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	9.3	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	6.08	ksf	**Capacity Demand Ratio (CDR)= 1.005**
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp A over I-95 - Abutment B Face & Wingwalls
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c' [3]	
Initial Overburden	6.5				0.20				2.75				
Sand Stratum 1	19				0.50								
I	10	0.614	0.051	0.244	0.95	3.80	0.80	0.65	2.54	1.58	0	1.612496	
II	10	0.614	0.051	0.244	1.27	3.80	1.07	0.50	2.44	1.17	0	1.079302	
Total Sand Settlement (See Attached Sheets)												1.0	
Footing Width (ft)	38										0.00	3.69	in
											TOTAL	3.69	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS-S1-21
Lab data on page URS-6

Project Name: SR 1/I-95 Interchange
Project Location: Newark, Delaware - Ramp A over I-95 - Abutment B Face & Wingwalls: Sand Settlement
Project Number: 20832687 00000
Calculations By: JPK
Date: 12/30/2008

Input Global Data		
Footing Width, B	38.0	feet
Elevation of Ground Surface	86.0	feet
Elevation of Base of Footing	86.0	feet
Elevation of Water Table	75.0	feet
Unit Weight of Water, γ_w	62.4	pcf
Net Bearing Pressure, ΔP	5500	psf
Soil Unit Weight Above Footing Base	125	pcf
Settlement Calculated at end of construction and at time t	1	years

Input Layer Data				
Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_t (pcf)
1	86.0	75.0	250	125
2	75.0	67.0	250	125
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Es based on SPT values

Note: The depth of the water table must be a layer boundary.

Compute Global Values for Axisymmetrical Case		
σ'_{vo} at Elevation	86.0	0 psf
Elev. of I_{zp}		67.0 feet
σ'_{vp} at elevation	67.0	1875.8 psf
I_{zp}		0.671
C_1		1.00
C_2		1.20

Computed Axisymmetrical Layer Information

Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_T (pcf)	Δz (ft)	Elev. Of Center of Layer (ft)	I_z	ε	ΔH (inches)
1	86	75	250	125	11	80.5	0.27	0.29%	0.39
2	75	67	250	125	8	71	0.55	0.61%	0.58
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

Immediate Settlement			1.0 inches
Settlement After	1	year	1.2 inches

Compute Global Values for Plane Strain Case		
σ'_{vo} at Elevation	86	0 psf
Elev. of I_{zp}		48 feet
σ'_{vp} at elevation	48	3065.2 psf
I_{zp}		0.634
C_1		1.00
C_2		1.20

Computed Plane Strain Layer Information

Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_T (pcf)	Δz (ft)	Elev. Of Center of Layer (ft)	I_z	ε	ΔH (inches)
1	86	75	250	125	11	80.5	0.26	0.29%	0.38
2	75	67	250	125	8	71	0.37	0.41%	0.39
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

Immediate Settlement			0.8 inches
Settlement After	1	year	0.9 inches

Global Stability

Short-term Case

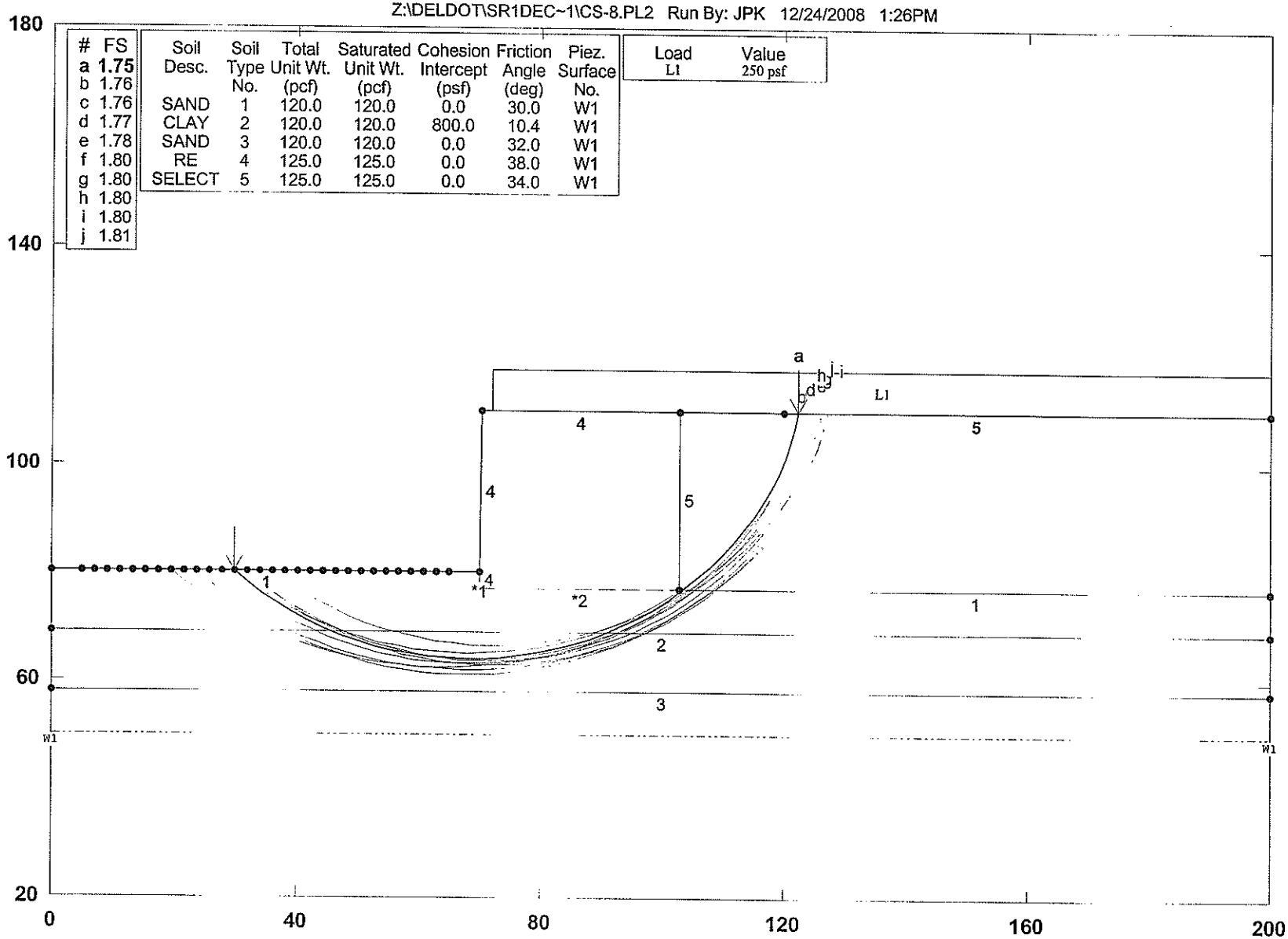
SR1/I95 Interchange CS-8 Consolidated Undrained

Z:\DELDOT\SR1DEC~1\CS-8.PL2 Run By: JPK 12/24/2008 1:26PM

#	FS
a	1.75
b	1.76
c	1.76
d	1.77
e	1.78
f	1.80
g	1.80
h	1.80
i	1.80
j	1.81

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
SAND	1	120.0	120.0	0.0	30.0	W1
CLAY	2	120.0	120.0	800.0	10.4	W1
SAND	3	120.0	120.0	0.0	32.0	W1
RE	4	125.0	125.0	0.0	38.0	W1
SELECT	5	125.0	125.0	0.0	34.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.75

Safety Factors Are Calculated By The Modified Bishop Method

STED

* For Cross Section Location see URS-10

Long-term Case

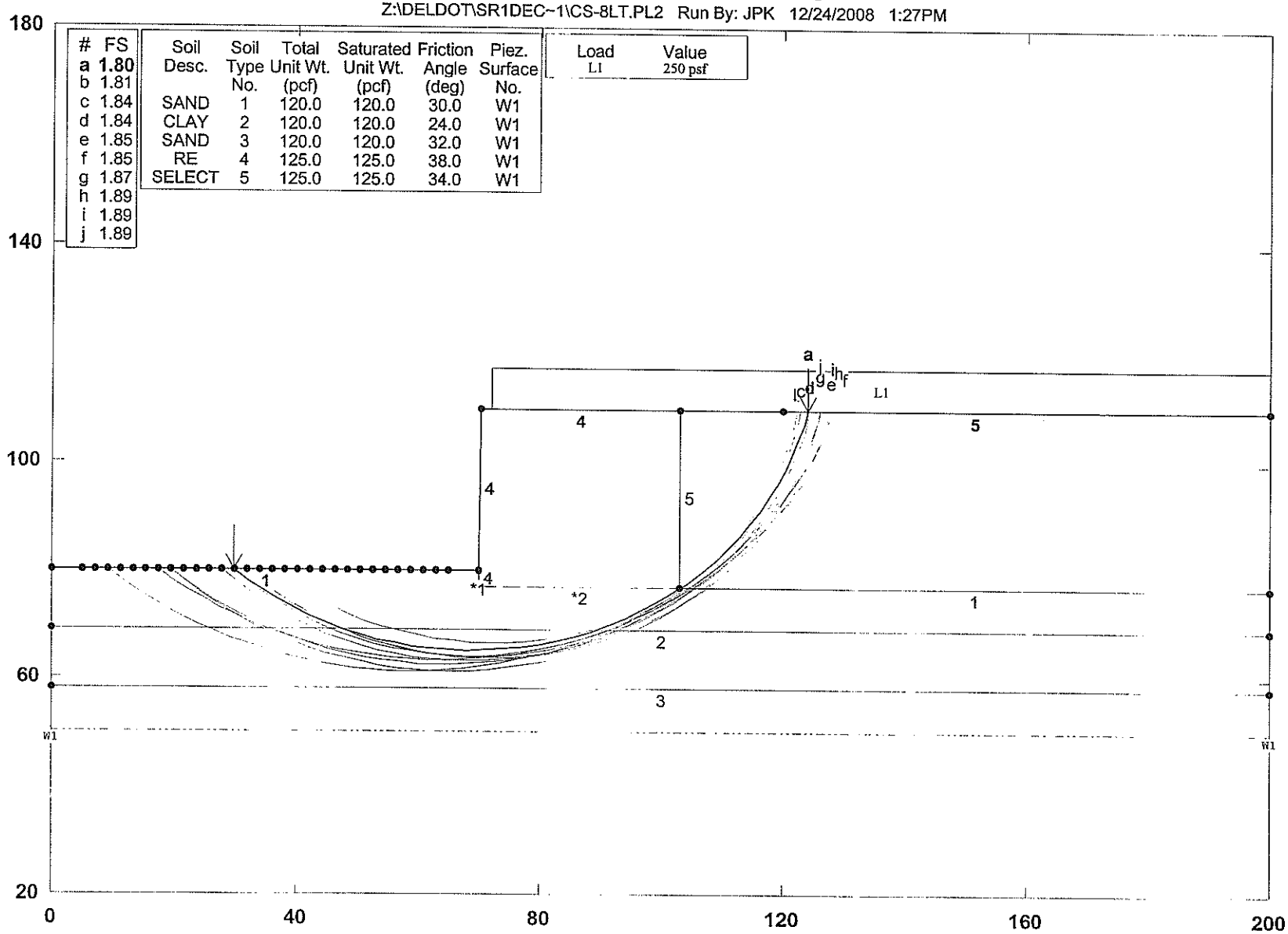
SR1/I95 Interchange CS-8 Long-Term

Z:\DELDOT\SR1DEC~1\CS-8LT.PL2 Run By: JPK 12/24/2008 1:27PM

#	FS
a	1.80
b	1.81
c	1.84
d	1.84
e	1.85
f	1.85
g	1.87
h	1.89
i	1.89
j	1.89

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
SAND	1	120.0	120.0	30.0	W1
CLAY	2	120.0	120.0	24.0	W1
SAND	3	120.0	120.0	32.0	W1
RE	4	125.0	125.0	38.0	W1
SELECT	5	125.0	125.0	34.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.80

Safety Factors Are Calculated By The Modified Bishop Method

STED

Short-term Case

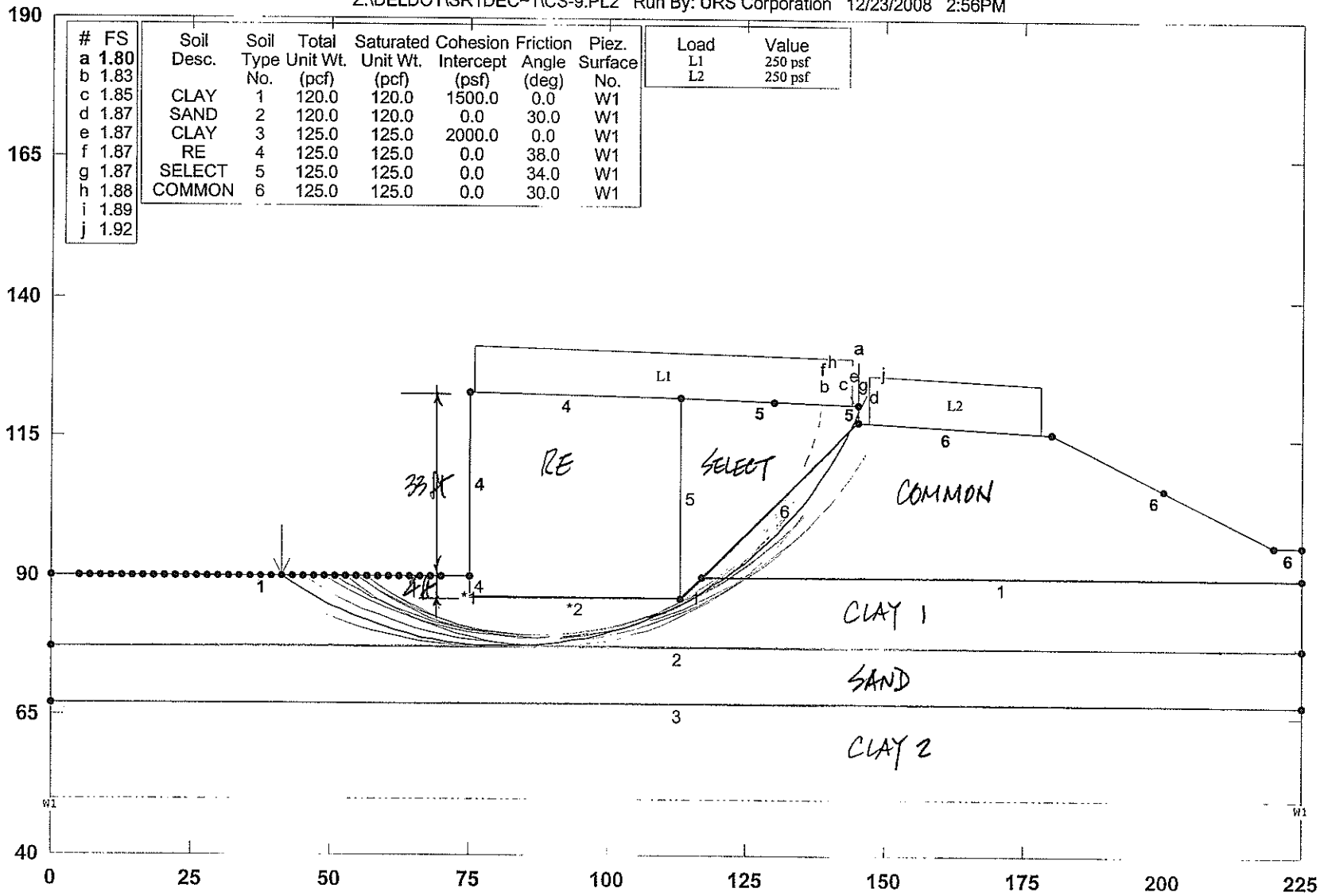
SR1/I95 Interchange CS-9 (Reversed)

Z:\DELDOT\SR1DEC~1\CS-9.PL2 Run By: URS Corporation 12/23/2008 2:56PM

#	FS
a	1.80
b	1.83
c	1.85
d	1.87
e	1.87
f	1.87
g	1.87
h	1.88
i	1.89
j	1.92

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	1500.0	0.0	W1
SAND	2	120.0	120.0	0.0	30.0	W1
CLAY	3	125.0	125.0	2000.0	0.0	W1
RE	4	125.0	125.0	0.0	38.0	W1
SELECT	5	125.0	125.0	0.0	34.0	W1
COMMON	6	125.0	125.0	0.0	30.0	W1

Load	Value
L1	250 psf
L2	250 psf



GSTABL7 FSmin=1.80

Safety Factors Are Calculated By The Modified Bishop Method

STED

Long-term Case

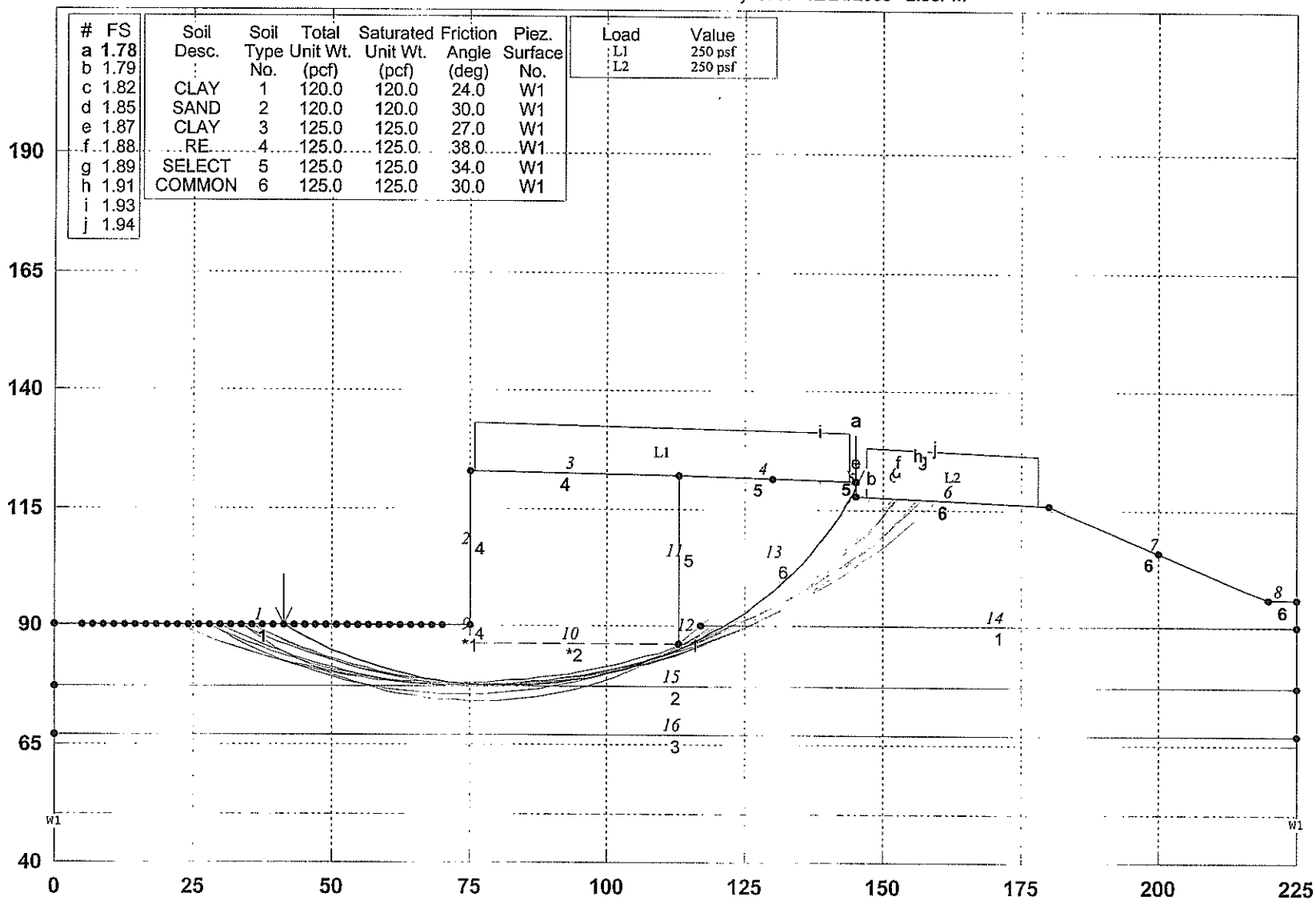
SR1/I95 Interchange CS-9 (Reversed) Long-Term

Z:\DELDOT\SR1DEC~1\CS-9LT.PL2 Run By: JPK 12/24/2008 2:58PM

#	FS
a	1.78
b	1.79
c	1.82
d	1.85
e	1.87
f	1.88
g	1.89
h	1.91
i	1.93
j	1.94

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	24.0	W1
SAND	2	120.0	120.0	30.0	W1
CLAY	3	125.0	125.0	27.0	W1
RE	4	125.0	125.0	38.0	W1
SELECT	5	125.0	125.0	34.0	W1
COMMON	6	125.0	125.0	30.0	W1

Load	Value
L1	250 psf
L2	250 psf



GSTABL7 FSmin=1.78

Safety Factors Are Calculated By The Modified Bishop Method

STED

Axial Capacity

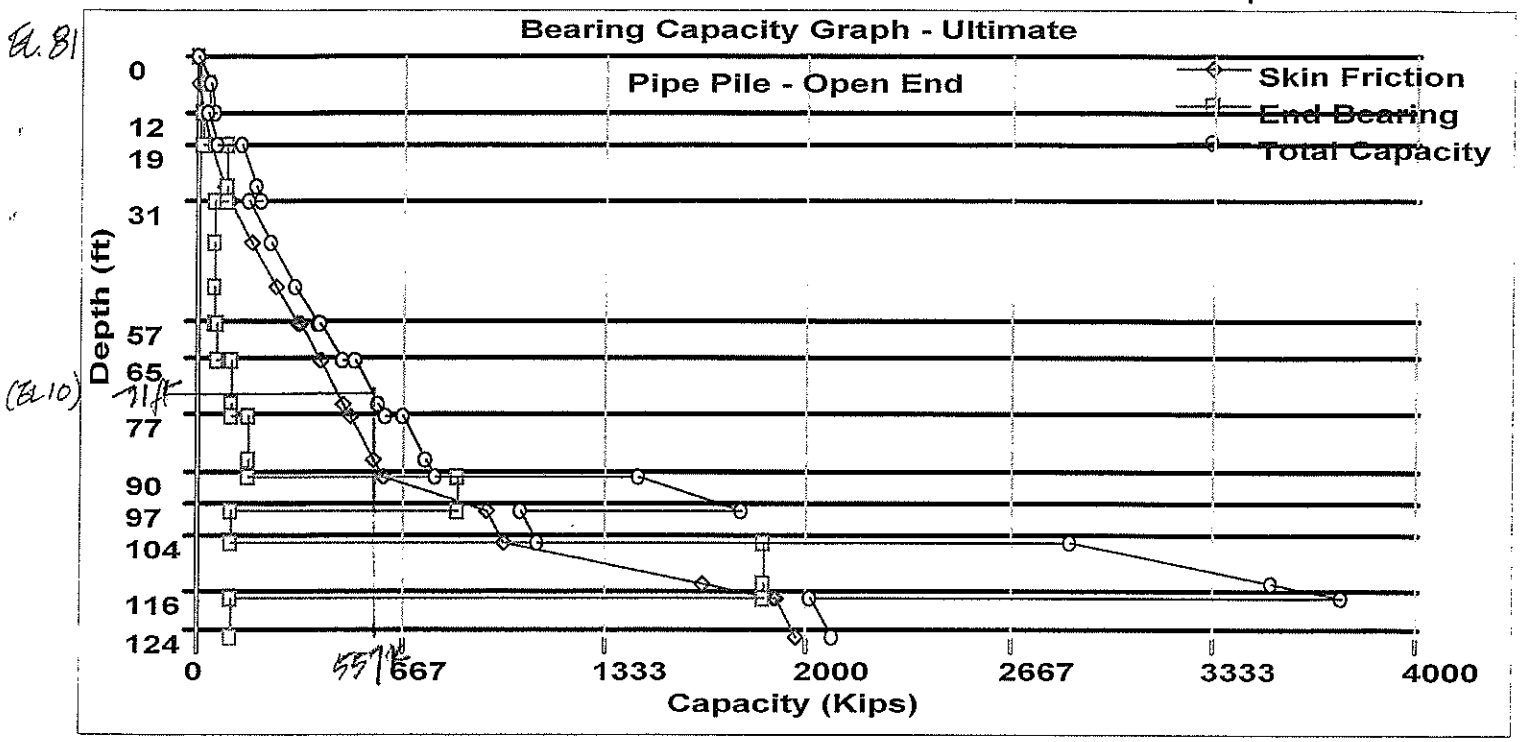
DelDOT SR1 / I-95 Interchange
Preliminary Pile Estimate

16-Dec-08

Location	Foundation	Required Factored Resistance, kip	Nominal Resistance, kip	Size of Pipe Pile		Estimated Pile Tip El.
				Diameter, in.	Wall in.	
S1-Ramp A Over I-95	Abut A	375	577	24	0.5	10
	Pier 1	835	1285	36	0.625	10
	Pier 2	835	1285	36	0.625	1
	Pier 3	835	1285	36	0.625	24
	Abut B	375	577	24	0.5	20

* 0.65 Resistance factor. Required capacity factor = 1.54

Filename: Z:\DELDOT\SR1DEC~1\A-95UTA.DVN RAMP A/I-95 ABUT. A 24"ϕ 0.5" WALL

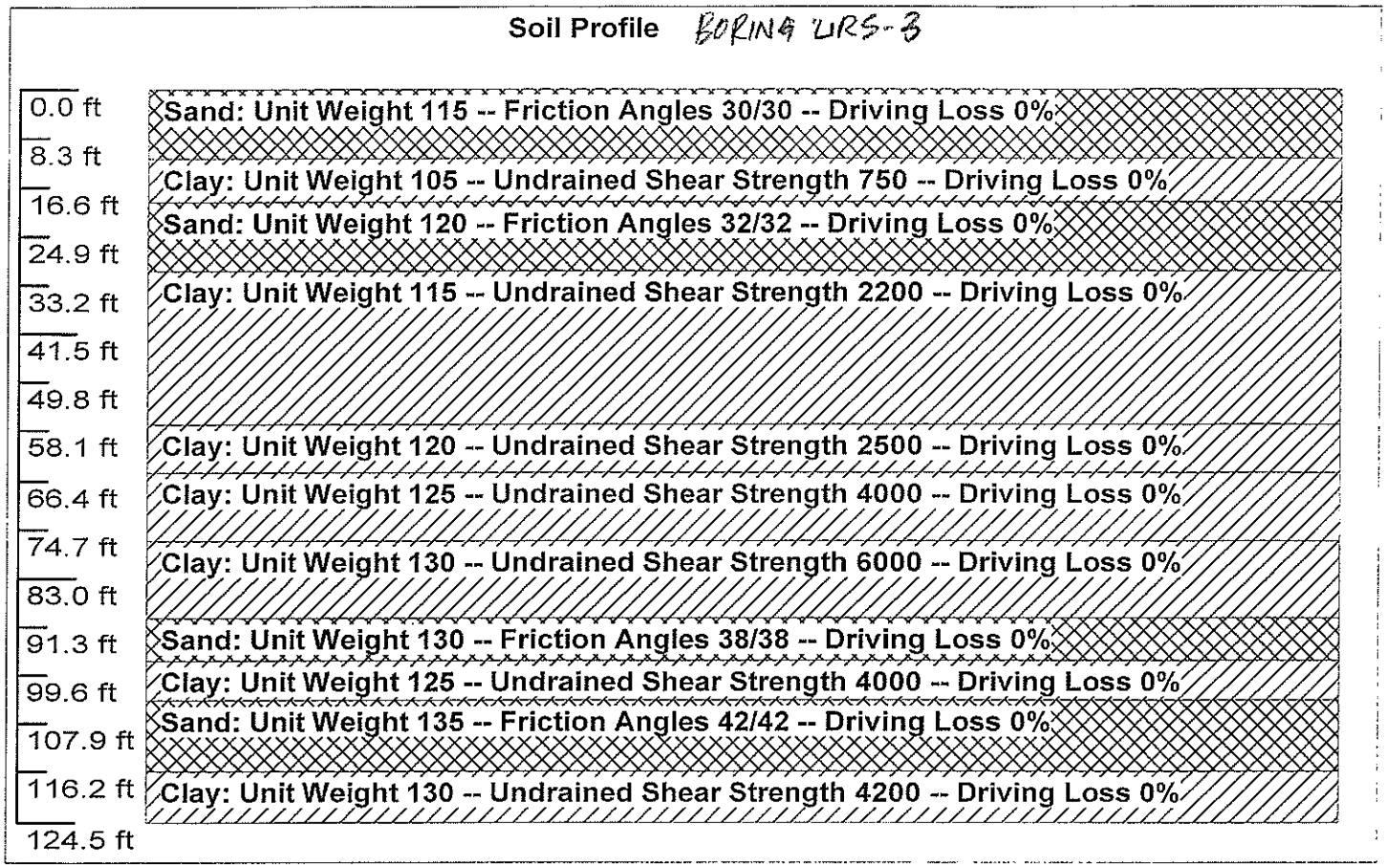


REQUIRED CAPACITY = 577K

EST. PILE TIP = EL. 10

Filename: Z:\DELDOT\SR1DEC~1\A-95UTA.DVN RAMP A /I-95 ABUT. A

Soil Profile BORING URS-3



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A-95UTA.DVN
Project Name: Ramp A/I95 Abut A
Project Date: 12/10/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 URS-3 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 24.00 in
Shell Thickness: 0.50 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	6.00 ft
	- Driving/Restrike	6.00 ft
	- Ultimate:	6.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	12.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
2	Cohesive	7.00 ft	0.00%	105.00 pcf	750.00 psf	T-79 Steel
3	Cohesionless	12.00 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund
4	Cohesive	26.00 ft	0.00%	115.00 pcf	2200.00 psf	T-79 Steel
5	Cohesive	8.00 ft	0.00%	120.00 pcf	2500.00 psf	T-79 Steel
6	Cohesive	12.00 ft	0.00%	125.00 pcf	4000.00 psf	T-79 Steel
7	Cohesive	13.00 ft	0.00%	130.00 pcf	6000.00 psf	T-79 Steel
8	Cohesionless	7.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund
9	Cohesive	7.00 ft	0.00%	125.00 pcf	4000.00 psf	T-79 Steel
10	Cohesionless	12.00 ft	0.00%	135.00 pcf	42.0/42.0	Nordlund
11	Cohesive	8.50 ft	0.00%	130.00 pcf	4200.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.57 psf	25.83	N/A	0.00 Kips
5.99 ft	Cohesionless	344.42 psf	25.83	N/A	5.27 Kips
6.01 ft	Cohesionless	690.26 psf	25.83	N/A	5.30 Kips
11.99 ft	Cohesionless	847.54 psf	25.83	N/A	18.24 Kips
12.01 ft	Cohesive	N/A	N/A	622.50 psf	18.30 Kips
18.99 ft	Cohesive	N/A	N/A	622.50 psf	45.60 Kips
19.01 ft	Cohesionless	1304.09 psf	27.55	N/A	45.68 Kips
28.01 ft	Cohesionless	1563.29 psf	27.55	N/A	90.11 Kips
30.99 ft	Cohesionless	1649.11 psf	27.55	N/A	108.07 Kips
31.01 ft	Cohesive	N/A	N/A	1204.41 psf	108.21 Kips
40.01 ft	Cohesive	N/A	N/A	1273.41 psf	180.22 Kips
49.01 ft	Cohesive	N/A	N/A	1342.41 psf	260.04 Kips
56.99 ft	Cohesive	N/A	N/A	1403.59 psf	337.34 Kips
57.01 ft	Cohesive	N/A	N/A	1323.84 psf	337.52 Kips
64.99 ft	Cohesive	N/A	N/A	1393.66 psf	407.40 Kips
65.01 ft	Cohesive	N/A	N/A	1137.58 psf	407.57 Kips
74.01 ft	Cohesive	N/A	N/A	1211.08 psf	476.06 Kips
76.99 ft	Cohesive	N/A	N/A	1235.42 psf	500.57 Kips
77.01 ft	Cohesive	N/A	N/A	1235.58 psf	500.73 Kips
86.01 ft	Cohesive	N/A	N/A	1260.00 psf	571.98 Kips
89.99 ft	Cohesive	N/A	N/A	1260.00 psf	603.49 Kips
90.01 ft	Cohesionless	5453.74 psf	30.32	N/A	604.04 Kips
96.99 ft	Cohesionless	5689.66 psf	30.32	N/A	944.34 Kips
97.01 ft	Cohesive	N/A	N/A	1260.00 psf	944.92 Kips
103.99 ft	Cohesive	N/A	N/A	1260.00 psf	1000.18 Kips
104.01 ft	Cohesionless	6365.16 psf	33.52	N/A	1000.96 Kips
113.01 ft	Cohesionless	6691.86 psf	33.52	N/A	1662.24 Kips
115.99 ft	Cohesionless	6800.04 psf	33.52	N/A	1895.43 Kips
116.01 ft	Cohesive	N/A	N/A	1260.00 psf	1896.30 Kips
124.49 ft	Cohesive	N/A	N/A	1260.00 psf	1963.44 Kips

A-95UTA-8

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.15 psf	30.00	41.85 Kips	0.06 Kips
5.99 ft	Cohesionless	688.85 psf	30.00	41.85 Kips	37.66 Kips
6.01 ft	Cohesionless	690.53 psf	30.00	41.85 Kips	37.75 Kips
11.99 ft	Cohesionless	1005.07 psf	30.00	41.85 Kips	41.85 Kips
12.01 ft	Cohesive	N/A	N/A	N/A	21.21 Kips
18.99 ft	Cohesive	N/A	N/A	N/A	21.21 Kips
19.01 ft	Cohesionless	1304.38 psf	40.40	103.67 Kips	103.57 Kips
28.01 ft	Cohesionless	1822.78 psf	40.40	103.67 Kips	103.67 Kips
30.99 ft	Cohesionless	1994.42 psf	40.40	103.67 Kips	103.67 Kips
31.01 ft	Cohesive	N/A	N/A	N/A	62.20 Kips
40.01 ft	Cohesive	N/A	N/A	N/A	62.20 Kips
49.01 ft	Cohesive	N/A	N/A	N/A	62.20 Kips
56.99 ft	Cohesive	N/A	N/A	N/A	62.20 Kips
57.01 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
64.99 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
65.01 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
74.01 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
76.99 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
77.01 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
86.01 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
89.99 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
90.01 ft	Cohesionless	5454.08 psf	110.40	843.83 Kips	843.83 Kips
96.99 ft	Cohesionless	5925.92 psf	110.40	843.83 Kips	843.83 Kips
97.01 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
103.99 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
104.01 ft	Cohesionless	6365.53 psf	244.00	1861.58 Kips	1861.58 Kips
113.01 ft	Cohesionless	7018.93 psf	244.00	1861.58 Kips	1861.58 Kips
115.99 ft	Cohesionless	7235.27 psf	244.00	1861.58 Kips	1861.58 Kips
116.01 ft	Cohesive	N/A	N/A	N/A	118.75 Kips
124.49 ft	Cohesive	N/A	N/A	N/A	118.75 Kips

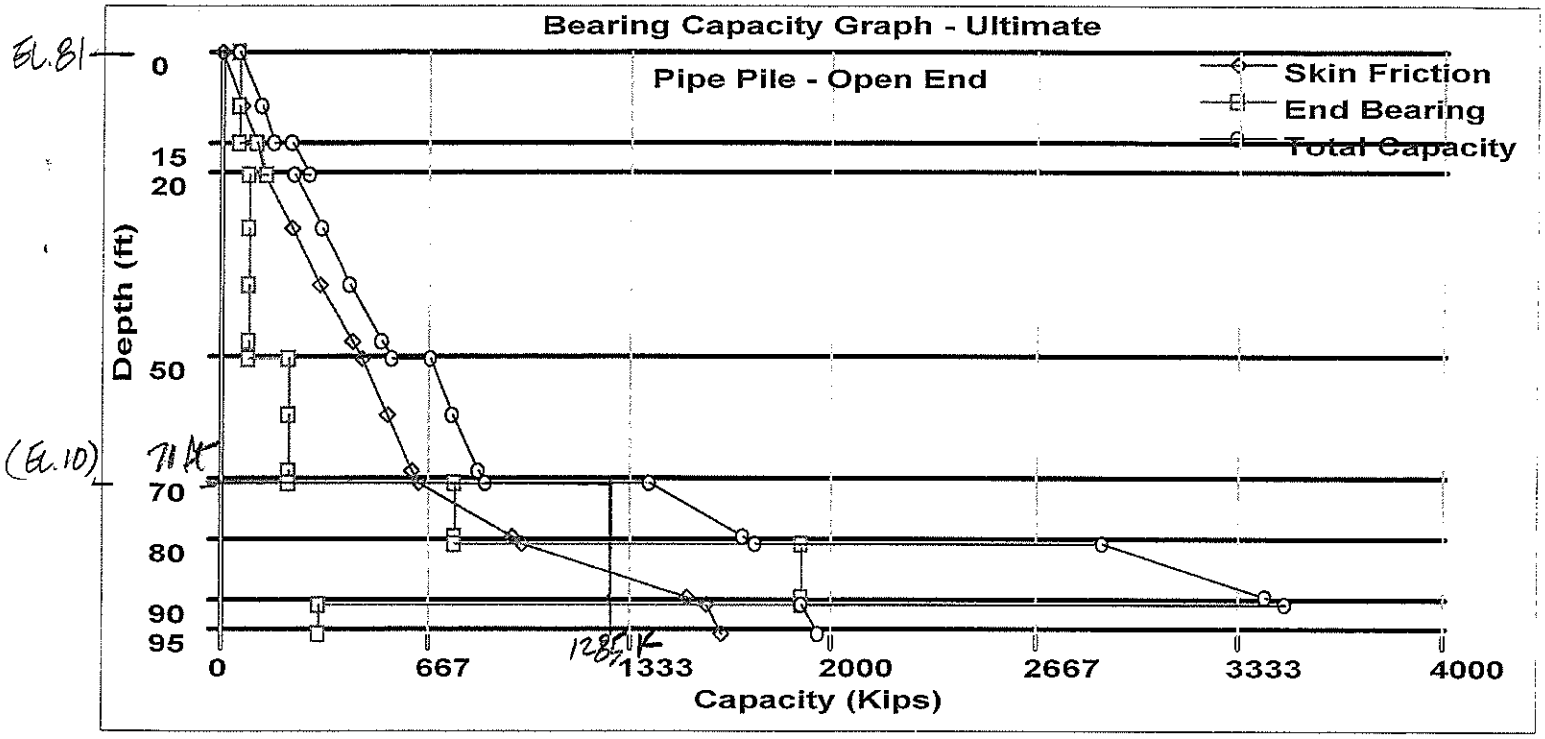
A-95UTA-9

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.06 Kips	0.06 Kips
5.99 ft	5.27 Kips	37.66 Kips	42.92 Kips
6.01 ft	5.30 Kips	37.75 Kips	43.05 Kips
11.99 ft	18.24 Kips	41.85 Kips	60.08 Kips
12.01 ft	18.30 Kips	21.21 Kips	39.51 Kips
18.99 ft	45.60 Kips	21.21 Kips	66.81 Kips
19.01 ft	45.68 Kips	103.57 Kips	149.25 Kips
28.01 ft	90.11 Kips	103.67 Kips	193.78 Kips
30.99 ft	108.07 Kips	103.67 Kips	211.74 Kips
31.01 ft	108.21 Kips	62.20 Kips	170.41 Kips
40.01 ft	180.22 Kips	62.20 Kips	242.42 Kips
49.01 ft	260.04 Kips	62.20 Kips	322.24 Kips
56.99 ft	337.34 Kips	62.20 Kips	399.54 Kips
57.01 ft	337.52 Kips	70.69 Kips	408.21 Kips
64.99 ft	407.40 Kips	70.69 Kips	478.09 Kips
65.01 ft	407.57 Kips	113.10 Kips	520.66 Kips
74.01 ft	476.06 Kips	113.10 Kips	589.15 Kips
76.99 ft	500.57 Kips	113.10 Kips	613.66 Kips
77.01 ft	500.73 Kips	169.65 Kips	670.37 Kips
86.01 ft	571.98 Kips	169.65 Kips	741.63 Kips
89.99 ft	603.49 Kips	169.65 Kips	773.14 Kips
90.01 ft	604.04 Kips	843.83 Kips	1447.87 Kips
96.99 ft	944.34 Kips	843.83 Kips	1788.17 Kips
97.01 ft	944.92 Kips	113.10 Kips	1058.02 Kips
103.99 ft	1000.18 Kips	113.10 Kips	1113.28 Kips
104.01 ft	1000.96 Kips	1861.58 Kips	2862.54 Kips
113.01 ft	1662.24 Kips	1861.58 Kips	3523.82 Kips
115.99 ft	1895.43 Kips	1861.58 Kips	3757.01 Kips
116.01 ft	1896.30 Kips	118.75 Kips	2015.05 Kips
124.49 ft	1963.44 Kips	118.75 Kips	2082.19 Kips

A-95UTA-10

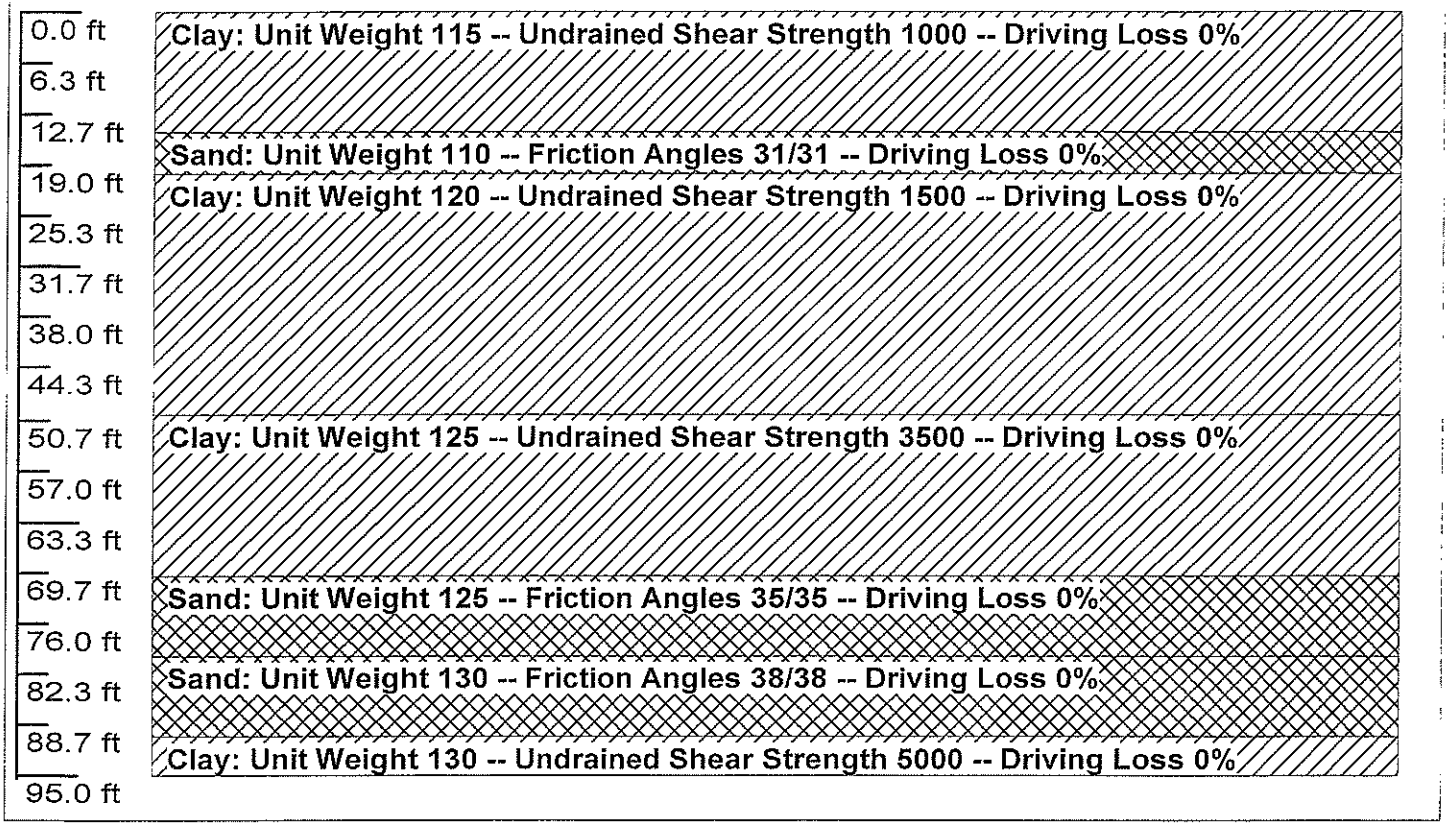
Filename: Z:\DELDOT\SR1DEC~1\A-95P1B.DVN RAMP A/I-95 PIER 1 36 ϕ 0.625" WALL



REQUIRED CAPACITY = 1285 K
EST. PILE TIP = EL. 10

Filename: Z:\DELDOT\SR1DEC~1\A-95P1B.DVN RAMP A/I-95 PIER 1 36" ϕ 0.625 WALL

Soil Profile BORING URS-3



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A-95P1B.DVN
Project Name: Ramp A / I95 Pier 1 Project Date: 12/12/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IRW-68 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 36.00 in
Shell Thickness: 0.62 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	15.00 ft	0.00%	115.00 pcf	1000.00 psf	T-79 Steel
2	Cohesionless	5.00 ft	0.00%	110.00 pcf	31.0/31.0	Nordlund
3	Cohesive	30.00 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
4	Cohesive	20.00 ft	0.00%	125.00 pcf	3500.00 psf	T-79 Steel
5	Cohesionless	10.00 ft	0.00%	125.00 pcf	35.0/35.0	Nordlund
6	Cohesionless	10.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund
7	Cohesive	5.00 ft	0.00%	130.00 pcf	5000.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	800.00 psf	0.08 Kips
9.01 ft	Cohesive	N/A	N/A	800.00 psf	67.93 Kips
14.99 ft	Cohesive	N/A	N/A	800.00 psf	113.02 Kips
15.01 ft	Cohesionless	789.24 psf	29.92	N/A	113.14 Kips
19.99 ft	Cohesionless	907.76 psf	29.92	N/A	137.43 Kips
20.01 ft	Cohesive	N/A	N/A	1060.00 psf	137.59 Kips
29.01 ft	Cohesive	N/A	N/A	1060.00 psf	227.50 Kips
38.01 ft	Cohesive	N/A	N/A	1080.92 psf	320.96 Kips
47.01 ft	Cohesive	N/A	N/A	1104.42 psf	418.63 Kips
49.99 ft	Cohesive	N/A	N/A	1112.20 psf	451.85 Kips
50.01 ft	Cohesive	N/A	N/A	878.94 psf	452.04 Kips
59.01 ft	Cohesive	N/A	N/A	927.94 psf	530.76 Kips
68.01 ft	Cohesive	N/A	N/A	976.94 psf	617.79 Kips
69.99 ft	Cohesive	N/A	N/A	987.72 psf	638.05 Kips
70.01 ft	Cohesionless	4007.31 psf	33.78	N/A	638.48 Kips
79.01 ft	Cohesionless	4289.01 psf	33.78	N/A	949.37 Kips
79.99 ft	Cohesionless	4319.69 psf	33.78	N/A	985.69 Kips
80.01 ft	Cohesionless	4633.34 psf	36.67	N/A	986.62 Kips
89.01 ft	Cohesionless	4937.54 psf	36.67	N/A	1521.73 Kips
89.99 ft	Cohesionless	4970.66 psf	36.67	N/A	1583.98 Kips
90.01 ft	Cohesive	N/A	N/A	1096.72 psf	1584.72 Kips
94.99 ft	Cohesive	N/A	N/A	1123.83 psf	1637.47 Kips

ULTIMATE - END BEARING

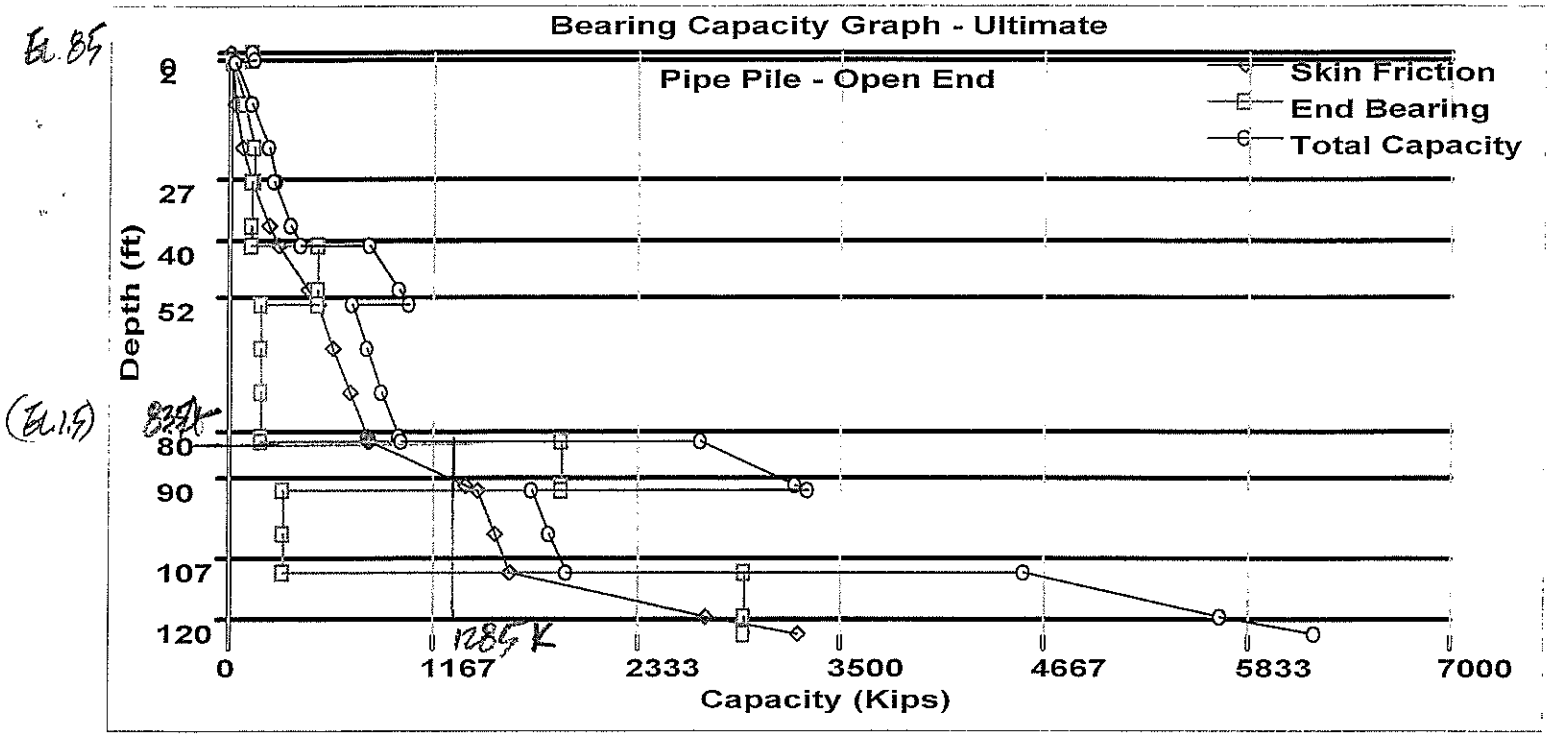
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	63.62 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	63.62 Kips
14.99 ft	Cohesive	N/A	N/A	N/A	63.62 Kips
15.01 ft	Cohesionless	789.48 psf	35.20	146.07 Kips	118.41 Kips
19.99 ft	Cohesionless	1026.52 psf	35.20	146.07 Kips	146.07 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
29.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
38.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
47.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
49.99 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
50.01 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
59.01 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
68.01 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
69.99 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
70.01 ft	Cohesionless	4007.63 psf	64.00	760.58 Kips	760.58 Kips
79.01 ft	Cohesionless	4571.03 psf	64.00	760.58 Kips	760.58 Kips
79.99 ft	Cohesionless	4632.37 psf	64.00	760.58 Kips	760.58 Kips
80.01 ft	Cohesionless	4633.68 psf	110.40	1898.62 Kips	1898.62 Kips
89.01 ft	Cohesionless	5242.08 psf	110.40	1898.62 Kips	1898.62 Kips
89.99 ft	Cohesionless	5308.32 psf	110.40	1898.62 Kips	1898.62 Kips
90.01 ft	Cohesive	N/A	N/A	N/A	318.09 Kips
94.99 ft	Cohesive	N/A	N/A	N/A	318.09 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.08 Kips	63.62 Kips	63.69 Kips
9.01 ft	67.93 Kips	63.62 Kips	131.55 Kips
14.99 ft	113.02 Kips	63.62 Kips	176.64 Kips
15.01 ft	113.14 Kips	118.41 Kips	231.55 Kips
19.99 ft	137.43 Kips	146.07 Kips	283.50 Kips
20.01 ft	137.59 Kips	95.43 Kips	233.01 Kips
29.01 ft	227.50 Kips	95.43 Kips	322.93 Kips
38.01 ft	320.96 Kips	95.43 Kips	416.39 Kips
47.01 ft	418.63 Kips	95.43 Kips	514.06 Kips
49.99 ft	451.85 Kips	95.43 Kips	547.28 Kips
50.01 ft	452.04 Kips	222.66 Kips	674.70 Kips
59.01 ft	530.76 Kips	222.66 Kips	753.42 Kips
68.01 ft	617.79 Kips	222.66 Kips	840.45 Kips
69.99 ft	638.05 Kips	222.66 Kips	860.71 Kips
70.01 ft	638.48 Kips	760.58 Kips	1399.06 Kips
79.01 ft	949.37 Kips	760.58 Kips	1709.95 Kips
79.99 ft	985.69 Kips	760.58 Kips	1746.27 Kips
80.01 ft	986.62 Kips	1898.62 Kips	2885.24 Kips
89.01 ft	1521.73 Kips	1898.62 Kips	3420.35 Kips
89.99 ft	1583.98 Kips	1898.62 Kips	3482.60 Kips
90.01 ft	1584.72 Kips	318.09 Kips	1902.81 Kips
94.99 ft	1637.47 Kips	318.09 Kips	1955.56 Kips

A-95P1B-10

Filename: Z:\DELDOT\SR1DEC~1\A-95P2A.DVN RAMP A/I-95 PIER 2

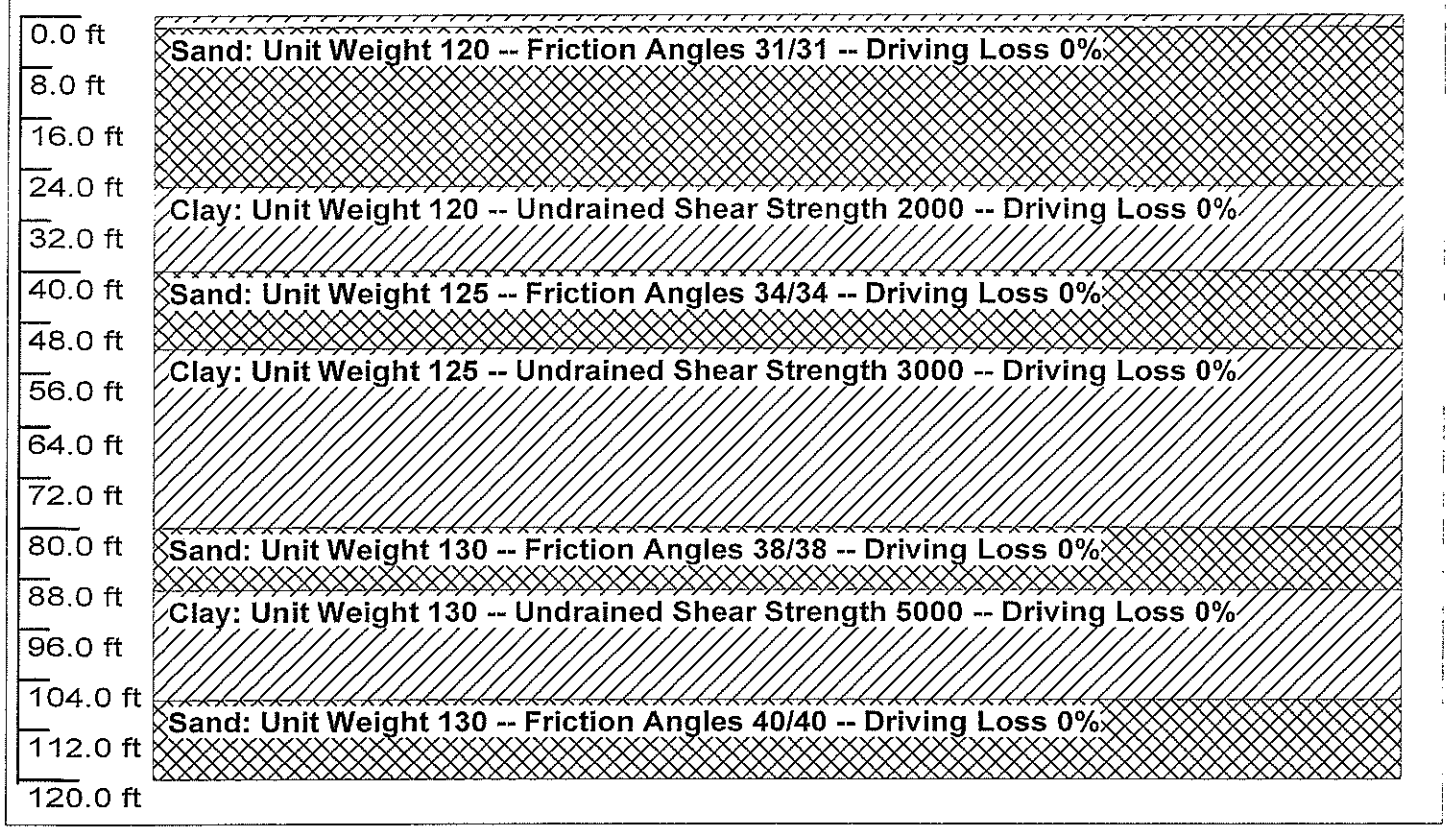


REQUIRED CAPACITY = 1285 KIP

EST. PILE TIP ≈ EL 1

Filename: Z:\DELDOT\SR1DEC~1\A-95P2A.DVN RAMPA / I-95 PIER 2 36 ϕ 1285 K

Soil Profile



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A-95P2A.DVN
Project Name: Ramp A / I95 Pier 2 Project Date: 12/14/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 I-BR-URS2 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 36.00 in
Shell Thickness: 0.62 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	2.00 ft	0.00%	120.00 pcf	2000.00 psf	T-79 Steel
2	Cohesionless	25.00 ft	0.00%	120.00 pcf	31.0/31.0	Nordlund
3	Cohesive	13.00 ft	0.00%	120.00 pcf	2000.00 psf	T-79 Steel
4	Cohesionless	12.00 ft	0.00%	125.00 pcf	34.0/34.0	Nordlund
5	Cohesive	28.00 ft	0.00%	125.00 pcf	3000.00 psf	T-79 Steel
6	Cohesionless	10.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund
7	Cohesive	17.00 ft	0.00%	130.00 pcf	5000.00 psf	T-79 Steel
8	Cohesionless	13.00 ft	0.00%	130.00 pcf	40.0/40.0	Nordlund

A-95P2A-1

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1165.00 psf	0.11 Kips
1.99 ft	Cohesive	N/A	N/A	1165.00 psf	21.85 Kips
2.01 ft	Cohesionless	115.49 psf	29.92	N/A	21.97 Kips
11.01 ft	Cohesionless	374.69 psf	29.92	N/A	40.10 Kips
20.01 ft	Cohesionless	633.89 psf	29.92	N/A	83.29 Kips
26.99 ft	Cohesionless	834.91 psf	29.92	N/A	134.06 Kips
27.01 ft	Cohesive	N/A	N/A	1165.00 psf	134.25 Kips
36.01 ft	Cohesive	N/A	N/A	1188.37 psf	235.05 Kips
39.99 ft	Cohesive	N/A	N/A	1203.85 psf	281.52 Kips
40.01 ft	Cohesionless	2304.31 psf	32.81	N/A	281.81 Kips
49.01 ft	Cohesionless	2586.01 psf	32.81	N/A	452.85 Kips
51.99 ft	Cohesionless	2679.29 psf	32.81	N/A	517.69 Kips
52.01 ft	Cohesive	N/A	N/A	914.72 psf	518.00 Kips
61.01 ft	Cohesive	N/A	N/A	965.72 psf	599.92 Kips
70.01 ft	Cohesive	N/A	N/A	1016.72 psf	690.49 Kips
79.01 ft	Cohesive	N/A	N/A	1067.72 psf	789.71 Kips
79.99 ft	Cohesive	N/A	N/A	1073.28 psf	801.04 Kips
80.01 ft	Cohesionless	4808.34 psf	36.67	N/A	801.74 Kips
89.01 ft	Cohesionless	5112.54 psf	36.67	N/A	1355.81 Kips
89.99 ft	Cohesionless	5145.66 psf	36.67	N/A	1420.13 Kips
90.01 ft	Cohesive	N/A	N/A	1096.72 psf	1420.89 Kips
99.01 ft	Cohesive	N/A	N/A	1145.72 psf	1518.08 Kips
106.99 ft	Cohesive	N/A	N/A	1189.17 psf	1611.21 Kips
107.01 ft	Cohesionless	6633.54 psf	31.92	N/A	1612.52 Kips
116.01 ft	Cohesionless	6937.74 psf	31.92	N/A	2740.23 Kips
119.99 ft	Cohesionless	7072.26 psf	31.92	N/A	3270.46 Kips

ULTIMATE - END BEARING

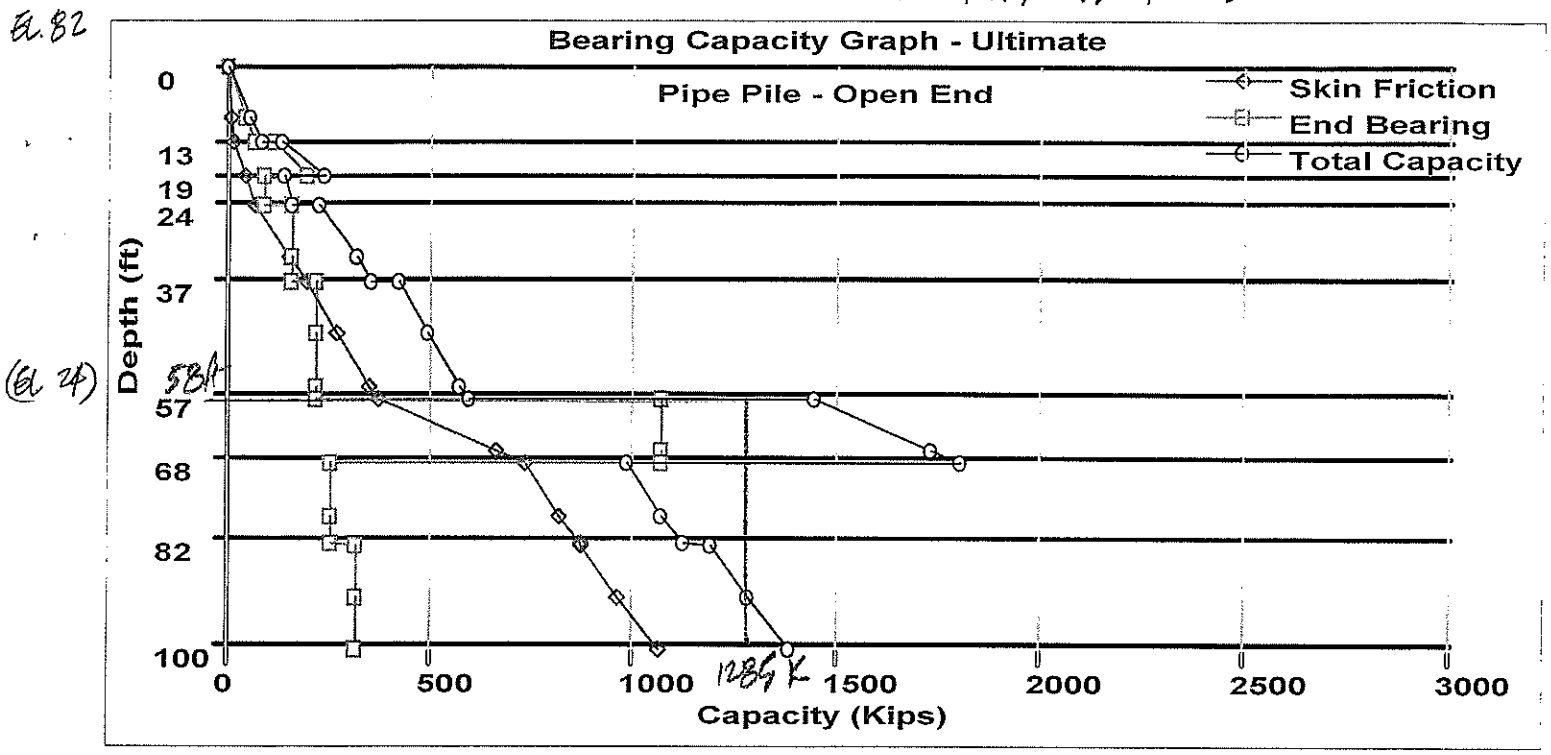
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
1.99 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
2.01 ft	Cohesionless	115.78 psf	35.20	146.07 Kips	17.36 Kips
11.01 ft	Cohesionless	634.18 psf	35.20	146.07 Kips	95.12 Kips
20.01 ft	Cohesionless	1152.58 psf	35.20	146.07 Kips	146.07 Kips
26.99 ft	Cohesionless	1554.62 psf	35.20	146.07 Kips	146.07 Kips
27.01 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
36.01 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
39.99 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
40.01 ft	Cohesionless	2304.63 psf	55.60	519.68 Kips	519.68 Kips
49.01 ft	Cohesionless	2868.03 psf	55.60	519.68 Kips	519.68 Kips
51.99 ft	Cohesionless	3054.57 psf	55.60	519.68 Kips	519.68 Kips
52.01 ft	Cohesive	N/A	N/A	N/A	190.85 Kips
61.01 ft	Cohesive	N/A	N/A	N/A	190.85 Kips
70.01 ft	Cohesive	N/A	N/A	N/A	190.85 Kips
79.01 ft	Cohesive	N/A	N/A	N/A	190.85 Kips
79.99 ft	Cohesive	N/A	N/A	N/A	190.85 Kips
80.01 ft	Cohesionless	4808.68 psf	110.40	1898.62 Kips	1898.62 Kips
89.01 ft	Cohesionless	5417.08 psf	110.40	1898.62 Kips	1898.62 Kips
89.99 ft	Cohesionless	5483.32 psf	110.40	1898.62 Kips	1898.62 Kips
90.01 ft	Cohesive	N/A	N/A	N/A	318.09 Kips
99.01 ft	Cohesive	N/A	N/A	N/A	318.09 Kips
106.99 ft	Cohesive	N/A	N/A	N/A	318.09 Kips
107.01 ft	Cohesionless	6633.88 psf	160.00	2951.84 Kips	2951.84 Kips
116.01 ft	Cohesionless	7242.28 psf	160.00	2951.84 Kips	2951.84 Kips
119.99 ft	Cohesionless	7511.32 psf	160.00	2951.84 Kips	2951.84 Kips

ULTIMATE - SUMMARY OF CAPACITIES

	Depth	Skin Friction	End Bearing	Total Capacity
	0.01 ft	0.11 Kips	127.23 Kips	127.34 Kips
	1.99 ft	21.85 Kips	127.23 Kips	149.08 Kips
	2.01 ft	21.97 Kips	17.36 Kips	39.33 Kips
	11.01 ft	40.10 Kips	95.12 Kips	135.21 Kips
	20.01 ft	83.29 Kips	146.07 Kips	229.36 Kips
	26.99 ft	134.06 Kips	146.07 Kips	280.12 Kips
	27.01 ft	134.25 Kips	127.23 Kips	261.48 Kips
	36.01 ft	235.05 Kips	127.23 Kips	362.29 Kips
	39.99 ft	281.52 Kips	127.23 Kips	408.76 Kips
	40.01 ft	281.81 Kips	519.68 Kips	801.49 Kips
	49.01 ft	452.85 Kips	519.68 Kips	972.53 Kips
	51.99 ft	517.69 Kips	519.68 Kips	1037.37 Kips
	52.01 ft	518.00 Kips	190.85 Kips	708.85 Kips
	61.01 ft	599.92 Kips	190.85 Kips	790.77 Kips
	70.01 ft	690.49 Kips	190.85 Kips	881.34 Kips
	79.01 ft	789.71 Kips	190.85 Kips	980.57 Kips
	79.99 ft	801.04 Kips	190.85 Kips	991.89 Kips
80 Ft.	80.01 ft	801.74 Kips	1898.62 Kips	2700.36 Kips
	89.01 ft	1355.81 Kips	1898.62 Kips	3254.43 Kips
	89.99 ft	1420.13 Kips	1898.62 Kips	3318.75 Kips
	90.01 ft	1420.89 Kips	318.09 Kips	1738.98 Kips
	99.01 ft	1518.08 Kips	318.09 Kips	1836.16 Kips
	106.99 ft	1611.21 Kips	318.09 Kips	1929.29 Kips
	107.01 ft	1612.52 Kips	2951.84 Kips	4564.36 Kips
	116.01 ft	2740.23 Kips	2951.84 Kips	5692.07 Kips
	119.99 ft	3270.46 Kips	2951.84 Kips	6222.30 Kips

A-95P2A-10

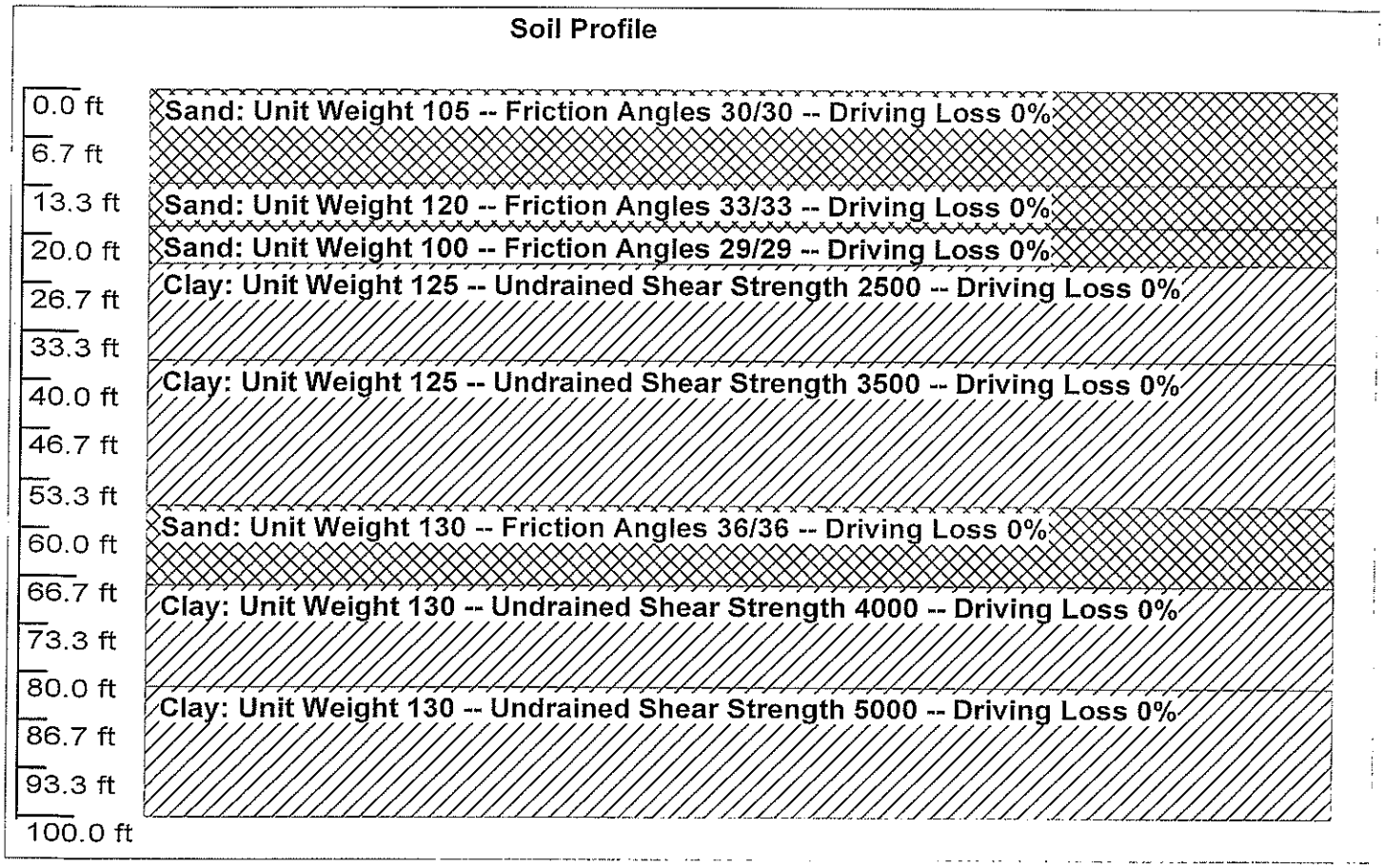
Filename: Z:\DELDOT\SR1DEC~1\A-95P3A.DVN RAMP A / I-95 PIER 3



REQUIRED CAPACITY = 1285 K

EST. PILE TIP = EL. 24

Filename: Z:\DELDOT\SR1DEC~1\A-95P3A.DVN



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A-95P3A.DVN
Project Name: Ramp A / I95 Pier 3 Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 I-BR-27A Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 36.00 in
Shell Thickness: 0.62 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	13.00 ft	0.00%	105.00 pcf	30.0/30.0	Nordlund
2	Cohesionless	6.00 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund
3	Cohesionless	5.00 ft	0.00%	100.00 pcf	29.0/29.0	Nordlund
4	Cohesive	13.00 ft	0.00%	125.00 pcf	2500.00 psf	T-79 Steel
5	Cohesive	20.00 ft	0.00%	125.00 pcf	3500.00 psf	T-79 Steel
6	Cohesionless	11.00 ft	0.00%	130.00 pcf	36.0/36.0	Nordlund
7	Cohesive	14.00 ft	0.00%	130.00 pcf	4000.00 psf	T-79 Steel
8	Cohesive	18.00 ft	0.00%	130.00 pcf	5000.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.21 psf	28.95	N/A	0.00 Kips
9.01 ft	Cohesionless	191.91 psf	28.95	N/A	8.24 Kips
12.99 ft	Cohesionless	276.69 psf	28.95	N/A	17.12 Kips
13.01 ft	Cohesionless	554.09 psf	31.85	N/A	17.18 Kips
18.99 ft	Cohesionless	726.31 psf	31.85	N/A	46.14 Kips
19.01 ft	Cohesionless	899.59 psf	27.99	N/A	46.24 Kips
23.99 ft	Cohesionless	993.21 psf	27.99	N/A	68.00 Kips
24.01 ft	Cohesive	N/A	N/A	1000.00 psf	68.15 Kips
33.01 ft	Cohesive	N/A	N/A	1017.56 psf	154.46 Kips
36.99 ft	Cohesive	N/A	N/A	1040.78 psf	195.47 Kips
37.01 ft	Cohesive	N/A	N/A	808.17 psf	195.65 Kips
46.01 ft	Cohesive	N/A	N/A	857.17 psf	268.36 Kips
55.01 ft	Cohesive	N/A	N/A	906.17 psf	349.39 Kips
56.99 ft	Cohesive	N/A	N/A	916.95 psf	368.33 Kips
57.01 ft	Cohesionless	3153.54 psf	34.74	N/A	368.72 Kips
66.01 ft	Cohesionless	3457.74 psf	34.74	N/A	659.26 Kips
67.99 ft	Cohesionless	3524.66 psf	34.74	N/A	730.03 Kips
68.01 ft	Cohesive	N/A	N/A	976.94 psf	730.49 Kips
77.01 ft	Cohesive	N/A	N/A	1025.94 psf	817.52 Kips
81.99 ft	Cohesive	N/A	N/A	1053.06 psf	869.25 Kips
82.01 ft	Cohesive	N/A	N/A	1053.17 psf	869.45 Kips
91.01 ft	Cohesive	N/A	N/A	1102.17 psf	962.95 Kips
99.99 ft	Cohesive	N/A	N/A	1151.06 psf	1064.52 Kips

A-95P3A-8

ULTIMATE - END BEARING

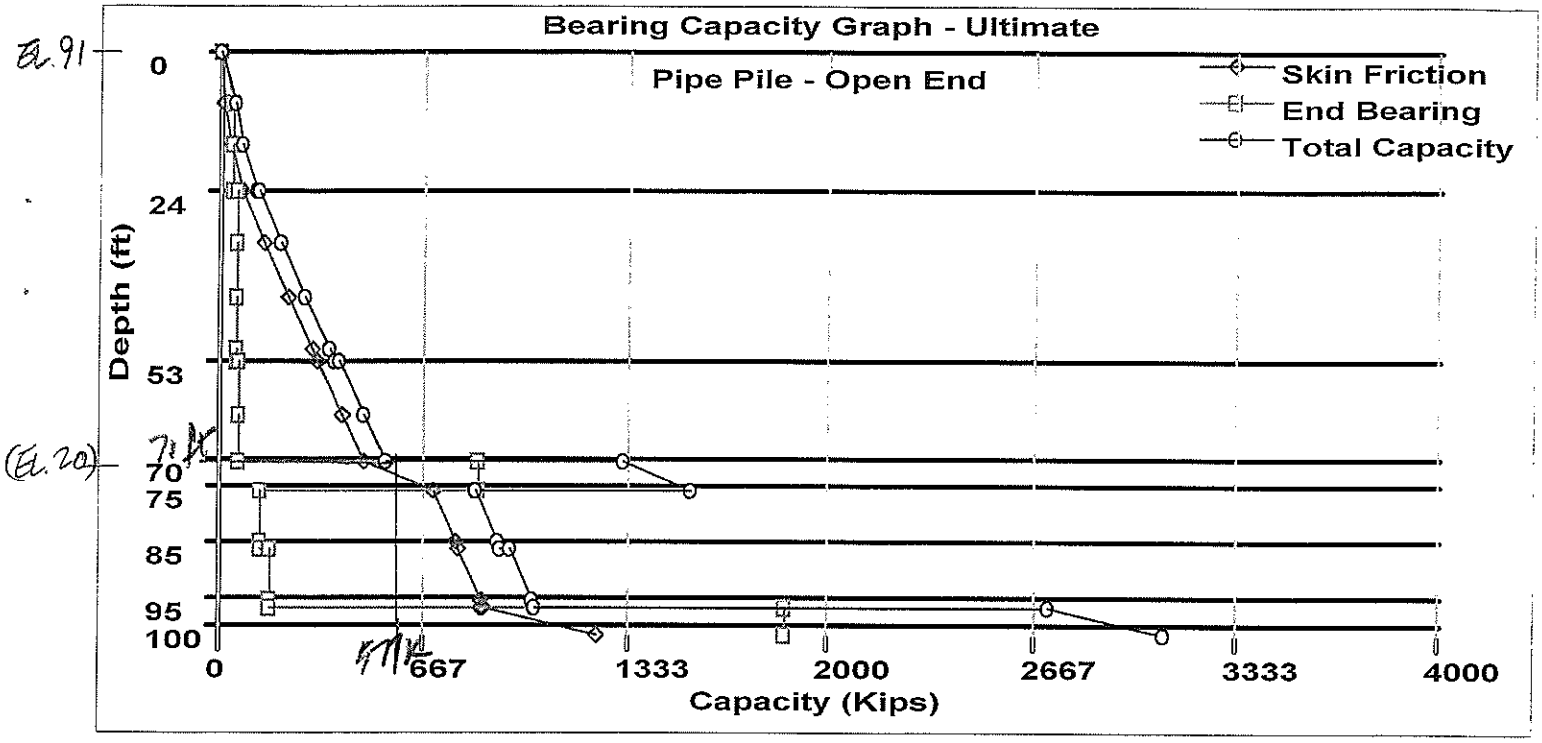
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.43 psf	30.00	94.15 Kips	0.05 Kips
9.01 ft	Cohesionless	383.83 psf	30.00	94.15 Kips	47.21 Kips
12.99 ft	Cohesionless	553.37 psf	30.00	94.15 Kips	68.06 Kips
13.01 ft	Cohesionless	554.38 psf	47.20	353.43 Kips	119.41 Kips
18.99 ft	Cohesionless	898.82 psf	47.20	353.43 Kips	193.60 Kips
19.01 ft	Cohesionless	899.78 psf	26.40	94.15 Kips	93.69 Kips
23.99 ft	Cohesionless	1087.02 psf	26.40	94.15 Kips	94.15 Kips
24.01 ft	Cohesive	N/A	N/A	N/A	159.04 Kips
33.01 ft	Cohesive	N/A	N/A	N/A	159.04 Kips
36.99 ft	Cohesive	N/A	N/A	N/A	159.04 Kips
37.01 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
46.01 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
55.01 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
56.99 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
57.01 ft	Cohesionless	3153.88 psf	77.60	1071.60 Kips	1071.60 Kips
66.01 ft	Cohesionless	3762.28 psf	77.60	1071.60 Kips	1071.60 Kips
67.99 ft	Cohesionless	3896.12 psf	77.60	1071.60 Kips	1071.60 Kips
68.01 ft	Cohesive	N/A	N/A	N/A	254.47 Kips
77.01 ft	Cohesive	N/A	N/A	N/A	254.47 Kips
81.99 ft	Cohesive	N/A	N/A	N/A	254.47 Kips
82.01 ft	Cohesive	N/A	N/A	N/A	318.09 Kips
91.01 ft	Cohesive	N/A	N/A	N/A	318.09 Kips
99.99 ft	Cohesive	N/A	N/A	N/A	318.09 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.05 Kips	0.05 Kips
9.01 ft	8.24 Kips	47.21 Kips	55.44 Kips
12.99 ft	17.12 Kips	68.06 Kips	85.18 Kips
13.01 ft	17.18 Kips	119.41 Kips	136.59 Kips
18.99 ft	46.14 Kips	193.60 Kips	239.75 Kips
19.01 ft	46.24 Kips	93.69 Kips	139.94 Kips
23.99 ft	68.00 Kips	94.15 Kips	162.16 Kips
24.01 ft	68.15 Kips	159.04 Kips	227.19 Kips
33.01 ft	154.46 Kips	159.04 Kips	313.50 Kips
36.99 ft	195.47 Kips	159.04 Kips	354.51 Kips
37.01 ft	195.65 Kips	222.66 Kips	418.31 Kips
46.01 ft	268.36 Kips	222.66 Kips	491.02 Kips
55.01 ft	349.39 Kips	222.66 Kips	572.05 Kips
56.99 ft	368.33 Kips	222.66 Kips	590.99 Kips
57.01 ft	368.72 Kips	1071.60 Kips	1440.32 Kips
66.01 ft	659.26 Kips	1071.60 Kips	1730.85 Kips
67.99 ft	730.03 Kips	1071.60 Kips	1801.63 Kips
68.01 ft	730.49 Kips	254.47 Kips	984.96 Kips
77.01 ft	817.52 Kips	254.47 Kips	1071.99 Kips
81.99 ft	869.25 Kips	254.47 Kips	1123.71 Kips
82.01 ft	869.45 Kips	318.09 Kips	1187.54 Kips
91.01 ft	962.95 Kips	318.09 Kips	1281.03 Kips
99.99 ft	1064.52 Kips	318.09 Kips	1382.60 Kips

A-95P3A-10

Filename: Z:\DELDOT\SR1DEC~1\A-95UTB.DVN RAMP A/I-95 ABUT. B

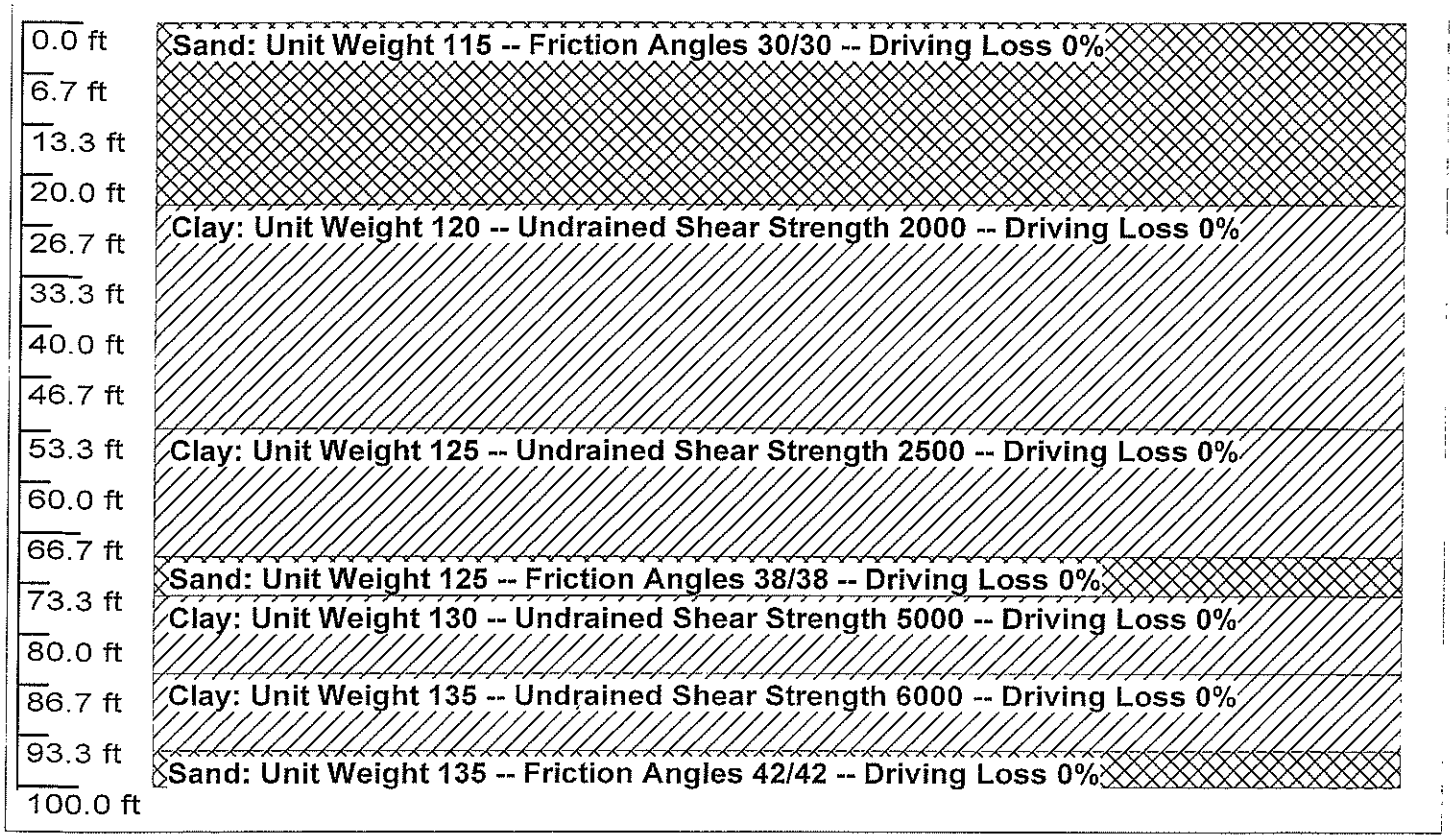


REQUIRED CAPACITY = 577 K

EST PILE TIP = EL. 20

Filename: Z:\DELDOT\SRIDEC~1\A-95UTB.DVN KAMP 4/I95 ABUT B

Soil Profile IBR-26



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A-95UTB.DVN
Project Name: Ramp A / I95 Abut B
Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-26 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 24.00 in
Shell Thickness: 0.50 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	16.00 ft
	- Driving/Restrike	16.00 ft
	- Ultimate:	16.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	24.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
2	Cohesive	29.00 ft	0.00%	120.00 pcf	2000.00 psf	T-79 Steel
3	Cohesive	17.00 ft	0.00%	125.00 pcf	2500.00 psf	T-79 Steel
4	Cohesionless	5.00 ft	0.00%	125.00 pcf	38.0/38.0	Nordlund
5	Cohesive	10.00 ft	0.00%	130.00 pcf	5000.00 psf	T-79 Steel
6	Cohesive	10.00 ft	0.00%	135.00 pcf	6000.00 psf	T-79 Steel
7	Cohesionless	5.00 ft	0.00%	135.00 pcf	42.0/42.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.57 psf	25.83	N/A	0.00 Kips
9.01 ft	Cohesionless	518.08 psf	25.83	N/A	11.91 Kips
15.99 ft	Cohesionless	919.42 psf	25.83	N/A	37.52 Kips
16.01 ft	Cohesionless	1840.26 psf	25.83	N/A	37.61 Kips
23.99 ft	Cohesionless	2050.14 psf	25.83	N/A	79.37 Kips
24.01 ft	Cohesive	N/A	N/A	1188.39 psf	79.50 Kips
33.01 ft	Cohesive	N/A	N/A	1240.89 psf	149.67 Kips
42.01 ft	Cohesive	N/A	N/A	1293.39 psf	225.79 Kips
51.01 ft	Cohesive	N/A	N/A	1345.89 psf	307.84 Kips
52.99 ft	Cohesive	N/A	N/A	1357.44 psf	326.68 Kips
53.01 ft	Cohesive	N/A	N/A	1288.84 psf	326.86 Kips
62.01 ft	Cohesive	N/A	N/A	1367.59 psf	404.20 Kips
69.99 ft	Cohesive	N/A	N/A	1437.41 psf	480.22 Kips
70.01 ft	Cohesionless	4995.71 psf	30.32	N/A	480.75 Kips
74.99 ft	Cohesionless	5151.59 psf	30.32	N/A	700.59 Kips
75.01 ft	Cohesive	N/A	N/A	1219.25 psf	701.12 Kips
84.01 ft	Cohesive	N/A	N/A	1260.00 psf	772.37 Kips
84.99 ft	Cohesive	N/A	N/A	1260.00 psf	780.13 Kips
85.01 ft	Cohesive	N/A	N/A	1260.00 psf	780.29 Kips
94.01 ft	Cohesive	N/A	N/A	1260.00 psf	851.54 Kips
94.99 ft	Cohesive	N/A	N/A	1260.00 psf	859.30 Kips
95.01 ft	Cohesionless	6710.76 psf	33.52	N/A	860.11 Kips
99.99 ft	Cohesionless	6891.54 psf	33.52	N/A	1236.94 Kips

A-95UTB-8

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.15 psf	30.00	41.85 Kips	0.06 Kips
9.01 ft	Cohesionless	1036.15 psf	30.00	41.85 Kips	41.85 Kips
15.99 ft	Cohesionless	1838.85 psf	30.00	41.85 Kips	41.85 Kips
16.01 ft	Cohesionless	1840.53 psf	30.00	41.85 Kips	41.85 Kips
23.99 ft	Cohesionless	2260.27 psf	30.00	41.85 Kips	41.85 Kips
24.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
33.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
42.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
51.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
52.99 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
53.01 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
62.01 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
69.99 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
70.01 ft	Cohesionless	4996.03 psf	110.40	843.83 Kips	843.83 Kips
74.99 ft	Cohesionless	5307.77 psf	110.40	843.83 Kips	843.83 Kips
75.01 ft	Cohesive	N/A	N/A	N/A	141.37 Kips
84.01 ft	Cohesive	N/A	N/A	N/A	141.37 Kips
84.99 ft	Cohesive	N/A	N/A	N/A	141.37 Kips
85.01 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
94.01 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
94.99 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
95.01 ft	Cohesionless	6711.13 psf	244.00	1861.58 Kips	1861.58 Kips
99.99 ft	Cohesionless	7072.67 psf	244.00	1861.58 Kips	1861.58 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.06 Kips	0.06 Kips
9.01 ft	11.91 Kips	41.85 Kips	53.76 Kips
15.99 ft	37.52 Kips	41.85 Kips	79.36 Kips
16.01 ft	37.61 Kips	41.85 Kips	79.46 Kips
23.99 ft	79.37 Kips	41.85 Kips	121.21 Kips
24.01 ft	79.50 Kips	56.55 Kips	136.05 Kips
33.01 ft	149.67 Kips	56.55 Kips	206.22 Kips
42.01 ft	225.79 Kips	56.55 Kips	282.34 Kips
51.01 ft	307.84 Kips	56.55 Kips	364.38 Kips
52.99 ft	326.68 Kips	56.55 Kips	383.23 Kips
53.01 ft	326.86 Kips	70.69 Kips	397.55 Kips
62.01 ft	404.20 Kips	70.69 Kips	474.89 Kips
69.99 ft	480.22 Kips	70.69 Kips	550.91 Kips
70.01 ft	480.75 Kips	843.83 Kips	1324.58 Kips
74.99 ft	700.59 Kips	843.83 Kips	1544.42 Kips
75.01 ft	701.12 Kips	141.37 Kips	842.49 Kips
84.01 ft	772.37 Kips	141.37 Kips	913.74 Kips
84.99 ft	780.13 Kips	141.37 Kips	921.50 Kips
85.01 ft	780.29 Kips	169.65 Kips	949.93 Kips
94.01 ft	851.54 Kips	169.65 Kips	1021.18 Kips
94.99 ft	859.30 Kips	169.65 Kips	1028.94 Kips
95.01 ft	860.11 Kips	1861.58 Kips	2721.69 Kips
99.99 ft	1236.94 Kips	1861.58 Kips	3098.52 Kips

A-95UTB-10

Lateral Analysis

URS

Job SR-1/I-95 Interchange | Project No. | Page ___ of ___
Description Ramp A over I-95 - Pier 1 | Computed by JPK | Sheet ___ of ___ | Date 8/26/08
Checked by | Date | Reference

From borings 1RW-68 & 1BR-24 (DONE)

LOAD = 1285 K 36" ϕ 0.625" WALL

EL. 80	Depth = 0 ft	x = 0 in				
	Assumed EL. 75 ▼	x = 60	γ = 115 pcf		γ = 0.067 c = 6.9	K = 675 ε = 0.0075
		1 Clay	c = 1000 psf	N = 10±	γ = 0.034 pci	K = 675 pci
			ϕ = 0		c = 6.9 psi	ε = 0.0075
EL 65	15 ft	180 in				
		2 Sand	γ = 110 pcf	N = 9	γ = 0.031	K = 40
EL 60	20 ft	240 in	c = 0		ϕ = 31°	
			ϕ = 31°			
		3 Clay	γ = 120 pcf	N = 14	γ = 0.036	K = 875
			c = 1500 psf		c = 10.4	ε = 0.0065
			ϕ = 0			
EL. 30	50 ft	600 in				
		4 Clay	γ = 125 pcf	N = 30±	γ = 0.039	ε = 0.004
			c = 3500 psf		c = 24.3	
			ϕ = 0		K = 2100	
EL. 10	70 ft	840 in				
		5 Sand	γ = 125 pcf	N = 30±	γ = 0.039	
			c = 0		K = 110	
EL. 0	80 ft	960 in	ϕ = 35°			
		6 Sand	γ = 130 pcf	N = 35±	γ = 0.042	
			c = 0		K = 300	
EL. -10	90 ft	1080 in	ϕ = 38°			
		7 Clay	γ = 130 pcf	50+	γ = 0.042	K = 3000
			c = 5000 psf		c = 34.7	ε = 0.002
EL. -15	95 ft	1140 in	ϕ = 0			

Total Shear = 280 K

Axial = 835 K

12 piles

Assume 3x4 config.

