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SR 1 / I-95 Interchange
MSE Retaining Wall 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 check 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.

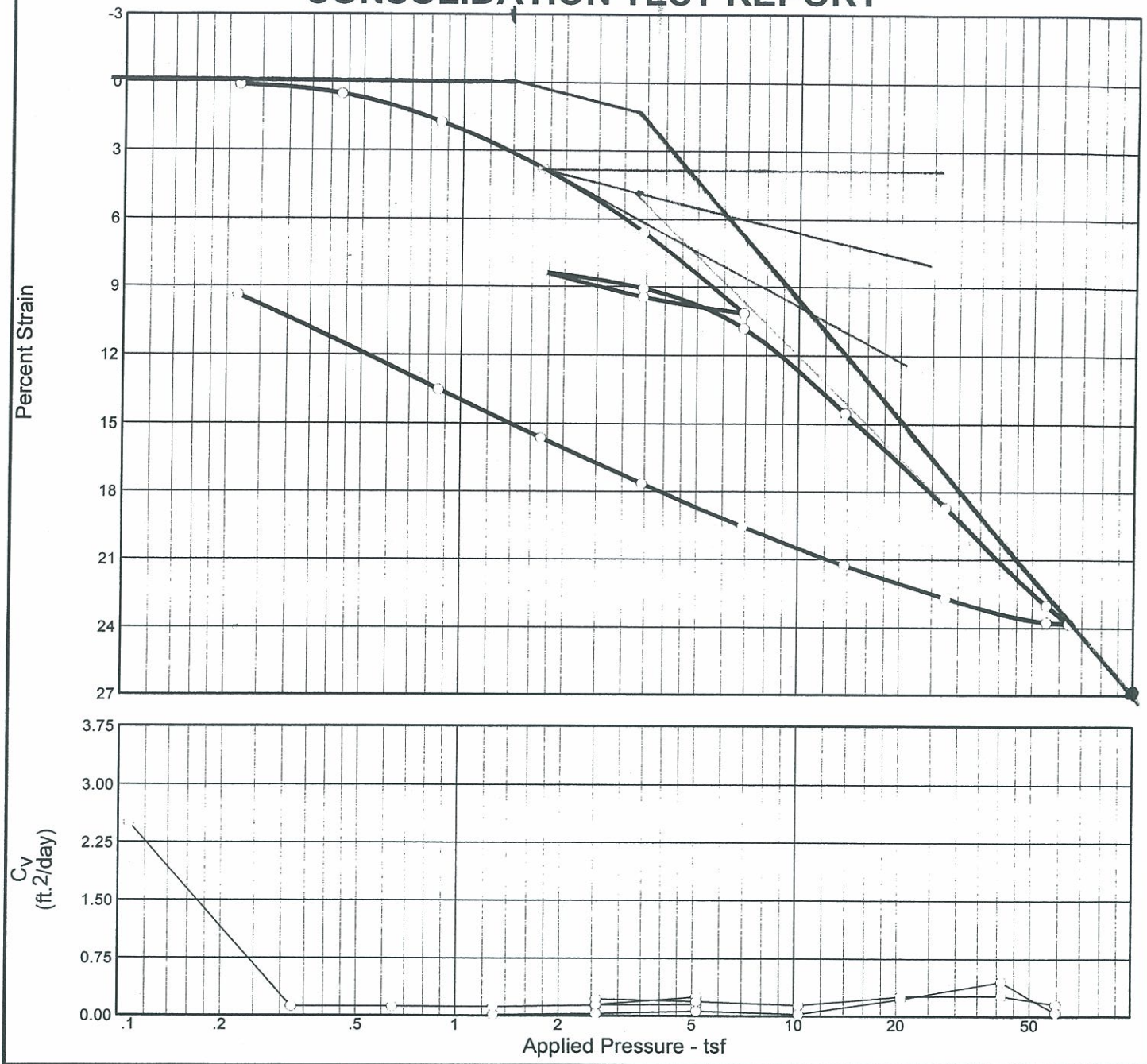
Interchange Reconstruction: Delaware Route 1 and Interstate I-95
Consolidated Undrained Test Summary

	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

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Swell %	e_o
Sat.	Moist.											
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

CONSOLIDATION TEST REPORT

Delaware Department of Transportation
Materials and Research Laboratory

Remarks:

Figure

URS

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

Test @ URS-4 U-1 @ 22 ft

$e_o = 0.851$

$0.42\, e_o = 0.357$

$\Delta e = 0.851 - 0.357$

$= 0.494$

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

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

$C_r = RR(1+e_o)$

$= 0.0349(1+0.851)$

$= 0.0646$

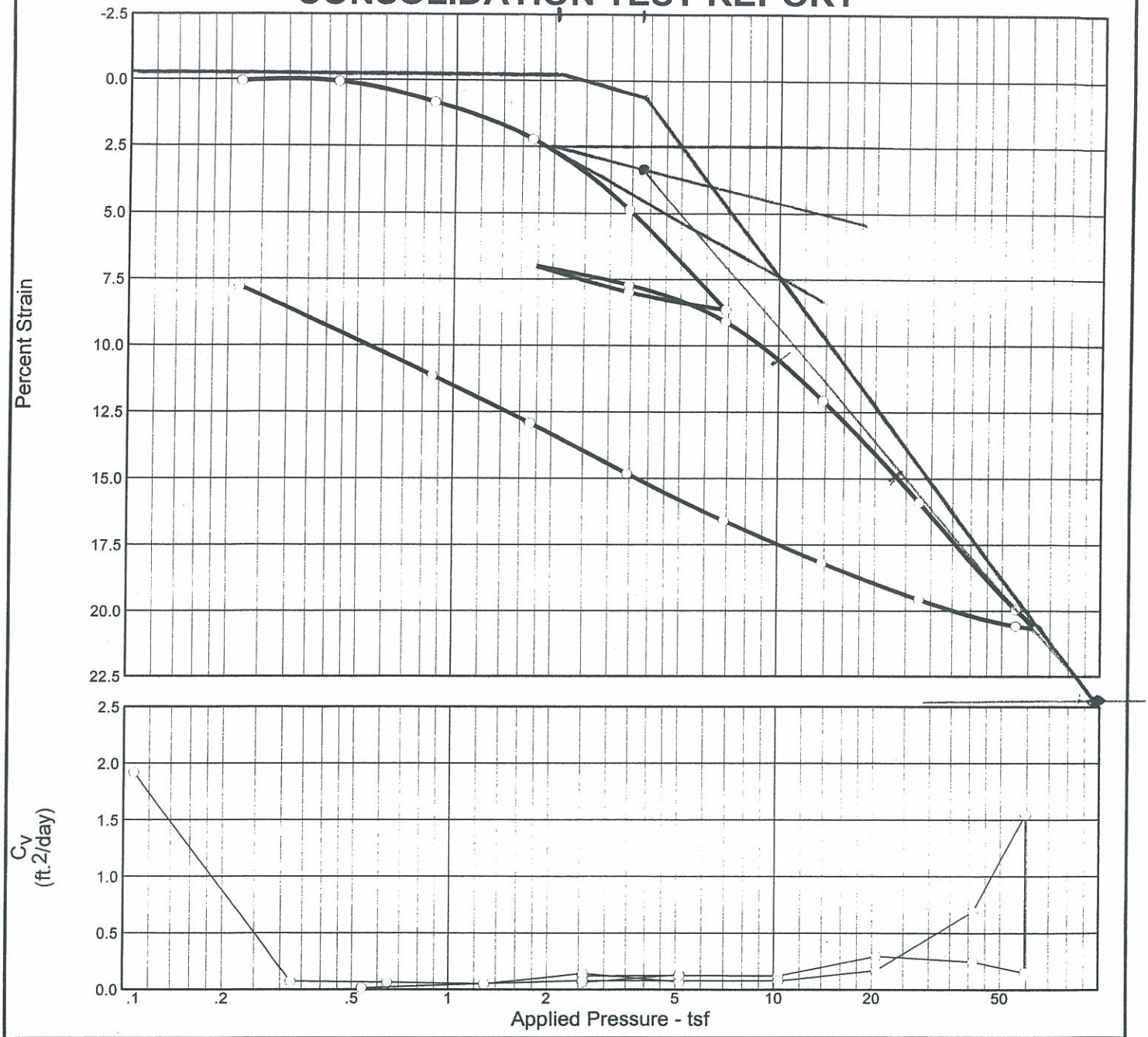
$CR = \frac{0.27 - 0.01}{\log \frac{100}{3.48}} = 0.178$

$C_c = CR(1+e_o)$

$= 0.178(1+0.851) = 0.329$

$p_o = 2.1$ tsf $p_c = 3.8$ tsf

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

CONSOLIDATION TEST REPORT

Delaware Department of Transportation
Materials and Research Laboratory

Remarks:

Figure

URS-6

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%

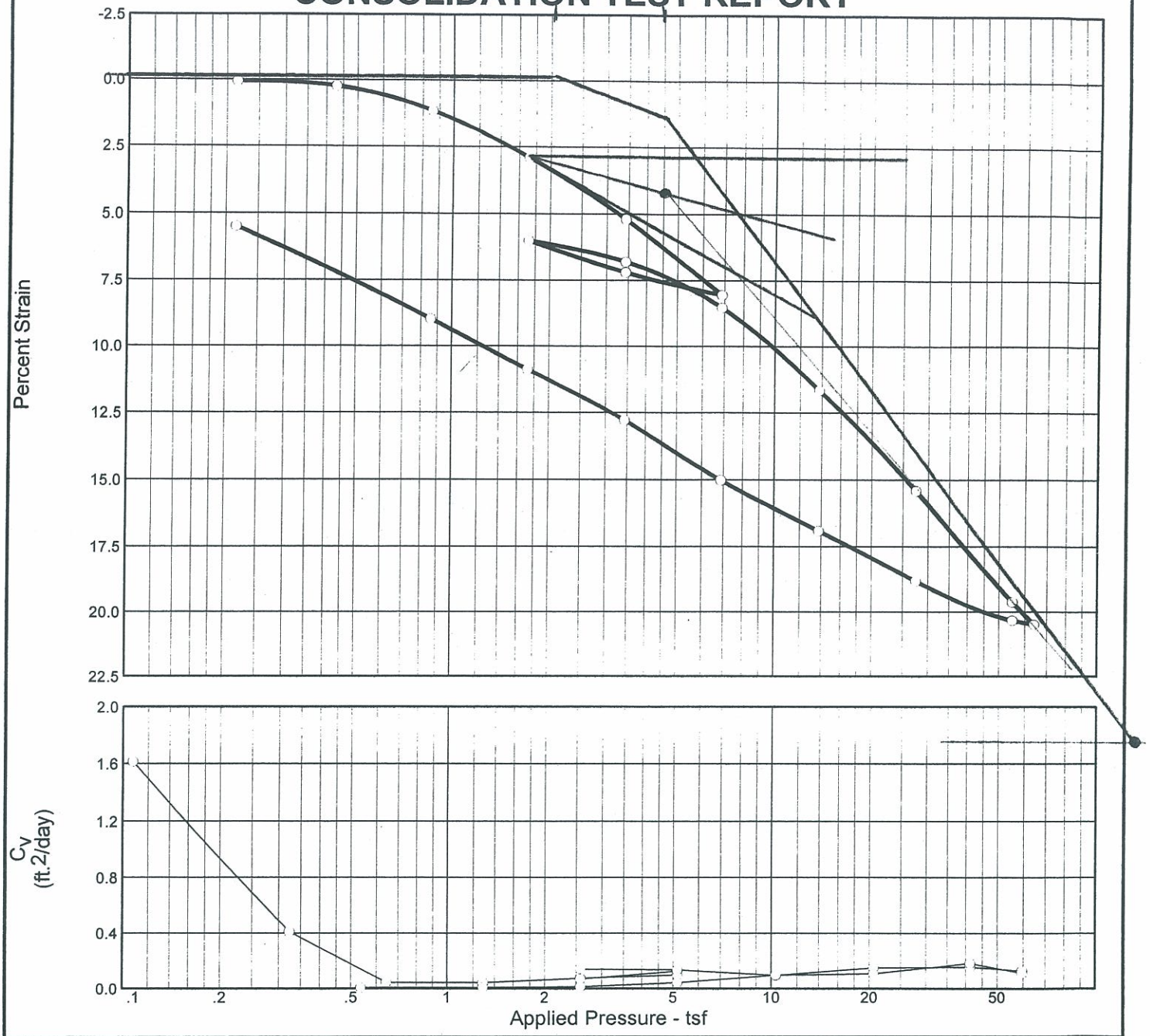
$RR = \frac{\Delta \varepsilon}{\log \frac{\sigma_f}{\sigma}} = \frac{0.089 - 0.07}{\log \frac{6.88}{1.72}} = 0.0316$

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

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

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

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Swell %	e_o
Sat.	Moist.											
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

CONSOLIDATION TEST REPORT

Delaware Department of Transportation
Materials and Research Laboratory

Remarks:

Figure

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%

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

$C_r = RR(1 + e_o)$

$= 0.0382(1 + 0.786) = 0.0682$

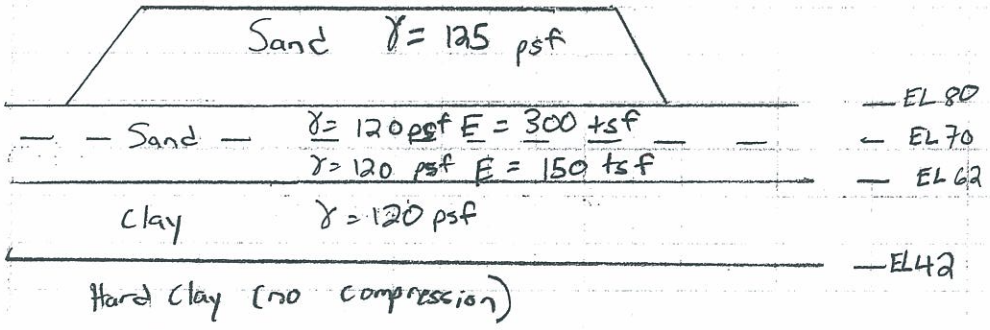
$CR = \frac{0.225 - 0.0125}{\log \frac{90}{4.5}} = 0.1633$