Table 10.7.2.4-1

Length Req'd = 24 ft

Row 1 - 4 piles @ 1.0
Row 2 - 4 piles @ 0.5
Row 3 - 4 piles @ 0.35

$$\text{Shear per pile} = \frac{280\text{ K}}{4(1) + 4(0.5) + 4(0.35)} = 37.8\text{ K}$$

```
================================================================================

                LPILE Plus for Windows, Version 4.0 (4.0.8)

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

                 (c) Copyright ENSOFT, Inc., 1985-2003
                          All Rights Reserved

================================================================================

This program is licensed to:

URS
URS

Path to file locations:      D:\Program Files\Ensoft\LpileP4\DelDOTSR1\
Name of input data file:     S1P1.lpd
Name of output file:         S1P1.lpo
Name of plot output file:    S1P1.lpp
Name of runtime file:        S1P1.lpr

--------------------------------------------------------------------------------
                         Time and Date of Analysis
--------------------------------------------------------------------------------

               Date:  January 22, 2009     Time:  10:32:20

--------------------------------------------------------------------------------
                               Problem Title
--------------------------------------------------------------------------------

Ramp A over I-95 - Pier 1

--------------------------------------------------------------------------------
                               Program Options
--------------------------------------------------------------------------------

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          150
- Maximum number of iterations allowed =          100
```

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 288.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	36.000	10900.0000	69.5000	30000000.000
2	288.0000	36.000	10900.0000	69.5000	30000000.000

Soil and Rock Layering Information

The soil profile is modelled using 8 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 60.000 in
p-y subgrade modulus k for top of soil layer = 675.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 675.000 lbs/in**3

Layer 2 is stiff clay with water-induced erosion
Distance from top of pile to top of layer = 60.000 in
Distance from top of pile to bottom of layer = 180.000 in
p-y subgrade modulus k for top of soil layer = 675.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 675.000 lbs/in**3

Layer 3 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 180.000 in
Distance from top of pile to bottom of layer = 240.000 in
p-y subgrade modulus k for top of soil layer = 40.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 40.000 lbs/in**3

Layer 4 is stiff clay with water-induced erosion
Distance from top of pile to top of layer = 240.000 in
Distance from top of pile to bottom of layer = 600.000 in
p-y subgrade modulus k for top of soil layer = 875.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 875.000 lbs/in**3

Layer 5 is stiff clay with water-induced erosion
Distance from top of pile to top of layer = 600.000 in
Distance from top of pile to bottom of layer = 840.000 in
p-y subgrade modulus k for top of soil layer = 2000.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 2000.000 lbs/in**3

```
Layer  6 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      840.000 in
Distance from top of pile to bottom of layer =      960.000 in
p-y subgrade modulus k for top of soil layer =      110.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      110.000 lbs/in**3

Layer  7 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      960.000 in
Distance from top of pile to bottom of layer =     1080.000 in
p-y subgrade modulus k for top of soil layer =      300.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      300.000 lbs/in**3

Layer  8 is stiff clay with water-induced erosion
Distance from top of pile to top of layer    =     1080.000 in
Distance from top of pile to bottom of layer =     1140.000 in
p-y subgrade modulus k for top of soil layer =     3000.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =     3000.000 lbs/in**3


(Depth of lowest layer extends  852.00 in below pile tip)


--------------------------------------------------------------------------------
                    Effective Unit Weight of Soil vs. Depth
--------------------------------------------------------------------------------

Distribution of effective unit weight of soil with depth
is defined using 16 points
```

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06700
2	60.00	.06700
3	60.00	.03400
4	180.00	.03400
5	180.00	.03100
6	240.00	.03100
7	240.00	.03600
8	600.00	.03600
9	600.00	.03900
10	840.00	.03900
11	840.00	.03900
12	960.00	.03900
13	960.00	.04200
14	1080.00	.04200
15	1080.00	.04200
16	1140.00	.04200

```
--------------------------------------------------------------------------------
                              Shear Strength of Soils
--------------------------------------------------------------------------------

Distribution of shear strength parameters with depth
defined using 16 points
```

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	6.90000	.00	.00750	.0
2	60.000	6.90000	.00	.00750	.0

3	60.000	6.90000	.00	.00750	.0
4	180.000	6.90000	.00	.00750	.0
5	180.000	.00000	31.00	------	------
6	240.000	.00000	31.00	------	------
7	240.000	10.40000	.00	.00650	.0
8	600.000	10.40000	.00	.00650	.0
9	600.000	24.30000	.00	.00400	.0
10	840.000	24.30000	.00	.00400	.0
11	840.000	.00000	35.00	------	------
12	960.000	.00000	35.00	------	------
13	960.000	.00000	38.00	------	------
14	1080.000	.00000	38.00	------	------
15	1080.000	34.70000	.00	.00200	.0
16	1140.000	34.70000	.00	.00200	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

---

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 37800.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 835000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 37800.000 lbs
Specified bending moment at pile head = .000 in-lbs
Specified axial load at pile head = 835000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth	Deflect.	Moment	Shear	Slope	Total	Soil Res

X in	y in	M lbs-in	V lbs	S Rad.	Stress lbs/in**2	p lbs/in
0.000	.118882	-1.231E-06	37800.0000	-.001073	12014.3885	-241.3910
1.920	.116821	73851.5840	37334.0553	-.001073	12136.3452	-243.9681
3.840	.114762	146803.1087	36863.2063	-.001072	12256.8156	-246.4995
5.760	.112704	218844.5557	36387.5417	-.001071	12375.7832	-248.9845
7.680	.110648	289966.0862	35907.1510	-.001070	12493.2316	-251.4225
9.600	.108596	360158.0434	35422.1251	-.001068	12609.1449	-253.8128
11.520	.106547	429410.9547	34932.5561	-.001066	12723.5075	-256.1549
13.440	.104504	497715.5344	34438.5371	-.001063	12836.3041	-258.4482
15.360	.102466	565062.6856	33940.1625	-.001060	12947.5195	-260.6920
17.280	.100435	631443.5027	33437.5280	-.001056	13057.1392	-262.8857
19.200	.098411	696849.2742	32930.7302	-.001052	13165.1488	-265.0287
21.120	.096394	761271.4844	32419.8673	-.001048	13271.5341	-267.1203
23.040	.094386	824701.8163	31905.0383	-.001043	13376.2814	-269.1599
24.960	.092388	887132.1540	31386.3437	-.001038	13479.3774	-271.1469
26.880	.090399	948554.5847	30863.8852	-.001033	13580.8089	-273.0807
28.800	.088422	1.009E+06	30337.7656	-.001027	13680.5633	-274.9606
30.720	.086455	1.068E+06	29808.0890	-.001021	13778.6281	-276.7858
32.640	.084501	1.127E+06	29274.9609	-.001015	13874.9914	-278.5559
34.560	.082559	1.184E+06	28738.4879	-.001008	13969.6414	-280.2701
36.480	.080631	1.240E+06	28198.7780	-.001001	14062.5668	-281.9278
38.400	.078716	1.296E+06	27655.9402	-9.933E-04	14153.7566	-283.5282
40.320	.076816	1.350E+06	27110.0852	-9.855E-04	14243.2003	-285.0708
42.240	.074932	1.403E+06	26561.3247	-9.774E-04	14330.8876	-286.5548
44.160	.073063	1.455E+06	26009.7718	-9.690E-04	14416.8087	-287.9795
46.080	.071211	1.506E+06	25455.5411	-9.603E-04	14500.9541	-289.3442
48.000	.069375	1.556E+06	24898.7482	-9.514E-04	14583.3146	-290.6484
49.920	.067557	1.604E+06	24339.5102	-9.421E-04	14663.8815	-291.8911
51.840	.065758	1.652E+06	23777.9458	-9.325E-04	14742.6466	-293.0718
53.760	.063977	1.699E+06	23214.1747	-9.227E-04	14819.6019	-294.1897
55.680	.062215	1.744E+06	22648.3182	-9.126E-04	14894.7399	-295.2441
57.600	.060472	1.789E+06	22080.4989	-9.022E-04	14968.0535	-296.2343
59.520	.058750	1.832E+06	21510.8409	-8.916E-04	15039.5358	-297.1595
61.440	.057049	1.874E+06	20622.6629	-8.807E-04	15109.1807	-628.0260
63.360	.055368	1.914E+06	19425.7983	-8.696E-04	15174.9733	-618.7079
65.280	.053709	1.951E+06	18246.8437	-8.582E-04	15236.9696	-609.3698
67.200	.052073	1.987E+06	17085.8361	-8.467E-04	15295.2260	-600.0131
69.120	.050458	2.020E+06	15942.8099	-8.349E-04	15349.7988	-590.6392
71.040	.048867	2.051E+06	14817.7967	-8.230E-04	15400.7447	-581.2496
72.960	.047298	2.079E+06	13710.8254	-8.108E-04	15448.1202	-571.8455
74.880	.045753	2.106E+06	12621.9227	-7.985E-04	15491.9823	-562.4282
76.800	.044232	2.130E+06	11551.1126	-7.861E-04	15532.3877	-552.9990
78.720	.042734	2.153E+06	10498.4170	-7.735E-04	15569.3936	-543.5589
80.640	.041261	2.173E+06	9463.8559	-7.608E-04	15603.0570	-534.1090
82.560	.039813	2.192E+06	8447.4469	-7.480E-04	15633.4352	-524.6503
84.480	.038389	2.208E+06	7449.2063	-7.351E-04	15660.5854	-515.1837
86.400	.036990	2.222E+06	6469.1483	-7.221E-04	15684.5651	-505.7100
88.320	.035616	2.235E+06	5507.2858	-7.090E-04	15705.4316	-496.2300
90.240	.034267	2.246E+06	4563.6304	-6.959E-04	15723.2426	-486.7443
92.160	.032944	2.255E+06	3638.1926	-6.826E-04	15738.0555	-477.2535
94.080	.031646	2.262E+06	2730.9817	-6.694E-04	15749.9280	-467.7579
96.000	.030373	2.268E+06	1842.0066	-6.561E-04	15758.9177	-458.2579
97.920	.029127	2.271E+06	971.2756	-6.428E-04	15765.0826	-448.7536
99.840	.027905	2.273E+06	118.7966	-6.294E-04	15768.4803	-439.2453
101.760	.026710	2.274E+06	-715.4222	-6.161E-04	15769.1687	-429.7326
103.680	.025540	2.273E+06	-1531.3725	-6.027E-04	15767.2056	-420.2155
105.600	.024395	2.270E+06	-2329.0451	-5.894E-04	15762.6492	-410.6935
107.520	.023276	2.265E+06	-3108.4301	-5.761E-04	15755.5573	-401.1659
109.440	.022183	2.260E+06	-3869.5161	-5.628E-04	15745.9880	-391.6320
111.360	.021115	2.252E+06	-4612.2897	-5.495E-04	15733.9995	-382.0906
113.280	.020073	2.244E+06	-5336.7354	-5.363E-04	15719.6500	-372.5404

115.200	.019056	2.234E+06	-6042.8348	-5.232E-04	15702.9977	-362.9798
117.120	.018064	2.222E+06	-6730.5661	-5.101E-04	15684.1010	-353.4069
119.040	.017097	2.209E+06	-7399.9033	-4.971E-04	15663.0183	-343.8193
120.960	.016155	2.195E+06	-8050.8156	-4.842E-04	15639.8082	-334.2143
122.880	.015238	2.180E+06	-8683.2664	-4.713E-04	15614.5295	-324.5886
124.800	.014345	2.164E+06	-9297.2125	-4.586E-04	15587.2408	-314.9385
126.720	.013477	2.146E+06	-9892.6025	-4.459E-04	15558.0013	-305.2594
128.640	.012633	2.127E+06	-10469.3760	-4.334E-04	15526.8702	-295.5464
130.560	.011812	2.107E+06	-11027.4620	-4.209E-04	15493.9068	-285.7932
132.480	.011016	2.086E+06	-11566.7766	-4.086E-04	15459.1708	-275.9928
134.400	.010243	2.064E+06	-12087.2212	-3.965E-04	15422.7223	-266.1370
136.320	.009494	2.041E+06	-12588.6801	-3.844E-04	15384.6215	-256.2160
138.240	.008767	2.017E+06	-13071.0170	-3.725E-04	15344.9293	-246.2182
140.160	.008063	1.992E+06	-13534.0713	-3.607E-04	15303.7068	-236.1300
142.080	.007382	1.966E+06	-13977.6536	-3.491E-04	15261.0159	-225.9349
144.000	.006723	1.939E+06	-14401.5396	-3.376E-04	15216.9191	-215.6130
145.920	.006085	1.912E+06	-14805.4628	-3.263E-04	15171.4795	-205.1403
147.840	.005470	1.884E+06	-15189.1047	-3.152E-04	15124.7613	-194.4867
149.760	.004875	1.854E+06	-15552.0822	-3.042E-04	15076.8300	-183.6149
151.680	.004301	1.825E+06	-15893.9304	-2.934E-04	15027.7520	-172.4769
153.600	.003748	1.794E+06	-16214.0783	-2.828E-04	14977.5957	-161.0105
155.520	.003216	1.763E+06	-16511.8149	-2.723E-04	14926.4313	-149.1318
157.440	.002703	1.732E+06	-16786.2372	-2.621E-04	14874.3316	-136.7247
159.360	.002209	1.700E+06	-17036.1685	-2.520E-04	14821.3727	-123.6203
161.280	.001735	1.667E+06	-17260.0190	-2.421E-04	14767.6348	-109.5572
163.200	.001279	1.634E+06	-17455.5234	-2.324E-04	14713.2041	-94.0932
165.120	8.42E-04	1.601E+06	-17619.1634	-2.229E-04	14658.1751	-76.3652
167.040	4.23E-04	1.567E+06	-17744.4784	-2.136E-04	14602.6564	-54.1713
168.960	2.20E-05	1.534E+06	-17802.0162	-2.045E-04	14546.7835	-5.7640
170.880	-3.62E-04	1.500E+06	-17759.5886	-1.956E-04	14490.8517	49.9594
172.800	-7.29E-04	1.466E+06	-17643.5114	-1.869E-04	14435.2007	70.9543
174.720	-.001080	1.432E+06	-17492.4853	-1.784E-04	14379.9589	86.3646
176.640	-.001414	1.399E+06	-17314.6782	-1.701E-04	14325.2206	98.8511
178.560	-.001733	1.367E+06	-17114.7273	-1.620E-04	14271.0623	109.4311
180.480	-.002036	1.334E+06	-17001.5679	-1.540E-04	14217.5489	8.4433
182.400	-.002325	1.302E+06	-16984.0379	-1.463E-04	14164.0662	9.8171
184.320	-.002598	1.269E+06	-16963.8884	-1.388E-04	14110.6230	11.1720
186.240	-.002857	1.237E+06	-16941.1574	-1.314E-04	14057.2281	12.5063
188.160	-.003103	1.205E+06	-16915.8858	-1.242E-04	14003.8901	13.8183
190.080	-.003334	1.172E+06	-16888.1182	-1.173E-04	13950.6174	15.1064
192.000	-.003553	1.140E+06	-16857.9015	-1.105E-04	13897.4186	16.3693
193.920	-.003759	1.108E+06	-16825.2858	-1.039E-04	13844.3016	17.6055
195.840	-.003952	1.076E+06	-16790.3233	-9.745E-05	13791.2746	18.8138
197.760	-.004133	1.044E+06	-16753.0687	-9.123E-05	13738.3454	19.9931
199.680	-.004302	1.012E+06	-16713.5786	-8.519E-05	13685.5217	21.1424
201.600	-.004460	980044.7077	-16671.9116	-7.934E-05	13632.8109	22.2607
203.520	-.004607	948198.2615	-16628.1279	-7.368E-05	13580.2205	23.3473
205.440	-.004743	916428.9573	-16582.2890	-6.821E-05	13527.7574	24.4015
207.360	-.004869	884740.9801	-16534.4579	-6.292E-05	13475.4286	25.4226
209.280	-.004985	853138.3925	-16484.6984	-5.782E-05	13423.2409	26.4102
211.200	-.005091	821625.1327	-16433.0752	-5.290E-05	13371.2006	27.3639
213.120	-.005188	790205.0130	-16379.6538	-4.817E-05	13319.3142	28.2834
215.040	-.005276	758881.7187	-16324.4999	-4.362E-05	13267.5877	29.1685
216.960	-.005355	727658.8078	-16267.6796	-3.926E-05	13216.0269	30.0193
218.880	-.005427	696539.7103	-16209.2590	-3.508E-05	13164.6376	30.8356
220.800	-.005490	665527.7282	-16149.3040	-3.108E-05	13113.4251	31.6176
222.720	-.005546	634626.0363	-16087.8802	-2.726E-05	13062.3948	32.3656
224.640	-.005595	603837.6830	-16025.0526	-2.363E-05	13011.5516	33.0798
226.560	-.005637	573165.5911	-15960.8856	-2.017E-05	12960.9005	33.7608
228.480	-.005672	542612.5597	-15895.4425	-1.690E-05	12910.4459	34.4091
230.400	-.005701	512181.2661	-15828.7856	-1.380E-05	12860.1924	35.0252
232.320	-.005725	481874.2681	-15760.9759	-1.088E-05	12810.1442	35.6099
234.240	-.005743	451694.0063	-15692.0730	-8.140E-06	12760.3052	36.1640

236.160	-.005756	421642.8075	-15622.1346	-5.576E-06	12710.6794	36.6885
238.080	-.005765	391722.8881	-15551.2168	-3.188E-06	12661.2703	37.1843
240.000	-.005769	361936.3575	-15205.1033	-9.755E-07	12612.0816	323.3506
241.920	-.005768	333338.4195	-14584.2730	1.066E-06	12564.8556	323.3476
243.840	-.005764	305929.3322	-13963.5497	2.942E-06	12519.5929	323.2392
245.760	-.005757	279708.9542	-13343.1273	4.662E-06	12476.2932	323.0341
247.680	-.005747	254676.7763	-12723.1837	6.231E-06	12434.9556	322.7404
249.600	-.005733	230831.9512	-12103.8818	7.656E-06	12395.5789	322.3657
251.520	-.005717	208173.3223	-11485.3701	8.945E-06	12358.1609	321.9173
253.440	-.005699	186699.4498	-10867.7833	1.010E-05	12322.6995	321.4022
255.360	-.005678	166408.6369	-10251.2435	1.114E-05	12289.1917	320.8268
257.280	-.005656	147298.9535	-9635.8604	1.206E-05	12257.6345	320.1973
259.200	-.005632	129368.2586	-9021.7324	1.287E-05	12228.0241	319.5194
261.120	-.005607	112614.2224	-8408.9471	1.358E-05	12200.3569	318.7987
263.040	-.005580	97034.3454	-7797.5818	1.420E-05	12174.6287	318.0401
264.960	-.005552	82625.9782	-7187.7047	1.473E-05	12150.8351	317.2485
266.880	-.005523	69386.3383	-6579.3749	1.517E-05	12128.9714	316.4283
268.800	-.005494	57312.5264	-5972.6437	1.555E-05	12109.0330	315.5835
270.720	-.005464	46401.5419	-5367.5545	1.585E-05	12091.0149	314.7178
272.640	-.005433	36650.2961	-4764.1443	1.609E-05	12074.9119	313.8346
274.560	-.005402	28055.6250	-4162.4437	1.628E-05	12060.7189	312.9369
276.480	-.005370	20614.3005	-3562.4778	1.643E-05	12048.4305	312.0275
278.400	-.005339	14323.0401	-2964.2671	1.653E-05	12038.0412	311.1087
280.320	-.005307	9178.5158	-2367.8278	1.660E-05	12029.5457	310.1824
282.240	-.005275	5177.3614	-1773.1724	1.664E-05	12022.9383	309.2503
284.160	-.005243	2316.1785	-1180.3110	1.666E-05	12018.2134	308.3137
286.080	-.005211	591.5413	-589.2514	1.667E-05	12015.3653	307.3734
288.000	-.005179	0.0000	0.0000	1.667E-05	12014.3885	306.4301

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.11888169	in
Computed slope at pile head	=	-.00107318	
Maximum bending moment	=	2273727.995	lbs-in
Maximum shear force	=	37800.000	lbs
Depth of maximum bending moment	=	101.760	in
Depth of maximum shear force	=	0.000	in
Number of iterations	=	17	
Number of zero deflection points	=	1	

Summary of Pile-head Response

Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

BC Type	Boundary Condition	Boundary Condition	Axial Load	Pile Head Deflection	Maximum Moment	Maximum Shear

	1	2	lbs	in	in-lbs	lbs
1	V= 37800.000	M= 0.000	835000.0000	.1189	2.274E+06	37800.0000

The analysis ended normally.

URS

Job SR-1 / I-95 Interchange | Project No. | Page ___ of ___ | Sheet ___ of ___

Description Ramp A over I-95 - Pier 2 | Computed by JPK | Date

Checked by | Date

Reference

From borings URS-2 (DONE)

- El. 90.3 FACTORED LOAD = 1285 K. 36" DIAM. 0.625" WALL

EL. 85	Depth = 0 ft	x = 0 in				
El. 83	2 ft.	Silty CLAY 24 in	C = 2000 psf	γ = 120 pcf	N = 13	γ = 0.069 K = 1100 c = 13.9 ε = 0.00
El. 75	ASSUMED ▼ 10 ft	x = 120 in SAND some silt	γ = 120 C = 0 φ = 31°		N =	γ = 0.069 pci K = 60 pci γ = 0.036 pci K = 40 pci
- El. 58±	27 ft	324 in				
		Silty CLAY	C = 2000 γ = 120		N = 12±	γ = 0.036 ε = 0.0065 K = 1100 c = 13.9
- El. 65±	40 ft	480 in				
		SAND	γ = 125 φ = 34° CLAY LENSES		N = 25	γ = 0.039 K = 90
- El. 33	52 ft	624 in				
		Silty CLAY	γ = 125 pcf C = 3000		N = 30±	C = 6.3 γ = 0.039 K = 1750 c = 20.8 ε = 0.0045
El. 5	80 ft	960 in				C = 5000
		SAND	γ = 130 φ = 38°		N = 40±	(C = 5600)
- El. -5	90 ft	1080 in				
		Silty CLAY	γ = 130 C = 5000 psf		N = 50±	C = 5571
- El. -22	107 ft.	1284 in				
		SAND	γ = 130 pcf φ = 40°		N = 80+	
- El. -35	120 ft	1440 in				

Shear per pile (See Pier 1) = 37.8 K Axial = 835 K

Length Req'd = 26 ft

```
==============================================================================

                LPILE Plus for Windows, Version 4.0 (4.0.8)

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

                 (c) Copyright ENSOFT, Inc., 1985-2003
                          All Rights Reserved

==============================================================================

This program is licensed to:

URS
URS

Path to file locations:      D:\Program Files\Ensoft\LpileP4\DelDOTSR1\
Name of input data file:     S1P2.lpd
Name of output file:         S1P2.lpo
Name of plot output file:    S1P2.lpp
Name of runtime file:        S1P2.lpr


------------------------------------------------------------------------------
                          Time and Date of Analysis
------------------------------------------------------------------------------

               Date:  January 22, 2009     Time:  10:49:53


------------------------------------------------------------------------------
                                Problem Title
------------------------------------------------------------------------------

Ramp A over I-95 - Pier 2


------------------------------------------------------------------------------
                                Program Options
------------------------------------------------------------------------------

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          150
- Maximum number of iterations allowed =          100
```

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 312.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	36.000	10900.0000	69.5000	30000000.000
2	312.0000	36.000	10900.0000	69.5000	30000000.000

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 24.000 in
p-y subgrade modulus k for top of soil layer = 1100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 1100.000 lbs/in**3

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 24.000 in
Distance from top of pile to bottom of layer = 120.000 in
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 3 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 120.000 in
Distance from top of pile to bottom of layer = 324.000 in
p-y subgrade modulus k for top of soil layer = 40.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 40.000 lbs/in**3

Layer 4 is stiff clay with water-induced erosion
Distance from top of pile to top of layer = 324.000 in
Distance from top of pile to bottom of layer = 480.000 in
p-y subgrade modulus k for top of soil layer = 1100.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 1100.000 lbs/in**3

(Depth of lowest layer extends 168.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06900
2	24.00	.06900
3	24.00	.06900
4	120.00	.06900
5	120.00	.03600
6	324.00	.03600
7	324.00	.03600
8	480.00	.03600

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	13.90000	.00	.00650	.0
2	24.000	13.90000	.00	.00650	.0
3	24.000	.00000	31.00	------	------
4	120.000	.00000	31.00	------	------
5	120.000	.00000	31.00	------	------
6	324.000	.00000	31.00	------	------
7	324.000	13.90000	.00	.00650	.0
8	480.000	13.90000	.00	.00650	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 37800.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 835000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 37800.000 lbs
Specified bending moment at pile head = .000 in-lbs
Specified axial load at pile head = 835000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.121599	-6.294E-05	37800.0000	-9.797E-04	12014.3885	-506.8253
2.080	.119561	79229.1498	36741.1647	-9.794E-04	12145.2256	-511.2855
4.160	.117524	156245.3988	35673.1386	-9.787E-04	12272.4084	-515.6627
6.240	.115489	231028.9584	34596.0947	-9.775E-04	12395.9042	-519.9563
8.320	.113458	303560.4266	33510.2079	-9.758E-04	12515.6809	-524.1656
10.400	.111430	373820.7912	32415.6543	-9.736E-04	12631.7072	-528.2898
12.480	.109408	441791.4329	31312.6115	-9.710E-04	12743.9523	-532.3283
14.560	.107391	507454.1290	30201.2587	-9.680E-04	12852.3861	-536.2802
16.640	.105381	570791.0561	29081.7764	-9.646E-04	12956.9792	-540.1450
18.720	.103378	631784.7939	27954.3467	-9.607E-04	13057.7028	-543.9220
20.800	.101384	690418.3280	26819.1531	-9.565E-04	13154.5288	-547.6103
22.880	.099399	746675.0535	25676.3807	-9.520E-04	13247.4299	-551.2093
24.960	.097424	800538.7781	24762.3007	-9.470E-04	13336.3791	-327.7138
27.040	.095460	852975.8378	24075.1387	-9.418E-04	13422.9724	-333.0189
29.120	.093506	903962.7014	23377.4097	-9.362E-04	13507.1709	-337.8744
31.200	.091565	953477.7985	22670.0417	-9.303E-04	13588.9390	-342.2871
33.280	.089636	1.002E+06	21953.9485	-9.241E-04	13668.2442	-346.2640
35.360	.087721	1.048E+06	21230.0291	-9.175E-04	13745.0572	-349.8124
37.440	.085819	1.093E+06	20499.1670	-9.107E-04	13819.3518	-352.9396
39.520	.083932	1.136E+06	19762.2301	-9.036E-04	13891.1050	-355.6536
41.600	.082060	1.178E+06	19020.0699	-8.963E-04	13960.2964	-357.9620
43.680	.080204	1.219E+06	18273.5212	-8.887E-04	14026.9089	-359.8732
45.760	.078363	1.257E+06	17523.4018	-8.808E-04	14090.9280	-361.3954
47.840	.076540	1.295E+06	16770.5121	-8.727E-04	14152.3422	-362.5370
49.920	.074733	1.330E+06	16015.6347	-8.643E-04	14211.1426	-363.3067
52.000	.072944	1.364E+06	15259.5340	-8.557E-04	14267.3231	-363.7132
54.080	.071173	1.397E+06	14502.9561	-8.470E-04	14320.8802	-363.7655
56.160	.069421	1.428E+06	13746.6286	-8.380E-04	14371.8128	-363.4725
58.240	.067687	1.457E+06	12991.2603	-8.288E-04	14420.1226	-362.8433
60.320	.065973	1.484E+06	12237.5406	-8.195E-04	14465.8134	-361.8871
62.400	.064278	1.511E+06	11486.1402	-8.099E-04	14508.8917	-360.6133
64.480	.062604	1.535E+06	10737.7101	-8.002E-04	14549.3660	-359.0311
66.560	.060949	1.558E+06	9992.8820	-7.904E-04	14587.2472	-357.1499
68.640	.059316	1.579E+06	9252.2679	-7.804E-04	14622.5483	-354.9791
70.720	.057703	1.599E+06	8516.4603	-7.703E-04	14655.2844	-352.5282
72.800	.056111	1.617E+06	7786.0320	-7.601E-04	14685.4727	-349.8067
74.880	.054541	1.634E+06	7061.5362	-7.497E-04	14713.1323	-346.8239

76.960	.052992	1.649E+06	6343.5064	-7.393E-04	14738.2843	-343.5894
79.040	.051465	1.663E+06	5632.4563	-7.288E-04	14760.9513	-340.1126
81.120	.049960	1.675E+06	4928.8802	-7.181E-04	14781.1580	-336.4029
83.200	.048478	1.686E+06	4233.2529	-7.075E-04	14798.9308	-332.4695
85.280	.047017	1.696E+06	3546.0298	-6.967E-04	14814.2975	-328.3219
87.360	.045580	1.703E+06	2867.6470	-6.859E-04	14827.2875	-323.9692
89.440	.044164	1.710E+06	2198.5216	-6.750E-04	14837.9318	-319.4206
91.520	.042771	1.715E+06	1539.0515	-6.641E-04	14846.2629	-314.6852
93.600	.041401	1.719E+06	889.6161	-6.532E-04	14852.3144	-309.7719
95.680	.040054	1.721E+06	250.5761	-6.423E-04	14856.1213	-304.6896
97.760	.038729	1.722E+06	-377.7260	-6.313E-04	14857.7201	-299.4470
99.840	.037428	1.721E+06	-994.9658	-6.204E-04	14857.1480	-294.0528
101.920	.036149	1.720E+06	-1600.8368	-6.094E-04	14854.4436	-288.5154
104.000	.034892	1.717E+06	-2195.0499	-5.985E-04	14849.6465	-282.8433
106.080	.033659	1.713E+06	-2777.3333	-5.876E-04	14842.7974	-277.0446
108.160	.032448	1.707E+06	-3347.4320	-5.767E-04	14833.9377	-271.1273
110.240	.031260	1.701E+06	-3905.1076	-5.659E-04	14823.1097	-265.0993
112.320	.030094	1.693E+06	-4450.1380	-5.551E-04	14810.3567	-258.9684
114.400	.028950	1.684E+06	-4982.3170	-5.444E-04	14795.7226	-252.7421
116.480	.027829	1.674E+06	-5501.4535	-5.337E-04	14779.2521	-246.4277
118.560	.026730	1.663E+06	-6007.3720	-5.231E-04	14760.9904	-240.0324
120.640	.025653	1.651E+06	-6418.6928	-5.125E-04	14740.9834	-155.4684
122.720	.024598	1.638E+06	-6737.5454	-5.021E-04	14719.8356	-151.1206
124.800	.023565	1.625E+06	-7047.3124	-4.917E-04	14697.5782	-146.7323
126.880	.022553	1.611E+06	-7347.9138	-4.814E-04	14674.2429	-142.3076
128.960	.021562	1.596E+06	-7639.2786	-4.712E-04	14649.8614	-137.8508
131.040	.020593	1.581E+06	-7921.3440	-4.611E-04	14624.4659	-133.3659
133.120	.019644	1.565E+06	-8194.0557	-4.511E-04	14598.0888	-128.8569
135.200	.018716	1.548E+06	-8457.3675	-4.412E-04	14570.7625	-124.3275
137.280	.017809	1.531E+06	-8711.2408	-4.314E-04	14542.5197	-119.7815
139.360	.016922	1.513E+06	-8955.6447	-4.217E-04	14513.3932	-115.2223
141.440	.016055	1.495E+06	-9190.5557	-4.121E-04	14483.4159	-110.6536
143.520	.015207	1.476E+06	-9415.9572	-4.027E-04	14452.6208	-106.0786
145.600	.014379	1.457E+06	-9631.8393	-3.934E-04	14421.0408	-101.5004
147.680	.013571	1.438E+06	-9838.1989	-3.841E-04	14388.7091	-96.9222
149.760	.012781	1.418E+06	-10035.0388	-3.751E-04	14355.6586	-92.3469
151.840	.012011	1.397E+06	-10222.3681	-3.661E-04	14321.9226	-87.7774
153.920	.011258	1.377E+06	-10400.2014	-3.573E-04	14287.5339	-83.2162
156.000	.010524	1.355E+06	-10568.5588	-3.486E-04	14252.5256	-78.6660
158.080	.009808	1.334E+06	-10727.4657	-3.401E-04	14216.9305	-74.1291
160.160	.009110	1.312E+06	-10876.9523	-3.316E-04	14180.7814	-69.6079
162.240	.008428	1.290E+06	-11017.0533	-3.234E-04	14144.1111	-65.1046
164.320	.007764	1.267E+06	-11147.8081	-3.152E-04	14106.9522	-60.6212
166.400	.007117	1.244E+06	-11269.2601	-3.072E-04	14069.3370	-56.1595
168.480	.006486	1.221E+06	-11381.4562	-2.994E-04	14031.2979	-51.7214
170.560	.005872	1.198E+06	-11484.4475	-2.917E-04	13992.8669	-47.3086
172.640	.005273	1.175E+06	-11578.2878	-2.842E-04	13954.0762	-42.9225
174.720	.004690	1.151E+06	-11663.0342	-2.768E-04	13914.9573	-38.5645
176.800	.004121	1.127E+06	-11738.7468	-2.695E-04	13875.5419	-34.2360
178.880	.003568	1.103E+06	-11805.4878	-2.624E-04	13835.8614	-29.9381
180.960	.003030	1.079E+06	-11863.3220	-2.555E-04	13795.9468	-25.6717
183.040	.002505	1.055E+06	-11912.3160	-2.487E-04	13755.8291	-21.4379
185.120	.001995	1.030E+06	-11952.5384	-2.421E-04	13715.5391	-17.2374
187.200	.001498	1.006E+06	-11984.0590	-2.356E-04	13675.1071	-13.0709
189.280	.001015	981105.8695	-12006.9490	-2.293E-04	13634.5633	-8.9388
191.360	5.45E-04	956504.8705	-12021.2808	-2.231E-04	13593.9378	-4.8417
193.440	8.69E-05	931872.3571	-12027.1274	-2.171E-04	13553.2603	-.7799
195.520	-3.58E-04	907226.1744	-12024.5623	-2.113E-04	13512.5602	3.2464
197.600	-7.92E-04	882584.0144	-12013.6594	-2.056E-04	13471.8667	7.2372
199.680	-.001214	857963.4148	-11994.4927	-2.000E-04	13431.2088	11.1923
201.760	-.001624	833381.7594	-11967.1361	-1.947E-04	13390.6152	15.1121
203.840	-.002023	808856.2781	-11931.6630	-1.894E-04	13350.1145	18.9966
205.920	-.002412	784404.0478	-11888.1465	-1.844E-04	13309.7346	22.8462

208.000	-.002790	760041.9937	-11836.6586	-1.795E-04	13269.5037	26.6613
210.080	-.003159	735786.8906	-11777.2707	-1.747E-04	13229.4494	30.4425
212.160	-.003517	711655.3654	-11710.0526	-1.701E-04	13189.5992	34.1903
214.240	-.003866	687663.8989	-11635.0730	-1.656E-04	13149.9802	37.9054
216.320	-.004206	663828.8294	-11552.3992	-1.613E-04	13110.6196	41.5887
218.400	-.004537	640166.3556	-11462.0963	-1.572E-04	13071.5439	45.2409
220.480	-.004860	616692.5399	-11364.2281	-1.532E-04	13032.7798	48.8632
222.560	-.005175	593423.3129	-11258.8557	-1.493E-04	12994.3536	52.4564
224.640	-.005481	570374.4773	-11146.0386	-1.456E-04	12956.2913	56.0217
226.720	-.005781	547561.7127	-11025.8333	-1.421E-04	12918.6188	59.5603
228.800	-.006072	525000.5804	-10898.2943	-1.387E-04	12881.3619	63.0734
230.880	-.006357	502706.5291	-10763.4730	-1.354E-04	12844.5461	66.5624
232.960	-.006636	480694.8996	-10621.4184	-1.323E-04	12808.1966	70.0286
235.040	-.006908	458980.9314	-10472.1762	-1.293E-04	12772.3387	73.4735
237.120	-.007174	437579.7683	-10315.7893	-1.264E-04	12736.9973	76.8985
239.200	-.007434	416506.4649	-10152.2973	-1.237E-04	12702.1973	80.3053
241.280	-.007688	395775.9928	-9981.7367	-1.211E-04	12667.9635	83.6953
243.360	-.007938	375403.2479	-9804.1405	-1.187E-04	12634.3205	87.0703
245.440	-.008182	355403.0565	-9619.5382	-1.164E-04	12601.2926	90.4319
247.520	-.008422	335790.1832	-9427.9561	-1.142E-04	12568.9044	93.7817
249.600	-.008657	316579.3375	-9229.4166	-1.121E-04	12537.1801	97.1216
251.680	-.008888	297785.1815	-9023.9386	-1.101E-04	12506.1438	100.4534
253.760	-.009115	279422.3371	-8811.5373	-1.083E-04	12475.8199	103.7787
255.840	-.009339	261505.3939	-8592.2241	-1.066E-04	12446.2323	107.0994
257.920	-.009559	244048.9165	-8366.0067	-1.050E-04	12417.4050	110.4173
260.000	-.009775	227067.4525	-8132.8890	-1.035E-04	12389.3623	113.7343
262.080	-.009989	210575.5398	-7892.8712	-1.021E-04	12362.1279	117.0521
264.160	-.010200	194587.7150	-7645.9495	-1.008E-04	12335.7260	120.3726
266.240	-.010408	179118.5205	-7392.1165	-9.961E-05	12310.1805	123.6976
268.320	-.010614	164182.5125	-7131.3609	-9.852E-05	12285.5156	127.0289
270.400	-.010818	149794.2686	-6863.6678	-9.752E-05	12261.7552	130.3684
272.480	-.011020	135968.3955	-6589.0183	-9.661E-05	12238.9235	133.7176
274.560	-.011220	122719.5363	-6307.3903	-9.579E-05	12217.0446	137.0785
276.640	-.011419	110062.3780	-6018.7577	-9.505E-05	12196.1429	140.4528
278.720	-.011616	98011.6586	-5723.0912	-9.438E-05	12176.2426	143.8420
280.800	-.011811	86582.1744	-5420.3578	-9.380E-05	12157.3682	147.2478
282.880	-.012006	75788.7865	-5110.5215	-9.328E-05	12139.5443	150.6718
284.960	-.012199	65646.4277	-4793.5427	-9.283E-05	12122.7954	154.1155
287.040	-.012392	56170.1089	-4469.3790	-9.244E-05	12107.1465	157.5803
289.120	-.012584	47374.9251	-4137.9850	-9.211E-05	12092.6223	161.0677
291.200	-.012775	39276.0615	-3799.3124	-9.184E-05	12079.2480	164.5790
293.280	-.012966	31888.7986	-3453.3103	-9.161E-05	12067.0489	168.1154
295.360	-.013156	25228.5177	-3099.9252	-9.143E-05	12056.0503	171.6780
297.440	-.013346	19310.7055	-2739.1016	-9.129E-05	12046.2777	175.2678
299.520	-.013536	14150.9588	-2370.7817	-9.118E-05	12037.7570	178.8860
301.600	-.013726	9764.9880	-1994.9058	-9.111E-05	12030.5142	182.5332
303.680	-.013915	6168.6208	-1611.4127	-9.106E-05	12024.5752	186.2102
305.760	-.014104	3377.8052	-1220.2397	-9.103E-05	12019.9665	189.9176
307.840	-.014294	1408.6120	-821.3232	-9.101E-05	12016.7146	193.6560
309.920	-.014483	277.2365	-414.5983	-9.101E-05	12014.8463	197.4256
312.000	-.014672	0.0000	0.0000	-9.100E-05	12014.3885	201.2266

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .12159852 in
Computed slope at pile head       =     -.00097968
Maximum bending moment            =    1721795.229 lbs-in
Maximum shear force               =      37800.000 lbs
```

```
Depth of maximum bending moment  =        97.760 in
Depth of maximum shear force     =         0.000 in
Number of iterations             =            10
Number of zero deflection points =             1
```

Summary of Pile-head Response

Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

BC Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 37800.000	M= 0.000	835000.0000	.1216	1.722E+06	37800.0000

The analysis ended normally.

URS

Job SR-1 / I-95 Interchange | Project No. | Page ___ of ___
Description Ramp A over I-95 - Pier 3 | Computed by JPK | Sheet ___ of ___ | Date 8/26/08
Checked by | Date | Reference

From borings 1BR-27A & 1BR28A (DONE)

128 SK 36" ϕ 0.625" WALL

EL. 82	Depth=0 ft	x=0 in	DRY	
6.25 ▽ 7ft		x=84 in	1 Sand, γ=105 pcf, c=0, ϕ=30°	γ=0.061 K=40 pci
EL. 72	10ft	x=120 in		γ=0.028 K=30 pci
EL. 63	19ft	228 in	2 Sand, γ=120 pcf, c=0, ϕ=33°	γ=0.036, K=75
EL. 58	24ft	288 in	3 Sand, γ=100 pcf, ϕ=29°	γ=0.025, K=20
EL. 45	37ft	444 in	4 Clay, γ=125 pcf, c=2500 psf, ϕ=0	γ=0.039, C=17.4, K=1500, ε=0.005
EL 25	57ft	684 in	5 Clay, γ=125 pcf, c=3500 psf, ϕ=0	
EL 14	68ft	816 in	6 Sand, γ=130 pcf, c=0, ϕ=36°	
EL. 0	82	984 in	7 Clay, γ=130 pcf, c=4000 psf, ϕ=0	
EL-18	100ft	1200 in	8 Clay, γ=130 pcf, c=5000 psf, ϕ=0	

Shear per pile (See Pier 1) = 37.8 K

Axial = 835 K

Length Req'd
27 ft

```
==============================================================================

                    LPILE Plus for Windows, Version 4.0 (4.0.8)

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

                      (c) Copyright ENSOFT, Inc., 1985-2003
                            All Rights Reserved

==============================================================================

This program is licensed to:

URS
URS

Path to file locations:      D:\Program Files\Ensoft\LpileP4\DelDOTSR1\
Name of input data file:     S1P3.lpd
Name of output file:         S1P3.lpo
Name of plot output file:    S1P3.lpp
Name of runtime file:        S1P3.lpr


------------------------------------------------------------------------------
                           Time and Date of Analysis
------------------------------------------------------------------------------

               Date:  January 22, 2009     Time:  10:58:17


------------------------------------------------------------------------------
                                 Problem Title
------------------------------------------------------------------------------

Ramp A over I-95 - Pier 3


------------------------------------------------------------------------------
                                 Program Options
------------------------------------------------------------------------------

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          150
- Maximum number of iterations allowed =          100
```

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 324.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	36.000	10900.0000	69.5000	30000000.000
2	324.0000	36.000	10900.0000	69.5000	30000000.000

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 84.000 in
p-y subgrade modulus k for top of soil layer = 40.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 40.000 lbs/in**3

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 84.000 in
Distance from top of pile to bottom of layer = 120.000 in
p-y subgrade modulus k for top of soil layer = 30.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 30.000 lbs/in**3

Layer 3 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 120.000 in
Distance from top of pile to bottom of layer = 228.000 in
p-y subgrade modulus k for top of soil layer = 75.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 75.000 lbs/in**3

Layer 4 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 228.000 in
Distance from top of pile to bottom of layer = 288.000 in
p-y subgrade modulus k for top of soil layer = 20.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 20.000 lbs/in**3

Layer 5 is stiff clay with water-induced erosion
Distance from top of pile to top of layer = 288.000 in
Distance from top of pile to bottom of layer = 444.000 in
p-y subgrade modulus k for top of soil layer = 1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 1500.000 lbs/in**3

(Depth of lowest layer extends 120.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 10 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06100
2	84.00	.06100
3	84.00	.02800
4	120.00	.02800
5	120.00	.03600
6	228.00	.03600
7	228.00	.02500
8	288.00	.02500
9	288.00	.03900
10	444.00	.03900

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 10 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	.00000	30.00	------	------
2	84.000	.00000	30.00	------	------
3	84.000	.00000	30.00	------	------
4	120.000	.00000	30.00	------	------
5	120.000	.00000	33.00	------	------
6	228.000	.00000	33.00	------	------
7	228.000	.00000	29.00	------	------
8	288.000	.00000	29.00	------	------
9	288.000	17.40000	.00	.00500	.0
10	444.000	17.40000	.00	.00500	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

---

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 37800.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 835000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 37800.000 lbs
Specified bending moment at pile head = .000 in-lbs
Specified axial load at pile head = 835000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.247886	-1.245E-04	37800.0000	-.001768	12014.3885	0.0000
2.160	.244067	84836.8984	37777.2256	-.001768	12154.4861	-21.0874
4.320	.240249	169574.4008	37709.6149	-.001767	12294.4196	-41.5151
6.480	.236434	254116.1901	37598.5923	-.001766	12434.0299	-61.2837
8.640	.232622	338369.0268	37445.5802	-.001764	12573.1630	-80.3942
10.800	.228815	422242.7452	37251.9984	-.001761	12711.6701	-98.8482
12.960	.225014	505650.2471	37019.2632	-.001758	12849.4072	-116.6474
15.120	.221221	588507.4948	36748.7863	-.001754	12986.2357	-133.7942
17.280	.217435	670733.5011	36441.9741	-.001750	13122.0218	-150.2912
19.440	.213659	752250.3179	36100.2267	-.001746	13256.6367	-166.1416
21.600	.209894	832983.0224	35724.9371	-.001740	13389.9568	-181.3488
23.760	.206141	912859.7021	35317.4904	-.001735	13521.8632	-195.9167
25.920	.202401	991811.4373	34879.2628	-.001728	13652.2422	-209.8496
28.080	.198675	1.070E+06	34411.6211	-.001721	13780.9849	-223.1520
30.240	.194965	1.147E+06	33915.9215	-.001714	13907.9872	-235.8291
32.400	.191270	1.222E+06	33393.5090	-.001706	14033.1500	-247.8862
34.560	.187593	1.297E+06	32845.7166	-.001698	14156.3789	-259.3290
36.720	.183935	1.370E+06	32273.8646	-.001689	14277.5842	-270.1636
38.880	.180296	1.443E+06	31679.2596	-.001680	14396.6810	-280.3965
41.040	.176678	1.513E+06	31063.1943	-.001670	14513.5890	-290.0344
43.200	.173081	1.583E+06	30426.9461	-.001660	14628.2327	-299.0843
45.360	.169507	1.651E+06	29771.7771	-.001649	14740.5409	-307.5537
47.520	.165957	1.717E+06	29098.9327	-.001638	14850.4470	-315.4503
49.680	.162431	1.782E+06	28409.6417	-.001627	14957.8889	-322.7821
51.840	.158930	1.846E+06	27705.1151	-.001615	15062.8088	-329.5573
54.000	.155456	1.908E+06	26986.5460	-.001602	15165.1532	-335.7845
56.160	.152009	1.968E+06	26255.1085	-.001589	15264.8731	-341.4725

58.320	.148590	2.027E+06	25511.9575	-.001576	15361.9232	-346.6303
60.480	.145200	2.084E+06	24758.2280	-.001563	15456.2628	-351.2674
62.640	.141840	2.140E+06	23995.0347	-.001549	15547.8550	-355.3931
64.800	.138510	2.193E+06	23223.4714	-.001534	15636.6669	-359.0174
66.960	.135211	2.246E+06	22444.6106	-.001520	15722.6696	-362.1500
69.120	.131945	2.296E+06	21659.5031	-.001505	15805.8378	-364.8013
71.280	.128711	2.345E+06	20869.1776	-.001489	15886.1502	-366.9816
73.440	.125511	2.391E+06	20074.6401	-.001474	15963.5890	-368.7013
75.600	.122345	2.437E+06	19276.8737	-.001458	16038.1401	-369.9713
77.760	.119214	2.480E+06	18476.8383	-.001441	16109.7926	-370.8022
79.920	.116118	2.522E+06	17675.4703	-.001425	16178.5395	-371.2052
82.080	.113058	2.561E+06	16873.6820	-.001408	16244.3768	-371.1914
84.240	.110034	2.600E+06	16172.6817	-.001391	16307.3038	-277.8830
86.400	.107048	2.636E+06	15573.1079	-.001374	16368.0386	-277.2780
88.560	.104099	2.672E+06	14975.1510	-.001356	16426.5853	-276.3858
90.720	.101189	2.706E+06	14379.4218	-.001339	16482.9499	-275.2152
92.880	.098317	2.739E+06	13786.5124	-.001321	16537.1408	-273.7749
95.040	.095484	2.770E+06	13196.9958	-.001302	16589.1685	-272.0738
97.200	.092691	2.800E+06	12611.4258	-.001284	16639.0455	-270.1207
99.360	.089937	2.829E+06	12030.3369	-.001265	16686.7862	-267.9246
101.520	.087224	2.857E+06	11454.2444	-.001247	16732.4069	-265.4945
103.680	.084552	2.883E+06	10883.6437	-.001228	16775.9259	-262.8395
105.840	.081921	2.908E+06	10319.0107	-.001209	16817.3631	-259.9688
108.000	.079331	2.932E+06	9760.8017	-.001189	16856.7401	-256.8914
110.160	.076783	2.955E+06	9209.4529	-.001170	16894.0802	-253.6167
112.320	.074278	2.976E+06	8665.3810	-.001150	16929.4080	-250.1537
114.480	.071814	2.997E+06	8128.9824	-.001130	16962.7500	-246.5117
116.640	.069394	3.016E+06	7600.6336	-.001111	16994.1337	-242.7001
118.800	.067017	3.033E+06	7080.6913	-.001091	17023.5882	-238.7280
120.960	.064683	3.050E+06	6218.5186	-.001071	17051.1437	-559.5801
123.120	.062392	3.064E+06	5020.3112	-.001050	17074.3278	-549.8712
125.280	.060145	3.076E+06	3843.4528	-.001030	17093.2150	-539.8125
127.440	.057942	3.084E+06	2688.6742	-.001010	17107.8827	-529.4269
129.600	.055783	3.091E+06	1556.6577	-9.893E-04	17118.4106	-518.7366
131.760	.053668	3.095E+06	448.0369	-9.689E-04	17124.8811	-507.7641
133.920	.051597	3.096E+06	-636.6022	-9.484E-04	17127.3785	-496.5313
136.080	.049571	3.095E+06	-1696.7206	-9.280E-04	17125.9893	-485.0598
138.240	.047588	3.092E+06	-2731.8259	-9.076E-04	17120.8021	-473.3710
140.400	.045650	3.087E+06	-3740.3757	-8.872E-04	17111.9069	-460.4714
142.560	.043756	3.079E+06	-4712.4702	-8.668E-04	17099.4031	-439.6162
144.720	.041906	3.070E+06	-5639.0743	-8.465E-04	17083.4517	-418.3506
146.880	.040099	3.058E+06	-6519.3892	-8.262E-04	17064.2166	-396.7559
149.040	.038336	3.044E+06	-7352.7965	-8.061E-04	17041.8645	-374.9176
151.200	.036617	3.029E+06	-8152.1968	-7.860E-04	17016.5639	-365.2679
153.360	.034941	3.012E+06	-8935.2145	-7.661E-04	16988.3895	-359.7485
155.520	.033307	2.993E+06	-9705.9568	-7.462E-04	16957.3840	-353.9018
157.680	.031717	2.973E+06	-10463.7245	-7.265E-04	16923.5930	-347.7350
159.840	.030169	2.951E+06	-11207.8348	-7.070E-04	16887.0643	-341.2560
162.000	.028663	2.927E+06	-11937.6218	-6.876E-04	16847.8483	-334.4728
164.160	.027198	2.902E+06	-12648.1480	-6.683E-04	16805.9977	-323.4218
166.320	.025776	2.875E+06	-13332.9756	-6.492E-04	16761.5981	-310.6779
168.480	.024394	2.846E+06	-13990.3199	-6.303E-04	16714.7483	-297.9741
170.640	.023053	2.817E+06	-14620.2833	-6.116E-04	16665.5468	-285.3253
172.800	.021751	2.785E+06	-15223.0000	-5.931E-04	16614.0915	-272.7457
174.960	.020490	2.753E+06	-15798.6348	-5.748E-04	16560.4800	-260.2494
177.120	.019268	2.719E+06	-16347.3819	-5.568E-04	16504.8091	-247.8497
179.280	.018085	2.684E+06	-16869.4637	-5.389E-04	16447.1752	-235.5594
181.440	.016940	2.648E+06	-17365.1299	-5.213E-04	16387.6736	-223.3908
183.600	.015833	2.611E+06	-17834.6560	-5.039E-04	16326.3987	-211.3556
185.760	.014763	2.573E+06	-18278.3423	-4.868E-04	16263.4441	-199.4651
187.920	.013730	2.534E+06	-18696.5128	-4.700E-04	16198.9020	-187.7299
190.080	.012733	2.494E+06	-19089.5140	-4.533E-04	16132.8636	-176.1601
192.240	.011771	2.453E+06	-19457.7135	-4.370E-04	16065.4189	-164.7654

194.400	.010845	2.411E+06	-19801.4993	-4.209E-04	15996.6565	-153.5548
196.560	.009953	2.369E+06	-20121.2781	-4.052E-04	15926.6636	-142.5367
198.720	.009095	2.326E+06	-20417.4744	-3.896E-04	15855.5259	-131.7192
200.880	.008270	2.282E+06	-20690.5295	-3.744E-04	15783.3275	-121.1096
203.040	.007477	2.238E+06	-20940.9001	-3.595E-04	15710.1512	-110.7149
205.200	.006717	2.193E+06	-21169.0570	-3.449E-04	15636.0778	-100.5415
207.360	.005987	2.148E+06	-21375.4845	-3.305E-04	15561.1866	-90.5951
209.520	.005289	2.102E+06	-21560.6787	-3.165E-04	15485.5551	-80.8811
211.680	.004620	2.056E+06	-21725.1468	-3.028E-04	15409.2592	-71.4042
213.840	.003981	2.009E+06	-21869.4056	-2.893E-04	15332.3726	-62.1688
216.000	.003370	1.962E+06	-21993.9807	-2.762E-04	15254.9675	-53.1786
218.160	.002788	1.915E+06	-22099.4053	-2.634E-04	15177.1141	-44.4368
220.320	.002232	1.868E+06	-22186.2192	-2.509E-04	15098.8807	-35.9464
222.480	.001704	1.820E+06	-22254.9676	-2.387E-04	15020.3335	-27.7095
224.640	.001201	1.773E+06	-22306.2000	-2.269E-04	14941.5370	-19.7280
226.800	7.24E-04	1.725E+06	-22340.4696	-2.153E-04	14862.5537	-12.0031
228.960	2.71E-04	1.677E+06	-22354.9535	-2.041E-04	14783.4440	-1.4080
231.120	-1.58E-04	1.629E+06	-22355.5790	-1.932E-04	14704.2904	.8288
233.280	-5.64E-04	1.581E+06	-22351.4658	-1.826E-04	14625.1111	2.9797
235.440	-9.47E-04	1.533E+06	-22342.7985	-1.723E-04	14545.9237	5.0455
237.600	-.001308	1.485E+06	-22329.7603	-1.623E-04	14466.7451	7.0269
239.760	-.001648	1.437E+06	-22312.5326	-1.527E-04	14387.5913	8.9247
241.920	-.001967	1.389E+06	-22291.2948	-1.433E-04	14308.4780	10.7400
244.080	-.002267	1.341E+06	-22266.2240	-1.343E-04	14229.4202	12.4738
246.240	-.002548	1.293E+06	-22237.4948	-1.256E-04	14150.4320	14.1273
248.400	-.002810	1.246E+06	-22205.2791	-1.172E-04	14071.5273	15.7020
250.560	-.003054	1.198E+06	-22169.7458	-1.091E-04	13992.7190	17.1992
252.720	-.003281	1.150E+06	-22131.0605	-1.014E-04	13914.0197	18.6205
254.880	-.003492	1.103E+06	-22089.3852	-9.395E-05	13835.4412	19.9676
257.040	-.003687	1.055E+06	-22044.8785	-8.682E-05	13756.9949	21.2423
259.200	-.003867	1.008E+06	-21997.6946	-8.001E-05	13678.6915	22.4464
261.360	-.004033	960503.5586	-21947.9839	-7.351E-05	13600.5412	23.5820
263.520	-.004185	913277.7799	-21895.8920	-6.732E-05	13522.5536	24.6512
265.680	-.004323	866156.1334	-21841.5600	-6.144E-05	13444.7381	25.6562
267.840	-.004450	819143.8692	-21785.1241	-5.587E-05	13367.1031	26.5993
270.000	-.004565	772245.9475	-21726.7153	-5.062E-05	13289.6570	27.4830
272.160	-.004669	725467.0501	-21666.4592	-4.567E-05	13212.4075	28.3097
274.320	-.004762	678811.5915	-21604.4758	-4.103E-05	13135.3618	29.0823
276.480	-.004846	632283.7320	-21540.8794	-3.670E-05	13058.5268	29.8033
278.640	-.004921	585887.3901	-21475.7780	-3.268E-05	12981.9089	30.4757
280.800	-.004987	539626.2557	-21409.2735	-2.896E-05	12905.5144	31.1025
282.960	-.005046	493503.8041	-21341.4613	-2.555E-05	12829.3489	31.6866
285.120	-.005098	447523.3101	-21272.4300	-2.244E-05	12753.4178	32.2313
287.280	-.005143	401687.8628	-21202.2612	-1.964E-05	12677.7262	32.7398
289.440	-.005182	356000.3807	-20535.1982	-1.714E-05	12602.2790	584.9111
291.600	-.005217	313037.6186	-19269.6869	-1.493E-05	12531.3313	586.8586
293.760	-.005247	272809.1746	-18000.2461	-1.299E-05	12464.8991	588.5495
295.920	-.005273	235323.4171	-16727.3930	-1.131E-05	12402.9960	590.0181
298.080	-.005296	200587.6447	-15451.5738	-9.873E-06	12345.6341	591.2960
300.240	-.005316	168608.2329	-14173.1695	-8.654E-06	12292.8241	592.4118
302.400	-.005333	139390.7687	-12892.5016	-7.637E-06	12244.5751	593.3918
304.560	-.005349	112940.1728	-11609.8377	-6.803E-06	12200.8952	594.2600
306.720	-.005362	89260.8106	-10325.3964	-6.135E-06	12161.7917	595.0376
308.880	-.005375	68356.5922	-9039.3526	-5.615E-06	12127.2709	595.7437
311.040	-.005387	50231.0611	-7751.8428	-5.223E-06	12097.3389	596.3950
313.200	-.005398	34887.4721	-6462.9696	-4.942E-06	12072.0008	597.0061
315.360	-.005408	22328.8593	-5172.8068	-4.753E-06	12051.2618	597.5891
317.520	-.005418	12558.0921	-3881.4043	-4.638E-06	12035.1266	598.1540
319.680	-.005428	5577.9224	-2588.7929	-4.578E-06	12023.5997	598.7084
321.840	-.005438	1391.0204	-1294.9891	-4.555E-06	12016.6856	599.2580
324.000	-.005448	0.0000	0.0000	-4.550E-06	12014.3885	599.8060

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.24788619	in
Computed slope at pile head	=	-.00176807	
Maximum bending moment	=	3096199.486	lbs-in
Maximum shear force	=	37800.000	lbs
Depth of maximum bending moment	=	133.920	in
Depth of maximum shear force	=	0.000	in
Number of iterations	=	12	
Number of zero deflection points	=	1	

Summary of Pile-head Response

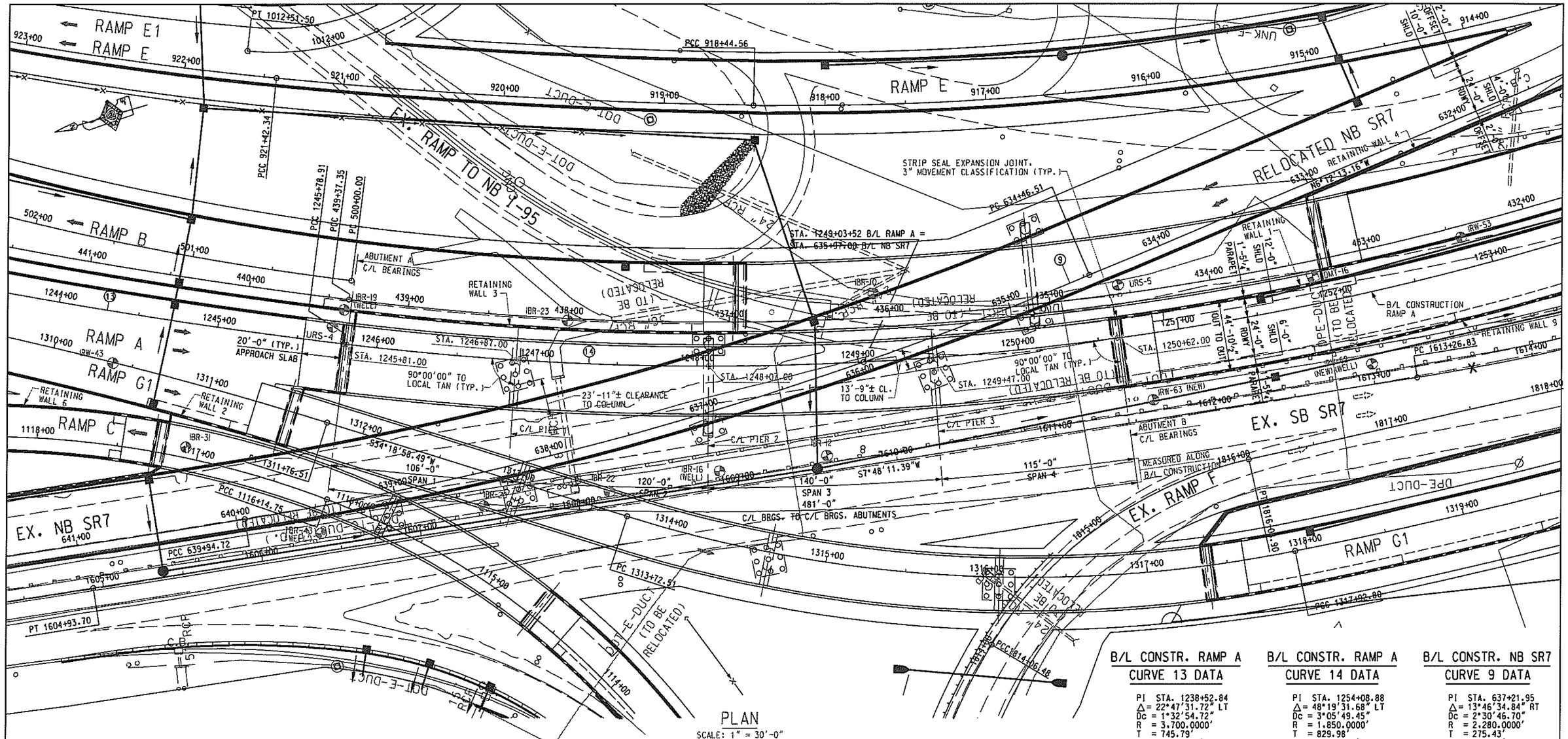
Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

BC Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 37800.000	M= 0.000	835000.0000	.2479	3.096E+06	37800.0000

The analysis ended normally.

Structure S2 – Ramp A over SR 7



PLAN
SCALE: 1" = 30'-0"

NOTE:

USE POT BEARINGS AT ABUTMENTS A AND B AND PIERS.

B/L CONSTR. RAMP A CURVE 13 DATA

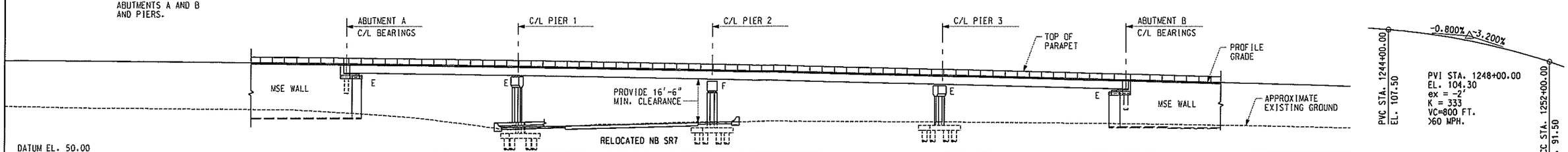
PI STA. 1238+52.84
Δ = 22°47'31.72" LT
Dc = 1°32'54.72"
R = 3,700.0000'
T = 745.79'
L = 1,471.85'

B/L CONSTR. RAMP A CURVE 14 DATA

PI STA. 1254+08.88
Δ = 48°19'31.68" LT
Dc = 3°05'49.45"
R = 1,850.0000'
T = 829.98'
L = 1,560.36'

B/L CONSTR. NB SR7 CURVE 9 DATA

PI STA. 637+21.95
Δ = 13°46'34.84" RT
Dc = 2°30'46.70"
R = 2,280.0000'
T = 275.43'
L = 548.21'



ELEVATION
SCALE: 1" = 30'-0"

NOTE:
MSE ABUTMENTS SHOWN

URS S2-2

RAMP A PROFILE
NOT TO SCALE

S2-1

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS	

SCALE 0 30 60 90 FEET

SR1 / I-95 INTERCHANGE

CONTRACT	BRIDGE NO.
28-090-03	DESIGNED BY: R. F. KIRCHNER URS
COUNTY	
NEW CASTLE	CHECKED BY:

RAMP A OVER SR 7
PLAN AND ELEVATION

SHEET NO. 7
TOTAL SHTS.

Jan 22, 2009 G:\20832687-XM\CAD\Bridge\pe201.dgn
Jason_kotova

MSE Wingwalls
Bearing Capacity, Sliding, Overturning, Eccentricity, Settlement

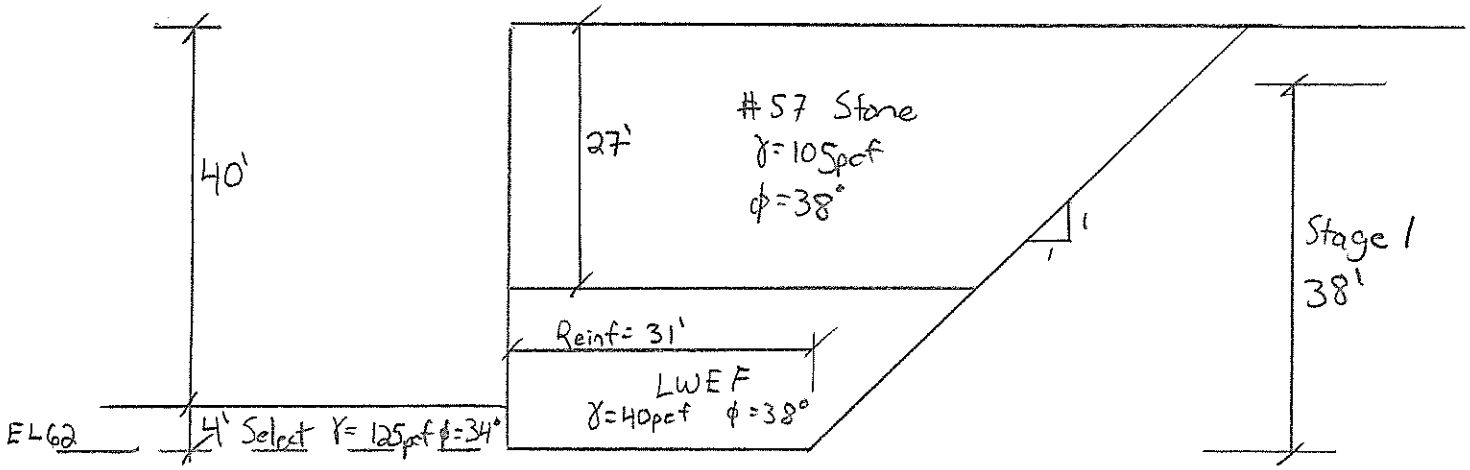
URS

Job SR1 / I-95 Interchange | Project No. | Page ___ of ___ | Sheet ___ of ___

Description Ramp A over SR7 | Computed by JPK | Date

Abut A Face & Wingwalls | Checked by | Date

Bearing Capacity, Sliding & Overturning | Reference



Clay
γ=120pcf

CD	CU	UU @ Stage 1
φ=24°	φ=10.3°	φ=0
c=0	c=940psf	c=1250psf
Traffic Surcharge=250psf	TS=250psf	TS=0 psf

EL30 ▽

Settlement

Assumptions:

1) 7 feet of overburden removed to reach bottom of footing
2) 20 feet of clay layer consolidating (based on test embankment back calculation)
3) Consolidation parameters from URS-4, U-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp A over SR 7 - Abutment A Face & Wingwalls
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	40	feet	
Embedment (below grade)	Df =	4	feet	
Total Height (Hw+Df)	H =	44	feet	
Wall Base Width	B =	31	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	50	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	32	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	27	feet	
Top Material Unit Weight	γ1 =	105	pcf	
Top Material Φ	Φ1 =	38	degrees	
Bottom Material Height	H2 =	17	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	38	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	79.89	pcf	
Retained Wedge - Vertical Component	Wrw	45	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	21.9	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.238	(dim)	
Horiz F2 Surcharge	F2 =	2.6	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	109.0	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	37.5	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	40.5	k/ft	as defined by Fig 10.6.3.4-1 $= f * B/1000 + Df * \gamma_e * K_p/1000$
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	40.5	k/ft	**Capacity Demand Ratio (CDR)= 1.08**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	5.36	ft	**e < 0.25*B, OK**
Effective Width	B' =	20.3	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	5.37	ksf	
Factored Bearing Pressure	Sigv =	7.92	ksf	

Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.31	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.28	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.75	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.80	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	16.7	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	10.86	ksf	**Capacity Demand Ratio (CDR)= 1.371**
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming quarantine period after Stage 1
Foundation Φ	Φf =	10.3	degrees	
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS-2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.19	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.11	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.75	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.80	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	12.3	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	8.00	ksf	**Capacity Demand Ratio (CDR)= 1.010**
				CDR > 1.0, OK

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp A over SR 7 - Abutment A Face & Wingwalls
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	34	feet	
Embedment (below grade)	Df =	4	feet	
Total Height (Hw+Df)	H =	38	feet	
Wall Base Width	B =	31	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	50	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	32	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	21	feet	
Top Material Unit Weight	γ1 =	105	pcf	
Top Material Φ	Φ1 =	38	degrees	
Bottom Material Height	H2 =	17	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	38	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	75.92	pcf	
Retained Wedge - Vertical Component	Wrw	32	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	15.8	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.238	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	89.4	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	23.7	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	40.5	k/ft	as defined by Fig 10.6.3.4-1 $= f * B/1000 + D_f * \gamma_e * K_p/1000$
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	40.5	k/ft	**Capacity Demand Ratio (CDR)= 1.71**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	3.36	ft	e < 0.25*B, OK
Effective Width	B' =	24.3	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	4.97	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.31	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.28	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.75	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.80	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	16.7	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	10.86	ksf	**Capacity Demand Ratio (CDR)= 2.184**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1, quarantine period to follow
Foundation Φ	Φf =	0.0	degrees	
Foundation Cohesion (c)	cf =	1250	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.12	(dim)	per Table 10.6.3.1.2a-3 $= 1 + B/5L$
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.80	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	7.7	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	5.02	ksf	**Capacity Demand Ratio (CDR)= 1.010**
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp A over SR 7 - Abutment A Face & Wingwalls
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c'' [3]
Initial Overburden	7				0.44				2.69			
I	10	0.851	0.065	0.33	0.75	3.48	0.39	0.85	2.60	1.85	0	2.274452
II	10	0.851	0.065	0.33	1.38	3.48	0.71	0.70	2.82	1.45	0	1.314847

Footing Width (ft) 31

0.00	3.59	in
TOTAL	3.59	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS-S2-4
Lab data on page URS-4

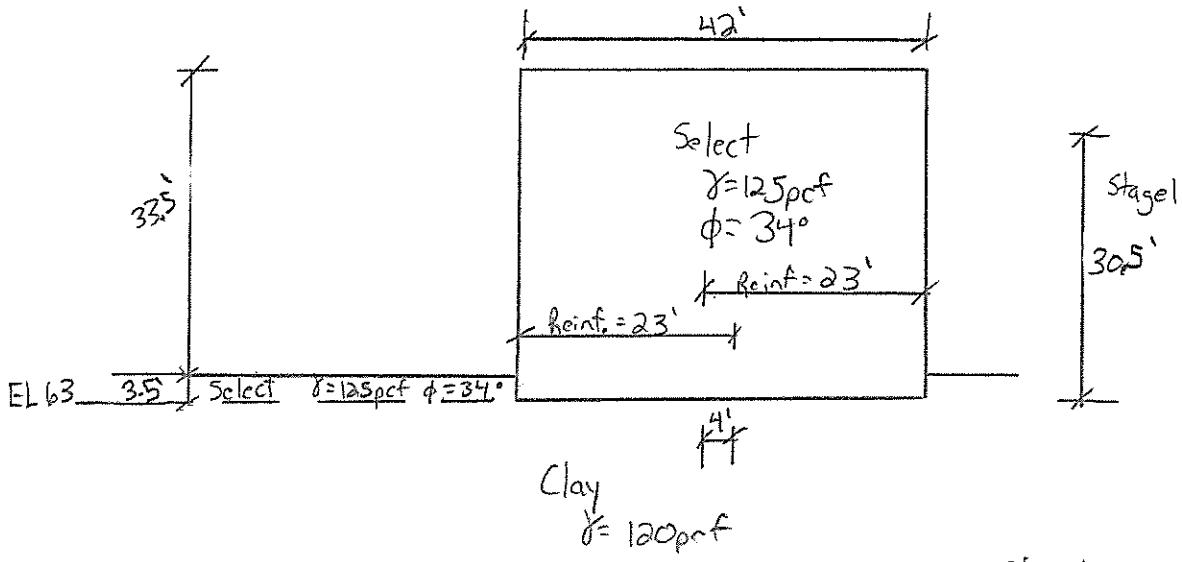
URS

Job SR 1 / I-95 Interchange | Project No. | Page ___ of ___ | Sheet ___ of ___

Description Retaining Wall 1 & Ramp A over SR7, Abut B Wingwalls | Computed by JPK | Date

Checked by | Date

Bearing Capacity, Sliding & Overturning | Reference



CD	CU	UU @ Stage1
φ=24°	φ=10.3	φ=0
c=0	c=940psf	c=1400psf
EL30 ▽ Traffic Surcharge=250psf	TS=250psf	TS=0psf

Settlement

Assumptions:

1) 7 feet of overburden removed to reach bottom of footing
2) 20 feet of clay layer consolidating (based on test embankment back calculation)
3) Consolidation parameters from URS-5, U-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp A over SR 7 - Abutment B Wingwalls (Back to Back) & Retaining Wall 1
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	33.5	feet	
Embedment (below grade)	Df =	3.5	feet	
Total Height (Hw+Df)	H =	37	feet	
Wall Base Width	B =	26	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	155	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	29.5	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	37	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	45	k/ft	
Wedge Influence Factor	WIF =	0.04		see attached spreadsheet calculations
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	0.9	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.1	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	120.3	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1400	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	1.5	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	37.9	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	37.9	k/ft	**Capacity Demand Ratio (CDR)=** 25.98
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	0.16	ft	e < 0.25*B, OK
Effective Width	B' =	25.7	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	4.68	ksf	
Factored Bearing Pressure	Sigv =	6.76	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.08	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.07	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.93	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.83	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	16.0	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	10.38	ksf	**Capacity Demand Ratio (CDR)=** 1.534
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming quarantine period after Stage 1
Foundation Φ	Φf =	10.3	degrees	
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS-2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.05	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.03	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.93	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.83	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	11.1	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.20	ksf	**Capacity Demand Ratio (CDR)=** 1.064
				CDR > 1.0, OK

Back to Back Wall Calculations
Ramp A over SR 7 - Abutment B Wingwalls (Back to Back) & Retaining Wall 1
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Total Height (Hw+Df)	H =	37	feet	
Wall Base Width	B =	26	feet	
Face to Face Distance	F =	42	feet	
Overlap	Lr =	10	feet	as defined by Fig 50 of FHWA-NHI-00-043
Wedge Distance at Top of Wall	Dwd=	19.67325	feet	as defined by Fig 50 of FHWA-NHI-00-043
Overlap Distance with No Wedge Influence	Lr' =	11.1	feet	as defined by Sec. 5.4 of FHWA-NHI-00-043
Wedge Influence Factor	WIF =	0.04		as defined by Sec. 5.4 of FHWA-NHI-00-043

Lr = (2*B)-F
Dwd = H*tan(45-Φ1|2 / 2)
Lr' = H*0.3
WIF = (Lr' - Lr) / (Lr'+Dwd)

Note: WIF linear interpolation between "full active" case and "zero-active" case

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp A over SR 7 - Abutment B Wingwalls (Back to Back) & Retaining Wall 1
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	26.5	feet	
Embedment (below grade)	Df =	3.5	feet	
Total Height (Hw+Df)	H =	30	feet	
Wall Base Width	B =	26	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	155	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	29.5	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	30	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	30	k/ft	
Wedge Influence Factor	WIF =	0.04		see attached spreadsheet calculations
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	0.6	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	97.5	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1400	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	0.9	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	37.9	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	37.9	k/ft	**Capacity Demand Ratio (CDR)= 45**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	0.09	ft	**e < 0.25*B, OK**
Effective Width	B' =	25.8	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	5.10	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.08	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.07	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.93	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.83	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	16.0	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	10.38	ksf	**Capacity Demand Ratio (CDR)= 2.036**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1,
Foundation Φ	Φf =	0.0	degrees	quarantine period to follow
Foundation Cohesion (c)	cf =	1400	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.03	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.83	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	7.9	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	5.12	ksf	**Capacity Demand Ratio (CDR)= 1.004**
				CDR > 1.0, OK

Predicted Settlement Calculations: Retaining Wall 1 & Ramp A over SR 7 - Abutment B Wingwalls
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c'' [3]
Initial Overburden	7				0.44				2.47			
I	10	0.786	0.068	0.29	0.75	4.50	0.52	0.75	2.17	1.42	0	2.103492
II	10	0.786	0.068	0.29	1.38	4.50	0.96	0.55	2.30	0.92	0	1.017346

Footing Width (ft)	23	0.00	3.12	in
		TOTAL	3.12	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS-S2-8
Lab data on page URS- 8

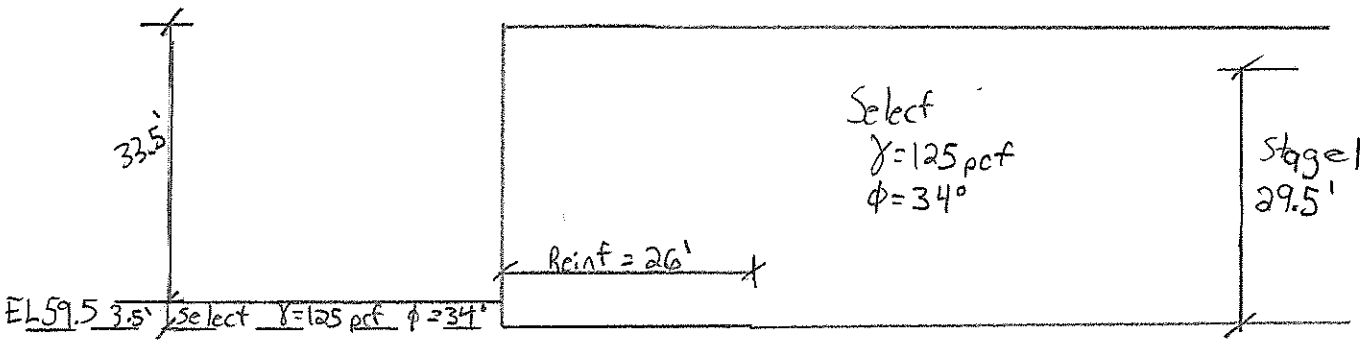
URS

Job SR 1 / I-95 Interchange | Project No. | Page ___ of ___ | Sheet ___ of ___

Description Ramp A over SR7 | Computed by JPK | Date

Abut. B Face | Checked by | Date

Bearing Capacity, Sliding & Over turning | Reference



Clay
γ=120 pcf

CD	CU	UU @ Stage 1
φ=24°	φ=10.3°	φ=0°
C=0	C=940 psf	C=1400 psf
	TS=250 psf	TS=0

EL 30 ▽ Traffic Surcharge = 250 psf

Settlement

Assumptions:

1) 6 feet of overburden removed to reach bottom of footing
2) 20 feet of clay layer consolidating (based on test embankment back calculation)
3) Consolidation parameters from URS-5, 4-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp A over SR 7 - Abutment B Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	33.5	feet	
Embedment (below grade)	Df =	3.5	feet	
Total Height (Hw+Df)	H =	37	feet	
Wall Base Width	B =	33	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	43	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	29.5	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	31	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	6	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	111.22	pcf	
Retained Wedge - Vertical Component	Wrw	45	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	23.6	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	2.6	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	135.8	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1400	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	40.2	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	47.7	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	47.7	k/ft	**Capacity Demand Ratio (CDR)= 1.19**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	3.86	ft	**e < 0.25*B, OK**
Effective Width	B' =	25.3	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	5.37	ksf	
Factored Bearing Pressure	Sigv =	7.82	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.38	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.34	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.69	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.76	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	15.5	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	10.09	ksf	**Capacity Demand Ratio (CDR)= 1.289**
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming
Foundation Φ	Φf =	10.3	degrees	quarantine period after Stage 1
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS-2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.23	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.14	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.69	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.76	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	12.4	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	8.07	ksf	**Capacity Demand Ratio (CDR)= 1.032**
				CDR > 1.0, OK

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp A over SR 7 - Abutment B Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	26	feet	
Embedment (below grade)	Df =	3.5	feet	
Total Height (Hw+Df)	H =	29.5	feet	
Wall Base Width	B =	33	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	43	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	29.5	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	29.5	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	29	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	15.4	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	121.7	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1400	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	23.1	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	47.7	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	47.7	k/ft	**Capacity Demand Ratio (CDR)=** 2.07
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	1.86	ft	e < 0.25*B, OK
Effective Width	B' =	29.3	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	5.61	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.38	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.34	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.69	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.76	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	15.5	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	10.09	ksf	**Capacity Demand Ratio (CDR)=** 1.797
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1, quarantine period to follow
Foundation Φ	Φf =	0.0	degrees	
Foundation Cohesion (c)	cf =	1400	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.15	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.76	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	8.7	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	5.68	ksf	**Capacity Demand Ratio (CDR)=** 1.012
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp A over SR 7 - Abutment B Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c'' [3]	
Initial Overburden	6				0.38				2.69				
I	10	0.786	0.068	0.29	0.69	4.50	0.42	0.80	2.46	1.77	0	2.530659	
II	10	0.786	0.068	0.29	1.31	4.50	0.81	0.65	2.68	1.37	0	1.419027	
Footing Width (ft)	26										0.00	3.95	in
											TOTAL	3.95	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS-~~52~~ 13
Lab data on page URS- 8

Global Stability

Short-term Case

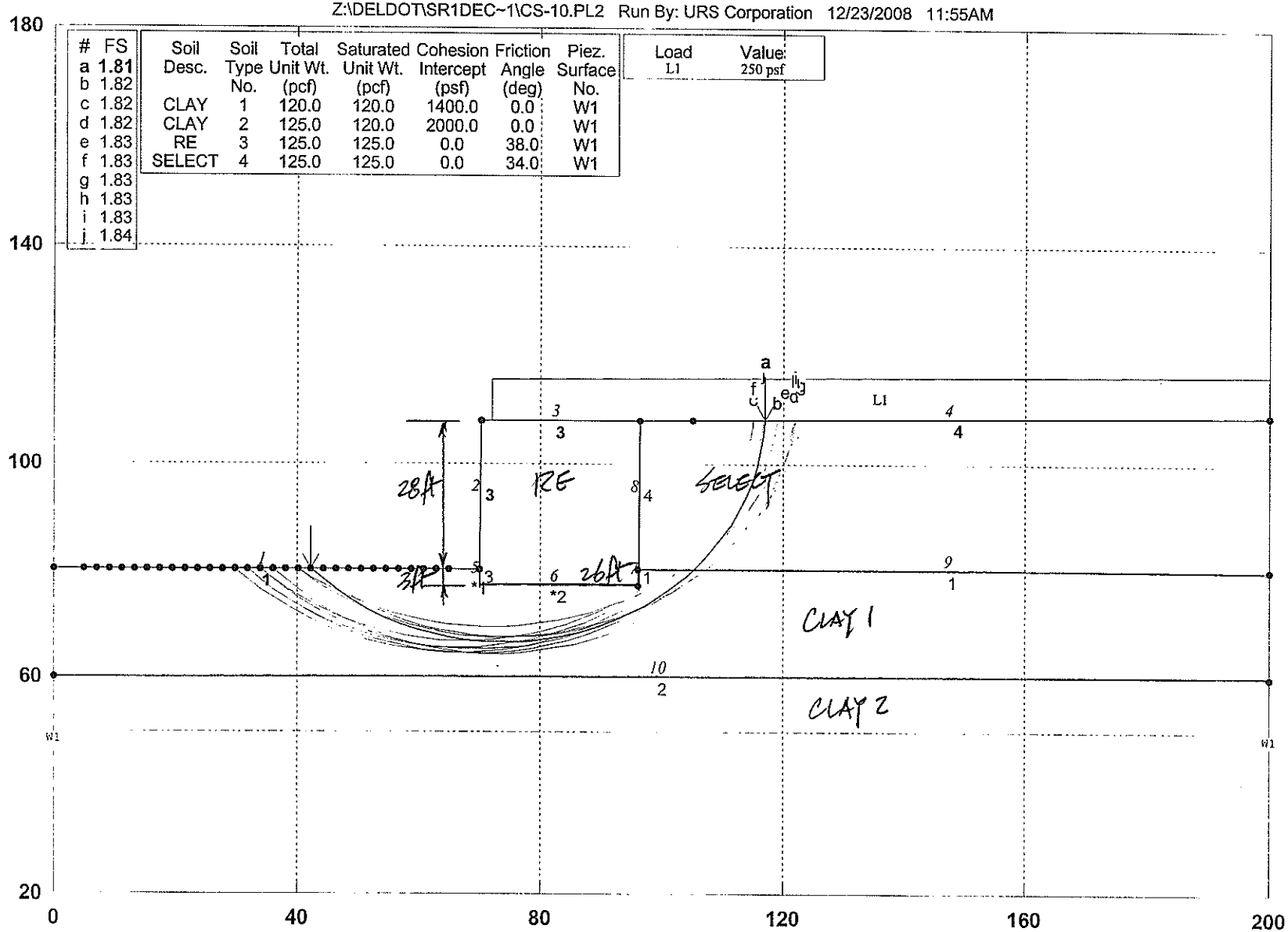
SR1/I95 Interchange CS-10

Z:\DELDOT\SR1DEC~1\CS-10.PL2 Run By: URS Corporation 12/23/2008 11:55AM

#	FS
a	1.81
b	1.82
c	1.82
d	1.82
e	1.83
f	1.83
g	1.83
h	1.83
i	1.83
j	1.84

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	1400.0	0.0	W1
CLAY	2	125.0	120.0	2000.0	0.0	W1
RE	3	125.0	125.0	0.0	38.0	W1
SELECT	4	125.0	125.0	0.0	34.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.81

Safety Factors Are Calculated By The Modified Bishop Method

STED

* For Cross Section Location See URS-11

URS S2-18

Long-term Case

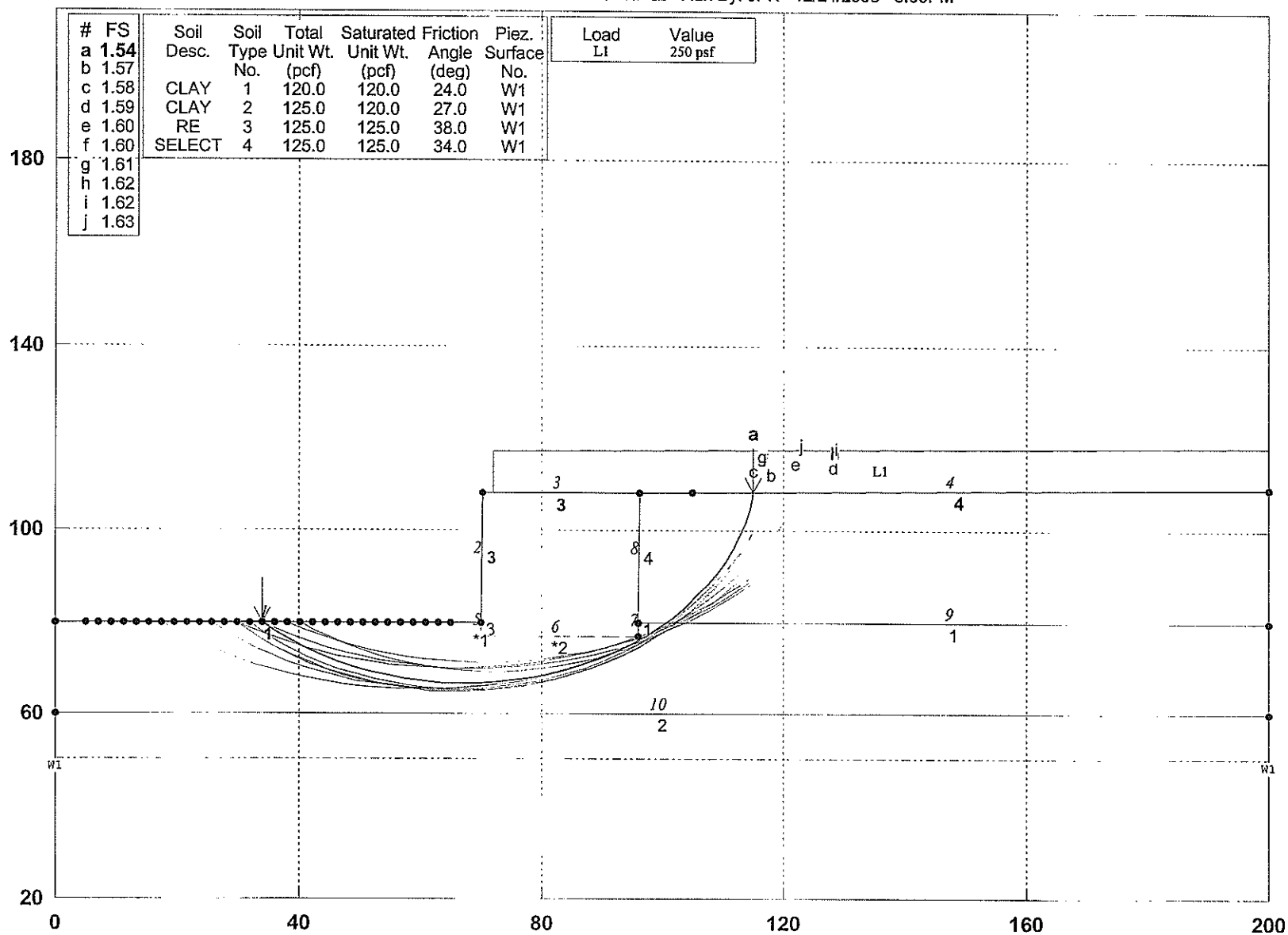
SR1/I95 Interchange CS-10 Long-Term

Z:\DELDOT\SR1DEC~1\CS-10LT.PL2 Run By: JPK 12/24/2008 3:00PM

#	FS
a	**1.54**
b	1.57
c	1.58
d	1.59
e	1.60
f	1.60
g	1.61
h	1.62
i	1.62
j	1.63

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	24.0	W1
CLAY	2	125.0	120.0	27.0	W1
RE	3	125.0	125.0	38.0	W1
SELECT	4	125.0	125.0	34.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.54

Safety Factors Are Calculated By The Modified Bishop Method

STED

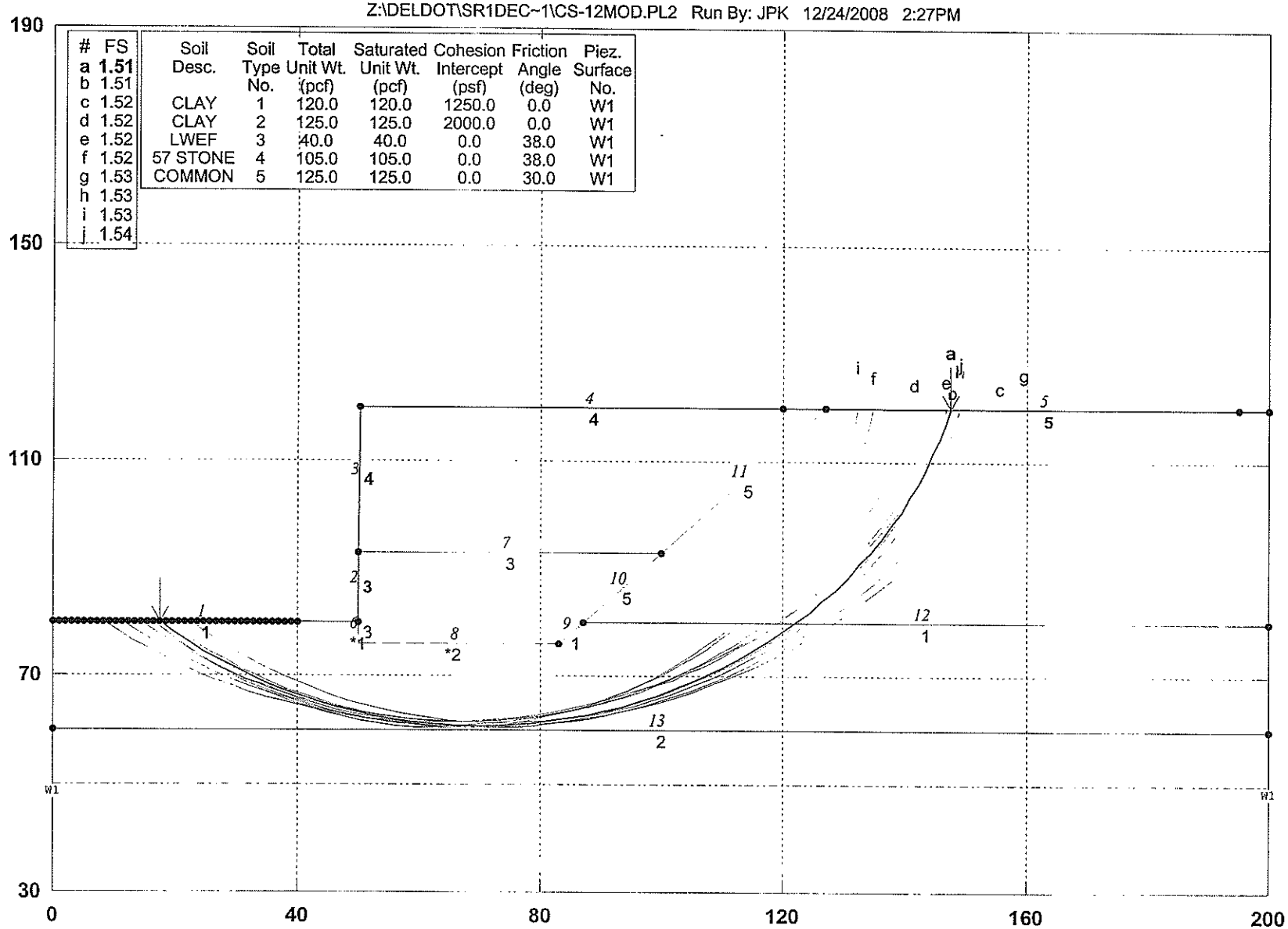
Short term Case (prior to traffic loading)

SR1/I95 Interchange CS-12 Unconsolidated Undrained

Z:\DELDOT\SR1DEC~1\CS-12MOD.PL2 Run By: JPK 12/24/2008 2:27PM

#	FS
a	1.51
b	1.51
c	1.52
d	1.52
e	1.52
f	1.52
g	1.53
h	1.53
i	1.53
j	1.54

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	1250.0	0.0	W1
CLAY	2	125.0	125.0	2000.0	0.0	W1
LWEF	3	40.0	40.0	0.0	38.0	W1
57 STONE	4	105.0	105.0	0.0	38.0	W1
COMMON	5	125.0	125.0	0.0	30.0	W1



GSTABL7 FSmin=1.51

Safety Factors Are Calculated By The Modified Bishop Method

STED

Short-term Case (after traffic loading)

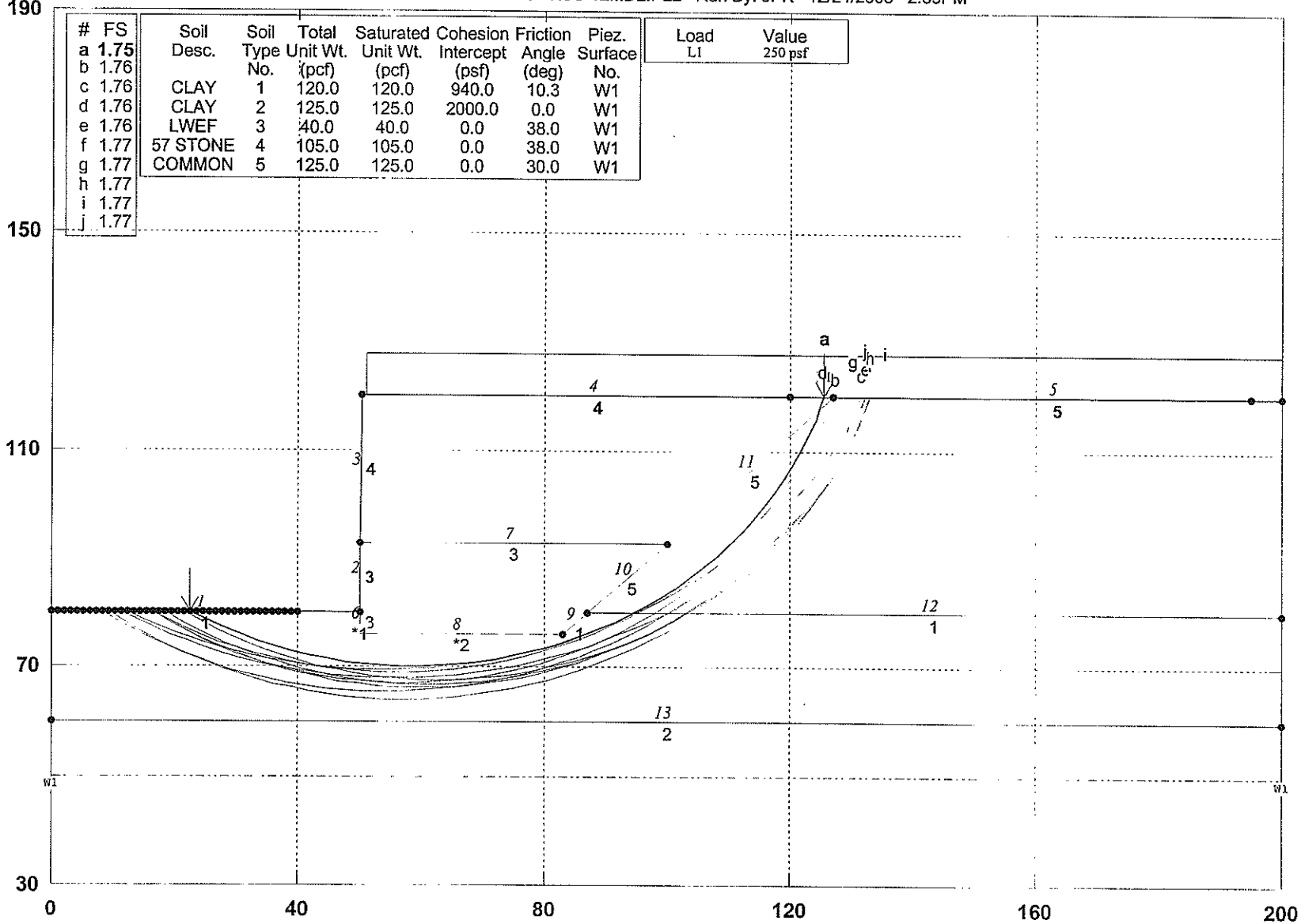
SR1/I95 Interchange CS-12 Consolidated Undrained

Z:\DELDOT\SR1DEC~1\CS-12MD2.PL2 Run By: JPK 12/24/2008 2:33PM

#	FS
a	1.75
b	1.76
c	1.76
d	1.76
e	1.76
f	1.77
g	1.77
h	1.77
i	1.77
j	1.77

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	940.0	10.3	W1
CLAY	2	125.0	125.0	2000.0	0.0	W1
LWEF	3	40.0	40.0	0.0	38.0	W1
57 STONE	4	105.0	105.0	0.0	38.0	W1
COMMON	5	125.0	125.0	0.0	30.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.75

Safety Factors Are Calculated By The Modified Bishop Method

STED

Long-term Case

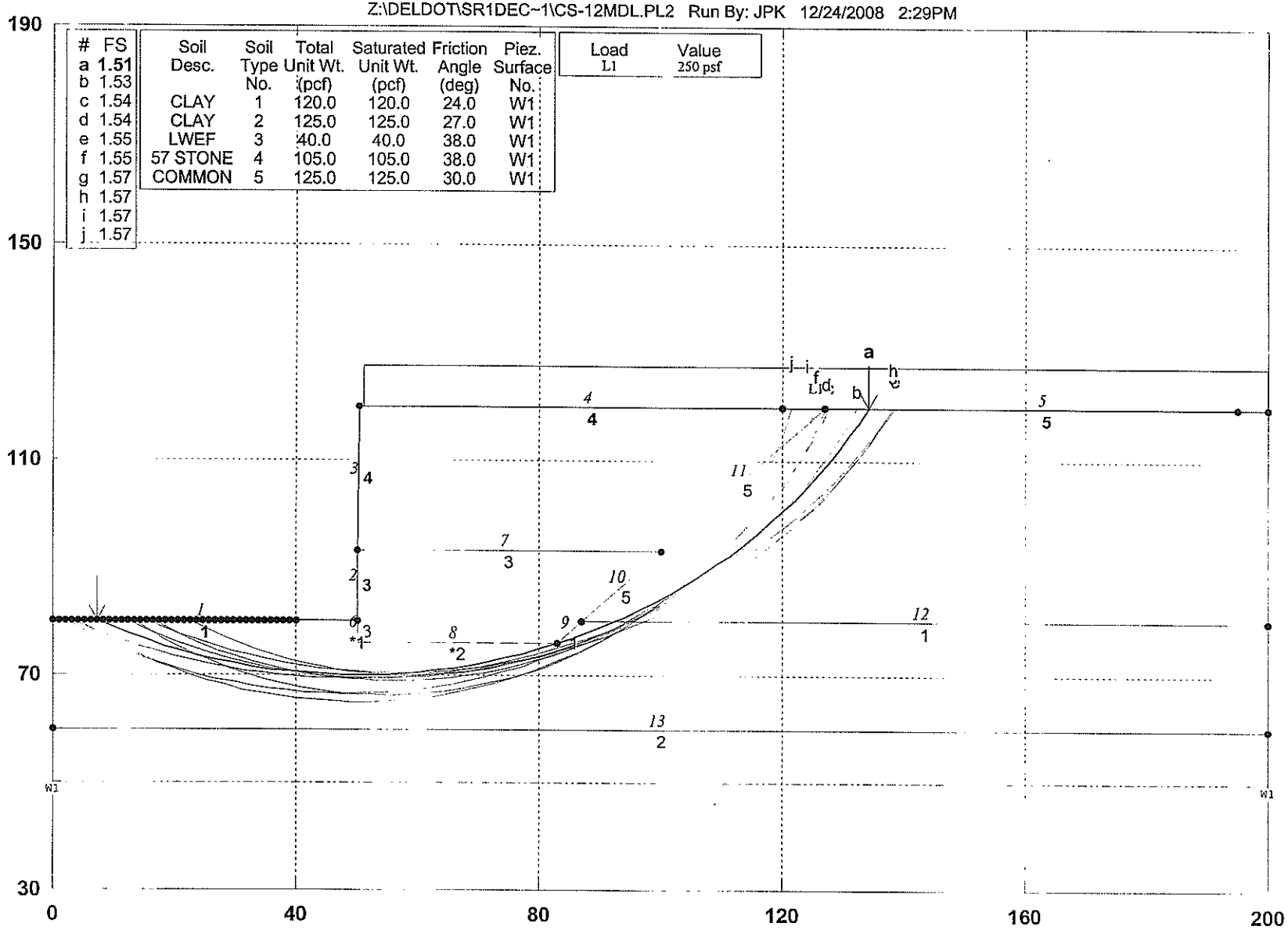
SR1/I95 Interchange CS-12 Long-Term

Z:\DELDOT\SR1DEC~1\CS-12MDL.PL2 Run By: JPK 12/24/2008 2:29PM

#	FS
a	1.51
b	1.53
c	1.54
d	1.54
e	1.55
f	1.55
g	1.57
h	1.57
i	1.57
j	1.57

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	24.0	W1
CLAY	2	125.0	125.0	27.0	W1
LWEF	3	40.0	40.0	38.0	W1
57 STONE	4	105.0	105.0	38.0	W1
COMMON	5	125.0	125.0	30.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.51

Safety Factors Are Calculated By The Modified Bishop Method

STED

Axial Capacity

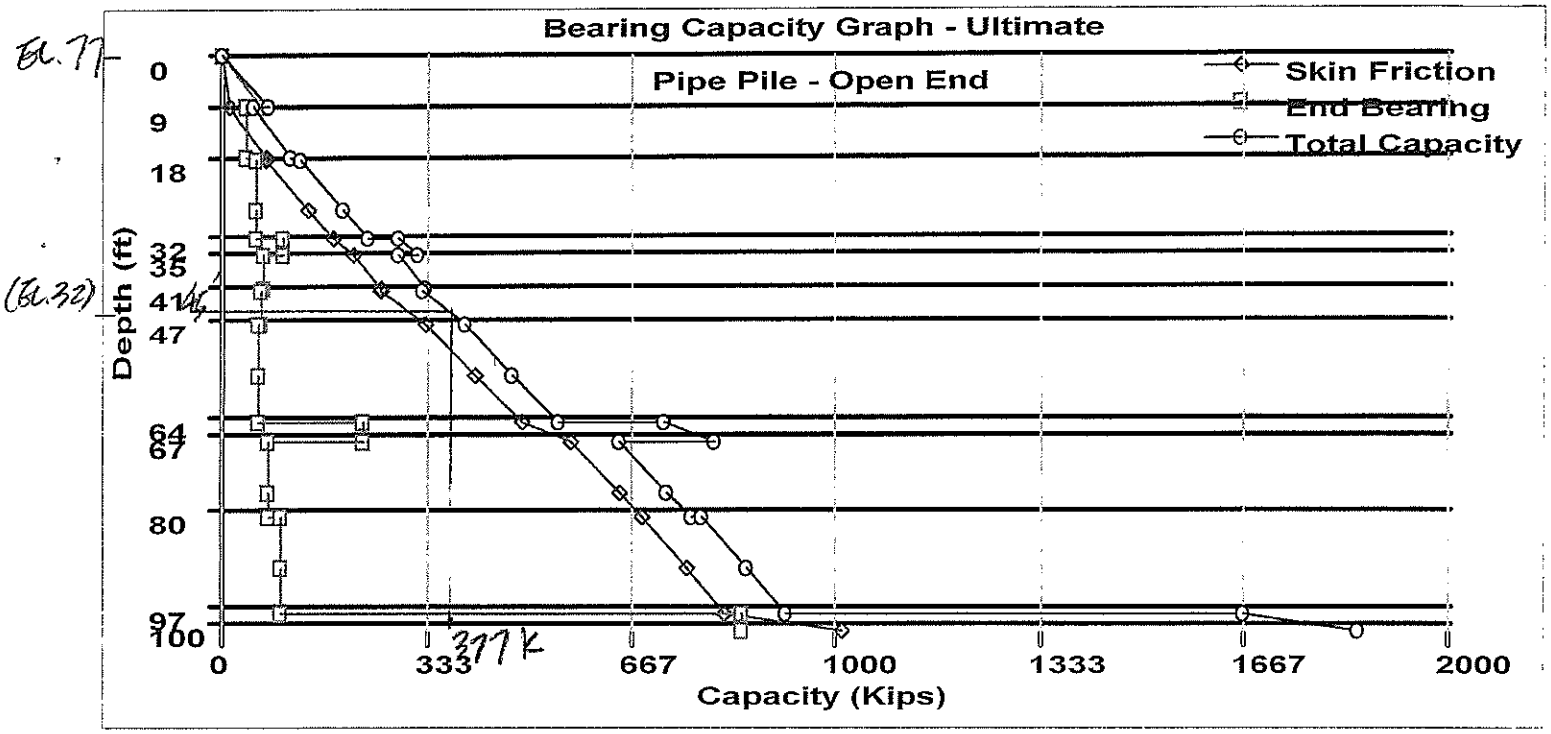
DelDOT SR1 / I-95 Interchange
Preliminary Pile Estimate

16-Dec-08

Location	Foundation	Required Factored Resistance, kip	Nominal Resistance, kip	Size of Pipe Pile		Estimated Pile Tip El.
				Diameter, in.	Wall in.	
S2-Ramp A Over SR 7	Abut A	245	377	24	0.5	32
	Pier 1	680	1046	30	0.625	-9
	Pier 2	500	769	30	0.625	14
	Pier 3	680	1046	30	0.625	**-18**
	Abut B	245	377	24	0.5	23

* 0.65 Resistance factor. Required capacity factor = 1.54

Filename: Z:\DELDOT\SR1DEC~1\A-R7UTA.DVN RAMP A/SR7 ABUT A 24"Φ 0.5" WALL



REQUIRED CAPACITY = 377 K

EST. PILE TIP = EL. 32

Filename: Z:\DELDOT\SR1DEC~1\A-R7UTA.DVN RAMP A/SR7 ABUT A

Soil Profile BORING IBR-19

0.0 ft	Sand: Unit Weight 115 -- Friction Angles 31/31 -- Driving Loss 0%
6.7 ft	Clay: Unit Weight 110 -- Undrained Shear Strength 1500 -- Driving Loss 0%
13.3 ft	
20.0 ft	Clay: Unit Weight 115 -- Undrained Shear Strength 2000 -- Driving Loss 0%
26.7 ft	
33.3 ft	Sand: Unit Weight 120 -- Friction Angles 32/32 -- Driving Loss 0%
	Clay: Unit Weight 120 -- Undrained Shear Strength 2500 -- Driving Loss 0%
40.0 ft	Sand: Unit Weight 120 -- Friction Angles 31/31 -- Driving Loss 0%
46.7 ft	Clay: Unit Weight 120 -- Undrained Shear Strength 2200 -- Driving Loss 0%
53.3 ft	
60.0 ft	Sand: Unit Weight 125 -- Friction Angles 34/34 -- Driving Loss 0%
66.7 ft	Clay: Unit Weight 120 -- Undrained Shear Strength 2800 -- Driving Loss 0%
73.3 ft	
80.0 ft	Clay: Unit Weight 125 -- Undrained Shear Strength 3500 -- Driving Loss 0%
86.7 ft	
93.3 ft	
100.0 ft	Sand: Unit Weight 130 -- Friction Angles 38/38 -- Driving Loss 0%

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A-R7UTA.DVN
Project Name: SR1 IBR-19 Profile
Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager:

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 24.00 in
Shell Thickness: 0.50 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	30.00 ft
	- Driving/Restrike	30.00 ft
	- Ultimate:	30.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	9.00 ft	0.00%	115.00 pcf	31.0/31.0	Nordlund
2	Cohesive	9.00 ft	0.00%	110.00 pcf	1500.00 psf	T-79 Steel
3	Cohesive	14.00 ft	0.00%	115.00 pcf	2000.00 psf	T-79 Steel
4	Cohesionless	3.00 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund
5	Cohesive	6.00 ft	0.00%	120.00 pcf	2500.00 psf	T-79 Steel
6	Cohesionless	6.00 ft	0.00%	120.00 pcf	31.0/31.0	Nordlund
7	Cohesive	17.00 ft	0.00%	120.00 pcf	2200.00 psf	T-79 Steel
8	Cohesionless	3.00 ft	0.00%	125.00 pcf	34.0/34.0	Nordlund
9	Cohesive	13.00 ft	0.00%	120.00 pcf	2800.00 psf	T-79 Steel
10	Cohesive	17.00 ft	0.00%	125.00 pcf	3500.00 psf	T-79 Steel
11	Cohesionless	3.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.57 psf	26.69	N/A	0.00 Kips
8.99 ft	Cohesionless	516.92 psf	26.69	N/A	13.24 Kips
9.01 ft	Cohesive	N/A	N/A	1060.00 psf	13.34 Kips
17.99 ft	Cohesive	N/A	N/A	1060.00 psf	73.15 Kips
18.01 ft	Cohesive	N/A	N/A	1165.00 psf	73.28 Kips
27.01 ft	Cohesive	N/A	N/A	1205.89 psf	141.48 Kips
31.99 ft	Cohesive	N/A	N/A	1234.94 psf	181.77 Kips
32.01 ft	Cohesionless	3510.49 psf	27.55	N/A	181.96 Kips
34.99 ft	Cohesionless	3596.31 psf	27.55	N/A	215.80 Kips
35.01 ft	Cohesive	N/A	N/A	1131.34 psf	215.98 Kips
40.99 ft	Cohesive	N/A	N/A	1183.66 psf	260.46 Kips
41.01 ft	Cohesionless	4028.89 psf	26.69	N/A	260.65 Kips
46.99 ft	Cohesionless	4201.11 psf	26.69	N/A	332.24 Kips
47.01 ft	Cohesive	N/A	N/A	1327.08 psf	332.45 Kips
56.01 ft	Cohesive	N/A	N/A	1396.08 psf	411.40 Kips
63.99 ft	Cohesive	N/A	N/A	1457.26 psf	487.93 Kips
64.01 ft	Cohesionless	5353.71 psf	27.13	N/A	488.29 Kips
66.99 ft	Cohesionless	5446.99 psf	27.13	N/A	569.40 Kips
67.01 ft	Cohesive	N/A	N/A	1282.55 psf	569.76 Kips
76.01 ft	Cohesive	N/A	N/A	1363.92 psf	646.89 Kips
79.99 ft	Cohesive	N/A	N/A	1399.91 psf	683.94 Kips
80.01 ft	Cohesive	N/A	N/A	1260.00 psf	684.11 Kips
89.01 ft	Cohesive	N/A	N/A	1260.00 psf	755.36 Kips
96.99 ft	Cohesive	N/A	N/A	1260.00 psf	818.54 Kips
97.01 ft	Cohesionless	7354.54 psf	30.32	N/A	819.25 Kips
99.99 ft	Cohesionless	7455.26 psf	30.32	N/A	1009.62 Kips

A-R7UTA-8

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.15 psf	35.20	64.92 Kips	0.08 Kips
8.99 ft	Cohesionless	1033.85 psf	35.20	64.92 Kips	64.92 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
17.99 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
27.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
31.99 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
32.01 ft	Cohesionless	3510.78 psf	40.40	103.67 Kips	103.67 Kips
34.99 ft	Cohesionless	3682.42 psf	40.40	103.67 Kips	103.67 Kips
35.01 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
40.99 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
41.01 ft	Cohesionless	4029.18 psf	35.20	64.92 Kips	64.92 Kips
46.99 ft	Cohesionless	4373.62 psf	35.20	64.92 Kips	64.92 Kips
47.01 ft	Cohesive	N/A	N/A	N/A	62.20 Kips
56.01 ft	Cohesive	N/A	N/A	N/A	62.20 Kips
63.99 ft	Cohesive	N/A	N/A	N/A	62.20 Kips
64.01 ft	Cohesionless	5354.03 psf	55.60	230.97 Kips	230.97 Kips
66.99 ft	Cohesionless	5540.57 psf	55.60	230.97 Kips	230.97 Kips
67.01 ft	Cohesive	N/A	N/A	N/A	79.17 Kips
76.01 ft	Cohesive	N/A	N/A	N/A	79.17 Kips
79.99 ft	Cohesive	N/A	N/A	N/A	79.17 Kips
80.01 ft	Cohesive	N/A	N/A	N/A	98.96 Kips
89.01 ft	Cohesive	N/A	N/A	N/A	98.96 Kips
96.99 ft	Cohesive	N/A	N/A	N/A	98.96 Kips
97.01 ft	Cohesionless	7354.88 psf	110.40	843.83 Kips	843.83 Kips
99.99 ft	Cohesionless	7556.32 psf	110.40	843.83 Kips	843.83 Kips

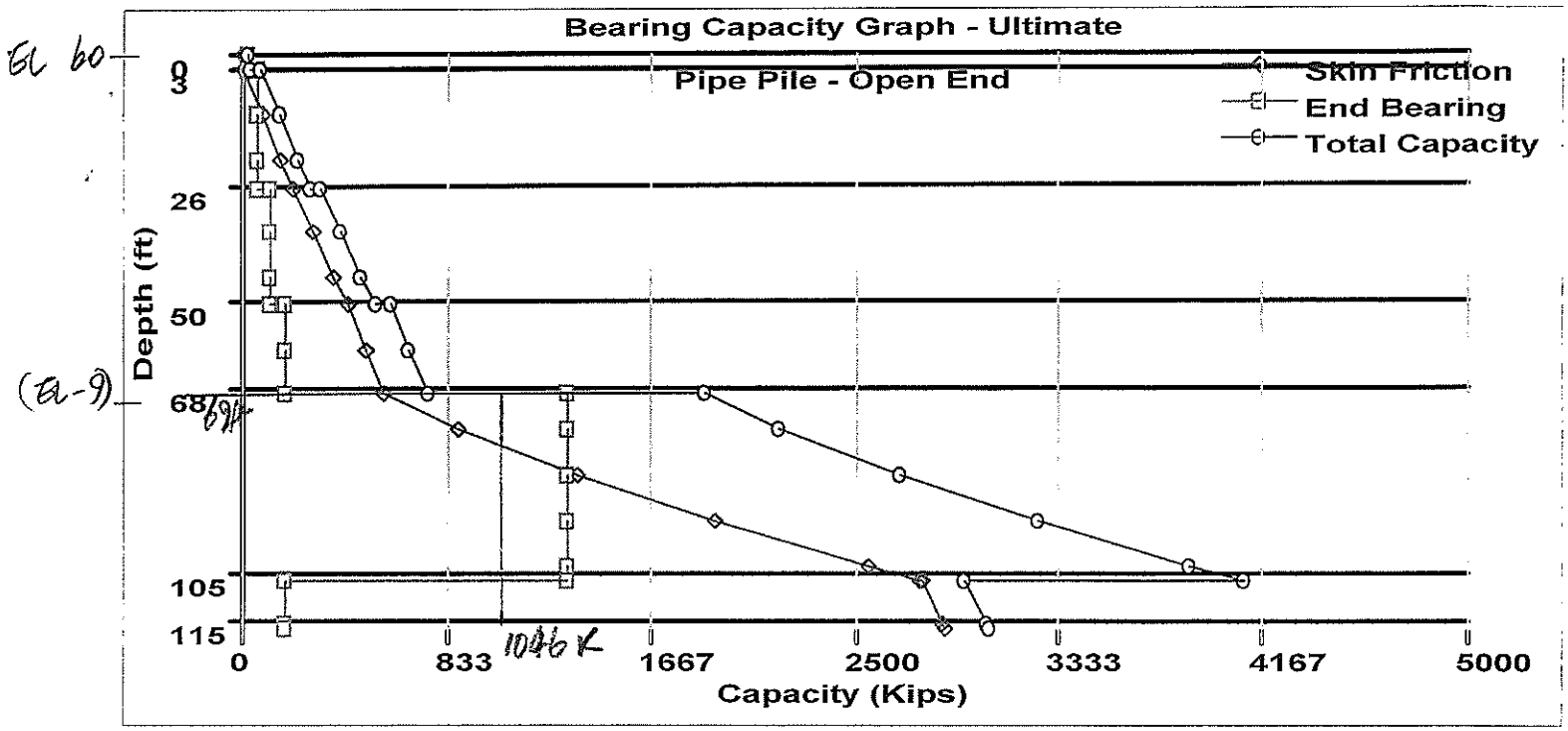
A-R7UTA-9

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.08 Kips	0.08 Kips
8.99 ft	13.24 Kips	64.92 Kips	78.16 Kips
9.01 ft	13.34 Kips	42.41 Kips	55.75 Kips
17.99 ft	73.15 Kips	42.41 Kips	115.56 Kips
18.01 ft	73.28 Kips	56.55 Kips	129.83 Kips
27.01 ft	141.48 Kips	56.55 Kips	198.03 Kips
31.99 ft	181.77 Kips	56.55 Kips	238.31 Kips
32.01 ft	181.96 Kips	103.67 Kips	285.63 Kips
34.99 ft	215.80 Kips	103.67 Kips	319.47 Kips
35.01 ft	215.98 Kips	70.69 Kips	286.67 Kips
40.99 ft	260.46 Kips	70.69 Kips	331.15 Kips
41.01 ft	260.65 Kips	64.92 Kips	325.57 Kips
46.99 ft	332.24 Kips	64.92 Kips	397.16 Kips
47.01 ft	332.45 Kips	62.20 Kips	394.65 Kips
56.01 ft	411.40 Kips	62.20 Kips	473.60 Kips
63.99 ft	487.93 Kips	62.20 Kips	550.13 Kips
64.01 ft	488.29 Kips	230.97 Kips	719.26 Kips
66.99 ft	569.40 Kips	230.97 Kips	800.37 Kips
67.01 ft	569.76 Kips	79.17 Kips	648.93 Kips
76.01 ft	646.89 Kips	79.17 Kips	726.06 Kips
79.99 ft	683.94 Kips	79.17 Kips	763.11 Kips
80.01 ft	684.11 Kips	98.96 Kips	783.07 Kips
89.01 ft	755.36 Kips	98.96 Kips	854.32 Kips
96.99 ft	818.54 Kips	98.96 Kips	917.50 Kips
97.01 ft	819.25 Kips	843.83 Kips	1663.08 Kips
99.99 ft	1009.62 Kips	843.83 Kips	1853.45 Kips

A-R7UTA-10

Filename: Z:\DELDOT\SR1DEC~1\A-R7P1A.DVN RAMP A/SR 7 PIER 1 36"Φ 0.625" WALL

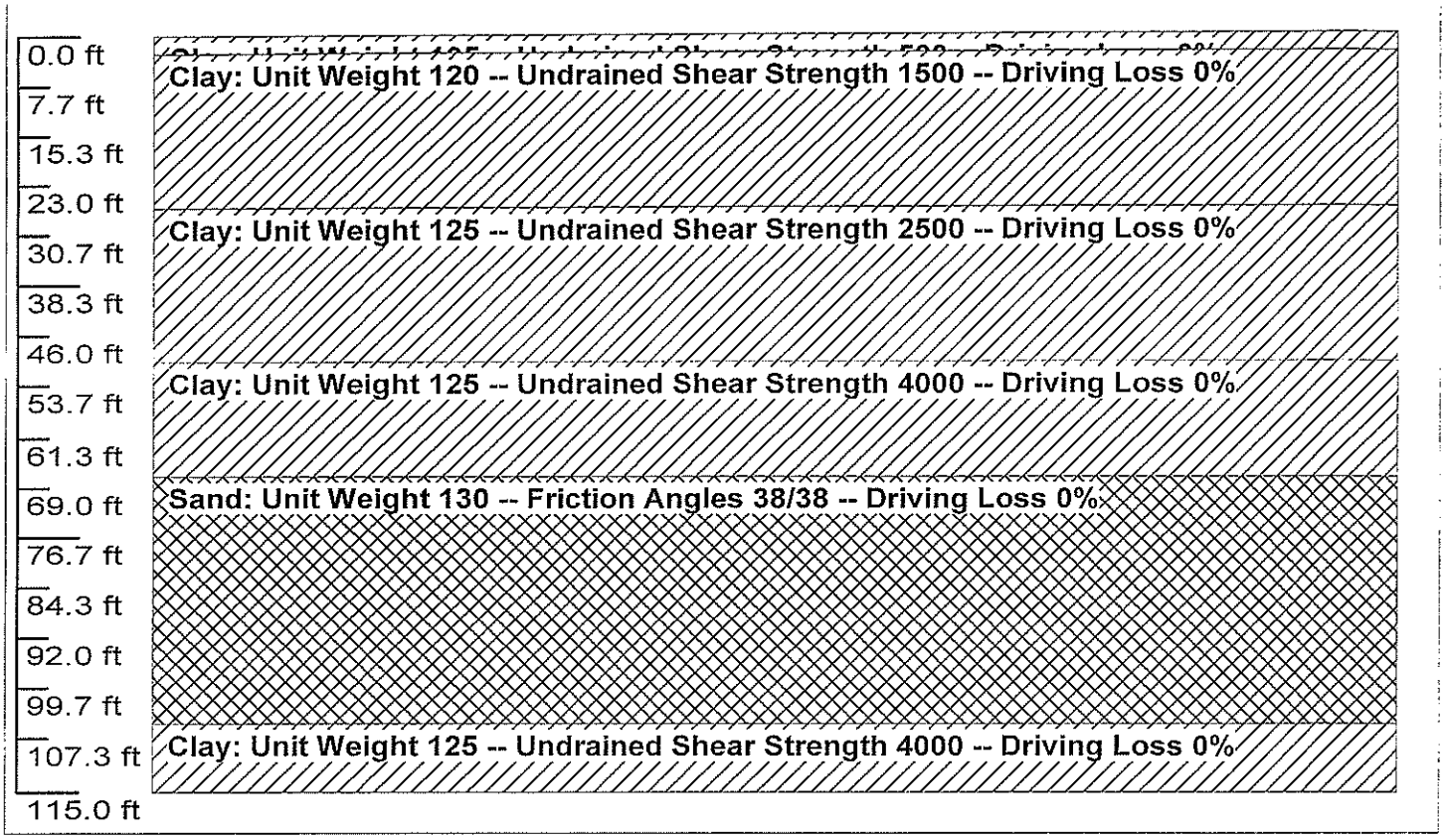


REQUIRED CAPACITY = 1046K
EST PILE TIP = EL.-9

NOTE: PILE PROBABLY DRIVEABLE TO 74±ft OR EL. -14 ±
(FOR DRIVEABILITY ASSESSMENT)

Filename: Z:\DELDOT\SR1DEC~1\A-R7P1A.DVN RAMP A/SR7 PIER 1

Soil Profile BORING IBR-23



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A-R7P1A.DVN
Project Name: Ramp A / SR7 Pier 1 Project Date: 12/05/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-23 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 30.00 in
Shell Thickness: 0.62 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.00 ft	0.00%	105.00 pcf	500.00 psf	T-79 Steel
2	Cohesive	23.50 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
3	Cohesive	23.50 ft	0.00%	125.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	17.50 ft	0.00%	125.00 pcf	4000.00 psf	T-79 Steel
5	Cohesionless	37.50 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund
6	Cohesive	10.00 ft	0.00%	125.00 pcf	4000.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	410.00 psf	0.03 Kips
2.99 ft	Cohesive	N/A	N/A	410.00 psf	9.63 Kips
3.01 ft	Cohesive	N/A	N/A	1060.00 psf	9.74 Kips
12.01 ft	Cohesive	N/A	N/A	1060.00 psf	84.67 Kips
21.01 ft	Cohesive	N/A	N/A	1060.00 psf	159.60 Kips
26.49 ft	Cohesive	N/A	N/A	1064.67 psf	206.08 Kips
26.51 ft	Cohesive	N/A	N/A	1010.57 psf	206.25 Kips
35.51 ft	Cohesive	N/A	N/A	1073.57 psf	282.14 Kips
44.51 ft	Cohesive	N/A	N/A	1136.57 psf	366.94 Kips
49.99 ft	Cohesive	N/A	N/A	1174.93 psf	422.93 Kips
50.01 ft	Cohesive	N/A	N/A	933.40 psf	423.11 Kips
59.01 ft	Cohesive	N/A	N/A	992.20 psf	493.25 Kips
67.49 ft	Cohesive	N/A	N/A	1047.60 psf	566.94 Kips
67.51 ft	Cohesionless	4048.34 psf	35.46	N/A	567.41 Kips
74.99 ft	Cohesionless	4301.16 psf	35.46	N/A	864.25 Kips
75.01 ft	Cohesionless	4555.34 psf	30.32	N/A	865.19 Kips
84.01 ft	Cohesionless	4859.54 psf	30.32	N/A	1364.45 Kips
93.01 ft	Cohesionless	5163.74 psf	30.32	N/A	1926.21 Kips
102.01 ft	Cohesionless	5467.94 psf	30.32	N/A	2550.47 Kips
104.99 ft	Cohesionless	5568.66 psf	30.32	N/A	2770.95 Kips
105.01 ft	Cohesive	N/A	N/A	1260.00 psf	2771.80 Kips
114.01 ft	Cohesive	N/A	N/A	1260.00 psf	2860.86 Kips
114.99 ft	Cohesive	N/A	N/A	1260.00 psf	2870.56 Kips

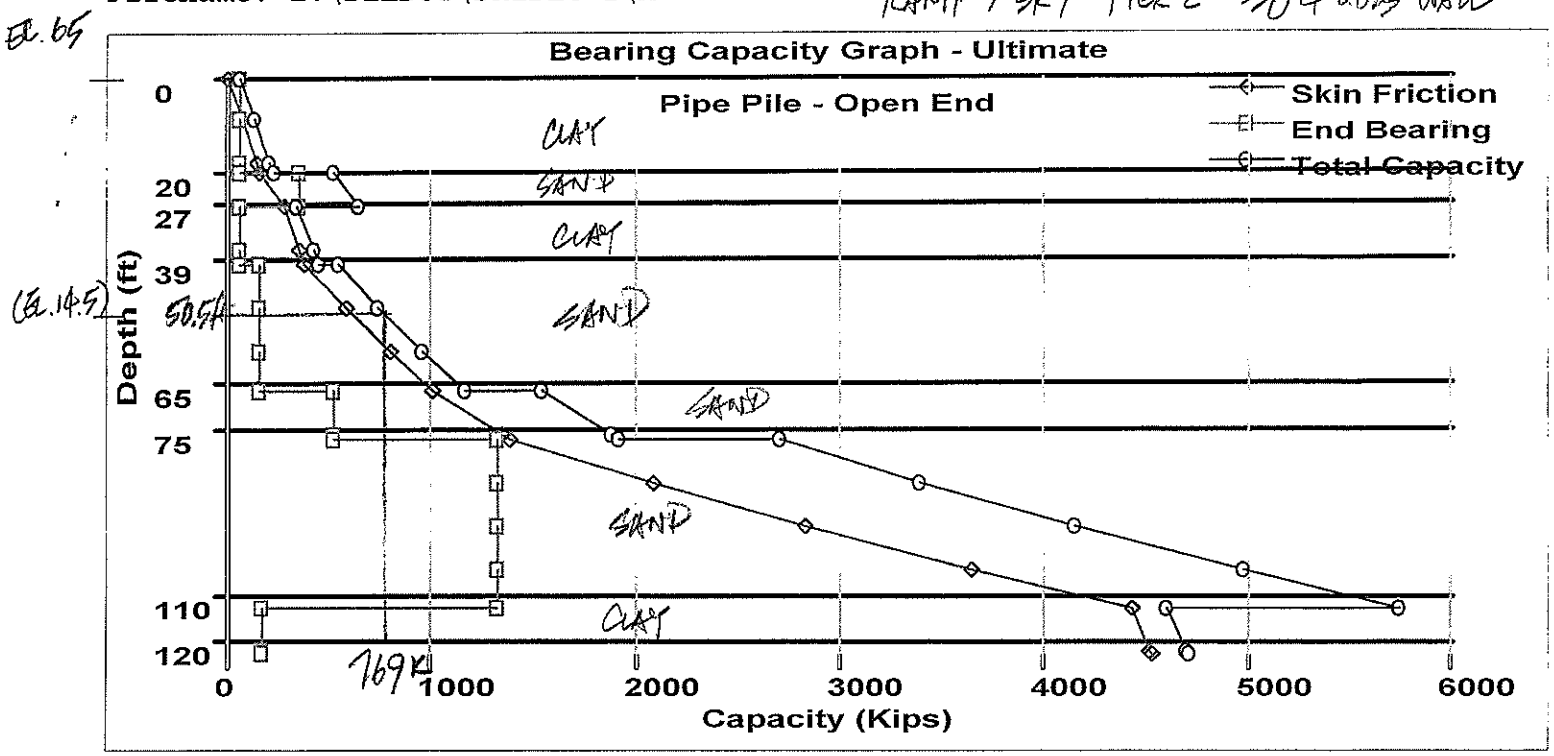
ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	22.09 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	22.09 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
12.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
21.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
26.49 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
26.51 ft	Cohesive	N/A	N/A	N/A	110.45 Kips
35.51 ft	Cohesive	N/A	N/A	N/A	110.45 Kips
44.51 ft	Cohesive	N/A	N/A	N/A	110.45 Kips
49.99 ft	Cohesive	N/A	N/A	N/A	110.45 Kips
50.01 ft	Cohesive	N/A	N/A	N/A	176.71 Kips
59.01 ft	Cohesive	N/A	N/A	N/A	176.71 Kips
67.49 ft	Cohesive	N/A	N/A	N/A	176.71 Kips
67.51 ft	Cohesionless	4048.68 psf	110.40	1318.49 Kips	1318.49 Kips
74.99 ft	Cohesionless	4554.32 psf	110.40	1318.49 Kips	1318.49 Kips
75.01 ft	Cohesionless	4555.68 psf	110.40	1318.49 Kips	1318.49 Kips
84.01 ft	Cohesionless	5164.08 psf	110.40	1318.49 Kips	1318.49 Kips
93.01 ft	Cohesionless	5772.48 psf	110.40	1318.49 Kips	1318.49 Kips
102.01 ft	Cohesionless	6380.88 psf	110.40	1318.49 Kips	1318.49 Kips
104.99 ft	Cohesionless	6582.32 psf	110.40	1318.49 Kips	1318.49 Kips
105.01 ft	Cohesive	N/A	N/A	N/A	176.71 Kips
114.01 ft	Cohesive	N/A	N/A	N/A	176.71 Kips
114.99 ft	Cohesive	N/A	N/A	N/A	176.71 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.03 Kips	22.09 Kips	22.12 Kips
2.99 ft	9.63 Kips	22.09 Kips	31.72 Kips
3.01 ft	9.74 Kips	66.27 Kips	76.01 Kips
12.01 ft	84.67 Kips	66.27 Kips	150.94 Kips
21.01 ft	159.60 Kips	66.27 Kips	225.87 Kips
26.49 ft	206.08 Kips	66.27 Kips	272.35 Kips
26.51 ft	206.25 Kips	110.45 Kips	316.70 Kips
35.51 ft	282.14 Kips	110.45 Kips	392.59 Kips
44.51 ft	366.94 Kips	110.45 Kips	477.38 Kips
49.99 ft	422.93 Kips	110.45 Kips	533.38 Kips
50.01 ft	423.11 Kips	176.71 Kips	599.83 Kips
59.01 ft	493.25 Kips	176.71 Kips	669.96 Kips
67.49 ft	566.94 Kips	176.71 Kips	743.66 Kips
67.51 ft	567.41 Kips	1318.49 Kips	1885.89 Kips
74.99 ft	864.25 Kips	1318.49 Kips	2182.74 Kips
75.01 ft	865.19 Kips	1318.49 Kips	2183.68 Kips
84.01 ft	1364.45 Kips	1318.49 Kips	2682.94 Kips
93.01 ft	1926.21 Kips	1318.49 Kips	3244.70 Kips
102.01 ft	2550.47 Kips	1318.49 Kips	3868.96 Kips
104.99 ft	2770.95 Kips	1318.49 Kips	4089.43 Kips
105.01 ft	2771.80 Kips	176.71 Kips	2948.51 Kips
114.01 ft	2860.86 Kips	176.71 Kips	3037.58 Kips
114.99 ft	2870.56 Kips	176.71 Kips	3047.27 Kips

Filename: Z:\DELDOT\SR1DEC~1\A-R7P2.DVN RAMP / SR7 PIER 2 30" ϕ 0.625" WALL

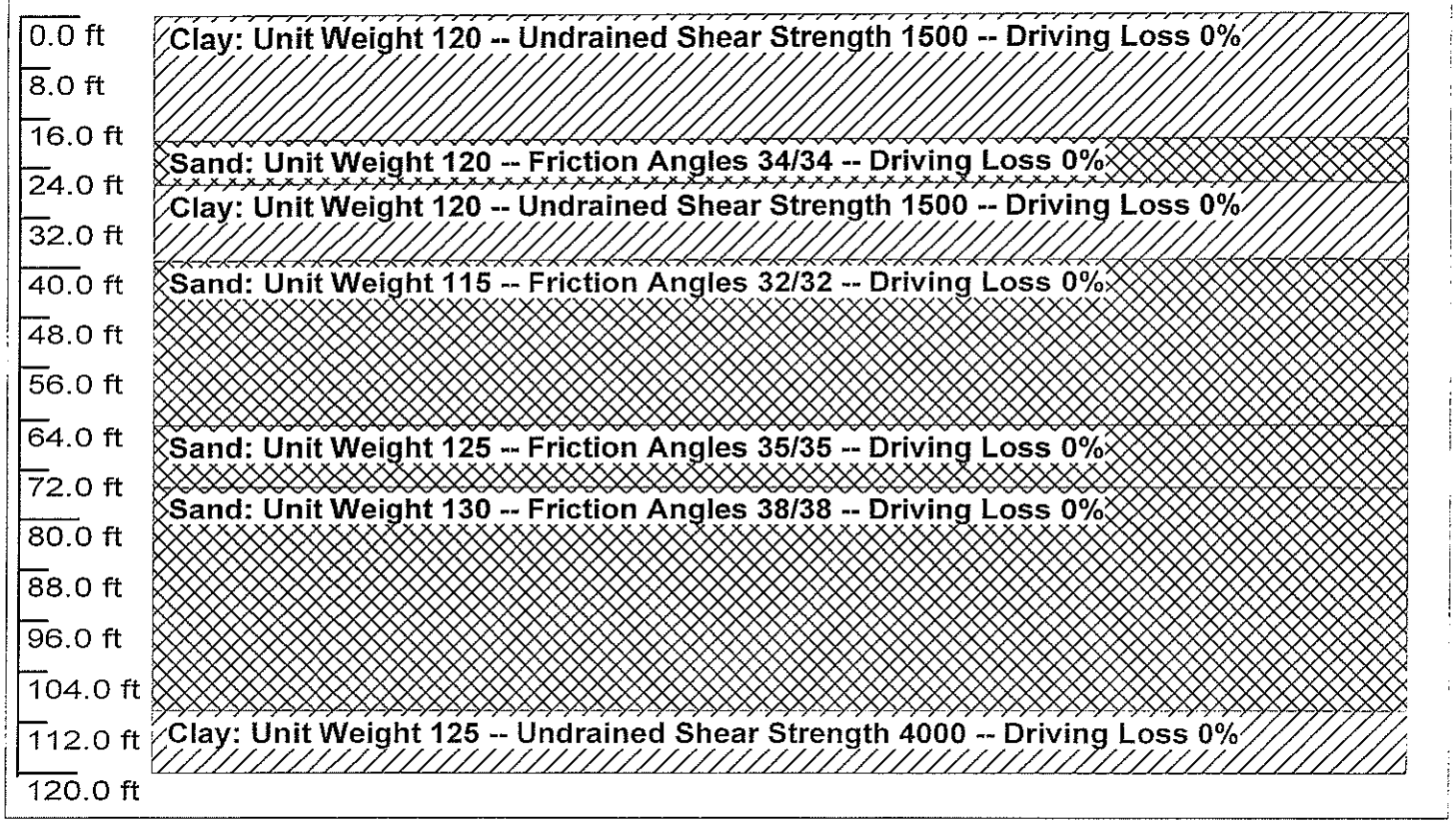


REQUIRED CAPACITY = 769 K

EST. PILE TIP = EL. 14

Filename: Z:\DELDOT\SR1DEC~1\A-R7P2.DVN RAMP A/SR7 PIER 2

Soil Profile BORING IBR-16



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A-R7P2.DVN
Project Name: Ramp A / SR7 Pier 2 Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-16 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 30.00 in
Shell Thickness: 0.62 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	35.00 ft
	- Driving/Restrike	35.00 ft
	- Ultimate:	35.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	20.00 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
2	Cohesionless	7.00 ft	0.00%	120.00 pcf	34.0/34.0	Nordlund
3	Cohesive	12.00 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
4	Cohesionless	26.00 ft	0.00%	115.00 pcf	32.0/32.0	Nordlund
5	Cohesionless	10.00 ft	0.00%	125.00 pcf	35.0/35.0	Nordlund
6	Cohesionless	35.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund
7	Cohesive	10.00 ft	0.00%	125.00 pcf	4000.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1060.00 psf	0.08 Kips
9.01 ft	Cohesive	N/A	N/A	1060.00 psf	75.01 Kips
18.01 ft	Cohesive	N/A	N/A	1060.00 psf	149.94 Kips
19.99 ft	Cohesive	N/A	N/A	1060.00 psf	166.42 Kips
20.01 ft	Cohesionless	2400.60 psf	31.73	N/A	166.64 Kips
26.99 ft	Cohesionless	2819.40 psf	31.73	N/A	278.64 Kips
27.01 ft	Cohesive	N/A	N/A	1066.30 psf	278.91 Kips
36.01 ft	Cohesive	N/A	N/A	1094.50 psf	356.28 Kips
38.99 ft	Cohesive	N/A	N/A	1103.84 psf	382.78 Kips
39.01 ft	Cohesionless	4430.66 psf	29.86	N/A	383.07 Kips
48.01 ft	Cohesionless	4667.36 psf	29.86	N/A	579.31 Kips
57.01 ft	Cohesionless	4904.06 psf	29.86	N/A	795.45 Kips
64.99 ft	Cohesionless	5113.94 psf	29.86	N/A	1003.74 Kips
65.01 ft	Cohesionless	5798.31 psf	32.66	N/A	1004.38 Kips
74.01 ft	Cohesionless	6080.01 psf	32.66	N/A	1345.04 Kips
74.99 ft	Cohesionless	6110.69 psf	32.66	N/A	1384.04 Kips
75.01 ft	Cohesionless	6424.34 psf	30.32	N/A	1385.17 Kips
84.01 ft	Cohesionless	6728.54 psf	30.32	N/A	2076.44 Kips
93.01 ft	Cohesionless	7032.74 psf	30.32	N/A	2830.20 Kips
102.01 ft	Cohesionless	7336.94 psf	30.32	N/A	3646.47 Kips
109.99 ft	Cohesionless	7606.66 psf	30.32	N/A	4422.50 Kips
110.01 ft	Cohesive	N/A	N/A	1260.00 psf	4423.60 Kips
119.01 ft	Cohesive	N/A	N/A	1260.00 psf	4512.66 Kips
119.99 ft	Cohesive	N/A	N/A	1260.00 psf	4522.36 Kips

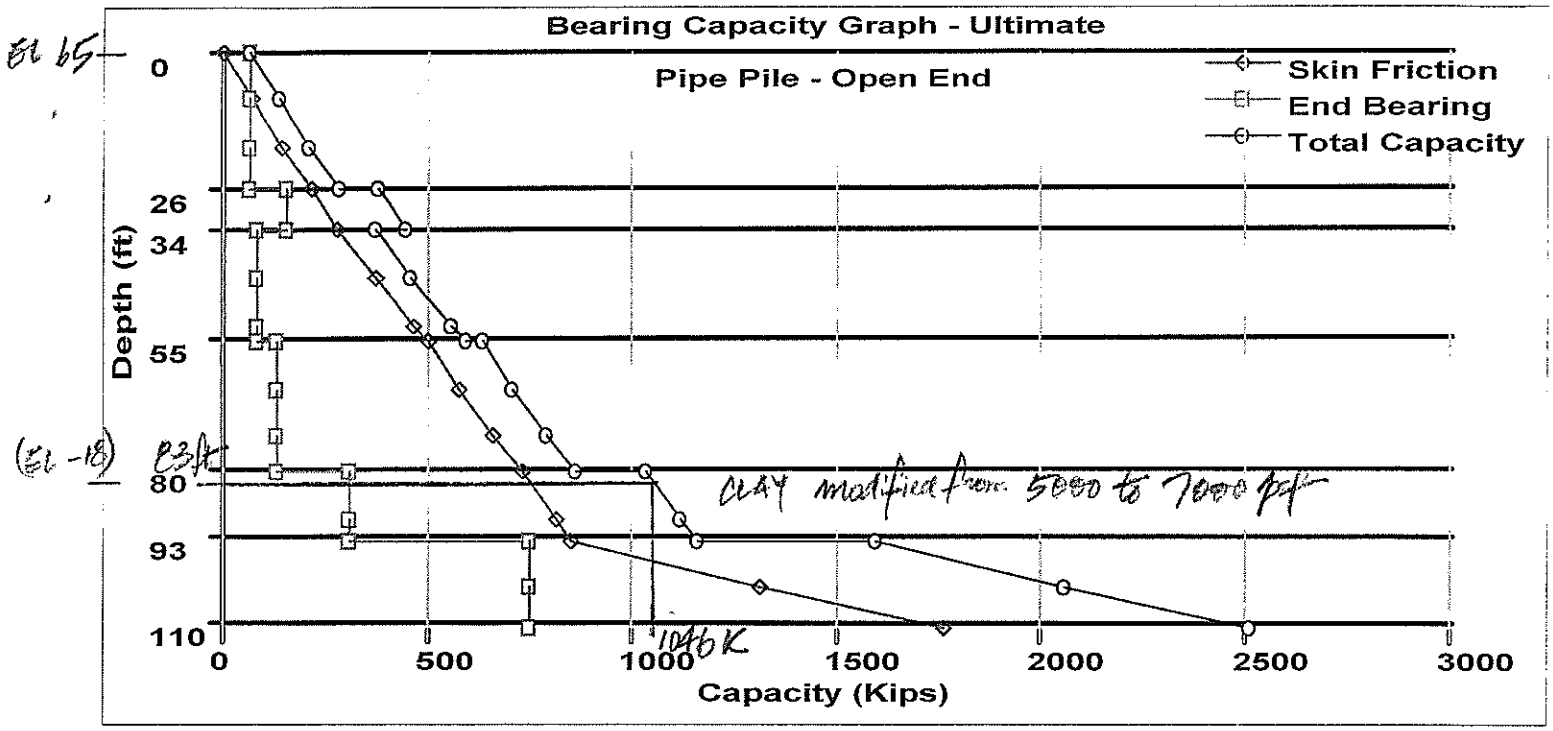
ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
19.99 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
20.01 ft	Cohesionless	2401.20 psf	55.60	360.89 Kips	360.89 Kips
26.99 ft	Cohesionless	3238.80 psf	55.60	360.89 Kips	360.89 Kips
27.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
36.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
38.99 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
39.01 ft	Cohesionless	4430.93 psf	40.40	161.99 Kips	161.99 Kips
48.01 ft	Cohesionless	4904.33 psf	40.40	161.99 Kips	161.99 Kips
57.01 ft	Cohesionless	5377.73 psf	40.40	161.99 Kips	161.99 Kips
64.99 ft	Cohesionless	5797.47 psf	40.40	161.99 Kips	161.99 Kips
65.01 ft	Cohesionless	5798.63 psf	64.00	528.18 Kips	528.18 Kips
74.01 ft	Cohesionless	6362.03 psf	64.00	528.18 Kips	528.18 Kips
74.99 ft	Cohesionless	6423.37 psf	64.00	528.18 Kips	528.18 Kips
75.01 ft	Cohesionless	6424.68 psf	110.40	1318.49 Kips	1318.49 Kips
84.01 ft	Cohesionless	7033.08 psf	110.40	1318.49 Kips	1318.49 Kips
93.01 ft	Cohesionless	7641.48 psf	110.40	1318.49 Kips	1318.49 Kips
102.01 ft	Cohesionless	8249.88 psf	110.40	1318.49 Kips	1318.49 Kips
109.99 ft	Cohesionless	8789.32 psf	110.40	1318.49 Kips	1318.49 Kips
110.01 ft	Cohesive	N/A	N/A	N/A	176.71 Kips
119.01 ft	Cohesive	N/A	N/A	N/A	176.71 Kips
119.99 ft	Cohesive	N/A	N/A	N/A	176.71 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.08 Kips	66.27 Kips	66.35 Kips
9.01 ft	75.01 Kips	66.27 Kips	141.28 Kips
18.01 ft	149.94 Kips	66.27 Kips	216.21 Kips
19.99 ft	166.42 Kips	66.27 Kips	232.69 Kips
20.01 ft	166.64 Kips	360.89 Kips	527.53 Kips
26.99 ft	278.64 Kips	360.89 Kips	639.53 Kips
27.01 ft	278.91 Kips	66.27 Kips	345.18 Kips
36.01 ft	356.28 Kips	66.27 Kips	422.55 Kips
38.99 ft	382.78 Kips	66.27 Kips	449.04 Kips
39.01 ft	383.07 Kips	161.99 Kips	545.06 Kips
48.01 ft	579.31 Kips	161.99 Kips	741.30 Kips
57.01 ft	795.45 Kips	161.99 Kips	957.44 Kips
64.99 ft	1003.74 Kips	161.99 Kips	1165.73 Kips
65.01 ft	1004.38 Kips	528.18 Kips	1532.56 Kips
74.01 ft	1345.04 Kips	528.18 Kips	1873.22 Kips
74.99 ft	1384.04 Kips	528.18 Kips	1912.22 Kips
75.01 ft	1385.17 Kips	1318.49 Kips	2703.66 Kips
84.01 ft	2076.44 Kips	1318.49 Kips	3394.92 Kips
93.01 ft	2830.20 Kips	1318.49 Kips	4148.69 Kips
102.01 ft	3646.47 Kips	1318.49 Kips	4964.95 Kips
109.99 ft	4422.50 Kips	1318.49 Kips	5740.98 Kips
110.01 ft	4423.60 Kips	176.71 Kips	4600.31 Kips
119.01 ft	4512.66 Kips	176.71 Kips	4689.38 Kips
119.99 ft	4522.36 Kips	176.71 Kips	4699.08 Kips

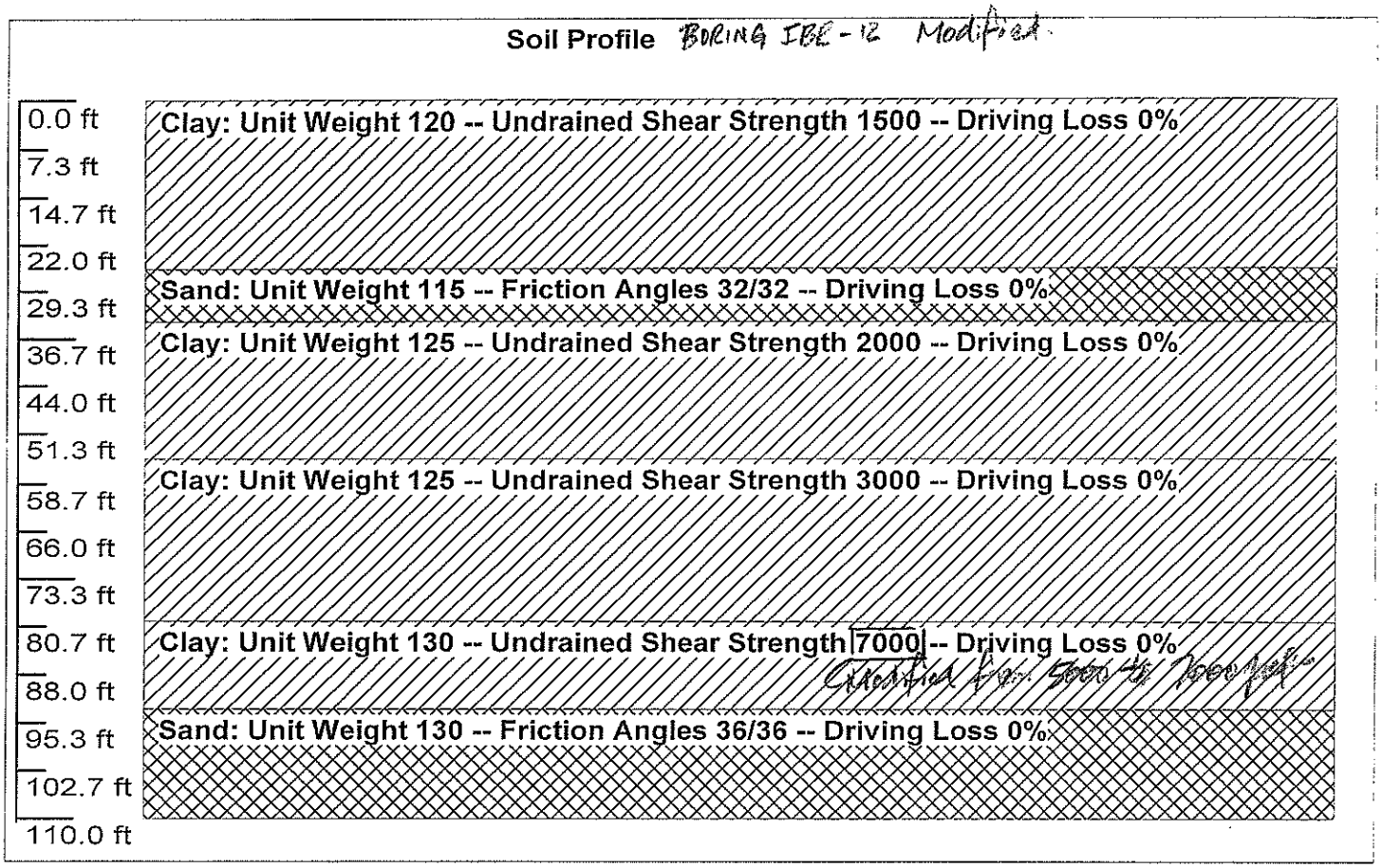
Filename: Z:\DELDOT\SR1DEC~1\A-R7P3B.DVN RAMP A / SR 7 PIER 3 30" ϕ, 0.625" WALL



REQUIRED CAPACITY = 1046 K
EST. PILE TIP = EL. -18

Filename: Z:\DELDOT\SR1DEC~1\A-R7P3B.DVN RAMP A/SR7 PIER 3

Soil Profile BORING IBE-12 Modified.



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A-R7P3B.DVN
Project Name: Ramp A / SR7 Pier 3 Project Date: 12/16/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-12 Profile modify

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 30.00 in
Shell Thickness: 0.62 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	26.00 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
2	Cohesionless	8.00 ft	0.00%	115.00 pcf	32.0/32.0	Nordlund
3	Cohesive	21.00 ft	0.00%	125.00 pcf	2000.00 psf	T-79 Steel
4	Cohesive	25.00 ft	0.00%	125.00 pcf	3000.00 psf	T-79 Steel
5	Cohesive	13.00 ft	0.00%	130.00 pcf	7000.00 psf	T-79 Steel
6	Cohesionless	17.00 ft	0.00%	130.00 pcf	36.0/36.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1060.00 psf	0.08 Kips
9.01 ft	Cohesive	N/A	N/A	1060.00 psf	75.01 Kips
18.01 ft	Cohesive	N/A	N/A	1060.00 psf	149.94 Kips
25.99 ft	Cohesive	N/A	N/A	1063.10 psf	217.01 Kips
26.01 ft	Cohesionless	1497.86 psf	29.86	N/A	217.17 Kips
33.99 ft	Cohesionless	1707.74 psf	29.86	N/A	280.84 Kips
34.01 ft	Cohesive	N/A	N/A	1207.05 psf	281.02 Kips
43.01 ft	Cohesive	N/A	N/A	1249.05 psf	369.31 Kips
52.01 ft	Cohesive	N/A	N/A	1291.05 psf	463.54 Kips
54.99 ft	Cohesive	N/A	N/A	1304.95 psf	496.05 Kips
55.01 ft	Cohesive	N/A	N/A	994.07 psf	496.24 Kips
64.01 ft	Cohesive	N/A	N/A	1055.27 psf	570.84 Kips
73.01 ft	Cohesive	N/A	N/A	1116.47 psf	654.09 Kips
79.99 ft	Cohesive	N/A	N/A	1163.93 psf	724.61 Kips
80.01 ft	Cohesive	N/A	N/A	1129.40 psf	724.80 Kips
89.01 ft	Cohesive	N/A	N/A	1188.20 psf	808.80 Kips
92.99 ft	Cohesive	N/A	N/A	1214.20 psf	848.59 Kips
93.01 ft	Cohesionless	5677.14 psf	28.73	N/A	849.18 Kips
102.01 ft	Cohesionless	5981.34 psf	28.73	N/A	1312.78 Kips
109.99 ft	Cohesionless	6251.06 psf	28.73	N/A	1763.27 Kips

A-R7P3B-8

ULTIMATE - END BEARING

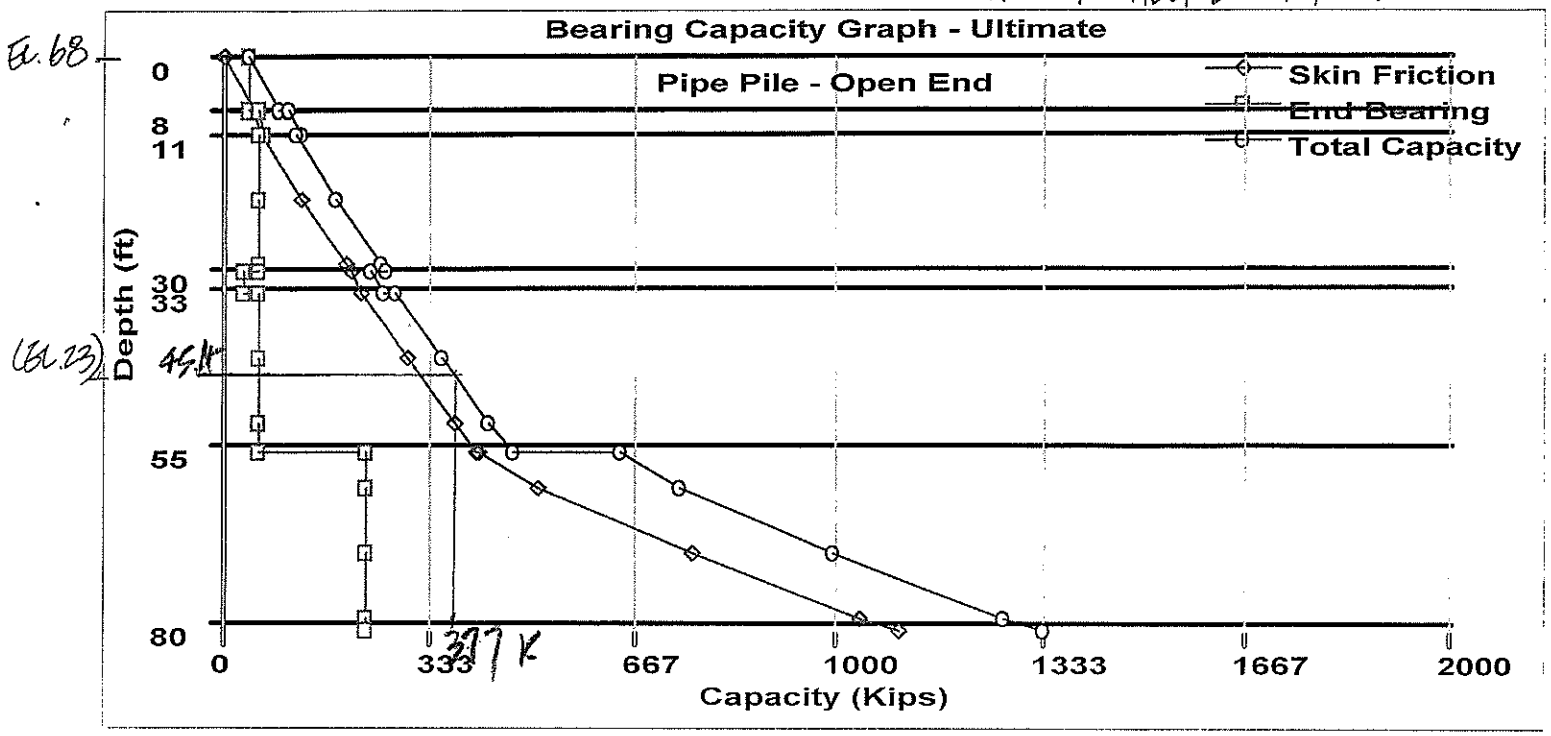
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
25.99 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
26.01 ft	Cohesionless	1498.13 psf	40.40	161.99 Kips	161.99 Kips
33.99 ft	Cohesionless	1917.87 psf	40.40	161.99 Kips	161.99 Kips
34.01 ft	Cohesive	N/A	N/A	N/A	88.36 Kips
43.01 ft	Cohesive	N/A	N/A	N/A	88.36 Kips
52.01 ft	Cohesive	N/A	N/A	N/A	88.36 Kips
54.99 ft	Cohesive	N/A	N/A	N/A	88.36 Kips
55.01 ft	Cohesive	N/A	N/A	N/A	132.54 Kips
64.01 ft	Cohesive	N/A	N/A	N/A	132.54 Kips
73.01 ft	Cohesive	N/A	N/A	N/A	132.54 Kips
79.99 ft	Cohesive	N/A	N/A	N/A	132.54 Kips
80.01 ft	Cohesive	N/A	N/A	N/A	309.25 Kips
89.01 ft	Cohesive	N/A	N/A	N/A	309.25 Kips
92.99 ft	Cohesive	N/A	N/A	N/A	309.25 Kips
93.01 ft	Cohesionless	5677.48 psf	77.60	744.16 Kips	744.16 Kips
102.01 ft	Cohesionless	6285.88 psf	77.60	744.16 Kips	744.16 Kips
109.99 ft	Cohesionless	6825.32 psf	77.60	744.16 Kips	744.16 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.08 Kips	66.27 Kips	66.35 Kips
9.01 ft	75.01 Kips	66.27 Kips	141.28 Kips
18.01 ft	149.94 Kips	66.27 Kips	216.21 Kips
25.99 ft	217.01 Kips	66.27 Kips	283.27 Kips
26.01 ft	217.17 Kips	161.99 Kips	379.15 Kips
33.99 ft	280.84 Kips	161.99 Kips	442.82 Kips
34.01 ft	281.02 Kips	88.36 Kips	369.38 Kips
43.01 ft	369.31 Kips	88.36 Kips	457.67 Kips
52.01 ft	463.54 Kips	88.36 Kips	551.90 Kips
54.99 ft	496.05 Kips	88.36 Kips	584.41 Kips
55.01 ft	496.24 Kips	132.54 Kips	628.78 Kips
64.01 ft	570.84 Kips	132.54 Kips	703.37 Kips
73.01 ft	654.09 Kips	132.54 Kips	786.62 Kips
79.99 ft	724.61 Kips	132.54 Kips	857.15 Kips
80.01 ft	724.80 Kips	309.25 Kips	1034.05 Kips
89.01 ft	808.80 Kips	309.25 Kips	1118.05 Kips
92.99 ft	848.59 Kips	309.25 Kips	1157.84 Kips
93.01 ft	849.18 Kips	744.16 Kips	1593.35 Kips
102.01 ft	1312.78 Kips	744.16 Kips	2056.94 Kips
109.99 ft	1763.27 Kips	744.16 Kips	2507.44 Kips

A-R7P3B-10

Filename: Z:\DELDOT\SR1DEC~1\A-R7UTB.DVN RAMP A/SR 7 ABUT B 24"Φ 0.5" WALL



REQUIRED CAPACITY = 377K
EST. PILE TIP = EL 23

Filename: Z:\DELDOT\SR1DEC~1\A-R7UTB.DVN RAMP A/SR7 ABUTB. 24"φ 0.5" WALL

Soil Profile BORING IRW-63

EL. 68

0.0 ft	Clay: Unit Weight 115 -- Undrained Shear Strength 1500 -- Driving Loss 0%
5.3 ft	Sand: Unit Weight 120 -- Friction Angles 31/31 -- Driving Loss 0%
10.7 ft	Clay: Unit Weight 120 -- Undrained Shear Strength 2000 -- Driving Loss 0%
16.0 ft	
21.3 ft	
26.7 ft	
32.0 ft	Clay: Unit Weight 115 -- Undrained Shear Strength 1200 -- Driving Loss 0%
37.3 ft	Clay: Unit Weight 120 -- Undrained Shear Strength 2000 -- Driving Loss 0%
42.7 ft	
48.0 ft	
53.3 ft	Sand: Unit Weight 125 -- Friction Angles 34/34 -- Driving Loss 0%
58.7 ft	
64.0 ft	
69.3 ft	
74.7 ft	
80.0 ft	

REQUIRED CAPACITY = 377 K

EST. PILE TIP =

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\A-R7UTB.DVN
Project Name: Ramp A / SR7 Abut B
Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IRW-63 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 24.00 in
Shell Thickness: 0.50 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	30.00 ft
	- Driving/Restrike	30.00 ft
	- Ultimate:	30.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	7.50 ft	0.00%	115.00 pcf	1500.00 psf	T-79 Steel
2	Cohesionless	3.50 ft	0.00%	120.00 pcf	31.0/31.0	Nordlund
3	Cohesive	19.00 ft	0.00%	120.00 pcf	2000.00 psf	T-79 Steel
4	Cohesive	3.00 ft	0.00%	115.00 pcf	1200.00 psf	T-79 Steel
5	Cohesive	22.00 ft	0.00%	120.00 pcf	2000.00 psf	T-79 Steel
6	Cohesionless	25.00 ft	0.00%	125.00 pcf	34.0/34.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1060.00 psf	0.07 Kips
7.49 ft	Cohesive	N/A	N/A	1060.00 psf	49.88 Kips
7.51 ft	Cohesionless	863.10 psf	26.69	N/A	49.98 Kips
10.99 ft	Cohesionless	1071.90 psf	26.69	N/A	60.61 Kips
11.01 ft	Cohesive	N/A	N/A	1165.00 psf	60.72 Kips
20.01 ft	Cohesive	N/A	N/A	1165.06 psf	126.60 Kips
29.01 ft	Cohesive	N/A	N/A	1217.56 psf	198.43 Kips
29.99 ft	Cohesive	N/A	N/A	1223.28 psf	206.60 Kips
30.01 ft	Cohesive	N/A	N/A	934.70 psf	206.75 Kips
32.99 ft	Cohesive	N/A	N/A	943.84 psf	224.42 Kips
33.01 ft	Cohesive	N/A	N/A	1240.89 psf	224.56 Kips
42.01 ft	Cohesive	N/A	N/A	1293.39 psf	297.70 Kips
51.01 ft	Cohesive	N/A	N/A	1345.89 psf	376.78 Kips
54.99 ft	Cohesive	N/A	N/A	1369.11 psf	413.65 Kips
55.01 ft	Cohesionless	4987.81 psf	29.28	N/A	413.93 Kips
59.99 ft	Cohesionless	5143.69 psf	29.28	N/A	511.37 Kips
60.01 ft	Cohesionless	5300.81 psf	27.13	N/A	511.84 Kips
69.01 ft	Cohesionless	5582.51 psf	27.13	N/A	762.89 Kips
78.01 ft	Cohesionless	5864.21 psf	27.13	N/A	1039.27 Kips
79.99 ft	Cohesionless	5926.19 psf	27.13	N/A	1103.48 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
7.49 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
7.51 ft	Cohesionless	863.70 psf	35.20	64.92 Kips	57.57 Kips
10.99 ft	Cohesionless	1281.30 psf	35.20	64.92 Kips	64.92 Kips
11.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
29.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
29.99 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
30.01 ft	Cohesive	N/A	N/A	N/A	33.93 Kips
32.99 ft	Cohesive	N/A	N/A	N/A	33.93 Kips
33.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
42.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
51.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
54.99 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
55.01 ft	Cohesionless	4988.13 psf	55.60	230.97 Kips	230.97 Kips
59.99 ft	Cohesionless	5299.87 psf	55.60	230.97 Kips	230.97 Kips
60.01 ft	Cohesionless	5301.13 psf	55.60	230.97 Kips	230.97 Kips
69.01 ft	Cohesionless	5864.53 psf	55.60	230.97 Kips	230.97 Kips
78.01 ft	Cohesionless	6427.93 psf	55.60	230.97 Kips	230.97 Kips
79.99 ft	Cohesionless	6551.87 psf	55.60	230.97 Kips	230.97 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.07 Kips	42.41 Kips	42.48 Kips
7.49 ft	49.88 Kips	42.41 Kips	92.30 Kips
7.51 ft	49.98 Kips	57.57 Kips	107.55 Kips
10.99 ft	60.61 Kips	64.92 Kips	125.53 Kips
11.01 ft	60.72 Kips	56.55 Kips	117.27 Kips
20.01 ft	126.60 Kips	56.55 Kips	183.15 Kips
29.01 ft	198.43 Kips	56.55 Kips	254.97 Kips
29.99 ft	206.60 Kips	56.55 Kips	263.15 Kips
30.01 ft	206.75 Kips	33.93 Kips	240.68 Kips
32.99 ft	224.42 Kips	33.93 Kips	258.35 Kips
33.01 ft	224.56 Kips	56.55 Kips	281.11 Kips
42.01 ft	297.70 Kips	56.55 Kips	354.25 Kips
51.01 ft	376.78 Kips	56.55 Kips	433.33 Kips
54.99 ft	413.65 Kips	56.55 Kips	470.19 Kips
55.01 ft	413.93 Kips	230.97 Kips	644.90 Kips
59.99 ft	511.37 Kips	230.97 Kips	742.34 Kips
60.01 ft	511.84 Kips	230.97 Kips	742.81 Kips
69.01 ft	762.89 Kips	230.97 Kips	993.86 Kips
78.01 ft	1039.27 Kips	230.97 Kips	1270.24 Kips
79.99 ft	1103.48 Kips	230.97 Kips	1334.45 Kips

A-R7UTB-10

Lateral Analysis

URS

Job SR-1 / I-95 Interchange | Project No. | Page ___ of ___
Description Ramp A - Pier 1 SR 1 | Computed by JPK | Sheet ___ of ___ | Date 8/22/08
Checked by | Date

Reference

From boring 1BR-23 (DONE)

LOAD = 1046 K 30" ϕ 0.625" WALL FOR DRIVEABILITY

EL. 60 Depth = 0 ft

1 Clay: γ = 105 pcf, ϕ = 0, c = 500 psf, x = 36 in — γ = 0.061, c = 3.5, K = 200, ε = 0.015

EL 57 3 ft

2 Clay: γ = 120 pcf, c = 1500 psf, ϕ = 0, N = 11± — γ = 0.069, c = 10.4, K = 875, ε = 0.0065

EL. 35 Assumed 25 ft — 300 in

EL. 30 30 ft — 360 in

3 Clay: γ = 125 pcf, c = 2500 psf, ϕ = 0, N = 20± — γ = 0.072, c = 17.4, K = 1500, ε = 0.005; γ = 0.039, c = 17.4, K = 1500, ε = 0.005

EL. 10 50 ft — 600 in

4 Clay: γ = 125 pcf, c = 4000 psf, ϕ = 0, N = 40± — γ = 0.039, c = 17.4, K = 1500, ε = 0.005

0

EL. -7.5 67.5 ft

5 Sand: γ = 130 pcf, c = 0, ϕ = 38°, N = 50±

-35

EL -45 105 ft

6 Clay: γ = 125 pcf, c = 4000, ϕ = 0

EL -55 115 ft

Total Shear = 265 K

Axial = 680 K

9 piles
Assume 3x3 config.
Table 10.7.2.4-1
Row 1 - 3 piles @ 1.0
Row 2 - 3 piles @ 0.5
Row 3 - 3 piles @ 0.35

Length Req'd
25.5 ft

Shear per pile = $\frac{265\ K}{3(1) + 3(0.5) + 3(0.35)} = 47.7\ K$

```
================================================================================

                LPILE Plus for Windows, Version 4.0 (4.0.8)

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

                 (c) Copyright ENSOFT, Inc., 1985-2003
                          All Rights Reserved

================================================================================


This program is licensed to:

URS
URS

Path to file locations:      D:\Program Files\Ensoft\LpileP4\DelDOTSR1\
Name of input data file:     S2P1.lpd
Name of output file:         S2P1.lpo
Name of plot output file:    S2P1.lpp
Name of runtime file:        S2P1.lpr


--------------------------------------------------------------------------------
                          Time and Date of Analysis
--------------------------------------------------------------------------------

               Date:  January 22, 2009     Time:  11:27:49


--------------------------------------------------------------------------------
                                Problem Title
--------------------------------------------------------------------------------

Ramp A over SR 7 - Pier 1


--------------------------------------------------------------------------------
                                Program Options
--------------------------------------------------------------------------------

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          150
- Maximum number of iterations allowed =          100
```

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 306.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	30.000	6220.0000	57.7000	30000000.000
2	306.0000	30.000	6220.0000	57.7000	30000000.000

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 36.000 in
p-y subgrade modulus k for top of soil layer = 200.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 200.000 lbs/in**3

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 36.000 in
Distance from top of pile to bottom of layer = 300.000 in
p-y subgrade modulus k for top of soil layer = 875.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 875.000 lbs/in**3

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 300.000 in
Distance from top of pile to bottom of layer = 360.000 in
p-y subgrade modulus k for top of soil layer = 1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 1500.000 lbs/in**3

Layer 4 is stiff clay with water-induced erosion
Distance from top of pile to top of layer = 360.000 in
Distance from top of pile to bottom of layer = 600.000 in
p-y subgrade modulus k for top of soil layer = 1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 1500.000 lbs/in**3

(Depth of lowest layer extends 294.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06100
2	36.00	.06100
3	36.00	.06900
4	300.00	.06900
5	300.00	.07200
6	360.00	.07200
7	360.00	.03900
8	600.00	.03900

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	3.50000	.00	.01500	.0
2	36.000	3.50000	.00	.01500	.0
3	36.000	10.40000	.00	.00650	.0
4	300.000	10.40000	.00	.00650	.0
5	300.000	17.40000	.00	.00500	.0
6	360.000	17.40000	.00	.00500	.0
7	360.000	17.40000	.00	.00500	.0
8	600.000	17.40000	.00	.00500	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 47700.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 680000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 47700.000 lbs
Specified bending moment at pile head = .000 in-lbs
Specified axial load at pile head = 680000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.402211	-2.190E-04	47700.0000	-.003237	11785.0953	-121.7904
2.040	.395608	101544.8180	47449.1923	-.003236	12029.9783	-124.0995
4.080	.389007	202571.6437	47193.7045	-.003235	12273.6121	-126.3788
6.120	.382410	303069.4595	46933.5977	-.003232	12515.9702	-128.6279
8.160	.375821	403027.3814	46668.9341	-.003228	12757.0263	-130.8463
10.200	.369240	502434.6612	46399.7765	-.003223	12996.7545	-133.0337
12.240	.362670	601280.6884	46126.1889	-.003217	13235.1291	-135.1895
14.280	.356114	699554.9921	45848.2358	-.003210	13472.1250	-137.3134
16.320	.349574	797247.2430	45565.9830	-.003202	13707.7173	-139.4050
18.360	.343051	894347.2555	45279.4970	-.003193	13941.8813	-141.4637
20.400	.336548	990844.9895	44988.8451	-.003182	14174.5929	-143.4891
22.440	.330067	1.087E+06	44694.0958	-.003171	14405.8282	-145.4809
24.480	.323611	1.182E+06	44395.3181	-.003158	14635.5637	-147.4385
26.520	.317181	1.277E+06	44092.5821	-.003145	14863.7762	-149.3615
28.560	.310779	1.371E+06	43785.9590	-.003131	15090.4431	-151.2495
30.600	.304408	1.464E+06	43475.5205	-.003115	15315.5419	-153.1020
32.640	.298070	1.557E+06	43161.3394	-.003099	15539.0506	-154.9186
34.680	.291766	1.649E+06	42843.4895	-.003081	15760.9477	-156.6990
36.720	.285499	1.740E+06	42220.2702	-.003063	15981.2118	-454.3003
38.760	.279271	1.829E+06	41289.5868	-.003043	16196.8529	-458.1344
40.800	.273083	1.917E+06	40351.1677	-.003023	16407.8293	-461.8843
42.840	.266939	2.002E+06	39405.1877	-.003001	16614.1001	-465.5470
44.880	.260839	2.086E+06	38451.8274	-.002979	16815.6254	-469.1199
46.920	.254785	2.168E+06	37491.2725	-.002956	17012.3663	-472.6006
48.960	.248780	2.247E+06	36523.7131	-.002931	17204.2849	-475.9870
51.000	.242825	2.325E+06	35549.3439	-.002906	17391.3443	-479.2770
53.040	.236922	2.400E+06	34568.3633	-.002881	17573.5087	-482.4687
55.080	.231073	2.474E+06	33580.9736	-.002854	17750.7433	-485.5605
57.120	.225278	2.545E+06	32587.3804	-.002826	17923.0142	-488.5505
59.160	.219541	2.615E+06	31587.7928	-.002798	18090.2890	-491.4373
61.200	.213861	2.682E+06	30582.4234	-.002769	18252.5361	-494.2191
63.240	.208242	2.747E+06	29571.4875	-.002740	18409.7251	-496.8945
65.280	.202684	2.810E+06	28555.2040	-.002709	18561.8268	-499.4619
67.320	.197188	2.871E+06	27533.7944	-.002678	18708.8132	-501.9200
69.360	.191756	2.930E+06	26507.4835	-.002647	18850.6572	-504.2672
71.400	.186390	2.987E+06	25476.4989	-.002614	18987.3333	-506.5020
73.440	.181091	3.041E+06	24441.0713	-.002581	19118.8169	-508.6231

75.480	.175859	3.093E+06	23401.4342	-.002548	19245.0847	-510.6290
77.520	.170696	3.144E+06	22357.8240	-.002514	19366.1147	-512.5182
79.560	.165603	3.192E+06	21310.4801	-.002479	19481.8861	-514.2894
81.600	.160582	3.237E+06	20259.6451	-.002444	19592.3794	-515.9411
83.640	.155633	3.281E+06	19205.5640	-.002408	19697.5762	-517.4717
85.680	.150756	3.322E+06	18148.4855	-.002372	19797.4597	-518.8799
87.720	.145954	3.362E+06	17088.6606	-.002336	19892.0142	-520.1641
89.760	.141227	3.399E+06	16026.3441	-.002299	19981.2254	-521.3228
91.800	.136576	3.433E+06	14961.7933	-.002261	20065.0803	-522.3545
93.840	.132001	3.466E+06	13895.2690	-.002224	20143.5673	-523.2576
95.880	.127504	3.496E+06	12827.0351	-.002185	20216.6761	-524.0305
97.920	.123085	3.524E+06	11757.3590	-.002147	20284.3978	-524.6716
99.960	.118744	3.550E+06	10686.5112	-.002108	20346.7251	-525.1792
102.000	.114482	3.574E+06	9614.7657	-.002069	20403.6518	-525.5516
104.040	.110300	3.595E+06	8542.4002	-.002030	20455.1733	-525.7871
106.080	.106198	3.614E+06	7469.6959	-.001991	20501.2865	-525.8838
108.120	.102177	3.631E+06	6396.9376	-.001951	20541.9898	-525.8399
110.160	.098237	3.646E+06	5324.4143	-.001912	20577.2830	-525.6535
112.200	.094378	3.658E+06	4252.4187	-.001872	20607.1673	-525.3226
114.240	.090601	3.668E+06	3181.2476	-.001832	20631.6457	-524.8451
116.280	.086906	3.676E+06	2111.2024	-.001791	20650.7226	-524.2189
118.320	.083292	3.682E+06	1042.5886	-.001751	20664.4040	-523.4417
120.360	.079761	3.685E+06	-24.2834	-.001711	20672.6974	-522.5113
122.400	.076312	3.687E+06	-1089.0987	-.001671	20675.6122	-521.4252
124.440	.072945	3.686E+06	-2151.5369	-.001630	20673.1590	-520.1809
126.480	.069660	3.682E+06	-3211.2726	-.001590	20665.3506	-518.7757
128.520	.066457	3.677E+06	-4267.9747	-.001550	20652.2010	-517.2067
130.560	.063337	3.669E+06	-5321.3061	-.001510	20633.7262	-515.4711
132.600	.060298	3.659E+06	-6370.9236	-.001470	20609.9440	-513.5656
134.640	.057341	3.647E+06	-7416.4773	-.001430	20580.8738	-511.4870
136.680	.054465	3.633E+06	-8457.6102	-.001390	20546.5369	-509.2316
138.720	.051670	3.617E+06	-9493.9579	-.001350	20506.9565	-506.7956
140.760	.048956	3.598E+06	-10525.1477	-.001311	20462.1577	-504.1749
142.800	.046322	3.577E+06	-11550.7985	-.001272	20412.1673	-501.3651
144.840	.043768	3.554E+06	-12570.5196	-.001233	20357.0143	-498.3615
146.880	.041293	3.529E+06	-13583.9104	-.001194	20296.7299	-495.1589
148.920	.038897	3.502E+06	-14590.5591	-.001155	20231.3469	-491.7516
150.960	.036579	3.473E+06	-15590.0420	-.001117	20160.9006	-488.1336
153.000	.034339	3.442E+06	-16581.9221	-.001079	20085.4283	-484.2979
155.040	.032175	3.409E+06	-17565.7481	-.001042	20004.9698	-480.2373
157.080	.030087	3.373E+06	-18541.0525	-.001005	19919.5669	-475.9435
159.120	.028075	3.336E+06	-19507.3501	-9.683E-04	19829.2641	-471.4071
161.160	.026136	3.296E+06	-20464.1358	-9.321E-04	19734.1082	-466.6180
163.200	.024272	3.255E+06	-21410.8818	-8.962E-04	19634.1489	-461.5644
165.240	.022480	3.211E+06	-22347.0353	-8.609E-04	19529.4382	-456.2332
167.280	.020759	3.166E+06	-23272.0146	-8.260E-04	19420.0313	-450.6093
169.320	.019110	3.119E+06	-24185.2048	-7.917E-04	19305.9863	-444.6753
171.360	.017529	3.069E+06	-25085.9531	-7.579E-04	19187.3644	-438.4112
173.400	.016017	3.018E+06	-25973.5620	-7.246E-04	19064.2304	-431.7936
175.440	.014573	2.966E+06	-26847.2819	-6.919E-04	18936.6526	-424.7946
177.480	.013195	2.911E+06	-27706.3013	-6.598E-04	18804.7030	-417.3813
179.520	.011881	2.854E+06	-28549.7341	-6.282E-04	18668.4581	-409.5137
181.560	.010631	2.796E+06	-29376.6040	-5.974E-04	18527.9990	-401.1431
183.600	.009444	2.736E+06	-30185.8230	-5.671E-04	18383.4117	-392.2089
185.640	.008318	2.674E+06	-30976.1633	-5.375E-04	18234.7881	-382.6346
187.680	.007251	2.611E+06	-31746.2186	-5.086E-04	18082.2266	-372.3215
189.720	.006242	2.546E+06	-32494.3483	-4.805E-04	17925.8330	-361.1390
191.760	.005291	2.480E+06	-33218.5974	-4.530E-04	17765.7219	-348.9091
193.800	.004394	2.412E+06	-33916.5721	-4.262E-04	17602.0184	-335.3797
195.840	.003552	2.343E+06	-34585.2385	-4.002E-04	17434.8608	-320.1756
197.880	.002761	2.272E+06	-35220.5715	-3.750E-04	17264.4042	-302.6999
199.920	.002021	2.200E+06	-35816.8722	-3.506E-04	17090.8267	-281.9086
201.960	.001331	2.127E+06	-36365.2124	-3.269E-04	16914.3394	-255.6798

204.000	6.88E-04	2.053E+06	-36848.6983	-3.041E-04	16735.2083	-218.3260
206.040	9.02E-05	1.977E+06	-37207.2832	-2.820E-04	16553.8111	-133.2279
208.080	-4.63E-04	1.902E+06	-37139.3329	-2.608E-04	16371.0045	199.8458
210.120	-9.74E-04	1.827E+06	-36688.2035	-2.405E-04	16190.1339	242.4380
212.160	-.001444	1.753E+06	-36166.2084	-2.209E-04	16011.6297	269.3219
214.200	-.001875	1.680E+06	-35596.3357	-2.021E-04	15835.7643	289.3768
216.240	-.002269	1.608E+06	-34989.6096	-1.842E-04	15662.7416	305.4527
218.280	-.002627	1.537E+06	-34352.8063	-1.670E-04	15492.7257	318.8643
220.320	-.002950	1.468E+06	-33690.6210	-1.505E-04	15325.8537	330.3370
222.360	-.003241	1.400E+06	-33006.5544	-1.349E-04	15162.2432	340.3166
224.400	-.003500	1.334E+06	-32303.3507	-1.199E-04	15001.9969	349.0987
226.440	-.003730	1.269E+06	-31583.2422	-1.057E-04	14845.2054	356.8900
228.480	-.003932	1.205E+06	-30848.0964	-9.216E-05	14691.9493	363.8411
230.520	-.004106	1.143E+06	-30099.5121	-7.932E-05	14542.3006	370.0651
232.560	-.004255	1.083E+06	-29338.8831	-6.715E-05	14396.3240	375.6496
234.600	-.004380	1.024E+06	-28567.4437	-5.564E-05	14254.0779	380.6635
236.640	-.004482	966388.6979	-27786.3014	-4.476E-05	14115.6147	385.1623
238.680	-.004563	910560.8498	-26996.4612	-3.450E-05	13980.9816	389.1909
240.720	-.004623	856338.8493	-26198.8444	-2.484E-05	13850.2212	392.7864
242.760	-.004664	803738.4820	-25394.3027	-1.577E-05	13723.3714	395.9799
244.800	-.004687	752773.8354	-24583.6301	-7.258E-06	13600.4663	398.7972
246.840	-.004694	703457.4069	-23767.5716	7.024E-07	13481.5360	401.2602
248.880	-.004684	655800.1945	-22946.8310	8.132E-06	13366.6070	403.3875
250.920	-.004660	609811.7739	-22122.0770	1.505E-05	13255.7025	405.1949
252.960	-.004623	565500.3643	-21293.9484	2.148E-05	13148.8422	406.6958
255.000	-.004573	522872.8839	-20463.0590	2.742E-05	13046.0428	407.9017
257.040	-.004511	481934.9975	-19630.0008	3.292E-05	12947.3180	408.8221
259.080	-.004439	442691.1561	-18795.3480	3.797E-05	12852.6785	409.4650
261.120	-.004356	405144.6306	-17959.6598	4.261E-05	12762.1322	409.8371
263.160	-.004265	369297.5392	-17123.4834	4.684E-05	12675.6842	409.9437
265.200	-.004165	335150.8687	-16287.3564	5.069E-05	12593.3370	409.7886
267.240	-.004058	302704.4918	-15451.8098	5.418E-05	12515.0901	409.3747
269.280	-.003944	271957.1782	-14617.3700	5.732E-05	12440.9406	408.7036
271.320	-.003824	242906.6008	-13784.5614	6.013E-05	12370.8829	407.7754
273.360	-.003699	215549.3378	-12953.9095	6.264E-05	12304.9088	406.5893
275.400	-.003568	189880.8678	-12125.9427	6.485E-05	12243.0074	405.1429
277.440	-.003434	165895.5607	-11301.1960	6.680E-05	12185.1650	403.4323
279.480	-.003296	143586.6616	-10480.2139	6.849E-05	12131.3654	401.4521
281.520	-.003155	122946.2681	-9664.3915	6.995E-05	12081.5895	398.3737
283.560	-.003011	103961.8822	-8856.4144	7.119E-05	12035.8073	393.7606
285.600	-.002864	86614.5940	-8058.0996	7.223E-05	11993.9730	388.9009
287.640	-.002716	70884.4422	-7269.9612	7.309E-05	11956.0385	383.7838
289.680	-.002566	56750.3702	-6492.5385	7.379E-05	11921.9531	378.3953
291.720	-.002415	44190.1674	-5726.4034	7.434E-05	11891.6632	372.7175
293.760	-.002263	33180.3957	-4972.1690	7.476E-05	11865.1124	366.7279
295.800	-.002110	23696.2958	-4230.5005	7.507E-05	11842.2407	360.3981
297.840	-.001956	15711.6693	-3502.1283	7.529E-05	11822.9852	353.6922
299.880	-.001803	9198.7301	-2787.8660	7.543E-05	11807.2788	346.5649
301.920	-.001649	4127.9160	-1940.0184	7.550E-05	11795.0501	484.6582
303.960	-.001495	1073.9930	-960.3861	7.553E-05	11787.6853	475.7657
306.000	-.001340	0.0000	0.0000	7.553E-05	11785.0953	465.7893

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .40221124 in
Computed slope at pile head       =     -.00323691
Maximum bending moment            =    3686600.982 lbs-in
Maximum shear force               =      47700.000 lbs
```

```
Depth of maximum bending moment  =        122.400 in
Depth of maximum shear force     =          0.000 in
Number of iterations             =             33
Number of zero deflection points =              1
```

Summary of Pile-head Response

Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

BC Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 47700.000	M= 0.000	680000.0000	.4022	3.687E+06	47700.0000

The analysis ended normally.