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

Test Embankment Back Calculation

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 See attached profile
IEB-13B
IEB-13A

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 ft (125 psf) = 3,625 psf = 1.813 tsf
σ_o = 120 psf (18 ft) + 125 psf (10 ft) = 3410 psf = 1.705 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)

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

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

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

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

$$= 0.1696\ ft$$

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

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**

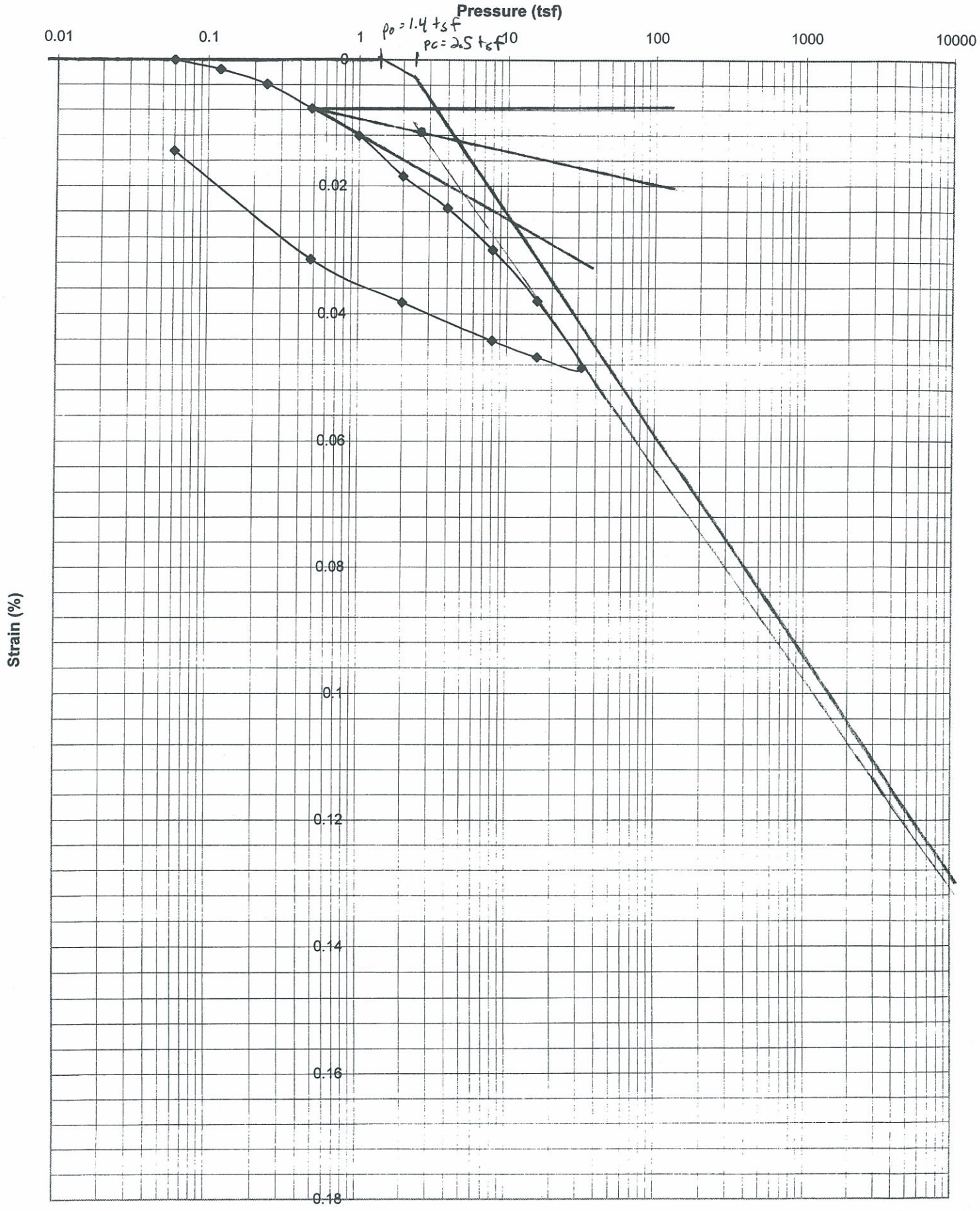
Compute Global Values for Plane Strain Case		
σ'_{vo} at Elevation	80	0 psf
Elev. of I_{zp}		5 feet
σ'_{vp} at elevation	5	9000 psf
I_{zp}		0.563
C_1		1.00
C_2		1.20

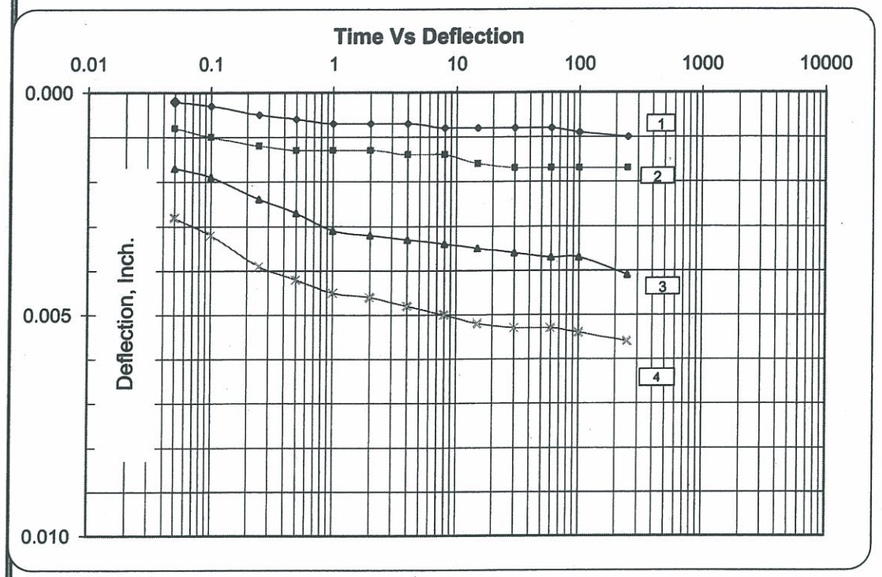
Computed Plane Strain Layer Information

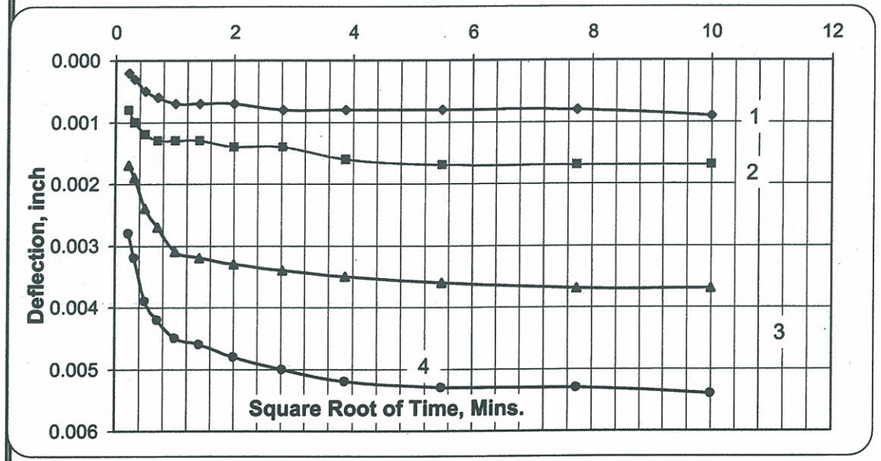
Layer No.	Elev. Of Top of layer (ft)	Elev. Of Bottom of layer (ft)	Soil Modulus E_s (tsf)	Total Unit Weight, γ_T (pcf)	Δz (ft)	Elev. Of Center of Layer (ft)	I_z	ε	ΔH (inches)
1	80	70	300	120	10	75	0.22	0.14%	0.16
2	70	65	150	120	5	67.5	0.26	0.31%	0.19
3	65	62	150	120	3	63.5	0.28	0.34%	0.12
4								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

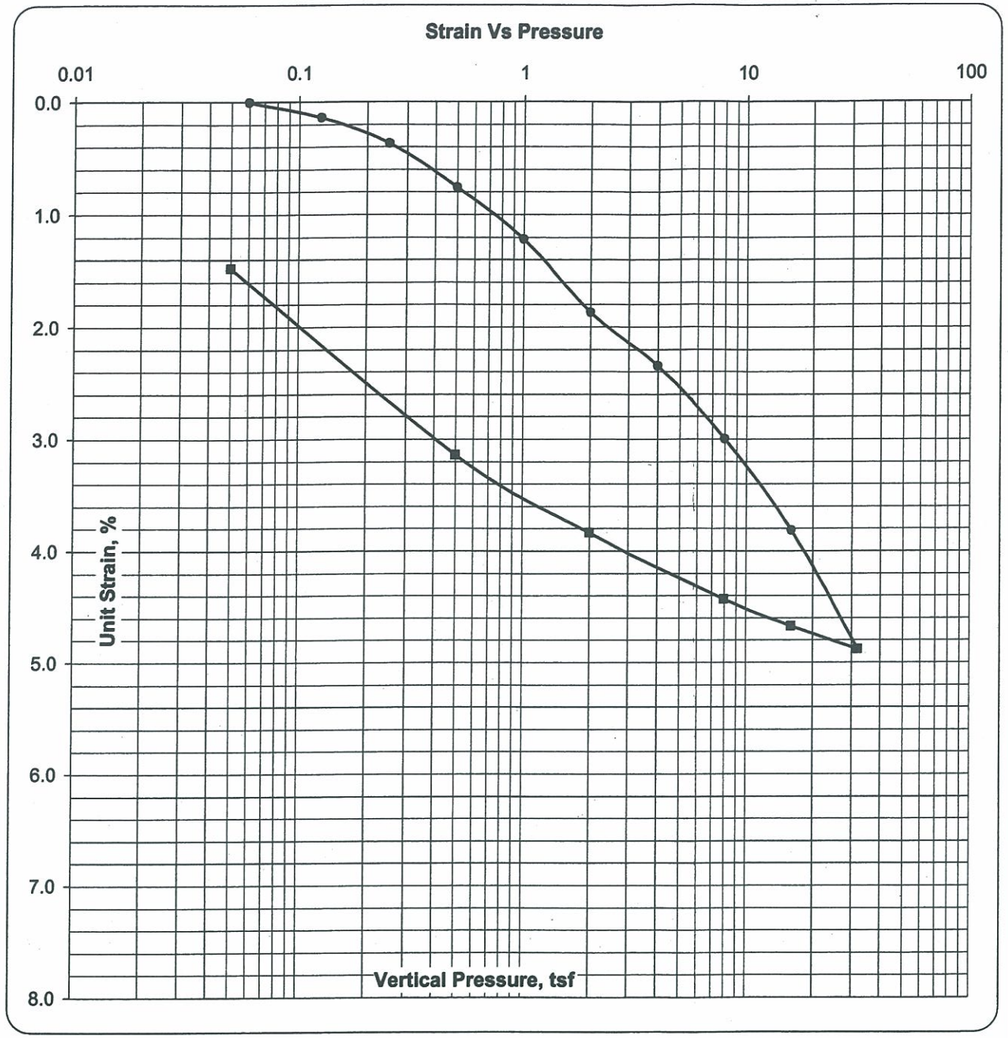
Immediate Settlement			0.5 inches
Settlement After	1	year	0.6 inches

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

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$e_o = 0.454$

$0.42\,e_o = 0.191$

$\Delta e = 0.454 - 0.191 = 0.263$

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

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

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

$RR = 0.012$

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

$C_r = 0.017$

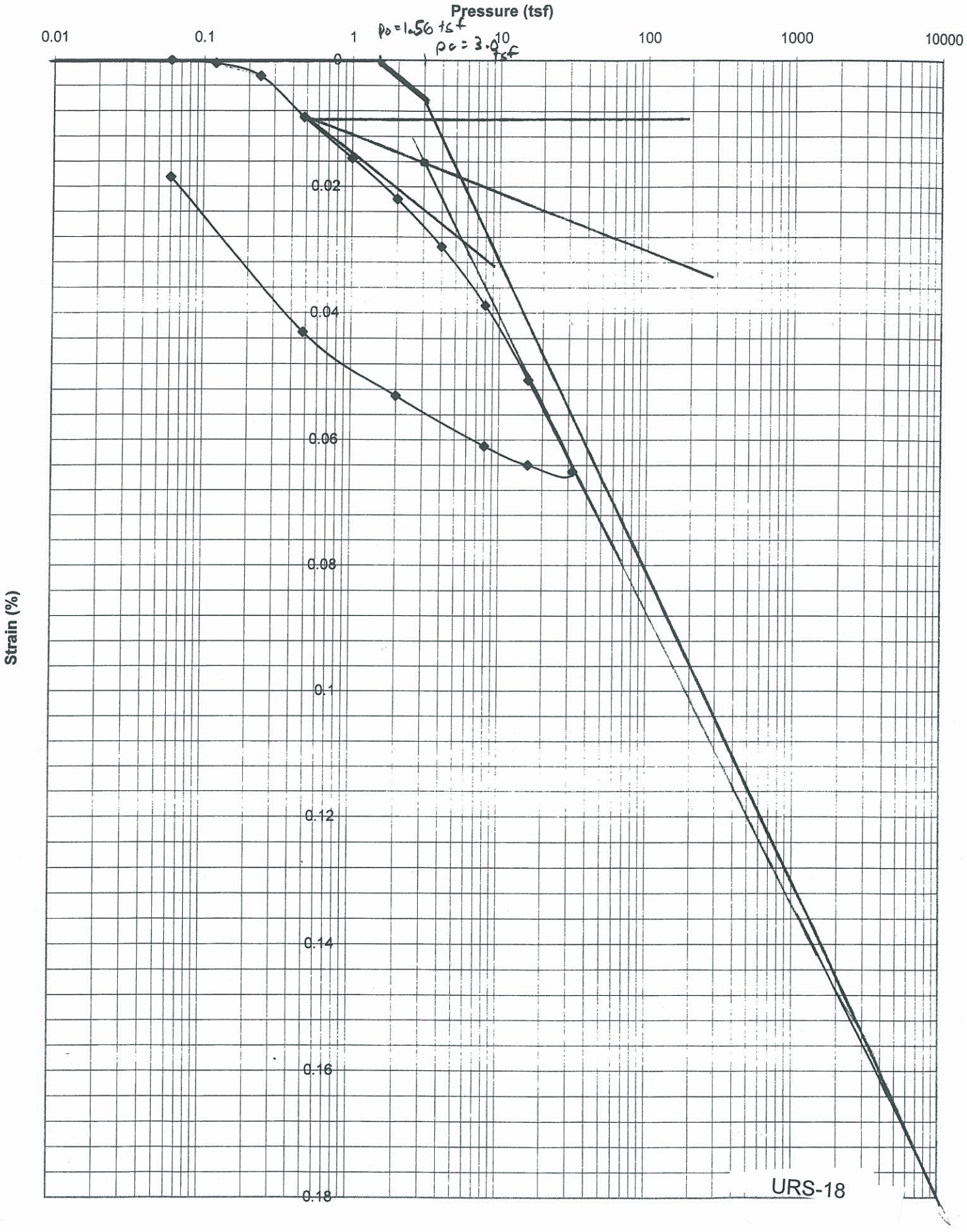
$CR = \frac{0.128 - 0.002}{\log \frac{10000}{2.5}}$

$= 0.035$

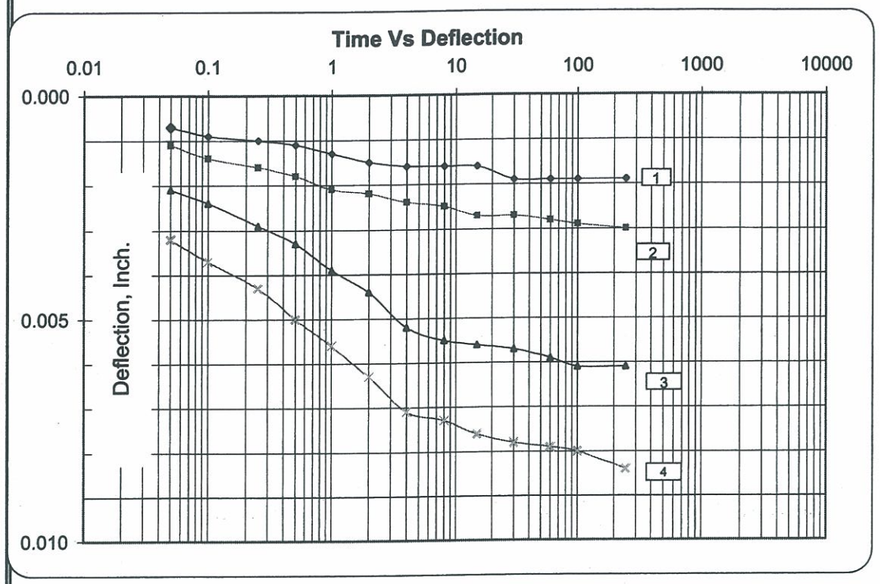
$C_c = CR(1+e_o)$

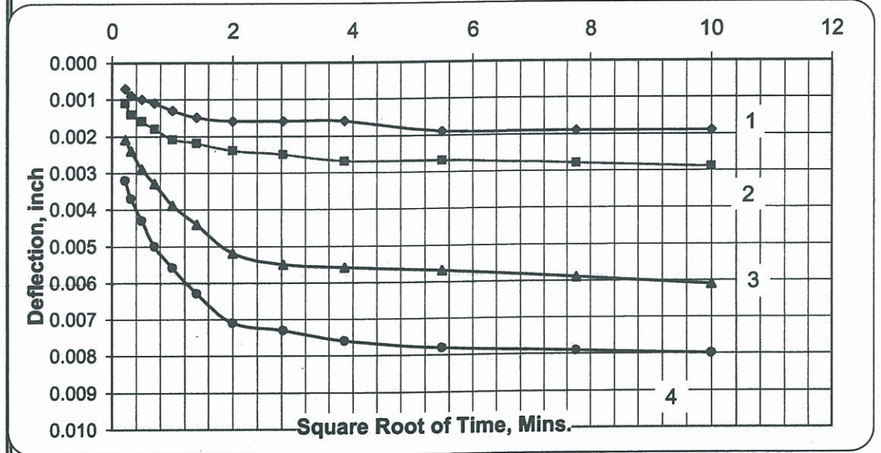
$= 0.051$

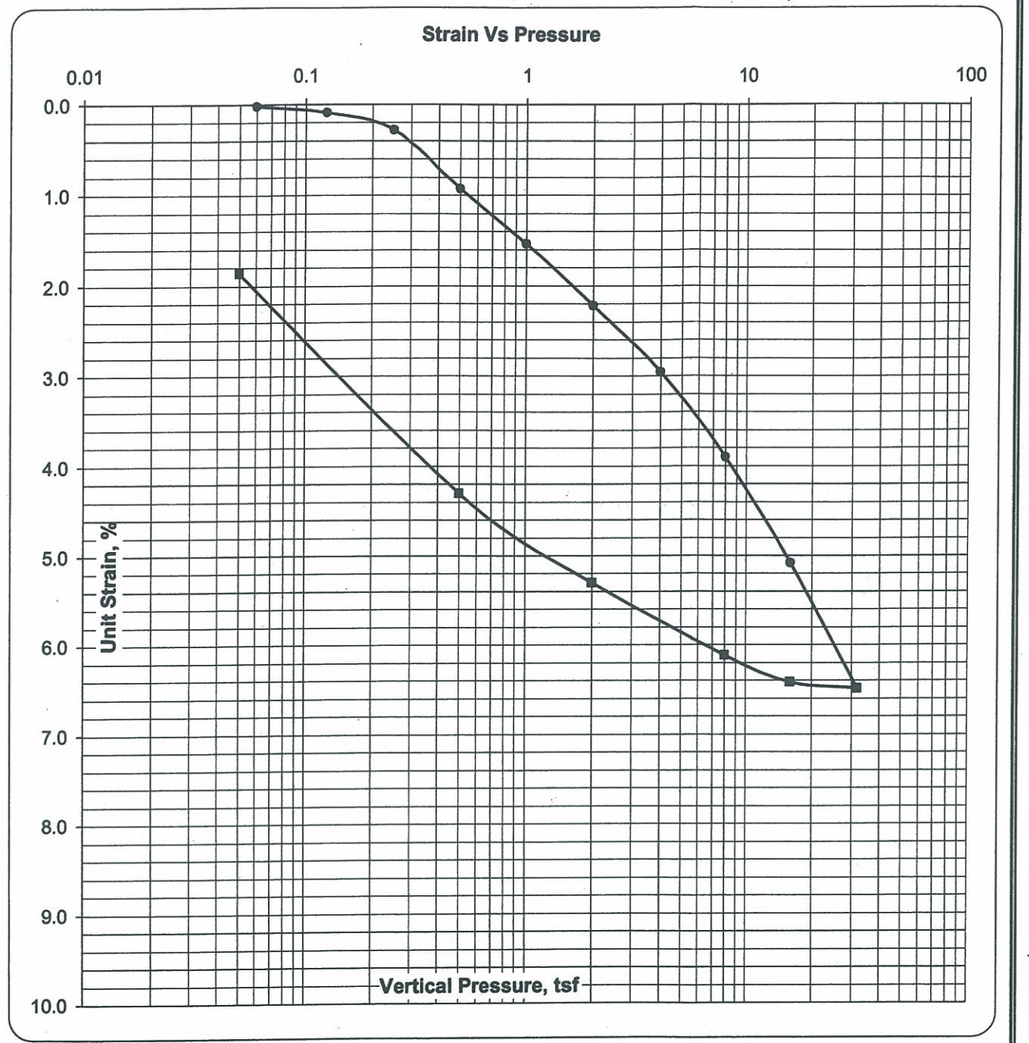
Boring IE-13B, Tube T-3



URS-18







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.)	
Liquid Limit (%)	27	(From Trims.)	
Plastic Limit (%)	14	(From Trims.)	
Plastic Index (%)	13	(From Trims.)	
Specific Gravity(assumed)	2.71	(From Trims.)	
Test Specimen Properties			
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 Dry Weight (pcf)	116.9		

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

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

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$e_o = 0.447$

$0.42e_o = 0.188$

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

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

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

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

$RR = 0.016$

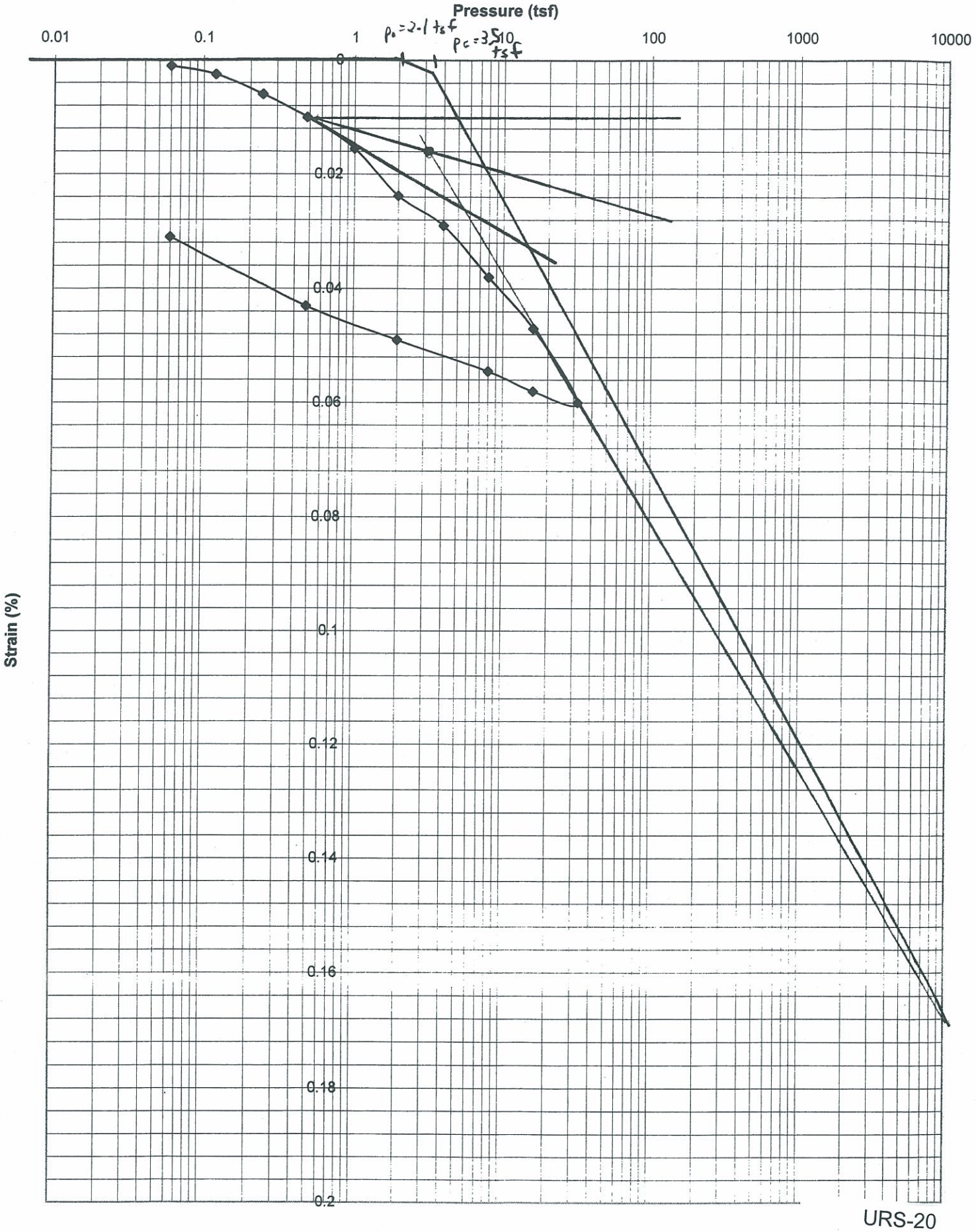
$C_r = RR(1+e_o)$

$C_r = 0.023$

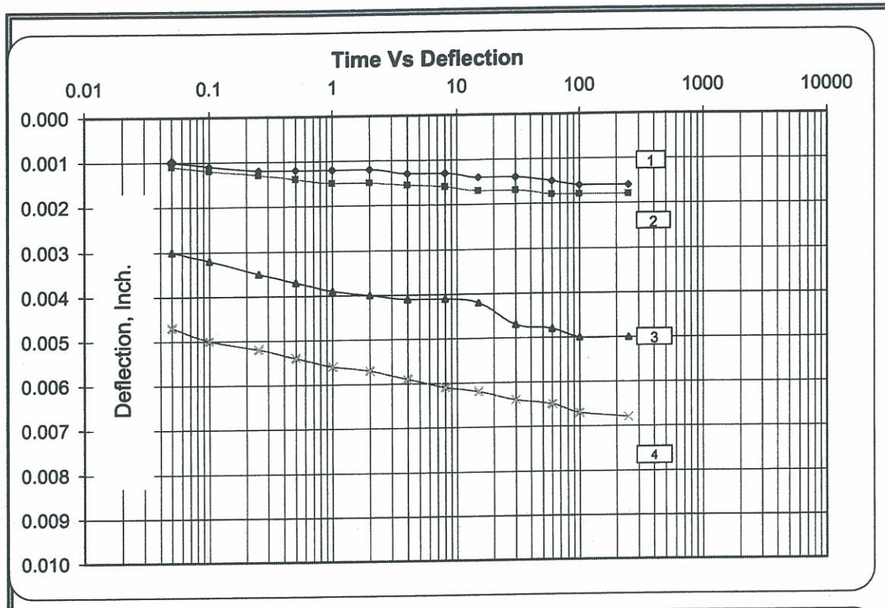
$CR = \frac{0.18 - 0.006}{\log \frac{10,000}{3.0}}$
$= 0.049$