URS

Job SR-1/I-95 Interchange | Project No. | Page ___ of ___
Description Ramp A - Pier 2 SR 7 | Computed by JPK | Sheet ___ of ___
Checked by | Date 8/22/08
Date | Reference

From boring 1BR-16 (DONE)

769K 30"φ 0.625 WALL

EL.65 Depth = 0 ft						
		1	Clay	γ = 120 pcf c = 1500 psf φ = 0	N = 17±	γ = 0.069 c = 10.4 K = 875 ε = 0.0065
EL.45	20 ft	x = 240 in				
		2	Sand	γ = 120 pcf φ = 34° c = 0	N = 20±	γ = 0.069 K = 150
EL.38	27 ft	324 in				
		3	Clay	γ = 120 pcf c = 1500 psf φ = 0	N = 15	γ = 0.069 K = 875 c = 10.4 ε = 0.0065 γ = 0.036 K = 875 c = 10.4 ε = 0.0065
EL.30 ASSUMED	35 ft	420 in				
EL.26	39 ft	468 in				
		4	Sand	γ = 115 pcf c = 0 φ = 32°	N = 20±	
EL.0	65 ft					
		5	Sand	γ = 125 pcf c = 0 φ = 35°	N = 40±	
EL-10	75 ft					
		6	Sand	γ = 130 pcf c = 0 φ = 38°	N = 60±	
EL-45	110 ft					
		7	Clay	γ = 125 pcf c = 4000 φ = 0		
EL-55	120					

Total Shear = 205 K

Axial = 500 K

12 piles

Assume 2x6 config

Table 10.7.2.4-1

Row 1 - 6 piles @ 1.0

Row 2 - 6 piles @ 0.5

Length Req'd = 17 ft

Shear per pile = $\frac{205\,K}{6(1) + 6(0.5)}$ = 22.8 K

```
==============================================================================

                LPILE Plus for Windows, Version 4.0 (4.0.8)

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

                 (c) Copyright ENSOFT, Inc., 1985-2003
                        All Rights Reserved

==============================================================================

This program is licensed to:

URS
URS

Path to file locations:      D:\Program Files\Ensoft\LpileP4\DelDOTSR1\
Name of input data file:     S2P2.lpd
Name of output file:         S2P2.lpo
Name of plot output file:    S2P2.lpp
Name of runtime file:        S2P2.lpr

------------------------------------------------------------------------------
                          Time and Date of Analysis
------------------------------------------------------------------------------

               Date:  January 22, 2009     Time:  11:34:53

------------------------------------------------------------------------------
                                Problem Title
------------------------------------------------------------------------------

Ramp A over SR 7 - Pier 2

------------------------------------------------------------------------------
                                Program Options
------------------------------------------------------------------------------

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          150
- Maximum number of iterations allowed =          100
```

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 204.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	30.000	6220.0000	57.7000	30000000.000
2	204.0000	30.000	6220.0000	57.7000	30000000.000

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 240.000 in
p-y subgrade modulus k for top of soil layer = 875.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 875.000 lbs/in**3

Layer 2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 240.000 in
Distance from top of pile to bottom of layer = 324.000 in
p-y subgrade modulus k for top of soil layer = 150.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 150.000 lbs/in**3

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 324.000 in
Distance from top of pile to bottom of layer = 420.000 in
p-y subgrade modulus k for top of soil layer = 875.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 875.000 lbs/in**3

Layer 4 is stiff clay with water-induced erosion
Distance from top of pile to top of layer = 420.000 in
Distance from top of pile to bottom of layer = 468.000 in
p-y subgrade modulus k for top of soil layer = 875.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 875.000 lbs/in**3

(Depth of lowest layer extends 264.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 8 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06900
2	240.00	.06900
3	240.00	.06900
4	324.00	.06900
5	324.00	.06900
6	420.00	.06900
7	420.00	.03600
8	468.00	.03600

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	10.40000	.00	.00650	.0
2	240.000	10.40000	.00	.00650	.0
3	240.000	.00000	34.00	------	------
4	324.000	.00000	34.00	------	------
5	324.000	10.40000	.00	.00650	.0
6	420.000	10.40000	.00	.00650	.0
7	420.000	10.40000	.00	.00650	.0
8	468.000	10.40000	.00	.00650	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 22800.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 500000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 22800.000 lbs
Specified bending moment at pile head = .000 in-lbs
Specified axial load at pile head = 500000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.047425	3.290E-05	22800.0000	-5.700E-04	8665.5113	-261.4019
1.360	.046649	31153.8797	22443.3542	-5.699E-04	8740.6412	-263.0772
2.720	.045874	61821.0174	22084.4546	-5.696E-04	8814.5973	-264.7164
4.080	.045100	91998.2293	21723.3504	-5.690E-04	8887.3719	-266.3192
5.440	.044327	121682.4013	21360.0914	-5.682E-04	8958.9576	-267.8853
6.800	.043554	150870.4896	20994.7277	-5.673E-04	9029.3469	-269.4142
8.160	.042784	179559.5216	20627.3101	-5.660E-04	9098.5326	-270.9057
9.520	.042015	207746.5965	20257.8898	-5.646E-04	9166.5079	-272.3594
10.880	.041248	235428.8857	19886.5184	-5.630E-04	9233.2658	-273.7749
12.240	.040483	262603.6341	19513.2483	-5.612E-04	9298.7998	-275.1518
13.600	.039721	289268.1602	19138.1319	-5.592E-04	9363.1033	-276.4898
14.960	.038962	315419.8571	18761.2227	-5.570E-04	9426.1701	-277.7885
16.320	.038206	341056.1931	18382.5741	-5.546E-04	9487.9940	-279.0476
17.680	.037454	366174.7124	18002.2405	-5.520E-04	9548.5693	-280.2666
19.040	.036705	390773.0360	17620.2765	-5.493E-04	9607.8900	-281.4452
20.400	.035960	414848.8618	17236.7374	-5.463E-04	9665.9506	-282.5830
21.760	.035219	438399.9660	16851.6787	-5.432E-04	9722.7459	-283.6797
23.120	.034482	461424.2036	16465.1569	-5.399E-04	9778.2706	-284.7348
24.480	.033750	483919.5088	16077.2285	-5.365E-04	9832.5197	-285.7481
25.840	.033023	505883.8960	15687.9509	-5.329E-04	9885.4885	-286.7190
27.200	.032301	527315.4605	15297.3818	-5.291E-04	9937.1723	-287.6473
28.560	.031584	548212.3792	14905.5795	-5.252E-04	9987.5668	-288.5325
29.920	.030872	568572.9111	14512.6029	-5.211E-04	10036.6678	-289.3743
31.280	.030166	588395.3986	14118.5113	-5.169E-04	10084.4712	-290.1722
32.640	.029466	607678.2675	13723.3646	-5.126E-04	10130.9733	-290.9258
34.000	.028772	626420.0282	13327.2234	-5.081E-04	10176.1705	-291.6349
35.360	.028084	644619.2765	12930.1485	-5.034E-04	10220.0594	-292.2988
36.720	.027403	662274.6942	12532.2015	-4.987E-04	10262.6367	-292.9173
38.080	.026728	679385.0497	12133.4445	-4.938E-04	10303.8996	-293.4900
39.440	.026060	695949.1991	11733.9402	-4.888E-04	10343.8453	-294.0163
40.800	.025399	711966.0867	11333.7519	-4.836E-04	10382.4713	-294.4959
42.160	.024744	727434.7462	10932.9434	-4.784E-04	10419.7751	-294.9284
43.520	.024097	742354.3009	10531.5791	-4.730E-04	10455.7548	-295.3133
44.880	.023458	756723.9650	10129.7239	-4.676E-04	10490.4083	-295.6502
46.240	.022826	770543.0441	9727.4436	-4.620E-04	10523.7340	-295.9385
47.600	.022201	783810.9366	9324.8044	-4.563E-04	10555.7306	-296.1780
48.960	.021584	796527.1335	8921.8730	-4.506E-04	10586.3966	-296.3681

50.320	.020975	808691.2205	8518.7171	-4.447E-04	10615.7313	-296.5083
51.680	.020375	820302.8779	8115.4048	-4.388E-04	10643.7336	-296.5981
53.040	.019782	831361.8819	7712.0048	-4.328E-04	10670.4033	-296.6371
54.400	.019198	841868.1056	7308.5867	-4.267E-04	10695.7398	-296.6248
55.760	.018621	851821.5197	6905.2206	-4.205E-04	10719.7432	-296.5606
57.120	.018054	861222.1936	6501.9774	-4.143E-04	10742.4137	-296.4441
58.480	.017495	870070.2963	6098.9287	-4.080E-04	10763.7515	-296.2746
59.840	.016944	878366.0974	5696.1469	-4.016E-04	10783.7575	-296.0517
61.200	.016402	886109.9681	5293.7049	-3.952E-04	10802.4324	-295.7747
62.560	.015869	893302.3823	4891.6768	-3.887E-04	10819.7775	-295.4431
63.920	.015345	899943.9176	4490.1371	-3.821E-04	10835.7940	-295.0564
65.280	.014830	906035.2565	4089.1614	-3.756E-04	10850.4837	-294.6138
66.640	.014324	911577.1873	3688.8260	-3.689E-04	10863.8485	-294.1147
68.000	.013826	916570.6058	3289.2082	-3.623E-04	10875.8905	-293.5586
69.360	.013338	921016.5157	2890.3860	-3.556E-04	10886.6122	-292.9446
70.720	.012859	924916.0306	2492.4386	-3.488E-04	10896.0162	-292.2722
72.080	.012389	928270.3751	2095.4461	-3.421E-04	10904.1054	-291.5405
73.440	.011929	931080.8857	1699.4894	-3.353E-04	10910.8832	-290.7488
74.800	.011477	933349.0129	1304.6507	-3.285E-04	10916.3529	-289.8963
76.160	.011035	935076.3222	911.0133	-3.217E-04	10920.5185	-288.9822
77.520	.010602	936264.4957	518.6616	-3.149E-04	10923.3838	-288.0056
78.880	.010179	936915.3339	127.6812	-3.081E-04	10924.9534	-286.9656
80.240	.009764	937030.7570	-261.8411	-3.012E-04	10925.2317	-285.8613
81.600	.009359	936612.8071	-649.8171	-2.944E-04	10924.2238	-284.6916
82.960	.008964	935663.6498	-1036.1570	-2.876E-04	10921.9349	-283.4554
84.320	.008577	934185.5762	-1420.7698	-2.808E-04	10918.3704	-282.1517
85.680	.008200	932181.0049	-1803.5628	-2.740E-04	10913.5362	-280.7792
87.040	.007832	929652.4844	-2184.4417	-2.672E-04	10907.4385	-279.3367
88.400	.007473	926602.6954	-2563.3102	-2.604E-04	10900.0837	-277.8228
89.760	.007124	923034.4529	-2940.0703	-2.537E-04	10891.4786	-276.2361
91.120	.006783	918950.7095	-3314.6218	-2.470E-04	10881.6303	-274.5750
92.480	.006452	914354.5578	-3686.8625	-2.403E-04	10870.5464	-272.8378
93.840	.006130	909249.2337	-4056.6878	-2.336E-04	10858.2345	-271.0228
95.200	.005816	903638.1196	-4423.9902	-2.270E-04	10844.7029	-269.1279
96.560	.005512	897524.7479	-4788.6600	-2.205E-04	10829.9600	-267.1511
97.920	.005217	890912.8055	-5150.5840	-2.140E-04	10814.0148	-265.0901
99.280	.004930	883806.1370	-5509.6459	-2.075E-04	10796.8765	-262.9422
100.640	.004652	876208.7504	-5865.7259	-2.011E-04	10778.5549	-260.7048
102.000	.004383	868124.8216	-6218.7001	-1.947E-04	10759.0599	-258.3748
103.360	.004123	859558.7003	-6568.4402	-1.884E-04	10738.4020	-255.9488
104.720	.003871	850514.9159	-6914.8131	-1.822E-04	10716.5923	-253.4231
106.080	.003627	840998.1850	-7257.6803	-1.760E-04	10693.6419	-250.7934
107.440	.003392	831013.4185	-7596.8973	-1.699E-04	10669.5629	-248.0551
108.800	.003165	820565.7307	-7932.3127	-1.639E-04	10644.3675	-245.2028
110.160	.002946	809660.4491	-8263.7673	-1.580E-04	10618.0686	-242.2305
111.520	.002735	798303.1253	-8591.0934	-1.521E-04	10590.6796	-239.1314
112.880	.002532	786499.5476	-8914.1130	-1.463E-04	10562.2144	-235.8975
114.240	.002337	774255.7561	-9232.6368	-1.406E-04	10532.6875	-232.5198
115.600	.002150	761578.0587	-9546.4617	-1.351E-04	10502.1143	-228.9876
116.960	.001970	748473.0514	-9855.3695	-1.295E-04	10470.5106	-225.2885
118.320	.001797	734947.6412	-10159.1228	-1.241E-04	10437.8930	-221.4077
119.680	.001632	721009.0729	-10457.4627	-1.188E-04	10404.2791	-217.3274
121.040	.001474	706664.9624	-10750.1033	-1.136E-04	10369.6872	-213.0264
122.400	.001323	691923.3359	-11036.7265	-1.085E-04	10334.1367	-208.4782
123.760	.001179	676792.6789	-11316.9738	-1.036E-04	10297.6480	-203.6502
125.120	.001041	661281.9964	-11590.4363	-9.867E-05	10260.2428	-198.5006
126.480	9.10E-04	645400.8899	-11856.6400	-9.391E-05	10221.9443	-192.9755
127.840	7.86E-04	629159.6571	-12115.0258	-8.927E-05	10182.7773	-187.0035
129.200	6.68E-04	612569.4245	-12364.9188	-8.474E-05	10142.7687	-180.4862
130.560	5.55E-04	595642.3287	-12605.4824	-8.034E-05	10101.9477	-173.2838
131.920	4.49E-04	578391.7751	-12835.6417	-7.606E-05	10060.3467	-165.1858
133.280	3.49E-04	560832.8274	-13053.9486	-7.191E-05	10018.0020	-155.8537
134.640	2.54E-04	542982.8332	-13258.3141	-6.789E-05	9974.9554	-144.6838

136.000	1.64E-04	524862.5407	-13445.3772	-6.400E-05	9931.2569	-130.4090
137.360	7.95E-05	506498.4425	-13608.4383	-6.024E-05	9886.9705	-109.3868
138.720	5.05E-08	487929.5122	-13697.1966	-5.661E-05	9842.1902	-21.1400
140.080	-7.45E-05	469319.0630	-13637.6371	-5.313E-05	9797.3096	108.7275
141.440	-1.44E-04	450907.3903	-13476.0170	-4.977E-05	9752.9085	128.9491
142.800	-2.10E-04	432731.9871	-13291.5702	-4.655E-05	9709.0772	142.2963
144.160	-2.71E-04	414817.6305	-13091.1390	-4.346E-05	9665.8753	152.4555
145.520	-3.28E-04	397183.1997	-12878.1835	-4.050E-05	9623.3486	160.7144
146.880	-3.81E-04	379844.0577	-12654.8687	-3.767E-05	9581.5339	167.6898
148.240	-4.31E-04	362813.1922	-12422.7033	-3.497E-05	9540.4627	173.7298
149.600	-4.76E-04	346101.8592	-12182.8116	-3.238E-05	9500.1621	179.0521
150.960	-5.19E-04	329719.9858	-11936.0702	-2.992E-05	9460.6559	183.8029
152.320	-5.58E-04	313676.4401	-11683.1861	-2.758E-05	9421.9657	188.0856
153.680	-5.94E-04	297979.2228	-11424.7439	-2.535E-05	9384.1107	191.9765
155.040	-6.27E-04	282635.6083	-11161.2370	-2.323E-05	9347.1084	195.5336
156.400	-6.57E-04	267652.2522	-10893.0884	-2.123E-05	9310.9749	198.8026
157.760	-6.84E-04	253035.2747	-10620.6653	-1.933E-05	9275.7250	201.8197
159.120	-7.09E-04	238790.3289	-10344.2900	-1.754E-05	9241.3722	204.6146
160.480	-7.32E-04	224922.6548	-10064.2480	-1.585E-05	9207.9292	207.2119
161.840	-7.53E-04	211437.1251	-9780.7938	-1.426E-05	9175.4079	209.6325
163.200	-7.71E-04	198338.2837	-9494.1558	-1.276E-05	9143.8190	211.8940
164.560	-7.87E-04	185630.3785	-9204.5399	-1.136E-05	9113.1729	214.0117
165.920	-8.02E-04	173317.3893	-8912.1327	-1.006E-05	9083.4792	215.9990
167.280	-8.15E-04	161403.0528	-8617.1033	-8.835E-06	9054.7469	217.8677
168.640	-8.26E-04	149890.8846	-8319.6059	-7.701E-06	9026.9845	219.6284
170.000	-8.36E-04	138784.1983	-8019.7811	-6.649E-06	9000.1998	221.2905
171.360	-8.44E-04	128086.1229	-7717.7571	-5.677E-06	8974.4006	222.8625
172.720	-8.51E-04	117799.6192	-7413.6511	-4.781E-06	8949.5939	224.3522
174.080	-8.57E-04	107927.4936	-7107.5701	-3.958E-06	8925.7866	225.7668
175.440	-8.62E-04	98472.4113	-6799.6119	-3.206E-06	8902.9849	227.1129
176.800	-8.66E-04	89436.9091	-6489.8654	-2.521E-06	8881.1951	228.3967
178.160	-8.69E-04	80823.4061	-6178.4116	-1.901E-06	8860.4230	229.6237
179.520	-8.71E-04	72634.2144	-5865.3239	-1.341E-06	8840.6742	230.7993
180.880	-8.72E-04	64871.5492	-5550.6690	-8.403E-07	8821.9539	231.9285
182.240	-8.73E-04	57537.5374	-5234.5067	-3.942E-07	8804.2674	233.0160
183.600	-8.73E-04	50634.2270	-4916.8909	5.643E-12	8787.6195	234.0662
184.960	-8.73E-04	44163.5943	-4597.8694	3.455E-07	8772.0151	235.0831
186.320	-8.72E-04	38127.5524	-4277.4849	6.453E-07	8757.4587	236.0706
187.680	-8.71E-04	32527.9578	-3955.7748	9.028E-07	8743.9549	237.0324
189.040	-8.70E-04	27366.6170	-3632.7720	1.121E-06	8731.5079	237.9718
190.400	-8.68E-04	22645.2934	-3308.5046	1.303E-06	8720.1221	238.8920
191.760	-8.66E-04	18365.7121	-2982.9968	1.453E-06	8709.8016	239.7959
193.120	-8.64E-04	14529.5662	-2656.2691	1.573E-06	8700.5504	240.6860
194.480	-8.62E-04	11138.5213	-2328.3385	1.666E-06	8692.3727	241.5650
195.840	-8.60E-04	8194.2196	-1999.2186	1.737E-06	8685.2722	242.4348
197.200	-8.57E-04	5698.2847	-1668.9207	1.787E-06	8679.2531	243.2974
198.560	-8.55E-04	3652.3245	-1337.4534	1.821E-06	8674.3191	244.1545
199.920	-8.52E-04	2057.9343	-1004.8233	1.842E-06	8670.4741	245.0074
201.280	-8.50E-04	916.6997	-671.0354	1.853E-06	8667.7220	245.8572
202.640	-8.47E-04	230.1979	-336.0933	1.857E-06	8666.0664	246.7047
204.000	-8.45E-04	0.0000	0.0000	1.858E-06	8665.5113	247.5503

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.04742462 in
Computed slope at pile head	=	-.00057004
Maximum bending moment	=	937030.757 lbs-in
Maximum shear force	=	22800.000 lbs

Depth of maximum bending moment = 80.240 in
Depth of maximum shear force = 0.000 in
Number of iterations = 25
Number of zero deflection points = 1

Summary of Pile-head Response

Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

BC Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 22800.000	M= 0.000	500000.0000	.047425	937030.7570	22800.0000

The analysis ended normally.

URS

Page ____ of ____

Job SR-1/I-95 Interchange | Project No. ____ | Sheet ____ of ____

Description Ramp A - Pier 3 SR7 | Computed by JPK | Date 8/22/08

Checked by ____ | Date ____

Reference

From borings IBR-12 & IBR-10 (DONE)

1046 K 30" φ 0.625" WALL

EL. 65 Depth = 0 ft

1 Clay: γ = 120 pcf, c = 1500 psf, φ = 0, N = 15± | γ = 0.069, c = 10.4, K = 875, ε = 0.065

EL. 39 26 ft x = 312 in

2 Sand: γ = 115 pcf, c = 0, φ = 32°, N = 20± | γ = 0.067, K = 90

ASSUMED

EL. 31 34 ft 408 in

EL. 30 35 ft

3 Clay: γ = 125 pcf, c = 2000 psf, φ = 0, N = 20+

EL. 10 55 ft

4 Clay: γ = 125 pcf, c = 3000 psf, φ = 0, N = 25±

EL. -15 80 ft

-18 ft

5 Clay: γ = 130 pcf, c = 5000 psf, φ = 0, N = 40±

EL. -28 93 ft

6 Sand: γ = 130 pcf, c = 0, φ = 36°

EL. -45 110 ft

Shear per Pile (See Pier 1) = 47.7 K

Axial = 680 K

Length Req'd = 22.5 ft

==========

LPILE Plus for Windows, Version 4.0 (4.0.8)

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

(c) Copyright ENSOFT, Inc., 1985-2003
All Rights Reserved

==========

This program is licensed to:

URS
URS

Path to file locations: D:\Program Files\Ensoft\LpileP4\DelDOTSR1\
Name of input data file: S2P3.lpd
Name of output file: S2P3.lpo
Name of plot output file: S2P3.lpp
Name of runtime file: S2P3.lpr

Time and Date of Analysis

Date: January 22, 2009 Time: 11:41:48

Problem Title

Ramp A over SR 7 - Pier 3

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 150
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 270.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	30.000	6220.0000	57.7000	30000000.000
2	270.0000	30.000	6220.0000	57.7000	30000000.000

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 312.000 in
p-y subgrade modulus k for top of soil layer = 875.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 875.000 lbs/in**3

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 312.000 in
Distance from top of pile to bottom of layer = 408.000 in
p-y subgrade modulus k for top of soil layer = 875.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 875.000 lbs/in**3

(Depth of lowest layer extends 138.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 4 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06900
2	312.00	.06900
3	312.00	.06900
4	408.00	.06900

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 4 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	10.40000	.00	.00650	.0
2	312.000	10.40000	.00	.00650	.0
3	312.000	10.40000	.00	.00650	.0
4	408.000	10.40000	.00	.00650	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 47700.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 680000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 47700.000 lbs
Specified bending moment at pile head = .000 in-lbs
Specified axial load at pile head = 680000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.232265	4.796E-06	47700.0000	-.002131	11785.0953	-388.8302
1.800	.228429	87838.5698	46996.6874	-.002131	11996.9247	-392.6283
3.600	.224594	174403.9867	46286.5970	-.002129	12205.6837	-396.3609
5.400	.220763	259683.1350	45569.8477	-.002127	12411.3408	-400.0272
7.200	.216936	343663.1290	44846.5593	-.002124	12613.8649	-403.6265
9.000	.213115	426331.3155	44116.8535	-.002121	12813.2255	-407.1579
10.800	.209302	507675.2769	43380.8528	-.002116	13009.3926	-410.6206
12.600	.205497	587682.8333	42638.6816	-.002111	13202.3369	-414.0140
14.400	.201702	666342.0453	41890.4654	-.002105	13392.0295	-417.3373
16.200	.197919	743641.2170	41136.3311	-.002098	13578.4423	-420.5897
18.000	.194149	819568.8979	40376.4071	-.002091	13761.5476	-423.7703
19.800	.190393	894113.8862	39610.8232	-.002082	13941.3185	-426.8785
21.600	.186653	967265.2313	38839.7103	-.002073	14117.7285	-429.9135
23.400	.182930	1.039E+06	38063.2011	-.002064	14290.7518	-432.8745
25.200	.179224	1.109E+06	37281.4294	-.002053	14460.3633	-435.7607
27.000	.175538	1.178E+06	36494.5306	-.002042	14626.5384	-438.5713
28.800	.171872	1.246E+06	35702.6414	-.002031	14789.2531	-441.3056
30.600	.168228	1.312E+06	34905.9000	-.002018	14948.4842	-443.9627
32.400	.164607	1.376E+06	34104.4458	-.002005	15104.2091	-446.5419
34.200	.161009	1.439E+06	33298.4200	-.001992	15256.4057	-449.0423
36.000	.157437	1.501E+06	32487.9650	-.001977	15405.0528	-451.4633
37.800	.153890	1.561E+06	31673.2246	-.001963	15550.1296	-453.8038
39.600	.150371	1.620E+06	30854.3443	-.001947	15691.6161	-456.0633
41.400	.146880	1.677E+06	30031.4707	-.001931	15829.4931	-458.2407
43.200	.143418	1.733E+06	29204.7522	-.001915	15963.7418	-460.3354
45.000	.139986	1.787E+06	28374.3387	-.001898	16094.3444	-462.3464
46.800	.136585	1.840E+06	27540.3813	-.001881	16221.2835	-464.2730
48.600	.133216	1.891E+06	26703.0328	-.001863	16344.5427	-466.1142
50.400	.129880	1.940E+06	25862.4477	-.001844	16464.1061	-467.8693
52.200	.126577	1.988E+06	25018.7817	-.001825	16579.9585	-469.5374
54.000	.123310	2.035E+06	24172.1922	-.001806	16692.0855	-471.1175
55.800	.120077	2.080E+06	23322.8384	-.001786	16800.4736	-472.6089
57.600	.116880	2.123E+06	22470.8809	-.001766	16905.1097	-474.0106
59.400	.113721	2.165E+06	21616.4817	-.001745	17005.9816	-475.3218
61.200	.110599	2.205E+06	20759.8049	-.001724	17103.0780	-476.5414
63.000	.107515	2.244E+06	19901.0159	-.001702	17196.3881	-477.6686
64.800	.104470	2.281E+06	19040.2819	-.001681	17285.9021	-478.7024
66.600	.101465	2.317E+06	18177.7720	-.001658	17371.6108	-479.6419
68.400	.098500	2.351E+06	17313.6567	-.001636	17453.5059	-480.4861
70.200	.095576	2.383E+06	16448.1086	-.001613	17531.5797	-481.2340
72.000	.092693	2.414E+06	15581.3019	-.001590	17605.8256	-481.8846
73.800	.089852	2.443E+06	14713.4126	-.001566	17676.2375	-482.4368
75.600	.087054	2.470E+06	13844.6189	-.001543	17742.8103	-482.8896
77.400	.084298	2.496E+06	12975.1005	-.001519	17805.5398	-483.2419
79.200	.081586	2.521E+06	12105.0394	-.001495	17864.4223	-483.4927
81.000	.078918	2.544E+06	11234.6194	-.001470	17919.4553	-483.6407
82.800	.076293	2.565E+06	10364.0265	-.001446	17970.6370	-483.6848
84.600	.073714	2.585E+06	9493.4487	-.001421	18017.9663	-483.6238
86.400	.071179	2.603E+06	8623.0763	-.001396	18061.4432	-483.4566
88.200	.068689	2.619E+06	7753.1017	-.001371	18101.0686	-483.1818
90.000	.066245	2.634E+06	6883.7198	-.001345	18136.8440	-482.7981
91.800	.063846	2.647E+06	6015.1277	-.001320	18168.7721	-482.3043
93.600	.061494	2.659E+06	5147.5249	-.001294	18196.8563	-481.6988
95.400	.059188	2.669E+06	4281.1138	-.001268	18221.1011	-480.9803
97.200	.056928	2.677E+06	3416.0991	-.001243	18241.5118	-480.1472
99.000	.054714	2.684E+06	2552.6883	-.001217	18258.0945	-479.1981
100.800	.052547	2.689E+06	1691.0920	-.001191	18270.8567	-478.1312

102.600	.050427	2.693E+06	831.5234	-.001165	18279.8063	-476.9449
104.400	.048354	2.695E+06	-25.8008	-.001139	18284.9527	-475.6375
106.200	.046327	2.696E+06	-880.6608	-.001113	18286.3060	-474.2070
108.000	.044347	2.695E+06	-1732.8334	-.001087	18283.8772	-472.6515
109.800	.042414	2.692E+06	-2582.0918	-.001061	18277.6787	-470.9689
111.600	.040528	2.688E+06	-3428.2053	-.001035	18267.7236	-469.1572
113.400	.038688	2.682E+06	-4270.9392	-.001009	18254.0262	-467.2139
115.200	.036895	2.675E+06	-5110.0547	-9.832E-04	18236.6018	-465.1366
117.000	.035148	2.666E+06	-5945.3081	-9.575E-04	18215.4669	-462.9228
118.800	.033448	2.656E+06	-6776.4512	-9.318E-04	18190.6390	-460.5696
120.600	.031794	2.644E+06	-7603.2306	-9.062E-04	18162.1369	-458.0741
122.400	.030186	2.631E+06	-8425.3871	-8.808E-04	18129.9803	-455.4331
124.200	.028623	2.616E+06	-9242.6558	-8.555E-04	18094.1902	-452.6432
126.000	.027106	2.600E+06	-10054.7652	-8.303E-04	18054.7889	-449.7006
127.800	.025634	2.582E+06	-10861.4371	-8.053E-04	18011.7999	-446.6014
129.600	.024207	2.563E+06	-11662.3853	-7.805E-04	17965.2478	-443.3411
131.400	.022824	2.542E+06	-12457.3156	-7.559E-04	17915.1587	-439.9149
133.200	.021486	2.520E+06	-13245.9248	-7.315E-04	17861.5599	-436.3176
135.000	.020191	2.496E+06	-14027.8996	-7.073E-04	17804.4802	-432.5433
136.800	.018939	2.471E+06	-14802.9157	-6.833E-04	17743.9498	-428.5857
138.600	.017731	2.444E+06	-15570.6366	-6.596E-04	17680.0003	-424.4376
140.400	.016565	2.416E+06	-16330.7123	-6.362E-04	17612.6648	-420.0910
142.200	.015441	2.387E+06	-17082.7773	-6.130E-04	17541.9781	-415.5369
144.000	.014358	2.357E+06	-17826.4491	-5.901E-04	17467.9767	-410.7652
145.800	.013316	2.324E+06	-18561.3257	-5.676E-04	17390.6986	-405.7643
147.600	.012315	2.291E+06	-19286.9825	-5.453E-04	17310.1839	-400.5211
149.400	.011353	2.256E+06	-20002.9698	-5.234E-04	17226.4745	-395.0203
151.200	.010431	2.220E+06	-20708.8080	-5.018E-04	17139.6144	-389.2443
153.000	.009547	2.183E+06	-21403.9831	-4.805E-04	17049.6497	-383.1724
154.800	.008701	2.144E+06	-22087.9403	-4.597E-04	16956.6289	-376.7801
156.600	.007892	2.105E+06	-22760.0767	-4.392E-04	16860.6030	-370.0382
158.400	.007120	2.064E+06	-23419.7312	-4.191E-04	16761.6260	-362.9114
160.200	.006383	2.021E+06	-24066.1724	-3.994E-04	16659.7545	-355.3566
162.000	.005682	1.978E+06	-24698.5814	-3.801E-04	16555.0490	-347.3201
163.800	.005015	1.933E+06	-25316.0301	-3.612E-04	16447.5733	-338.7340
165.600	.004382	1.888E+06	-25917.4505	-3.428E-04	16337.3959	-329.5109
167.400	.003781	1.841E+06	-26501.5917	-3.248E-04	16224.5901	-319.5349
169.200	.003212	1.793E+06	-27066.9563	-3.073E-04	16109.2352	-308.6480
171.000	.002675	1.744E+06	-27611.7033	-2.902E-04	15991.4176	-296.6265
172.800	.002168	1.694E+06	-28133.4908	-2.736E-04	15871.2327	-283.1373
174.600	.001690	1.644E+06	-28629.2002	-2.575E-04	15748.7872	-267.6509
176.400	.001241	1.592E+06	-29094.4024	-2.419E-04	15624.2036	-249.2403
178.200	8.19E-04	1.539E+06	-29522.1376	-2.268E-04	15497.6273	-226.0210
180.000	4.24E-04	1.486E+06	-29899.1981	-2.122E-04	15369.2411	-192.9351
181.800	5.49E-05	1.432E+06	-30178.2447	-1.981E-04	15239.3051	-117.1167
183.600	-2.89E-04	1.378E+06	-30124.3407	-1.846E-04	15108.4132	177.0101
185.400	-6.10E-04	1.324E+06	-29771.8542	-1.716E-04	14978.8652	214.6416
187.200	-9.07E-04	1.271E+06	-29364.0634	-1.590E-04	14850.9565	238.4592
189.000	-.001182	1.219E+06	-28918.8049	-1.470E-04	14724.8749	256.2725
190.800	-.001436	1.168E+06	-28444.6244	-1.355E-04	14600.7609	270.5947
192.600	-.001670	1.117E+06	-27946.7607	-1.245E-04	14478.7280	282.5872
194.400	-.001884	1.067E+06	-27428.8301	-1.140E-04	14358.8712	292.8914
196.200	-.002080	1.018E+06	-26893.5155	-1.039E-04	14241.2726	301.9026
198.000	-.002258	970696.7544	-26342.9080	-9.430E-05	14126.0039	309.8835
199.800	-.002420	923891.2274	-25778.6967	-8.517E-05	14013.1288	317.0180
201.600	-.002565	878101.9303	-25202.2835	-7.647E-05	13902.7045	323.4410
203.400	-.002695	833350.2144	-24614.8578	-6.822E-05	13794.7823	329.2543
205.200	-.002811	789655.4428	-24017.4458	-6.039E-05	13689.4091	334.5369
207.000	-.002912	747035.2471	-23410.9461	-5.298E-05	13586.6273	339.3517
208.800	-.003001	705505.7306	-22796.1548	-4.597E-05	13486.4757	343.7497
210.600	-.003078	665081.6333	-22173.7844	-3.936E-05	13388.9899	347.7729
212.400	-.003143	625776.4675	-21544.4781	-3.314E-05	13294.2026	351.4564
214.200	-.003197	587602.6319	-20908.8205	-2.728E-05	13202.1435	354.8298

216.000	-.003241	550571.5070	-20267.3467	-2.180E-05	13112.8401	357.9188
217.800	-.003276	514693.5382	-19620.5491	-1.666E-05	13026.3177	360.7453
219.600	-.003301	479978.3073	-18968.8824	-1.186E-05	12942.5993	363.3288
221.400	-.003318	446434.5944	-18312.7689	-7.392E-06	12861.7061	365.6863
223.200	-.003328	414070.4339	-17652.6015	-3.241E-06	12783.6575	367.8330
225.000	-.003330	382893.1636	-16988.7473	6.026E-07	12708.4711	369.7828
226.800	-.003326	352909.4685	-16321.5497	4.152E-06	12636.1632	371.5478
228.600	-.003315	324125.4217	-15651.3311	7.417E-06	12566.7483	373.1395
230.400	-.003299	296546.5199	-14978.3941	1.041E-05	12500.2397	374.5682
232.200	-.003278	270177.7178	-14303.0236	1.314E-05	12436.6493	375.8434
234.000	-.003252	245023.4584	-13625.4879	1.563E-05	12375.9879	376.9740
235.800	-.003221	221087.7018	-12946.0399	1.788E-05	12318.2650	377.9683
237.600	-.003187	198373.9521	-12264.9179	1.990E-05	12263.4891	378.8339
239.400	-.003150	176885.2820	-11582.3471	2.171E-05	12211.6675	379.5781
241.200	-.003109	156624.3564	-10898.5399	2.332E-05	12162.8068	380.2077
243.000	-.003066	137593.4545	-10213.6967	2.474E-05	12116.9123	380.7291
244.800	-.003020	119794.4903	-9528.0071	2.598E-05	12073.9888	381.1483
246.600	-.002972	103229.0323	-8841.6497	2.705E-05	12034.0399	381.4710
248.400	-.002923	87898.3215	-8154.7935	2.798E-05	11997.0688	381.7025
250.200	-.002872	73803.2890	-7467.5983	2.876E-05	11963.0775	381.8477
252.000	-.002819	60944.5717	-6780.2153	2.941E-05	11932.0678	381.9112
253.800	-.002766	49322.5272	-6092.7876	2.994E-05	11904.0403	381.8973
255.600	-.002711	38937.2474	-5405.4515	3.036E-05	11878.9954	381.8096
257.400	-.002656	29788.5711	-4718.3363	3.070E-05	11856.9327	381.6516
259.200	-.002601	21876.0943	-4033.0736	3.094E-05	11837.8512	379.7515
261.000	-.002545	15193.7539	-3351.3584	3.112E-05	11821.7362	377.7098
262.800	-.002489	9735.0139	-2673.3574	3.124E-05	11808.5720	375.6246
264.600	-.002432	5493.1828	-1999.1474	3.132E-05	11798.3425	373.4976
266.400	-.002376	2461.4192	-1328.8025	3.136E-05	11791.0312	371.3300
268.200	-.002320	632.7357	-662.3957	3.137E-05	11786.6212	369.1220
270.000	-.002263	0.0000	0.0000	3.137E-05	11785.0953	366.8732

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.23226486	in
Computed slope at pile head	=	-.00213111	
Maximum bending moment	=	2695835.347	lbs-in
Maximum shear force	=	47700.000	lbs
Depth of maximum bending moment	=	106.200	in
Depth of maximum shear force	=	0.000	in
Number of iterations	=	32	
Number of zero deflection points	=	1	

Summary of Pile-head Response

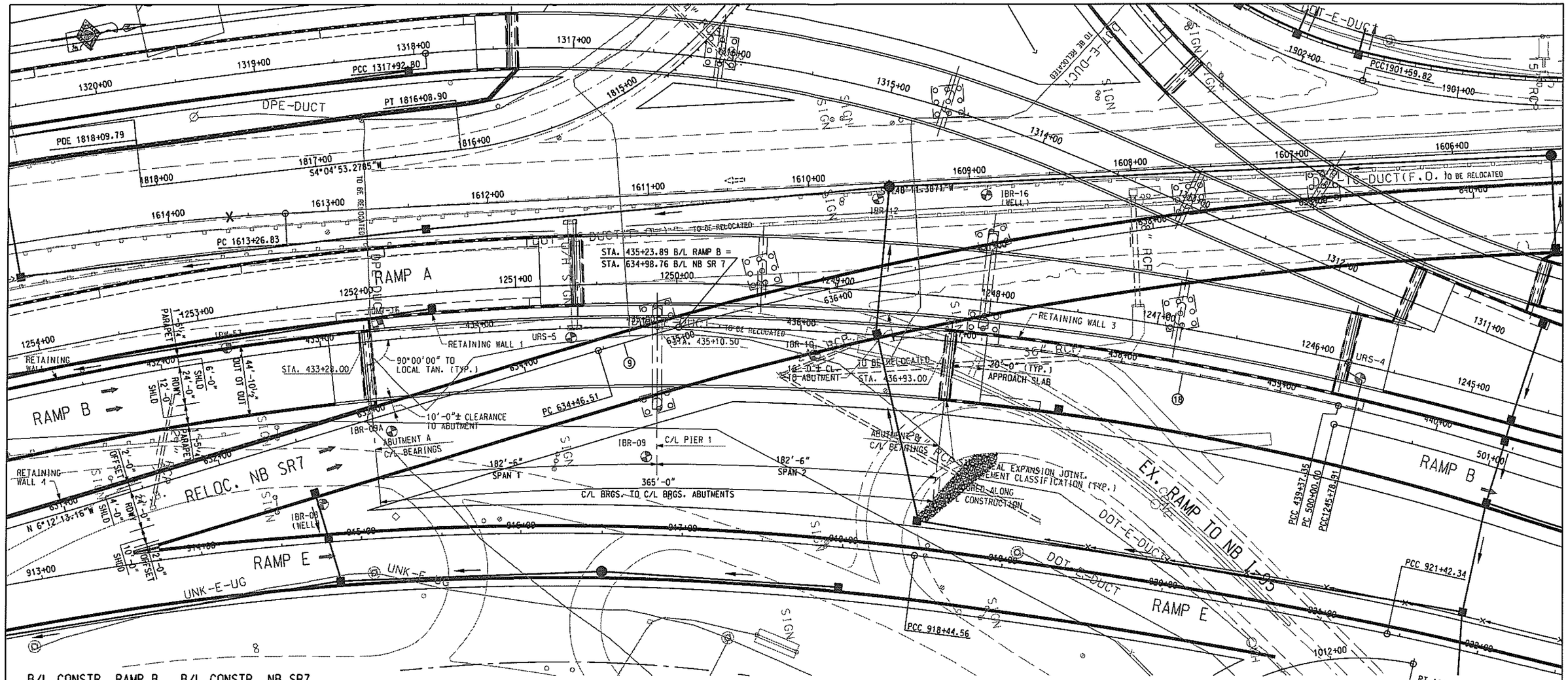
Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

BC Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 47700.000	M= 0.000	680000.0000	.2323	2.696E+06	47700.0000

The analysis ended normally.

Structure S3 – Ramp B over SR 7



B/L CONSTR. RAMP B
CURVE 18 DATA

PI STA. 432+05.12
Δ = 49°15'06.54" RT
Dc = 3°08'22.18"
R = 1,825.0000'
T = 836.55'
L = 1,568.78'

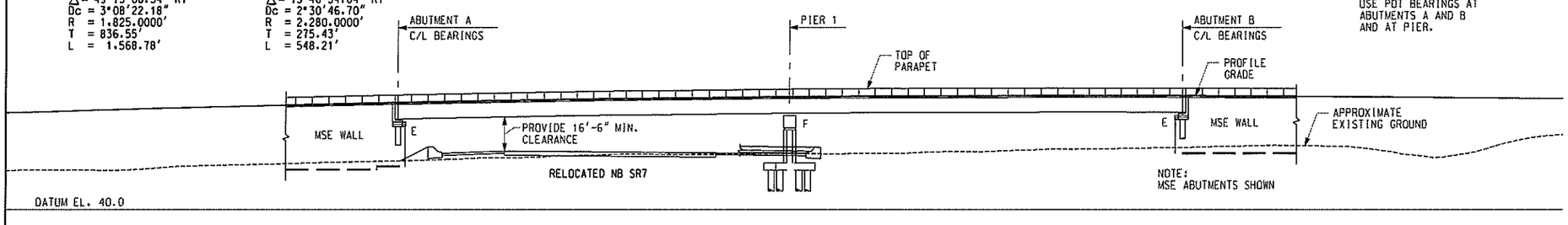
B/L CONSTR. NB SR7
CURVE 9 DATA

PI STA. 637+21.94
Δ = 13°46'34.84" RT
Dc = 2°30'46.70"
R = 2,280.0000'
T = 275.43'
L = 548.21'

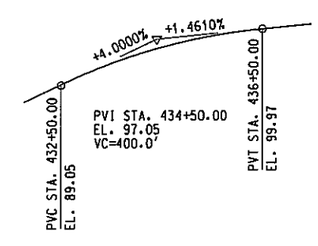
PLAN
SCALE: 1" = 30'-0"

NOTE:

USE POT BEARINGS AT ABUTMENTS A AND B AND AT PIER.



ELEVATION
SCALE: 1" = 30'-0"



RAMP B PROFILE
NOT TO SCALE

URS S3-2

DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS	SCALE 0 30 60 90 FEET	SR1 / I-95 INTERCHANGE	CONTRACT 28-090-03	BRIDGE NO.	RAMP B OVER SR 7 PLAN AND ELEVATION
				COUNTY NEW CASTLE	DESIGNED BY: R. F. KIRCHNER URS	
					CHECKED BY:	

S3-1
SHEET NO. 12
TOTAL SHTS.

Jan 22, 2009 0:\20832687-XM\CAD\Bridge\pe30i.dgn
Jason_Kotova

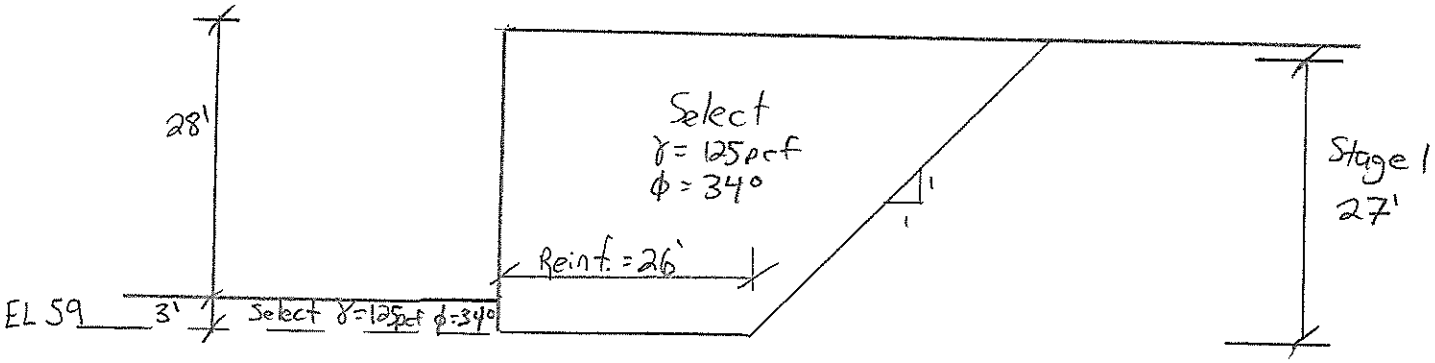
MSE Wingwalls
Bearing Capacity, Sliding, Overturning, Eccentricity, Settlement

URS

Job SR1 / I-95 Interchange
Description Ramp B over SR7
Abut A Face & Wingwalls
Bearing, Capacity, Sliding & Overturning

Project No.
Computed by JPK
Checked by

Page ___ of ___
Sheet ___ of ___
Date
Date
Reference



Clay
γ=120pcf

CD
φ=24°
c=0
Traffic Surcharge = 250psf

CU
φ=10.3°
c=940psf
TS=250 psf

UU @ Stage 1
φ=0°
c=1400psf
TS=0 psf

EL 30 ▽

Settlement

Assumptions:

1) 6 feet of overburden removed to reach bottom of footing
2) 20 feet of clay layer consolidating (based on test embankment back calculation)
3) Consolidation parameters from URS-5, U-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp B over SR 7- Abutment A Face & WW
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	28	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	31	feet	
Wall Base Width	B =	26	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	43	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	29	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	31	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	32	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	17.0	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	2.2	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	100.8	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1400	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	29.3	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	37.7	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	37.7	k/ft	**Capacity Demand Ratio (CDR)= 1.29**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	3.20	ft	**e < 0.25*B, OK**
Effective Width	B' =	19.6	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	5.14	ksf	
Factored Bearing Pressure	Sigv =	7.52	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.30	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.27	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.76	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.83	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	13.9	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11 5 6-1
Factored Bearing Resistance (ksf)	qr =	9.02	ksf	Capacity Demand Ratio (CDR)= 1.199
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming quarantine period after Stage 1
Foundation Φ	Φr =	10.3	degrees	
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS-2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.16	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.11	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.76	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.83	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	11.7	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.59	ksf	**Capacity Demand Ratio (CDR)= 1.014**
				CDR > 1.0, OK

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp B over SR 7- Abutment A Face & WW
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	24	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	27	feet	
Wall Base Width	B =	26	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	43	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	29	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	27	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	24	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	12.9	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	87.8	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1400	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	19.3	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	37.7	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	37.7	k/ft	**Capacity Demand Ratio (CDR)= 1.95**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	1.98	ft	**e < 0.25*B, OK**
Effective Width	B' =	22.0	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	5.38	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.30	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.27	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.76	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.83	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	13.9	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	9.02	ksf	**Capacity Demand Ratio (CDR)= 1.678**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1, quarantine period to follow
Foundation Φ	Φf =	0.0	degrees	
Foundation Cohesion (c)	cf =	1400	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.12	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.83	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	8.4	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	5.49	ksf	**Capacity Demand Ratio (CDR)= 1.021**
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp B over SR 7 - Abutment A Face & Wingwalls
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c'' [3]	
Initial Overburden	6				0.38				2.57				
I	10	0.786	0.068	0.29	0.69	4.50	0.42	0.85	2.50	1.81	0	2.559233	
II	10	0.786	0.068	0.29	1.31	4.50	0.81	0.65	2.61	1.30	0	1.362475	
Footing Width (ft)	26										0.00	3.92	in
											TOTAL	3.92	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

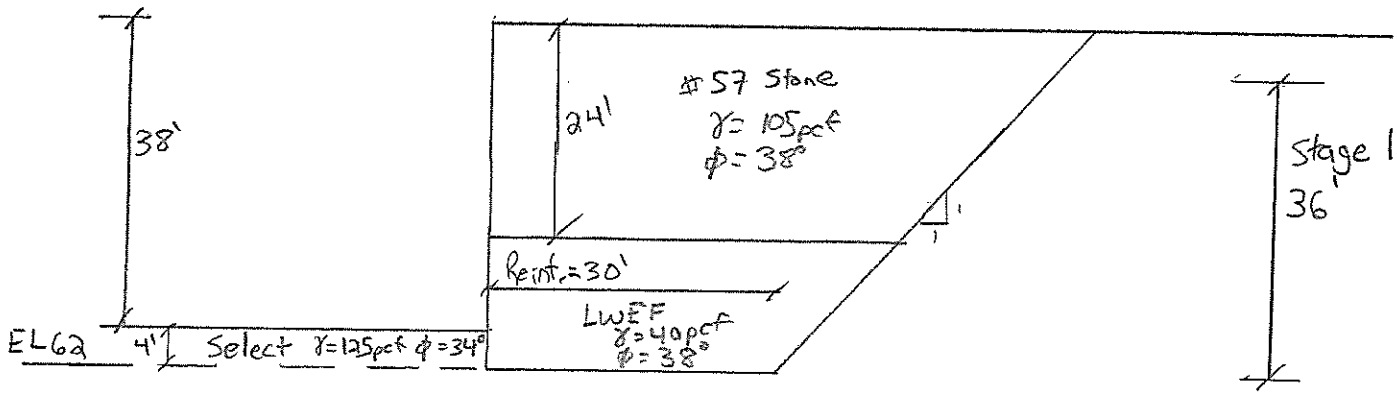
Profile described on page URS-S3-4
Lab data on page URS- 8

URS

Job SR 1 / I-95 Interchange
Description Retaining wall 3 + Ramp B over SR 7 Abut B Wingwall
Bearing Capacity, Sliding + Overturning

Project No.
Computed by JPK
Checked by

Page ___ of ___
Sheet ___ of ___
Date
Date
Reference



Clay
γ = 120pcf

CD	CU	UU @ Stage 1
φ = 24°	φ = 10.3°	φ = 0
c = 0	c = 940psf	c = 1250 psf
	TS = 250 psf	TS = 0

EL30 ▽ Traffic Surcharge = 250 psf

Settlement

Assumptions:

1) 6 feet of overburden removed to reach bottom of footing.
2) 20 feet of clay layer consolidating (based on test embankment back calculation)
3) Consolidation parameters from URS-4, 4-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Retaining Wall 3 & Ramp B over SR 7 - Abutment B Wingwall
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	38	feet	
Embedment (below grade)	Df =	4	feet	
Total Height (Hw+Df)	H =	42	feet	
Wall Base Width	B =	30	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11 10.2.1)
Total Footing Length (=Length of Wall)	L =	264	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	32	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	24	feet	
Top Material Unit Weight	γ1 =	105	pcf	
Top Material Φ	Φ1 =	38	degrees	
Bottom Material Height	H2 =	18	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	38	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	77.14	pcf	
Retained Wedge - Vertical Component	Wrw	40	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	19.5	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.238	(dim)	
Horiz F2 Surcharge	F2 =	2.5	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	97.2	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	33.7	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	39.3	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	39.3	k/ft	**Capacity Demand Ratio (CDR)= 1.17**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	5.16	ft	**e < 0.25*B, OK**
Effective Width	B' =	19.7	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	4.94	ksf	
Factored Bearing Pressure	Sigv =	7.34	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.06	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.05	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.95	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.81	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	18.2	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	11.83	ksf	**Capacity Demand Ratio (CDR)= 1.613**
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming
Foundation Φ	Φf =	10.3	degrees	quarantine period after Stage 1
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS-2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.03	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.02	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.95	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.81	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	11.3	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.36	ksf	**Capacity Demand Ratio (CDR)= 1.004**
				CDR > 1.0, OK

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Retaining Wall 3 & Ramp B over SR 7 - Abutment B Wingwall
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	32	feet	
Embedment (below grade)	Df =	4	feet	
Total Height (Hw+Df)	H =	36	feet	
Wall Base Width	B =	30	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	264	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	32	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	18	feet	
Top Material Unit Weight	γ1 =	105	pcf	
Top Material Φ	Φ1 =	38	degrees	
Bottom Material Height	H2 =	18	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	38	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	72.50	pcf	
Retained Wedge - Vertical Component	Wrw	28	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	13.7	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.238	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	78.3	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	20.5	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	39.3	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	39.3	k/ft	**Capacity Demand Ratio (CDR)= 1.91**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	3.14	ft	**e < 0.25*B, OK**
Effective Width	B' =	23.7	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	4.46	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.06	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.05	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.95	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.81	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	18.2	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	11.83	ksf	**Capacity Demand Ratio (CDR)= 2.654**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1, quarantine period to follow
Foundation Φ	Φf =	0.0	degrees	
Foundation Cohesion (c)	cf =	1250	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.02	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.81	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	7.1	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	4.60	ksf	**Capacity Demand Ratio (CDR)= 1.031**
				CDR > 1.0, OK

Predicted Settlement Calculations: Retaining Wall 3 & Ramp B over SR 7 - Abutment B West Wingwall
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c'' [3]
Initial Overburden	6				0.38				2.47			
I	10	0.851	0.065	0.33	0.69	3.48	0.37	0.85	2.41	1.72	0	2.297037
II	10	0.851	0.065	0.33	1.31	3.48	0.70	0.70	2.67	1.35	0	1.297228

Footing Width (ft)	30	0.00	3.59	in
		TOTAL	3.59	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS-S3-8
Lab data on page URS-4

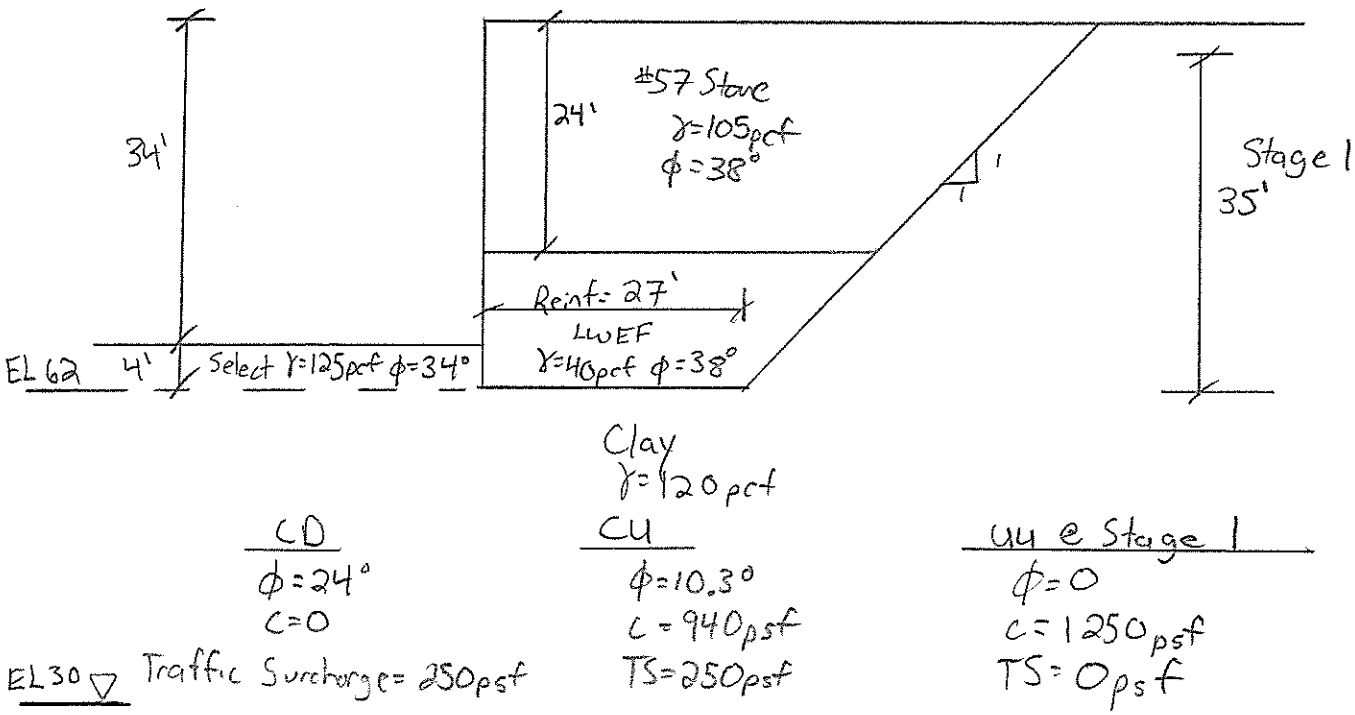
URS

Job SR 1 / I-95 Interchange | Project No. | Page ___ of ___ | Sheet ___ of ___

Description Ramp B over SR 7 | Computed by JPK | Date

Abut B Face | Checked by | Date

Bearing Capacity, Sliding & Overturning | Reference



Settlement

Assumptions:

1) 7 feet of overburden removed to reach bottom of footing
2) 20 feet of clay layer consolidating (based on test embankment back calculation)
3) Consolidation parameters from URS-4, 4-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp B over SR 7- Abutment B Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	34	feet	
Embedment (below grade)	Df =	4	feet	
Total Height (Hw+Df)	H =	38	feet	
Wall Base Width	B =	27	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	43	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	32	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	24	feet	
Top Material Unit Weight	γ1 =	105	pcf	
Top Material Φ	Φ1 =	38	degrees	
Bottom Material Height	H2 =	14	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	38	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	81.05	pcf	
Retained Wedge - Vertical Component	Wrw	34	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	16.5	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.238	(dim)	
Horiz F2 Surcharge	F2 =	2.3	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	83.2	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	28.7	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	35.5	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	35.5	k/ft	**Capacity Demand Ratio (CDR)= 1.24**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	4.68	ft	**e < 0.25*B, OK**
Effective Width	B' =	17.6	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	4.71	ksf	
Factored Bearing Pressure	Sigv =	7.03	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.31	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.28	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.75	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.85	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	15.8	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	10.29	ksf	**Capacity Demand Ratio (CDR)= 1.463**
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming
Foundation Φ	Φf =	10.3	degrees	quarantine period after Stage 1
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS-a
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.19	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.11	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.75	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.85	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	12.2	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.93	ksf	**Capacity Demand Ratio (CDR)= 1.128**
				CDR > 1.0, OK

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp B over SR 7- Abutment B Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	31	feet	
Embedment (below grade)	Df =	4	feet	
Total Height (Hw+Df)	H =	35	feet	
Wall Base Width	B =	27	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	43	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	32	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	21	feet	
Top Material Unit Weight	γ1 =	105	pcf	
Top Material Φ	Φ1 =	38	degrees	
Bottom Material Height	H2 =	14	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	38	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	79.00	pcf	
Retained Wedge - Vertical Component	Wrw	28	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	13.8	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.238	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	74.7	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	20.7	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	35.5	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	35.5	k/ft	**Capacity Demand Ratio (CDR)= 1.72**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	3.23	ft	**e < 0.25*B, OK**
Effective Width	B' =	20.5	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	4.91	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.31	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.28	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.75	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.85	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	15.8	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	10.29	ksf	**Capacity Demand Ratio (CDR)= 2.097**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1, quarantine period to follow
Foundation Φ	Φi =	0.0	degrees	
Foundation Cohesion (c)	ci =	1250	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.13	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.85	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	7.7	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	5.03	ksf	**Capacity Demand Ratio (CDR)= 1.024**
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp B over SR 7 - Abutment B Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c'' [3]	
Initial Overburden	7				0.44				2.36				
I	10	0.851	0.065	0.33	0.75	3.48	0.44	0.85	2.32	1.57	0	2.065444	
II	10	0.851	0.065	0.33	1.38	3.48	0.81	0.65	2.47	1.10	0	1.073113	
Footing Width (ft)	27										0.00	3.14	in
										TOTAL		3.14	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS-S3-12
Lab data on page URS-4

Global Stability

Short-term Case

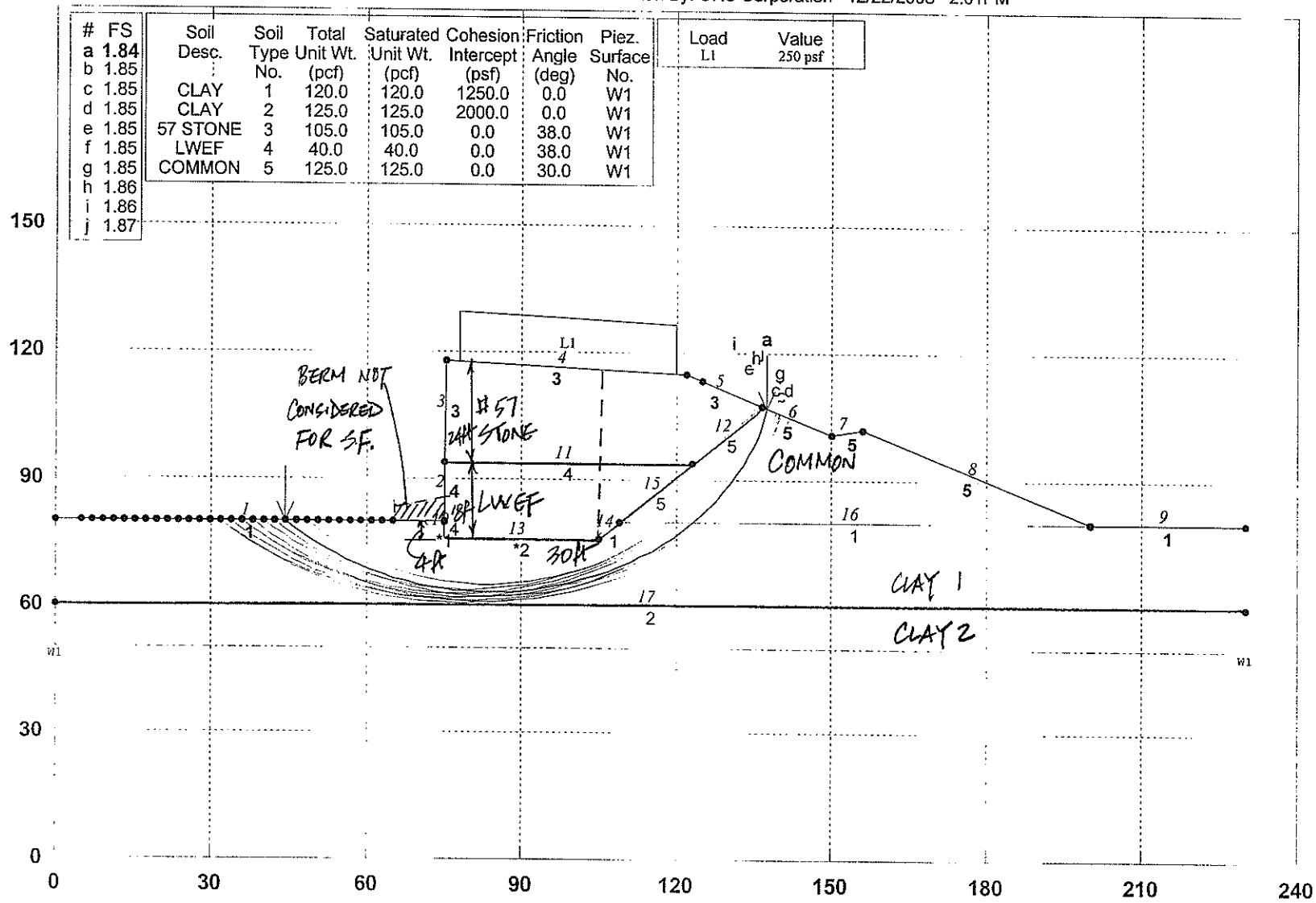
SR1/I95 Interchange CS-3 (Reversed)

Z:\DELDOT\SR1DEC~1\CS-3.PL2 Run By: URS Corporation 12/22/2008 2:01PM

#	FS
a	1.84
b	1.85
c	1.85
d	1.85
e	1.85
f	1.85
g	1.85
h	1.86
i	1.86
j	1.87

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	1250.0	0.0	W1
CLAY	2	125.0	125.0	2000.0	0.0	W1
57 STONE	3	105.0	105.0	0.0	38.0	W1
LWEF	4	40.0	40.0	0.0	38.0	W1
COMMON	5	125.0	125.0	0.0	30.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.84

Safety Factors Are Calculated By The Modified Bishop Method

STED

* For Cross section location See URS-11

URS S3-17

Long-term Case

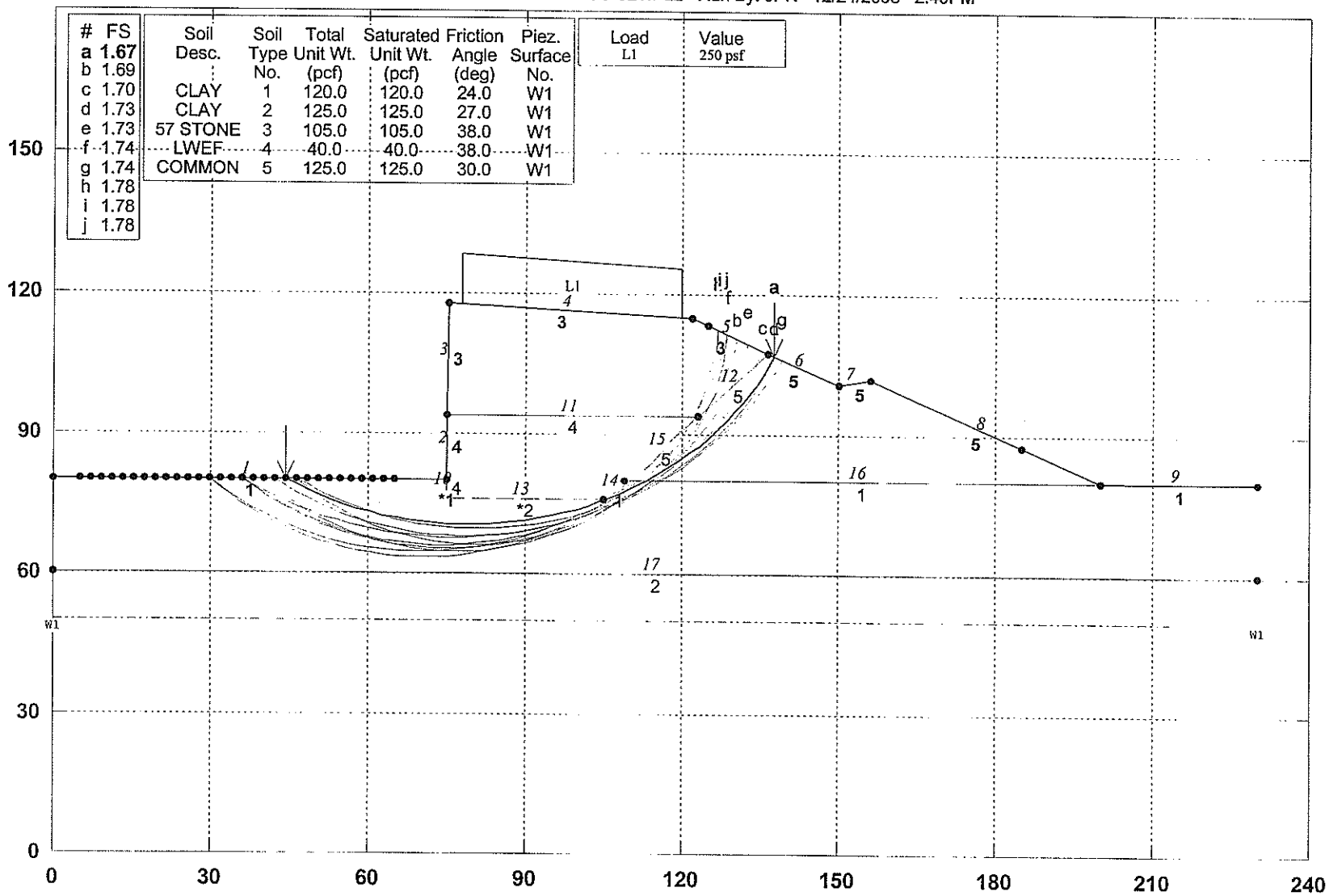
SR1/I95 Interchange CS-3 (Reversed) Long-Term

Z:\DELDOT\SR1DEC~1\CS-3LT.PL2 Run By: JPK 12/24/2008 2:49PM

#	FS
a	1.67
b	1.69
c	1.70
d	1.73
e	1.73
f	1.74
g	1.74
h	1.78
i	1.78
j	1.78

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	24.0	W1
CLAY	2	125.0	125.0	27.0	W1
57 STONE	3	105.0	105.0	38.0	W1
LWEF	4	40.0	40.0	38.0	W1
COMMON	5	125.0	125.0	30.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.67

Safety Factors Are Calculated By The Modified Bishop Method

STED

Short-term Case

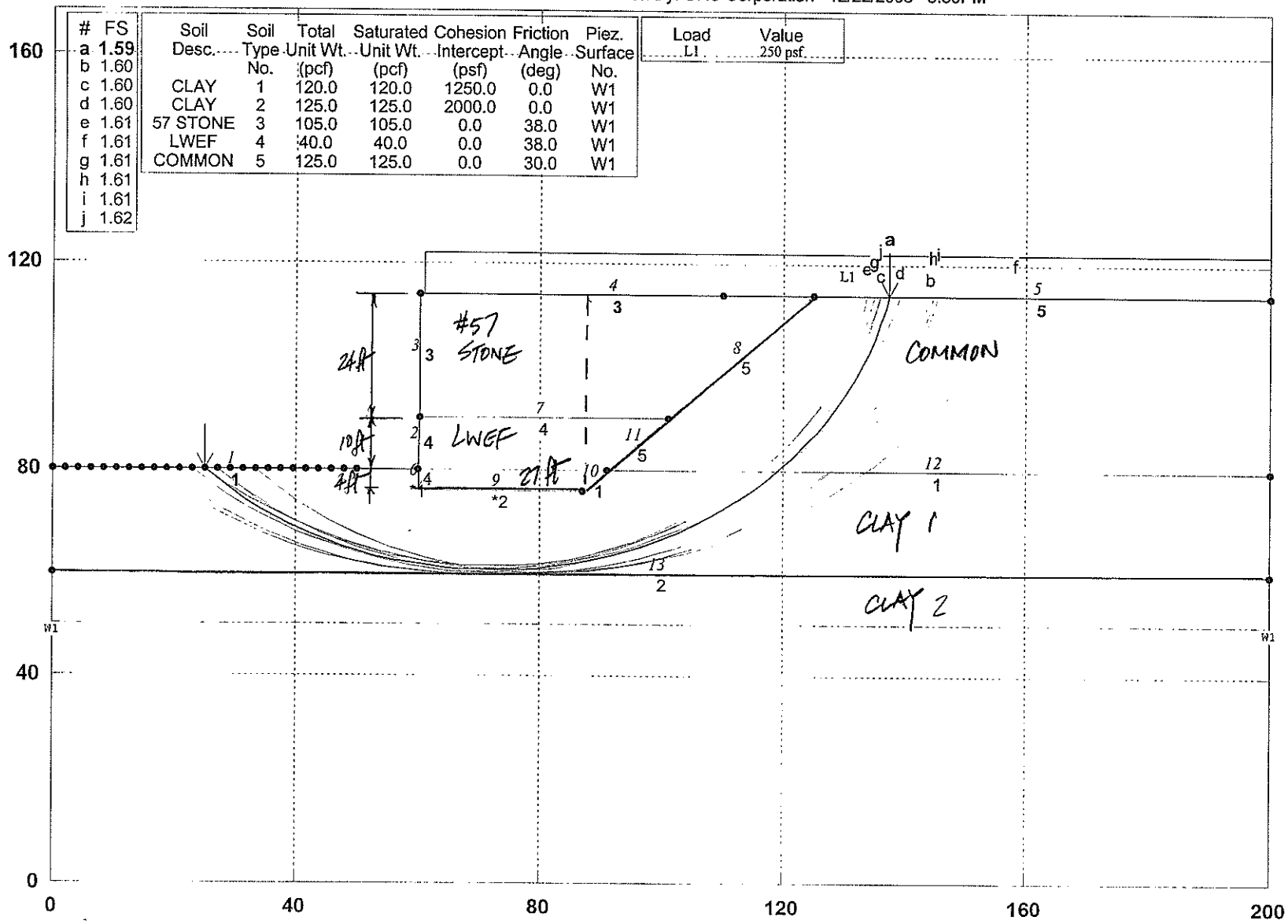
SR1/I95 Interchange CS-5

Z:\DELDOT\SR1DEC~1\CS-5.PL2 Run By: URS Corporation 12/22/2008 3:39PM

#	FS
a	1.59
b	1.60
c	1.60
d	1.60
e	1.61
f	1.61
g	1.61
h	1.61
i	1.61
j	1.62

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	1250.0	0.0	W1
CLAY	2	125.0	125.0	2000.0	0.0	W1
57 STONE	3	105.0	105.0	0.0	38.0	W1
LWEF	4	40.0	40.0	0.0	38.0	W1
COMMON	5	125.0	125.0	0.0	30.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.59

Safety Factors Are Calculated By The Modified Bishop Method

STED

Long-term Case

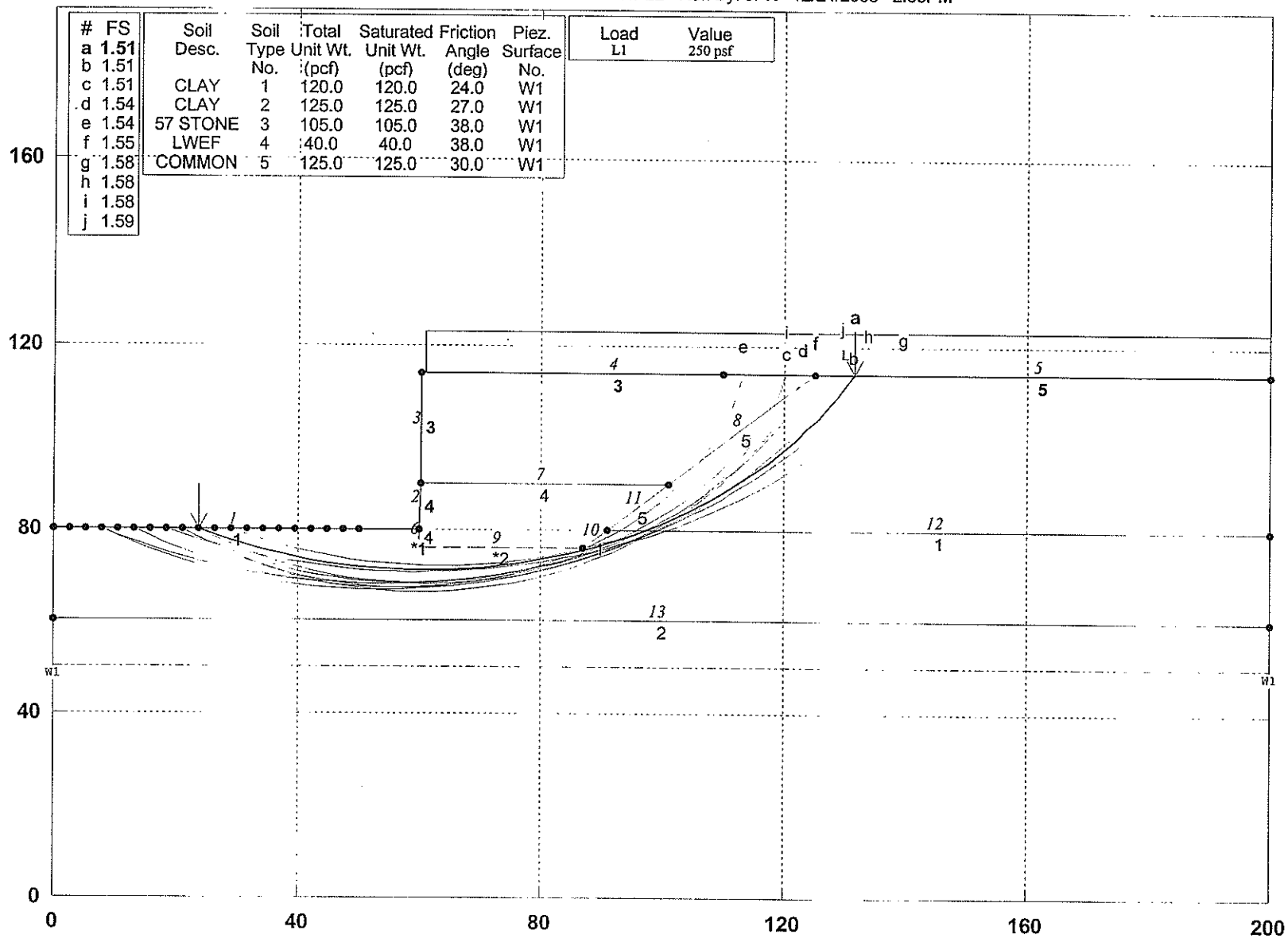
SR1/I95 Interchange CS-5 Long-Term

Z:\DELDOT\SR1DEC~1\CS-5LT.PL2 Run By: JPK 12/24/2008 2:55PM

#	FS
a	**1.51**
b	1.51
c	1.51
d	1.54
e	1.54
f	1.55
g	1.58
h	1.58
i	1.58
j	1.59

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	24.0	W1
CLAY	2	125.0	125.0	27.0	W1
57 STONE	3	105.0	105.0	38.0	W1
LWEF	4	40.0	40.0	38.0	W1
COMMON	5	125.0	125.0	30.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.51