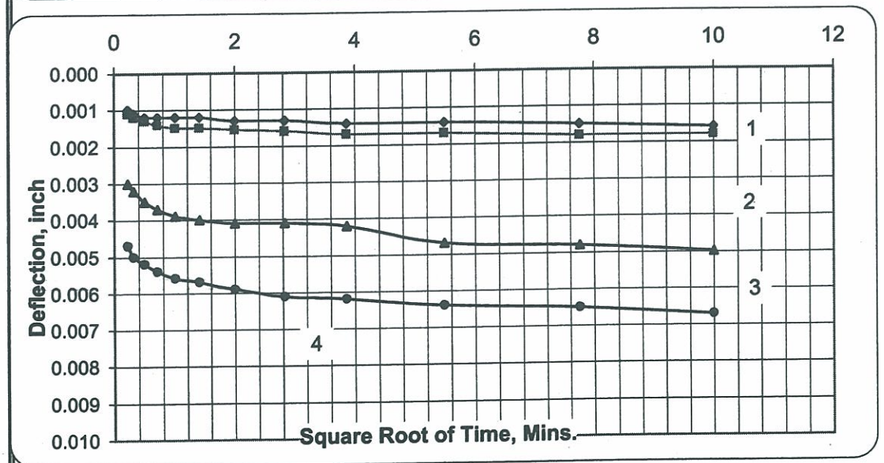
$Cc = CR(1+e_o)$
$= 0.071$

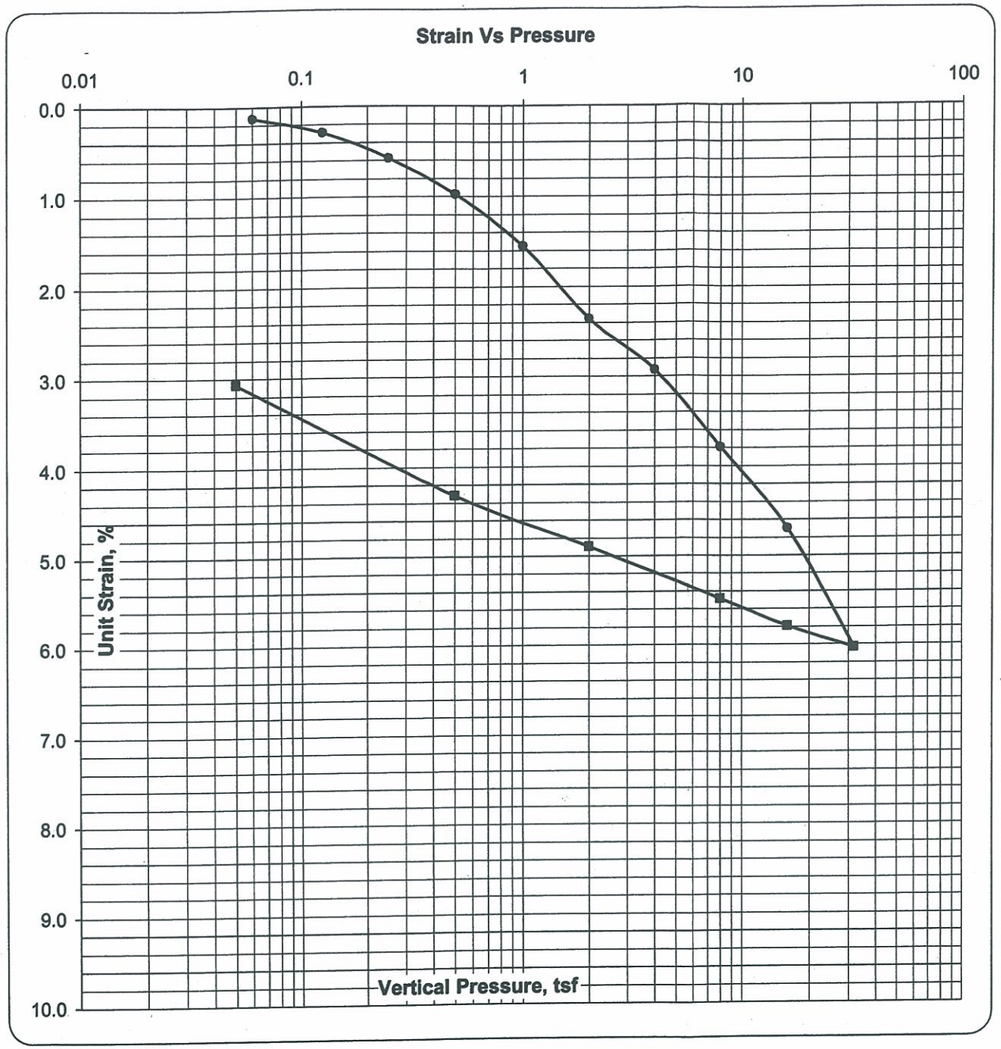
Boring IE-13B, Tube T-4



URS-20







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.)	**Consolidation Properties (Unit Strain Basis)**
Liquid Limit (%)	N.P	(From Trims.)	Compression Ratio (Cc') *
Plastic Limit (%)		(From Trims.)	Recompression Ratio (Cr')*
Plastic Index (%)		(From Trims.)	Swelling Ratio (Cs')*
Specific Gravity(assumed)	2.51	(From Trims.)	Preconsolidation Stress, Pc (tsf)*
Test Specimen Properties			Existing Overburden Stress, Po (tsf)*
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		

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

$e_o = 0.505$

$0.42 e_o = 0.212$

$\Delta e = 0.505 - 0.212 = 0.293$

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

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

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

$RR = 0.010$

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

$CR = \frac{0.166 - 0.002}{\log \frac{10,000}{3.5}} = 0.042$

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

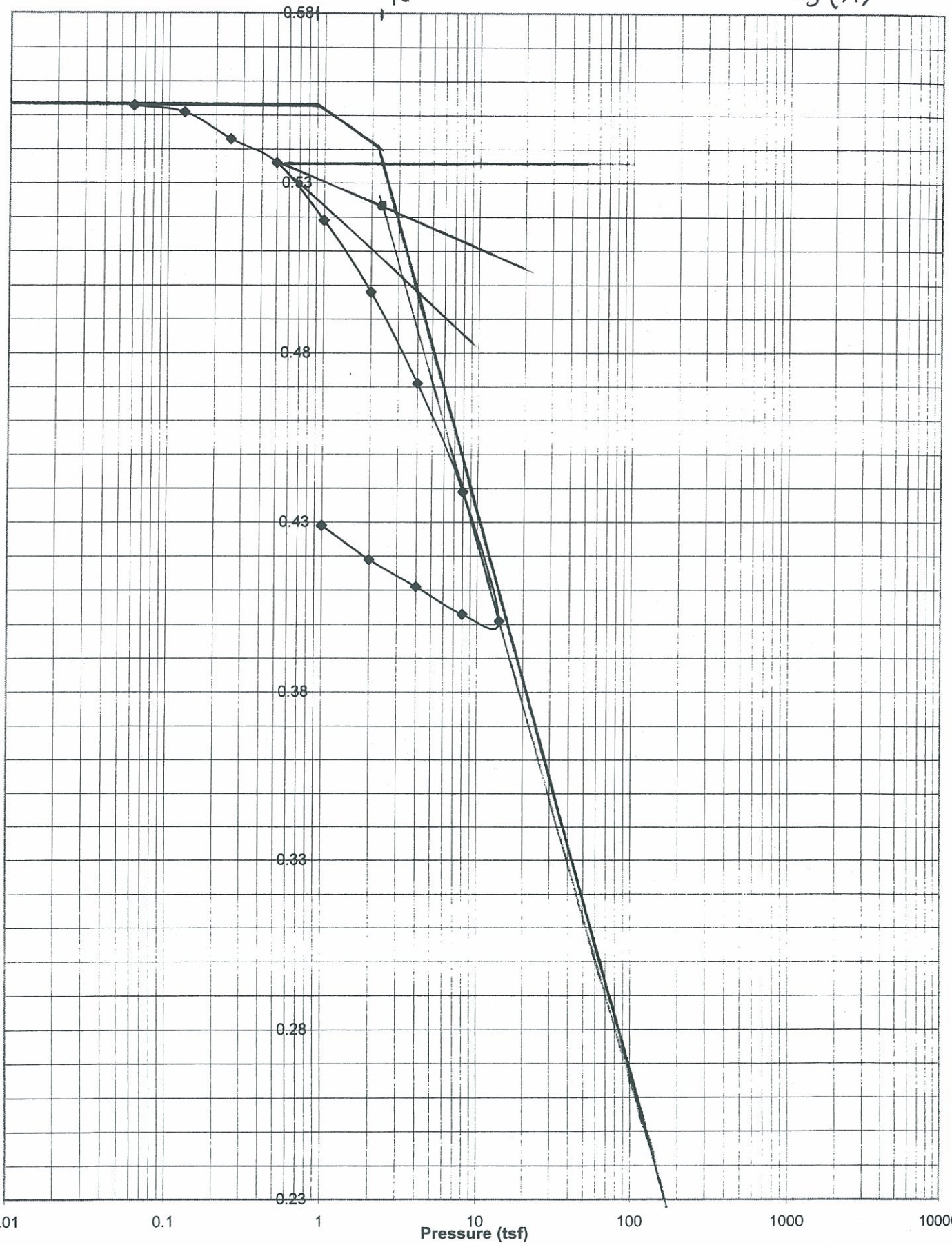
$C_c = \frac{\quad}{\log \frac{180}{2.2}} = 0.15$