Safety Factors Are Calculated By The Modified Bishop Method

STED

URS S3-20

Short-term Case

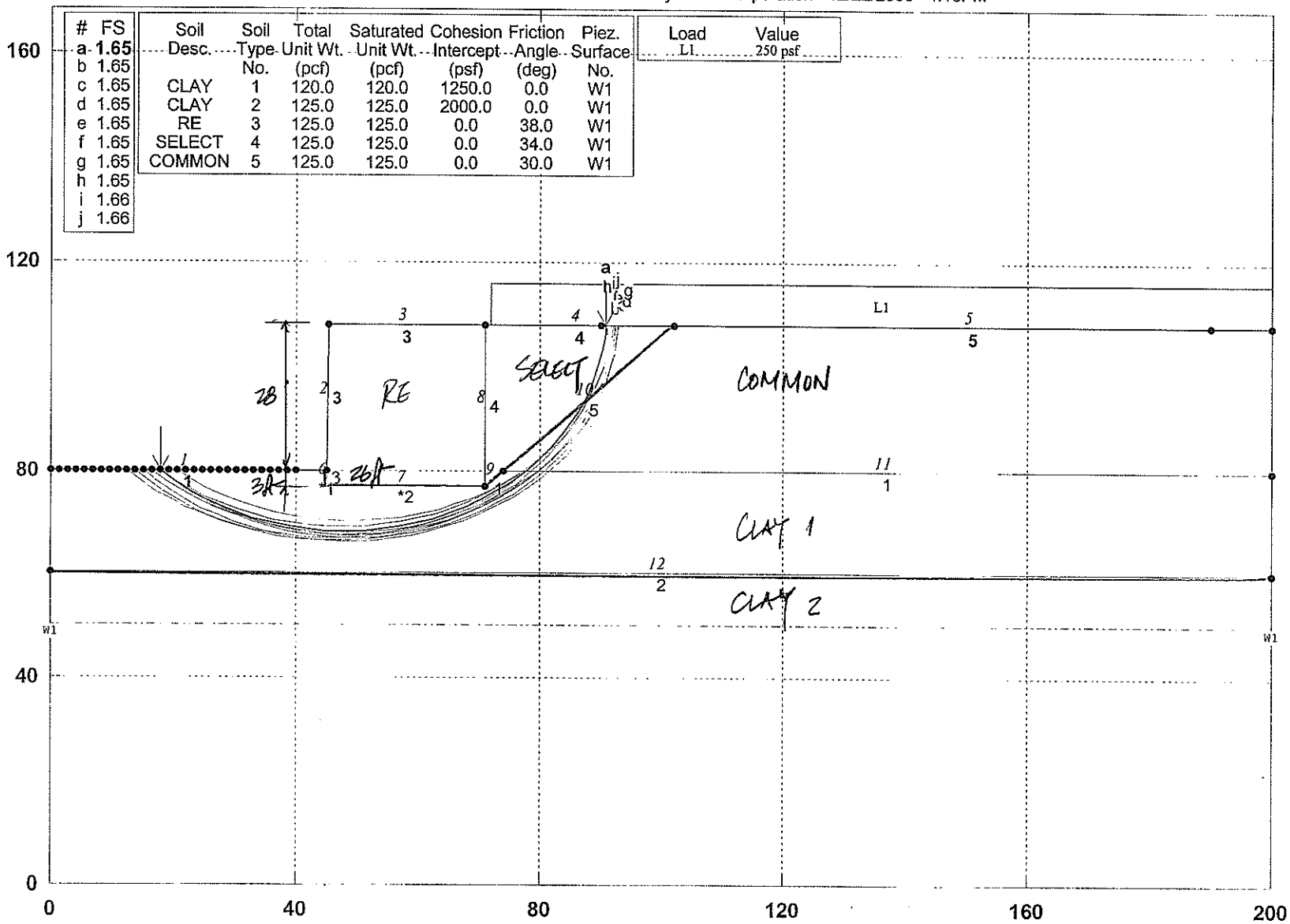
SR1/I95 Interchange CS-6

Z:\DELDOT\SR1DEC~1\CS-6.PL2 Run By: URS Corporation 12/22/2008 4:16PM

#	FS
a	1.65
b	1.65
c	1.65
d	1.65
e	1.65
f	1.65
g	1.65
h	1.65
i	1.66
j	1.66

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	1250.0	0.0	W1
CLAY	2	125.0	125.0	2000.0	0.0	W1
RE	3	125.0	125.0	0.0	38.0	W1
SELECT	4	125.0	125.0	0.0	34.0	W1
COMMON	5	125.0	125.0	0.0	30.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.65

Safety Factors Are Calculated By The Modified Bishop Method

STED

Long-term Case

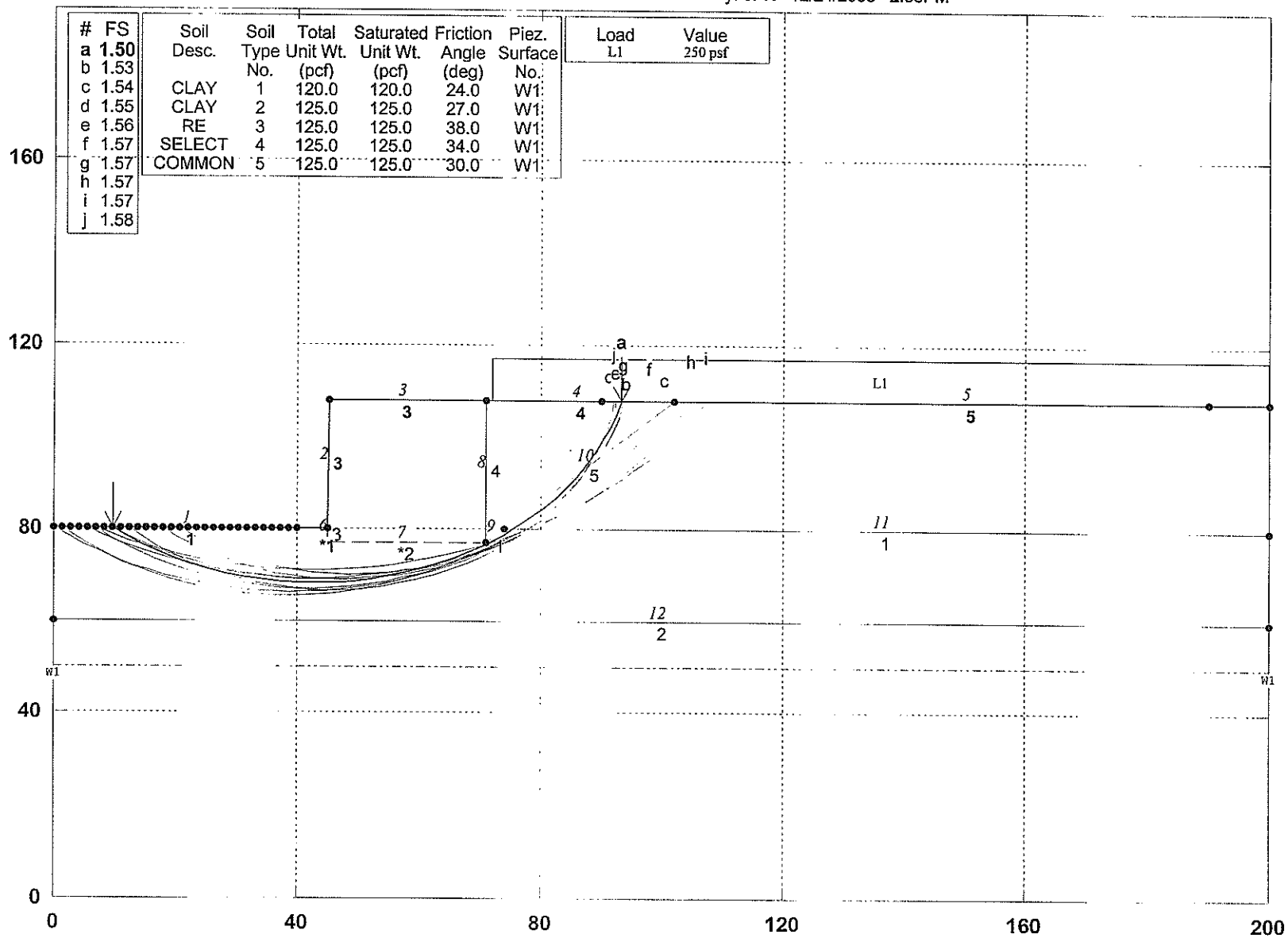
SR1/I95 Interchange CS-6 Long-Term

Z:\DELDOT\SR1DEC~1\CS-6LT.PL2 Run By: JPK 12/24/2008 2:55PM

#	FS
a	**1.50**
b	1.53
c	1.54
d	1.55
e	1.56
f	1.57
g	1.57
h	1.57
i	1.57
j	1.58

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	24.0	W1
CLAY	2	125.0	125.0	27.0	W1
RE	3	125.0	125.0	38.0	W1
SELECT	4	125.0	125.0	34.0	W1
COMMON	5	125.0	125.0	30.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.50

Safety Factors Are Calculated By The Modified Bishop Method

STED

Axial Capacity

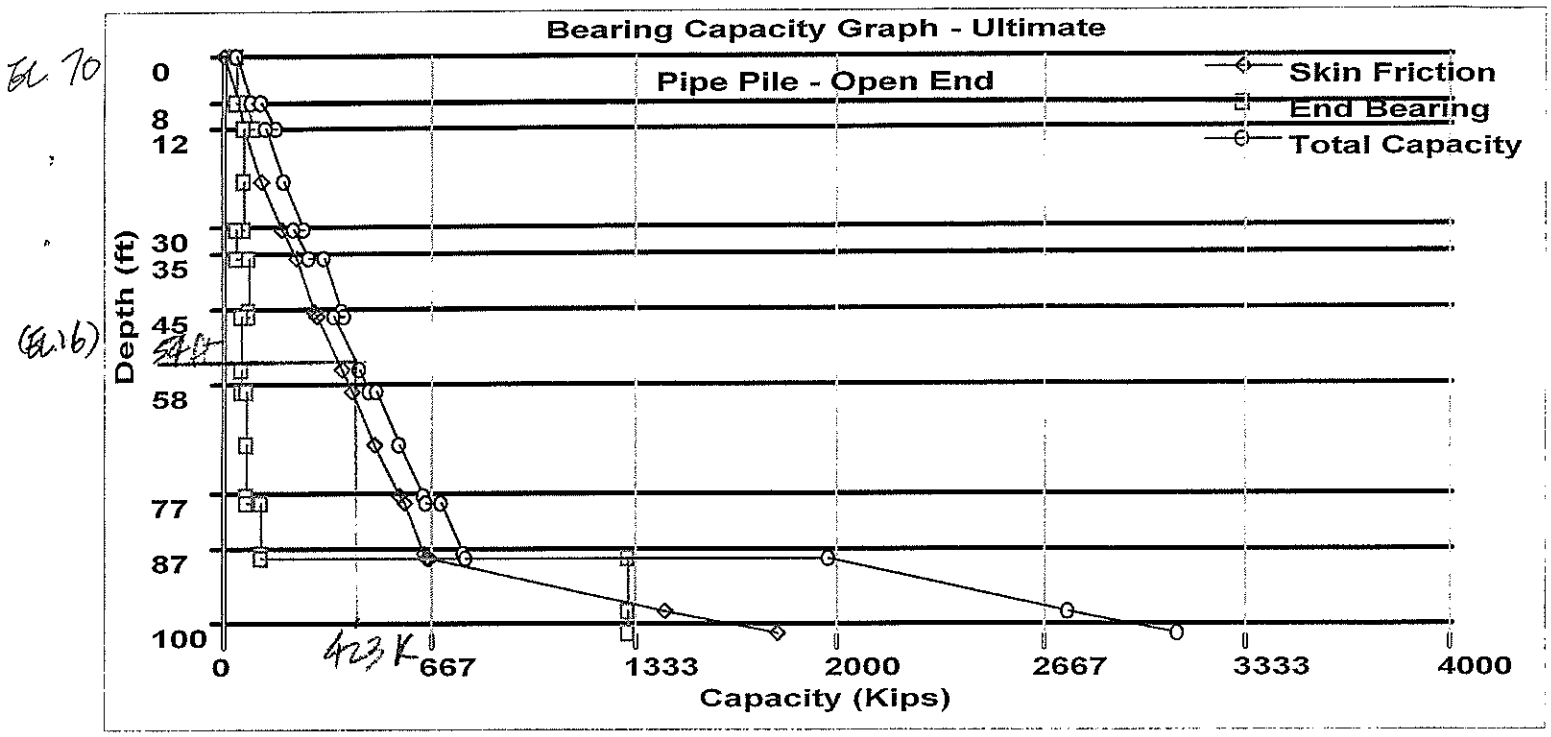
DelDOT SR1 / I-95 Interchange
Preliminary Pile Estimate

16-Dec-08

Location	Foundation	Required Factored Resistance, kip	Nominal Resistance, kip	Size of Pipe Pile		Estimated Pile Tip El.
				Diameter, in.	Wall in.	
S3-Ramp B Over SR 7	Abut A	275	423	24	0.5	16
	Pier 1	775	1192	36	0.625	**-13**
	Abut B	275	423	24	0.5	19

* 0.65 Resistance factor. Required capacity factor = 1.54

Filename: Z:\DELDOT\SR1DEC~1\B-R7UTA.DVN RAMP B/SR7 ABUT A 24"Φ 0.5" WALL

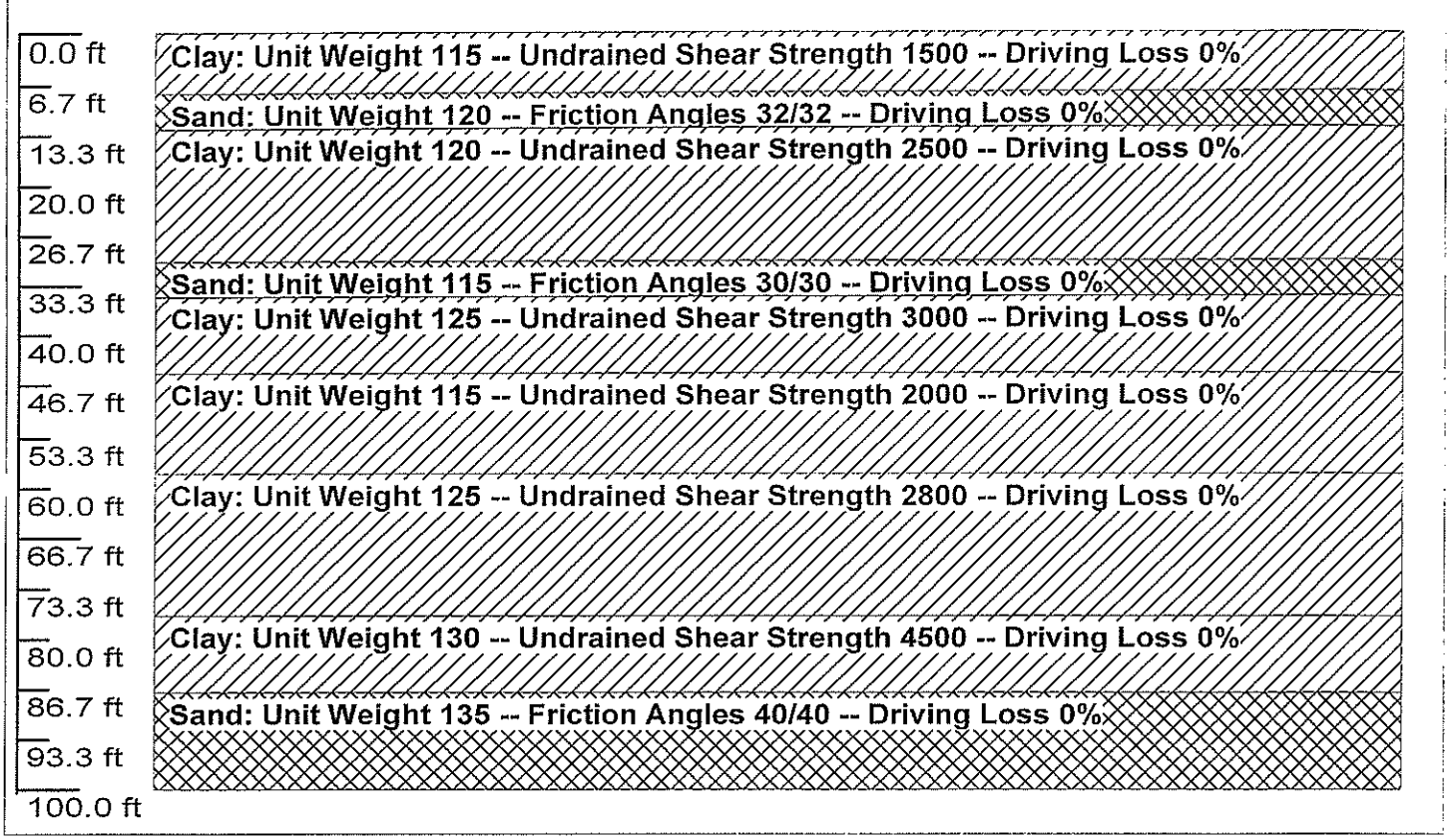


REQUIRED CAPACITY = 423K

EST. PILE TIP = EL. 16

Filename: Z:\DELDOT\SR1DEC~1\B-R7UTA.DVN RAMP B / SR7 ABUT A

Soil Profile BORING IBR-09A



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\B-R7UTA.DVN
Project Name: Ramp B / I95 Abut A
Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-09A Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 24.00 in
Shell Thickness: 0.50 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	42.00 ft
	- Driving/Restrike	42.00 ft
	- Ultimate:	42.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	8.00 ft	0.00%	115.00 pcf	1500.00 psf	T-79 Steel
2	Cohesionless	4.50 ft	0.00%	120.00 pcf	32.0/32.0	Nordlund
3	Cohesive	17.50 ft	0.00%	120.00 pcf	2500.00 psf	T-79 Steel
4	Cohesionless	5.00 ft	0.00%	115.00 pcf	30.0/30.0	Nordlund
5	Cohesive	10.00 ft	0.00%	125.00 pcf	3000.00 psf	T-79 Steel
6	Cohesive	13.00 ft	0.00%	115.00 pcf	2000.00 psf	T-79 Steel
7	Cohesive	19.00 ft	0.00%	125.00 pcf	2800.00 psf	T-79 Steel
8	Cohesive	10.00 ft	0.00%	130.00 pcf	4500.00 psf	T-79 Steel
9	Cohesionless	13.00 ft	0.00%	135.00 pcf	40.0/40.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1060.00 psf	0.07 Kips
7.99 ft	Cohesive	N/A	N/A	1060.00 psf	53.21 Kips
8.01 ft	Cohesionless	920.60 psf	27.55	N/A	53.31 Kips
12.49 ft	Cohesionless	1189.40 psf	27.55	N/A	70.14 Kips
12.51 ft	Cohesive	N/A	N/A	1000.00 psf	70.25 Kips
21.51 ft	Cohesive	N/A	N/A	1013.21 psf	127.55 Kips
29.99 ft	Cohesive	N/A	N/A	1087.41 psf	189.69 Kips
30.01 ft	Cohesionless	3560.58 psf	25.83	N/A	189.86 Kips
34.99 ft	Cohesionless	3846.93 psf	25.83	N/A	238.75 Kips
35.01 ft	Cohesive	N/A	N/A	917.58 psf	238.92 Kips
44.01 ft	Cohesive	N/A	N/A	994.08 psf	295.14 Kips
44.99 ft	Cohesive	N/A	N/A	1002.42 psf	301.78 Kips
45.01 ft	Cohesive	N/A	N/A	1310.89 psf	301.93 Kips
54.01 ft	Cohesive	N/A	N/A	1363.39 psf	379.03 Kips
57.99 ft	Cohesive	N/A	N/A	1386.61 psf	415.02 Kips
58.01 ft	Cohesive	N/A	N/A	1201.17 psf	415.19 Kips
67.01 ft	Cohesive	N/A	N/A	1282.55 psf	487.72 Kips
76.01 ft	Cohesive	N/A	N/A	1363.92 psf	569.45 Kips
76.99 ft	Cohesive	N/A	N/A	1372.78 psf	578.91 Kips
77.01 ft	Cohesive	N/A	N/A	1235.58 psf	579.08 Kips
86.01 ft	Cohesive	N/A	N/A	1260.00 psf	650.34 Kips
86.99 ft	Cohesive	N/A	N/A	1260.00 psf	658.10 Kips
87.01 ft	Cohesionless	7747.36 psf	31.92	N/A	659.00 Kips
96.01 ft	Cohesionless	8074.06 psf	31.92	N/A	1436.34 Kips
99.99 ft	Cohesionless	8218.54 psf	31.92	N/A	1800.15 Kips

B-R7UTA-8

ULTIMATE - END BEARING

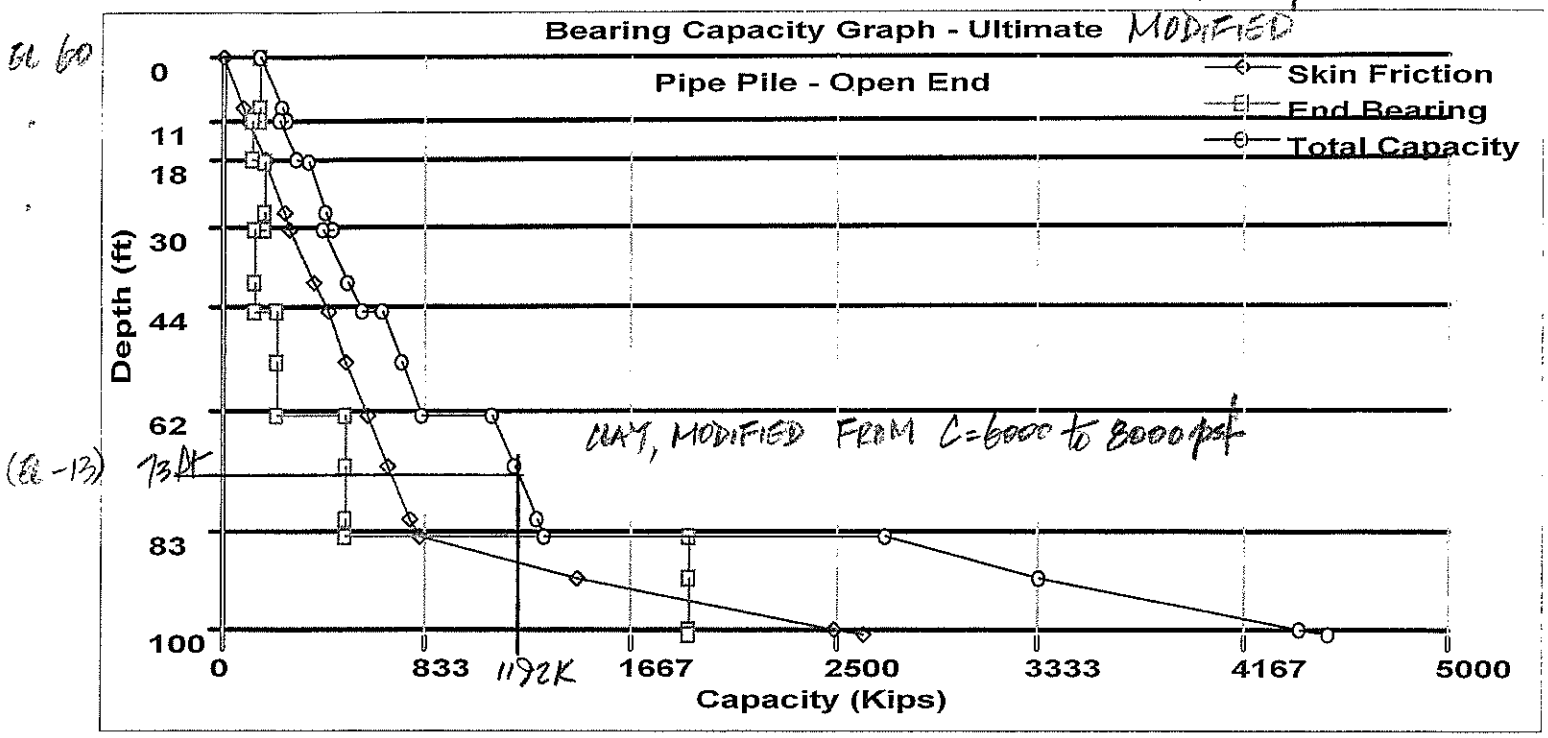
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
7.99 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
8.01 ft	Cohesionless	921.20 psf	40.40	103.67 Kips	73.14 Kips
12.49 ft	Cohesionless	1458.80 psf	40.40	103.67 Kips	103.67 Kips
12.51 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
21.51 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
29.99 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
30.01 ft	Cohesionless	3561.15 psf	30.00	41.85 Kips	41.85 Kips
34.99 ft	Cohesionless	4133.85 psf	30.00	41.85 Kips	41.85 Kips
35.01 ft	Cohesive	N/A	N/A	N/A	84.82 Kips
44.01 ft	Cohesive	N/A	N/A	N/A	84.82 Kips
44.99 ft	Cohesive	N/A	N/A	N/A	84.82 Kips
45.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
54.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
57.99 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
58.01 ft	Cohesive	N/A	N/A	N/A	79.17 Kips
67.01 ft	Cohesive	N/A	N/A	N/A	79.17 Kips
76.01 ft	Cohesive	N/A	N/A	N/A	79.17 Kips
76.99 ft	Cohesive	N/A	N/A	N/A	79.17 Kips
77.01 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
86.01 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
86.99 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
87.01 ft	Cohesionless	7747.73 psf	160.00	1311.93 Kips	1311.93 Kips
96.01 ft	Cohesionless	8401.13 psf	160.00	1311.93 Kips	1311.93 Kips
99.99 ft	Cohesionless	8690.07 psf	160.00	1311.93 Kips	1311.93 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.07 Kips	42.41 Kips	42.48 Kips
7.99 ft	53.21 Kips	42.41 Kips	95.63 Kips
8.01 ft	53.31 Kips	73.14 Kips	126.45 Kips
12.49 ft	70.14 Kips	103.67 Kips	173.81 Kips
12.51 ft	70.25 Kips	70.69 Kips	140.94 Kips
21.51 ft	127.55 Kips	70.69 Kips	198.23 Kips
29.99 ft	189.69 Kips	70.69 Kips	260.37 Kips
30.01 ft	189.86 Kips	41.85 Kips	231.70 Kips
34.99 ft	238.75 Kips	41.85 Kips	280.60 Kips
35.01 ft	238.92 Kips	84.82 Kips	323.74 Kips
44.01 ft	295.14 Kips	84.82 Kips	379.96 Kips
44.99 ft	301.78 Kips	84.82 Kips	386.60 Kips
45.01 ft	301.93 Kips	56.55 Kips	358.48 Kips
54.01 ft	379.03 Kips	56.55 Kips	435.58 Kips
57.99 ft	415.02 Kips	56.55 Kips	471.57 Kips
58.01 ft	415.19 Kips	79.17 Kips	494.36 Kips
67.01 ft	487.72 Kips	79.17 Kips	566.89 Kips
76.01 ft	569.45 Kips	79.17 Kips	648.62 Kips
76.99 ft	578.91 Kips	79.17 Kips	658.08 Kips
77.01 ft	579.08 Kips	127.23 Kips	706.32 Kips
86.01 ft	650.34 Kips	127.23 Kips	777.57 Kips
86.99 ft	658.10 Kips	127.23 Kips	785.33 Kips
87.01 ft	659.00 Kips	1311.93 Kips	1970.93 Kips
96.01 ft	1436.34 Kips	1311.93 Kips	2748.27 Kips
99.99 ft	1800.15 Kips	1311.93 Kips	3112.08 Kips

B-R7UTA-10

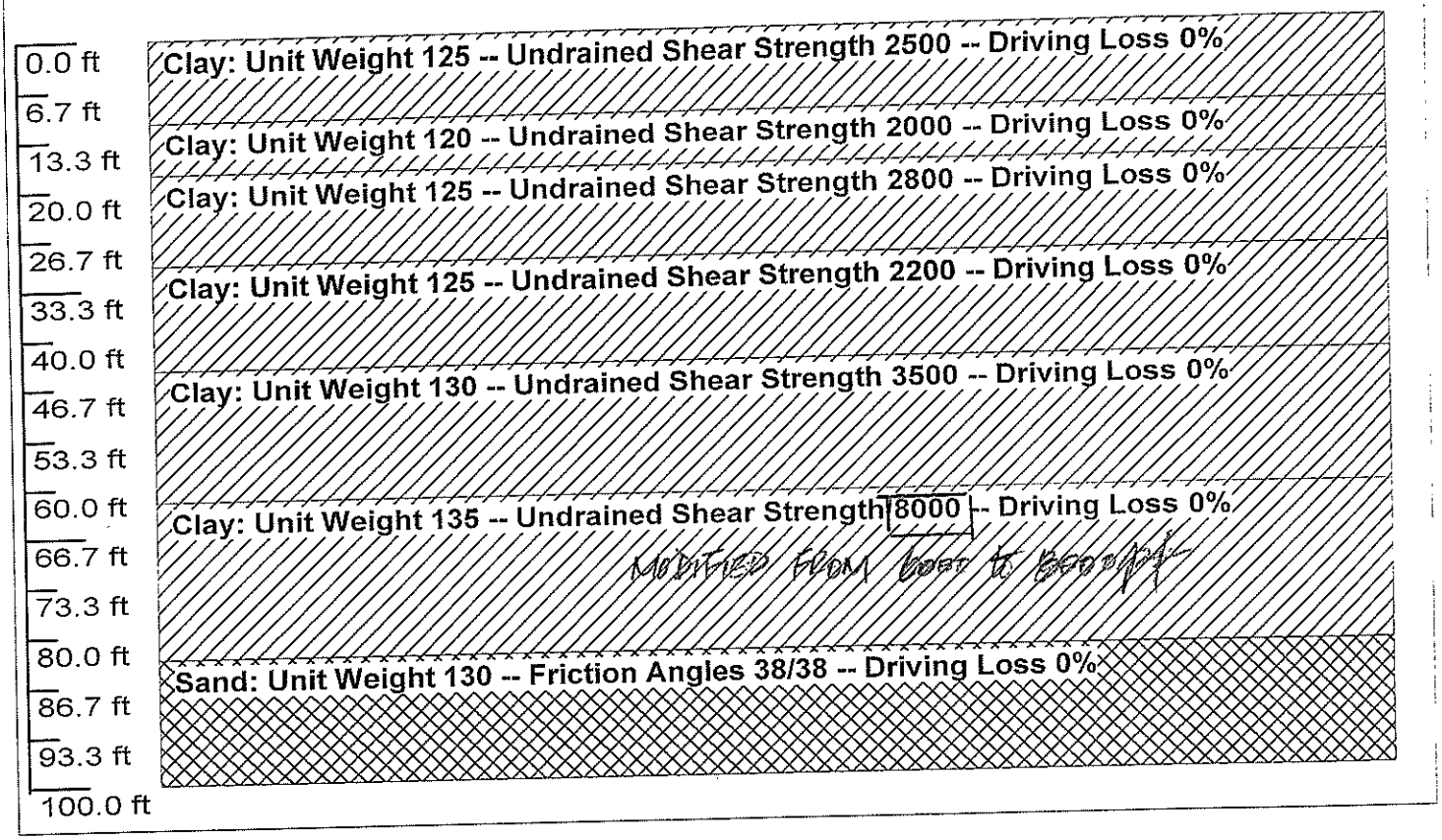
Filename: Z:\DELDOT\SR1DEC~1\B-R7P1B.DVN RAMP B/SR 7 PIER # 36" ϕ 0.625" WALL



REQUIRED CAPACITY = 1192 K
EST. PILE TIP = -13

Filename: Z:\DELDOT\SR1DEC~1\B-R7P1B.DVN RAMP B/SR 7 PIER 1 36"Φ

Soil Profile BORING IBR-09 MODIFIED



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\B-R7P1B.DVN
Project Name: Ramp B / SR7 Pier 1 Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-09 Profile modify

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 36.00 in
Shell Thickness: 0.62 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	30.00 ft
	- Driving/Restrike	30.00 ft
	- Ultimate:	30.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	11.00 ft	0.00%	125.00 pcf	2500.00 psf	T-79 Steel
2	Cohesive	7.00 ft	0.00%	120.00 pcf	2000.00 psf	T-79 Steel
3	Cohesive	12.00 ft	0.00%	125.00 pcf	2800.00 psf	T-79 Steel
4	Cohesive	14.00 ft	0.00%	125.00 pcf	2200.00 psf	T-79 Steel
5	Cohesive	18.00 ft	0.00%	130.00 pcf	3500.00 psf	T-79 Steel
6	Cohesive	21.00 ft	0.00%	135.00 pcf	8000.00 psf	T-79 Steel
7	Cohesionless	17.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund

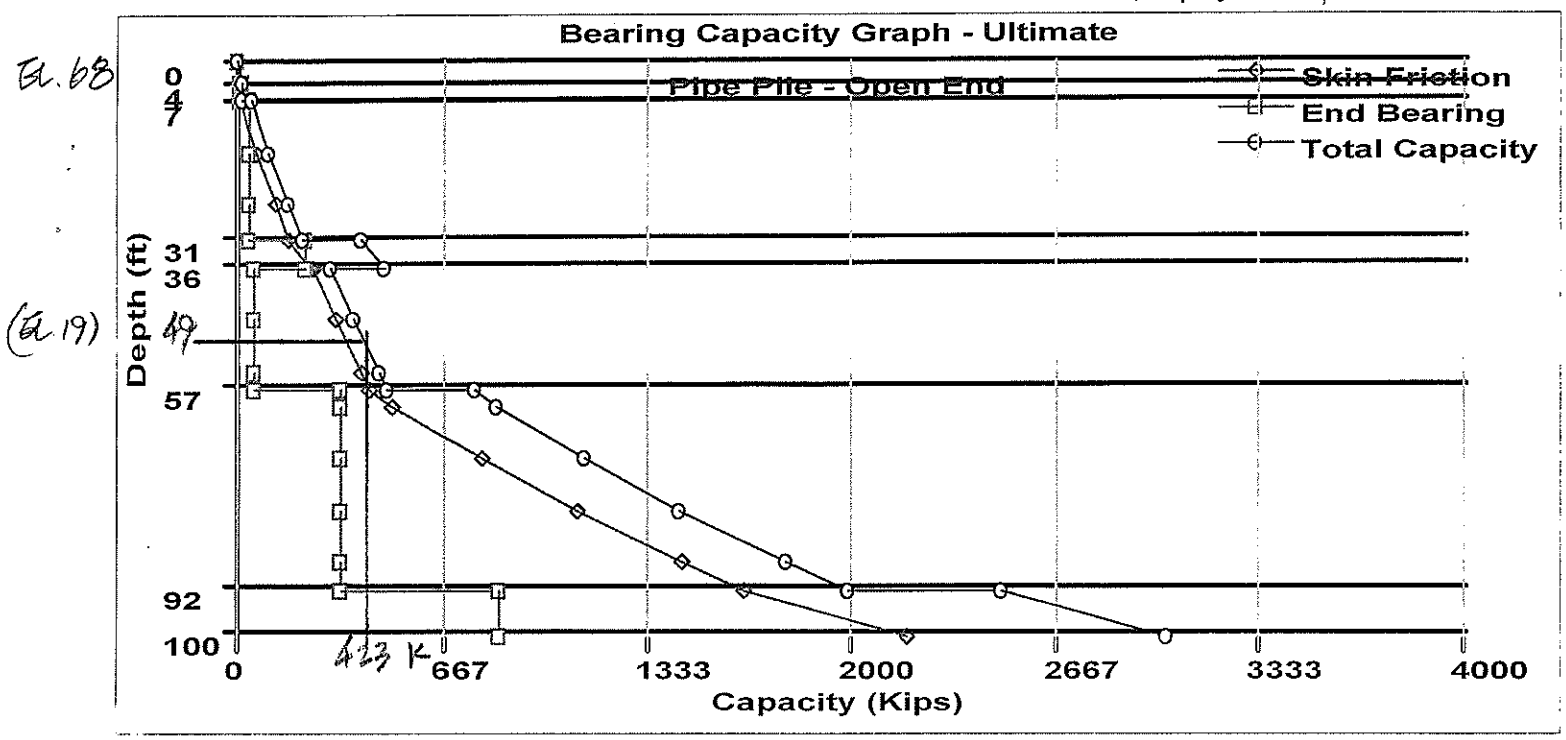
ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1000.00 psf	0.09 Kips
9.01 ft	Cohesive	N/A	N/A	1000.00 psf	84.92 Kips
10.99 ft	Cohesive	N/A	N/A	1000.00 psf	103.58 Kips
11.01 ft	Cohesive	N/A	N/A	1165.00 psf	103.78 Kips
17.99 ft	Cohesive	N/A	N/A	1165.00 psf	180.42 Kips
18.01 ft	Cohesive	N/A	N/A	857.50 psf	180.61 Kips
27.01 ft	Cohesive	N/A	N/A	857.50 psf	253.35 Kips
29.99 ft	Cohesive	N/A	N/A	857.50 psf	277.43 Kips
30.01 ft	Cohesive	N/A	N/A	1120.05 psf	277.62 Kips
39.01 ft	Cohesive	N/A	N/A	1166.05 psf	376.53 Kips
43.99 ft	Cohesive	N/A	N/A	1191.50 psf	434.62 Kips
44.01 ft	Cohesive	N/A	N/A	846.28 psf	434.81 Kips
53.01 ft	Cohesive	N/A	N/A	895.28 psf	510.76 Kips
61.99 ft	Cohesive	N/A	N/A	944.17 psf	594.82 Kips
62.01 ft	Cohesive	N/A	N/A	944.28 psf	595.01 Kips
71.01 ft	Cohesive	N/A	N/A	993.28 psf	679.26 Kips
80.01 ft	Cohesive	N/A	N/A	1042.28 psf	771.83 Kips
82.99 ft	Cohesive	N/A	N/A	1058.50 psf	804.32 Kips
83.01 ft	Cohesionless	7333.14 psf	36.67	N/A	805.31 Kips
89.99 ft	Cohesionless	7569.06 psf	36.67	N/A	1441.49 Kips
90.01 ft	Cohesionless	7806.34 psf	30.32	N/A	1443.55 Kips
99.01 ft	Cohesionless	8110.54 psf	30.32	N/A	2493.83 Kips
99.99 ft	Cohesionless	8143.66 psf	30.32	N/A	2612.95 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	159.04 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	159.04 Kips
10.99 ft	Cohesive	N/A	N/A	N/A	159.04 Kips
11.01 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
17.99 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	178.13 Kips
27.01 ft	Cohesive	N/A	N/A	N/A	178.13 Kips
29.99 ft	Cohesive	N/A	N/A	N/A	178.13 Kips
30.01 ft	Cohesive	N/A	N/A	N/A	139.96 Kips
39.01 ft	Cohesive	N/A	N/A	N/A	139.96 Kips
43.99 ft	Cohesive	N/A	N/A	N/A	139.96 Kips
44.01 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
53.01 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
61.99 ft	Cohesive	N/A	N/A	N/A	222.66 Kips
62.01 ft	Cohesive	N/A	N/A	N/A	508.94 Kips
71.01 ft	Cohesive	N/A	N/A	N/A	508.94 Kips
80.01 ft	Cohesive	N/A	N/A	N/A	508.94 Kips
82.99 ft	Cohesive	N/A	N/A	N/A	508.94 Kips
83.01 ft	Cohesionless	7333.48 psf	110.40	1898.62 Kips	1898.62 Kips
89.99 ft	Cohesionless	7805.32 psf	110.40	1898.62 Kips	1898.62 Kips
90.01 ft	Cohesionless	7806.68 psf	110.40	1898.62 Kips	1898.62 Kips
99.01 ft	Cohesionless	8415.08 psf	110.40	1898.62 Kips	1898.62 Kips
99.99 ft	Cohesionless	8481.32 psf	110.40	1898.62 Kips	1898.62 Kips

Filename: Z:\DELDOT\SR1DEC~1\B-R7UTB.DVN RAMP B/SR7 ABUT B 24"Φ 0.5" WALL

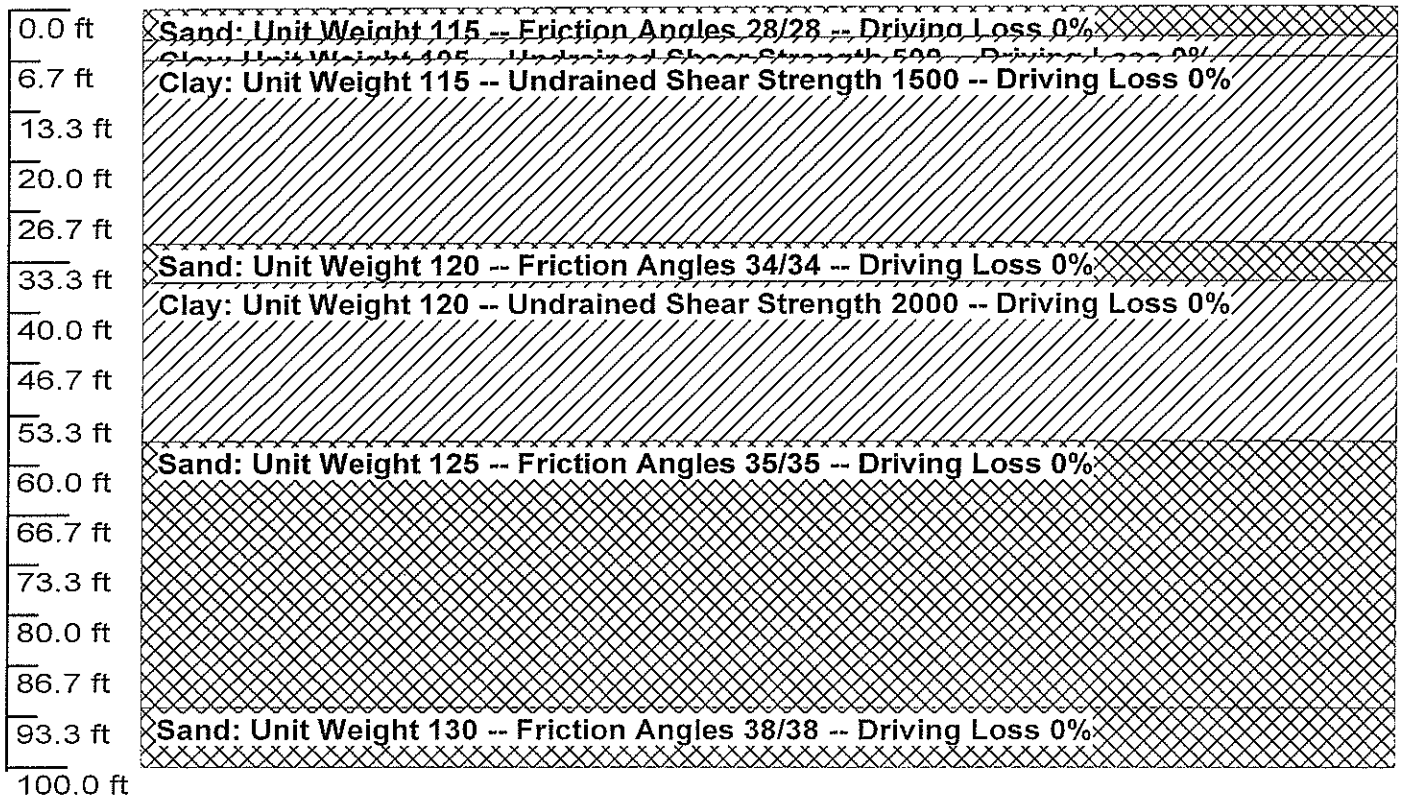


REQUIRED CAPACITY = 423 K

EST. PILE TIP = EL. 19

Filename: Z:\DELDOT\SR1DEC~1\B-R7UTB.DVN RAMP B/SR7 ABUT. B 24"ϕ 0.5" WALL

Soil Profile BORING IBR-10



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\B-R7UTB.DVN
Project Name: Ramp B / I95 Abut B
Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-10 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 24.00 in
Shell Thickness: 0.50 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	36.00 ft
	- Driving/Restrike	36.00 ft
	- Ultimate:	36.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	4.00 ft	0.00%	115.00 pcf	28.0/28.0	Nordlund
2	Cohesive	3.00 ft	0.00%	105.00 pcf	500.00 psf	T-79 Steel
3	Cohesive	24.00 ft	0.00%	115.00 pcf	1500.00 psf	T-79 Steel
4	Cohesionless	5.00 ft	0.00%	120.00 pcf	34.0/34.0	Nordlund
5	Cohesive	21.00 ft	0.00%	120.00 pcf	2000.00 psf	T-79 Steel
6	Cohesionless	35.00 ft	0.00%	125.00 pcf	35.0/35.0	Nordlund
7	Cohesionless	8.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.57 psf	24.11	N/A	0.00 Kips
3.99 ft	Cohesionless	229.43 psf	24.11	N/A	2.01 Kips
4.01 ft	Cohesive	N/A	N/A	410.00 psf	2.04 Kips
6.99 ft	Cohesive	N/A	N/A	410.00 psf	9.72 Kips
7.01 ft	Cohesive	N/A	N/A	1060.00 psf	9.81 Kips
16.01 ft	Cohesive	N/A	N/A	1060.00 psf	69.75 Kips
25.01 ft	Cohesive	N/A	N/A	1079.62 psf	131.92 Kips
30.99 ft	Cohesive	N/A	N/A	1103.04 psf	176.01 Kips
31.01 ft	Cohesionless	3535.60 psf	29.28	N/A	176.22 Kips
35.99 ft	Cohesionless	3834.40 psf	29.28	N/A	248.87 Kips
36.01 ft	Cohesive	N/A	N/A	1258.39 psf	249.10 Kips
45.01 ft	Cohesive	N/A	N/A	1310.89 psf	323.24 Kips
54.01 ft	Cohesive	N/A	N/A	1363.39 psf	403.31 Kips
56.99 ft	Cohesive	N/A	N/A	1380.78 psf	431.13 Kips
57.01 ft	Cohesionless	5344.91 psf	30.14	N/A	431.44 Kips
59.99 ft	Cohesionless	5438.19 psf	30.14	N/A	498.57 Kips
60.01 ft	Cohesionless	5532.71 psf	27.93	N/A	499.10 Kips
69.01 ft	Cohesionless	5814.41 psf	27.93	N/A	787.26 Kips
78.01 ft	Cohesionless	6096.11 psf	27.93	N/A	1103.33 Kips
87.01 ft	Cohesionless	6377.81 psf	27.93	N/A	1447.32 Kips
91.99 ft	Cohesionless	6533.69 psf	27.93	N/A	1649.67 Kips
92.01 ft	Cohesionless	7535.94 psf	30.32	N/A	1650.73 Kips
99.99 ft	Cohesionless	7805.66 psf	30.32	N/A	2184.46 Kips

B-R7UTB-8

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.15 psf	22.80	41.85 Kips	0.04 Kips
3.99 ft	Cohesionless	458.85 psf	22.80	41.85 Kips	17.62 Kips
4.01 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
6.99 ft	Cohesive	N/A	N/A	N/A	14.14 Kips
7.01 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
16.01 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
25.01 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
30.99 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
31.01 ft	Cohesionless	3536.20 psf	55.60	230.97 Kips	230.97 Kips
35.99 ft	Cohesionless	4133.80 psf	55.60	230.97 Kips	230.97 Kips
36.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
45.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
54.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
56.99 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
57.01 ft	Cohesionless	5345.23 psf	64.00	338.04 Kips	338.04 Kips
59.99 ft	Cohesionless	5531.77 psf	64.00	338.04 Kips	338.04 Kips
60.01 ft	Cohesionless	5533.03 psf	64.00	338.04 Kips	338.04 Kips
69.01 ft	Cohesionless	6096.43 psf	64.00	338.04 Kips	338.04 Kips
78.01 ft	Cohesionless	6659.83 psf	64.00	338.04 Kips	338.04 Kips
87.01 ft	Cohesionless	7223.23 psf	64.00	338.04 Kips	338.04 Kips
91.99 ft	Cohesionless	7534.97 psf	64.00	338.04 Kips	338.04 Kips
92.01 ft	Cohesionless	7536.28 psf	110.40	843.83 Kips	843.83 Kips
99.99 ft	Cohesionless	8075.72 psf	110.40	843.83 Kips	843.83 Kips

B-R7UTB-9

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.04 Kips	0.04 Kips
3.99 ft	2.01 Kips	17.62 Kips	19.62 Kips
4.01 ft	2.04 Kips	14.14 Kips	16.18 Kips
6.99 ft	9.72 Kips	14.14 Kips	23.86 Kips
7.01 ft	9.81 Kips	42.41 Kips	52.22 Kips
16.01 ft	69.75 Kips	42.41 Kips	112.16 Kips
25.01 ft	131.92 Kips	42.41 Kips	174.33 Kips
30.99 ft	176.01 Kips	42.41 Kips	218.42 Kips
31.01 ft	176.22 Kips	230.97 Kips	407.19 Kips
35.99 ft	248.87 Kips	230.97 Kips	479.84 Kips
36.01 ft	249.10 Kips	56.55 Kips	305.65 Kips
45.01 ft	323.24 Kips	56.55 Kips	379.78 Kips
54.01 ft	403.31 Kips	56.55 Kips	459.85 Kips
56.99 ft	431.13 Kips	56.55 Kips	487.67 Kips
57.01 ft	431.44 Kips	338.04 Kips	769.48 Kips
59.99 ft	498.57 Kips	338.04 Kips	836.60 Kips
60.01 ft	499.10 Kips	338.04 Kips	837.14 Kips
69.01 ft	787.26 Kips	338.04 Kips	1125.29 Kips
78.01 ft	1103.33 Kips	338.04 Kips	1441.36 Kips
87.01 ft	1447.32 Kips	338.04 Kips	1785.36 Kips
91.99 ft	1649.67 Kips	338.04 Kips	1987.70 Kips
92.01 ft	1650.73 Kips	843.83 Kips	2494.56 Kips
99.99 ft	2184.46 Kips	843.83 Kips	3028.29 Kips

B-R7UTB-10

Lateral Analysis

URS

Job SR-1 / I-95 Interchange
Description Ramp B - Pier 1
SR7

Project No.
Computed by JPK
Checked by

Page ___ of ___
Sheet ___ of ___
Date
Date

Reference

From borings 1BR-09 & URS-5 (DONE)
1192K 36" ϕ 0.625" WALL

EL. 60	Depth = 0 ft				
		1 CLAY X=132 in	γ=125 pcf ϕ=0 C=2500	N=20±	γ=0.072 ε=0.005 c=17.4 K=1500
EL 49	11 ft				
EL 42	18 ft	2 CLAY 216 in	γ=120 ϕ=0 C=2000	N=15+	γ=0.069 K=1200 c=13.9 ε=0.0068
EL 30 (ASSUMED)	30 ft	3 CLAY 360 in	γ=125 ϕ=0 C=2800	N=25	γ=0.072 k=1650 c=19.4 ε=0.0058
		4 CLAY	γ=125 ϕ=0 ~~C=2500~~ C=2200	N=15	
EL 16	44 ft				
		5 CLAY	γ=130 ϕ=0 C=3500	N=30±	
EL -2	62 ft				
		6 CLAY	γ=135 ϕ=0° C=6000	N=50±	
EL -23	83 ft				
		7 SAND	γ=130 ϕ=38° C=0	N=40+	
EL -40	100 ft				

Total Shear = 275 K

12 piles

Assume 2x6 config

Table 10.7.2.4-1

Row 1 - 6 piles @ 1.0

Row 2 - 6 piles @ 0.5

$$\text{Shear per pile} = \frac{275\text{ K}}{6(1) + 6(0.5)} = 30.6$$

Axial = 775 K

Length Req'd = 15.5 ft

==========

LPILE Plus for Windows, Version 4.0 (4.0.8)

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

(c) Copyright ENSOFT, Inc., 1985-2003
All Rights Reserved

==========

This program is licensed to:

URS
URS

Path to file locations: D:\Program Files\Ensoft\LpileP4\DelDOTSR1\
Name of input data file: S3P1.lpd
Name of output file: S3P1.lpo
Name of plot output file: S3P1.lpp
Name of runtime file: S3P1.lpr

Time and Date of Analysis

Date: January 22, 2009 Time: 11:56:32

Problem Title

Ramp B over SR 7 - Pier 1

Program Options

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 150
- Maximum number of iterations allowed = 100

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 186.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	36.000	10900.0000	69.5000	30000000.000
2	186.0000	36.000	10900.0000	69.5000	30000000.000

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 132.000 in
p-y subgrade modulus k for top of soil layer = 1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 1500.000 lbs/in**3

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 132.000 in
Distance from top of pile to bottom of layer = 216.000 in
p-y subgrade modulus k for top of soil layer = 1200.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 1200.000 lbs/in**3

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 216.000 in
Distance from top of pile to bottom of layer = 360.000 in
p-y subgrade modulus k for top of soil layer = 1650.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 1650.000 lbs/in**3

(Depth of lowest layer extends 174.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 6 points

Point	Depth X	Eff. Unit Weight

No.	in	lbs/in**3
1	.00	.07200
2	132.00	.07200
3	132.00	.06900
4	216.00	.06900
5	216.00	.07200
6	360.00	.07200

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 6 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	17.40000	.00	.00500	.0
2	132.000	17.40000	.00	.00500	.0
3	132.000	13.90000	.00	.00680	.0
4	216.000	13.90000	.00	.00680	.0
5	216.000	19.40000	.00	.00580	.0
6	360.000	19.40000	.00	.00580	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 30600.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 775000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 30600.000 lbs
Specified bending moment at pile head = .000 in-lbs
Specified axial load at pile head = 775000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.022323	-1.476E-06	30600.0000	-3.135E-04	11151.0791	-443.5745
1.240	.021935	37904.2322	30049.1313	-3.134E-04	11213.6733	-444.9234
2.480	.021546	75124.2120	29496.6236	-3.132E-04	11275.1375	-446.2180
3.720	.021158	111657.8132	28942.5446	-3.128E-04	11335.4682	-447.4577
4.960	.020770	147502.9966	28386.9627	-3.123E-04	11394.6621	-448.6422
6.200	.020383	182657.8101	27829.9464	-3.117E-04	11452.7159	-449.7711
7.440	.019997	217120.3900	27271.5652	-3.110E-04	11509.6266	-450.8438
8.680	.019612	250888.9613	26711.8889	-3.101E-04	11565.3912	-451.8599
9.920	.019228	283961.8385	26150.9881	-3.091E-04	11620.0069	-452.8190
11.160	.018846	316337.4265	25588.9336	-3.079E-04	11673.4712	-453.7205
12.400	.018465	348014.2211	25025.7971	-3.067E-04	11725.7815	-454.5641
13.640	.018085	378990.8096	24461.6508	-3.053E-04	11776.9355	-455.3493
14.880	.017708	409265.8719	23896.5673	-3.038E-04	11826.9310	-456.0756
16.120	.017332	438838.1810	23330.6201	-3.022E-04	11875.7660	-456.7425
17.360	.016958	467706.6036	22763.8830	-3.005E-04	11923.4387	-457.3496
18.600	.016587	495870.1010	22196.4306	-2.986E-04	11969.9472	-457.8963
19.840	.016218	523327.7301	21628.3379	-2.967E-04	12015.2901	-458.3822
21.080	.015851	550078.6437	21059.6808	-2.947E-04	12059.4659	-458.8067
22.320	.015487	576122.0915	20490.5355	-2.925E-04	12102.4734	-459.1695
23.560	.015125	601457.4208	19920.9791	-2.903E-04	12144.3116	-459.4699
24.800	.014767	626084.0773	19351.0892	-2.880E-04	12184.9794	-459.7074
26.040	.014411	650001.6062	18780.9440	-2.856E-04	12224.4763	-459.8816
27.280	.014059	673209.6525	18210.6224	-2.830E-04	12262.8015	-459.9919
28.520	.013709	695707.9619	17640.2041	-2.804E-04	12299.9547	-460.0377
29.760	.013363	717496.3822	17069.7693	-2.778E-04	12335.9355	-460.0185
31.000	.013020	738574.8633	16499.3989	-2.750E-04	12370.7440	-459.9338
32.240	.012681	758943.4588	15929.1745	-2.722E-04	12404.3803	-459.7829
33.480	.012345	778602.3263	15359.1786	-2.693E-04	12436.8444	-459.5654
34.720	.012013	797551.7288	14789.4941	-2.663E-04	12468.1370	-459.2806
35.960	.011685	815792.0350	14220.2049	-2.632E-04	12498.2586	-458.9278
37.200	.011361	833323.7209	13651.3955	-2.601E-04	12527.2101	-458.5066
38.440	.011040	850147.3703	13083.1513	-2.569E-04	12554.9922	-458.0163
39.680	.010723	866263.6757	12515.5583	-2.536E-04	12581.6063	-457.4562
40.920	.010411	881673.4397	11948.7036	-2.503E-04	12607.0536	-456.8257
42.160	.010103	896377.5756	11382.6748	-2.469E-04	12631.3357	-456.1240
43.400	.009799	910377.1087	10817.5605	-2.435E-04	12654.4542	-455.3506
44.640	.009499	923673.1771	10253.4502	-2.400E-04	12676.4110	-454.5047
45.880	.009203	936267.0331	9690.4343	-2.365E-04	12697.2082	-453.5855
47.120	.008912	948160.0441	9128.6040	-2.329E-04	12716.8480	-452.5924
48.360	.008626	959353.6938	8568.0515	-2.293E-04	12735.3329	-451.5245
49.600	.008343	969849.5833	8008.8700	-2.257E-04	12752.6656	-450.3811
50.840	.008066	979649.4326	7451.1538	-2.220E-04	12768.8488	-449.1612
52.080	.007793	988755.0815	6894.9980	-2.182E-04	12783.8857	-447.8642
53.320	.007525	997168.4914	6340.4991	-2.145E-04	12797.7794	-446.4889
54.560	.007261	1.005E+06	5787.7545	-2.107E-04	12810.5334	-445.0347
55.800	.007002	1.012E+06	5236.8627	-2.069E-04	12822.1513	-443.5004
57.040	.006748	1.018E+06	4687.9237	-2.030E-04	12832.6371	-441.8851

58.280	.006499	1.024E+06	4141.0385	-1.991E-04	12841.9947	-440.1878
59.520	.006254	1.029E+06	3596.3096	-1.952E-04	12850.2284	-438.4072
60.760	.006015	1.033E+06	3053.8408	-1.913E-04	12857.3427	-436.5425
62.000	.005780	1.037E+06	2513.7373	-1.874E-04	12863.3424	-434.5922
63.240	.005550	1.040E+06	1976.1060	-1.835E-04	12868.2323	-432.5551
64.480	.005325	1.042E+06	1441.0552	-1.795E-04	12872.0177	-430.4300
65.720	.005105	1.044E+06	908.6950	-1.756E-04	12874.7039	-428.2154
66.960	.004889	1.045E+06	379.1373	-1.716E-04	12876.2964	-425.9099
68.200	.004679	1.045E+06	-147.5041	-1.676E-04	12876.8013	-423.5118
69.440	.004473	1.045E+06	-671.1135	-1.637E-04	12876.2244	-421.0195
70.680	.004273	1.044E+06	-1191.5730	-1.597E-04	12874.5723	-418.4313
71.920	.004077	1.042E+06	-1708.7623	-1.558E-04	12871.8514	-415.7451
73.160	.003887	1.040E+06	-2222.5589	-1.518E-04	12868.0686	-412.9590
74.400	.003701	1.037E+06	-2732.8375	-1.479E-04	12863.2310	-410.0709
75.640	.003520	1.033E+06	-3239.4699	-1.440E-04	12857.3459	-407.0783
76.880	.003344	1.029E+06	-3742.3252	-1.401E-04	12850.4210	-403.9786
78.120	.003173	1.024E+06	-4241.2689	-1.362E-04	12842.4641	-400.7693
79.360	.003006	1.019E+06	-4736.1631	-1.323E-04	12833.4834	-397.4472
80.600	.002844	1.013E+06	-5226.8659	-1.284E-04	12823.4874	-394.0091
81.840	.002688	1.006E+06	-5713.2314	-1.246E-04	12812.4849	-390.4514
83.080	.002535	998806.7909	-6195.1088	-1.208E-04	12800.4848	-386.7702
84.320	.002388	990941.7806	-6672.3424	-1.170E-04	12787.4968	-382.9613
85.560	.002245	982484.3178	-7144.7706	-1.133E-04	12773.5303	-379.0198
86.800	.002107	973440.4939	-7612.2259	-1.096E-04	12758.5955	-374.9404
88.040	.001973	963816.6143	-8074.5336	-1.059E-04	12742.7029	-370.7172
89.280	.001844	953619.2076	-8531.5112	-1.023E-04	12725.8631	-366.3435
90.520	.001720	942855.0360	-8982.9677	-9.868E-05	12708.0875	-361.8120
91.760	.001600	931531.1064	-9428.7018	-9.512E-05	12689.3874	-357.1140
93.000	.001484	919654.6836	-9868.5013	-9.161E-05	12669.7749	-352.2400
94.240	.001372	907233.3052	-10302.1409	-8.815E-05	12649.2626	-347.1788
95.480	.001265	894274.7985	-10729.3808	-8.473E-05	12627.8632	-341.9177
96.720	.001162	880787.3003	-11149.9638	-8.137E-05	12605.5903	-336.4418
97.960	.001064	866779.2793	-11563.6126	-7.806E-05	12582.4578	-330.7337
99.200	9.69E-04	852259.5635	-11970.0266	-7.480E-05	12558.4803	-324.7727
100.440	8.78E-04	837237.3714	-12368.8769	-7.159E-05	12533.6730	-318.5342
101.680	7.91E-04	821722.3502	-12759.8009	-6.845E-05	12508.0518	-311.9884
102.920	7.08E-04	805724.6210	-13142.3950	-6.536E-05	12481.6336	-305.0989
104.160	6.29E-04	789254.8357	-13516.2049	-6.234E-05	12454.4357	-297.8204
105.400	5.54E-04	772324.2455	-13880.7130	-5.938E-05	12426.4770	-290.0959
106.640	4.82E-04	754944.7894	-14235.3206	-5.648E-05	12397.7770	-281.8517
107.880	4.14E-04	737129.2070	-14579.3231	-5.365E-05	12368.3567	-272.9910
109.120	3.49E-04	718891.1873	-14911.8746	-5.089E-05	12338.2389	-263.3823
110.360	2.87E-04	700245.5712	-15231.9331	-4.820E-05	12307.4480	-252.8411
111.600	2.29E-04	681208.6349	-15538.1748	-4.558E-05	12276.0108	-241.0973
112.840	1.74E-04	661798.5050	-15828.8506	-4.303E-05	12243.9574	-227.7347
114.080	1.23E-04	642035.7985	-16101.5337	-4.056E-05	12211.3217	-212.0766
115.320	7.38E-05	621944.6633	-16352.7161	-3.817E-05	12178.1437	-193.0563
116.560	2.79E-05	601554.4184	-16579.8764	-3.585E-05	12144.4718	-173.3314
117.800	-1.51E-05	580895.4669	-16629.4454	-3.360E-05	12110.3561	93.3813
119.040	-5.54E-05	560377.9817	-16474.6838	-3.144E-05	12076.4740	156.2342
120.280	-9.31E-05	540098.6801	-16263.3818	-2.935E-05	12042.9852	184.5755
121.520	-1.28E-04	520101.2137	-16022.7287	-2.734E-05	12009.9619	203.5745
122.760	-1.61E-04	500414.8680	-15761.3476	-2.541E-05	11977.4523	218.0080
124.000	-1.91E-04	481061.9080	-15483.7856	-2.355E-05	11945.4933	229.6726
125.240	-2.19E-04	462060.3393	-15192.9294	-2.176E-05	11914.1146	239.4503
126.480	-2.45E-04	443425.2658	-14890.8066	-2.004E-05	11883.3410	247.8445
127.720	-2.69E-04	425169.6619	-14578.9370	-1.840E-05	11853.1942	255.1711
128.960	-2.91E-04	407304.8598	-14258.5123	-1.682E-05	11823.6927	261.6429
130.200	-3.11E-04	389840.8755	-13930.4993	-1.531E-05	11794.8531	267.4102
131.440	-3.29E-04	372786.6405	-13595.7031	-1.386E-05	11766.6901	272.5837
132.680	-3.45E-04	356150.1718	-13286.0768	-1.248E-05	11739.2170	226.8135
133.920	-3.60E-04	339861.1536	-13002.7212	-1.116E-05	11712.3177	230.2118
135.160	-3.73E-04	323924.8705	-12715.3513	-9.900E-06	11686.0009	233.2880

136.400	-3.84E-04	308346.1106	-12424.3451	-8.701E-06	11660.2745	236.0768
137.640	-3.94E-04	293129.2188	-12130.0412	-7.561E-06	11635.1457	238.6069
138.880	-4.03E-04	278278.1407	-11832.7457	-6.478E-06	11610.6210	240.9020
140.120	-4.10E-04	263796.4595	-11532.7374	-5.450E-06	11586.7063	242.9823
141.360	-4.17E-04	249687.4265	-11230.2721	-4.476E-06	11563.4070	244.8650
142.600	-4.22E-04	235953.9880	-10925.5857	-3.555E-06	11540.7279	246.5648
143.840	-4.25E-04	222598.8077	-10618.8968	-2.686E-06	11518.6735	248.0947
145.080	-4.28E-04	209624.2867	-10310.4092	-1.867E-06	11497.2477	249.4659
146.320	-4.30E-04	197032.5805	-10000.3134	-1.096E-06	11476.4540	250.6885
147.560	-4.31E-04	184825.6150	-9688.7884	-3.715E-07	11456.2957	251.7712
148.800	-4.31E-04	173005.0992	-9376.0028	3.070E-07	11436.7756	252.7219
150.040	-4.30E-04	161572.5382	-9062.1156	9.413E-07	11417.8962	253.5477
151.280	-4.29E-04	150529.2433	-8747.2779	1.533E-06	11399.6595	254.2551
152.520	-4.26E-04	139876.3424	-8431.6329	2.084E-06	11382.0676	254.8498
153.760	-4.23E-04	129614.7887	-8115.3171	2.595E-06	11365.1219	255.3371
155.000	-4.20E-04	119745.3690	-7798.4606	3.067E-06	11348.8238	255.7219
156.240	-4.16E-04	110268.7109	-7481.1877	3.504E-06	11333.1743	256.0085
157.480	-4.11E-04	101185.2897	-7163.6177	3.904E-06	11318.1741	256.2012
158.720	-4.06E-04	92495.4347	-6845.8648	4.272E-06	11303.8239	256.3035
159.960	-4.01E-04	84199.3349	-6528.0387	4.607E-06	11290.1239	256.3191
161.200	-3.95E-04	76297.0445	-6210.2453	4.911E-06	11277.0743	256.2510
162.440	-3.88E-04	68788.4875	-5892.5863	5.186E-06	11264.6748	256.1022
163.680	-3.82E-04	61673.4626	-5575.1603	5.433E-06	11252.9252	255.8754
164.920	-3.75E-04	54951.6470	-5258.0622	5.655E-06	11241.8250	255.5731
166.160	-3.68E-04	48622.6003	-4941.3844	5.851E-06	11231.3733	255.1976
167.400	-3.60E-04	42685.7682	-4625.2164	6.024E-06	11221.5694	254.7508
168.640	-3.53E-04	37140.4853	-4309.6454	6.175E-06	11212.4120	254.2347
169.880	-3.45E-04	31985.9785	-3994.7563	6.307E-06	11203.9000	253.6509
171.120	-3.37E-04	27221.3686	-3680.6324	6.419E-06	11196.0319	253.0007
172.360	-3.29E-04	22845.6734	-3367.3551	6.514E-06	11188.8059	252.2852
173.600	-3.21E-04	18857.8086	-3055.0049	6.593E-06	11182.2205	251.5055
174.840	-3.13E-04	15256.5900	-2743.6610	6.657E-06	11176.2735	250.6621
176.080	-3.05E-04	12040.7337	-2433.4023	6.709E-06	11170.9629	249.7553
177.320	-2.96E-04	9208.8573	-2124.3072	6.749E-06	11166.2864	248.7851
178.560	-2.88E-04	6759.4793	-1816.4547	6.780E-06	11162.2416	247.7513
179.800	-2.79E-04	4691.0190	-1509.9240	6.801E-06	11158.8258	246.6530
181.040	-2.71E-04	3001.7953	-1204.7959	6.816E-06	11156.0362	245.4891
182.280	-2.63E-04	1690.0246	-901.1529	6.825E-06	11153.8700	244.2578
183.520	-2.54E-04	753.8186	-599.0798	6.830E-06	11152.3240	242.9569
184.760	-2.46E-04	191.1803	-298.6648	6.831E-06	11151.3948	241.5835
186.000	-2.37E-04	0.0000	0.0000	6.832E-06	11151.0791	240.1339

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.02232343	in
Computed slope at pile head	=	-.00031348	
Maximum bending moment	=	1045020.622	lbs-in
Maximum shear force	=	30600.000	lbs
Depth of maximum bending moment	=	68.200	in
Depth of maximum shear force	=	0.000	in
Number of iterations	=	12	
Number of zero deflection points	=	1	

Summary of Pile-head Response

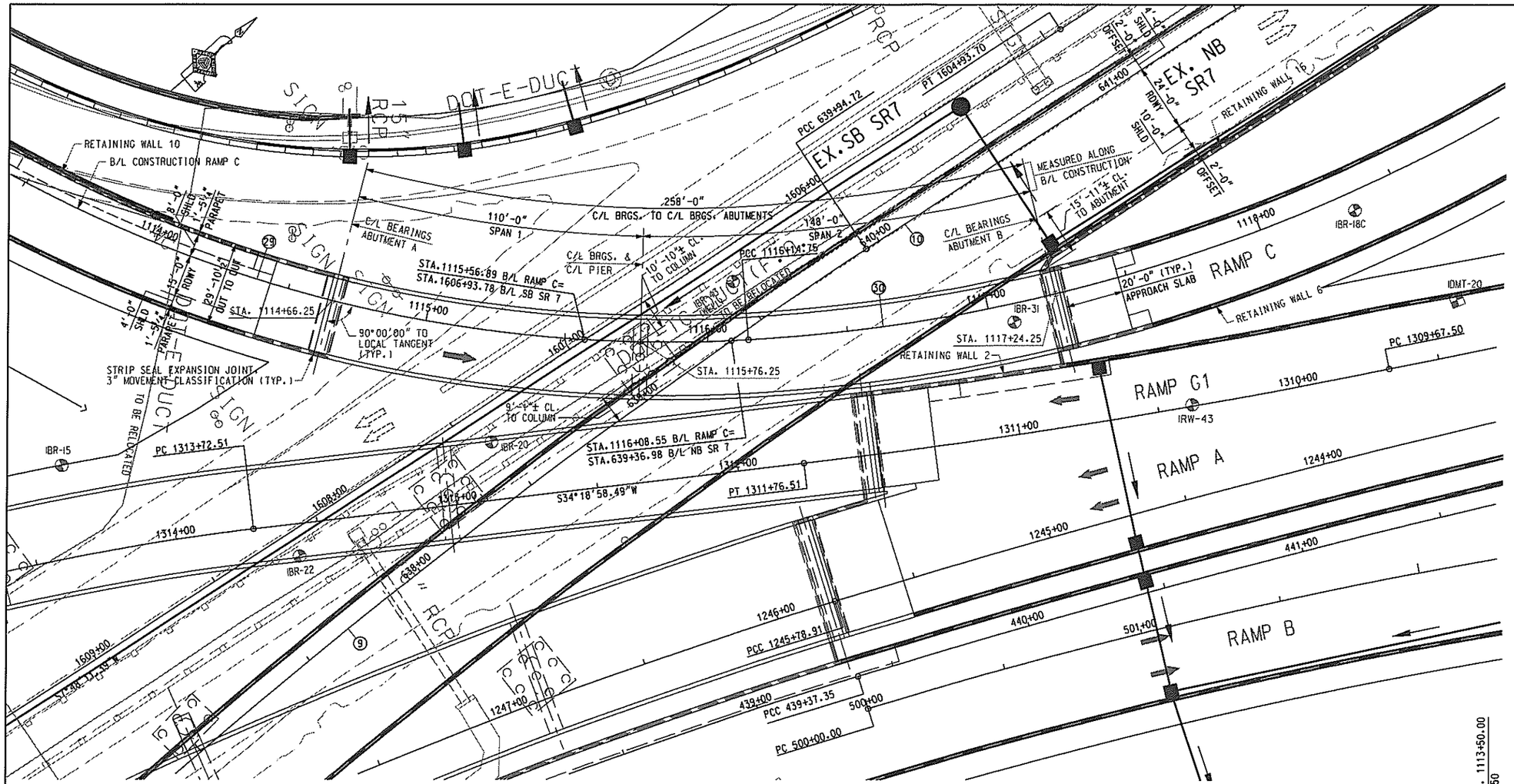
Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

BC Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 30600.000	M= 0.000	775000.0000	.022323	1.045E+06	30600.0000

The analysis ended normally.

Structure S4 – Ramp C over SR 7

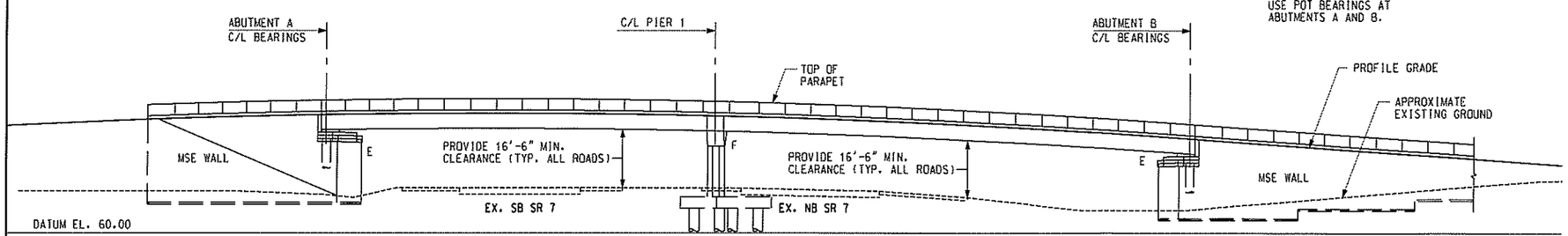


PLAN

SCALE: 1" = 20'-0"

NOTE:

USE POT BEARINGS AT ABUTMENTS A AND B.



ELEVATION

SCALE: 1" = 20'-0"

NOTE:
MSE ABUTMENTS SHOWN.

B/L CONSTR. RAMP C CURVE 29 DATA

PI STA. 1113+47.25
Δ= 77°59'15.12" LT
Dc = 11°48'48.83"
R = 485.0'
T = 392.66'
L = 660.15'

B/L CONSTR. RAMP C CURVE 30 DATA

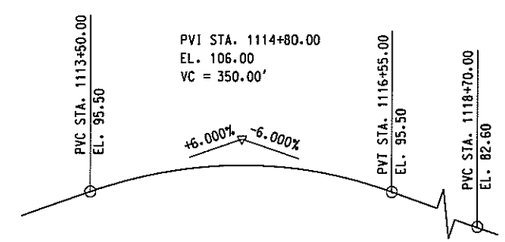
PI STA. 1118+29.56
Δ= 39°23'47.62" LT
Dc = 9°32'57.47"
R = 600.0'
T = 214.81'
L = 412.56'

B/L CONSTR. NB SR7 CURVE 9 DATA

PI STA. 637+21.94
Δ= 13°46'34.84" RT
Dc = 2°30'46.70"
R = 2,280.0000'
T = 275.43'
L = 548.21'

B/L CONSTR. NB SR7 CURVE 10 DATA

PI STA. 647+53.60
Δ= 07°43'05.43" RT
Dc = 0°30'33.46"
R = 11,250.0000'
T = 785.88'
L = 1,515.46'



RAMP C - VERTICAL CURVE DATA

NOT TO SCALE

URS S4-2

DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS	SCALE 0 20 40 60 FEET	SR1 / I-95 INTERCHANGE	CONTRACT 28-090-03 / COUNTY NEW CASTLE	BRIDGE NO. / DESIGNED BY: B. E. KIBCHNER URS / CHECKED BY:	RAMP C OVER SR 7 PLAN AND ELEVATION	S4-1 / SHEET NO. 16 / TOTAL SHTS.

jason_kotova Jan 22, 2009 G:\20832687-XM\CAD\Bridge\pa401.dgn

MSE Wingwalls
Bearing Capacity, Sliding, Overturning, Eccentricity, Settlement

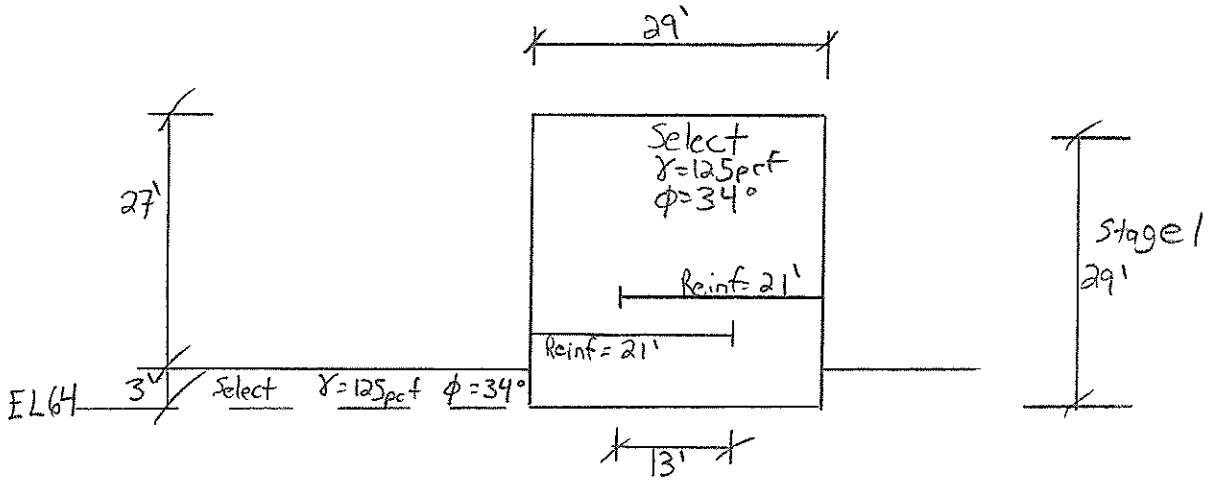
URS

Job SR 1 / I-95 Interchange | Project No. | Page ___ of ___ | Sheet ___ of ___

Description Ramp C over SR 7 | Computed by JPK | Date

Abut A Wingwalls | Checked by | Date

Bearing Capacity, Sliding & Overturning | Reference



Clay γ=120 pcf

CD	CU	UU @ Stage 1
φ=24°	φ=10.3°	φ=0
c=0	c=940psf	c=1250psf
	TS=250psf	TS=0 psf

EL30 ▽ Traffic Surcharge = 250psf

Settlement

Assumptions:

(Same as "Ramp C over SR 7 - Abut A Face")

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp C over SR 7 - Abutment A Wingwalls (Back to Back)
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	27	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	30	feet	
Wall Base Width	B =	21	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	30	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	34	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	30	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	30	k/ft	
Wedge Influence Factor	WIF =	0.00		see attached spreadsheet calculations
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	0.0	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	73.8	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	0.0	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	27.6	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	27.6	k/ft	**Capacity Demand Ratio (CDR)= #DIV/0!**
				#DIV/0!
Eccentricity, parallel to width	e_B =	0.00	ft	**e < 0.25*B, OK**
Effective Width	B' =	21.0	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	3.75	ksf	
Factored Bearing Pressure	Sigv =	5.50	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.35	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.31	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.72	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.99	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	13.2	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	8.59	ksf	**Capacity Demand Ratio (CDR)= 1.563**
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming quarantine period after Stage 1
Foundation Φ	Φi =	10.3	degrees	
Foundation Cohesion (c)	ci =	940	psf	- Averaged from CU lab data- See Sheet URS-2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.21	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.13	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.72	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.99	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	11.9	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.72	ksf	**Capacity Demand Ratio (CDR)= 1.403**
				CDR > 1.0, OK

Back to Back Wall Calculations
Ramp C over SR 7 - Abutment A Wingwalls (Back to Back)
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Total Height (Hw+Df)	H =	30	feet	
Wall Base Width	B =	21	feet	as defined by Fig 11.10.2-1
Face to Face Distance	F =	29	feet	
Overlap	Lr =	13	feet	as defined by Fig 50 of FHWA-NHI-00-043
Wedge Distance at Top of Wall	Dwd=	15.95128	feet	as defined by Fig 50 of FHWA-NHI-00-043
Overlap Distance with No Wedge Influence	Lr' =	9	feet	as defined by Sec. 5.4 of FHWA-NHI-00-043
Wedge Influence Factor	WIF =	0.00		as defined by Sec. 5.4 of FHWA-NHI-00-043

Since Lr > Lr'
WIF = 0

Lr = (2*B)-F
Dwd = H*tan(45-Φ1|2 / 2)
Lr' = H*0.3
~~WIF = (Lr' - Lr) / (Lr'+Dwd)~~

Note: WIF linear interpolation between "full active" case and "zero-active" case

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp C over SR 7 - Abutment A Wingwalls (Back to Back)
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	26	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	29	feet	
Wall Base Width	B =	21	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	30	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	34	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	29	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	26	k/ft	
Wedge Influence Factor	WIF =	0.00		see attached spreadsheet calculations
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	0.0	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	76.1	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	0.0	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	27.6	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	27.6	k/ft	**Capacity Demand Ratio (CDR)= 19220**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	0.00	ft	**e < 0.25*B, OK**
Effective Width	B' =	21.0	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	4.89	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.35	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.31	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.72	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.99	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	13.2	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	8.59	ksf	**Capacity Demand Ratio (CDR)= 1.756**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1, quarantine period to follow
Foundation Φ	Φf =	0.0	degrees	
Foundation Cohesion (c)	cf =	1250	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.14	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.99	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	7.7	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	5.00	ksf	**Capacity Demand Ratio (CDR)= 1.023**
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp C over SR 7 - Abutment A Wingwall
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor*	σ_f'	Tot. $\Delta\sigma'$	S_c'	S_c''
Initial Overburden	4				0.25				2.01			
I	10	0.851	0.065	0.33	0.56	3.48	0.43	0.80	1.92	1.36	0	2.247259
II	10	0.851	0.065	0.33	1.19	3.48	0.90	0.60	2.14	0.96	0	1.080833

Footing Width (ft) 21

0.00	3.33	in
TOTAL	3.33	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

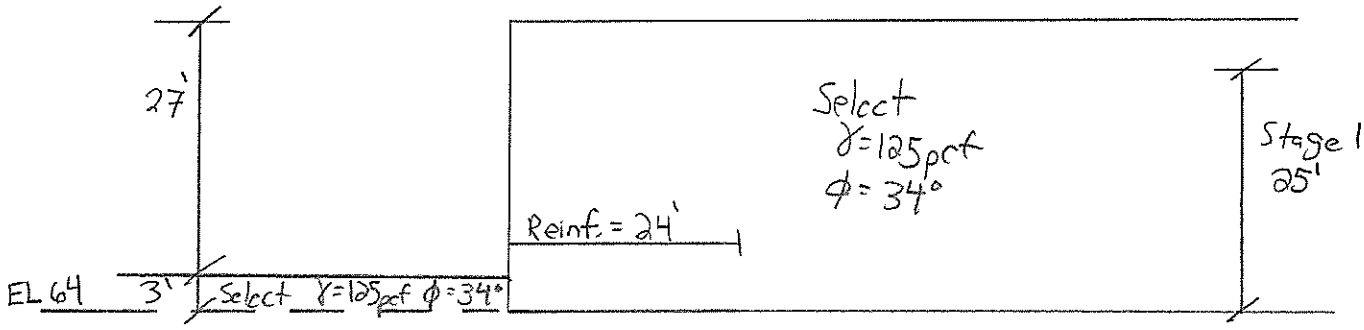
Profile described on page URS-S4-4
Lab data on page URS-4

URS

Job SR 1 / I-95 Interchange
Description Ramp C over SR7
Abut A Face
Bearing Capacity, Sliding & Overturning

Project No.
Computed by JPK
Checked by

Page ___ of ___
Sheet ___ of ___
Date
Date
Reference



Clay γ=120pcf

CD	CU	UU @ Stage 1
φ=24°	φ=10.3°	φ=0
c=0	c=940psf	c=1250psf
Traffic Surcharge = 250psf	TS=250psf	TS=0

EL30 ▽

Settlement

Assumptions:

1) 4 feet of overburden removed to reach bottom of footing
2) 20 feet of clay layer consolidating (based on test embankment back calculation)
3) Consolidation parameters from URS-4, 4-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp C over SR 7 - Abutment A Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	27	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	30	feet	
Wall Base Width	B =	24	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	30	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	34	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	30	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	30	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	15.9	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.288	(dim)	
Horiz F2 Surcharge	F2 =	2.1	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	90.0	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	27.6	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	31.3	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	31.3	k/ft	**Capacity Demand Ratio (CDR)= 1.14**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	3.27	ft	**e < 0.25*B, OK**
Effective Width	B' =	17.5	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	5.15	ksf	
Factored Bearing Pressure	Sigv =	7.56	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.40	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.36	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.68	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.93	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	13.5	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	8.77	ksf	**Capacity Demand Ratio (CDR)= 1.160**
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming
Foundation Φ	Φf =	10.3	degrees	quarantine period after Stage 1
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS-2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.24	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.15	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.68	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.93	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	12.1	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.89	ksf	**Capacity Demand Ratio (CDR)= 1.044**
				CDR > 1.0, OK

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp C over SR 7 - Abutment A Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	22	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	25	feet	
Wall Base Width	B =	24	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	30	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	34	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	25	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	21	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	11.0	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	75.0	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	16.6	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	31.3	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	31.3	k/ft	**Capacity Demand Ratio (CDR)= 1.89**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	1.84	ft	**e < 0.25*B, OK**
Effective Width	B' =	20.3	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	4.98	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.40	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.36	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.68	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.93	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	13.5	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	8.77	ksf	**Capacity Demand Ratio (CDR)= 1.759**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1,
Foundation Φ	Φf =	0.0	degrees	quarantine period to follow
Foundation Cohesion (c)	cf =	1250	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.16	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.93	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	7.8	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	5.09	ksf	**Capacity Demand Ratio (CDR)= 1.021**
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp C over SR 7 - Abutment A Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor*	σ_f'	Tot. $\Delta\sigma'$	S_c'	S_c''	
Initial Overburden	4				0.25				2.58				
I	10	0.851	0.065	0.33	0.56	3.48	0.38	0.80	2.38	1.81	0	2.637147	
II	10	0.851	0.065	0.33	1.19	3.48	0.79	0.65	2.61	1.43	0	1.444349	
Footing Width (ft)	24										0.00	4.08	in
											TOTAL	4.08	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

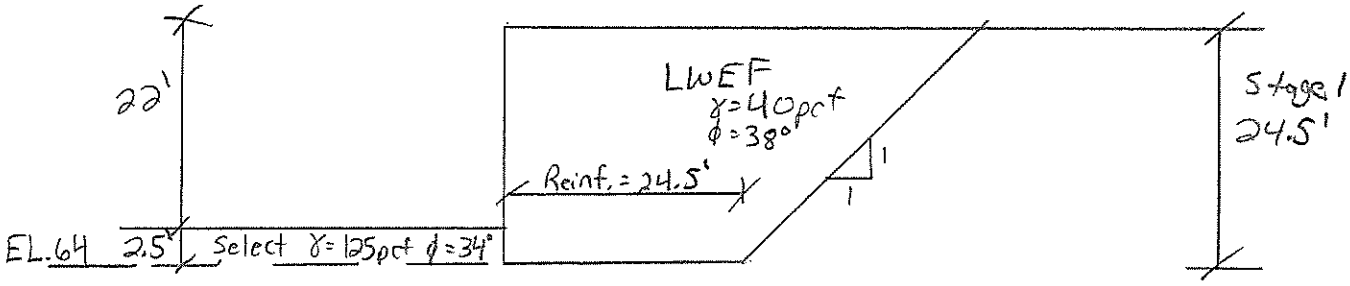
Profile described on page URS-S4-9
Lab data on page URS-4

URS

Job SR1 / I-95 Interchange
Description Ramp C over SR7
Abut. B West Wingwall & Face
Bearing Capacity, Sliding & Overturning

Project No.
Computed by JPK
Checked by

Page of
Sheet of
Date
Date
Reference



Clay γ=120pcf

CD	CU	UU @ Stage 1
φ=24°	φ=10.3°	φ=0
c=0	c=940psf	c=1250psf
Traffic Surcharge=250psf	TS=250psf	TS=0

EL30 ▽

Settlement

Assumptions:

1) 3 feet of overburden removed to reach bottom of footing
2) 20 feet of clay layer consolidating (based on test embankment back calculation)
3) Consolidation parameters from URS-4, U-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp C over SR 7 - Abutment B West Wingwall and Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	22	feet	
Embedment (below grade)	Df =	2.5	feet	
Total Height (Hw+Df)	H =	24.5	feet	
Wall Base Width	B =	24.5	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	30	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	34	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	0	feet	
Top Material Unit Weight	γ1 =	105	pcf	
Top Material Φ	Φ1 =	38	degrees	
Bottom Material Height	H2 =	24.5	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	38	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	40.00	pcf	
Retained Wedge - Vertical Component	Wrw	6	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	2.9	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.238	(dim)	
Horiz F2 Surcharge	F2 =	1.5	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	24.0	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	6.8	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	31.7	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	31.7	k/ft	**Capacity Demand Ratio (CDR)= 4.64**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	2.76	ft	**e < 0.25*B, OK**
Effective Width	B' =	19.0	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	1.26	ksf	
Factored Bearing Pressure	Sigv =	2.27	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.41	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.36	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.67	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.93	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	12.8	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	8.30	ksf	**Capacity Demand Ratio (CDR)= 3.653**
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming
Foundation Φ	Φfi =	10.3	degrees	quarantine period after Stage 1
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS-2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.24	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.15	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.67	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.93	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	12.0	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.81	ksf	**Capacity Demand Ratio (CDR)= 3.437**
				CDR > 1.0, OK