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

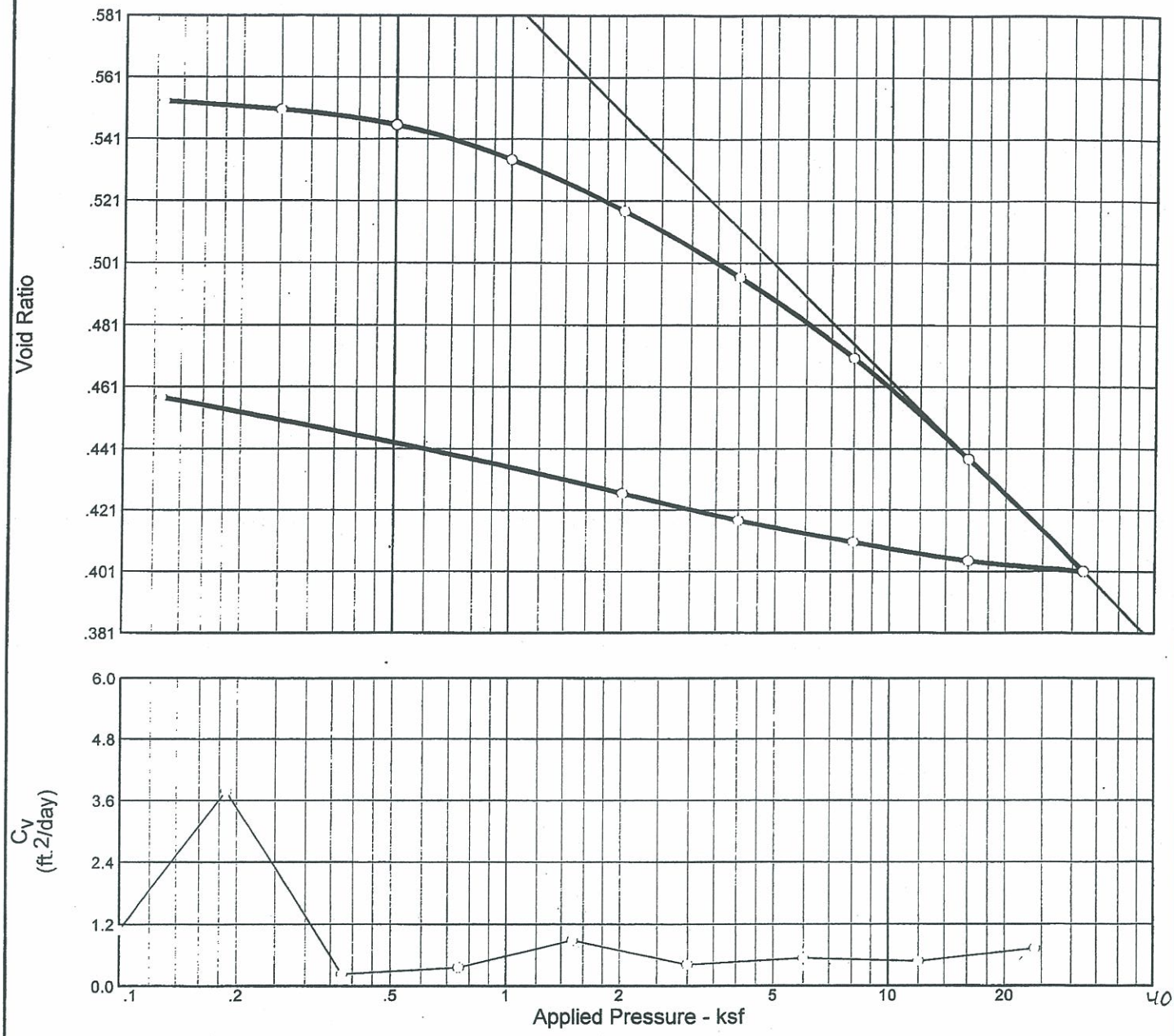
Boring IE-13A, Tube T-1

$p_o = 0.9$ 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

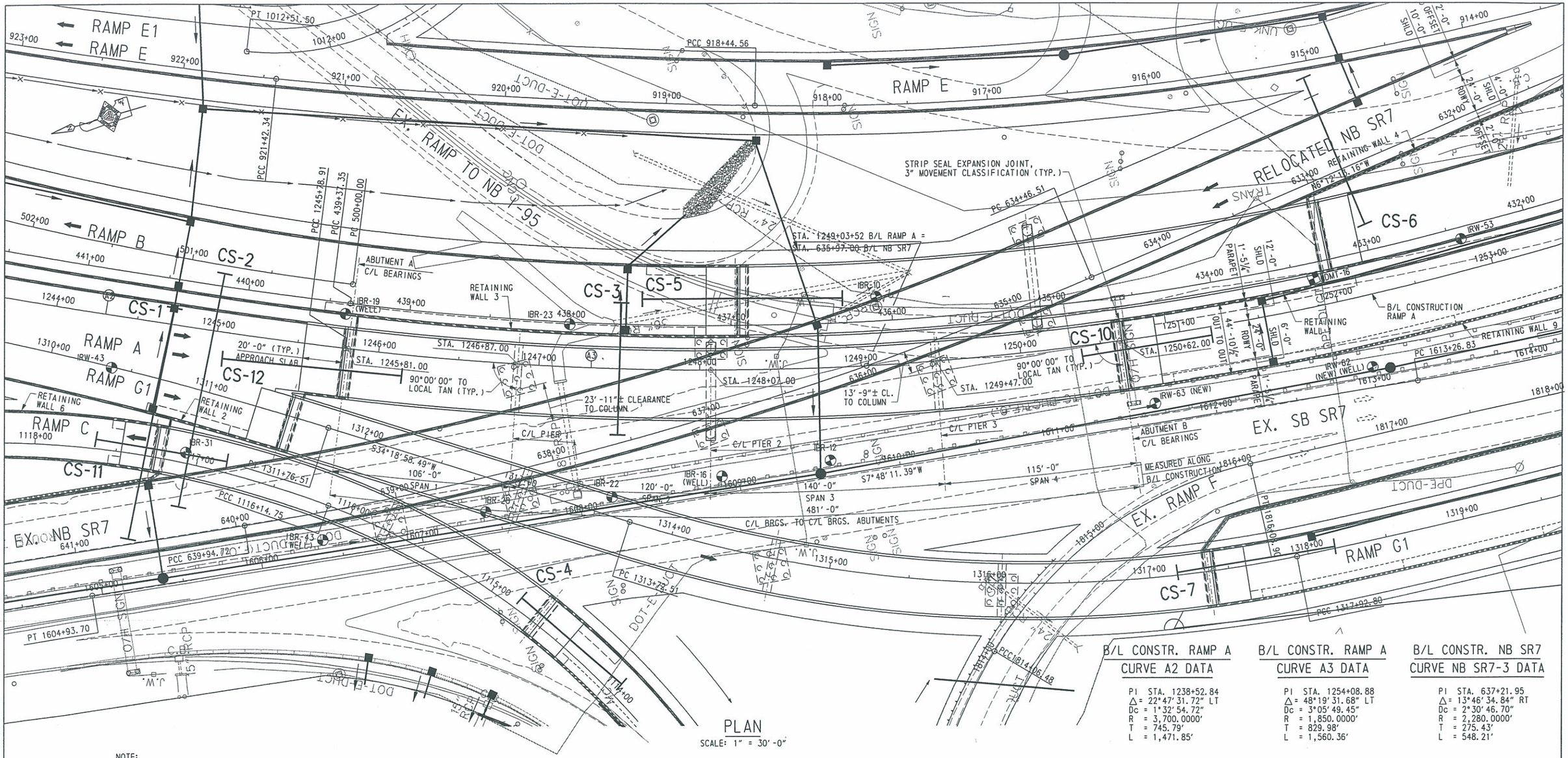
Project: DELAWARE TURNPIKE IMPROVEMENTS -Interchange
RK & K Job No. 103-059

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

Remarks:
Undisturbed Sample

CONSOLIDATION TEST REPORT (ASTM D2435)

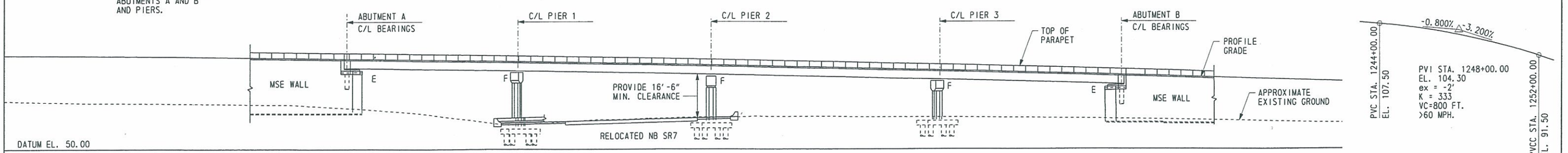
The Robert B. Balter Company



PLAN
SCALE: 1" = 30'-0"

NOTE:

USE POT BEARINGS AT ABUTMENTS A AND B AND PIERS.



ELEVATION
SCALE: 1" = 30'-0"

NOTE:
MSE ABUTMENTS SHOWN

RAMP A PROFILE
NOT TO SCALE

URS-24

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'

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

SCALE
0 30 60 90
FEET

SR1 / I-95 INTERCHANGE

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

GLOBAL STABILITY CROSS SECTIONS S2 THRU S5

SHEET NO.	TOTAL SHTS.
S2-1	7

Rodriguez_V8_01 Feb 10, 2009 o:\20832687-XM\CAD\Bridge\FileRemovedFromBridge\pe201CrossSect.dgn

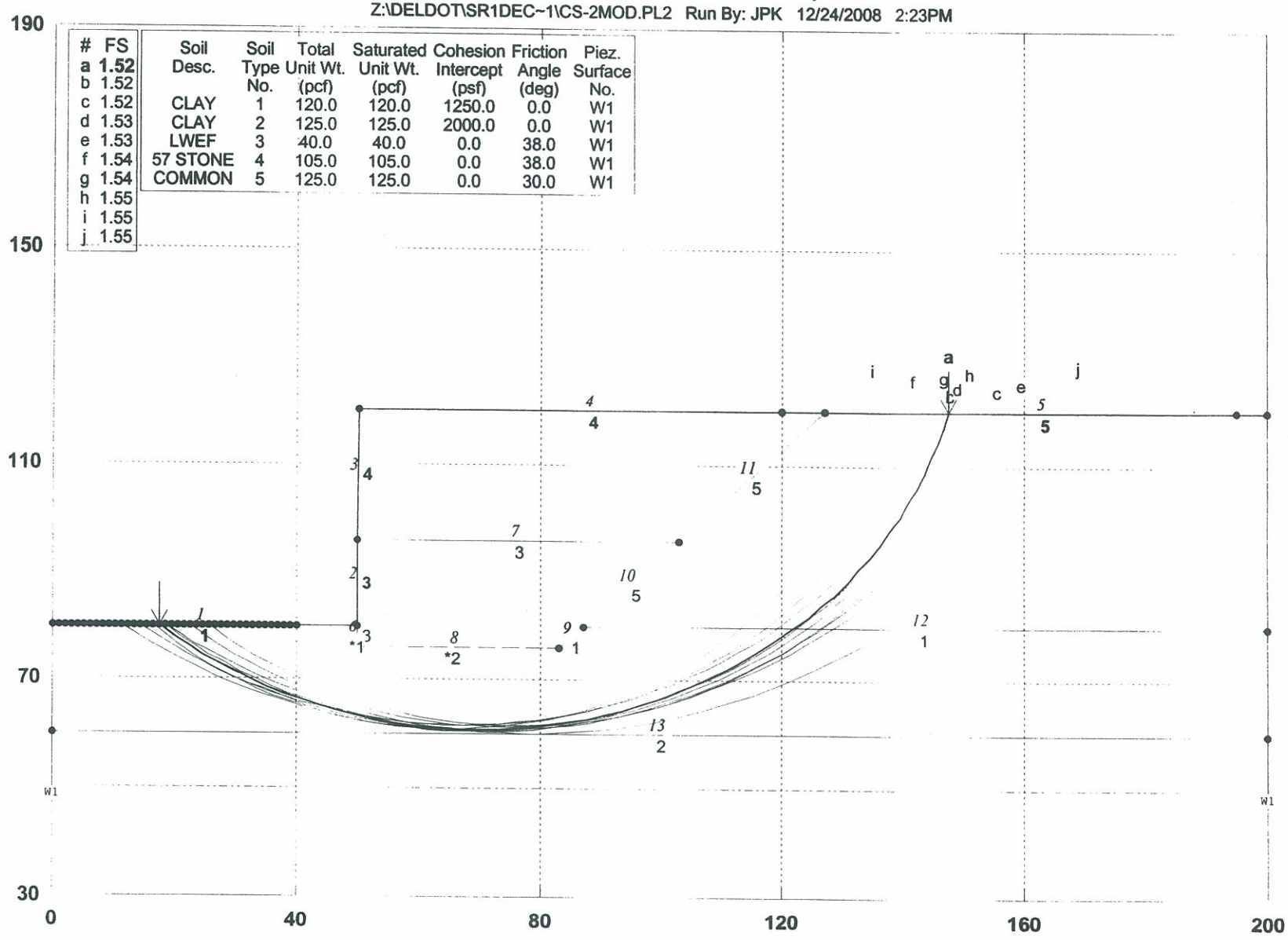
Short-term Case (prior to traffic loading)

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

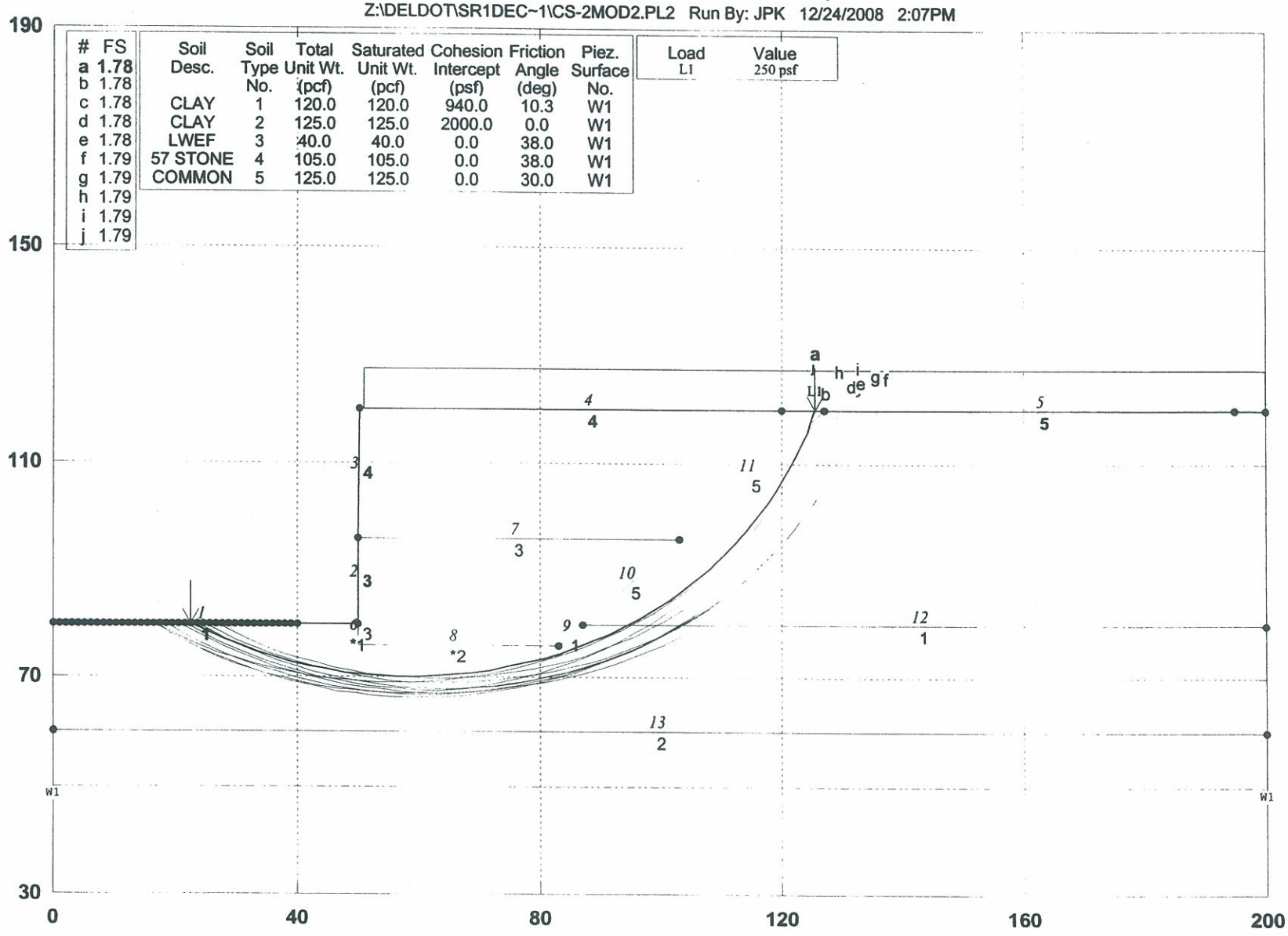
STED

* For Cross section location see URS-24

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



GSTABL7 FSmin=1.78

Safety Factors Are Calculated By The Modified Bishop Method

STED

URS-26

Long-term Case

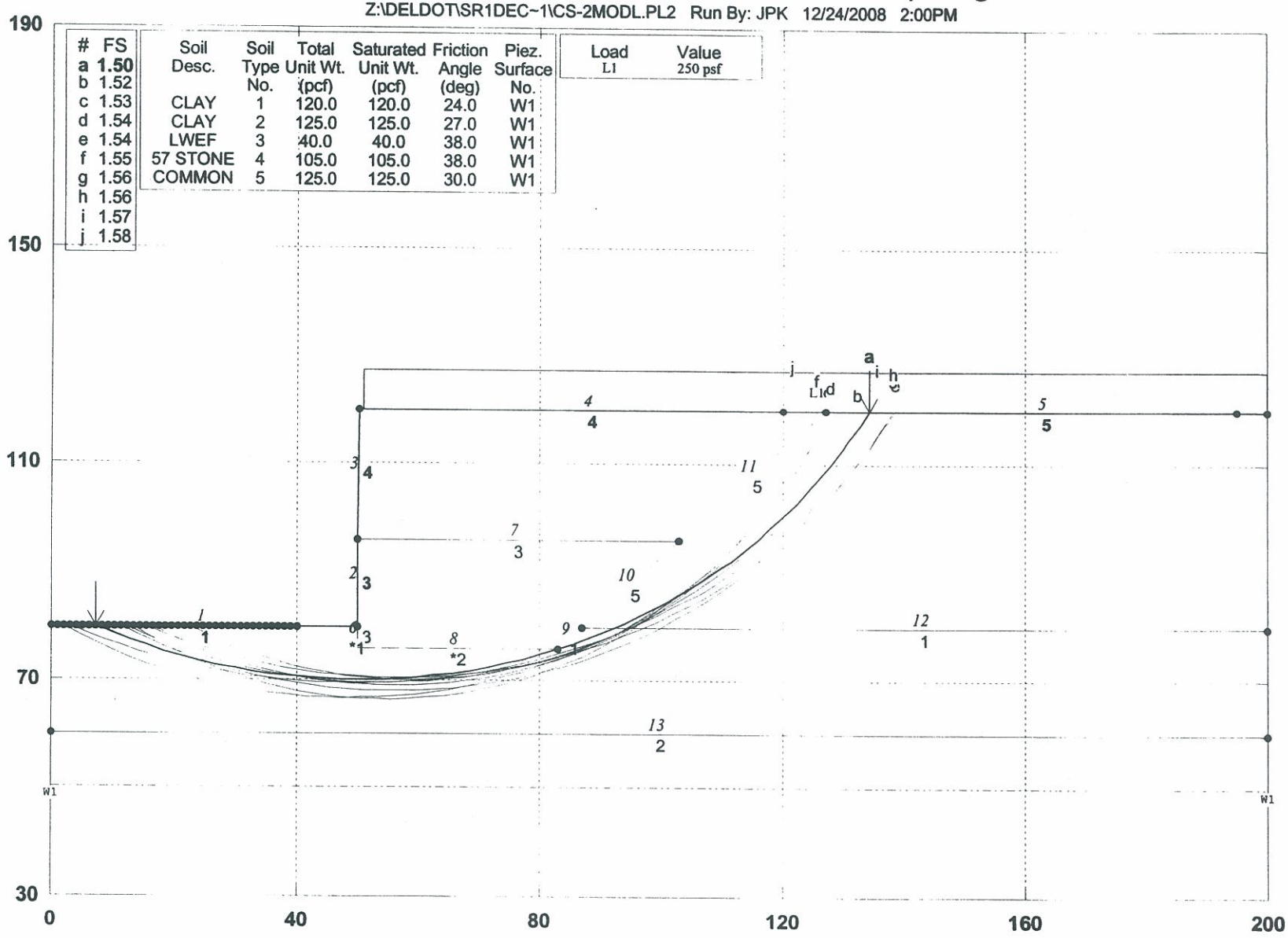
SR1/I95 Interchange CS-2 Modified (Sect. Reversed) Long-Term

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

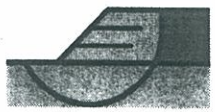
Load	Value
L1	250 psf



GSTABL7 FSmin=1.50

Safety Factors Are Calculated By The Modified Bishop Method

STED



URS-27

Short-term Case

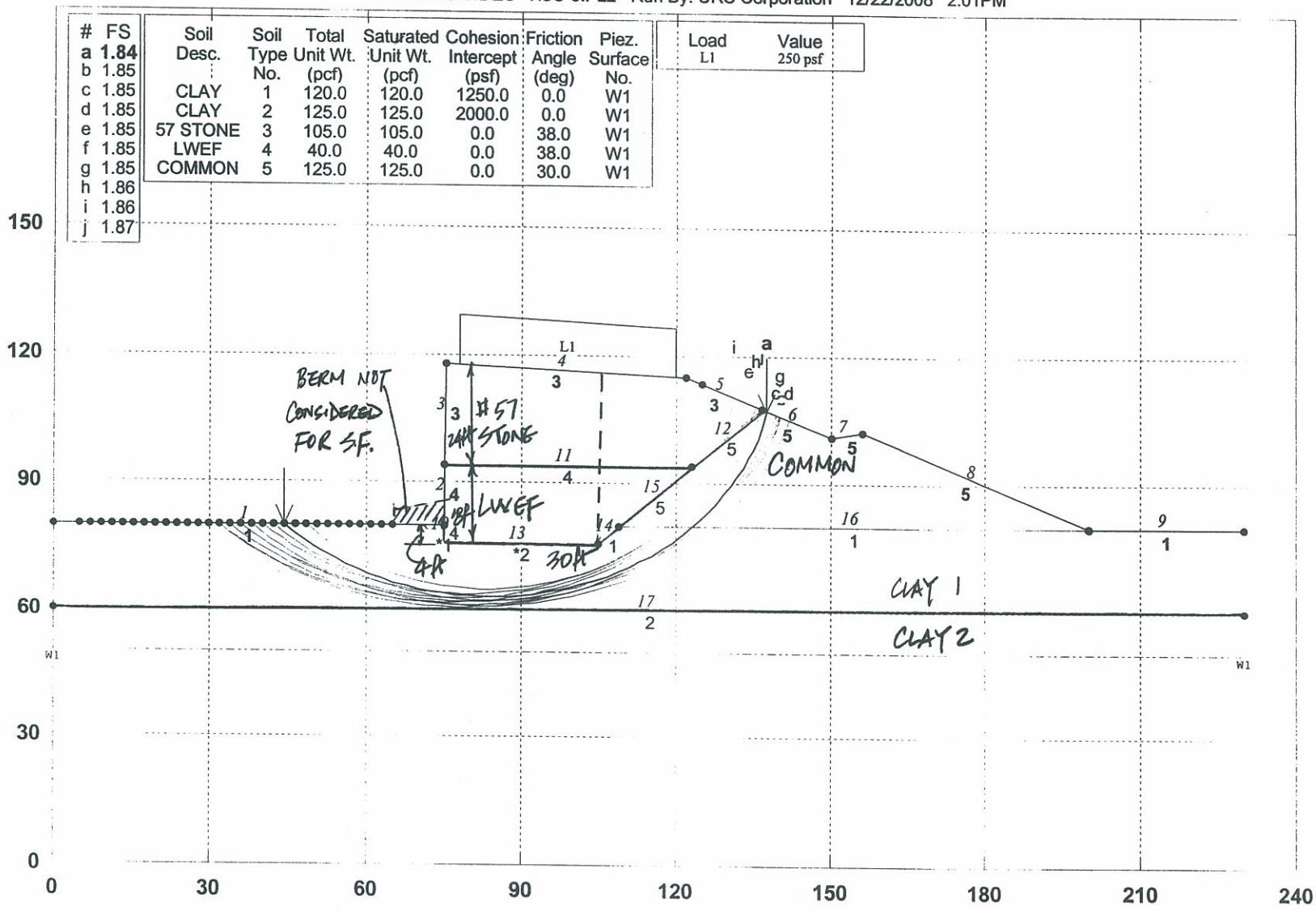
SR1/I95 Interchange CS-3 (Reversed)

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

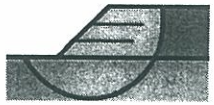
Load	Value
L1	250 psf



GSTABL7 FSmin=1.84

Safety Factors Are Calculated By The Modified Bishop Method

STED



* For cross section location See URS-24

Long-term Case

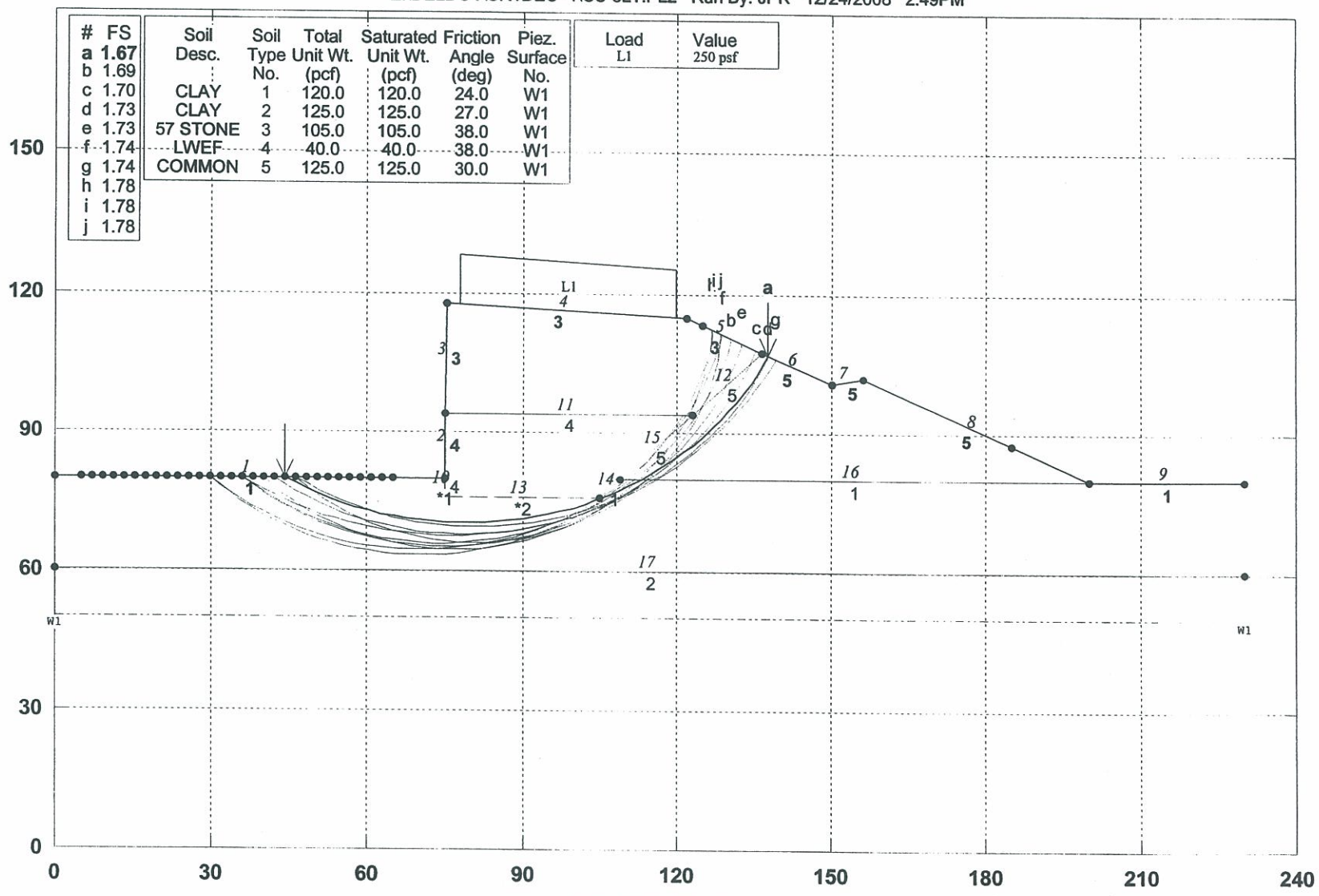
SR1/I95 Interchange CS-3 (Reversed) Long-Term