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp C over SR 7 - Abutment B West Wingwall and Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	22	feet	
Embedment (below grade)	Df =	2.5	feet	
Total Height (Hw+Df)	H =	24.5	feet	
Wall Base Width	B =	24.5	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	30	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	34	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	0	feet	
Top Material Unit Weight	γ1 =	105	pcf	
Top Material Φ	Φ1 =	38	degrees	
Bottom Material Height	H2 =	24.5	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	38	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	40.00	pcf	
Retained Wedge - Vertical Component	Wrw	6	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	2.9	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.238	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	24.0	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	4.3	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	31.7	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	31.7	k/ft	**Capacity Demand Ratio (CDR)= 7.41**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	1.46	ft	**e < 0.25*B, OK**
Effective Width	B' =	21.6	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	1.59	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.41	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.36	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.67	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.93	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	12.8	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	8.30	ksf	**Capacity Demand Ratio (CDR)= 5.528**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1, quarantine period to follow
Foundation Φ	Φf =	0.0	degrees	
Foundation Cohesion (c)	cf =	1250	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.16	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.93	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	7.8	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	5.06	ksf	**Capacity Demand Ratio (CDR)= 3.371**
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp C over SR 7 - Abutment B Wingwall & Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c'' [3]
Initial Overburden	3				0.19				0.63			
I	10	0.851	0.065	0.33	0.50	3.48	0.33	0.80	0.82	0.32	0	0.897511
II	10	0.851	0.065	0.33	1.13	3.48	0.73	0.70	1.38	0.25	0	0.371898

Footing Width (ft) 24.5

0.00	1.27	in
TOTAL	1.27	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS-S4-13
Lab data on page URS- 4

Global Stability

Short-term Case

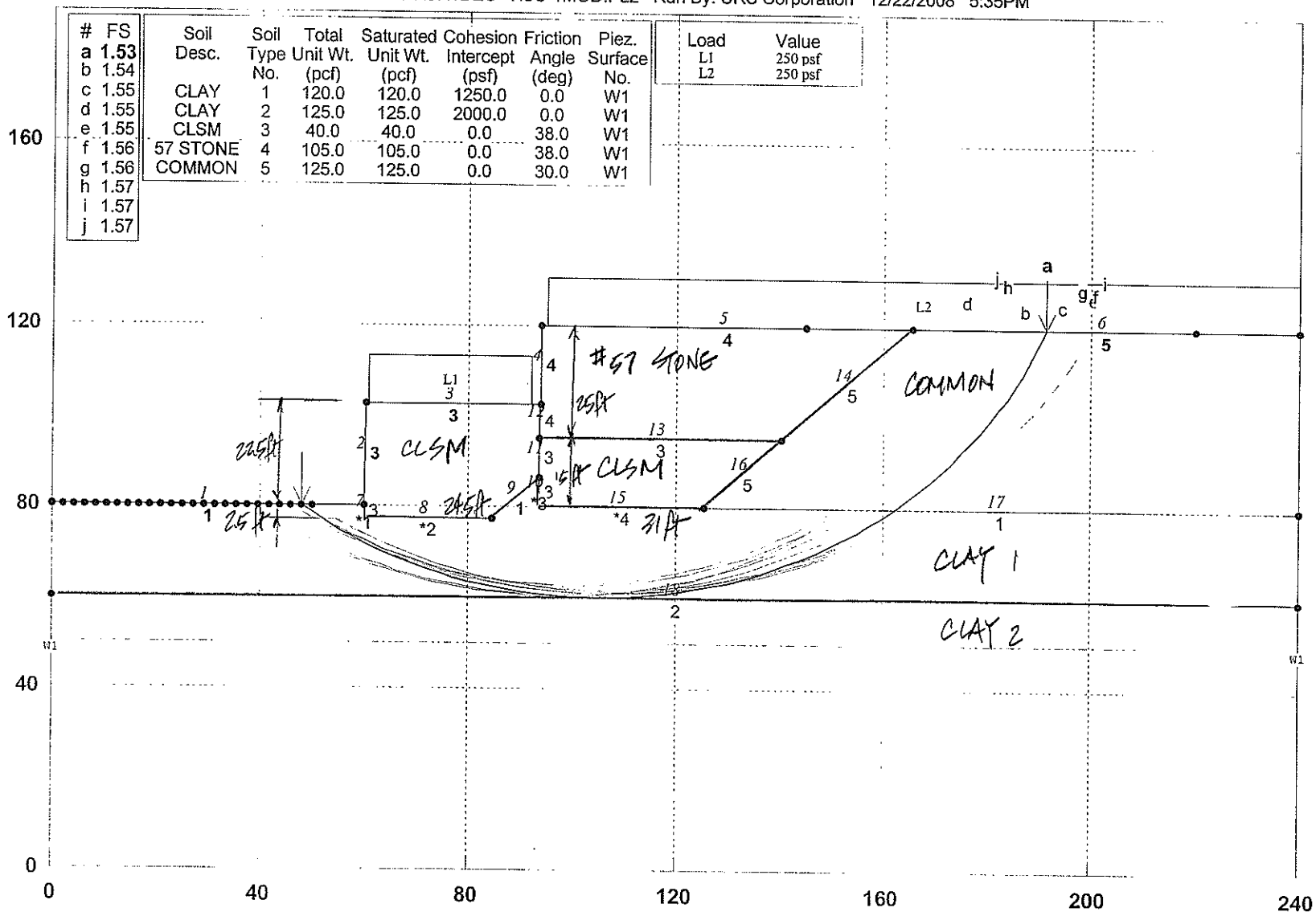
SR1/I95 Interchange CS-1 Modified (Section Reversed)

Z:\DELDOT\SR1DEC~1\CS-1MOD.PL2 Run By: URS Corporation 12/22/2008 5:35PM

#	FS
a	1.53
b	1.54
c	1.55
d	1.55
e	1.55
f	1.56
g	1.56
h	1.57
i	1.57
j	1.57

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	1250.0	0.0	W1
CLAY	2	125.0	125.0	2000.0	0.0	W1
CLSM	3	40.0	40.0	0.0	38.0	W1
57 STONE	4	105.0	105.0	0.0	38.0	W1
COMMON	5	125.0	125.0	0.0	30.0	W1

Load	Value
L1	250 psf
L2	250 psf



GSTABL7 FSmin=1.53

Safety Factors Are Calculated By The Modified Bishop Method

STED

* For cross section location see URS-11

Long-term Case

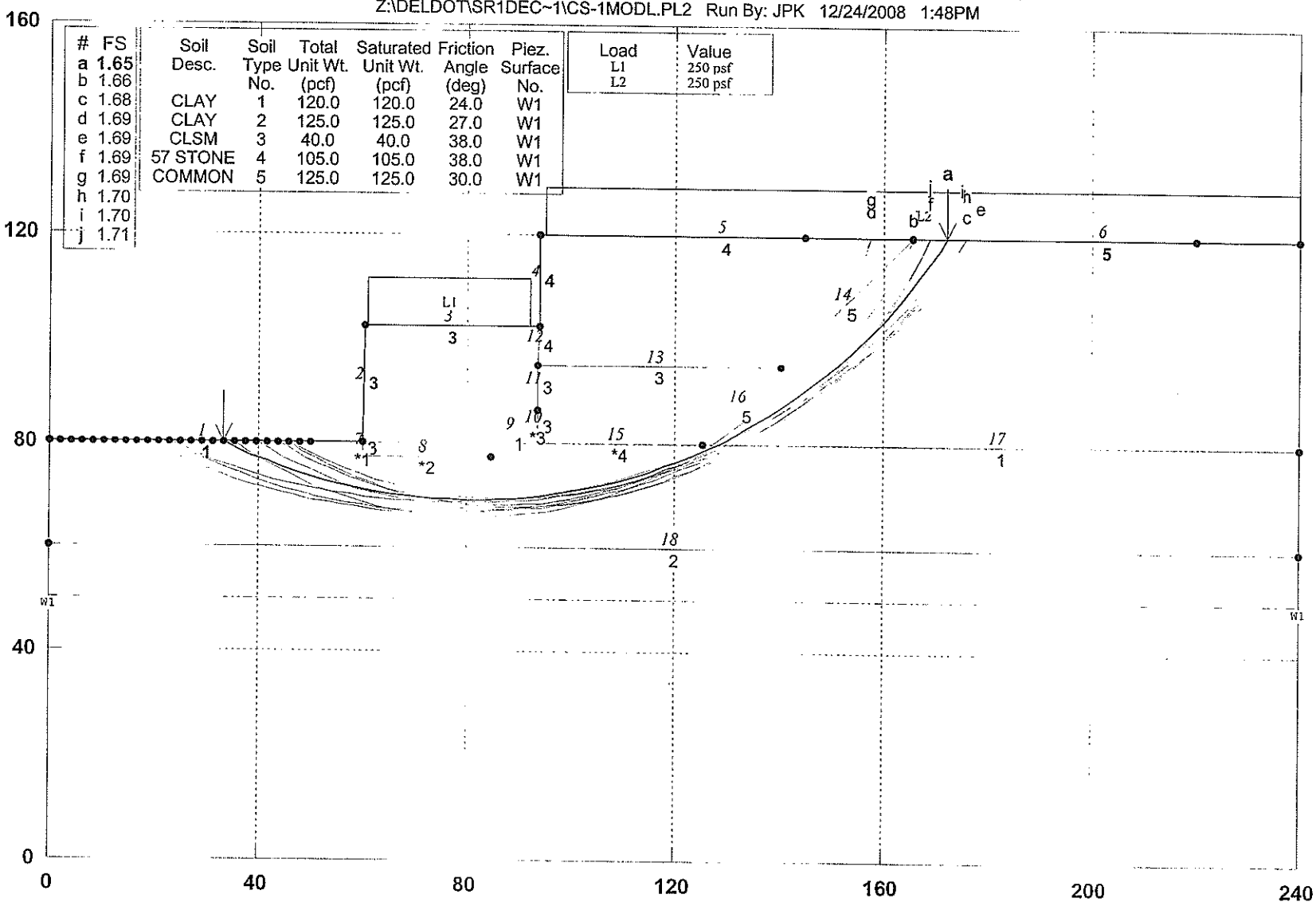
SR1/I95 Interchange CS-1 Modified (Section Reversed) Long-Term

Z:\DELDOT\SR1DEC~1\CS-1MODL.PL2 Run By: JPK 12/24/2008 1:48PM

#	FS
a	1.65
b	1.66
c	1.68
d	1.69
e	1.69
f	1.69
g	1.69
h	1.70
i	1.70
j	1.71

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	24.0	W1
CLAY	2	125.0	125.0	27.0	W1
CLSM	3	40.0	40.0	38.0	W1
57 STONE	4	105.0	105.0	38.0	W1
COMMON	5	125.0	125.0	30.0	W1

Load	Value
L1	250 psf
L2	250 psf



GSTABL7 FSmin=1.65

Safety Factors Are Calculated By The Modified Bishop Method

STED

Short-term Case

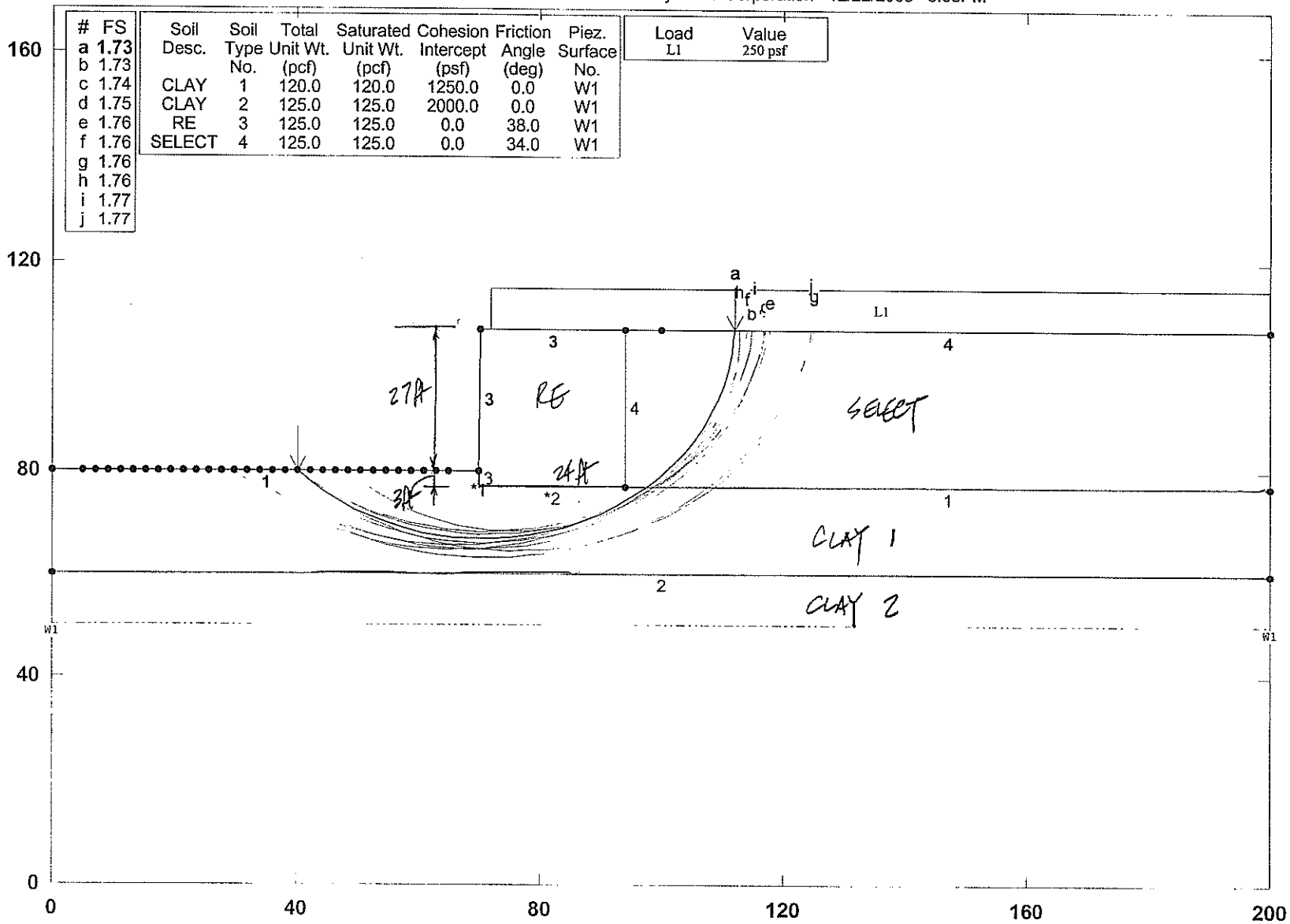
SR1/I95 Interchange CS-4

Z:\DELDOT\SR1DEC~1\CS-4.PL2 Run By: URS Corporation 12/22/2008 3:03PM

#	FS
a	1.73
b	1.73
c	1.74
d	1.75
e	1.76
f	1.76
g	1.76
h	1.76
i	1.77
j	1.77

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	1250.0	0.0	W1
CLAY	2	125.0	125.0	2000.0	0.0	W1
RE	3	125.0	125.0	0.0	38.0	W1
SELECT	4	125.0	125.0	0.0	34.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.73

Safety Factors Are Calculated By The Modified Bishop Method

STED

URS S4-20

Long-term Case

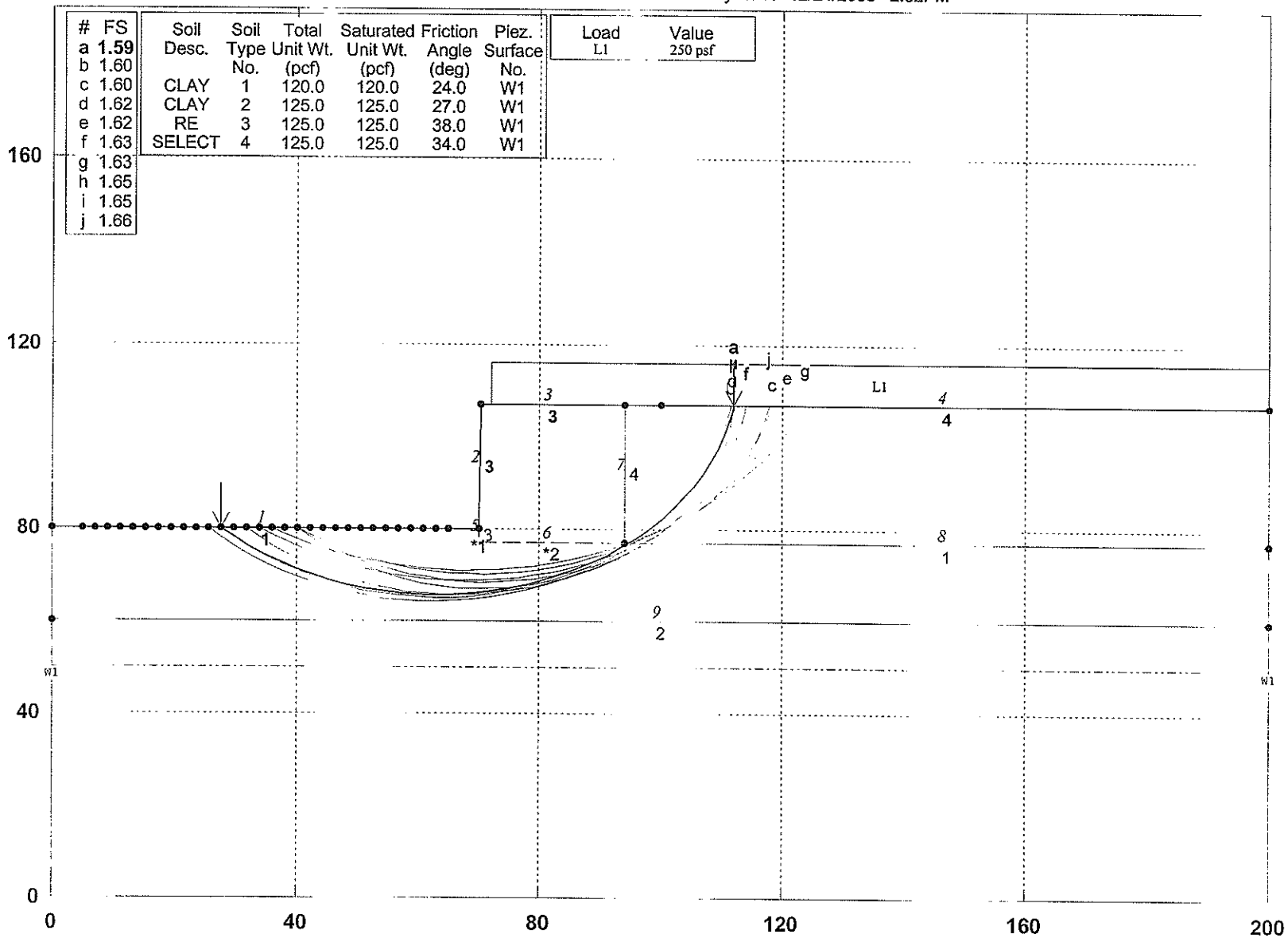
SR1/I95 Interchange CS-4 Long-Term

Z:\DELDOT\SR1DEC~1\CS-4LT.PL2 Run By: JPK 12/24/2008 2:52PM

#	FS
a	**1.59**
b	1.60
c	1.60
d	1.62
e	1.62
f	1.63
g	1.63
h	1.65
i	1.65
j	1.66

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	24.0	W1
CLAY	2	125.0	125.0	27.0	W1
RE	3	125.0	125.0	38.0	W1
SELECT	4	125.0	125.0	34.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.59

Safety Factors Are Calculated By The Modified Bishop Method

STED

Short-term Case

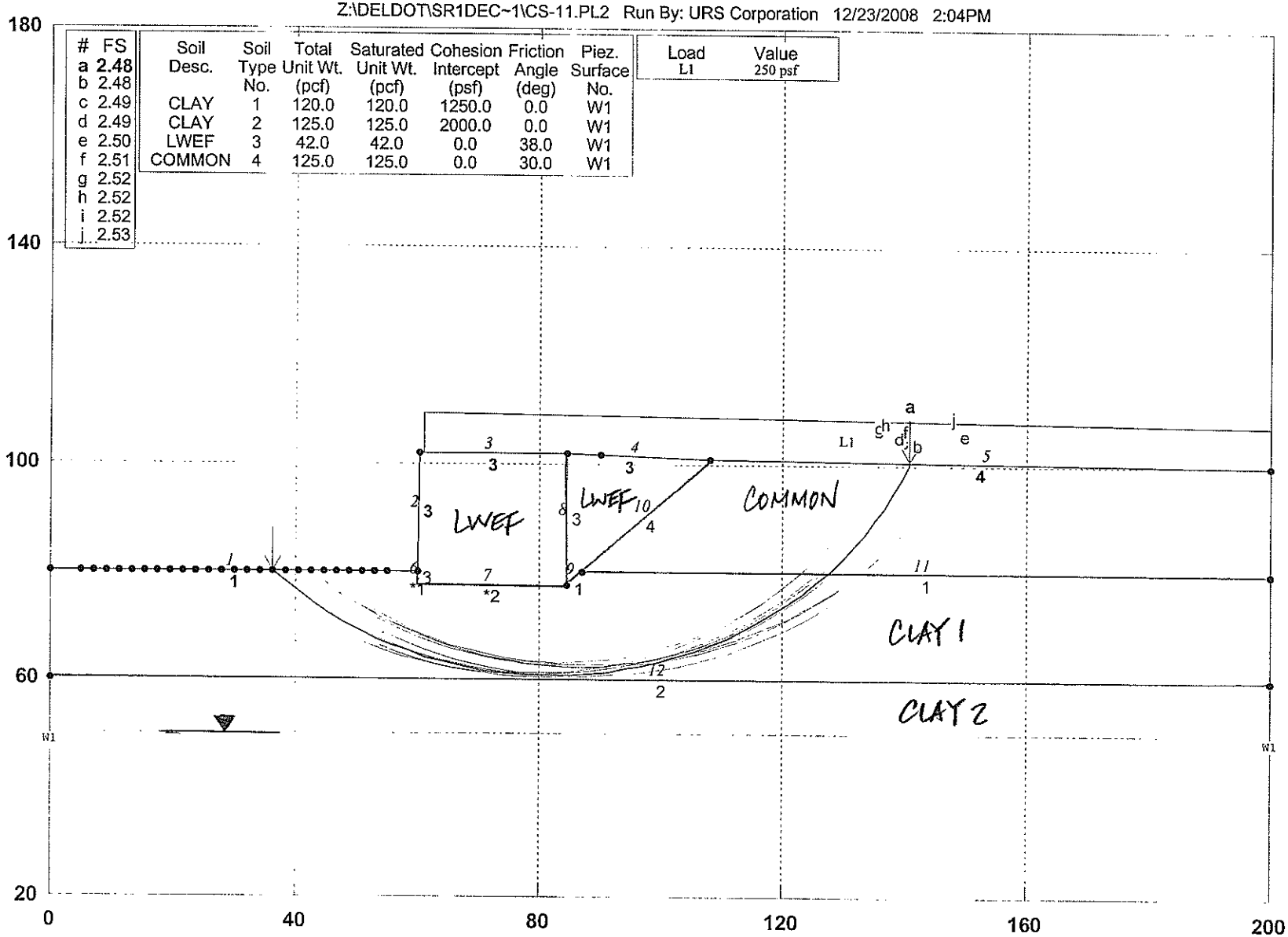
SR1/I95 Interchange CS-11

Z:\DELDOT\SR1DEC~1\CS-11.PL2 Run By: URS Corporation 12/23/2008 2:04PM

#	FS
a	2.48
b	2.48
c	2.49
d	2.49
e	2.50
f	2.51
g	2.52
h	2.52
i	2.52
j	2.53

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	1250.0	0.0	W1
CLAY	2	125.0	125.0	2000.0	0.0	W1
LWEF	3	42.0	42.0	0.0	38.0	W1
COMMON	4	125.0	125.0	0.0	30.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=2.48

Safety Factors Are Calculated By The Modified Bishop Method

STED

Long-term Case

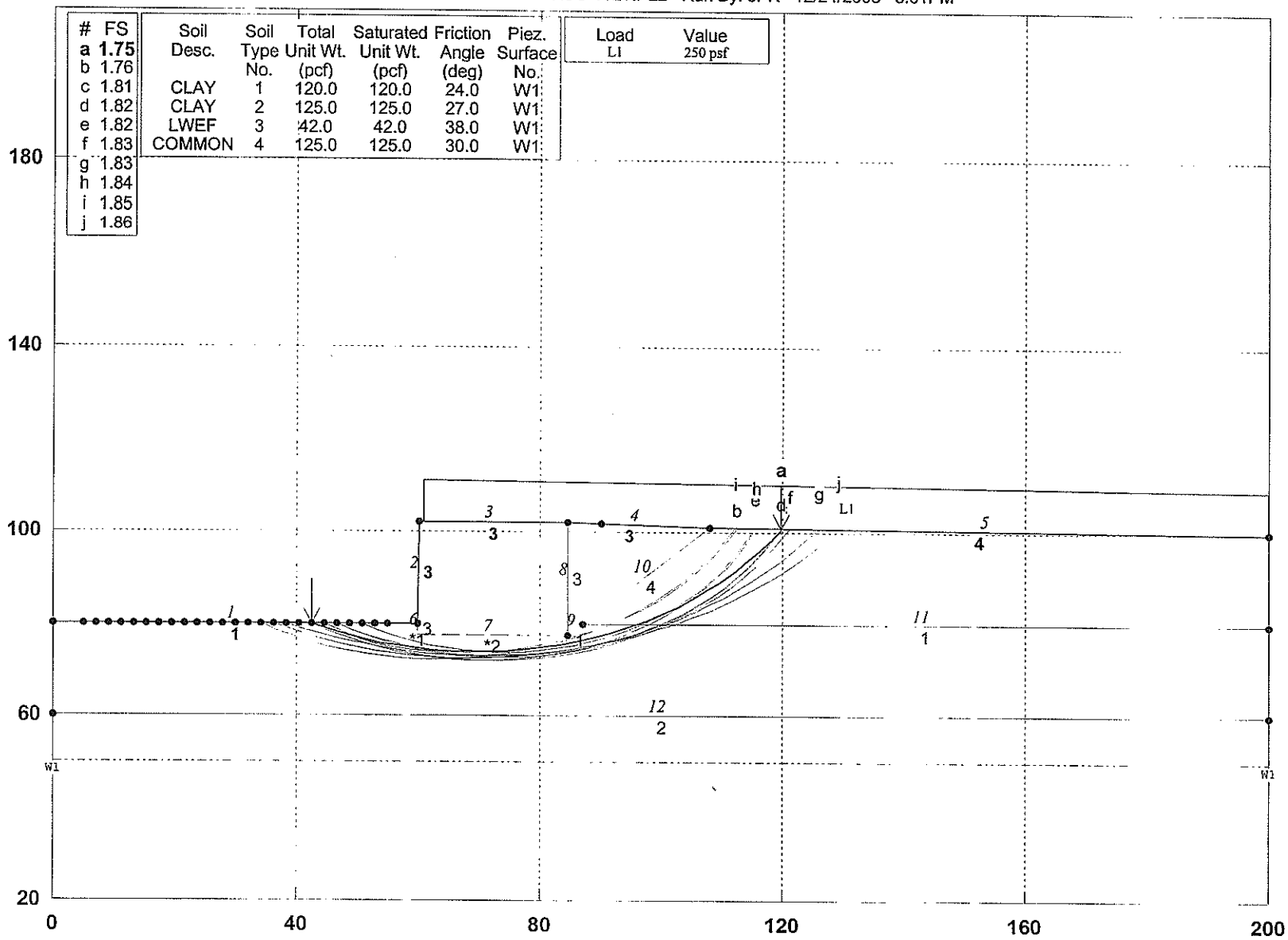
SR1/I95 Interchange CS-11 Long-Term

Z:\DELDOT\SR1DEC~1\CS-11LT.PL2 Run By: JPK 12/24/2008 3:01PM

#	FS
a	**1.75**
b	1.76
c	1.81
d	1.82
e	1.82
f	1.83
g	1.83
h	1.84
i	1.85
j	1.86

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	24.0	W1
CLAY	2	125.0	125.0	27.0	W1
LWEF	3	42.0	42.0	38.0	W1
COMMON	4	125.0	125.0	30.0	W1

Load	Value
LI	250 psf



GSTABL7 FSmin=1.75

Safety Factors Are Calculated By The Modified Bishop Method

STED

Axial Capacity

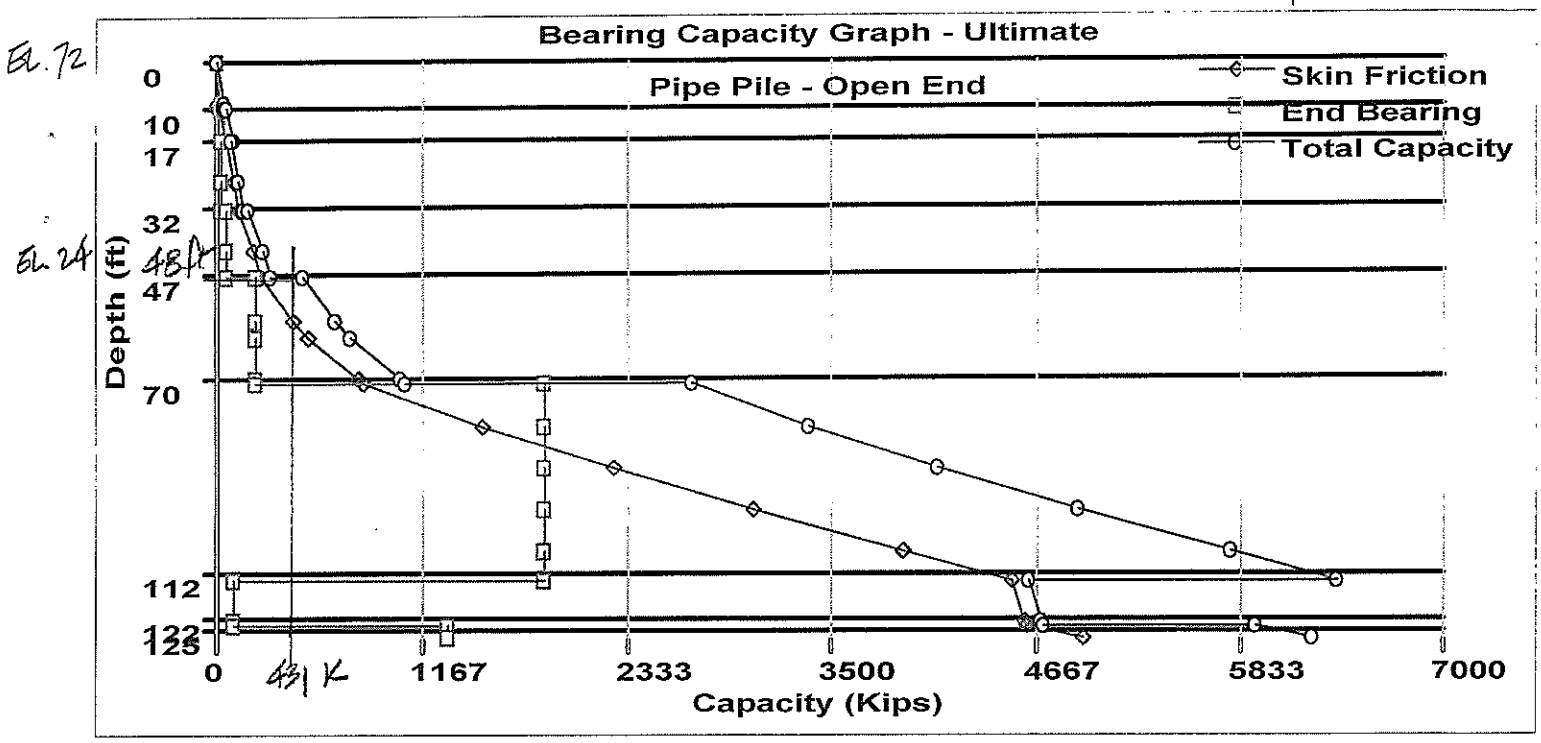
DelDOT SR1 / I-95 Interchange
Preliminary Pile Estimate

16-Dec-08

Location	Foundation	Required Factored Resistance, kip	Nominal Resistance, kip	Size of Pipe Pile		Estimated Pile Tip El.
				Diameter, in.	Wall in.	
S4-Ramp C Over SR 7	Abut A	280	431	24	0.5	24
	Pier 1	530	815	30	0.625	1
	Abut B	280	431	24	0.5	19

* 0.65 Resistance factor. Required capacity factor = 1.54

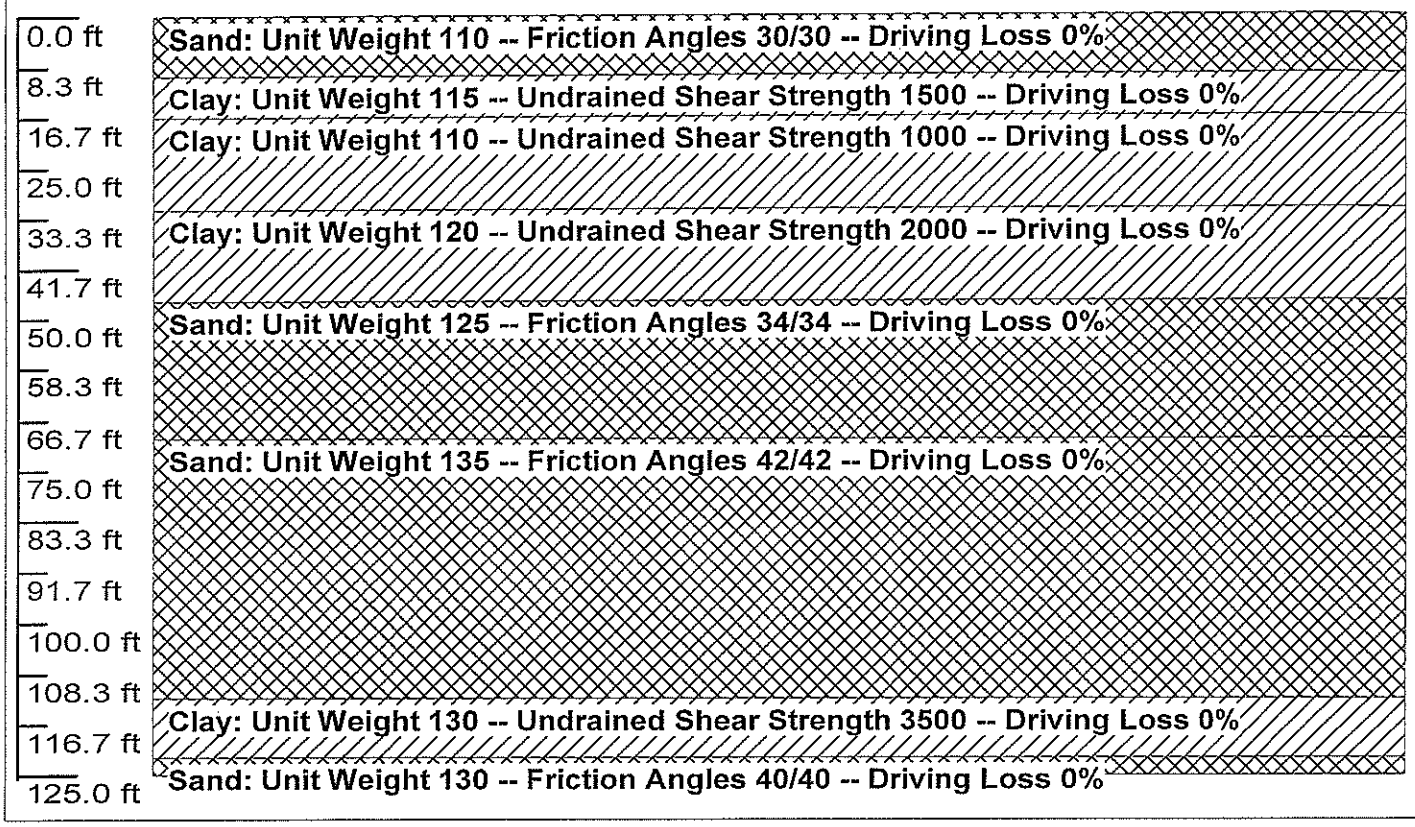
Filename: Z:\DELDOT\SR1DEC~1\C-R7UTA.DVN RAMP C/SR7 ABUT A 24"φ 0.5" WALL



REQUIRED CAPACITY = 431 K
EST. PILE TIP = 24

Filename: Z:\DELDOT\SR1DEC~1\C-R7UTA.DVN RAMP C /SR7 ABUT A 24"φ 0.5" WALL

Soil Profile BORING URS-1



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\C-R7UTA.DVN
Project Name: Ramp C / SR7 Abut A
Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 URS-1 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 24.00 in
Shell Thickness: 0.50 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	42.00 ft
	- Driving/Restrike	42.00 ft
	- Ultimate:	42.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	10.00 ft	0.00%	110.00 pcf	30.0/30.0	Nordlund
2	Cohesive	7.00 ft	0.00%	115.00 pcf	1500.00 psf	T-79 Steel
3	Cohesive	15.00 ft	0.00%	110.00 pcf	1000.00 psf	T-79 Steel
4	Cohesive	15.00 ft	0.00%	120.00 pcf	2000.00 psf	T-79 Steel
5	Cohesionless	23.00 ft	0.00%	125.00 pcf	34.0/34.0	Nordlund
6	Cohesionless	42.00 ft	0.00%	135.00 pcf	42.0/42.0	Nordlund
7	Cohesive	10.00 ft	0.00%	130.00 pcf	3500.00 psf	T-79 Steel
8	Cohesionless	3.00 ft	0.00%	130.00 pcf	40.0/40.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.55 psf	25.83	N/A	0.00 Kips
9.01 ft	Cohesionless	495.55 psf	25.83	N/A	11.39 Kips
9.99 ft	Cohesionless	549.45 psf	25.83	N/A	14.01 Kips
10.01 ft	Cohesive	N/A	N/A	1060.00 psf	14.10 Kips
16.99 ft	Cohesive	N/A	N/A	1060.00 psf	60.59 Kips
17.01 ft	Cohesive	N/A	N/A	800.00 psf	60.71 Kips
26.01 ft	Cohesive	N/A	N/A	815.03 psf	106.80 Kips
31.99 ft	Cohesive	N/A	N/A	829.97 psf	138.83 Kips
32.01 ft	Cohesive	N/A	N/A	1235.06 psf	138.96 Kips
41.01 ft	Cohesive	N/A	N/A	1287.56 psf	211.77 Kips
46.99 ft	Cohesive	N/A	N/A	1322.44 psf	263.44 Kips
47.01 ft	Cohesionless	5043.31 psf	29.28	N/A	263.72 Kips
56.01 ft	Cohesionless	5325.01 psf	29.28	N/A	446.02 Kips
59.99 ft	Cohesionless	5449.59 psf	29.28	N/A	532.79 Kips
60.01 ft	Cohesionless	5857.11 psf	27.13	N/A	533.31 Kips
69.01 ft	Cohesionless	6138.81 psf	27.13	N/A	809.38 Kips
69.99 ft	Cohesionless	6169.49 psf	27.13	N/A	840.97 Kips
70.01 ft	Cohesionless	6483.16 psf	33.52	N/A	842.00 Kips
79.01 ft	Cohesionless	6809.86 psf	33.52	N/A	1514.94 Kips
88.01 ft	Cohesionless	7136.56 psf	33.52	N/A	2252.45 Kips
97.01 ft	Cohesionless	7463.26 psf	33.52	N/A	3054.52 Kips
106.01 ft	Cohesionless	7789.96 psf	33.52	N/A	3921.16 Kips
111.99 ft	Cohesionless	8007.04 psf	33.52	N/A	4532.69 Kips
112.01 ft	Cohesive	N/A	N/A	1260.00 psf	4533.81 Kips
121.01 ft	Cohesive	N/A	N/A	1260.00 psf	4605.07 Kips
121.99 ft	Cohesive	N/A	N/A	1260.00 psf	4612.83 Kips
122.01 ft	Cohesionless	10208.34 psf	31.92	N/A	4614.00 Kips
124.99 ft	Cohesionless	10309.06 psf	31.92	N/A	4942.62 Kips

C-R7UTA-8

ULTIMATE - END BEARING

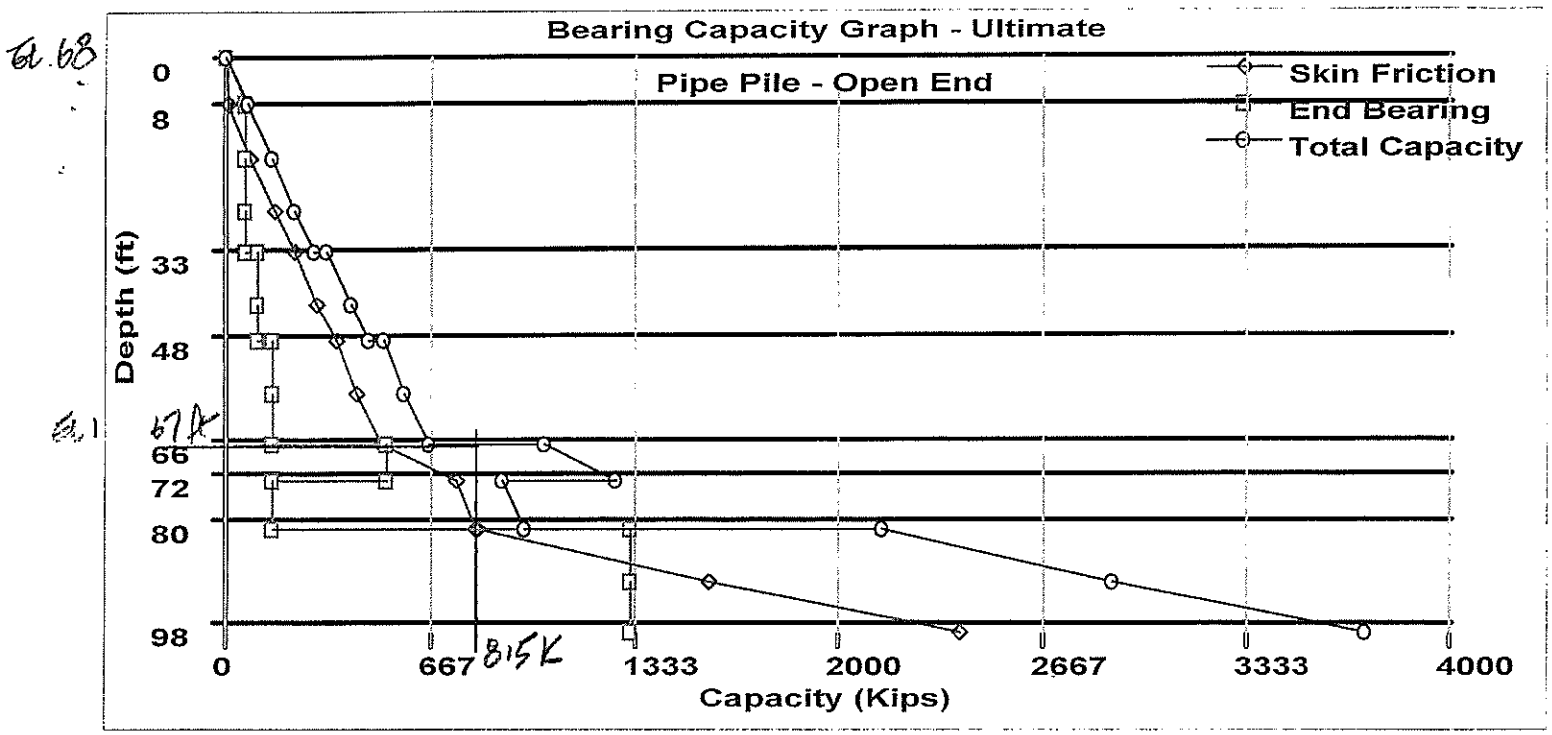
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.10 psf	30.00	41.85 Kips	0.06 Kips
9.01 ft	Cohesionless	991.10 psf	30.00	41.85 Kips	41.85 Kips
9.99 ft	Cohesionless	1098.90 psf	30.00	41.85 Kips	41.85 Kips
10.01 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
16.99 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
17.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
26.01 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
31.99 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
32.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
41.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
47.01 ft	Cohesionless	5043.63 psf	55.60	230.97 Kips	230.97 Kips
56.01 ft	Cohesionless	5607.03 psf	55.60	230.97 Kips	230.97 Kips
59.99 ft	Cohesionless	5856.17 psf	55.60	230.97 Kips	230.97 Kips
60.01 ft	Cohesionless	5857.43 psf	55.60	230.97 Kips	230.97 Kips
69.01 ft	Cohesionless	6420.83 psf	55.60	230.97 Kips	230.97 Kips
69.99 ft	Cohesionless	6482.17 psf	55.60	230.97 Kips	230.97 Kips
70.01 ft	Cohesionless	6483.53 psf	244.00	1861.58 Kips	1861.58 Kips
79.01 ft	Cohesionless	7136.93 psf	244.00	1861.58 Kips	1861.58 Kips
88.01 ft	Cohesionless	7790.33 psf	244.00	1861.58 Kips	1861.58 Kips
97.01 ft	Cohesionless	8443.73 psf	244.00	1861.58 Kips	1861.58 Kips
106.01 ft	Cohesionless	9097.13 psf	244.00	1861.58 Kips	1861.58 Kips
111.99 ft	Cohesionless	9531.27 psf	244.00	1861.58 Kips	1861.58 Kips
112.01 ft	Cohesive	N/A	N/A	N/A	98.96 Kips
121.01 ft	Cohesive	N/A	N/A	N/A	98.96 Kips
121.99 ft	Cohesive	N/A	N/A	N/A	98.96 Kips
122.01 ft	Cohesionless	10208.68 psf	160.00	1311.93 Kips	1311.93 Kips
124.99 ft	Cohesionless	10410.12 psf	160.00	1311.93 Kips	1311.93 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.06 Kips	0.06 Kips
9.01 ft	11.39 Kips	41.85 Kips	53.24 Kips
9.99 ft	14.01 Kips	41.85 Kips	55.85 Kips
10.01 ft	14.10 Kips	42.41 Kips	56.51 Kips
16.99 ft	60.59 Kips	42.41 Kips	103.00 Kips
17.01 ft	60.71 Kips	28.27 Kips	88.98 Kips
26.01 ft	106.80 Kips	28.27 Kips	135.07 Kips
31.99 ft	138.83 Kips	28.27 Kips	167.10 Kips
32.01 ft	138.96 Kips	56.55 Kips	195.51 Kips
41.01 ft	211.77 Kips	56.55 Kips	268.32 Kips
46.99 ft	263.44 Kips	56.55 Kips	319.99 Kips
47.01 ft	263.72 Kips	230.97 Kips	494.69 Kips
56.01 ft	446.02 Kips	230.97 Kips	676.99 Kips
59.99 ft	532.79 Kips	230.97 Kips	763.76 Kips
60.01 ft	533.31 Kips	230.97 Kips	764.28 Kips
69.01 ft	809.38 Kips	230.97 Kips	1040.35 Kips
69.99 ft	840.97 Kips	230.97 Kips	1071.94 Kips
70.01 ft	842.00 Kips	1861.58 Kips	2703.58 Kips
79.01 ft	1514.94 Kips	1861.58 Kips	3376.52 Kips
88.01 ft	2252.45 Kips	1861.58 Kips	4114.03 Kips
97.01 ft	3054.52 Kips	1861.58 Kips	4916.10 Kips
106.01 ft	3921.16 Kips	1861.58 Kips	5782.74 Kips
111.99 ft	4532.69 Kips	1861.58 Kips	6394.27 Kips
112.01 ft	4533.81 Kips	98.96 Kips	4632.78 Kips
121.01 ft	4605.07 Kips	98.96 Kips	4704.03 Kips
121.99 ft	4612.83 Kips	98.96 Kips	4711.79 Kips
122.01 ft	4614.00 Kips	1311.93 Kips	5925.92 Kips
124.99 ft	4942.62 Kips	1311.93 Kips	6254.55 Kips

C-R7UTA-10

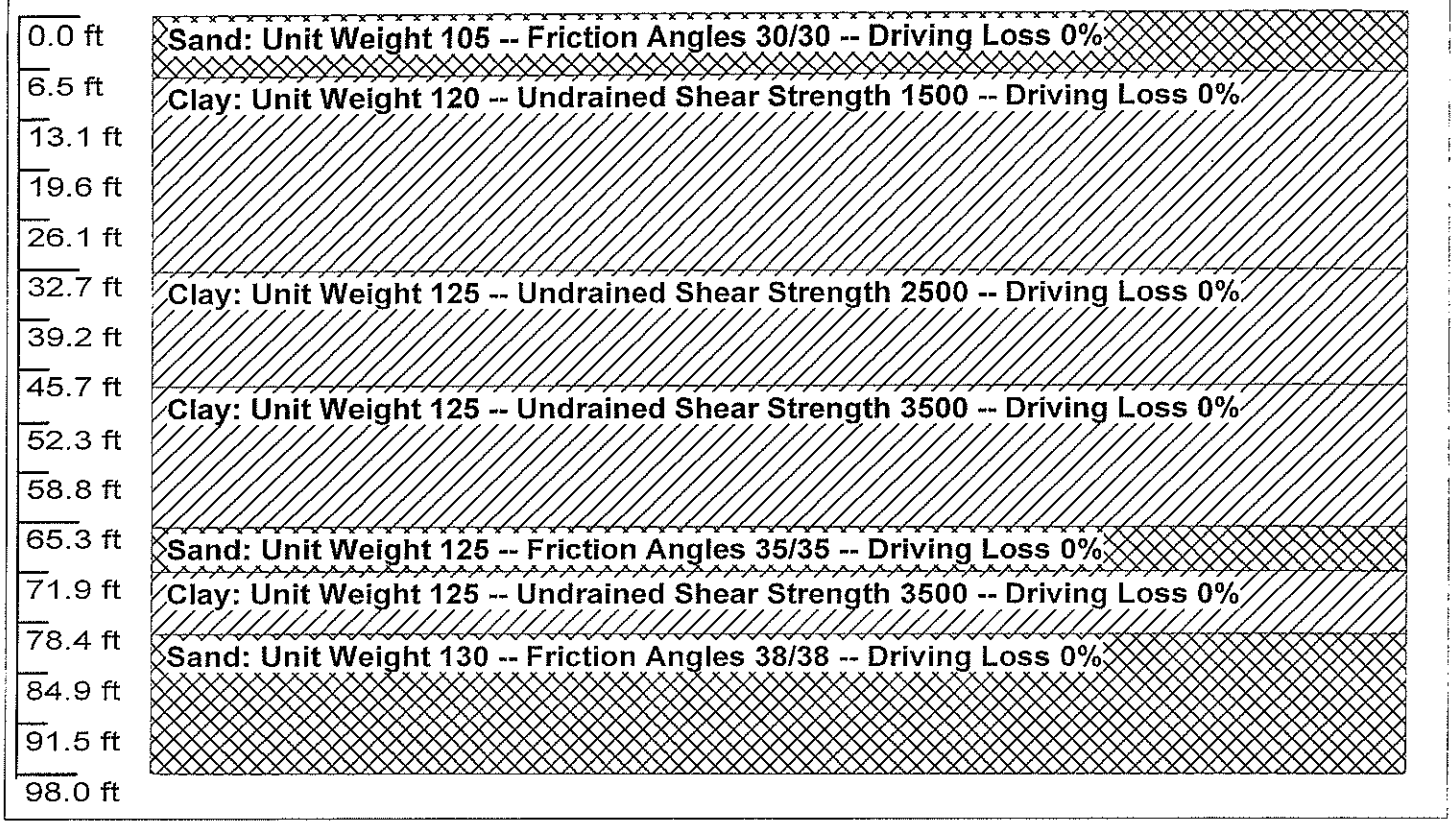
Filename: Z:\DELDOT\SR1DEC~1\C-R7P1.DVN RAMP C/SR 7 PIER 1 30"φ 0.625" WALL



REQUIRED CAPACITY = 815 K
EST. PILE TIP = EL. 1

Filename: Z:\DELDOT\SR1DEC~1\C-R7P1.DVN RAMP C/SR7 PIER 1

Soil Profile BORING IBR-43



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\C-R7P1.DVN
Project Name: Ramp C / SR7 Pier C
Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-43 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 30.00 in
Shell Thickness: 0.62 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	38.00 ft
	- Driving/Restrike	38.00 ft
	- Ultimate:	38.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	8.00 ft	0.00%	105.00 pcf	30.0/30.0	Nordlund
2	Cohesive	25.00 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
3	Cohesive	15.00 ft	0.00%	125.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	18.00 ft	0.00%	125.00 pcf	3500.00 psf	T-79 Steel
5	Cohesionless	6.00 ft	0.00%	125.00 pcf	35.0/35.0	Nordlund
6	Cohesive	8.00 ft	0.00%	125.00 pcf	3500.00 psf	T-79 Steel
7	Cohesionless	18.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.52 psf	28.00	N/A	0.00 Kips
7.99 ft	Cohesionless	419.47 psf	28.00	N/A	12.48 Kips
8.01 ft	Cohesive	N/A	N/A	1060.00 psf	12.60 Kips
17.01 ft	Cohesive	N/A	N/A	1060.00 psf	87.52 Kips
26.01 ft	Cohesive	N/A	N/A	1063.16 psf	162.90 Kips
32.99 ft	Cohesive	N/A	N/A	1085.04 psf	225.47 Kips
33.01 ft	Cohesive	N/A	N/A	1056.07 psf	225.65 Kips
42.01 ft	Cohesive	N/A	N/A	1119.07 psf	304.76 Kips
47.99 ft	Cohesive	N/A	N/A	1160.93 psf	362.24 Kips
48.01 ft	Cohesive	N/A	N/A	920.33 psf	362.41 Kips
57.01 ft	Cohesive	N/A	N/A	979.13 psf	431.63 Kips
65.99 ft	Cohesive	N/A	N/A	1037.80 psf	508.98 Kips
66.01 ft	Cohesionless	6218.11 psf	32.66	N/A	509.45 Kips
71.99 ft	Cohesionless	6405.29 psf	32.66	N/A	747.92 Kips
72.01 ft	Cohesive	N/A	N/A	1077.13 psf	748.41 Kips
79.99 ft	Cohesive	N/A	N/A	1129.27 psf	819.19 Kips
80.01 ft	Cohesionless	7094.54 psf	30.32	N/A	820.09 Kips
89.01 ft	Cohesionless	7398.74 psf	30.32	N/A	1580.21 Kips
97.99 ft	Cohesionless	7702.26 psf	30.32	N/A	2400.92 Kips

ULTIMATE - END BEARING

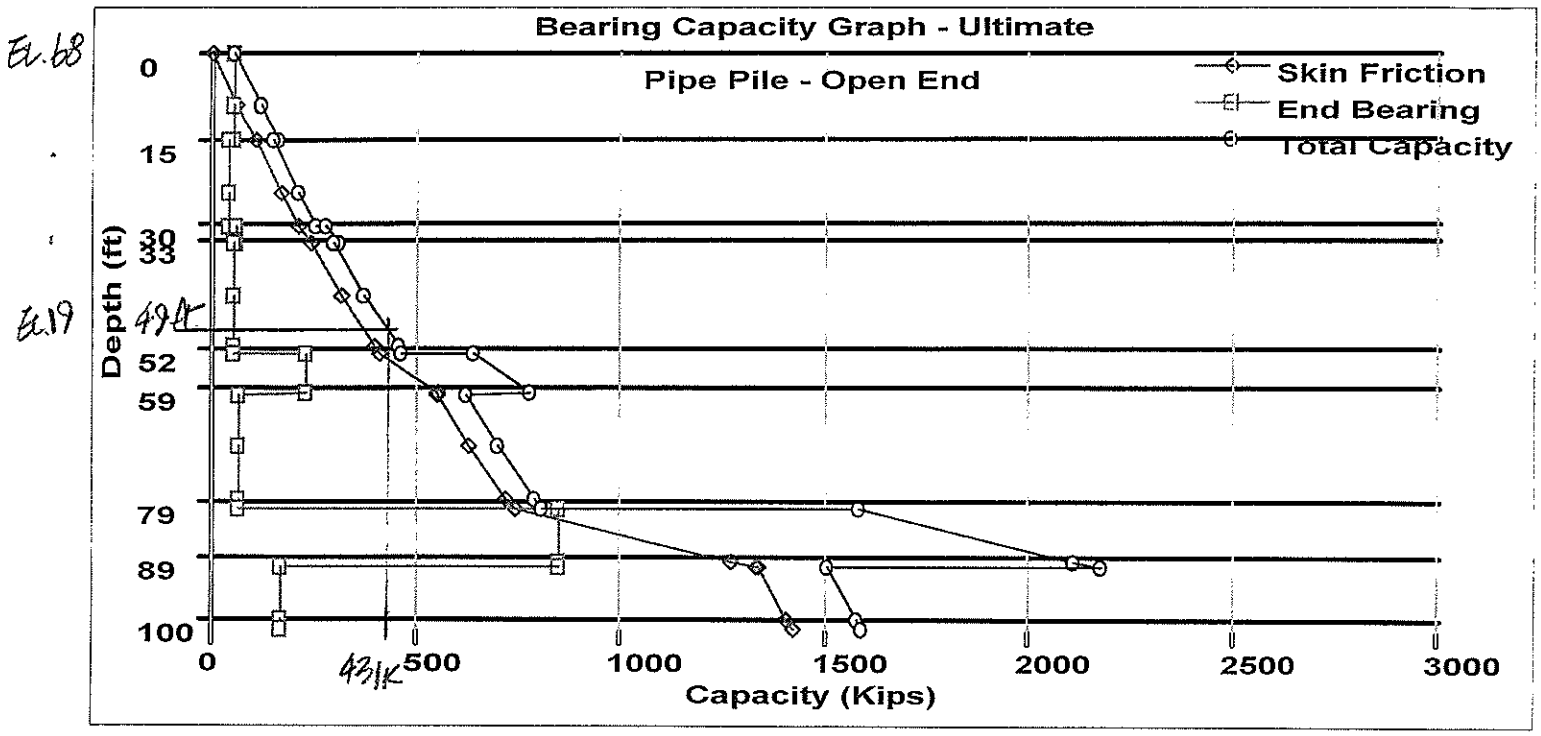
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	1.05 psf	30.00	65.38 Kips	0.09 Kips
7.99 ft	Cohesionless	838.95 psf	30.00	65.38 Kips	65.38 Kips
8.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
17.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
26.01 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
32.99 ft	Cohesive	N/A	N/A	N/A	66.27 Kips
33.01 ft	Cohesive	N/A	N/A	N/A	110.45 Kips
42.01 ft	Cohesive	N/A	N/A	N/A	110.45 Kips
47.99 ft	Cohesive	N/A	N/A	N/A	110.45 Kips
48.01 ft	Cohesive	N/A	N/A	N/A	154.63 Kips
57.01 ft	Cohesive	N/A	N/A	N/A	154.63 Kips
65.99 ft	Cohesive	N/A	N/A	N/A	154.63 Kips
66.01 ft	Cohesionless	6218.43 psf	64.00	528.18 Kips	528.18 Kips
71.99 ft	Cohesionless	6592.77 psf	64.00	528.18 Kips	528.18 Kips
72.01 ft	Cohesive	N/A	N/A	N/A	154.63 Kips
79.99 ft	Cohesive	N/A	N/A	N/A	154.63 Kips
80.01 ft	Cohesionless	7094.88 psf	110.40	1318.49 Kips	1318.49 Kips
89.01 ft	Cohesionless	7703.28 psf	110.40	1318.49 Kips	1318.49 Kips
97.99 ft	Cohesionless	8310.32 psf	110.40	1318.49 Kips	1318.49 Kips

C-R7P1-6

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.09 Kips	0.09 Kips
7.99 ft	12.48 Kips	65.38 Kips	77.87 Kips
8.01 ft	12.60 Kips	66.27 Kips	78.86 Kips
17.01 ft	87.52 Kips	66.27 Kips	153.79 Kips
26.01 ft	162.90 Kips	66.27 Kips	229.17 Kips
32.99 ft	225.47 Kips	66.27 Kips	291.74 Kips
33.01 ft	225.65 Kips	110.45 Kips	336.09 Kips
42.01 ft	304.76 Kips	110.45 Kips	415.20 Kips
47.99 ft	362.24 Kips	110.45 Kips	472.69 Kips
48.01 ft	362.41 Kips	154.63 Kips	517.04 Kips
57.01 ft	431.63 Kips	154.63 Kips	586.26 Kips
65.99 ft	508.98 Kips	154.63 Kips	663.60 Kips
66.01 ft	509.45 Kips	528.18 Kips	1037.63 Kips
71.99 ft	747.92 Kips	528.18 Kips	1276.10 Kips
72.01 ft	748.41 Kips	154.63 Kips	903.04 Kips
79.99 ft	819.19 Kips	154.63 Kips	973.82 Kips
80.01 ft	820.09 Kips	1318.49 Kips	2138.58 Kips
89.01 ft	1580.21 Kips	1318.49 Kips	2898.69 Kips
97.99 ft	2400.92 Kips	1318.49 Kips	3719.41 Kips

Filename: Z:\DELDOT\SR1DEC~1\C-R7UTB.DVN RAMP C/SR 7 ABUT. B 24"φ 0.5" WALL



REQUIRED CAPACITY = 431K
EST. PILE TIP = EL. 19

Filename: Z:\DELDOT\SR1DEC~1\C-R7UTB.DVN RAMP C/SR7 ABUT B 24"Φ 0.5" WALL

Soil Profile BORING IBR-31

EL. 68

0.0 ft	Clay: Unit Weight 115 -- Undrained Shear Strength 2000 -- Driving Loss 0%
6.7 ft	
13.3 ft	Clay: Unit Weight 110 -- Undrained Shear Strength 1500 -- Driving Loss 0%
20.0 ft	
26.7 ft	
33.3 ft	Clay: Unit Weight 115 -- Undrained Shear Strength 2000 -- Driving Loss 0%
40.0 ft	
46.7 ft	
53.3 ft	Sand: Unit Weight 125 -- Friction Angles 34/34 -- Driving Loss 0%
60.0 ft	Clay: Unit Weight 120 -- Undrained Shear Strength 2500 -- Driving Loss 0%
66.7 ft	
73.3 ft	
80.0 ft	Sand: Unit Weight 130 -- Friction Angles 38/38 -- Driving Loss 0%
86.7 ft	
93.3 ft	Clay: Unit Weight 135 -- Undrained Shear Strength 6000 -- Driving Loss 0%
100.0 ft	

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\C-R7UTB.DVN
Project Name: Ramp C / SR7 Abut B
Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-31 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 24.00 in
Shell Thickness: 0.50 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	38.00 ft
	- Driving/Restrike	38.00 ft
	- Ultimate:	38.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	15.00 ft	0.00%	115.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	15.00 ft	0.00%	110.00 pcf	1500.00 psf	T-79 Steel
3	Cohesionless	3.00 ft	0.00%	115.00 pcf	31.0/31.0	Nordlund
4	Cohesive	19.00 ft	0.00%	115.00 pcf	2000.00 psf	T-79 Steel
5	Cohesionless	7.00 ft	0.00%	125.00 pcf	34.0/34.0	Nordlund
6	Cohesive	20.00 ft	0.00%	120.00 pcf	2500.00 psf	T-79 Steel
7	Cohesionless	10.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund
8	Cohesive	11.00 ft	0.00%	135.00 pcf	6000.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1165.00 psf	0.07 Kips
9.01 ft	Cohesive	N/A	N/A	1165.00 psf	65.95 Kips
14.99 ft	Cohesive	N/A	N/A	1165.00 psf	109.73 Kips
15.01 ft	Cohesive	N/A	N/A	1060.00 psf	109.87 Kips
24.01 ft	Cohesive	N/A	N/A	1075.71 psf	170.70 Kips
29.99 ft	Cohesive	N/A	N/A	1099.13 psf	213.32 Kips
30.01 ft	Cohesionless	3375.58 psf	26.69	N/A	213.49 Kips
32.99 ft	Cohesionless	3546.93 psf	26.69	N/A	243.61 Kips
33.01 ft	Cohesive	N/A	N/A	1240.89 psf	243.79 Kips
42.01 ft	Cohesive	N/A	N/A	1293.39 psf	316.94 Kips
51.01 ft	Cohesive	N/A	N/A	1345.89 psf	396.02 Kips
51.99 ft	Cohesive	N/A	N/A	1351.61 psf	404.99 Kips
52.01 ft	Cohesionless	5031.71 psf	29.28	N/A	405.27 Kips
58.99 ft	Cohesionless	5250.19 psf	29.28	N/A	544.67 Kips
59.01 ft	Cohesive	N/A	N/A	1341.34 psf	544.96 Kips
68.01 ft	Cohesive	N/A	N/A	1420.09 psf	625.27 Kips
77.01 ft	Cohesive	N/A	N/A	1498.84 psf	714.49 Kips
78.99 ft	Cohesive	N/A	N/A	1516.16 psf	735.31 Kips
79.01 ft	Cohesionless	6621.94 psf	30.32	N/A	735.98 Kips
88.01 ft	Cohesionless	6926.14 psf	30.32	N/A	1270.12 Kips
88.99 ft	Cohesionless	6959.26 psf	30.32	N/A	1331.11 Kips
89.01 ft	Cohesive	N/A	N/A	1260.00 psf	1331.82 Kips
98.01 ft	Cohesive	N/A	N/A	1260.00 psf	1403.07 Kips
99.99 ft	Cohesive	N/A	N/A	1260.00 psf	1418.74 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
14.99 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
15.01 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
24.01 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
29.99 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
30.01 ft	Cohesionless	3376.15 psf	35.20	64.92 Kips	64.92 Kips
32.99 ft	Cohesionless	3718.85 psf	35.20	64.92 Kips	64.92 Kips
33.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
42.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
51.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
51.99 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
52.01 ft	Cohesionless	5032.03 psf	55.60	230.97 Kips	230.97 Kips
58.99 ft	Cohesionless	5468.97 psf	55.60	230.97 Kips	230.97 Kips
59.01 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
68.01 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
77.01 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
78.99 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
79.01 ft	Cohesionless	6622.28 psf	110.40	843.83 Kips	843.83 Kips
88.01 ft	Cohesionless	7230.68 psf	110.40	843.83 Kips	843.83 Kips
88.99 ft	Cohesionless	7296.92 psf	110.40	843.83 Kips	843.83 Kips
89.01 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
98.01 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
99.99 ft	Cohesive	N/A	N/A	N/A	169.65 Kips

C-R7UTB-9

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.07 Kips	56.55 Kips	56.62 Kips
9.01 ft	65.95 Kips	56.55 Kips	122.50 Kips
14.99 ft	109.73 Kips	56.55 Kips	166.27 Kips
15.01 ft	109.87 Kips	42.41 Kips	152.28 Kips
24.01 ft	170.70 Kips	42.41 Kips	213.11 Kips
29.99 ft	213.32 Kips	42.41 Kips	255.73 Kips
30.01 ft	213.49 Kips	64.92 Kips	278.41 Kips
32.99 ft	243.61 Kips	64.92 Kips	308.53 Kips
33.01 ft	243.79 Kips	56.55 Kips	300.34 Kips
42.01 ft	316.94 Kips	56.55 Kips	373.48 Kips
51.01 ft	396.02 Kips	56.55 Kips	452.57 Kips
51.99 ft	404.99 Kips	56.55 Kips	461.53 Kips
52.01 ft	405.27 Kips	230.97 Kips	636.24 Kips
58.99 ft	544.67 Kips	230.97 Kips	775.64 Kips
59.01 ft	544.96 Kips	70.69 Kips	615.65 Kips
68.01 ft	625.27 Kips	70.69 Kips	695.96 Kips
77.01 ft	714.49 Kips	70.69 Kips	785.17 Kips
78.99 ft	735.31 Kips	70.69 Kips	806.00 Kips
79.01 ft	735.98 Kips	843.83 Kips	1579.82 Kips
88.01 ft	1270.12 Kips	843.83 Kips	2113.95 Kips
88.99 ft	1331.11 Kips	843.83 Kips	2174.94 Kips
89.01 ft	1331.82 Kips	169.65 Kips	1501.46 Kips
98.01 ft	1403.07 Kips	169.65 Kips	1572.71 Kips
99.99 ft	1418.74 Kips	169.65 Kips	1588.39 Kips

C-R7UTB-10

Lateral Analysis

URS

Job SR-1/I-95 Interchange | Project No. | Page ___ of ___
Description Ramp C - Pier 1 | Computed by JPK | Sheet ___ of ___ | Date 8/26/08
Checked by | Date
Reference

From boring IBR-43 (DONE)

815K 30"φ 0.625" WALL

EL.68	Depth = 0 ft				
		1 Sand	γ = 105 pcf, c = 0, φ = 30°	N = 17	γ = 0.061, K = 40
EL.60	8 ft	96 in			
		2 Clay	γ = 120 pcf, c = 1500 psf, φ = 0	N = 14±	γ = 0.069, ε = 0.0065, c = 10.4, K = 875
EL 35	33 ft	396 in			
EL 30	~~38 ft~~	3 Clay	γ = 125 pcf, c = 2500 psf, φ = 0	N = 20 +	
EL.20	48 ft				
		4 Clay	γ = 125 pcf, c = 3500 psf, φ = 0	N = 24 ±	
EL 2	66 ft				
		5 Sand	~~γ = 125 pcf~~, φ = 35°, c = 0	N = 36	
EL -4	72 ft				
		6 Clay	γ = 125 pcf, c = 3500 psf, φ = 0	N = 20	
EL -12	80 ft				
		7 Sand	γ = 130 pcf, c = 0, φ = 38°	N = 70±	
EL -30	98 ft				

Total Shear = 161 K

9 piles

Assume 3x3 config

Table 10.7.2.4-1

Row 1 - 3 piles @ 1.0

Row 2 - 3 piles @ 0.5

Row 3 - 3 piles @ 0.35

Axial = 530 K

Length Req'd = 225 ft

$$\text{Shear per pile} = \frac{161\ K}{3(1) + 3(0.5) + 3(0.35)} = 29\ K$$

```
==============================================================================

                LPILE Plus for Windows, Version 4.0 (4.0.8)

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

                 (c) Copyright ENSOFT, Inc., 1985-2003
                          All Rights Reserved

==============================================================================

This program is licensed to:

URS
URS

Path to file locations:      D:\Program Files\Ensoft\LpileP4\DelDOTSR1\
Name of input data file:     S4P1.lpd
Name of output file:         S4P1.lpo
Name of plot output file:    S4P1.lpp
Name of runtime file:        S4P1.lpr


------------------------------------------------------------------------------
                          Time and Date of Analysis
------------------------------------------------------------------------------

               Date:  January 22, 2009     Time:  13:26:32


------------------------------------------------------------------------------
                                Problem Title
------------------------------------------------------------------------------

Ramp C over SR 7 - Pier 1


------------------------------------------------------------------------------
                                Program Options
------------------------------------------------------------------------------

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          150
- Maximum number of iterations allowed =          100
```

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 270.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	30.000	6220.0000	57.7000	30000000.000
2	270.0000	30.000	6220.0000	57.7000	30000000.000

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 96.000 in
p-y subgrade modulus k for top of soil layer = 40.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 40.000 lbs/in**3

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 96.000 in
Distance from top of pile to bottom of layer = 396.000 in
p-y subgrade modulus k for top of soil layer = 875.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 875.000 lbs/in**3

(Depth of lowest layer extends 126.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth is defined using 4 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06100
2	96.00	.06100
3	96.00	.06900
4	396.00	.06900

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 4 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	.00000	30.00	------	------
2	96.000	.00000	30.00	------	------
3	96.000	10.40000	.00	.00650	.0
4	396.000	10.40000	.00	.00650	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 29000.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 530000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 29000.000 lbs
Specified bending moment at pile head = .000 in-lbs
Specified axial load at pile head = 530000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.214949	-6.394E-05	29000.0000	-.001809	9185.4419	0.0000
1.800	.211694	53925.3914	28986.2823	-.001808	9315.4871	-15.2419
3.600	.208439	107800.9025	28945.5508	-.001808	9445.4120	-30.0152
5.400	.205186	161578.1723	28878.6488	-.001806	9575.0999	-44.3203
7.200	.201937	215210.3573	28786.4186	-.001804	9704.4380	-58.1578
9.000	.198691	268652.1308	28669.7009	-.001802	9833.3169	-71.5286
10.800	.195449	321859.6794	28529.3345	-.001799	9961.6309	-84.4340
12.600	.192213	374790.6997	28366.1560	-.001796	10089.2780	-96.8755
14.400	.188984	427404.3945	28180.9988	-.001792	10216.1599	-108.8547
16.200	.185762	479661.4668	27974.6931	-.001788	10342.1818	-120.3738
18.000	.182548	531524.1139	27748.0654	-.001783	10467.2525	-131.4348
19.800	.179344	582956.0208	27501.9376	-.001777	10591.2844	-142.0405
21.600	.176150	633922.3518	27237.1271	-.001772	10714.1936	-152.1934
23.400	.172967	684389.7424	26954.4460	-.001765	10835.8995	-161.8967
25.200	.169795	734326.2897	26654.7008	-.001758	10956.3253	-171.1536
27.000	.166637	783701.5417	26338.6918	-.001751	11075.3974	-179.9675
28.800	.163492	832486.4868	26007.2130	-.001743	11193.0460	-188.3423
30.600	.160361	880653.5419	25661.0511	-.001735	11309.2045	-196.2819
32.400	.157246	928176.5392	25300.9859	-.001726	11423.8098	-203.7906
34.200	.154147	975030.7134	24927.7890	-.001717	11536.8022	-210.8727
36.000	.151064	1.021E+06	24542.2241	-.001707	11648.1253	-217.5328
37.800	.148000	1.067E+06	24145.0461	-.001697	11757.7260	-223.7760
39.600	.144954	1.111E+06	23737.0012	-.001687	11865.5546	-229.6072
41.400	.141927	1.155E+06	23318.8261	-.001676	11971.5645	-235.0318
43.200	.138921	1.198E+06	22891.2479	-.001665	12075.7123	-240.0551
45.000	.135935	1.241E+06	22454.9835	-.001653	12177.9578	-244.6830
46.800	.132971	1.282E+06	22010.7396	-.001641	12278.2640	-248.9213
48.600	.130029	1.323E+06	21559.2121	-.001628	12376.5968	-252.7760
50.400	.127110	1.363E+06	21101.0856	-.001615	12472.9251	-256.2534
52.200	.124214	1.402E+06	20637.0337	-.001602	12567.2210	-259.3599
54.000	.121344	1.441E+06	20167.7180	-.001588	12659.4592	-262.1020
55.800	.118498	1.478E+06	19693.7883	-.001574	12749.6175	-264.4865
57.600	.115677	1.514E+06	19215.8821	-.001560	12837.6765	-266.5204
59.400	.112883	1.550E+06	18734.6242	-.001545	12923.6193	-268.2106
61.200	.110116	1.585E+06	18250.6267	-.001530	13007.4322	-269.5644
63.000	.107377	1.619E+06	17764.4887	-.001514	13089.1036	-270.5890
64.800	.104665	1.652E+06	17276.7958	-.001498	13168.6248	-271.2920
66.600	.101982	1.684E+06	16788.1201	-.001482	13245.9896	-271.6810
68.400	.099329	1.715E+06	16299.0200	-.001466	13321.1943	-271.7636
70.200	.096705	1.745E+06	15810.0399	-.001449	13394.2375	-271.5477
72.000	.094112	1.775E+06	15321.7098	-.001432	13465.1202	-271.0413
73.800	.091549	1.803E+06	14834.5456	-.001415	13533.8458	-270.2523
75.600	.089018	1.831E+06	14349.0483	-.001397	13600.4197	-269.1891
77.400	.086518	1.857E+06	13865.7044	-.001380	13664.8497	-267.8597
79.200	.084051	1.883E+06	13384.9854	-.001362	13727.1455	-266.2726
81.000	.081616	1.908E+06	12907.3476	-.001343	13787.3190	-264.4361
82.800	.079215	1.932E+06	12433.2322	-.001325	13845.3840	-262.3588
84.600	.076847	1.956E+06	11963.0650	-.001306	13901.3562	-260.0492
86.400	.074513	1.978E+06	11497.2564	-.001287	13955.2531	-257.5159
88.200	.072213	1.999E+06	11036.2011	-.001268	14007.0940	-254.7678
90.000	.069948	2.020E+06	10580.2779	-.001249	14056.8999	-251.8135
91.800	.067718	2.040E+06	10129.8502	-.001229	14104.6934	-248.6618
93.600	.065524	2.059E+06	9685.2652	-.001209	14150.4987	-245.3216
95.400	.063365	2.077E+06	9246.8541	-.001189	14194.3415	-241.8019
97.200	.061243	2.094E+06	8649.6403	-.001169	14236.2489	-421.7690
99.000	.059156	2.110E+06	7890.2878	-.001149	14274.8143	-421.9560
100.800	.057107	2.125E+06	7130.6858	-.001128	14310.0359	-422.0462

102.600	.055094	2.138E+06	6371.0098	-.001108	14341.9127	-422.0382
104.400	.053119	2.150E+06	5611.4378	-.001087	14370.4445	-421.9307
106.200	.051180	2.160E+06	4852.1499	-.001066	14395.6318	-421.7225
108.000	.049280	2.170E+06	4093.3289	-.001045	14417.4760	-421.4120
109.800	.047417	2.177E+06	3335.1600	-.001025	14435.9793	-420.9979
111.600	.045591	2.184E+06	2577.8309	-.001003	14451.1449	-420.4788
113.400	.043804	2.188E+06	1821.5323	-9.824E-04	14462.9766	-419.8530
115.200	.042055	2.192E+06	1066.4575	-9.613E-04	14471.4792	-419.1190
117.000	.040343	2.194E+06	312.8028	-9.401E-04	14476.6583	-418.2751
118.800	.038670	2.195E+06	-439.2324	-9.190E-04	14478.5206	-417.3196
120.600	.037035	2.194E+06	-1189.4457	-8.978E-04	14477.0735	-416.2507
122.400	.035438	2.192E+06	-1937.6311	-8.766E-04	14472.3252	-415.0664
124.200	.033879	2.189E+06	-2683.5790	-8.555E-04	14464.2852	-413.7647
126.000	.032358	2.184E+06	-3427.0763	-8.344E-04	14452.9637	-412.3434
127.800	.030875	2.178E+06	-4167.9057	-8.134E-04	14438.3718	-410.8004
129.600	.029430	2.171E+06	-4905.8458	-7.924E-04	14420.5218	-409.1331
131.400	.028023	2.162E+06	-5640.6706	-7.715E-04	14399.4269	-407.3389
133.200	.026653	2.152E+06	-6372.1492	-7.507E-04	14375.1013	-405.4151
135.000	.025320	2.141E+06	-7100.0456	-7.300E-04	14347.5601	-403.3587
136.800	.024025	2.128E+06	-7824.1183	-7.094E-04	14316.8199	-401.1664
138.600	.022766	2.114E+06	-8544.1194	-6.889E-04	14282.8978	-398.8348
140.400	.021545	2.098E+06	-9259.7946	-6.686E-04	14245.8126	-396.3599
142.200	.020359	2.082E+06	-9970.8825	-6.485E-04	14205.5839	-393.7377
144.000	.019210	2.064E+06	-10677.1136	-6.285E-04	14162.2324	-390.9635
145.800	.018097	2.044E+06	-11378.2097	-6.087E-04	14115.7804	-388.0322
147.600	.017019	2.024E+06	-12073.8832	-5.890E-04	14066.2511	-384.9384
149.400	.015976	2.002E+06	-12763.8358	-5.696E-04	14013.6692	-381.6756
151.200	.014968	1.979E+06	-13447.7571	-5.504E-04	13958.0607	-378.2370
153.000	.013995	1.955E+06	-14125.3237	-5.314E-04	13899.4528	-374.6148
154.800	.013055	1.929E+06	-14796.1970	-5.127E-04	13837.8745	-370.8000
156.600	.012149	1.902E+06	-15460.0212	-4.942E-04	13773.3562	-366.7826
158.400	.011276	1.874E+06	-16116.4215	-4.760E-04	13705.9298	-362.5511
160.200	.010436	1.845E+06	-16765.0004	-4.581E-04	13635.6290	-358.0922
162.000	.009627	1.815E+06	-17405.3348	-4.404E-04	13562.4892	-353.3905
163.800	.008850	1.784E+06	-18036.9716	-4.231E-04	13486.5480	-348.4281
165.600	.008104	1.751E+06	-18659.4223	-4.060E-04	13407.8448	-343.1838
167.400	.007388	1.717E+06	-19272.1566	-3.893E-04	13326.4212	-337.6322
169.200	.006703	1.682E+06	-19874.5943	-3.729E-04	13242.3214	-331.7430
171.000	.006046	1.646E+06	-20466.0942	-3.568E-04	13155.5922	-325.4791
172.800	.005418	1.609E+06	-21045.9407	-3.411E-04	13066.2834	-318.7948
174.600	.004818	1.571E+06	-21613.3253	-3.258E-04	12974.4479	-311.6326
176.400	.004245	1.532E+06	-22167.3217	-3.108E-04	12880.1426	-303.9190
178.200	.003699	1.492E+06	-22706.8507	-2.962E-04	12783.4287	-295.5578
180.000	.003179	1.451E+06	-23230.6303	-2.820E-04	12684.3723	-286.4195
181.800	.002684	1.409E+06	-23737.0997	-2.683E-04	12583.0457	-276.3242
183.600	.002213	1.366E+06	-24224.3005	-2.549E-04	12479.5289	-265.0100
185.400	.001766	1.322E+06	-24689.6754	-2.419E-04	12373.9110	-252.0733
187.200	.001342	1.278E+06	-25129.6970	-2.294E-04	12266.2943	-236.8396
189.000	9.40E-04	1.232E+06	-25539.0845	-2.173E-04	12156.7986	-218.0353
190.800	5.60E-04	1.186E+06	-25908.7450	-2.056E-04	12045.5720	-192.6987
192.600	2.00E-04	1.139E+06	-26216.9942	-1.944E-04	11932.8134	-149.8005
194.400	-1.40E-04	1.092E+06	-26227.3810	-1.836E-04	11818.8590	138.2596
196.200	-4.61E-04	1.045E+06	-25934.4829	-1.733E-04	11705.9608	187.1828
198.000	-7.64E-04	998956.8307	-25573.7511	-1.635E-04	11594.5018	213.6303
199.800	-.001049	953421.4973	-25172.0785	-1.540E-04	11484.6899	232.6726
201.600	-.001318	908631.2492	-24739.6420	-1.451E-04	11376.6749	247.8123
203.400	-.001571	864635.5513	-24282.1695	-1.365E-04	11270.5759	260.4905
205.200	-.001810	821475.8855	-23803.4191	-1.284E-04	11166.4931	271.4545
207.000	-.002034	779188.1728	-23306.0776	-1.206E-04	11064.5131	281.1471
208.800	-.002244	737804.2060	-22792.1763	-1.133E-04	10964.7125	289.8543
210.600	-.002442	697352.5776	-22263.3117	-1.064E-04	10867.1604	297.7731
212.400	-.002627	657859.3165	-21720.7748	-9.987E-05	10771.9194	305.0456
214.200	-.002801	619348.3492	-21165.6334	-9.371E-05	10679.0473	311.7783

216.000	-.002964	581841.8439	-20598.7849	-8.792E-05	10588.5975	318.0533
217.800	-.003118	545360.4770	-20020.9946	-8.248E-05	10500.6199	323.9359
219.600	-.003261	509923.6435	-19432.9216	-7.739E-05	10415.1613	329.4786
221.400	-.003396	475549.6282	-18835.1384	-7.264E-05	10332.2658	334.7250
223.200	-.003523	442255.7455	-18228.1458	-6.821E-05	10251.9751	339.7113
225.000	-.003642	410058.4574	-17612.3841	-6.410E-05	10174.3289	344.4684
226.800	-.003754	378973.4733	-16988.2418	-6.030E-05	10099.3651	349.0230
228.600	-.003859	349015.8361	-16356.0630	-5.679E-05	10027.1200	353.3980
230.400	-.003958	320199.9965	-15716.1523	-5.356E-05	9957.6284	357.6138
232.200	-.004052	292539.8792	-15068.7803	-5.060E-05	9890.9240	361.6884
234.000	-.004140	266048.9402	-14414.1867	-4.791E-05	9827.0391	365.6377
235.800	-.004224	240740.2192	-13752.5842	-4.547E-05	9766.0052	369.4762
237.600	-.004304	216626.3856	-13084.1605	-4.326E-05	9707.8528	373.2167
239.400	-.004380	193719.7807	-12409.0814	-4.128E-05	9652.6118	376.8712
241.200	-.004453	172032.4556	-11727.4923	-3.952E-05	9600.3112	380.4501
243.000	-.004522	151576.2057	-11039.5202	-3.796E-05	9550.9794	383.9634
244.800	-.004589	132362.6023	-10345.2754	-3.659E-05	9504.6444	387.4198
246.600	-.004654	114403.0208	-9644.8528	-3.540E-05	9461.3335	390.8275
248.400	-.004717	97708.6675	-8938.3336	-3.437E-05	9421.0738	394.1939
250.200	-.004778	82290.6032	-8225.7861	-3.350E-05	9383.8919	397.5256
252.000	-.004837	68159.7646	-7507.2671	-3.278E-05	9349.8144	400.8289
253.800	-.004896	55326.9843	-6782.8229	-3.218E-05	9318.8671	404.1091
255.600	-.004953	43803.0082	-6052.4907	-3.171E-05	9291.0762	407.3712
257.400	-.005010	33598.5115	-5316.2991	-3.133E-05	9266.4673	410.6195
259.200	-.005066	24724.1129	-4574.2695	-3.105E-05	9245.0660	413.8579
261.000	-.005122	17190.3862	-3826.4168	-3.085E-05	9226.8979	417.0896
262.800	-.005177	11007.8716	-3072.7505	-3.071E-05	9211.9883	420.3174
264.600	-.005232	6187.0842	-2313.2755	-3.063E-05	9200.3626	423.5436
266.400	-.005287	2738.5212	-1547.9933	-3.059E-05	9192.0461	426.7699
268.200	-.005342	672.6675	-776.9025	-3.057E-05	9187.0641	429.9976
270.000	-.005397	0.0000	0.0000	-3.057E-05	9185.4419	433.2274

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.21494911	in
Computed slope at pile head	=	-.00180859	
Maximum bending moment	=	2194863.295	lbs-in
Maximum shear force	=	29000.000	lbs
Depth of maximum bending moment	=	118.800	in
Depth of maximum shear force	=	0.000	in
Number of iterations	=	24	
Number of zero deflection points	=	1	

Summary of Pile-head Response

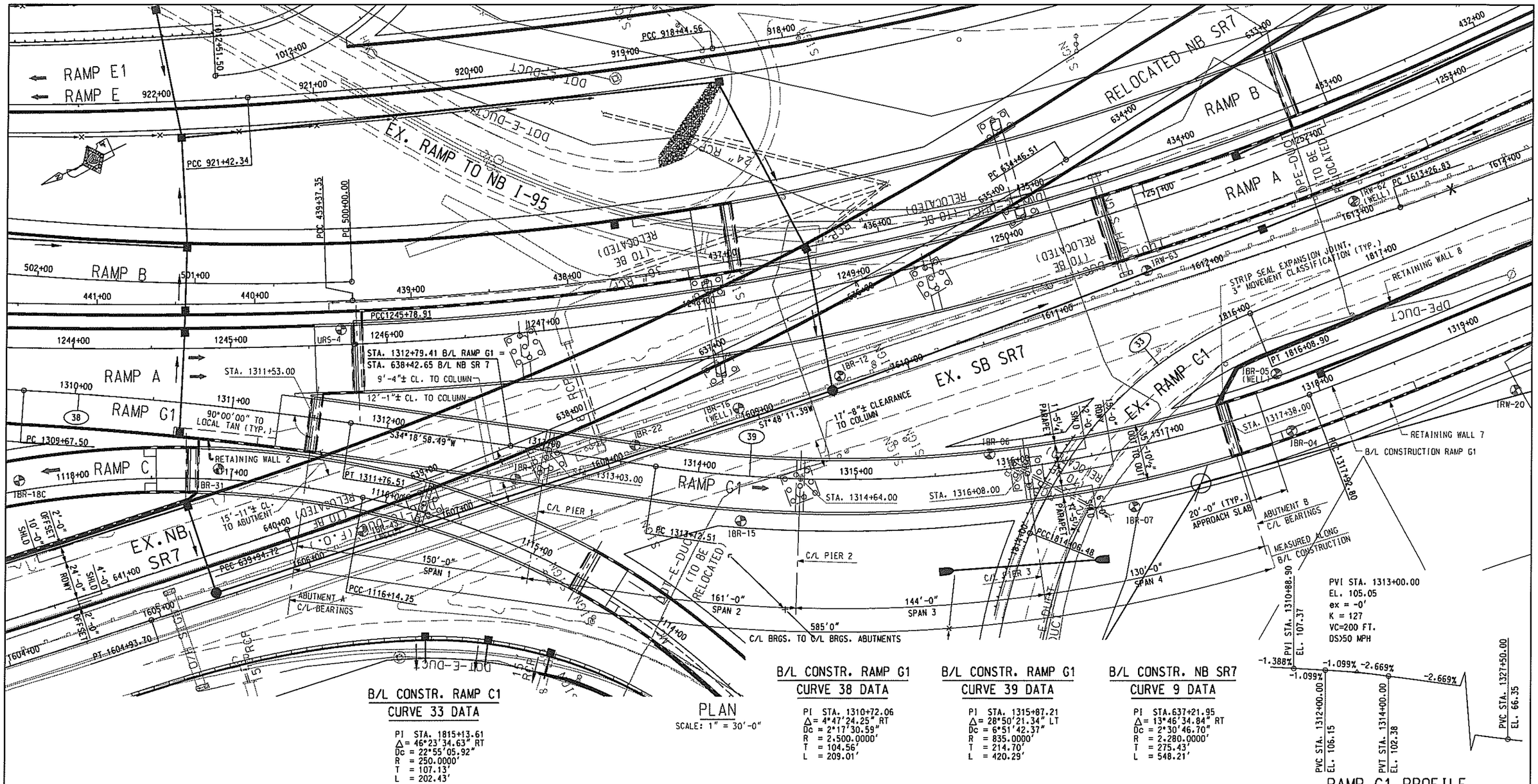
Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

BC Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 29000.000	M= 0.000	530000.0000	.2149	2.195E+06	29000.0000

The analysis ended normally.