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



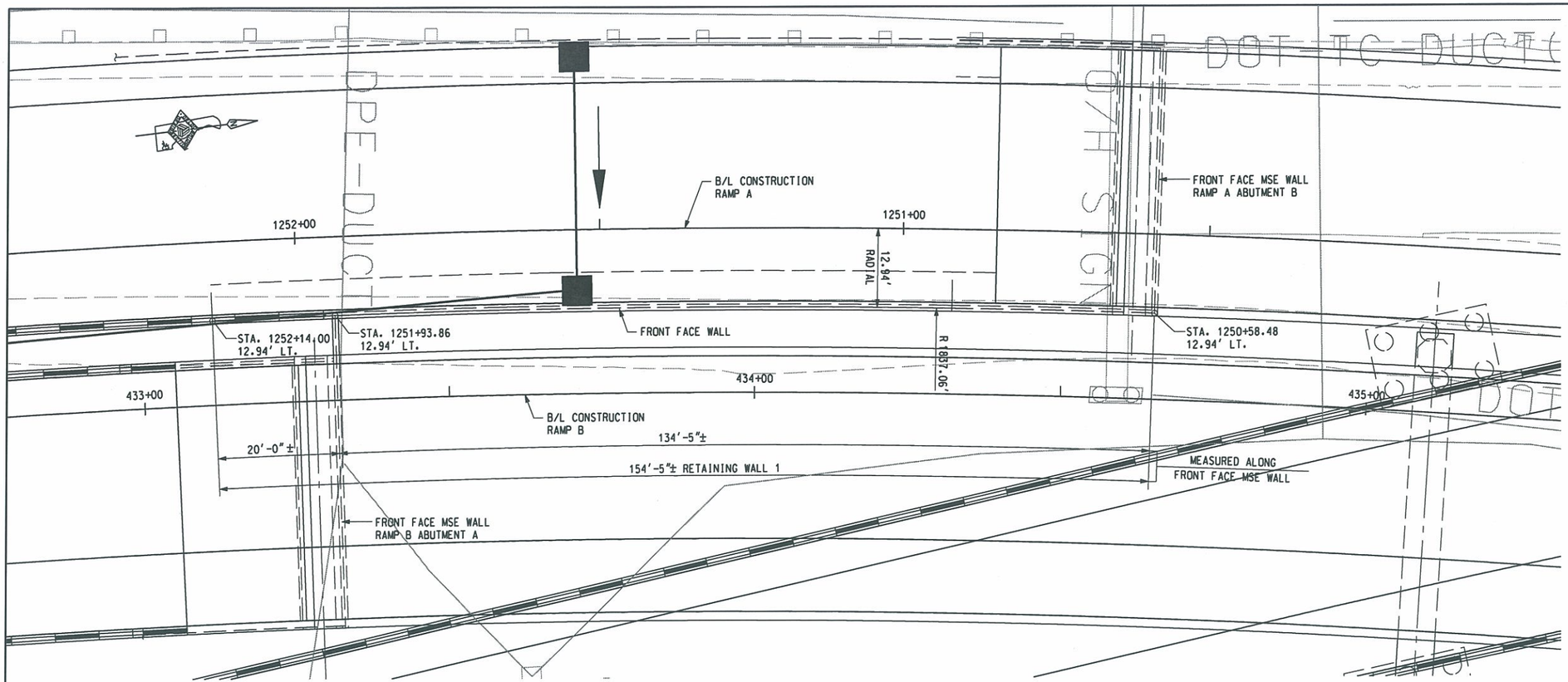
GSTABL7 FSmin=1.67

Safety Factors Are Calculated By The Modified Bishop Method

STED

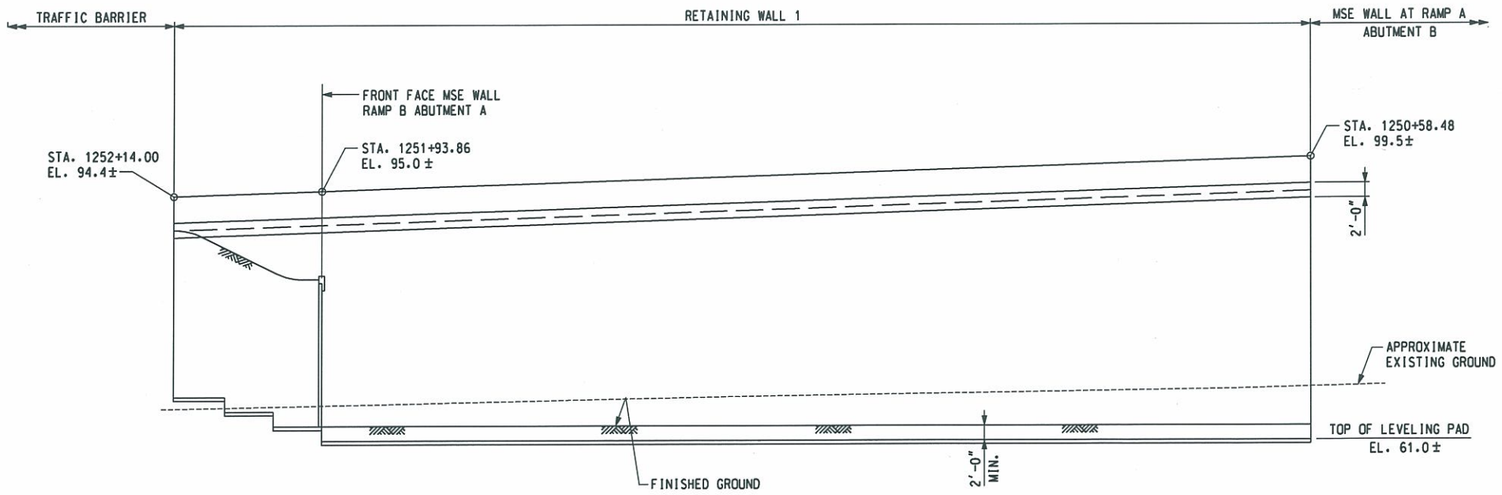
URS-29

Retaining Wall 1



PLAN

SCALE: 1" = 10'-0"



DEVELOPED ELEVATION

SCALE: 1" = 10'-0"

NOTES:

1. FOR GENERAL NOTES, SEE DWG. R-1.
2. FOR TYPICAL WALL SECTION, SEE DWG. R-1.

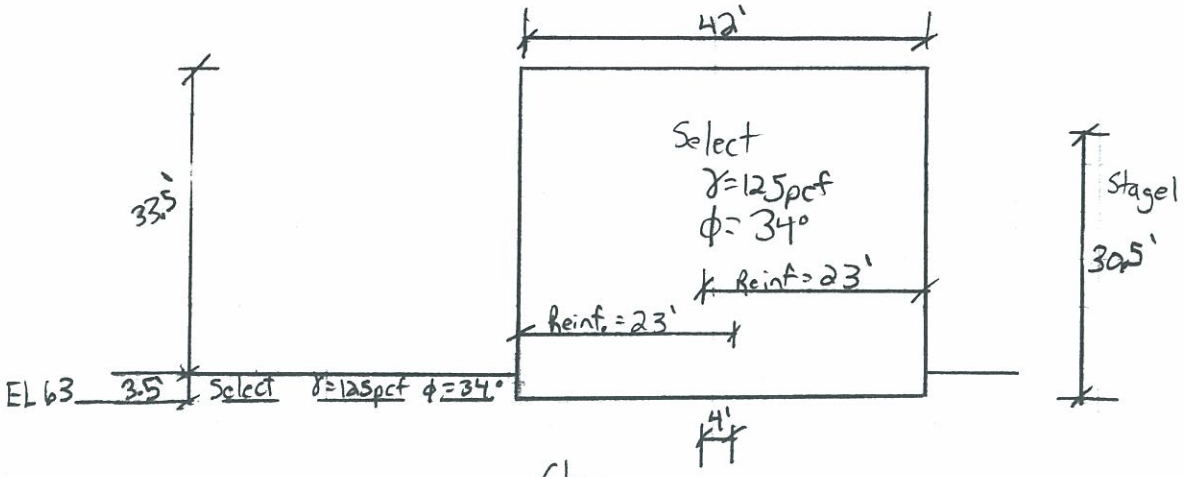
URS RW1-2

jason.kotova Feb 10, 2009 0:\20832687-XM\CAD\Bridge\rd01.dgn

DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS		SR1 / I-95 INTERCHANGE	CONTRACT 28-090-03	BRIDGE NO.	RETAINING WALL 1 PLAN AND ELEVATION
				COUNTY NEW CASTLE	DESIGNED BY: R. F. KIRCHNER URS	SHEET NO. R1-1
					CHECKED BY:	TOTAL SHTS. 238 / 435

URS

Job SR 1/I-95 Interchange | Project No. | Page ___ of ___
Description Retaining Wall 1 & Ramp A over SR7, Abut B Wingwalls | Computed by JPK | Date | Sheet ___ of ___
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
EL 30 ▽ 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, 4-1

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	$= [H_2 \tan(45-\Phi 1/2/2) * \gamma_2 * H_2/2 + H_2 \tan(45-\Phi 1/2/2) * H1 * H1 * \tan(45-\Phi 1/2/2) * \gamma 1 * H1/2] * \frac{1}{1000}$
Wedge Influence Factor	WIF =	0.04		see attached spreadsheet calculations

Note: See Figure on following page

Embedment Soil Properties

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 =	0.9	k/ft	as defined by Fig 11.10.5.2-1 $= Wrw * WIF * \tan(45 - \Phi 1/2/2)$
Rankine Coeff. Active Earth Pressure	Ka =	0.283	(dim)	$= \tan^2(45 - \Phi 1/2/2)$
Horiz F2 Surcharge	F2 =	0.1	k/ft	per Eq 3.11.6.4-1 $= Ka * qs/1000 * H * WIF$
MSE Mass	V1 =	120.3	k/ft	as defined by Fig 11.10.5.2-1 $= \gamma rei/1000 * H * B$

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 $= F1 * EHLF + F2 * LSLF$
Nominal Sliding Resistance	Rn =	37.9	k/ft	as defined by Fig 10.6.3.4-1 $= f * B/1000 + Df * \gamma c * Kp/1000$
Sliding Resistance Factor	Φt =	1	(dim)	per Table 11.5.6-1
Factored Sliding Resistance	Rr =	37.9	k/ft	$= Rn * \Phi t$

Capacity Demand Ratio (CDR)= 25.98
CDR > 1.0, OK

Eccentrity, parallel to width	e_B =	0.16	ft	$= \frac{F1 * EHLF * H/3 + F2 * LSLF * H/2}{V1}$ e < 0.25*B, OK
Effective Width	B' =	25.7	ft	$= B - 2e_B$
MSE Mass Load Factor	MMLF =	1.35	(dim)	per Table 3.4.1-2
Unfactored Dead Load Bearing Pressure	DLBP =	4.68	ksf	$= V1/B'$
Factored Bearing Pressure	Sigv =	6.76	ksf	$= (V1 * MMLF + qs * LSLF * B/1000)/B'$

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 $= 1 + B/L * Nq/Nc$
	sq =	1.07	(dim)	per Table 10.6.3.1.2a-3 $= 1 - 0.4B/L$
	sγ =	0.93	(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
	Cwγ =	0.83	(dim)	per Table 10.6.3.1.2a-2 $= 0.5 + (1.0 - 0.5) \frac{GWD - Df}{(1.5B + Df) - Df}$
				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)= 1.534
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 =	1.05	(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
				per Eq 10.6.3.1.2a-1 & Sec. 11.10.5.4, load inclination factors & depth
Nominal Bearing Resistance (ksf)	qn =	11.1	ksf	correction factor = 1.0
Bearing Resistance Factor	Φb =	0.65	(dim)	per Table 11.5.6-1
Factored Bearing Resistance (ksf)	qr =	7.20	ksf	

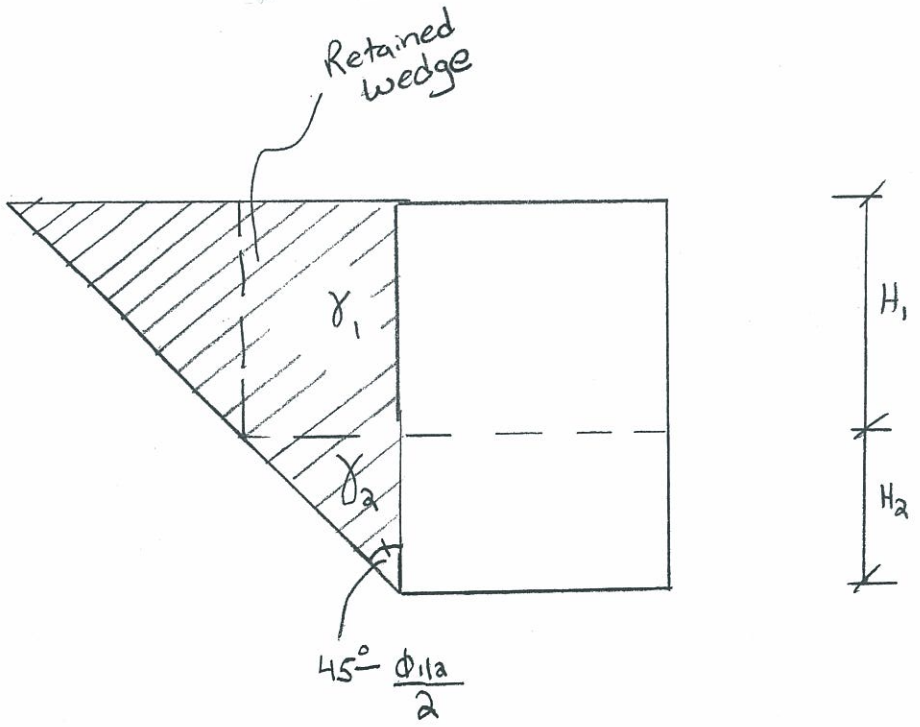
Capacity Demand Ratio (CDR)= 1.064
CDR > 1.0, OK