Structure S5 – Ramp G1 over SR 7



B/L CONSTR. RAMP C1
CURVE 33 DATA

PI STA. 1815+13.61
Δ = 46°23'34.63" RT
Dc = 22°55'05.92"
R = 250.0000'
T = 107.13'
L = 202.43'

B/L CONSTR. RAMP G1
CURVE 38 DATA

PI STA. 1310+72.06
Δ = 4°47'24.25" RT
Dc = 2°17'30.59"
R = 2,500.0000'
T = 104.56'
L = 209.01'

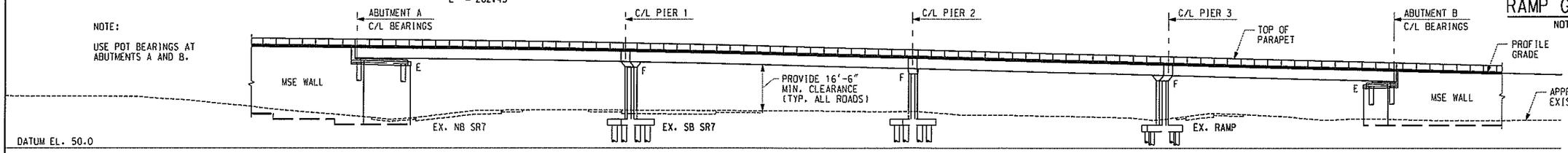
B/L CONSTR. RAMP G1
CURVE 39 DATA

PI STA. 1315+87.21
Δ = 28°50'21.34" LT
Dc = 6°51'42.37"
R = 835.0000'
T = 214.70'
L = 420.29'

B/L CONSTR. NB SR7
CURVE 9 DATA

PI STA.637+21.95
Δ = 13°46'34.84" RT
Dc = 2°30'46.70"
R = 2,280.0000'
T = 275.43'
L = 548.21'

NOTE:
USE POT BEARINGS AT ABUTMENTS A AND B.



ELEVATION
SCALE: 1" = 30'-0"

NOTE:
MSE ABUTMENTS SHOWN

URS S5-2

Jan 22, 2009 Q:\20832687-XM\CAD\Bridge\pe501.dgn
Jason_Kotova

DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS	SCALE 0 30 60 90 FEET	SR1 / I-95 INTERCHANGE	CONTRACT 28-090-03 / COUNTY NEW CASTLE	BRIDGE NO. / DESIGNED BY: URS / CHECKED BY:	RAMP G1 OVER SR 7 PLAN AND ELEVATION	SHEET NO. S5-1 / TOTAL SHTS. 20

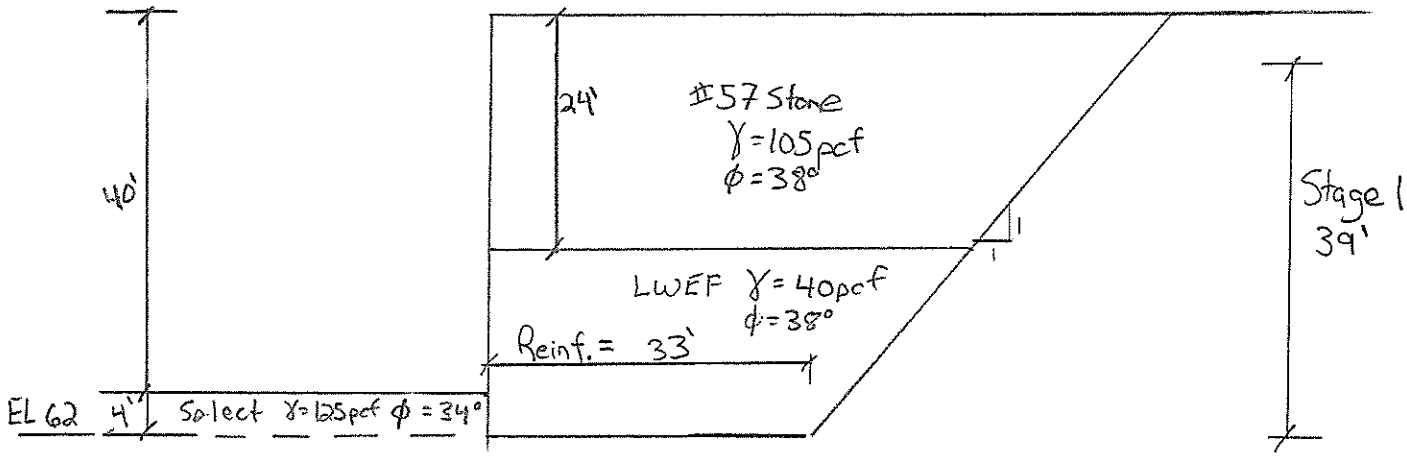
MSE Wingwalls
Bearing Capacity, Sliding, Overturning, Eccentricity, Settlement

URS

Job SR 1 / I-95 Interchange | Project No. | Page ___ of ___ | Sheet ___ of ___

Description Retaining Wall 2 & Ramp G1 over SR 7 Abut A Wingwall & Ramp C over SR 7 Abut A East Wingwall | Computed by JPK | Date | Checked by | Date | Reference

Bearing Capacity, Sliding & Overturning



Clay
γ=120pcf

	CD	CU	UU @ Stage 1
	φ=24°	φ=10.3°	φ=0
EL 30 ▽	c=0	c=940 psf	c=1250psf
	Traffic Surcharge = 250psf	TS= 250psf	TS=0

Settlement

Assumptions:

1) 6 feet of overburden removed to reach bottom of footing
2) 20 feet of clay layer consolidating (based on test embankment back calculation)
3) Consolidation parameters from URS-4, U-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Retaining Wall 2, Ramp G1 over SR 7-Abutment A Wingwall, Ramp C over SR 7-Abutment A East Wingwall
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	40	feet	
Embedment (below grade)	Df =	4	feet	
Total Height (Hw+Df)	H =	44	feet	
Wall Base Width	B =	33	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	91	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	32	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	24	feet	
Top Material Unit Weight	γ1 =	105	pcf	
Top Material Φ	Φ1 =	38	degrees	
Bottom Material Height	H2 =	20	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	38	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	75.45	pcf	
Retained Wedge - Vertical Component	Wrw	43	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	21.1	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.238	(dim)	
Horiz F2 Surcharge	F2 =	2.6	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	109.6	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	35.2	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	43.0	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	43.0	k/ft	**Capacity Demand Ratio (CDR)=** 1.19
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	5.15	ft	e < 0.25*B, OK
Effective Width	B' =	22.7	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	4.83	ksf	
Factored Bearing Pressure	Sigv =	7.15	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.18	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.16	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.85	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.78	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	18.1	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	11.76	ksf	**Capacity Demand Ratio (CDR)=** 1.644
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming quarantine period after Stage 1
Foundation Φ	Φf =	10.3	degrees	
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS-2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.11	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.07	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.85	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.78	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	11.9	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.73	ksf	**Capacity Demand Ratio (CDR)=** 1.081
				CDR > 1.0, OK

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Retaining Wall 2, Ramp G1 over SR 7-Abutment A Wingwall, Ramp C over SR 7-Abutment A East Wingwall
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	35	feet	
Embedment (below grade)	Df =	4	feet	
Total Height (Hw+Df)	H =	39	feet	
Wall Base Width	B =	33	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	91	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	32	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	19	feet	
Top Material Unit Weight	γ1 =	105	pcf	
Top Material Φ	Φ1 =	38	degrees	
Bottom Material Height	H2 =	20	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	38	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	71.67	pcf	
Retained Wedge - Vertical Component	Wrw	33	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	15.9	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.236	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	92.2	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	23.9	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	43.0	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	43.0	k/ft	**Capacity Demand Ratio (CDR)= 1.80**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	3.36	ft	**e < 0.25*B, OK**
Effective Width	B' =	26.3	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	4.74	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.18	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.16	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.85	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.78	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	18.1	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	11.76	ksf	**Capacity Demand Ratio (CDR)= 2.481**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1,
Foundation Φ	Φf =	0.0	degrees	quarantine period to follow
Foundation Cohesion (c)	cf =	1250	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.07	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.78	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	7.4	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	4.80	ksf	**Capacity Demand Ratio (CDR)= 1.014**
				CDR > 1.0, OK

Predicted Settlement Calculations: Retaining Wall 2, Ramp G1 over SR 7-AbutmentA Wingwall, Ramp C over SR 7- Abutment A East Wingwall
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c' [3]
Initial Overburden	6				0.38				2.41			
I	10	0.851	0.065	0.33	0.69	3.48	0.33	0.85	2.36	1.67	0	2.257926
II	10	0.851	0.065	0.33	1.31	3.48	0.64	0.75	2.75	1.43	0	1.350327

Footing Width (ft)	33	0.00	3.61	in
		TOTAL	3.61	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS-S5-4
Lab data on page URS-4

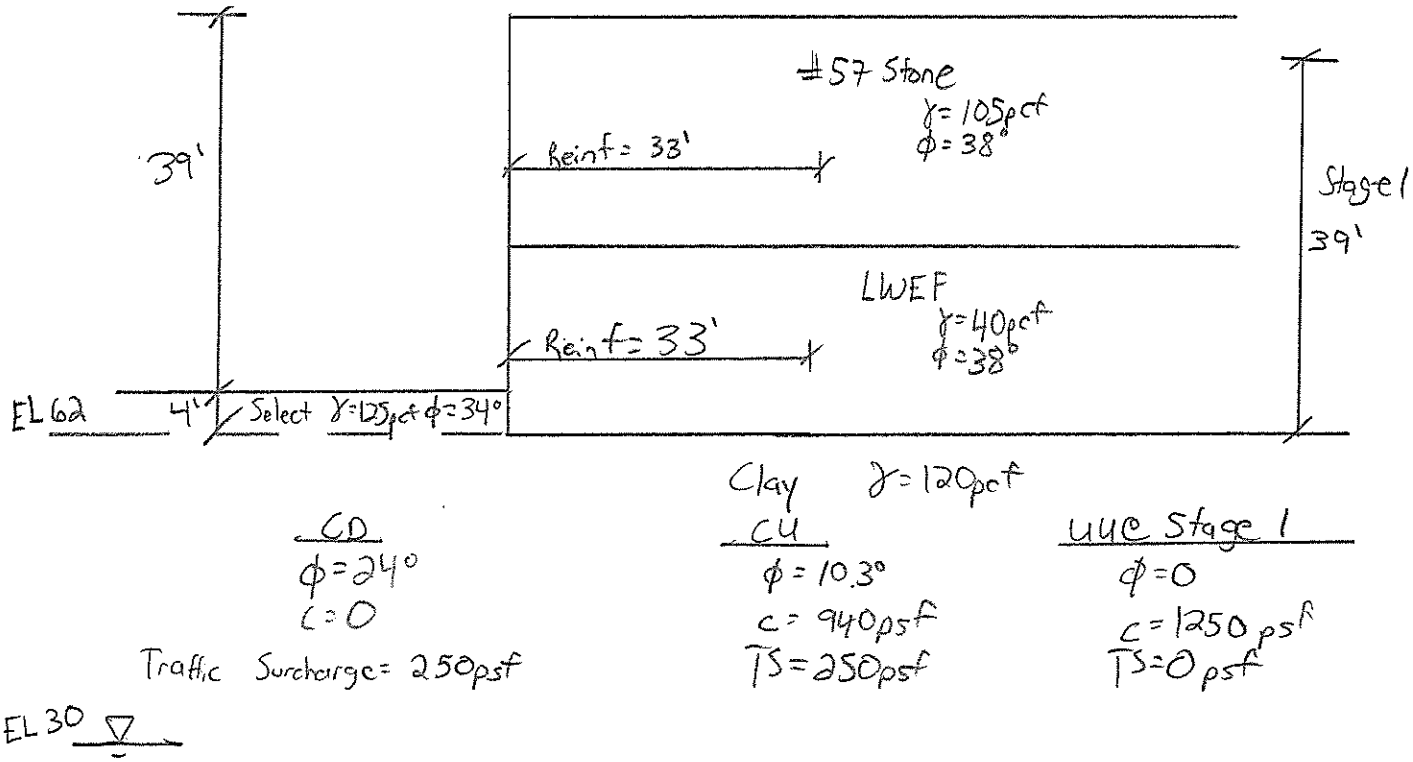
URS

Job SR 1 / I-95 Interchange | Project No. | Page ___ of ___ | Sheet ___ of ___

Description Ramp G1 over SR7 | Computed by JDK | Date

Abut A Face | Checked by | Date

Bearing Capacity, Sliding & Overturning | Reference



Settlement

1) 6 feet of overburden removed to reach bottom of footing
2) 20 feet of clay layer consolidating (based on test embankment back calculation)
3) Consolidation parameters from URS-4, 4-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp G1 over SR 7 - Abutment A Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	39	feet	
Embedment (below grade)	Df =	4	feet	
Total Height (Hw+Df)	H =	43	feet	
Wall Base Width	B =	33	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	34	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	32	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	24	feet	
Top Material Unit Weight	γ1 =	105	pcf	
Top Material Φ	Φ1 =	38	degrees	
Bottom Material Height	H2 =	19	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	38	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	76.28	pcf	
Retained Wedge - Vertical Component	Wrw	42	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	20.3	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.238	(dim)	
Horiz F2 Surcharge	F2 =	2.6	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	108.2	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	34.9	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	43.0	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	43.0	k/ft	**Capacity Demand Ratio (CDR)= 1.23**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	4.92	ft	**e < 0.25*B, OK**
Effective Width	B' =	23.2	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	4.67	ksf	
Factored Bearing Pressure	Sigv =	6.93	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.48	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.43	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.61	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.78	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	15.8	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	10.29	ksf	**Capacity Demand Ratio (CDR)= 1.484**
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming
Foundation Φ	Φf =	10.3	degrees	quarantine period after Stage 1
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS- 2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.29	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.18	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.61	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.78	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	13.0	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	8.45	ksf	**Capacity Demand Ratio (CDR)= 1.219**
				CDR > 1.0, OK

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp G1 over SR 7 - Abutment A Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	35	feet	
Embedment (below grade)	Df =	4	feet	
Total Height (Hw+Df)	H =	39	feet	
Wall Base Width	B =	33	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	34	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	32	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	20	feet	
Top Material Unit Weight	γ1 =	105	pcf	
Top Material Φ	Φ1 =	38	degrees	
Bottom Material Height	H2 =	19	feet	
Bottom Material Unit Weight	γ2 =	40	pcf	
Bottom Material Φ	Φ2 =	38	degrees	
Design Φ	Φ1|2 =	38	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	73.33	pcf	
Retained Wedge - Vertical Component	Wrw	33	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	16.2	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.236	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	94.4	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1250	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	24.3	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	43.0	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	43.0	k/ft	**Capacity Demand Ratio (CDR)= 1.77**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	3.35	ft	e < 0.25*B, OK
Effective Width	B' =	26.3	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	4.84	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.48	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.43	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.61	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.78	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	15.8	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	10.29	ksf	**Capacity Demand Ratio (CDR)= 2.124**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1, quarantine period to follow
Foundation Φ	Φf =	0.0	degrees	
Foundation Cohesion (c)	cf =	1250	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.19	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.78	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	8.2	ksf	per Eq 10.6.3.1.2a-1 & Sec 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	5.31	ksf	**Capacity Demand Ratio (CDR)= 1.097**
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp G1 over SR 7 - Abutment A Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

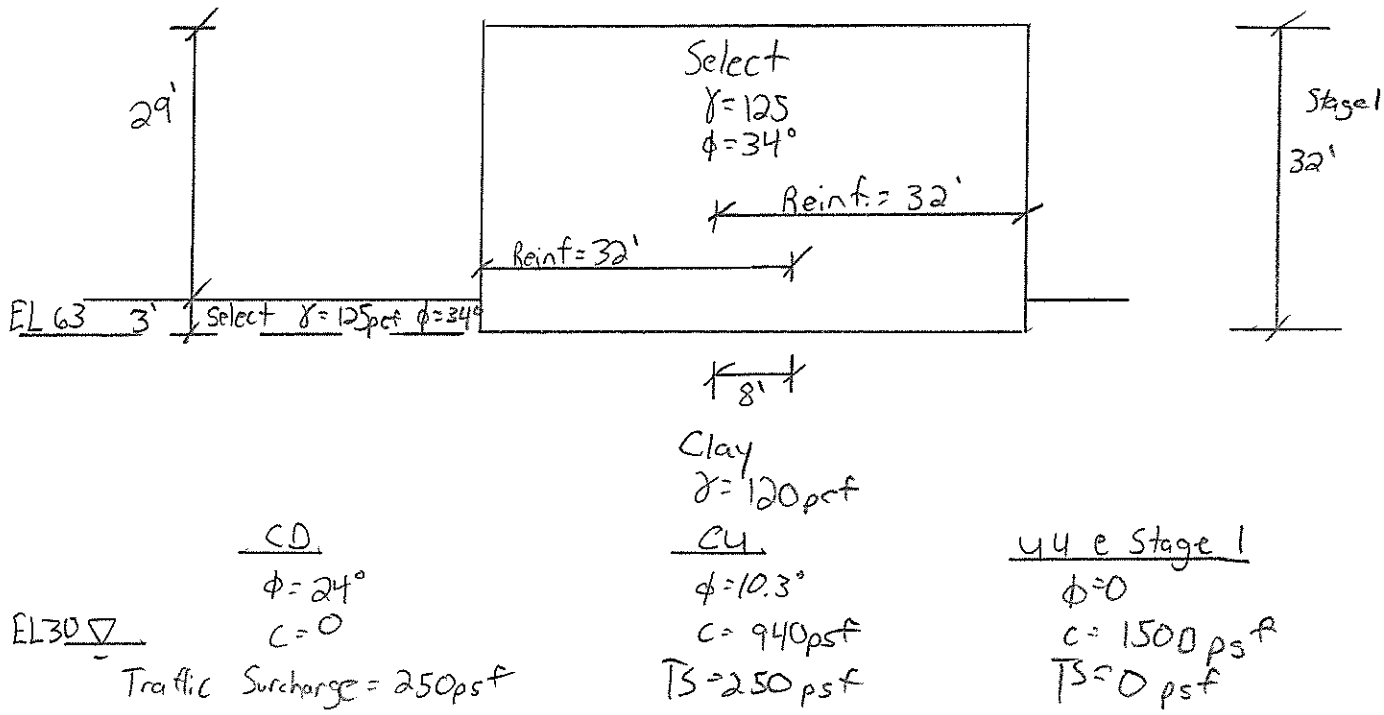
Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c'' [3]	
Initial Overburden	6				0.38				2.34				
I	10	0.851	0.065	0.33	0.69	3.48	0.33	0.85	2.30	1.61	0	2.211215	
II	10	0.851	0.065	0.33	1.31	3.48	0.64	0.75	2.69	1.38	0	1.314986	
Footing Width (ft)	33										0.00	3.53	in
											TOTAL	3.53	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS-S5-8
Lab data on page URS- 4

URS

Job SR1 / I-95 Interchange | Project No. | Page ___ of ___
Description Ramp G1 over SR 7 | Computed by JPK | Sheet ___ of ___ | Date
Abut B Wingwalls | Checked by | Date
Bearing Capacity, Sliding & overturning | Reference



Settlement

Assumptions: (Same as "Ramp G1 over SR 7 -Abut B Face")

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp G1 over SR 7 - Abutment B Wingwalls (Back to Back)
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	29	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	32	feet	
Wall Base Width	B =	32	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	30	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	33	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	32	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	34	k/ft	
Wedge Influence Factor	WIF =	0.06		see attached spreadsheet calculations
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	1.1	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.1	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	128.0	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1500	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	1.9	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	49.3	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	49.3	k/ft	**Capacity Demand Ratio (CDR)= 26.38**
				CDR > 1.0, OK
Eccentricity, parallel to width	e_B =	0.17	ft	**e < 0.25*B, OK**
Effective Width	B' =	31.7	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	4.04	ksf	
Factored Bearing Pressure	Sigv =	5.90	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.53	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.47	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.57	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.81	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	13.8	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	8.94	ksf	**Capacity Demand Ratio (CDR)= 1.516**
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming
Foundation Φ	Φf =	10.3	degrees	quarantine period after Stage 1
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS- 2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.32	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.19	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.57	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.81	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	12.8	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	8.32	ksf	**Capacity Demand Ratio (CDR)= 1.411**
				CDR > 1.0, OK

Back to Back Wall Calculations
Ramp G1 over SR 7 - Abutment B Wingwalls (Back to Back)
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Total Height (Hw+Df)	H =	32	feet	
Wall Base Width	B =	32	feet	as defined by Fig 11.10.2-1
Face to Face Distance	F =	56	feet	
Overlap	Lr =	8	feet	as defined by Fig 50 of FHWA-NHI-00-043
Wedge Distance at Top of Wall	Dwd=	17.0147	feet	as defined by Fig 50 of FHWA-NHI-00-043
Overlap Distance with No Wedge Influence	Lr' =	9.6	feet	as defined by Sec. 5.4 of FHWA-NHI-00-043
Wedge Influence Factor	WIF =	0.06		as defined by Sec. 5.4 of FHWA-NHI-00-043

Lr = (2*B)-F
Dwd = H*tan(45-Φ1|2 / 2)
Lr' = H*0.3
WIF = (Lr' - Lr) / (Lr'+Dwd)

Note: WIF linear interpolation between "full active" case and "zero-active" case

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp G1 over SR 7 - Abutment B Wingwalls (Back to Back)
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	29	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	32	feet	
Wall Base Width	B =	32	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	30	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	33	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	32	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	34	k/ft	
Wedge Influence Factor	WIF =	0.06		see attached spreadsheet calculations
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	1.1	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	128.0	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1500	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	1.6	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	49.3	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	49.3	k/ft	**Capacity Demand Ratio (CDR)= 30**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	0.14	ft	**e < 0.25*B, OK**
Effective Width	B' =	31.7	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	5.45	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.53	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.47	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.57	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.81	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	13.8	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	8.94	ksf	**Capacity Demand Ratio (CDR)= 1.642**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1,
Foundation Φ	Φi =	0.0	degrees	quarantine period to follow
Foundation Cohesion (c)	ci =	1500	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.21	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.81	(dim)	per Table 10.6.3.1.2a-2
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	9.7	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	6.32	ksf	**Capacity Demand Ratio (CDR)= 1.161**
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp G1 over SR 7 - Abutment B Wingwalls
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c'' [3]
Initial Overburden	3.5				0.22				2.08			
I	10	0.786	0.068	0.29	0.53	4.50	0.27	0.85	2.08	1.55	0	2.70874
II	10	0.786	0.068	0.29	1.16	4.50	0.58	0.75	2.50	1.34	0	1.528075

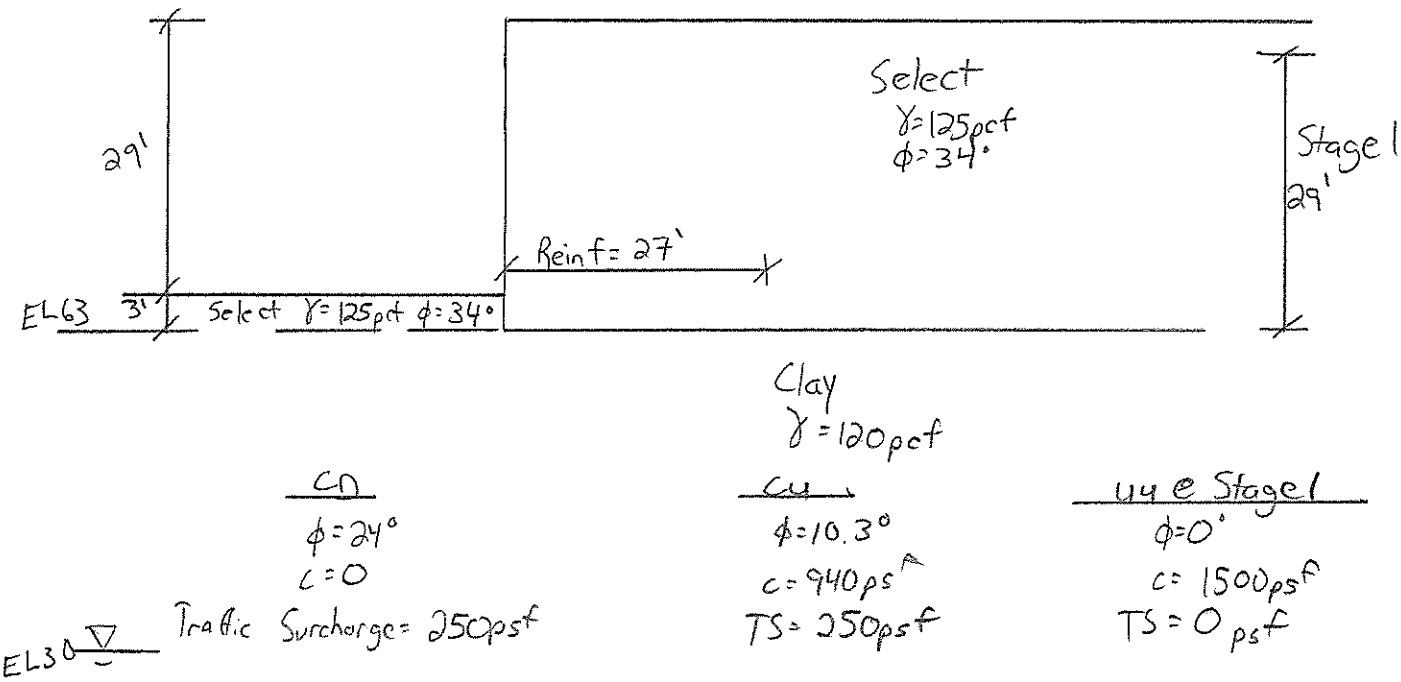
Footing Width (ft)	32	0.00	4.24	in
		TOTAL	4.24	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS-S5-10
Lab data on page URS-8

URS

Job SR 1 / I-95 Interchange | Project No. | Page ___ of ___
Description Ramp G1 over SR7 | Computed by JPK | Sheet ___ of ___ | Date
Abut B Face | Checked by | Date
Bearing Capacity, Sliding & overturning | Reference



Settlement

Assumptions:

1) 3.5 feet of overburden removed to reach bottom of footing
2) 20 feet of clay layer consolidating (based on test embankment back calculation)
3) Consolidation parameters from URS-5, 4-1

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp G1 over SR 7 - Abutment B Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Height of Wall (exposed)	Hw =	29	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	32	feet	
Wall Base Width	B =	27	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	35	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	33	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	250	psf	per Table 3.11.6.4-2
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	32	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	34	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	18.1	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	2.3	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	108.0	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1500	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	31.1	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	41.8	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	41.8	k/ft	**Capacity Demand Ratio (CDR)= 1.34**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	3.27	ft	**e < 0.25*B, OK**
Effective Width	B' =	20.5	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	5.28	ksf	
Factored Bearing Pressure	Sigv =	7.70	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.38	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.34	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.69	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.87	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	14.0	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	9.13	ksf	**Capacity Demand Ratio (CDR)= 1.185**
				CDR > 1.0, OK
Consolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction, assuming quarantine period after Stage 1
Foundation Φ	Φf =	10.3	degrees	
Foundation Cohesion (c)	cf =	940	psf	- Averaged from CU lab data- See Sheet URS- 2
Cohesion Term Bearing Capacity Factor	Nc =	8.48	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	2.54	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	1.29	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.23	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.14	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.69	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.87	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	12.2	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.90	ksf	**Capacity Demand Ratio (CDR)= 1.026**
				CDR > 1.0, OK

MSE Bearing Pressure, Bearing Capacity, Sliding and Overturning
Ramp G1 over SR 7 - Abutment B Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
STAGE 1

Height of Wall (exposed)	Hw =	26	feet	
Embedment (below grade)	Df =	3	feet	
Total Height (Hw+Df)	H =	29	feet	
Wall Base Width	B =	27	feet	as defined by Fig 11.10.2-1 (minimum=0.7*H per Sec. 11.10.2.1)
Total Footing Length (=Length of Wall)	L =	35	feet	as defined in Sec 10.6.3.1.2a
Groundwater Depth	GWD =	33	feet	as defined in Sec 10.6.3.1.2a
Surcharge	qs =	0	psf	No traffic, wall only partially built
Surcharge Load Factor	LSLF =	1.75	(dim)	per Table 3.4.1-1 (@ Load Combination "Strength I")
Retained/Reinforced Material				
Top Material Height	H1 =	29	feet	
Top Material Unit Weight	γ1 =	125	pcf	
Top Material Φ	Φ1 =	34	degrees	
Bottom Material Height	H2 =	0	feet	
Bottom Material Unit Weight	γ2 =	0	pcf	
Bottom Material Φ	Φ2 =	0	degrees	
Design Φ	Φ1|2 =	34	degrees	- Uses lowest Φ for design
Reinforced Unit Weight	γrei =	125.00	pcf	
Retained Wedge - Vertical Component	Wrw	28	k/ft	
Embedment Soil Properties				
Embedment Unit Weight	γe =	125	pcf	
Embedment Φ	Φe =	34	degrees	
Embedment Coeff. Passive Earth Pressure	Kp =	3.537		
Foundation Unit Weight	γf =	120	pcf	
Loads				
Horiz F1 Soil	F1 =	14.9	k/ft	as defined by Fig 11.10.5.2-1
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	
Horiz F2 Surcharge	F2 =	0.0	k/ft	per Eq 3.11.6.4-1
MSE Mass	V1 =	97.9	k/ft	as defined by Fig 11.10.5.2-1
Loading Conditions				
Foundation Undrained Shear Strength	f =	1500	psf	- Estimate based on lab & SPT data
Horizontal Earth Pressure Load Factor	EHLF =	1.5	(dim)	per Table 3.4.1-2
Factored Horizontal Load	FHL =	22.3	k/ft	as defined by Fig 11.10.5.2-1
Nominal Sliding Resistance	Rn =	41.8	k/ft	as defined by Fig 10.6.3.4-1
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	41.8	k/ft	**Capacity Demand Ratio (CDR)= 1.88**
				CDR > 1.0, OK
Eccentrity, parallel to width	e_B =	2.20	ft	**e < 0.25*B, OK**
Effective Width	B' =	22.6	ft	
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Factored Bearing Pressure	Sigv =	5.85	ksf	
Consolidated Drained Case (Long Term)				- Case represents conditions after full consolidation & fully drained
Foundation Φ	Φf =	24.0	degrees	- Based on SPT data
Foundation Cohesion (c)	cf =	0	psf	
Cohesion Term Bearing Capacity Factor	Nc =	19.32	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	9.60	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	9.44	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.36	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.34	(dim)	per Table 10.6.3.1.2a-3
	sγ =	0.69	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.87	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	14.0	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	9.13	ksf	**Capacity Demand Ratio (CDR)= 1.561**
				CDR > 1.0, OK
Unconsolidated Undrained Case (Short Term)				- Case represents conditions immediately following construction of Stage 1, quarantine period to follow
Foundation Φ	Φi =	0.0	degrees	
Foundation Cohesion (c)	ci =	1500	psf	- Estimate based on lab & SPT data
Cohesion Term Bearing Capacity Factor	Nc =	5.14	(dim)	per Table 10.6.3.1.2a-1
Surcharge Term Bearing Capacity Factor	Nq =	1.00	(dim)	per Table 10.6.3.1.2a-1
Unit Weight Term Bearing Capacity Factor	Nγ =	0.00	(dim)	per Table 10.6.3.1.2a-1
Footing Shape Correction Factors	sc =	1.15	(dim)	per Table 10.6.3.1.2a-3
	sq =	1.00	(dim)	per Table 10.6.3.1.2a-3
	sγ =	1.00	(dim)	per Table 10.6.3.1.2a-3
Ground Water Table Correction Factors	Cwq =	1.0	(dim)	per Table 10.6.3.1.2a-2
	Cwγ =	0.87	(dim)	per Table 10.6.3.1.2a-2
Nominal Bearing Resistance (ksf)	qn =	9.3	ksf	per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	6.03	ksf	**Capacity Demand Ratio (CDR)= 1.031**
				CDR > 1.0, OK

Predicted Settlement Calculations: Ramp G1 over SR 7 - Abutment B Face
Interchange Reconstruction: Delaware Route 1 and Interstate I-95

Layer	H(feet)	e_o	C_r	C_c	σ_o'	σ_p'	Depth/ Footing Width	Stress Influence Factor[1]	σ_f'	Tot. $\Delta\sigma'$	S_c' [2]	S_c'' [3]
Initial Overburden	3.5				0.22				2.64			
I	10	0.786	0.068	0.29	0.53	4.50	0.31	0.85	2.56	2.03	0	3.117553
II	10	0.786	0.068	0.29	1.16	4.50	0.69	0.75	2.92	1.76	0	1.836499

Footing Width (ft)	27	0.00	4.95	in
		TOTAL	4.95	in

[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS-S5-17
Lab data on page URS- 8

Global Stability

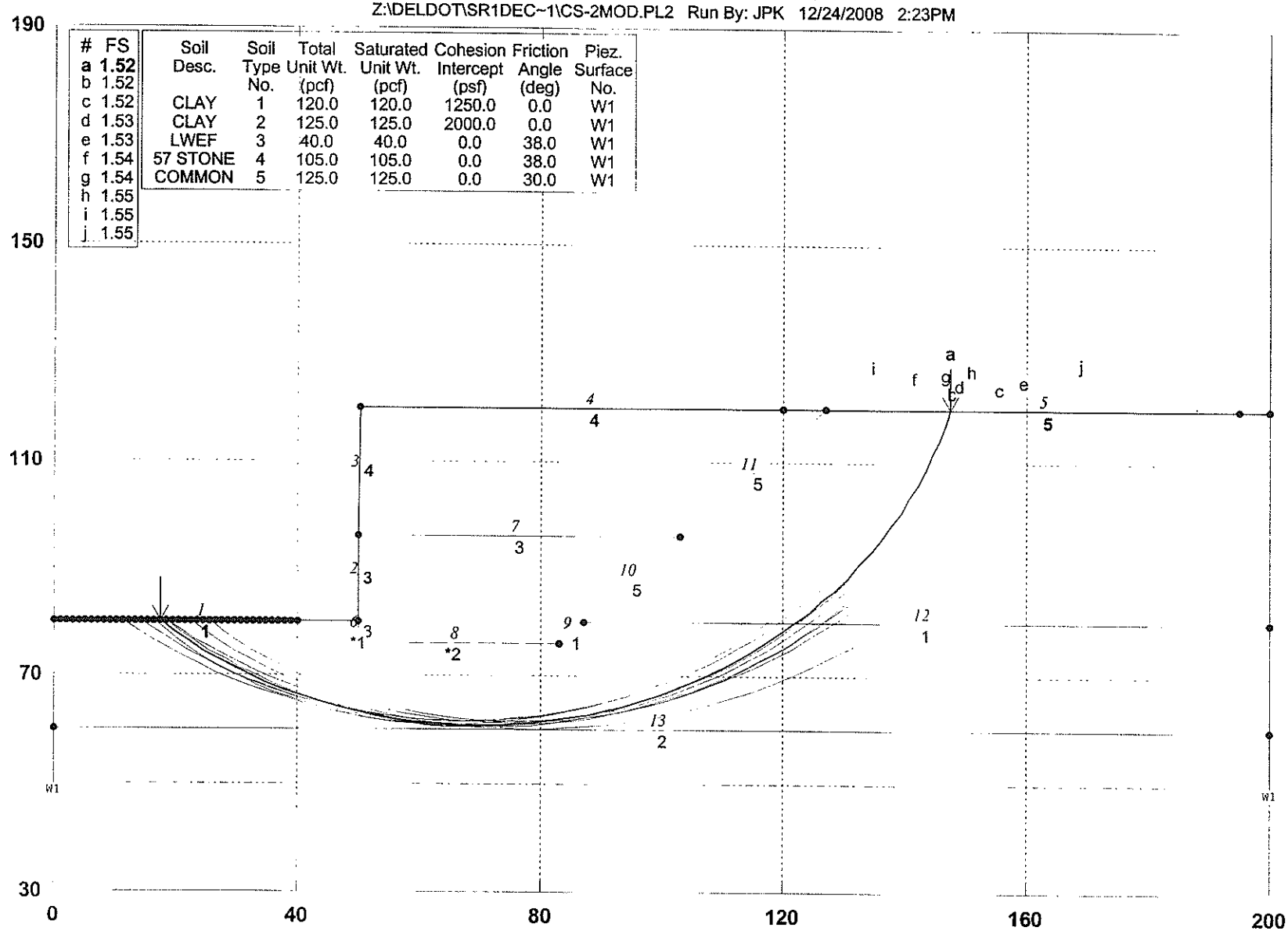
Short-term Case (prior to traffic loading)

SR1/I95 Interchange CS-2 Modified (Sect. Reversed)Unconsolidated Undrained

Z:\DELDOT\SR1DEC~1\CS-2MOD.PL2 Run By: JPK 12/24/2008 2:23PM

#	FS
a	1.52
b	1.52
c	1.52
d	1.53
e	1.53
f	1.54
g	1.54
h	1.55
i	1.55
j	1.55

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	1250.0	0.0	W1
CLAY	2	125.0	125.0	2000.0	0.0	W1
LWEF	3	40.0	40.0	0.0	38.0	W1
57 STONE	4	105.0	105.0	0.0	38.0	W1
COMMON	5	125.0	125.0	0.0	30.0	W1



GSTABL7 FSmin=1.52

Safety Factors Are Calculated By The Modified Bishop Method

STED

* For Cross Section location See URS-11

Short-term Case (after traffic loading)

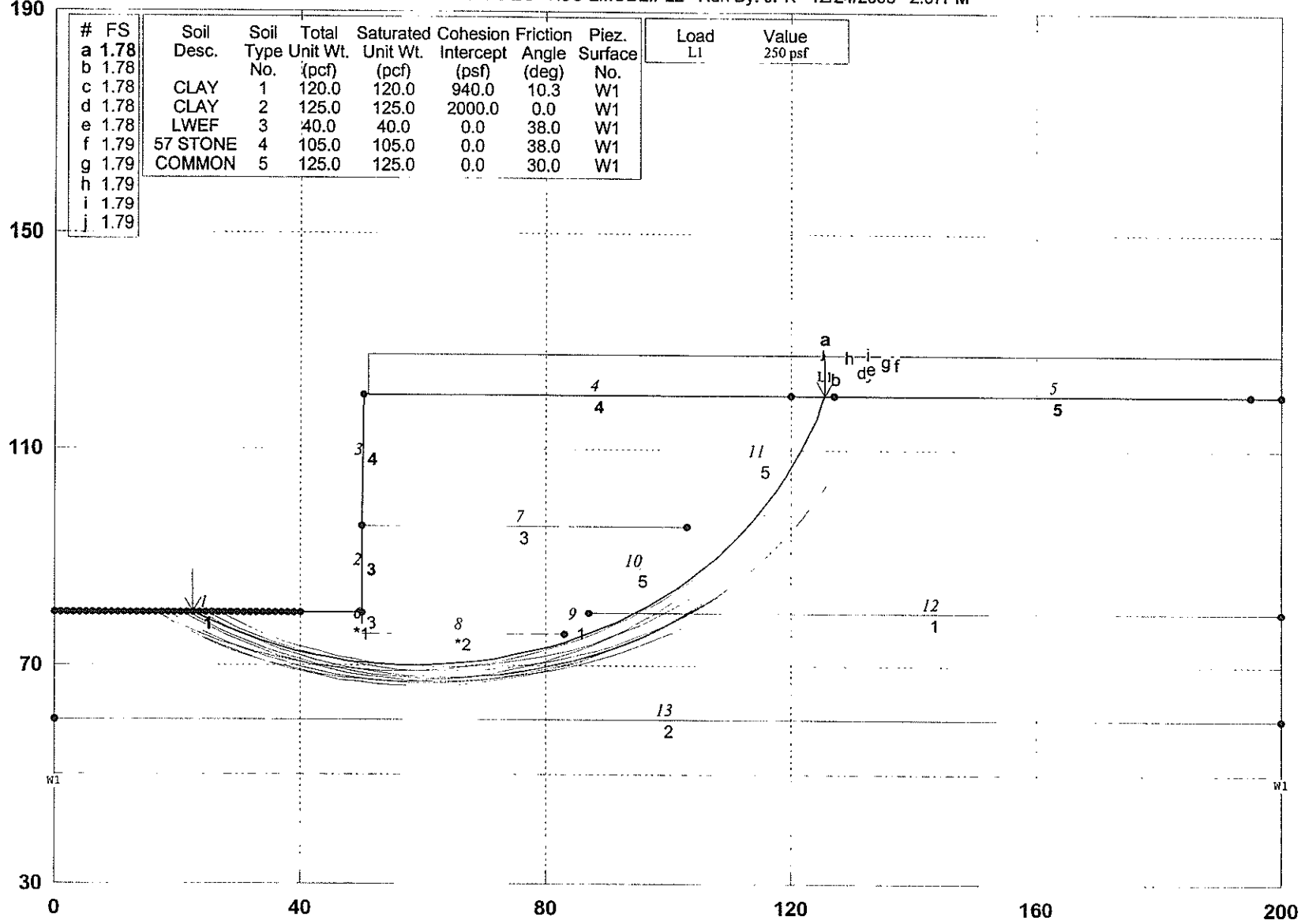
SR1/I95 Interchange CS-2 Modified (Sect. Reversed)Consolidated Undrained

Z:\DELDOT\SR1DEC~1\CS-2MOD2.PL2 Run By: JPK 12/24/2008 2:07PM

#	FS
a	1.78
b	1.78
c	1.78
d	1.78
e	1.78
f	1.79
g	1.79
h	1.79
i	1.79
j	1.79

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	940.0	10.3	W1
CLAY	2	125.0	125.0	2000.0	0.0	W1
LWEF	3	40.0	40.0	0.0	38.0	W1
57 STONE	4	105.0	105.0	0.0	38.0	W1
COMMON	5	125.0	125.0	0.0	30.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.78

Safety Factors Are Calculated By The Modified Bishop Method

STED

Long-term Case

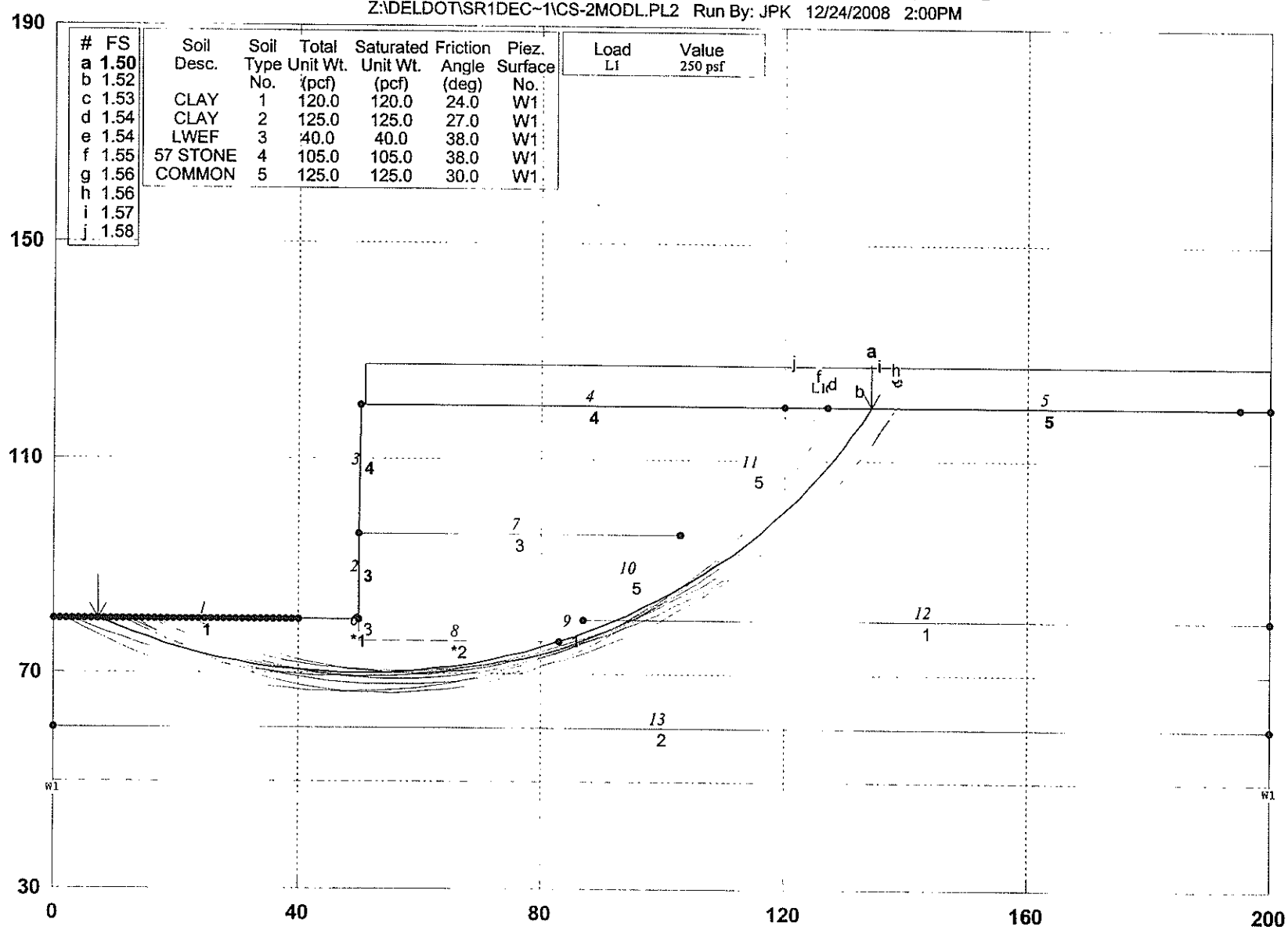
SR1/I95 Interchange CS-2 Modified (Sect. Reversed) Long-Term

Z:\DELDOT\SR1DEC~1\CS-2MODL.PL2 Run By: JPK 12/24/2008 2:00PM

#	FS
a	1.50
b	1.52
c	1.53
d	1.54
e	1.54
f	1.55
g	1.56
h	1.56
i	1.57
j	1.58

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	24.0	W1
CLAY	2	125.0	125.0	27.0	W1
LWEF	3	40.0	40.0	38.0	W1
57 STONE	4	105.0	105.0	38.0	W1
COMMON	5	125.0	125.0	30.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.50

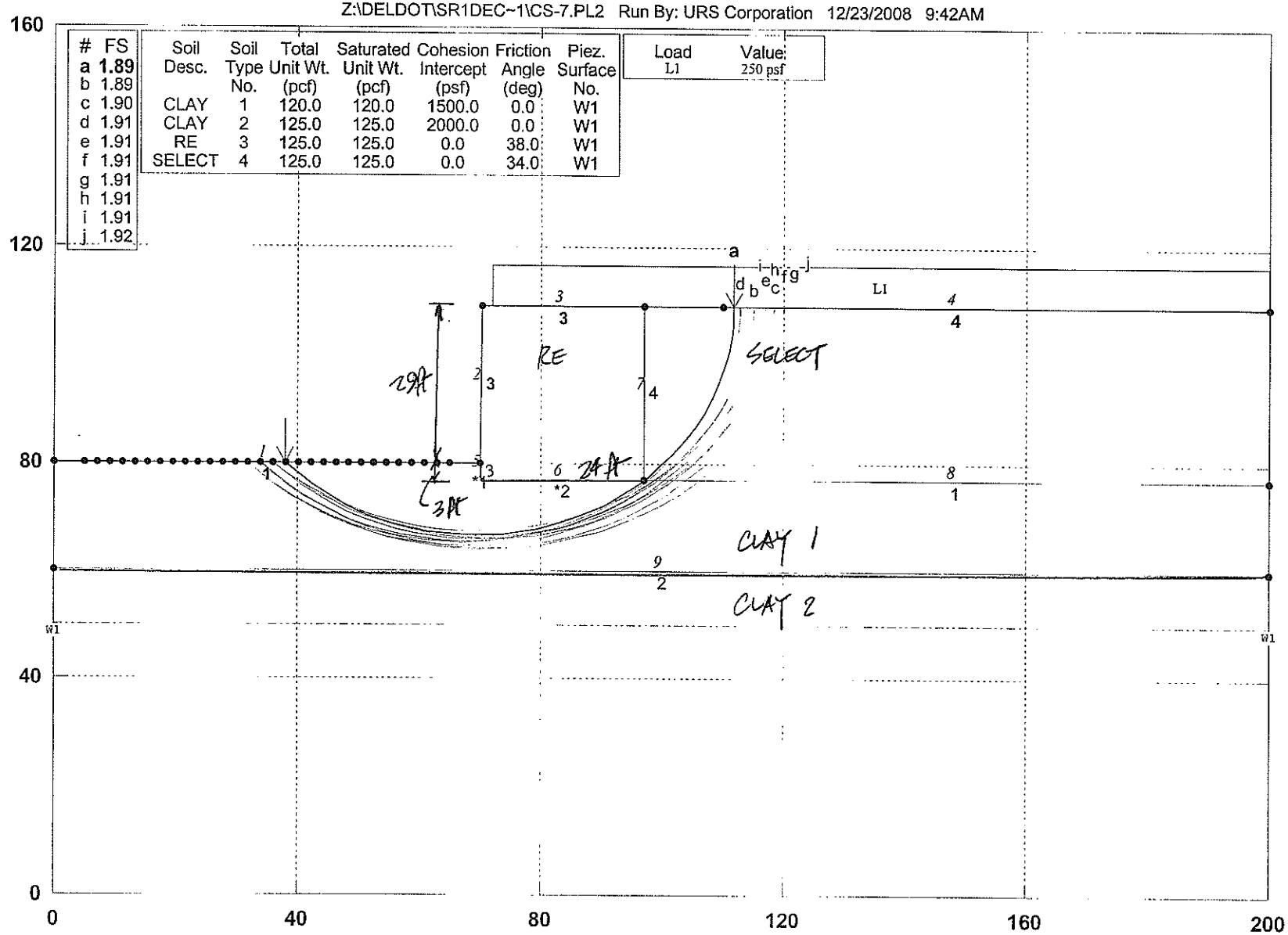
Safety Factors Are Calculated By The Modified Bishop Method

STED

Short-term Case

SR1/I95 Interchange CS-7

Z:\DELDOT\SR1DEC~1\CS-7.PL2 Run By: URS Corporation 12/23/2008 9:42AM



#	FS
a	1.89
b	1.89
c	1.90
d	1.91
e	1.91
f	1.91
g	1.91
h	1.91
i	1.91
j	1.92

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	1500.0	0.0	W1
CLAY	2	125.0	125.0	2000.0	0.0	W1
RE	3	125.0	125.0	0.0	38.0	W1
SELECT	4	125.0	125.0	0.0	34.0	W1

Load	Value
L1	250 psf

GSTABL7 FSmin=1.89

Safety Factors Are Calculated By The Modified Bishop Method

STED

Long-term Case

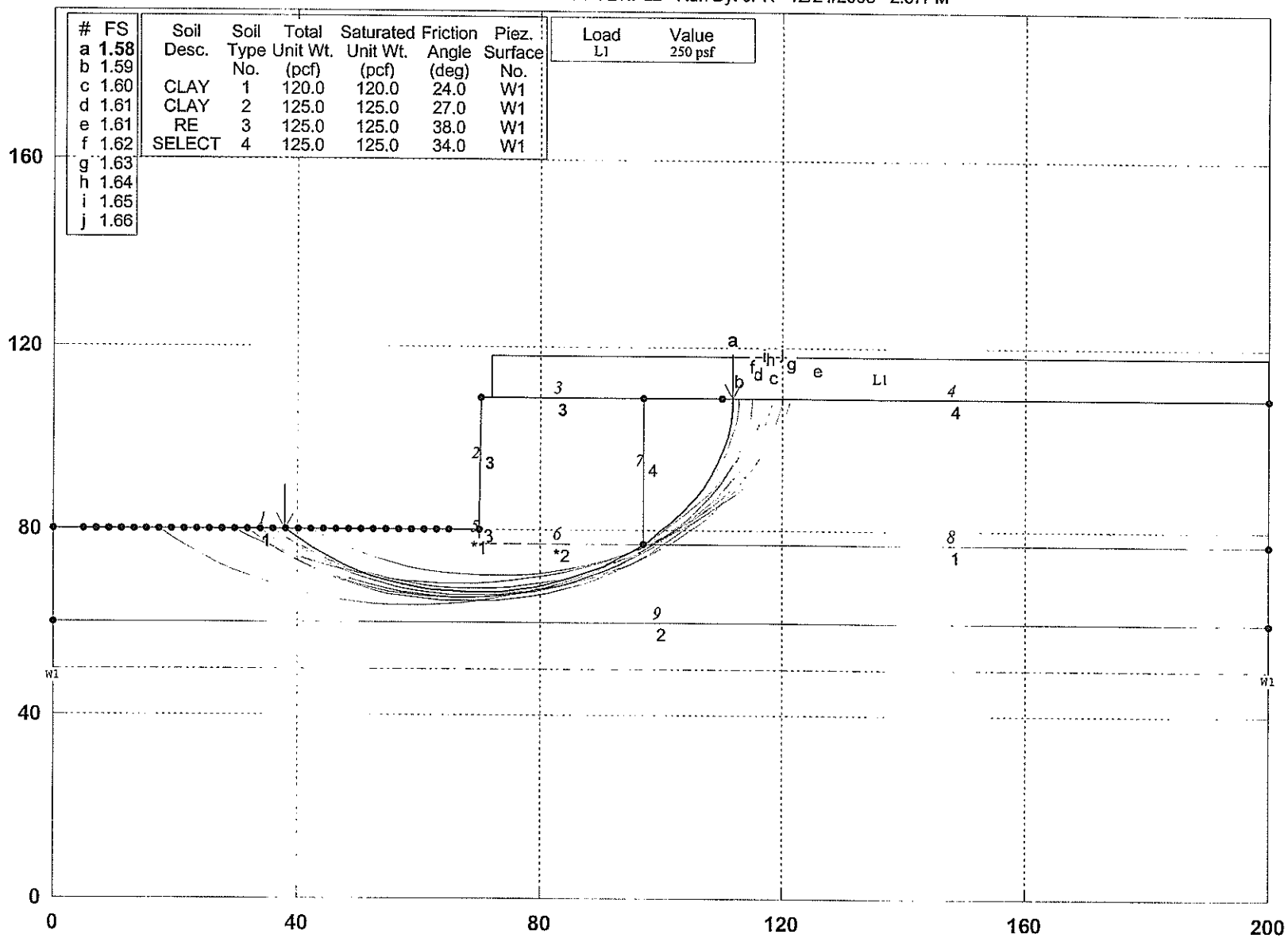
SR1/I95 Interchange CS-7 Long-Term

Z:\DELDOT\SR1DEC~1\CS-7LT.PL2 Run By: JPK 12/24/2008 2:57PM

#	FS
a	**1.58**
b	1.59
c	1.60
d	1.61
e	1.61
f	1.62
g	1.63
h	1.64
i	1.65
j	1.66

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
CLAY	1	120.0	120.0	24.0	W1
CLAY	2	125.0	125.0	27.0	W1
RE	3	125.0	125.0	38.0	W1
SELECT	4	125.0	125.0	34.0	W1

Load	Value
L1	250 psf



GSTABL7 FSmin=1.58

Safety Factors Are Calculated By The Modified Bishop Method

STED

Axial Capacity

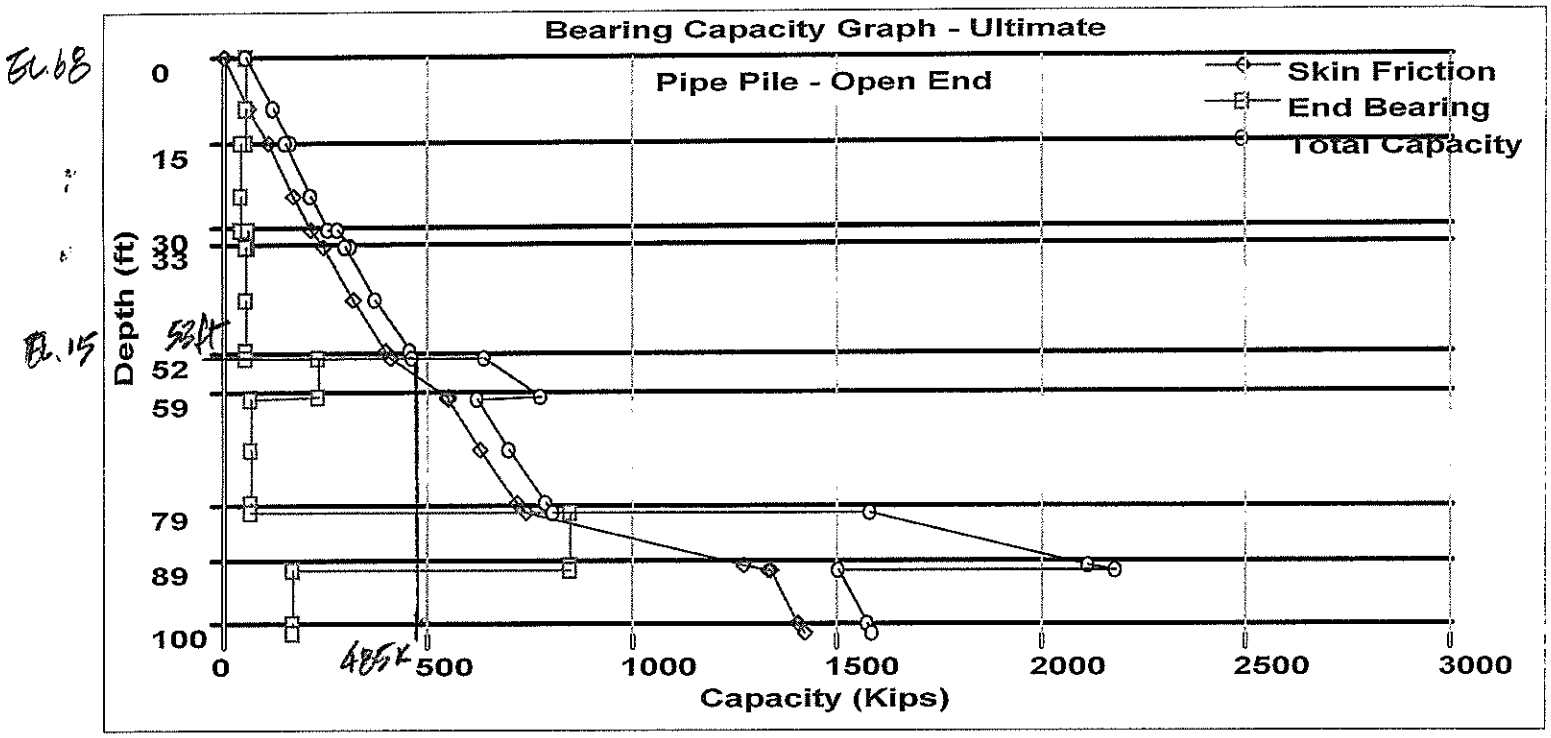
DelDOT SR1 / I-95 Interchange
Preliminary Pile Estimate

16-Dec-08

Location	Foundation	Required Factored Resistance, kip	Nominal Resistance, kip	Size of Pipe Pile		Estimated Pile Tip El.
				Diameter, in.	Wall in.	
S5-Ramp G1 Over SR 7	Abut A	315	485	24	0.5	15
	Pier 1	735	1131	36	0.625	11
	Pier 2	735	1131	36	0.625	24
	Pier 3	735	1131	36	0.625	-4
	Abut B	315	485	24	0.5	15

* 0.65 Resistance factor. Required capacity factor = 1.54

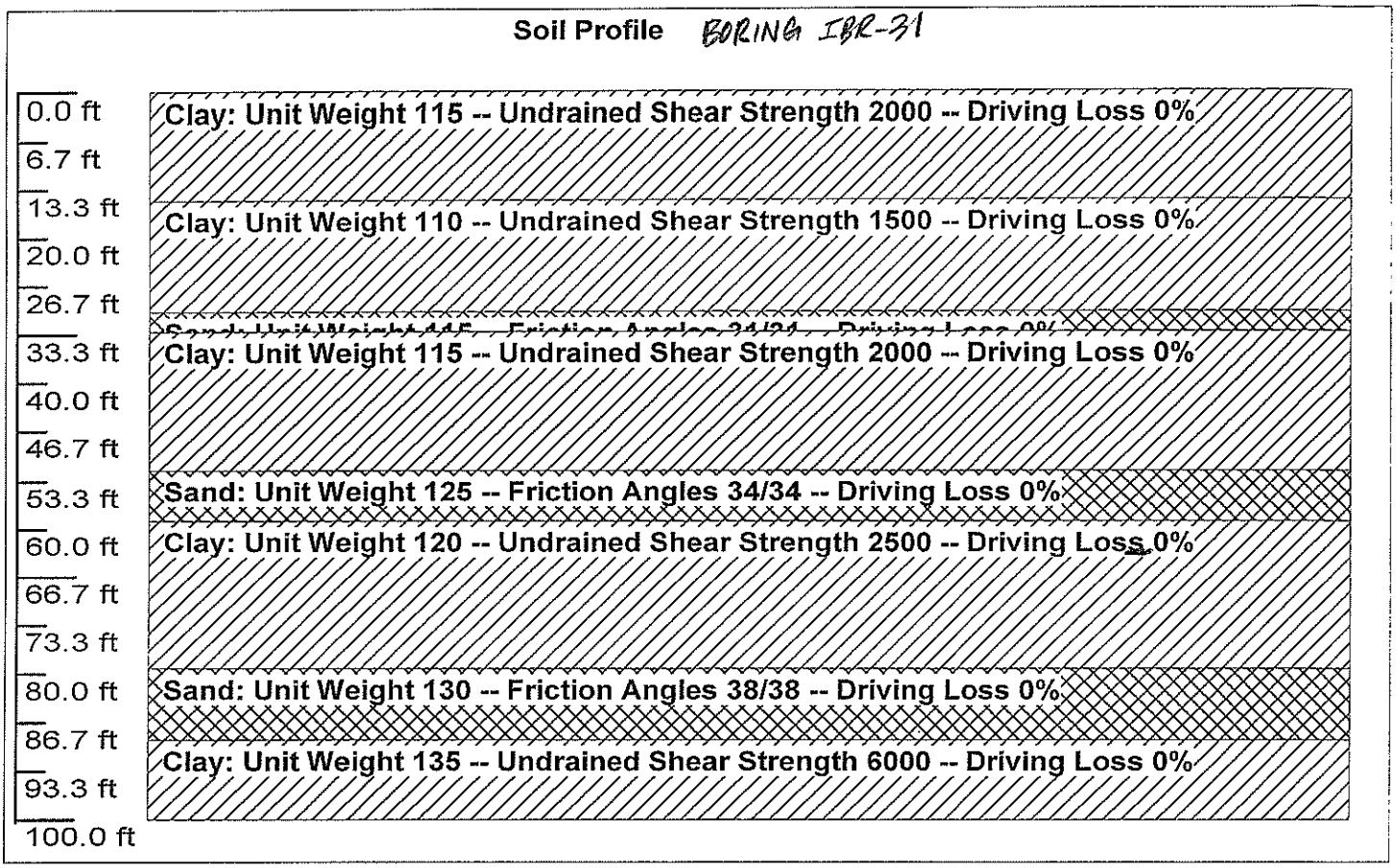
Filename: Z:\DELDOT\SR1DEC~1\G1R7UTA.DVN RAMP G1/SR7 ABUT. A 24"φ 0.5" WALL



REQUIRED CAPACITY = 485 K
EST. PILE TIP = EL. 15

Filename: Z:\DELDOT\SR1DEC~1\G1R7UTA.DVN RAMP G1 / SR7 ABUT A 24"φ 0.5" WALL

Soil Profile BORING IBR-31



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\G1R7UTA.DVN
Project Name: Ramp G1 / SR7 Abut A
Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-31 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 24.00 in
Shell Thickness: 0.50 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	38.00 ft
	- Driving/Restrike	38.00 ft
	- Ultimate:	38.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	15.00 ft	0.00%	115.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	15.00 ft	0.00%	110.00 pcf	1500.00 psf	T-79 Steel
3	Cohesionless	3.00 ft	0.00%	115.00 pcf	31.0/31.0	Nordlund
4	Cohesive	19.00 ft	0.00%	115.00 pcf	2000.00 psf	T-79 Steel
5	Cohesionless	7.00 ft	0.00%	125.00 pcf	34.0/34.0	Nordlund
6	Cohesive	20.00 ft	0.00%	120.00 pcf	2500.00 psf	T-79 Steel
7	Cohesionless	10.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund
8	Cohesive	11.00 ft	0.00%	135.00 pcf	6000.00 psf	T-79 Steel

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1165.00 psf	0.07 Kips
9.01 ft	Cohesive	N/A	N/A	1165.00 psf	65.95 Kips
14.99 ft	Cohesive	N/A	N/A	1165.00 psf	109.73 Kips
15.01 ft	Cohesive	N/A	N/A	1060.00 psf	109.87 Kips
24.01 ft	Cohesive	N/A	N/A	1075.71 psf	170.70 Kips
29.99 ft	Cohesive	N/A	N/A	1099.13 psf	213.32 Kips
30.01 ft	Cohesionless	3375.58 psf	26.69	N/A	213.49 Kips
32.99 ft	Cohesionless	3546.93 psf	26.69	N/A	243.61 Kips
33.01 ft	Cohesive	N/A	N/A	1240.89 psf	243.79 Kips
42.01 ft	Cohesive	N/A	N/A	1293.39 psf	316.94 Kips
51.01 ft	Cohesive	N/A	N/A	1345.89 psf	396.02 Kips
51.99 ft	Cohesive	N/A	N/A	1351.61 psf	404.99 Kips
52.01 ft	Cohesionless	5031.71 psf	29.28	N/A	405.27 Kips
58.99 ft	Cohesionless	5250.19 psf	29.28	N/A	544.67 Kips
59.01 ft	Cohesive	N/A	N/A	1341.34 psf	544.96 Kips
68.01 ft	Cohesive	N/A	N/A	1420.09 psf	625.27 Kips
77.01 ft	Cohesive	N/A	N/A	1498.84 psf	714.49 Kips
78.99 ft	Cohesive	N/A	N/A	1516.16 psf	735.31 Kips
79.01 ft	Cohesionless	6621.94 psf	30.32	N/A	735.98 Kips
88.01 ft	Cohesionless	6926.14 psf	30.32	N/A	1270.12 Kips
88.99 ft	Cohesionless	6959.26 psf	30.32	N/A	1331.11 Kips
89.01 ft	Cohesive	N/A	N/A	1260.00 psf	1331.82 Kips
98.01 ft	Cohesive	N/A	N/A	1260.00 psf	1403.07 Kips
99.99 ft	Cohesive	N/A	N/A	1260.00 psf	1418.74 Kips

G1R7UTA-8

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
14.99 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
15.01 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
24.01 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
29.99 ft	Cohesive	N/A	N/A	N/A	42.41 Kips
30.01 ft	Cohesionless	3376.15 psf	35.20	64.92 Kips	64.92 Kips
32.99 ft	Cohesionless	3718.85 psf	35.20	64.92 Kips	64.92 Kips
33.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
42.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
51.01 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
51.99 ft	Cohesive	N/A	N/A	N/A	56.55 Kips
52.01 ft	Cohesionless	5032.03 psf	55.60	230.97 Kips	230.97 Kips
58.99 ft	Cohesionless	5468.97 psf	55.60	230.97 Kips	230.97 Kips
59.01 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
68.01 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
77.01 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
78.99 ft	Cohesive	N/A	N/A	N/A	70.69 Kips
79.01 ft	Cohesionless	6622.28 psf	110.40	843.83 Kips	843.83 Kips
88.01 ft	Cohesionless	7230.68 psf	110.40	843.83 Kips	843.83 Kips
88.99 ft	Cohesionless	7296.92 psf	110.40	843.83 Kips	843.83 Kips
89.01 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
98.01 ft	Cohesive	N/A	N/A	N/A	169.65 Kips
99.99 ft	Cohesive	N/A	N/A	N/A	169.65 Kips

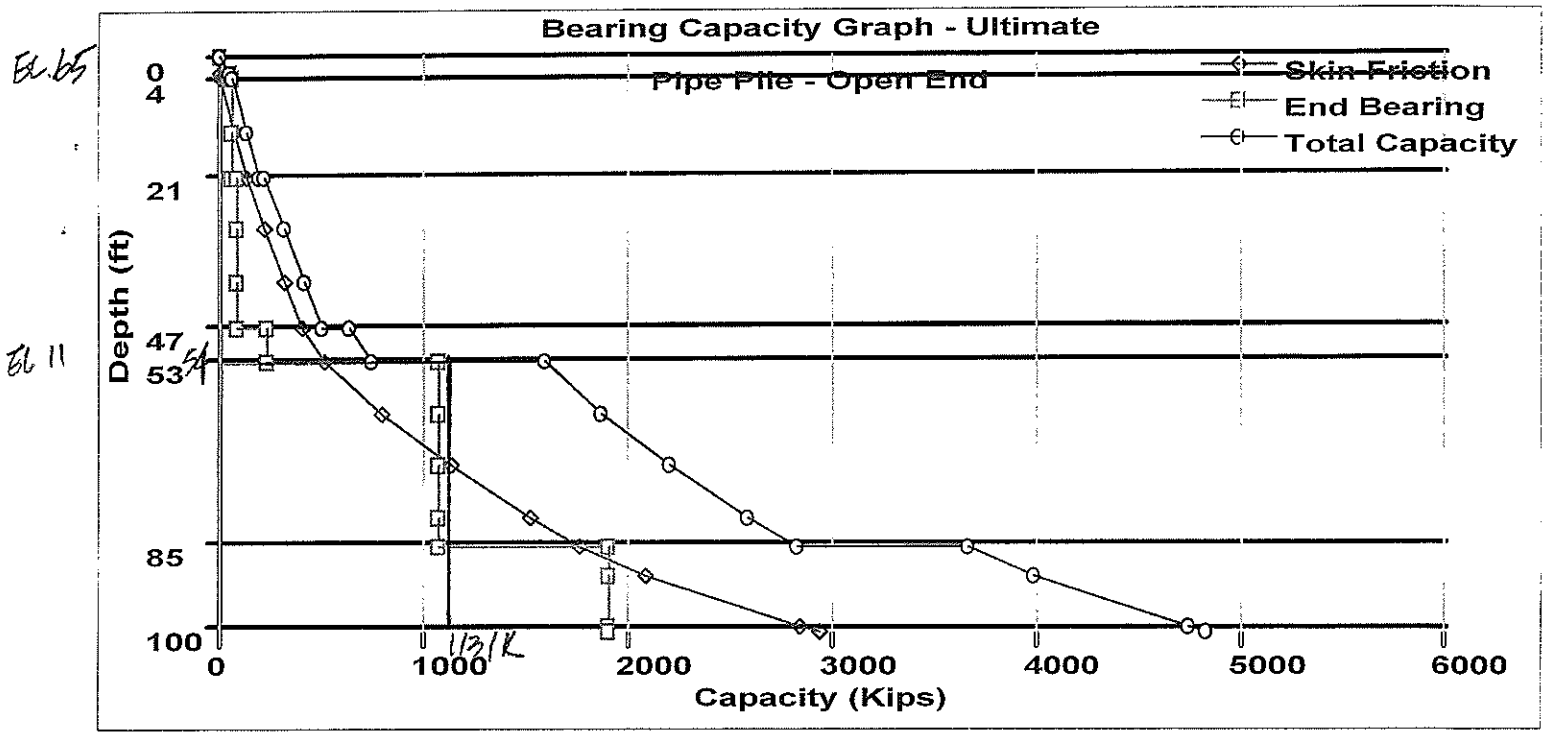
G1R7UTA-9

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.07 Kips	56.55 Kips	56.62 Kips
9.01 ft	65.95 Kips	56.55 Kips	122.50 Kips
14.99 ft	109.73 Kips	56.55 Kips	166.27 Kips
15.01 ft	109.87 Kips	42.41 Kips	152.28 Kips
24.01 ft	170.70 Kips	42.41 Kips	213.11 Kips
29.99 ft	213.32 Kips	42.41 Kips	255.73 Kips
30.01 ft	213.49 Kips	64.92 Kips	278.41 Kips
32.99 ft	243.61 Kips	64.92 Kips	308.53 Kips
33.01 ft	243.79 Kips	56.55 Kips	300.34 Kips
42.01 ft	316.94 Kips	56.55 Kips	373.48 Kips
51.01 ft	396.02 Kips	56.55 Kips	452.57 Kips
51.99 ft	404.99 Kips	56.55 Kips	461.53 Kips
52.01 ft	405.27 Kips	230.97 Kips	636.24 Kips
58.99 ft	544.67 Kips	230.97 Kips	775.64 Kips
59.01 ft	544.96 Kips	70.69 Kips	615.65 Kips
68.01 ft	625.27 Kips	70.69 Kips	695.96 Kips
77.01 ft	714.49 Kips	70.69 Kips	785.17 Kips
78.99 ft	735.31 Kips	70.69 Kips	806.00 Kips
79.01 ft	735.98 Kips	843.83 Kips	1579.82 Kips
88.01 ft	1270.12 Kips	843.83 Kips	2113.95 Kips
88.99 ft	1331.11 Kips	843.83 Kips	2174.94 Kips
89.01 ft	1331.82 Kips	169.65 Kips	1501.46 Kips
98.01 ft	1403.07 Kips	169.65 Kips	1572.71 Kips
99.99 ft	1418.74 Kips	169.65 Kips	1588.39 Kips

G1R7UTA-10

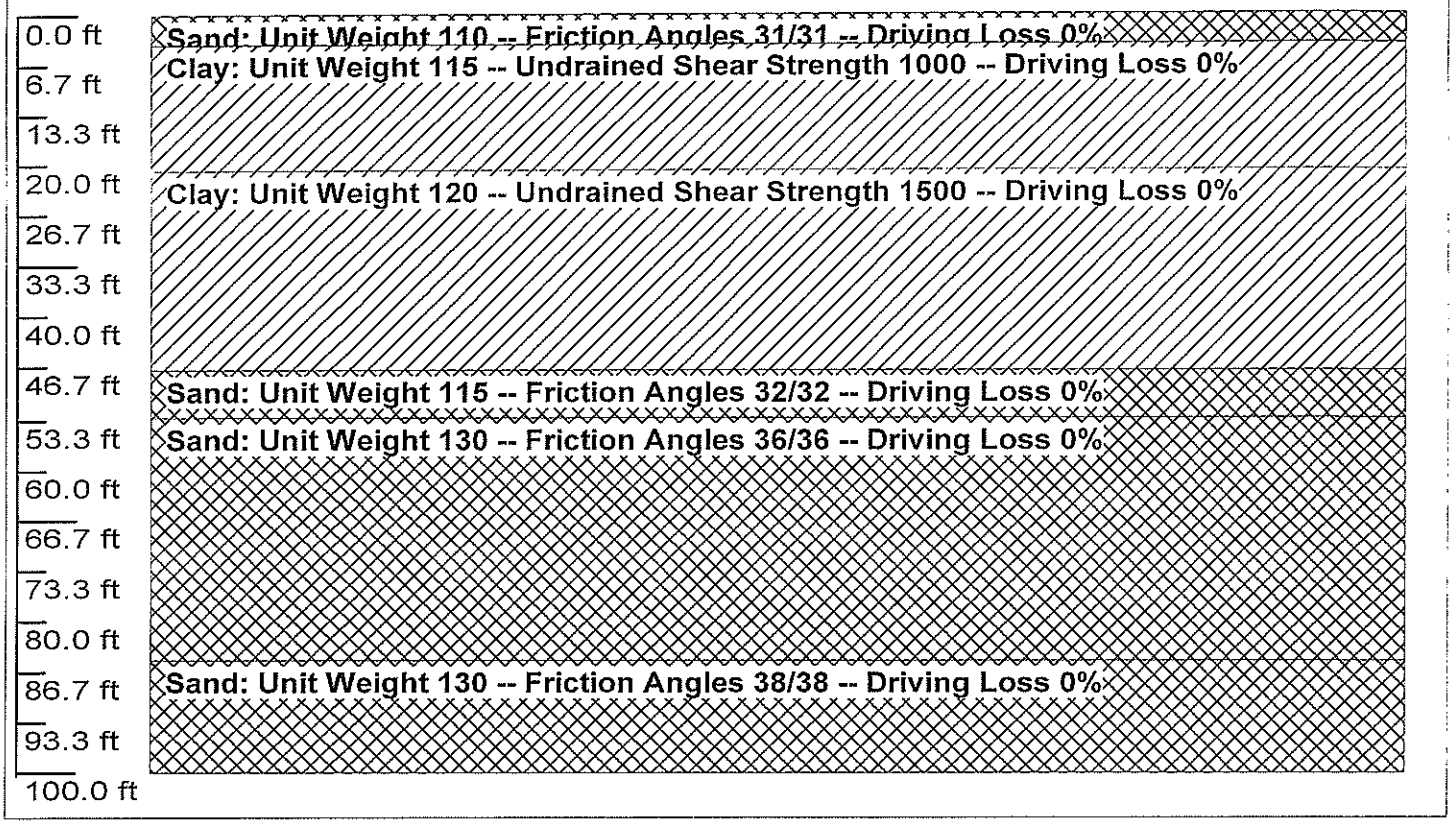
Filename: Z:\DELDOT\SR1DEC~1\G1R7P1A.DVN RAMP G1 /SR1 PIER 1 36"φ 0.625" WALL



REQUIRED CAPACITY = 1131K
EST. PILE TIP = EL. 11

Filename: Z:\DELDOT\SR1DEC~1\G1R7P1A.DVN RAMP G1 / SR7 PIER 1

Soil Profile BORING IBR - 20



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\G1R7P2.DVN
Project Name: Ramp G1 / SR7 Pier 2 Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SRI IBR-15 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 36.00 in
Shell Thickness: 0.62 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	35.00 ft
	- Driving/Restrike	35.00 ft
	- Ultimate:	35.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	40.00 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
2	Cohesionless	13.00 ft	0.00%	125.00 pcf	35.0/35.0	Nordlund
3	Cohesionless	12.00 ft	0.00%	115.00 pcf	32.0/32.0	Nordlund
4	Cohesionless	5.00 ft	0.00%	115.00 pcf	35.0/35.0	Nordlund
5	Cohesionless	30.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1060.00 psf	0.10 Kips
9.01 ft	Cohesive	N/A	N/A	1060.00 psf	90.01 Kips
18.01 ft	Cohesive	N/A	N/A	1060.00 psf	179.92 Kips
27.01 ft	Cohesive	N/A	N/A	1060.00 psf	269.84 Kips
36.01 ft	Cohesive	N/A	N/A	1075.69 psf	365.08 Kips
39.99 ft	Cohesive	N/A	N/A	1086.08 psf	409.34 Kips
40.01 ft	Cohesionless	4488.31 psf	33.78	N/A	409.82 Kips
49.01 ft	Cohesionless	4770.01 psf	33.78	N/A	755.57 Kips
52.99 ft	Cohesionless	4894.59 psf	33.78	N/A	921.50 Kips
53.01 ft	Cohesionless	5302.06 psf	30.88	N/A	922.24 Kips
62.01 ft	Cohesionless	5538.76 psf	30.88	N/A	1221.69 Kips
64.99 ft	Cohesionless	5617.14 psf	30.88	N/A	1326.48 Kips
65.01 ft	Cohesionless	5933.26 psf	33.78	N/A	1327.32 Kips
69.99 ft	Cohesionless	6064.24 psf	33.78	N/A	1570.54 Kips
70.01 ft	Cohesionless	6196.34 psf	36.67	N/A	1571.79 Kips
79.01 ft	Cohesionless	6500.54 psf	36.67	N/A	2276.28 Kips
88.01 ft	Cohesionless	6804.74 psf	36.67	N/A	3046.70 Kips
89.99 ft	Cohesionless	6871.66 psf	36.67	N/A	3225.04 Kips
90.01 ft	Cohesionless	7548.34 psf	30.32	N/A	3227.04 Kips
99.01 ft	Cohesionless	7852.54 psf	30.32	N/A	4243.91 Kips
99.99 ft	Cohesionless	7885.66 psf	30.32	N/A	4359.39 Kips

G1R7P2-8

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
27.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
36.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
39.99 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
40.01 ft	Cohesionless	4488.63 psf	64.00	760.58 Kips	760.58 Kips
49.01 ft	Cohesionless	5052.03 psf	64.00	760.58 Kips	760.58 Kips
52.99 ft	Cohesionless	5301.17 psf	64.00	760.58 Kips	760.58 Kips
53.01 ft	Cohesionless	5302.33 psf	40.40	233.26 Kips	233.26 Kips
62.01 ft	Cohesionless	5775.73 psf	40.40	233.26 Kips	233.26 Kips
64.99 ft	Cohesionless	5932.47 psf	40.40	233.26 Kips	233.26 Kips
65.01 ft	Cohesionless	5933.53 psf	64.00	760.58 Kips	760.58 Kips
69.99 ft	Cohesionless	6195.47 psf	64.00	760.58 Kips	760.58 Kips
70.01 ft	Cohesionless	6196.68 psf	110.40	1898.62 Kips	1898.62 Kips
79.01 ft	Cohesionless	6805.08 psf	110.40	1898.62 Kips	1898.62 Kips
88.01 ft	Cohesionless	7413.48 psf	110.40	1898.62 Kips	1898.62 Kips
89.99 ft	Cohesionless	7547.32 psf	110.40	1898.62 Kips	1898.62 Kips
90.01 ft	Cohesionless	7548.68 psf	110.40	1898.62 Kips	1898.62 Kips
99.01 ft	Cohesionless	8157.08 psf	110.40	1898.62 Kips	1898.62 Kips
99.99 ft	Cohesionless	8223.32 psf	110.40	1898.62 Kips	1898.62 Kips

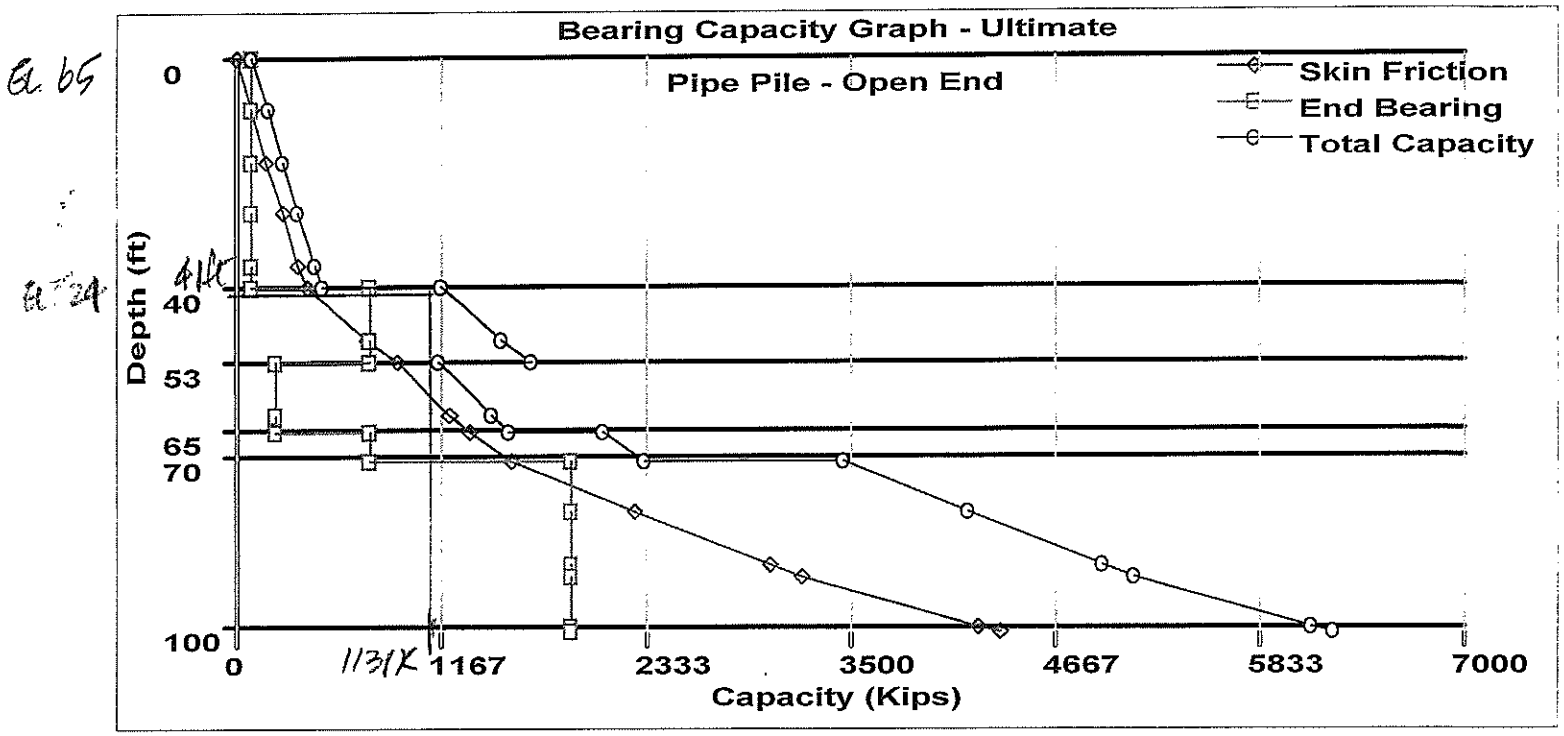
G1R7P2-9

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.10 Kips	95.43 Kips	95.53 Kips
9.01 ft	90.01 Kips	95.43 Kips	185.44 Kips
18.01 ft	179.92 Kips	95.43 Kips	275.35 Kips
27.01 ft	269.84 Kips	95.43 Kips	365.26 Kips
36.01 ft	365.08 Kips	95.43 Kips	460.50 Kips
39.99 ft	409.34 Kips	95.43 Kips	504.77 Kips
40.01 ft	409.82 Kips	760.58 Kips	1170.39 Kips
49.01 ft	755.57 Kips	760.58 Kips	1516.15 Kips
52.99 ft	921.50 Kips	760.58 Kips	1682.08 Kips
53.01 ft	922.24 Kips	233.26 Kips	1155.51 Kips
62.01 ft	1221.69 Kips	233.26 Kips	1454.95 Kips
64.99 ft	1326.48 Kips	233.26 Kips	1559.74 Kips
65.01 ft	1327.32 Kips	760.58 Kips	2087.89 Kips
69.99 ft	1570.54 Kips	760.58 Kips	2331.12 Kips
70.01 ft	1571.79 Kips	1898.62 Kips	3470.41 Kips
79.01 ft	2276.28 Kips	1898.62 Kips	4174.90 Kips
88.01 ft	3046.70 Kips	1898.62 Kips	4945.32 Kips
89.99 ft	3225.04 Kips	1898.62 Kips	5123.66 Kips
90.01 ft	3227.04 Kips	1898.62 Kips	5125.66 Kips
99.01 ft	4243.91 Kips	1898.62 Kips	6142.53 Kips
99.99 ft	4359.39 Kips	1898.62 Kips	6258.01 Kips

G1R7P2-10

Filename: Z:\DELDOT\SR1DEC~1\G1R7P2.DVN RAMP G1/SR7 PIER 2 36"φ 0.625" WALL

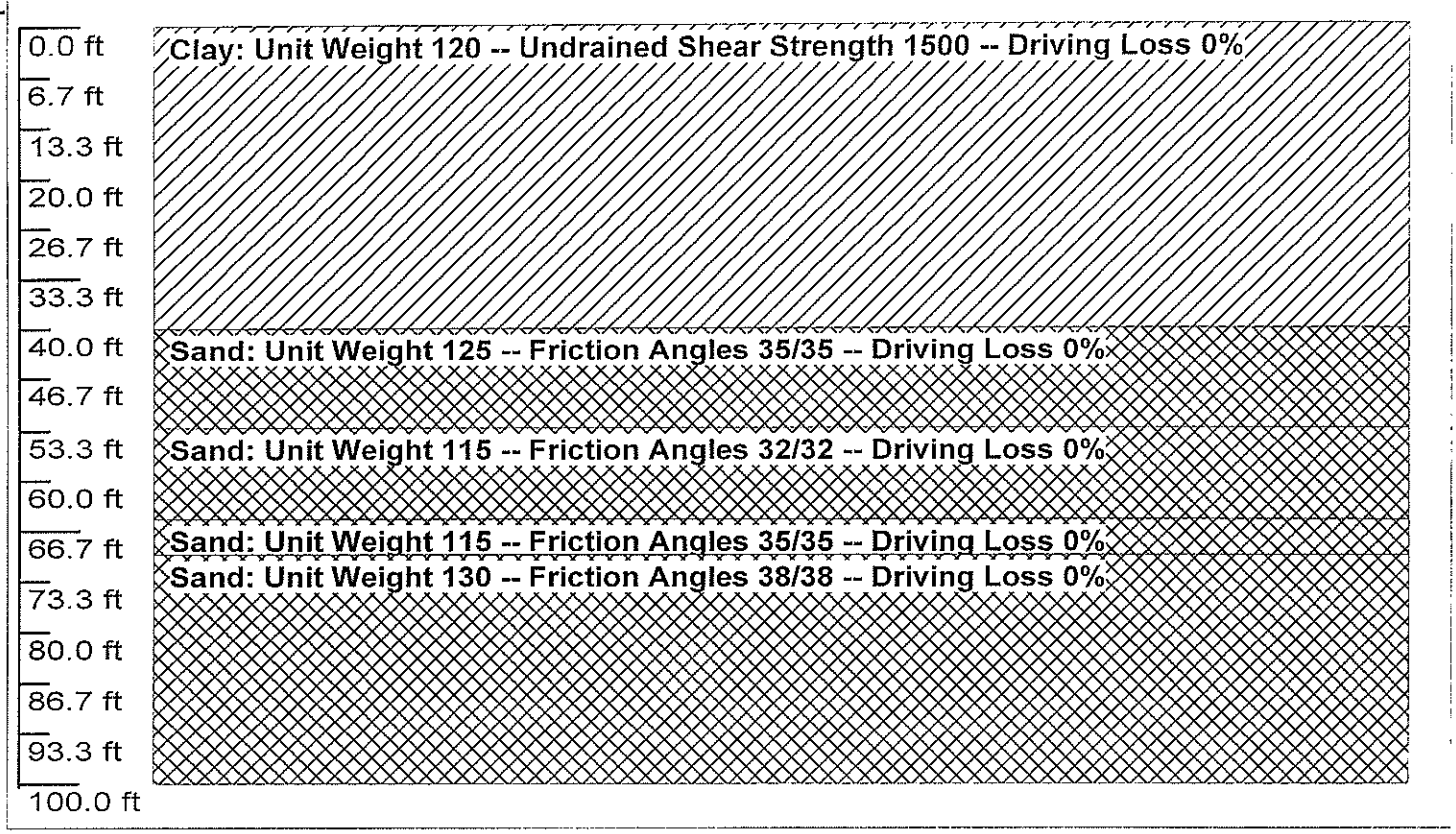


REQUIRED CAPACITY = 1131K
EST. PILE TIP = El. 24

Filename: Z:\DELDOT\SR1DEC~1\G1R7P2.DVN RAMP G1/SR 7 PIER 2 36" ϕ 0.625" WALL

Soil Profile BORING IBR-15

EL. 65



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\G1R7P2.DVN
Project Name: Ramp G1 / SR7 Pier 2 Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR! IBR-15 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 36.00 in
Shell Thickness: 0.62 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	35.00 ft
	- Driving/Restrike	35.00 ft
	- Ultimate:	35.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	40.00 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
2	Cohesionless	13.00 ft	0.00%	125.00 pcf	35.0/35.0	Nordlund
3	Cohesionless	12.00 ft	0.00%	115.00 pcf	32.0/32.0	Nordlund
4	Cohesionless	5.00 ft	0.00%	115.00 pcf	35.0/35.0	Nordlund
5	Cohesionless	30.00 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1060.00 psf	0.10 Kips
9.01 ft	Cohesive	N/A	N/A	1060.00 psf	90.01 Kips
18.01 ft	Cohesive	N/A	N/A	1060.00 psf	179.92 Kips
27.01 ft	Cohesive	N/A	N/A	1060.00 psf	269.84 Kips
36.01 ft	Cohesive	N/A	N/A	1075.69 psf	365.08 Kips
39.99 ft	Cohesive	N/A	N/A	1086.08 psf	409.34 Kips
40.01 ft	Cohesionless	4488.31 psf	33.78	N/A	409.82 Kips
49.01 ft	Cohesionless	4770.01 psf	33.78	N/A	755.57 Kips
52.99 ft	Cohesionless	4894.59 psf	33.78	N/A	921.50 Kips
53.01 ft	Cohesionless	5302.06 psf	30.88	N/A	922.24 Kips
62.01 ft	Cohesionless	5538.76 psf	30.88	N/A	1221.69 Kips
64.99 ft	Cohesionless	5617.14 psf	30.88	N/A	1326.48 Kips
65.01 ft	Cohesionless	5933.26 psf	33.78	N/A	1327.32 Kips
69.99 ft	Cohesionless	6064.24 psf	33.78	N/A	1570.54 Kips
70.01 ft	Cohesionless	6196.34 psf	36.67	N/A	1571.79 Kips
79.01 ft	Cohesionless	6500.54 psf	36.67	N/A	2276.28 Kips
88.01 ft	Cohesionless	6804.74 psf	36.67	N/A	3046.70 Kips
89.99 ft	Cohesionless	6871.66 psf	36.67	N/A	3225.04 Kips
90.01 ft	Cohesionless	7548.34 psf	30.32	N/A	3227.04 Kips
99.01 ft	Cohesionless	7852.54 psf	30.32	N/A	4243.91 Kips
99.99 ft	Cohesionless	7885.66 psf	30.32	N/A	4359.39 Kips