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

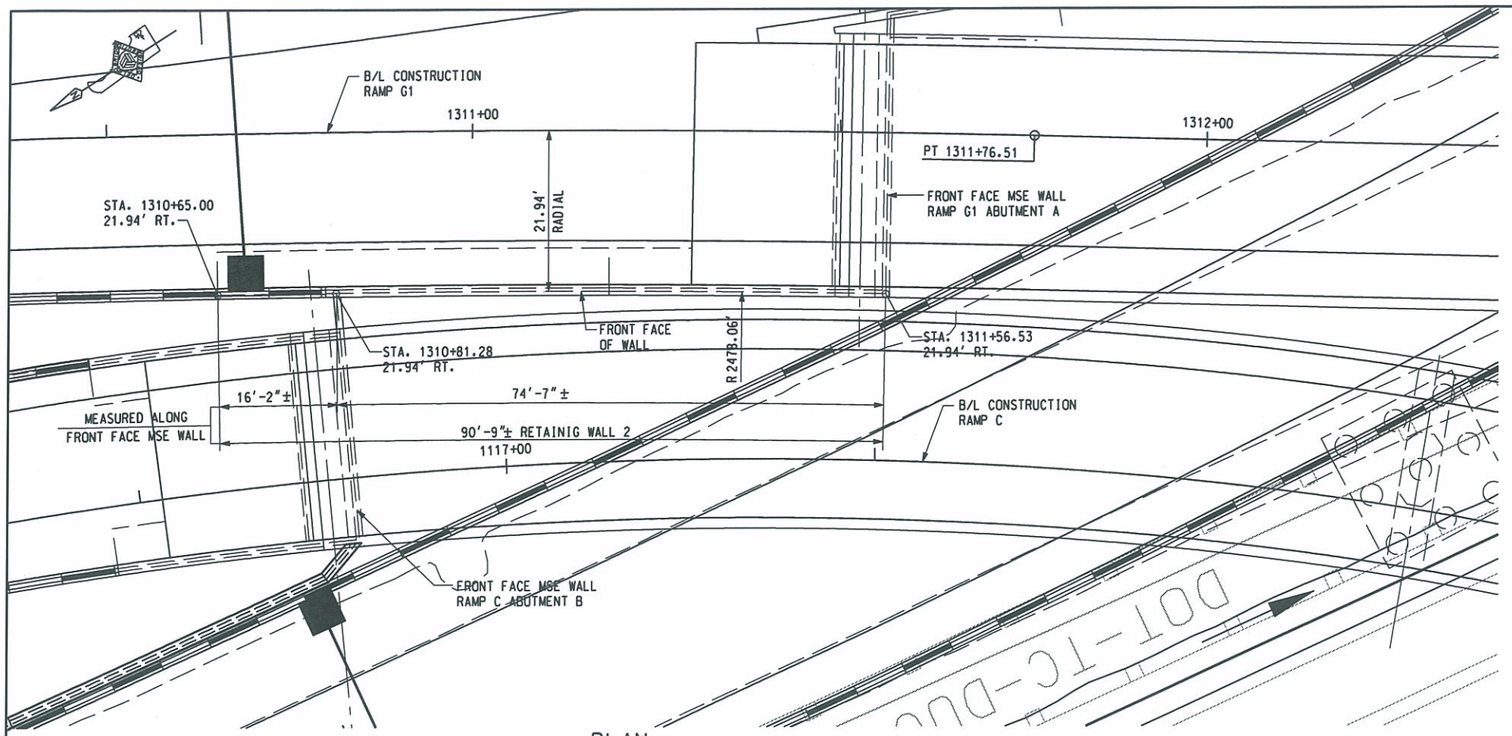
Footing Width (ft) 23

0.00	3.12	in
TOTAL	3.12	in

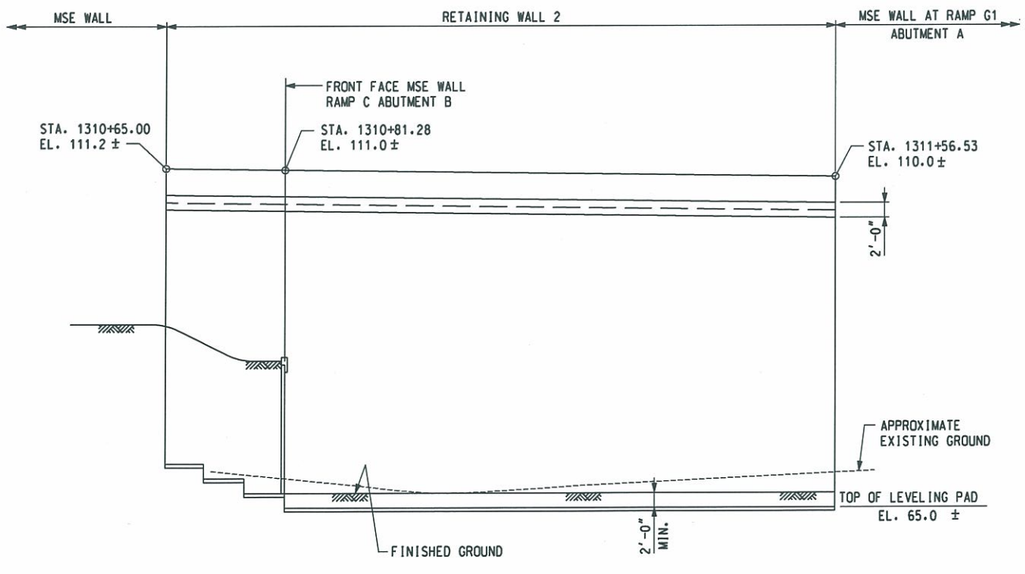
[1] Stress Influence Factors interpolated from Figure 10.6.2.4.1-1
[2] Sc' based on Eq. 10.6.2.4.3-1
[3] Sc" based on Das Reference Eq. 8.19

Profile described on page URS- RW1-3
Lab data on page URS- 8

Retaining Wall 2



PLAN
SCALE: 1" = 10'-0"



DEVELOPED ELEVATION
SCALE: 1" = 10'-0"

NOTES:

1. FOR GENERAL NOTES, SEE DWG. R-1
2. FOR TYPICAL WALL SECTION, SEE DWG. R-1.

URS RW2-2

R2-1

DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS		SR1 / I-95 INTERCHANGE	CONTRACT 28-090-03	BRIDGE NO.	RETAINING WALL 2 PLAN AND ELEVATION
				COUNTY NEW CASTLE	DESIGNED BY: R. F. KIRCHNER URS	SHEET NO. 241
					CHECKED BY:	TOTAL SHTS. 435

Jason_kotova Feb 10, 2009 O:\20832687-XM\CAD\Bridge\rd02.dgn

URS

Page ____ of ____

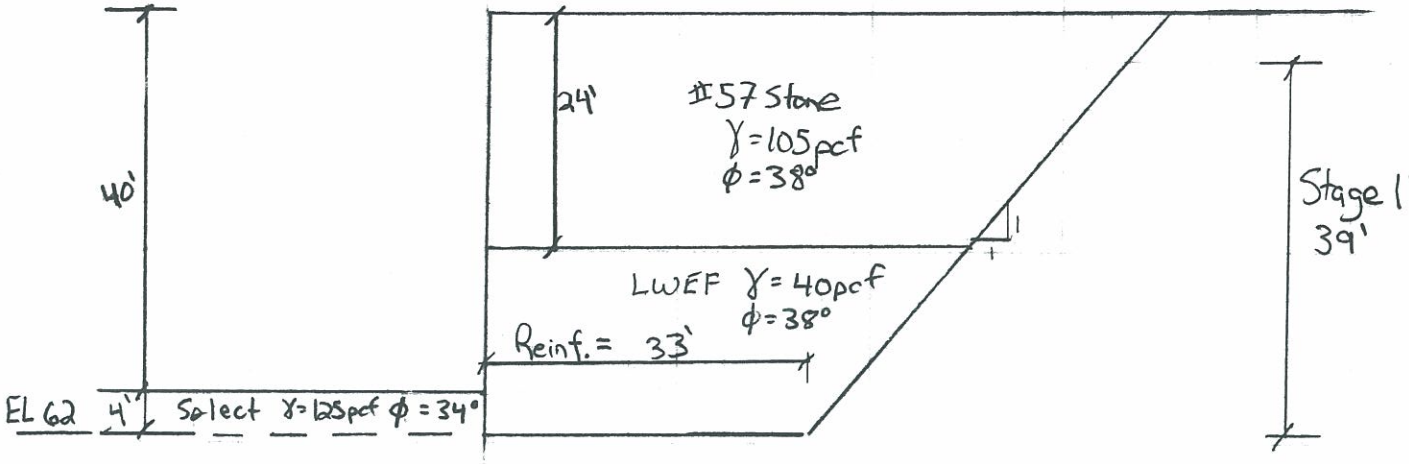
Job SR 1 / I-95 Interchange | Project No. ____ | Sheet ____ of ____

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 = 120 pcf

CD	CU	UU @ Stage 1
φ = 24°	φ = 10.3°	φ = 0
c = 0	c = 940 psf	c = 1250 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 CRS-4, 4-1

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 =	36.2	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 =	0.238	(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
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)= 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
Nominal Bearing Resistance (ksf)	qn =	7.4	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 =	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

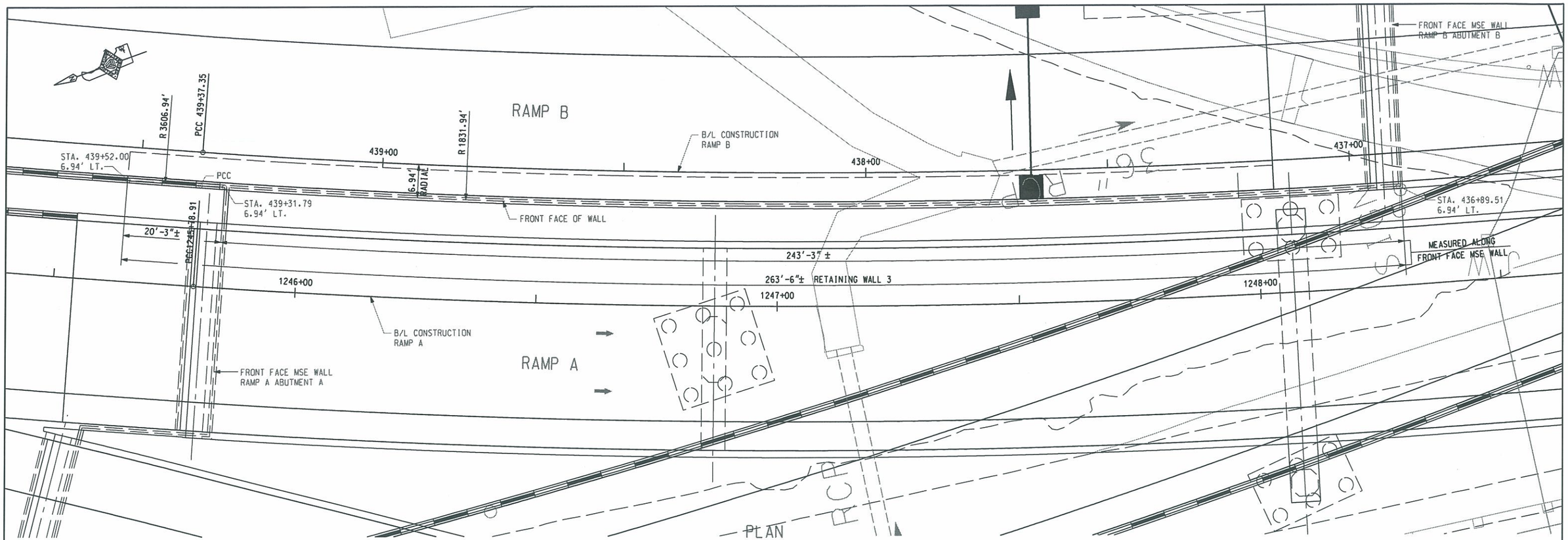
Footing Width (ft) 33

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- RW2-3
Lab data on page URS- 4

Retaining Wall 3



NOTES:

1. FOR GENERAL NOTES, SEE DWG. R-1.
2. FOR TYPICAL WALL SECTION, SEE DWG. R-1.

URS RW3-2

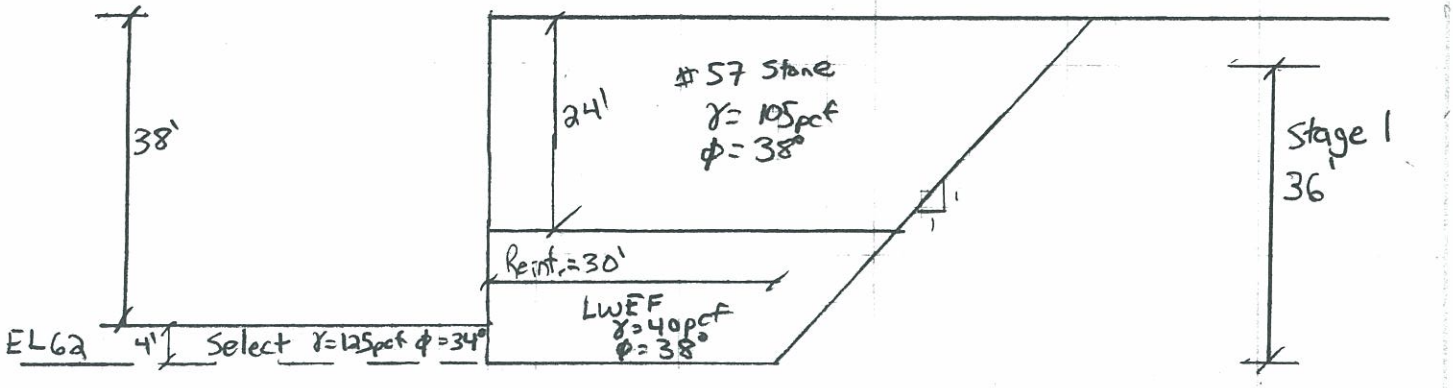
R3-1

DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS		SR1 / I-95 INTERCHANGE	CONTRACT 28-090-03	BRIDGE NO.	RETAINING WALL 3 PLAN AND ELEVATION	SHEET NO. 244
				COUNTY NEW CASTLE	DESIGNED BY: R. F. KIRCHNER URS		TOTAL SHTS. 435
					CHECKED BY:		

Jason_kotova Feb 10, 2009 O:\20832687-XM\CAD\BridgeVrd03.dgn

URS

Job SR1/I-95 Interchange | Project No. | Page ___ of ___
Description Retaining wall 3 + Ramp B over SR7 Abut B Wingwall | Computed by JPK | Date | Sheet ___ of ___
Bearing Capacity, Sliding & Overturning | Checked by | 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 ▽ Trafic 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
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)= 1.613**
				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-9
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
Nominal Bearing Resistance (ksf)	qn =	11.3	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 =	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- RW3-3
Lab data on page URS- 4