ULTIMATE - END BEARING

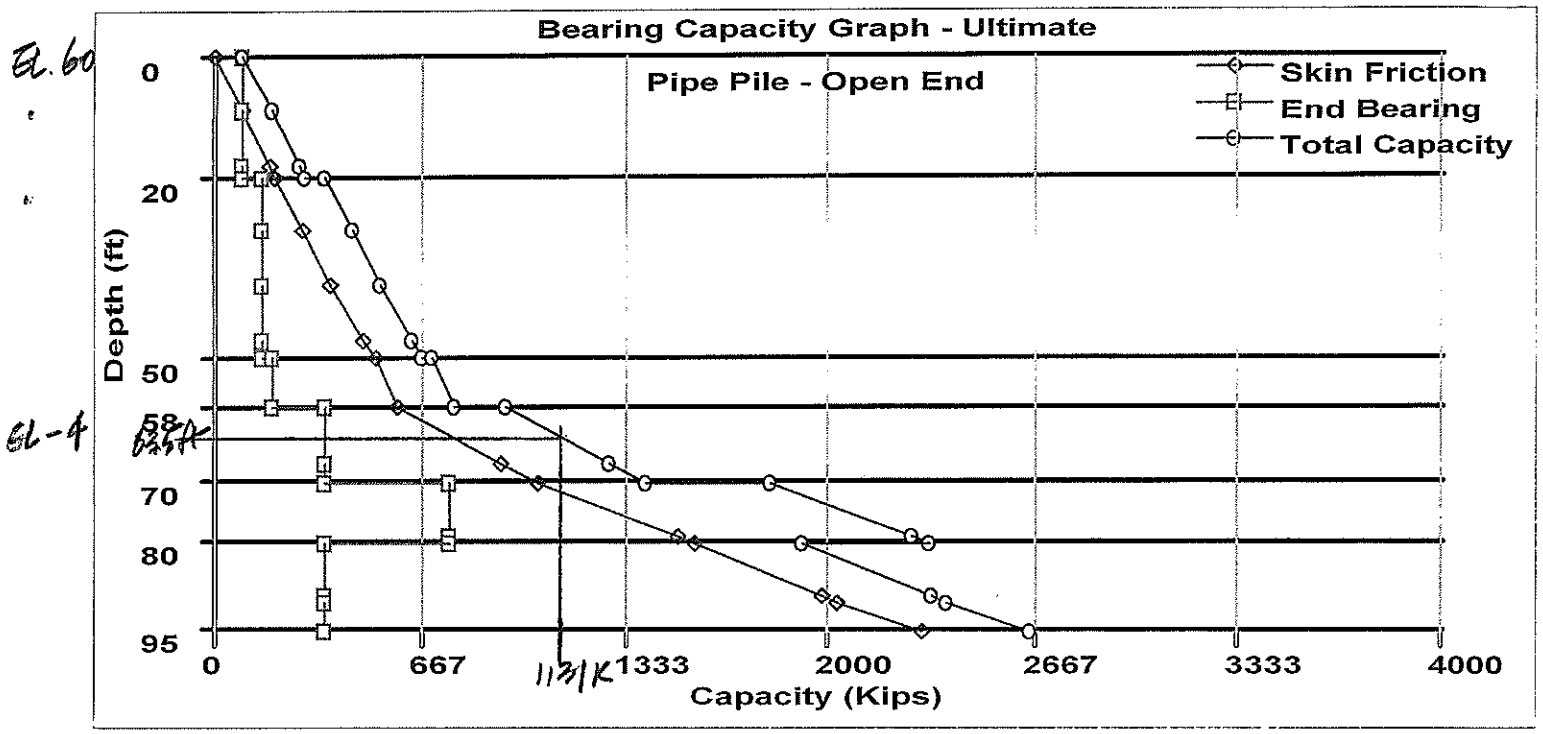
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
27.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
36.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
39.99 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
40.01 ft	Cohesionless	4488.63 psf	64.00	760.58 Kips	760.58 Kips
49.01 ft	Cohesionless	5052.03 psf	64.00	760.58 Kips	760.58 Kips
52.99 ft	Cohesionless	5301.17 psf	64.00	760.58 Kips	760.58 Kips
53.01 ft	Cohesionless	5302.33 psf	40.40	233.26 Kips	233.26 Kips
62.01 ft	Cohesionless	5775.73 psf	40.40	233.26 Kips	233.26 Kips
64.99 ft	Cohesionless	5932.47 psf	40.40	233.26 Kips	233.26 Kips
65.01 ft	Cohesionless	5933.53 psf	64.00	760.58 Kips	760.58 Kips
69.99 ft	Cohesionless	6195.47 psf	64.00	760.58 Kips	760.58 Kips
70.01 ft	Cohesionless	6196.68 psf	110.40	1898.62 Kips	1898.62 Kips
79.01 ft	Cohesionless	6805.08 psf	110.40	1898.62 Kips	1898.62 Kips
88.01 ft	Cohesionless	7413.48 psf	110.40	1898.62 Kips	1898.62 Kips
89.99 ft	Cohesionless	7547.32 psf	110.40	1898.62 Kips	1898.62 Kips
90.01 ft	Cohesionless	7548.68 psf	110.40	1898.62 Kips	1898.62 Kips
99.01 ft	Cohesionless	8157.08 psf	110.40	1898.62 Kips	1898.62 Kips
99.99 ft	Cohesionless	8223.32 psf	110.40	1898.62 Kips	1898.62 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.10 Kips	95.43 Kips	95.53 Kips
9.01 ft	90.01 Kips	95.43 Kips	185.44 Kips
18.01 ft	179.92 Kips	95.43 Kips	275.35 Kips
27.01 ft	269.84 Kips	95.43 Kips	365.26 Kips
36.01 ft	365.08 Kips	95.43 Kips	460.50 Kips
39.99 ft	409.34 Kips	95.43 Kips	504.77 Kips
40.01 ft	409.82 Kips	760.58 Kips	1170.39 Kips
49.01 ft	755.57 Kips	760.58 Kips	1516.15 Kips
52.99 ft	921.50 Kips	760.58 Kips	1682.08 Kips
53.01 ft	922.24 Kips	233.26 Kips	1155.51 Kips
62.01 ft	1221.69 Kips	233.26 Kips	1454.95 Kips
64.99 ft	1326.48 Kips	233.26 Kips	1559.74 Kips
65.01 ft	1327.32 Kips	760.58 Kips	2087.89 Kips
69.99 ft	1570.54 Kips	760.58 Kips	2331.12 Kips
70.01 ft	1571.79 Kips	1898.62 Kips	3470.41 Kips
79.01 ft	2276.28 Kips	1898.62 Kips	4174.90 Kips
88.01 ft	3046.70 Kips	1898.62 Kips	4945.32 Kips
89.99 ft	3225.04 Kips	1898.62 Kips	5123.66 Kips
90.01 ft	3227.04 Kips	1898.62 Kips	5125.66 Kips
99.01 ft	4243.91 Kips	1898.62 Kips	6142.53 Kips
99.99 ft	4359.39 Kips	1898.62 Kips	6258.01 Kips

G1R7P2-10

Filename: Z:\DELDOT\SR1DEC~1\G1R7P3A.DVN RAMP G1/SR7 PIER 3 36"φ 0.625" WALL

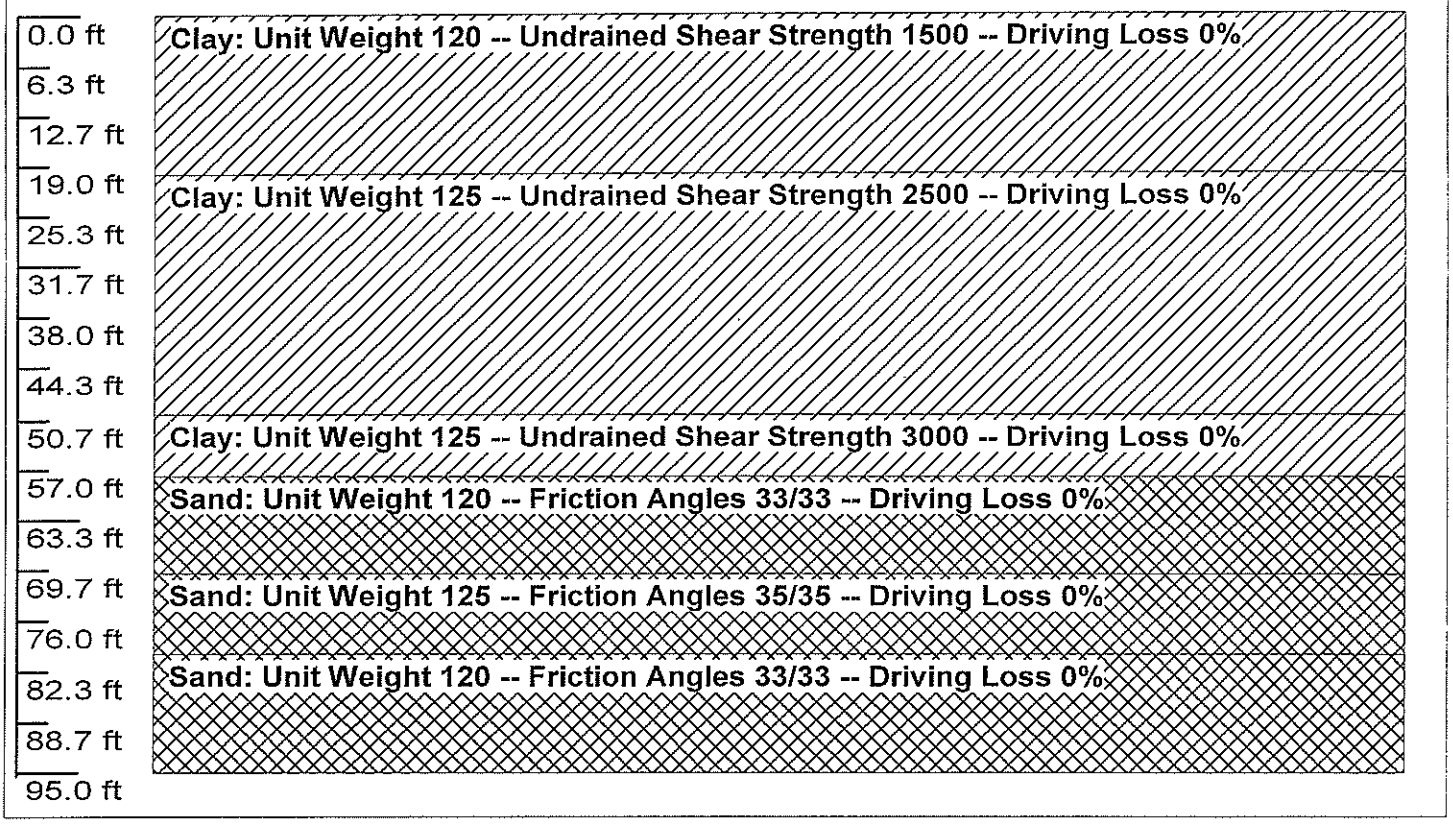


REQUIRED CAPACITY = 1131K

EST. PILE TIP = GL.-4

Filename: Z:\DELDOT\SR1DEC~1\G1R7P3A.DVN RAMP G1/SR7 PIER 3 36"φ · 0.625" WALL

Soil Profile BORING IBR-06



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\G1R7P3A.DVN
Project Name: Ramp G1 / SR7 Pier 3 Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-06 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 36.00 in
Shell Thickness: 0.62 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	30.00 ft
	- Driving/Restrike	30.00 ft
	- Ultimate:	30.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	20.00 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
2	Cohesive	30.00 ft	0.00%	125.00 pcf	2500.00 psf	T-79 Steel
3	Cohesive	8.00 ft	0.00%	125.00 pcf	3000.00 psf	T-79 Steel
4	Cohesionless	12.00 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund
5	Cohesionless	10.00 ft	0.00%	125.00 pcf	35.0/35.0	Nordlund
6	Cohesionless	15.00 ft	0.00%	120.00 pcf	33.0/33.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	1060.00 psf	0.10 Kips
9.01 ft	Cohesive	N/A	N/A	1060.00 psf	90.01 Kips
18.01 ft	Cohesive	N/A	N/A	1060.00 psf	179.92 Kips
19.99 ft	Cohesive	N/A	N/A	1060.00 psf	199.71 Kips
20.01 ft	Cohesive	N/A	N/A	1000.00 psf	199.90 Kips
29.01 ft	Cohesive	N/A	N/A	1000.00 psf	284.72 Kips
38.01 ft	Cohesive	N/A	N/A	1046.72 psf	377.48 Kips
47.01 ft	Cohesive	N/A	N/A	1099.22 psf	479.63 Kips
49.99 ft	Cohesive	N/A	N/A	1116.61 psf	515.41 Kips
50.01 ft	Cohesive	N/A	N/A	903.39 psf	515.62 Kips
57.99 ft	Cohesive	N/A	N/A	948.61 psf	586.97 Kips
58.01 ft	Cohesionless	5403.09 psf	31.85	N/A	587.42 Kips
67.01 ft	Cohesionless	5662.29 psf	31.85	N/A	927.11 Kips
69.99 ft	Cohesionless	5748.11 psf	31.85	N/A	1046.44 Kips
70.01 ft	Cohesionless	6094.31 psf	33.78	N/A	1047.34 Kips
79.01 ft	Cohesionless	6376.01 psf	33.78	N/A	1509.50 Kips
79.99 ft	Cohesionless	6406.69 psf	33.78	N/A	1562.29 Kips
80.01 ft	Cohesionless	6720.29 psf	31.85	N/A	1563.28 Kips
89.01 ft	Cohesionless	6979.49 psf	31.85	N/A	1981.99 Kips
89.99 ft	Cohesionless	7007.71 psf	31.85	N/A	2029.46 Kips
90.01 ft	Cohesionless	7296.29 psf	26.33	N/A	2030.49 Kips
94.99 ft	Cohesionless	7439.71 psf	26.33	N/A	2304.84 Kips

ULTIMATE - END BEARING

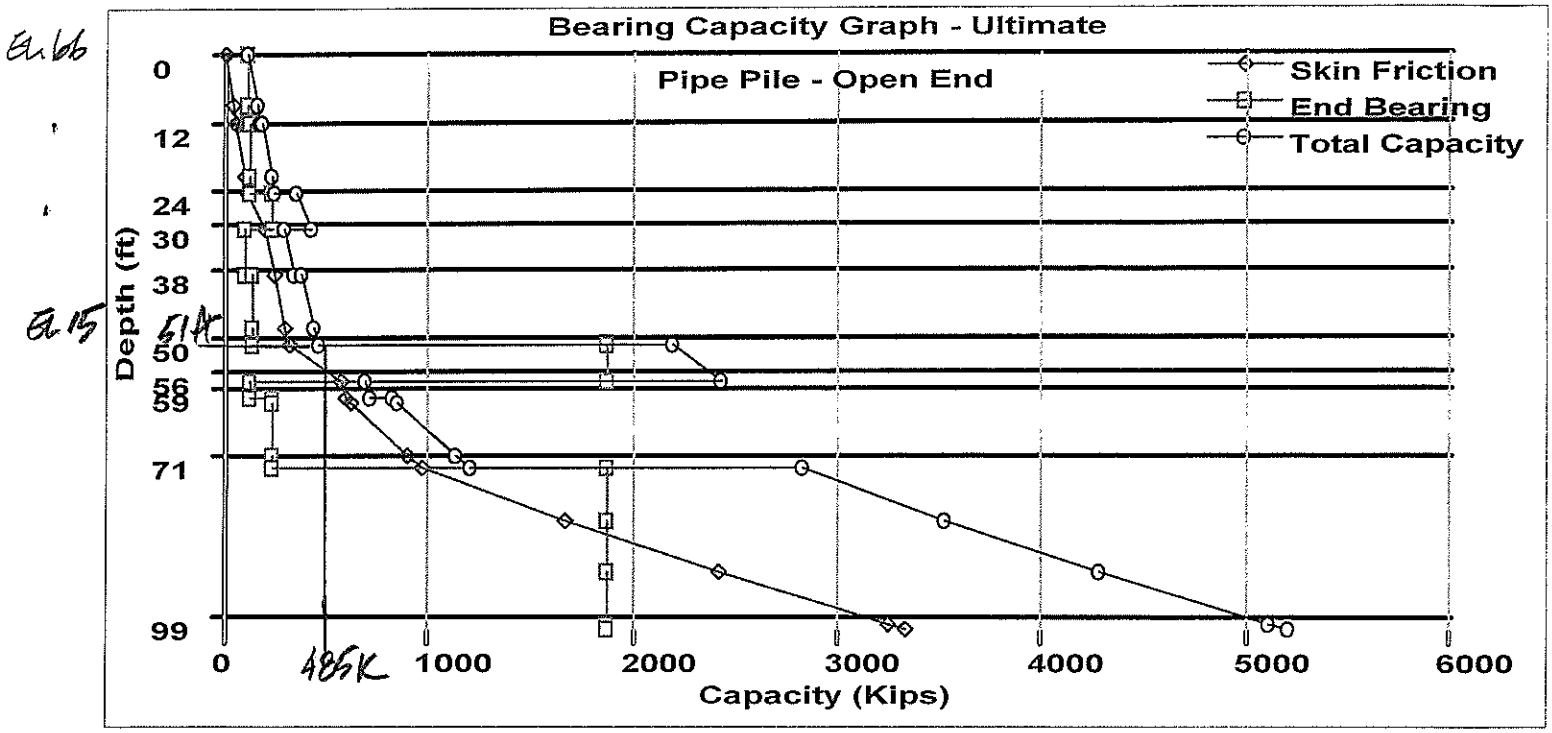
Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
18.01 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
19.99 ft	Cohesive	N/A	N/A	N/A	95.43 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	159.04 Kips
29.01 ft	Cohesive	N/A	N/A	N/A	159.04 Kips
38.01 ft	Cohesive	N/A	N/A	N/A	159.04 Kips
47.01 ft	Cohesive	N/A	N/A	N/A	159.04 Kips
49.99 ft	Cohesive	N/A	N/A	N/A	159.04 Kips
50.01 ft	Cohesive	N/A	N/A	N/A	190.85 Kips
57.99 ft	Cohesive	N/A	N/A	N/A	190.85 Kips
58.01 ft	Cohesionless	5403.38 psf	47.20	353.43 Kips	353.43 Kips
67.01 ft	Cohesionless	5921.78 psf	47.20	353.43 Kips	353.43 Kips
69.99 ft	Cohesionless	6093.42 psf	47.20	353.43 Kips	353.43 Kips
70.01 ft	Cohesionless	6094.63 psf	64.00	760.58 Kips	760.58 Kips
79.01 ft	Cohesionless	6658.03 psf	64.00	760.58 Kips	760.58 Kips
79.99 ft	Cohesionless	6719.37 psf	64.00	760.58 Kips	760.58 Kips
80.01 ft	Cohesionless	6720.58 psf	47.20	353.43 Kips	353.43 Kips
89.01 ft	Cohesionless	7238.98 psf	47.20	353.43 Kips	353.43 Kips
89.99 ft	Cohesionless	7295.42 psf	47.20	353.43 Kips	353.43 Kips
90.01 ft	Cohesionless	7296.58 psf	47.20	353.43 Kips	353.43 Kips
94.99 ft	Cohesionless	7583.42 psf	47.20	353.43 Kips	353.43 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.10 Kips	95.43 Kips	95.53 Kips
9.01 ft	90.01 Kips	95.43 Kips	185.44 Kips
18.01 ft	179.92 Kips	95.43 Kips	275.35 Kips
19.99 ft	199.71 Kips	95.43 Kips	295.13 Kips
20.01 ft	199.90 Kips	159.04 Kips	358.94 Kips
29.01 ft	284.72 Kips	159.04 Kips	443.77 Kips
38.01 ft	377.48 Kips	159.04 Kips	536.52 Kips
47.01 ft	479.63 Kips	159.04 Kips	638.67 Kips
49.99 ft	515.41 Kips	159.04 Kips	674.46 Kips
50.01 ft	515.62 Kips	190.85 Kips	706.47 Kips
57.99 ft	586.97 Kips	190.85 Kips	777.82 Kips
58.01 ft	587.42 Kips	353.43 Kips	940.85 Kips
67.01 ft	927.11 Kips	353.43 Kips	1280.54 Kips
69.99 ft	1046.44 Kips	353.43 Kips	1399.87 Kips
70.01 ft	1047.34 Kips	760.58 Kips	1807.92 Kips
79.01 ft	1509.50 Kips	760.58 Kips	2270.08 Kips
79.99 ft	1562.29 Kips	760.58 Kips	2322.87 Kips
80.01 ft	1563.28 Kips	353.43 Kips	1916.71 Kips
89.01 ft	1981.99 Kips	353.43 Kips	2335.42 Kips
89.99 ft	2029.46 Kips	353.43 Kips	2382.89 Kips
90.01 ft	2030.49 Kips	353.43 Kips	2383.92 Kips
94.99 ft	2304.84 Kips	353.43 Kips	2658.27 Kips

G1R7P3A-10

Filename: Z:\DELDOT\SR1DEC~1\G1R7UTB.DVN RAMP G1/SR7 ABUT B 24"Φ .05" WALL

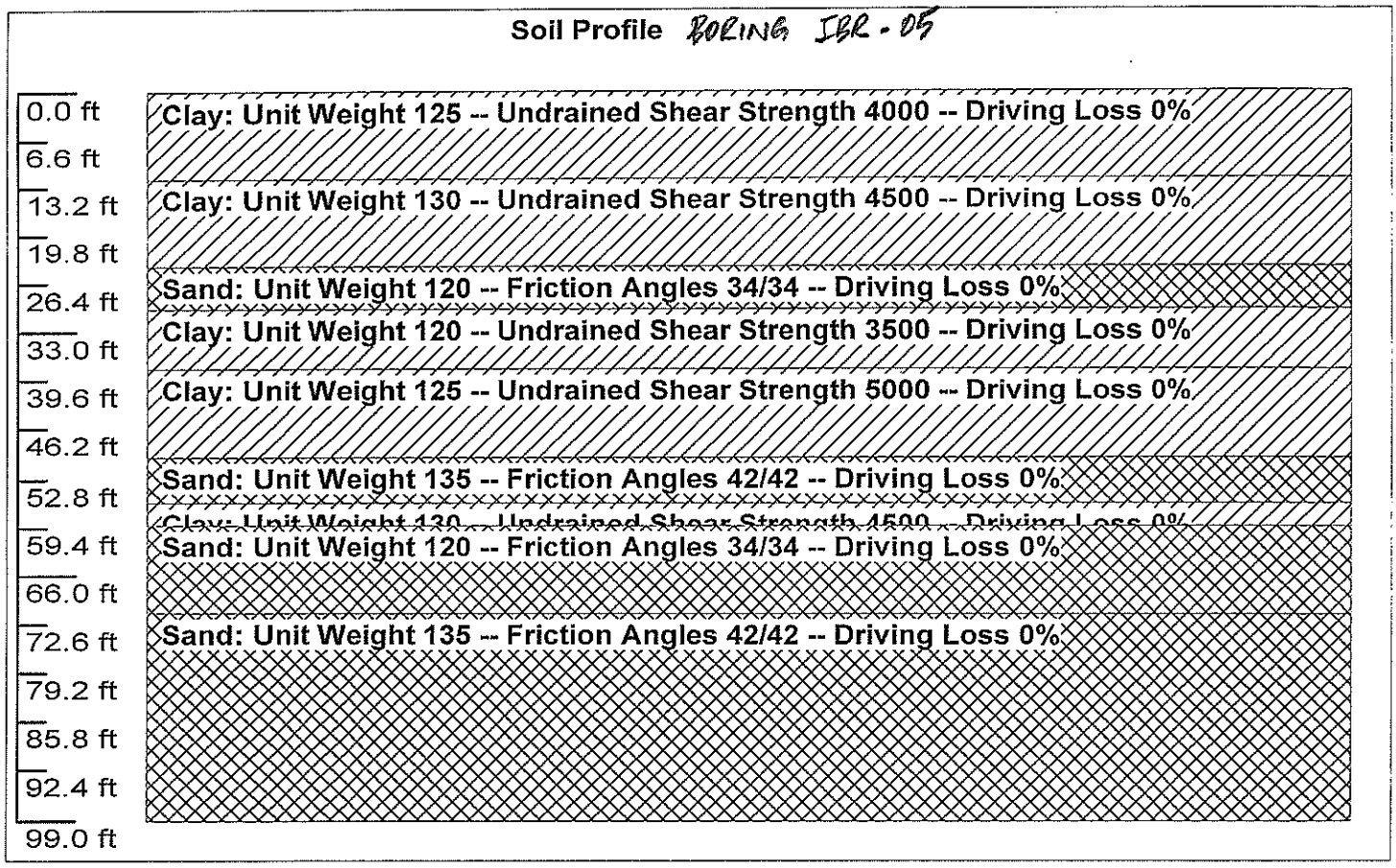


REQUIRED CAPACITY = 485 K

EST. PILE TIP = EL. 15

Filename: Z:\DELDOT\SR1DEC~1\G1R7UTB.DVN RAMP G1 /SR7 ABUT B

Soil Profile BORING IBR-05



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: Z:\DELDOT\SR1DEC~1\G1R7UTB.DVN
Project Name: Ramp G1 / SR7 Abut B
Project Date: 12/15/2008
Project Client: DelDOT
Computed By: KLL
Project Manager: SR1 IBR-05 Profile

PILE INFORMATION

Pile Type: Pipe Pile - Open End
Top of Pile: 0.00 ft
Diameter of Pile: 24.00 in
Shell Thickness: 0.50 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	36.00 ft
	- Driving/Restrike	36.00 ft
	- Ultimate:	36.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	12.00 ft	0.00%	125.00 pcf	4000.00 psf	T-79 Steel
2	Cohesive	12.00 ft	0.00%	130.00 pcf	4500.00 psf	T-79 Steel
3	Cohesionless	6.00 ft	0.00%	120.00 pcf	34.0/34.0	Nordlund
4	Cohesive	8.00 ft	0.00%	120.00 pcf	3500.00 psf	T-79 Steel
5	Cohesive	12.00 ft	0.00%	125.00 pcf	5000.00 psf	T-79 Steel
6	Cohesionless	6.00 ft	0.00%	135.00 pcf	42.0/42.0	Nordlund
7	Cohesive	3.00 ft	0.00%	130.00 pcf	4500.00 psf	T-79 Steel
8	Cohesionless	12.00 ft	0.00%	120.00 pcf	34.0/34.0	Nordlund
9	Cohesionless	28.00 ft	0.00%	135.00 pcf	42.0/42.0	Nordlund

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	770.00 psf	0.05 Kips
9.01 ft	Cohesive	N/A	N/A	770.00 psf	43.59 Kips
11.99 ft	Cohesive	N/A	N/A	770.00 psf	58.01 Kips
12.01 ft	Cohesive	N/A	N/A	770.00 psf	58.10 Kips
21.01 ft	Cohesive	N/A	N/A	778.25 psf	102.11 Kips
23.99 ft	Cohesive	N/A	N/A	802.59 psf	118.52 Kips
24.01 ft	Cohesionless	3060.60 psf	29.28	N/A	118.69 Kips
29.99 ft	Cohesionless	3419.40 psf	29.28	N/A	196.49 Kips
30.01 ft	Cohesive	N/A	N/A	851.75 psf	196.68 Kips
37.99 ft	Cohesive	N/A	N/A	916.92 psf	242.66 Kips
38.01 ft	Cohesive	N/A	N/A	917.08 psf	242.78 Kips
47.01 ft	Cohesive	N/A	N/A	990.58 psf	298.80 Kips
49.99 ft	Cohesive	N/A	N/A	1014.92 psf	319.18 Kips
50.01 ft	Cohesionless	5366.76 psf	36.17	N/A	319.66 Kips
55.99 ft	Cohesionless	5583.84 psf	36.17	N/A	571.01 Kips
56.01 ft	Cohesive	N/A	N/A	1064.08 psf	571.51 Kips
58.99 ft	Cohesive	N/A	N/A	1088.42 psf	591.89 Kips
59.01 ft	Cohesionless	6005.09 psf	29.28	N/A	592.19 Kips
59.99 ft	Cohesionless	6033.31 psf	29.28	N/A	614.68 Kips
60.01 ft	Cohesionless	6062.69 psf	27.13	N/A	615.21 Kips
69.01 ft	Cohesionless	6321.89 psf	27.13	N/A	899.51 Kips
70.99 ft	Cohesionless	6378.91 psf	27.13	N/A	965.18 Kips
71.01 ft	Cohesionless	6696.36 psf	33.52	N/A	966.25 Kips
80.01 ft	Cohesionless	7023.06 psf	33.52	N/A	1660.26 Kips
89.01 ft	Cohesionless	7349.76 psf	33.52	N/A	2418.84 Kips
98.01 ft	Cohesionless	7676.46 psf	33.52	N/A	3241.97 Kips
98.99 ft	Cohesionless	7712.04 psf	33.52	N/A	3335.50 Kips

G1R7UTB-8

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
9.01 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
11.99 ft	Cohesive	N/A	N/A	N/A	113.10 Kips
12.01 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
21.01 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
23.99 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
24.01 ft	Cohesionless	3061.20 psf	55.60	230.97 Kips	230.97 Kips
29.99 ft	Cohesionless	3778.80 psf	55.60	230.97 Kips	230.97 Kips
30.01 ft	Cohesive	N/A	N/A	N/A	98.96 Kips
37.99 ft	Cohesive	N/A	N/A	N/A	98.96 Kips
38.01 ft	Cohesive	N/A	N/A	N/A	141.37 Kips
47.01 ft	Cohesive	N/A	N/A	N/A	141.37 Kips
49.99 ft	Cohesive	N/A	N/A	N/A	141.37 Kips
50.01 ft	Cohesionless	5367.13 psf	244.00	1861.58 Kips	1861.58 Kips
55.99 ft	Cohesionless	5801.27 psf	244.00	1861.58 Kips	1861.58 Kips
56.01 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
58.99 ft	Cohesive	N/A	N/A	N/A	127.23 Kips
59.01 ft	Cohesionless	6005.38 psf	55.60	230.97 Kips	230.97 Kips
59.99 ft	Cohesionless	6061.82 psf	55.60	230.97 Kips	230.97 Kips
60.01 ft	Cohesionless	6062.98 psf	55.60	230.97 Kips	230.97 Kips
69.01 ft	Cohesionless	6581.38 psf	55.60	230.97 Kips	230.97 Kips
70.99 ft	Cohesionless	6695.42 psf	55.60	230.97 Kips	230.97 Kips
71.01 ft	Cohesionless	6696.73 psf	244.00	1861.58 Kips	1861.58 Kips
80.01 ft	Cohesionless	7350.13 psf	244.00	1861.58 Kips	1861.58 Kips
89.01 ft	Cohesionless	8003.53 psf	244.00	1861.58 Kips	1861.58 Kips
98.01 ft	Cohesionless	8656.93 psf	244.00	1861.58 Kips	1861.58 Kips
98.99 ft	Cohesionless	8728.07 psf	244.00	1861.58 Kips	1861.58 Kips

G1R7UTB-9

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.05 Kips	113.10 Kips	113.15 Kips
9.01 ft	43.59 Kips	113.10 Kips	156.69 Kips
11.99 ft	58.01 Kips	113.10 Kips	171.11 Kips
12.01 ft	58.10 Kips	127.23 Kips	185.34 Kips
21.01 ft	102.11 Kips	127.23 Kips	229.35 Kips
23.99 ft	118.52 Kips	127.23 Kips	245.75 Kips
24.01 ft	118.69 Kips	230.97 Kips	349.66 Kips
29.99 ft	196.49 Kips	230.97 Kips	427.46 Kips
30.01 ft	196.68 Kips	98.96 Kips	295.64 Kips
37.99 ft	242.66 Kips	98.96 Kips	341.62 Kips
38.01 ft	242.78 Kips	141.37 Kips	384.15 Kips
47.01 ft	298.80 Kips	141.37 Kips	440.17 Kips
49.99 ft	319.18 Kips	141.37 Kips	460.55 Kips
50.01 ft	319.66 Kips	1861.58 Kips	2181.24 Kips
55.99 ft	571.01 Kips	1861.58 Kips	2432.59 Kips
56.01 ft	571.51 Kips	127.23 Kips	698.74 Kips
58.99 ft	591.89 Kips	127.23 Kips	719.12 Kips
59.01 ft	592.19 Kips	230.97 Kips	823.16 Kips
59.99 ft	614.68 Kips	230.97 Kips	845.65 Kips
60.01 ft	615.21 Kips	230.97 Kips	846.18 Kips
69.01 ft	899.51 Kips	230.97 Kips	1130.48 Kips
70.99 ft	965.18 Kips	230.97 Kips	1196.15 Kips
71.01 ft	966.25 Kips	1861.58 Kips	2827.84 Kips
80.01 ft	1660.26 Kips	1861.58 Kips	3521.84 Kips
89.01 ft	2418.84 Kips	1861.58 Kips	4280.42 Kips
98.01 ft	3241.97 Kips	1861.58 Kips	5103.56 Kips
98.99 ft	3335.50 Kips	1861.58 Kips	5197.08 Kips

G1R7UTB-10

Lateral Analysis

URS

Job SR-1 / I-95 Interchange
Description Ramp G1 - Pier 1
GR 7

Project No.
Computed by JPK
Checked by

Page ____ of ____
Sheet ____ of ____
Date 8/22/08
Date

Reference

From boring IBR-20 (DONE)
1131 K 36" ϕ 0.625" WALL

EL. 65.0 Depth = 0 ft

EL. 61.0 4 ft — 48 in — 1 Sand — γ = 110 pcf, c = 0, ϕ = 31°, N = 10± — γ = 0.064, K = 40

2 Clay — γ = 115 pcf, c = 1000 psf, ϕ = 0°, N = 12± — γ = 0.067, c = 6.9, K = 600, ε = 0.0068

EL. 44 21 ft — 252 in

ASSUMED ▽ EL. 30 35 ft — 420 in — 3 Clay — γ = 120 pcf, c = 1500 psf, ϕ = 0, N = 15± — γ = 0.069, c = 10.4, K = 875, ε = 0.0065

EL. 18 47 ft

4 Sand — γ = 115 pcf, c = 0, ϕ = 32°, N = 15±

EL. 12 53 ft

5 Sand — γ = 130 pcf, c = 0, ϕ = 36°, N = 25±

EL. -20 85 ft

6 Sand — γ = 130 pcf, c = 0, ϕ = 38°, N = 50+

EL. -35 100 ft

Total Shear = 280 K

9 piles
Assume 3x3 config
Table 10.7.24-1

Row 1 - 3 piles @ 1.0
Row 2 - 3 piles @ 0.5
Row 3 - 3 piles @ 0.35

Axial = 735 K

Length Req'd = 28.5 ft

$$\text{Shear per pile} = \frac{280\,K}{3(1) + 3(0.5) + 3(0.35)} = 50.5\ K$$

```
================================================================================

                LPILE Plus for Windows, Version 4.0 (4.0.8)

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

                 (c) Copyright ENSOFT, Inc., 1985-2003
                          All Rights Reserved

================================================================================


This program is licensed to:

URS
URS

Path to file locations:      D:\Program Files\Ensoft\LpileP4\DelDOTSR1\
Name of input data file:     S5P1.lpd
Name of output file:         S5P1.lpo
Name of plot output file:    S5P1.lpp
Name of runtime file:        S5P1.lpr


--------------------------------------------------------------------------------
                          Time and Date of Analysis
--------------------------------------------------------------------------------

               Date:  January 22, 2009     Time:  13:37:55


--------------------------------------------------------------------------------
                                 Problem Title
--------------------------------------------------------------------------------

Ramp G1 over SR 7 - Pier 1


--------------------------------------------------------------------------------
                                 Program Options
--------------------------------------------------------------------------------

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          150
- Maximum number of iterations allowed =          100
```

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 342.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	36.000	10900.0000	69.5000	30000000.000
2	342.0000	36.000	10900.0000	69.5000	30000000.000

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 48.000 in
p-y subgrade modulus k for top of soil layer = 40.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 40.000 lbs/in**3

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 48.000 in
Distance from top of pile to bottom of layer = 252.000 in
p-y subgrade modulus k for top of soil layer = 600.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 600.000 lbs/in**3

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 252.000 in
Distance from top of pile to bottom of layer = 420.000 in
p-y subgrade modulus k for top of soil layer = 875.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 875.000 lbs/in**3

(Depth of lowest layer extends 78.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 6 points

Point	Depth X	Eff. Unit Weight

No.	in	lbs/in**3
1	.00	.06400
2	48.00	.06400
3	48.00	.06700
4	252.00	.06700
5	252.00	.06900
6	420.00	.06900

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 6 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	.00000	31.00	------	------
2	48.000	.00000	31.00	------	------
3	48.000	6.90000	.00	.00680	.0
4	252.000	6.90000	.00	.00680	.0
5	252.000	10.40000	.00	.00650	.0
6	420.000	10.40000	.00	.00650	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 50500.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 735000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 50500.000 lbs
Specified bending moment at pile head = .000 in-lbs
Specified axial load at pile head = 735000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.357109	1.327E-04	50500.0000	-.002469	10575.5396	0.0000
2.280	.351480	119277.0275	50467.8700	-.002468	10772.5108	-28.1842
4.560	.345853	238406.1486	50370.2256	-.002467	10969.2378	-57.4688
6.840	.340230	357233.7382	50204.7665	-.002465	11165.4668	-87.6707
9.120	.334613	475601.4060	49969.6091	-.002462	11360.9364	-118.6076
11.400	.329004	593346.9468	49663.3672	-.002458	11555.3786	-150.0256
13.680	.323403	710305.6614	49290.5964	-.002454	11748.5214	-176.9663
15.960	.317814	826336.1349	48857.5572	-.002448	11940.1314	-202.8927
18.240	.312239	941302.2357	48366.5570	-.002442	12129.9836	-227.8092
20.520	.306678	1.055E+06	47819.8925	-.002435	12317.8621	-251.7210
22.800	.301134	1.168E+06	47219.8480	-.002428	12503.5593	-274.6338
25.080	.295608	1.279E+06	46568.6938	-.002419	12686.8764	-296.5540
27.360	.290103	1.388E+06	45868.6853	-.002410	12867.6231	-317.4886
29.640	.284620	1.496E+06	45122.0608	-.002400	13045.6175	-337.4452
31.920	.279160	1.602E+06	44331.0409	-.002389	13220.6862	-356.4320
34.200	.273726	1.706E+06	43497.8265	-.002377	13392.6642	-374.4578
36.480	.268320	1.808E+06	42624.5980	-.002365	13561.3948	-391.5321
38.760	.262942	1.908E+06	41713.5135	-.002352	13726.7293	-407.6648
41.040	.257594	2.006E+06	40766.7081	-.002338	13888.5275	-422.8663
43.320	.252278	2.102E+06	39786.2922	-.002324	14046.6568	-437.1476
45.600	.246996	2.195E+06	38774.3507	-.002309	14200.9929	-450.5203
47.880	.241748	2.287E+06	37732.9416	-.002294	14351.4191	-462.9964
50.160	.236537	2.375E+06	36781.9147	-.002277	14497.8266	-371.2378
52.440	.231364	2.462E+06	35931.8841	-.002260	14641.0014	-374.4031
54.720	.226230	2.547E+06	35074.7217	-.002243	14780.9145	-377.4937
57.000	.221136	2.629E+06	34210.5992	-.002225	14917.5380	-380.5085
59.280	.216084	2.710E+06	33339.6907	-.002206	15050.8442	-383.4463
61.560	.211075	2.789E+06	32462.1728	-.002187	15180.8065	-386.3062
63.840	.206110	2.865E+06	31578.2243	-.002167	15307.3987	-389.0871
66.120	.201191	2.940E+06	30688.0267	-.002147	15430.5955	-391.7880
68.400	.196319	3.013E+06	29791.7632	-.002126	15550.3722	-394.4080
70.680	.191495	3.083E+06	28889.6197	-.002105	15666.7050	-396.9460
72.960	.186719	3.151E+06	27981.7841	-.002083	15779.5708	-399.4011
75.240	.181994	3.218E+06	27068.4465	-.002061	15888.9470	-401.7723
77.520	.177320	3.282E+06	26149.7992	-.002039	15994.8122	-404.0587
79.800	.172698	3.344E+06	25226.0366	-.002016	16097.1454	-406.2594
82.080	.168129	3.403E+06	24297.3554	-.001992	16195.9265	-408.3733
84.360	.163615	3.461E+06	23363.9542	-.001968	16291.1363	-410.3996
86.640	.159155	3.517E+06	22426.0342	-.001944	16382.7562	-412.3373
88.920	.154751	3.570E+06	21483.7984	-.001919	16470.7685	-414.1854
91.200	.150404	3.621E+06	20537.4521	-.001894	16555.1564	-415.9429
93.480	.146115	3.670E+06	19587.2028	-.001869	16635.9038	-417.6090
95.760	.141884	3.717E+06	18633.2605	-.001843	16712.9953	-419.1826
98.040	.137712	3.761E+06	17675.8370	-.001817	16786.4167	-420.6626
100.320	.133600	3.803E+06	16715.1467	-.001790	16856.1543	-422.0482
102.600	.129548	3.843E+06	15751.4061	-.001764	16922.1955	-423.3382
104.880	.125557	3.881E+06	14784.8343	-.001737	16984.5283	-424.5318

107.160	.121628	3.916E+06	13815.6526	-.001710	17043.1419	-425.6277
109.440	.117762	3.950E+06	12844.0846	-.001682	17098.0260	-426.6249
111.720	.113958	3.981E+06	11870.3566	-.001655	17149.1716	-427.5225
114.000	.110217	4.009E+06	10894.6971	-.001627	17196.5703	-428.3191
116.280	.106540	4.036E+06	9917.3376	-.001599	17240.2148	-429.0138
118.560	.102927	4.060E+06	8938.5117	-.001570	17280.0985	-429.6054
120.840	.099379	4.082E+06	7958.4559	-.001542	17316.2159	-430.0926
123.120	.095896	4.101E+06	6977.4095	-.001513	17348.5624	-430.4744
125.400	.092478	4.119E+06	5995.6145	-.001485	17377.1343	-430.7494
127.680	.089125	4.134E+06	5013.3156	-.001456	17401.9290	-430.9163
129.960	.085838	4.146E+06	4030.7608	-.001427	17422.9448	-430.9739
132.240	.082617	4.157E+06	3048.2009	-.001398	17440.1808	-430.9208
134.520	.079462	4.165E+06	2065.8898	-.001369	17453.6374	-430.7556
136.800	.076374	4.171E+06	1084.0848	-.001340	17463.3158	-430.4769
139.080	.073351	4.175E+06	103.0465	-.001311	17469.2182	-430.0831
141.360	.070395	4.176E+06	-876.9611	-.001282	17471.3481	-429.5727
143.640	.067506	4.175E+06	-1855.6703	-.001253	17469.7097	-428.9441
145.920	.064682	4.172E+06	-2832.8096	-.001224	17464.3085	-428.1957
148.200	.061925	4.166E+06	-3808.1038	-.001195	17455.1509	-427.3255
150.480	.059235	4.158E+06	-4781.2732	-.001166	17442.2446	-426.3319
152.760	.056610	4.148E+06	-5752.0341	-.001137	17425.5982	-425.2128
155.040	.054051	4.136E+06	-6720.0981	-.001108	17405.2215	-423.9662
157.320	.051559	4.121E+06	-7685.1722	-.001079	17381.1254	-422.5900
159.600	.049131	4.104E+06	-8646.9581	-.001050	17353.3221	-421.0818
161.880	.046769	4.085E+06	-9605.1522	-.001022	17321.8249	-419.4394
164.160	.044472	4.064E+06	-10559.4454	-9.934E-04	17286.6481	-417.6600
166.440	.042239	4.040E+06	-11509.5224	-9.651E-04	17247.8075	-415.7409
168.720	.040071	4.015E+06	-12455.0614	-9.371E-04	17205.3200	-413.6793
171.000	.037966	3.987E+06	-13395.7336	-9.092E-04	17159.2038	-411.4718
173.280	.035925	3.957E+06	-14331.2029	-8.815E-04	17109.4784	-409.1152
175.560	.033947	3.924E+06	-15261.1248	-8.540E-04	17056.1645	-406.6057
177.840	.032031	3.890E+06	-16185.1462	-8.267E-04	16999.2845	-403.9394
180.120	.030177	3.853E+06	-17102.9045	-7.997E-04	16938.8618	-401.1118
182.400	.028384	3.815E+06	-18014.0265	-7.730E-04	16874.9213	-398.1181
184.680	.026652	3.774E+06	-18918.1277	-7.466E-04	16807.4896	-394.9531
186.960	.024980	3.731E+06	-19814.8106	-7.204E-04	16736.5947	-391.6109
189.240	.023367	3.686E+06	-20703.6640	-6.945E-04	16662.2659	-388.0851
191.520	.021813	3.639E+06	-21584.2609	-6.690E-04	16584.5345	-384.3684
193.800	.020316	3.590E+06	-22456.1570	-6.438E-04	16503.4333	-380.4527
196.080	.018877	3.539E+06	-23318.8880	-6.190E-04	16418.9968	-376.3288
198.360	.017494	3.485E+06	-24171.9674	-5.945E-04	16331.2614	-371.9864
200.640	.016166	3.430E+06	-25014.8833	-5.704E-04	16240.2654	-367.4135
202.920	.014893	3.373E+06	-25847.0947	-5.466E-04	16146.0492	-362.5964
205.200	.013673	3.314E+06	-26668.0265	-5.233E-04	16048.6552	-357.5192
207.480	.012506	3.253E+06	-27477.0646	-5.004E-04	15948.1281	-352.1633
209.760	.011391	3.191E+06	-28273.5484	-4.780E-04	15844.5151	-346.5067
212.040	.010327	3.126E+06	-29056.7624	-4.559E-04	15737.8660	-340.5231
214.320	.009312	3.060E+06	-29825.9249	-4.344E-04	15628.2332	-334.1809
216.600	.008346	2.992E+06	-30580.1742	-4.133E-04	15515.6727	-327.4413
218.880	.007428	2.922E+06	-31318.5496	-3.927E-04	15400.2435	-320.2564
221.160	.006556	2.850E+06	-32039.9665	-3.725E-04	15282.0087	-312.5654
223.440	.005729	2.777E+06	-32743.1821	-3.529E-04	15161.0357	-304.2903
225.720	.004946	2.702E+06	-33426.7469	-3.338E-04	15037.3969	-295.3280
228.000	.004207	2.625E+06	-34088.9347	-3.153E-04	14911.1708	-285.5385
230.280	.003509	2.548E+06	-34727.6344	-2.972E-04	14782.4427	-274.7244
232.560	.002851	2.468E+06	-35340.1771	-2.797E-04	14651.3072	-262.5938
234.840	.002233	2.387E+06	-35923.0371	-2.628E-04	14517.8697	-248.6869
237.120	.001653	2.305E+06	-36471.2598	-2.465E-04	14382.2514	-232.2101
239.400	.001109	2.222E+06	-36977.1888	-2.307E-04	14244.5952	-211.5872
241.680	6.01E-04	2.137E+06	-37426.7729	-2.155E-04	14105.0797	-182.7848
243.960	1.27E-04	2.052E+06	-37777.7078	-2.009E-04	13963.9539	-125.0528
246.240	-3.15E-04	1.966E+06	-37741.1117	-1.869E-04	13821.7149	157.1546
248.520	-7.25E-04	1.880E+06	-37339.6390	-1.735E-04	13680.7871	195.0145

250.800	-.001106	1.796E+06	-36868.6559	-1.606E-04	13541.4972	218.1285
253.080	-.001458	1.713E+06	-36297.7236	-1.484E-04	13404.0451	282.6892
255.360	-.001783	1.631E+06	-35634.2130	-1.367E-04	13268.9867	299.3376
257.640	-.002081	1.551E+06	-34935.7940	-1.257E-04	13136.4665	313.3106
259.920	-.002356	1.472E+06	-34207.7026	-1.151E-04	13006.6060	325.3660
262.200	-.002606	1.395E+06	-33453.7842	-1.051E-04	12879.5102	335.9659
264.480	-.002835	1.320E+06	-32677.0102	-9.565E-05	12755.2716	345.4148
266.760	-.003043	1.246E+06	-31879.7623	-8.670E-05	12633.9727	353.9255
269.040	-.003230	1.175E+06	-31064.0027	-7.826E-05	12515.6881	361.6531
271.320	-.003399	1.105E+06	-30231.3829	-7.031E-05	12400.4854	368.7151
273.600	-.003551	1.037E+06	-29383.3166	-6.285E-05	12288.4266	375.2027
275.880	-.003686	971328.8043	-28521.0304	-5.584E-05	12179.5688	381.1886
278.160	-.003806	907379.5486	-27645.6007	-4.929E-05	12073.9645	386.7322
280.440	-.003911	845430.0790	-26757.9801	-4.318E-05	11971.6626	391.8824
282.720	-.004003	785507.8926	-25859.0181	-3.750E-05	11872.7086	396.6808
285.000	-.004082	727638.6332	-24949.4766	-3.222E-05	11777.1447	401.1627
287.280	-.004149	671846.2758	-24030.0421	-2.734E-05	11685.0105	405.3588
289.560	-.004206	618153.2856	-23101.3352	-2.285E-05	11596.3432	409.2963
291.840	-.004254	566580.7583	-22163.9188	-1.872E-05	11511.1775	412.9988
294.120	-.004292	517148.5440	-21218.3037	-1.494E-05	11429.5463	416.4881
296.400	-.004322	469875.3588	-20264.9542	-1.150E-05	11351.4805	419.7834
298.680	-.004344	424778.8853	-19304.2923	-8.378E-06	11277.0093	422.9025
300.960	-.004360	381875.8650	-18336.7010	-5.566E-06	11206.1603	425.8617
303.240	-.004370	341182.1823	-17362.5278	-3.045E-06	11138.9597	428.6761
305.520	-.004374	302712.9431	-16382.0870	-8.001E-07	11075.4325	431.3597
307.800	-.004373	266482.5472	-15395.6618	1.184E-06	11015.6025	433.9255
310.080	-.004368	232504.7561	-14403.5069	2.924E-06	10959.4924	436.3858
312.360	-.004360	200792.7562	-13405.8498	4.434E-06	10907.1239	438.7520
314.640	-.004348	171359.2186	-12402.8928	5.732E-06	10858.5181	441.0348
316.920	-.004334	144216.3544	-11394.8144	6.832E-06	10813.6950	443.2444
319.200	-.004317	119375.9666	-10381.7713	7.751E-06	10772.6742	445.3900
321.480	-.004298	96849.4992	-9363.8991	8.505E-06	10735.4745	447.4803
323.760	-.004278	76648.0820	-8341.3147	9.110E-06	10702.1144	449.5235
326.040	-.004257	58782.5722	-7314.1173	9.582E-06	10672.6117	451.5268
328.320	-.004235	43263.5928	-6282.3902	9.938E-06	10646.9840	453.4969
330.600	-.004212	30101.5662	-5246.2025	1.019E-05	10625.2486	455.4397
332.880	-.004188	19306.7457	-4205.6106	1.037E-05	10607.4223	457.3602
335.160	-.004164	10889.2408	-3160.6604	1.047E-05	10593.5218	459.2627
337.440	-.004140	4859.0402	-2111.3891	1.053E-05	10583.5637	461.1507
339.720	-.004116	1226.0286	-1057.8270	1.055E-05	10577.5642	463.0266
342.000	-.004092	0.0000	0.0000	1.055E-05	10575.5396	464.8918

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.35710873	in
Computed slope at pile head	=	-.00246869	
Maximum bending moment	=	4175795.152	lbs-in
Maximum shear force	=	50500.000	lbs
Depth of maximum bending moment	=	141.360	in
Depth of maximum shear force	=	0.000	in
Number of iterations	=	30	
Number of zero deflection points	=	1	

Summary of Pile-head Response

Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

BC Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 50500.000	M= 0.000	735000.0000	.3571	4.176E+06	50500.0000

The analysis ended normally.

URS

Job SR-1/I-95 Interchange | Project No. | Page ___ of ___
Description Ramp G1 - Pier 2 | Computed by JPK | Sheet ___ of ___
Date 8/22/08
Checked by | Date
Reference

From borings 1BR-15 & 1BR-16 (DONE)
113K 36"φ 0.5" WALL

EL. 65 Depth = 0ft

420 in	1 Clay	γ = 120 pcf c = 1500 psf φ = 0	γ = 0.069 c = 10.4 K = 875 ε = 0.0065
EL. 25	40ft		
EL. 12	53ft	2 Sand γ = 125 pcf c = 0 φ = 35°	
EL. 0	65	3 Sand γ = 115 pcf c = 0 φ = 32°	
EL. -5	70	4 Sand γ = 125 pcf φ = 35° c = 0	
EL. -35	100	5 Sand γ = 130 pcf c = 0 φ = 38°	

ASSUMED
~~EL 30~~ ~~35ft~~

Shear per Pile (See Pier 1) = 50.5K

Axial = 735K

Length Req'd = 23.5 ft

```
==============================================================================

                LPILE Plus for Windows, Version 4.0 (4.0.8)

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

                 (c) Copyright ENSOFT, Inc., 1985-2003
                         All Rights Reserved

==============================================================================

This program is licensed to:

URS
URS

Path to file locations:      D:\Program Files\Ensoft\LpileP4\DelDOTSR1\
Name of input data file:     S5P2.lpd
Name of output file:         S5P2.lpo
Name of plot output file:    S5P2.lpp
Name of runtime file:        S5P2.lpr

------------------------------------------------------------------------------
                          Time and Date of Analysis
------------------------------------------------------------------------------

               Date:  January 22, 2009     Time:  13:44:18

------------------------------------------------------------------------------
                                Problem Title
------------------------------------------------------------------------------

Ramp G1 over SR 7 - Pier 2

------------------------------------------------------------------------------
                                Program Options
------------------------------------------------------------------------------

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          150
- Maximum number of iterations allowed =          100
```

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 282.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	36.000	10900.0000	69.5000	30000000.000
2	282.0000	36.000	10900.0000	69.5000	30000000.000

Soil and Rock Layering Information

The soil profile is modelled using 1 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 420.000 in
p-y subgrade modulus k for top of soil layer = 875.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 875.000 lbs/in**3

(Depth of lowest layer extends 138.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 2 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06900
2	420.00	.06900

Shear Strength of Soils

Distribution of shear strength parameters with depth

defined using 2 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	10.40000	.00	.00650	.0
2	420.000	10.40000	.00	.00650	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

---

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 50500.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 735000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 50500.000 lbs
Specified bending moment at pile head = .000 in-lbs
Specified axial load at pile head = 735000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.155654	1.541E-04	50500.0000	-.001372	10575.5396	-403.3644
1.880	.153075	96122.7628	49738.3990	-.001372	10734.2744	-406.8494
3.760	.150497	190806.7932	48970.3068	-.001371	10890.6334	-410.2700
5.640	.147921	284039.2498	48195.8452	-.001369	11044.5952	-413.6253

7.520	.145349	375807.5325	47415.1376	-.001367	11196.1392	-416.9147
9.400	.142780	466099.2863	46628.3084	-.001365	11345.2448	-420.1375
11.280	.140216	554902.4031	45835.4838	-.001362	11491.8922	-423.2930
13.160	.137658	642205.0249	45036.7909	-.001359	11636.0616	-426.3803
15.040	.135107	727995.5464	44232.3586	-.001355	11777.7340	-429.3988
16.920	.132564	812262.6174	43422.3168	-.001350	11916.8907	-432.3477
18.800	.130030	894995.1457	42606.7971	-.001345	12053.5132	-435.2264
20.680	.127506	976182.2996	41785.9323	-.001340	12187.5837	-438.0341
22.560	.124992	1.056E+06	40959.8565	-.001334	12319.0848	-440.7699
24.440	.122489	1.134E+06	40128.7054	-.001328	12447.9994	-443.4333
26.320	.119999	1.210E+06	39292.6160	-.001321	12574.3110	-446.0235
28.200	.117522	1.285E+06	38451.7265	-.001314	12698.0035	-448.5397
30.080	.115059	1.359E+06	37606.1769	-.001306	12819.0611	-450.9812
31.960	.112610	1.430E+06	36756.1083	-.001298	12937.4687	-453.3472
33.840	.110177	1.500E+06	35901.6633	-.001290	13053.2115	-455.6369
35.720	.107760	1.569E+06	35042.9859	-.001281	13166.2753	-457.8497
37.600	.105360	1.636E+06	34180.2216	-.001272	13276.6461	-459.9847
39.480	.102977	1.701E+06	33313.5172	-.001262	13384.3108	-462.0412
41.360	.100614	1.764E+06	32443.0212	-.001252	13489.2564	-464.0184
43.240	.098269	1.826E+06	31568.8833	-.001242	13591.4705	-465.9155
45.120	.095944	1.887E+06	30691.2548	-.001231	13690.9413	-467.7318
47.000	.093639	1.945E+06	29810.2885	-.001220	13787.6574	-469.4664
48.880	.091355	2.002E+06	28926.1386	-.001209	13881.6078	-471.1186
50.760	.089093	2.057E+06	28038.9610	-.001197	13972.7823	-472.6875
52.640	.086853	2.111E+06	27148.9128	-.001185	14061.1708	-474.1723
54.520	.084636	2.163E+06	26256.1531	-.001173	14146.7642	-475.5722
56.400	.082443	2.213E+06	25360.8421	-.001160	14229.5534	-476.8863
58.280	.080273	2.261E+06	24463.1418	-.001148	14309.5301	-478.1139
60.160	.078128	2.308E+06	23563.2159	-.001134	14386.6867	-479.2540
62.040	.076007	2.353E+06	22661.2296	-.001121	14461.0157	-480.3059
63.920	.073912	2.396E+06	21757.3497	-.001107	14532.5105	-481.2685
65.800	.071843	2.438E+06	20851.7447	-.001094	14601.1649	-482.1411
67.680	.069801	2.478E+06	19944.5849	-.001079	14666.9732	-482.9226
69.560	.067785	2.516E+06	19036.0421	-.001065	14729.9304	-483.6122
71.440	.065796	2.552E+06	18126.2901	-.001050	14790.0319	-484.2090
73.320	.063835	2.587E+06	17215.5043	-.001036	14847.2738	-484.7120
75.200	.061902	2.620E+06	16303.8621	-.001021	14901.6526	-485.1202
77.080	.059997	2.651E+06	15391.5426	-.001006	14953.1657	-485.4325
78.960	.058121	2.680E+06	14478.7267	-9.903E-04	15001.8106	-485.6481
80.840	.056274	2.708E+06	13565.5976	-9.748E-04	15047.5859	-485.7658
82.720	.054456	2.734E+06	12652.3402	-9.591E-04	15090.4904	-485.7846
84.600	.052667	2.758E+06	11739.1414	-9.433E-04	15130.5237	-485.7034
86.480	.050909	2.781E+06	10826.1903	-9.274E-04	15167.6859	-485.5211
88.360	.049180	2.802E+06	9913.6782	-9.114E-04	15201.9779	-485.2365
90.240	.047482	2.821E+06	9001.7984	-8.952E-04	15233.4010	-484.8484
92.120	.045814	2.838E+06	8090.7468	-8.789E-04	15261.9571	-484.3555
94.000	.044177	2.853E+06	7180.7212	-8.626E-04	15287.6491	-483.7568
95.880	.042571	2.867E+06	6271.9222	-8.461E-04	15310.4801	-483.0507
97.760	.040996	2.879E+06	5364.5527	-8.296E-04	15330.4541	-482.2360
99.640	.039452	2.890E+06	4458.8182	-8.130E-04	15347.5757	-481.3113
101.520	.037939	2.898E+06	3554.9271	-7.964E-04	15361.8501	-480.2750
103.400	.036457	2.905E+06	2653.0903	-7.797E-04	15373.2834	-479.1258
105.280	.035007	2.911E+06	1753.5218	-7.630E-04	15381.8821	-477.8620
107.160	.033588	2.914E+06	856.4386	-7.463E-04	15387.6534	-476.4819
109.040	.032201	2.916E+06	-37.9390	-7.295E-04	15390.6055	-474.9837
110.920	.030845	2.916E+06	-929.3876	-7.127E-04	15390.7471	-473.3658
112.800	.029521	2.914E+06	-1817.6801	-6.960E-04	15388.0875	-471.6262
114.680	.028229	2.911E+06	-2702.5857	-6.792E-04	15382.6370	-469.7628
116.560	.026967	2.906E+06	-3583.8697	-6.625E-04	15374.4065	-467.7735
118.440	.025738	2.899E+06	-4461.2934	-6.458E-04	15363.4076	-465.6560
120.320	.024539	2.891E+06	-5334.6135	-6.292E-04	15349.6529	-463.4080
122.200	.023372	2.881E+06	-6203.5822	-6.126E-04	15333.1554	-461.0268
124.080	.022236	2.869E+06	-7067.9467	-5.960E-04	15313.9294	-458.5098

125.960	.021131	2.856E+06	-7927.4486	-5.796E-04	15291.9895	-455.8540
127.840	.020057	2.841E+06	-8781.8242	-5.632E-04	15267.3515	-453.0562
129.720	.019013	2.825E+06	-9630.8034	-5.469E-04	15240.0320	-450.1131
131.600	.018000	2.806E+06	-10474.1094	-5.307E-04	15210.0482	-447.0209
133.480	.017018	2.787E+06	-11311.4582	-5.147E-04	15177.4186	-443.7757
135.360	.016065	2.765E+06	-12142.5581	-4.987E-04	15142.1622	-440.3731
137.240	.015142	2.742E+06	-12967.1087	-4.829E-04	15104.2992	-436.8083
139.120	.014249	2.718E+06	-13784.8000	-4.672E-04	15063.8508	-433.0761
141.000	.013386	2.692E+06	-14595.3120	-4.516E-04	15020.8390	-429.1707
142.880	.012551	2.664E+06	-15398.3130	-4.362E-04	14975.2871	-425.0857
144.760	.011746	2.635E+06	-16193.4586	-4.210E-04	14927.2190	-420.8139
146.640	.010968	2.605E+06	-16980.3901	-4.059E-04	14876.6603	-416.3474
148.520	.010219	2.572E+06	-17758.7331	-3.910E-04	14823.6374	-411.6771
150.400	.009498	2.539E+06	-18528.0949	-3.763E-04	14768.1779	-406.7929
152.280	.008804	2.504E+06	-19288.0625	-3.619E-04	14710.3108	-401.6832
154.160	.008138	2.467E+06	-20038.1995	-3.476E-04	14650.0663	-396.3348
156.040	.007497	2.429E+06	-20778.0425	-3.335E-04	14587.4763	-390.7323
157.920	.006884	2.390E+06	-21507.0973	-3.196E-04	14522.5738	-384.8579
159.800	.006296	2.349E+06	-22224.8329	-3.060E-04	14455.3937	-378.6907
161.680	.005733	2.307E+06	-22930.6757	-2.926E-04	14385.9725	-372.2059
163.560	.005195	2.264E+06	-23624.0008	-2.795E-04	14314.3486	-365.3740
165.440	.004682	2.219E+06	-24304.1220	-2.666E-04	14240.5624	-358.1591
167.320	.004193	2.173E+06	-24970.2778	-2.540E-04	14164.6567	-350.5173
169.200	.003727	2.126E+06	-25621.6140	-2.416E-04	14086.6766	-342.3937
171.080	.003285	2.078E+06	-26257.1598	-2.295E-04	14006.6703	-333.7188
172.960	.002864	2.028E+06	-26875.7940	-2.177E-04	13924.6888	-324.4027
174.840	.002466	1.977E+06	-27476.1986	-2.062E-04	13840.7874	-314.3256
176.720	.002089	1.925E+06	-28056.7886	-1.950E-04	13755.0254	-303.3234
178.600	.001733	1.872E+06	-28615.6051	-1.841E-04	13667.4677	-291.1621
180.480	.001397	1.818E+06	-29150.1379	-1.735E-04	13578.1861	-277.4899
182.360	.001081	1.763E+06	-29657.0141	-1.632E-04	13487.2611	-261.7400
184.240	7.83E-04	1.707E+06	-30131.3769	-1.532E-04	13394.7852	-242.9013
186.120	5.05E-04	1.650E+06	-30565.4230	-1.435E-04	13300.8692	-218.8499
188.000	2.44E-04	1.593E+06	-30943.6074	-1.342E-04	13205.6542	-183.4740
189.880	-4.31E-11	1.534E+06	-31114.9729	-1.252E-04	13109.3475	1.1702
191.760	-2.27E-04	1.476E+06	-30942.5097	-1.166E-04	13013.0274	182.3013
193.640	-4.38E-04	1.418E+06	-30568.0479	-1.083E-04	12917.7520	216.0624
195.520	-6.34E-04	1.361E+06	-30140.9681	-1.003E-04	12823.7191	238.2779
197.400	-8.15E-04	1.305E+06	-29677.1709	-9.259E-05	12731.0591	255.1233
199.280	-9.82E-04	1.250E+06	-29184.7236	-8.525E-05	12639.8710	268.7569
201.160	-.001136	1.196E+06	-28668.6926	-7.822E-05	12550.2351	280.2123
203.040	-.001276	1.142E+06	-28132.6247	-7.150E-05	12462.2190	290.0727
204.920	-.001405	1.090E+06	-27579.1762	-6.508E-05	12375.8810	298.7023
206.800	-.001521	1.039E+06	-27010.4312	-5.896E-05	12291.2721	306.3455
208.680	-.001626	988810.4705	-26428.0818	-5.313E-05	12208.4376	313.1750
210.560	-.001721	939748.6038	-25833.5386	-4.758E-05	12127.4180	319.3178
212.440	-.001805	891807.8681	-25228.0019	-4.232E-05	12048.2498	324.8703
214.320	-.001880	845008.2690	-24612.5106	-3.733E-05	11970.9661	329.9077
216.200	-.001946	799367.9828	-23987.9766	-3.260E-05	11895.5968	334.4901
218.080	-.002003	754903.5680	-23355.2097	-2.813E-05	11822.1693	338.6662
219.960	-.002051	711630.1378	-22714.9360	-2.392E-05	11750.7086	342.4761
221.840	-.002092	669561.5019	-22067.8120	-1.995E-05	11681.2375	345.9536
223.720	-.002126	628710.2851	-21414.4361	-1.621E-05	11613.7767	349.1272
225.600	-.002153	589088.0288	-20755.3564	-1.271E-05	11548.3455	352.0214
227.480	-.002174	550705.2771	-20091.0781	-9.436E-06	11484.9611	354.6575
229.360	-.002189	513571.6522	-19422.0691	-6.377E-06	11423.6395	357.0542
231.240	-.002198	477695.9195	-18748.7641	-3.527E-06	11364.3952	359.2278
233.120	-.002202	443086.0466	-18071.5686	-8.801E-07	11307.2413	361.1930
235.000	-.002201	409749.2542	-17390.8620	1.571E-06	11252.1897	362.9630
236.880	-.002196	377692.0628	-16707.0001	3.835E-06	11199.2512	364.5496
238.760	-.002187	346920.3351	-16020.3176	5.918E-06	11148.4355	365.9637
240.640	-.002174	317439.3137	-15331.1293	7.828E-06	11099.7513	367.2153
242.520	-.002158	289253.6562	-14639.7323	9.572E-06	11053.2062	368.3134

244.400	-.002138	262367.4677	-13946.4071	1.116E-05	11008.8069	369.2665
246.280	-.002116	236784.3306	-13251.4190	1.259E-05	10966.5596	370.0825
248.160	-.002091	212507.3321	-12555.0188	1.388E-05	10926.4691	370.7687
250.040	-.002063	189539.0903	-11857.4442	1.504E-05	10888.5399	371.3320
251.920	-.002034	167881.7784	-11158.9202	1.607E-05	10852.7755	371.7787
253.800	-.002003	147537.1473	-10459.6602	1.697E-05	10819.1789	372.1149
255.680	-.001970	128506.5471	-9759.8667	1.777E-05	10787.7522	372.3463
257.560	-.001936	110790.9467	-9059.7318	1.846E-05	10758.4971	372.4781
259.440	-.001901	94390.9528	-8359.4379	1.905E-05	10731.4145	372.5154
261.320	-.001865	79306.8274	-7659.1587	1.954E-05	10706.5050	372.4625
263.200	-.001827	65538.5035	-6959.0594	1.996E-05	10683.7683	372.3239
265.080	-.001790	53085.6005	-6259.2979	2.030E-05	10663.2039	372.1032
266.960	-.001751	41947.4374	-5560.0251	2.057E-05	10644.8106	371.8040
268.840	-.001712	32123.0451	-4861.3860	2.079E-05	10628.5868	371.4292
270.720	-.001673	23611.1769	-4163.5202	2.095E-05	10614.5305	370.9812
272.600	-.001633	16410.3172	-3466.5634	2.106E-05	10602.6392	370.4622
274.480	-.001594	10518.6887	-2770.6478	2.114E-05	10592.9099	369.8735
276.360	-.001554	5934.2577	-2075.9037	2.119E-05	10585.3393	369.2159
278.240	-.001514	2654.7362	-1382.4606	2.121E-05	10579.9235	368.4895
280.120	-.001474	677.5828	-690.4486	2.122E-05	10576.6585	367.6935
282.000	-.001434	0.0000	0.0000	2.122E-05	10575.5396	366.8263

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	.15565438	in
Computed slope at pile head	=	-.00137183	
Maximum bending moment	=	2915875.651	lbs-in
Maximum shear force	=	50500.000	lbs
Depth of maximum bending moment	=	110.920	in
Depth of maximum shear force	=	0.000	in
Number of iterations	=	29	
Number of zero deflection points	=	1	

Summary of Pile-head Response

Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

BC Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 50500.000	M= 0.000	735000.0000	.1557	2.916E+06	50500.0000

The analysis ended normally.

URS

Job SR-1/I-95 Interchange | Project No. | Page ___ of ___
Description Ramp G1 - Pier 3 SR7 | Computed by JPK | Sheet ___ of ___
Checked by | Date 8/22/08
Reference

From boring 1BR-06 (DONE)

1131K 36"φ 0.625" WALL

EL. 60 Depth=0ft

1 Clay γ=120pcf c=1500 psf φ=0

γ=0.069
c=10.4
K=875
ε=0.0065

EL 40 20ft

x=240in

2 Clay γ=125pcf c=2500 psf φ=0

γ=0.072K=1500
c=17.4 ε=0.005

ASSUMED

EL 30 30ft

x=360in

EL 10 50ft

3 Clay γ=125pcf c=3000psf φ=0

EL 2 58ft

4 Sand γ=120pcf c=0 φ=33°

EL-10 70ft

5 Sand γ=125pcf c=0 φ=35°

EL-20 80ft

6 Sand γ=120pcf c=0 φ=33°

EL-35 95ft

Shear per pile (See Pier 1) = 50.5K

Axial = 735K

Length Req'd = 22.5ft

```
================================================================================

                LPILE Plus for Windows, Version 4.0 (4.0.8)

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

                 (c) Copyright ENSOFT, Inc., 1985-2003
                         All Rights Reserved

================================================================================

This program is licensed to:

URS
URS

Path to file locations:      D:\Program Files\Ensoft\LpileP4\DelDOTSR1\
Name of input data file:     S5P3.lpd
Name of output file:         S5P3.lpo
Name of plot output file:    S5P3.lpp
Name of runtime file:        S5P3.lpr

--------------------------------------------------------------------------------
                          Time and Date of Analysis
--------------------------------------------------------------------------------

               Date:  January 22, 2009     Time:  13:48:43

--------------------------------------------------------------------------------
                                Problem Title
--------------------------------------------------------------------------------

Ramp G1 over SR 7 - Pier 3

--------------------------------------------------------------------------------
                                Program Options
--------------------------------------------------------------------------------

Units Used in Computations - US Customary Units, inches, pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          150
- Maximum number of iterations allowed =          100
```

- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 270.00 in
Depth of ground surface below top of pile = .00 in
Slope angle of ground surface = .00 deg.

Structural properties of pile defined using 2 points

Point	Depth X in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	36.000	10900.0000	69.5000	30000000.000
2	270.0000	36.000	10900.0000	69.5000	30000000.000

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = .000 in
Distance from top of pile to bottom of layer = 240.000 in
p-y subgrade modulus k for top of soil layer = 875.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 875.000 lbs/in**3

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 240.000 in
Distance from top of pile to bottom of layer = 360.000 in
p-y subgrade modulus k for top of soil layer = 1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 1500.000 lbs/in**3

(Depth of lowest layer extends 90.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Distribution of effective unit weight of soil with depth
is defined using 4 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	.00	.06900
2	240.00	.06900
3	240.00	.07200
4	360.00	.07200

Shear Strength of Soils

Distribution of shear strength parameters with depth
defined using 4 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	.000	10.40000	.00	.00650	.0
2	240.000	10.40000	.00	.00650	.0
3	240.000	17.40000	.00	.00500	.0
4	360.000	17.40000	.00	.00500	.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 50500.000 lbs
Bending moment at pile head = .000 in-lbs
Axial load at pile head = 735000.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

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

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Specified shear force at pile head = 50500.000 lbs
Specified bending moment at pile head = .000 in-lbs
Specified axial load at pile head = 735000.000 lbs

(Zero moment for this load indicates free-head conditions)

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res p lbs/in
0.000	.156567	5.603E-05	50500.0000	-.001375	10575.5396	-403.9523
1.800	.154091	92064.9587	49769.8722	-.001375	10727.5734	-407.3007
3.600	.151617	182809.5926	49033.7703	-.001374	10877.4270	-410.5903
5.400	.149144	272222.5826	48291.8007	-.001373	11025.0814	-413.8204
7.200	.146674	360292.8120	47544.0711	-.001371	11170.5185	-416.9903
9.000	.144208	447009.3690	46790.6903	-.001369	11313.7202	-420.0994
10.800	.141746	532361.5485	46031.7684	-.001366	11454.6687	-423.1472
12.600	.139290	616338.8542	45267.4163	-.001363	11593.3469	-426.1329
14.400	.136839	698931.0008	44497.7464	-.001359	11729.7376	-429.0559
16.200	.134395	780127.9162	43722.8720	-.001355	11863.8242	-431.9156
18.000	.131960	859919.7435	42942.9076	-.001351	11995.5905	-434.7114
19.800	.129532	938296.8434	42157.9689	-.001346	12125.0206	-437.4427
21.600	.127114	1.015E+06	41368.1727	-.001341	12252.0989	-440.1087
23.400	.124706	1.091E+06	40573.6369	-.001335	12376.8101	-442.7089
25.200	.122309	1.165E+06	39774.4806	-.001329	12499.1396	-445.2426
27.000	.119923	1.237E+06	38970.8241	-.001322	12619.0728	-447.7091
28.800	.117550	1.309E+06	38162.7888	-.001315	12736.5957	-450.1079
30.600	.115190	1.378E+06	37350.4972	-.001308	12851.6945	-452.4383
32.400	.112843	1.447E+06	36534.0731	-.001300	12964.3561	-454.6996
34.200	.110510	1.513E+06	35713.6414	-.001292	13074.5673	-456.8912
36.000	.108193	1.579E+06	34889.3282	-.001283	13182.3158	-459.0124
37.800	.105891	1.642E+06	34061.2608	-.001274	13287.5894	-461.0626
39.600	.103606	1.705E+06	33229.5675	-.001265	13390.3763	-463.0410
41.400	.101337	1.765E+06	32394.3782	-.001255	13490.6653	-464.9471
43.200	.099086	1.824E+06	31555.8236	-.001246	13588.4453	-466.7802
45.000	.096853	1.882E+06	30714.0358	-.001235	13683.7060	-468.5396
46.800	.094638	1.938E+06	29869.1481	-.001225	13776.4370	-470.2245
48.600	.092443	1.993E+06	29021.2951	-.001214	13866.6289	-471.8344
50.400	.090268	2.046E+06	28170.6125	-.001203	13954.2723	-473.3685
52.200	.088113	2.098E+06	27317.2374	-.001192	14039.3583	-474.8261
54.000	.085978	2.148E+06	26461.3080	-.001180	14121.8785	-476.2065
55.800	.083865	2.196E+06	25602.9640	-.001168	14201.8250	-477.5091
57.600	.081774	2.243E+06	24742.3462	-.001156	14279.1902	-478.7330
59.400	.079705	2.288E+06	23879.5967	-.001143	14353.9670	-479.8775
61.200	.077658	2.332E+06	23014.8591	-.001131	14426.1487	-480.9420
63.000	.075635	2.374E+06	22148.2782	-.001118	14495.7291	-481.9256
64.800	.073635	2.414E+06	21280.0002	-.001104	14562.7024	-482.8277
66.600	.071659	2.453E+06	20410.1727	-.001091	14627.0634	-483.6474
68.400	.069707	2.491E+06	19538.9445	-.001077	14688.8071	-484.3839
70.200	.067780	2.527E+06	18666.4661	-.001064	14747.9291	-485.0365
72.000	.065878	2.561E+06	17792.8893	-.001050	14804.4256	-485.6044
73.800	.064002	2.593E+06	16918.3673	-.001035	14858.2932	-486.0867
75.600	.062151	2.624E+06	16043.0549	-.001021	14909.5287	-486.4826
77.400	.060326	2.654E+06	15167.1084	-.001006	14958.1298	-486.7913
79.200	.058528	2.682E+06	14290.6856	-9.918E-04	15004.0943	-487.0118
81.000	.056756	2.708E+06	13413.9458	-9.770E-04	15047.4210	-487.1434
82.800	.055011	2.733E+06	12537.0502	-9.620E-04	15088.1086	-487.1851
84.600	.053293	2.756E+06	11660.1613	-9.469E-04	15126.1566	-487.1359
86.400	.051602	2.777E+06	10783.4435	-9.317E-04	15161.5652	-486.9950
88.200	.049939	2.797E+06	9907.0629	-9.163E-04	15194.3346	-486.7613
90.000	.048303	2.815E+06	9031.1874	-9.009E-04	15224.4661	-486.4338
91.800	.046695	2.832E+06	8155.9865	-8.853E-04	15251.9610	-486.0116
93.600	.045116	2.847E+06	7281.6320	-8.697E-04	15276.8216	-485.4935
95.400	.043565	2.860E+06	6408.2972	-8.540E-04	15299.0502	-484.8785
97.200	.042042	2.872E+06	5536.1576	-8.382E-04	15318.6502	-484.1654
99.000	.040547	2.882E+06	4665.3909	-8.224E-04	15335.6251	-483.3531
100.800	.039081	2.891E+06	3796.1767	-8.065E-04	15349.9791	-482.4404

102.600	.037644	2.898E+06	2928.6970	-7.906E-04	15361.7171	-481.4260
104.400	.036235	2.904E+06	2063.1359	-7.746E-04	15370.8444	-480.3086
106.200	.034855	2.908E+06	1199.6801	-7.586E-04	15377.3670	-479.0868
108.000	.033504	2.910E+06	338.5187	-7.426E-04	15381.2912	-477.7592
109.800	.032182	2.911E+06	-520.1566	-7.266E-04	15382.6242	-476.3245
111.600	.030888	2.910E+06	-1376.1514	-7.105E-04	15381.3736	-474.7809
113.400	.029624	2.908E+06	-2229.2683	-6.945E-04	15377.5477	-473.1268
115.200	.028388	2.904E+06	-3079.3070	-6.785E-04	15371.1554	-471.3606
117.000	.027181	2.899E+06	-3926.0641	-6.626E-04	15362.2062	-469.4805
118.800	.026003	2.892E+06	-4769.3326	-6.466E-04	15350.7102	-467.4845
120.600	.024853	2.883E+06	-5608.9023	-6.307E-04	15336.6782	-465.3706
122.400	.023732	2.873E+06	-6444.5589	-6.149E-04	15320.1215	-463.1367
124.200	.022640	2.862E+06	-7276.0843	-5.991E-04	15301.0523	-460.7804
126.000	.021576	2.848E+06	-8103.2562	-5.834E-04	15279.4833	-458.2994
127.800	.020540	2.834E+06	-8925.8475	-5.677E-04	15255.4280	-455.6910
129.600	.019532	2.818E+06	-9743.6264	-5.522E-04	15228.9003	-452.9523
131.400	.018552	2.800E+06	-10556.3559	-5.367E-04	15199.9153	-450.0804
133.200	.017600	2.781E+06	-11363.7930	-5.214E-04	15168.4885	-447.0720
135.000	.016675	2.761E+06	-12165.6889	-5.061E-04	15134.6362	-443.9234
136.800	.015778	2.739E+06	-12961.7877	-4.910E-04	15098.3755	-440.6309
138.600	.014907	2.715E+06	-13751.8267	-4.760E-04	15059.7243	-437.1902
140.400	.014064	2.691E+06	-14535.5349	-4.611E-04	15018.7013	-433.5966
142.200	.013247	2.664E+06	-15312.6324	-4.463E-04	14975.3259	-429.8451
144.000	.012457	2.637E+06	-16082.8300	-4.318E-04	14929.6187	-425.9299
145.800	.011693	2.608E+06	-16845.8273	-4.173E-04	14881.6008	-421.8449
147.600	.010955	2.577E+06	-17601.3124	-4.031E-04	14831.2945	-417.5830
149.400	.010242	2.545E+06	-18348.9598	-3.890E-04	14778.7230	-413.1363
151.200	.009555	2.512E+06	-19088.4288	-3.750E-04	14723.9103	-408.4960
153.000	.008892	2.478E+06	-19819.3621	-3.613E-04	14666.8819	-403.6521
154.800	.008254	2.442E+06	-20541.3828	-3.478E-04	14607.6639	-398.5931
156.600	.007640	2.405E+06	-21254.0920	-3.344E-04	14546.2838	-393.3060
158.400	.007050	2.366E+06	-21957.0654	-3.213E-04	14482.7705	-387.7756
160.200	.006483	2.326E+06	-22649.8492	-3.084E-04	14417.1540	-381.9842
162.000	.005940	2.285E+06	-23331.9551	-2.957E-04	14349.4657	-375.9112
163.800	.005419	2.243E+06	-24002.8541	-2.832E-04	14279.7386	-369.5321
165.600	.004920	2.200E+06	-24661.9686	-2.710E-04	14208.0074	-362.8175
167.400	.004443	2.155E+06	-25308.6631	-2.590E-04	14134.3085	-355.7319
169.200	.003988	2.109E+06	-25942.2304	-2.473E-04	14058.6803	-348.2318
171.000	.003553	2.062E+06	-26561.8758	-2.358E-04	13981.1635	-340.2630
172.800	.003139	2.014E+06	-27166.6936	-2.246E-04	13901.8014	-331.7568
174.600	.002745	1.965E+06	-27755.6364	-2.136E-04	13820.6401	-322.6241
176.400	.002370	1.915E+06	-28327.4704	-2.029E-04	13737.7289	-312.7470
178.200	.002014	1.864E+06	-28880.7104	-1.925E-04	13653.1213	-301.9640
180.000	.001677	1.811E+06	-29413.5187	-1.824E-04	13566.8757	-290.0452
181.800	.001357	1.758E+06	-29923.5413	-1.726E-04	13479.0564	-276.6465
183.600	.001055	1.704E+06	-30407.6175	-1.631E-04	13389.7358	-261.2160
185.400	7.70E-04	1.649E+06	-30861.2096	-1.538E-04	13298.9971	-242.7752
187.200	5.02E-04	1.593E+06	-31277.0706	-1.449E-04	13206.9395	-219.2926
189.000	2.49E-04	1.537E+06	-31640.9862	-1.363E-04	13113.6895	-185.0581
190.800	1.10E-05	1.480E+06	-31885.2445	-1.280E-04	13019.4309	-86.3401
192.600	-2.12E-04	1.423E+06	-31801.3770	-1.200E-04	12924.6925	179.5263
194.400	-4.21E-04	1.366E+06	-31446.9287	-1.123E-04	12830.8976	214.3051
196.200	-6.16E-04	1.310E+06	-31040.7442	-1.050E-04	12738.2328	237.0110
198.000	-7.99E-04	1.254E+06	-30598.6305	-9.792E-05	12646.8204	254.2264
199.800	-9.69E-04	1.200E+06	-30128.4501	-9.116E-05	12556.7532	268.1962
201.600	-.001127	1.146E+06	-29635.0878	-8.470E-05	12468.1065	279.9842
203.400	-.001274	1.093E+06	-29121.9336	-7.854E-05	12380.9441	290.1871
205.200	-.001410	1.041E+06	-28591.5063	-7.267E-05	12295.3211	299.1765
207.000	-.001536	990535.5895	-28045.7663	-6.707E-05	12211.2864	307.2013
208.800	-.001651	940636.0078	-27486.2916	-6.176E-05	12128.8834	314.4373
210.600	-.001758	891748.3525	-26914.3855	-5.672E-05	12048.1515	321.0139
212.400	-.001856	843894.2882	-26331.1461	-5.194E-05	11969.1265	327.0298
214.200	-.001945	797093.6546	-25737.5135	-4.742E-05	11891.8410	332.5620

216.000	-.002026	751364.7172	-25134.3025	-4.316E-05	11816.3253	337.6724
217.800	-.002100	706724.3664	-24522.2272	-3.915E-05	11742.6073	342.4113
219.600	-.002167	663188.2815	-23901.9184	-3.538E-05	11670.7129	346.8207
221.400	-.002228	620771.0660	-23273.9372	-3.184E-05	11600.6661	350.9361
223.200	-.002282	579486.3627	-22638.7858	-2.854E-05	11532.4895	354.7877
225.000	-.002330	539346.9513	-21996.9151	-2.546E-05	11466.2043	358.4019
226.800	-.002373	500364.8344	-21348.7317	-2.260E-05	11401.8301	361.8018
228.600	-.002412	462551.3115	-20694.6029	-1.995E-05	11339.3858	365.0080
230.400	-.002445	425917.0460	-20034.8609	-1.750E-05	11278.8888	368.0387
232.200	-.002475	390472.1241	-19369.8064	-1.526E-05	11220.3559	370.9107
234.000	-.002500	356226.1092	-18699.7115	-1.320E-05	11163.8029	373.6391
235.800	-.002522	323188.0909	-18024.8222	-1.133E-05	11109.2447	376.2379
237.600	-.002541	291366.7299	-17345.3600	-9.639E-06	11056.6956	378.7201
239.400	-.002557	260770.3000	-16661.5241	-8.119E-06	11006.1694	381.0976
241.200	-.002570	231406.7272	-15845.3552	-6.765E-06	10957.6791	525.7567
243.000	-.002581	203744.9208	-14895.9653	-5.567E-06	10911.9991	529.1211
244.800	-.002590	177795.9829	-13940.6086	-4.517E-06	10869.1476	532.3863
246.600	-.002598	153570.6818	-12979.4526	-3.605E-06	10829.1425	535.5648
248.400	-.002603	131079.4924	-12012.6430	-2.822E-06	10792.0011	538.6681
250.200	-.002608	110332.6330	-11040.3055	-2.157E-06	10757.7402	541.7069
252.000	-.002611	91340.1004	-10062.5473	-1.602E-06	10726.3764	544.6911
253.800	-.002613	74111.7019	-9079.4584	-1.147E-06	10697.9259	547.6299
255.600	-.002615	58657.0845	-8091.1131	-7.813E-07	10672.4045	550.5315
257.400	-.002616	44985.7620	-7097.5715	-4.960E-07	10649.8280	553.4036
259.200	-.002617	33107.1395	-6098.8808	-2.811E-07	10630.2119	556.2528
261.000	-.002617	23030.5349	-5095.0766	-1.266E-07	10613.5716	559.0851
262.800	-.002617	14765.1985	-4086.1849	-2.255E-08	10599.9225	561.9056
264.600	-.002617	8320.3289	-3072.2231	4.099E-08	10589.2796	564.7185
266.400	-.002617	3705.0867	-2053.2020	7.409E-08	10581.6581	567.5272
268.200	-.002617	928.6057	-1029.1269	8.684E-08	10577.0730	570.3340
270.000	-.002617	0.0000	0.0000	8.940E-08	10575.5396	573.1404

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection              =      .15656665 in
Computed slope at pile head       =     -.00137518
Maximum bending moment            =    2910956.785 lbs-in
Maximum shear force               =      50500.000 lbs
Depth of maximum bending moment   =        109.800 in
Depth of maximum shear force      =          0.000 in
Number of iterations              =             31
Number of zero deflection points  =              1
```

Summary of Pile-head Response

Definition of symbols for pile-head boundary conditions:

y = pile-head displacment, in
M = pile-head moment, lbs-in
V = pile-head shear force, lbs
S = pile-head slope, radians
R = rotational stiffness of pile-head, in-lbs/rad

BC Type	Boundary Condition 1	Boundary Condition 2	Axial Load lbs	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 50500.000	M= 0.000	735000.0000	.1566	2.911E+06	50500.0000

The analysis ended normally.