

SCOPE OF ENGINEERING

Wall(s): West Wall - Wet Case & 100pcf

Design: The Reinforced Earth Company has performed the following analyses for

- Overturning
- Sliding
- Pull out
- Applied bearing pressure

The Reinforced Earth Company **has not** performed the following analyse
It is the responsibility of the others to perform the following analyses:

- Bearing capacity of foundation soils
- Settlement analysis
- Slip circle analysis
- Site drainage analysis (surface run-off must be diverted away from the
- Slope stability analysis for temporary cut-slope (if required)
- Scour analysis (if required)

T-WALL® Retaining Wall System

Shop Drawing Calculations

West Wall - Wet Case

Stability Calculations
100pcf

CERTIFIED WITH RESPECT TO
THE INTERNAL STABILITY OF T-
WALL® STRUCTURES ONLY.

PROJECT INFO

Wall Name: West Wall - Wet Case
 Project No: TOS 19553
 Date: 3/11/2019
 Designed By: ABC
 Checked by: KD

DESIGN CASES

Service: Yes
 Est I: Yes
 Est II: Yes
 ASHTO LRFD Edition 7th Ed., 2014

PROGRAM VERSION

Name: T-Wall Retaining Wall Calculations
 Method: LRFD
 Loading: HWY
 Units: 2.5x5.0 Units
 Version: v11c
 Date: 3/2/2012
 By: BZY

FACE DIMENSIONS

FACE WIDTH = 5 FT
 FACE THICKNESS = 0.5 FT
 STEM THICKNESS = 0.5 FT

LEVEL 1 DIMENSIONS

DEPTH TO MOMENT SLAB = 2.00 FT
 TOP UNIT FACE HEIGHT = 4.50 FT
 TOP UNIT STEM HEIGHT = 2.50 FT

WALL GEOMETRY

BATTER (1) = 0

GRADING GEOMETRY

DISTANCE TO SLOPE (1) = 0 FT
 FILL SURCHARGE = 0 FT
 DISTANCE TO BREAK = 0 FT
 SLOPE ANGLE (R1) = 0.0 DEG
 SLOPE ANGLE (1) = 0.0 DEG
 TRAFFIC SURCHARGE = 2.4 FT

SOIL PROPERTIES

SELECT
 INTERNAL FRICTION (φ) = 34 DEG
 WEIGHT (γ) = 100 PCF
 COHESION = 0 (assumed)
 UNCLASSIFIED
 INTERNAL FRICTION (φ) = 34 DEG
 WEIGHT (γ) = 100 PCF
 COHESION = 0 (assumed)
 FOUNDATION
 FOUNDATION TYPE = S (S for Sol, R for rock)
 INTERNAL FRICTION (φ) = 34 DEG
 FACTORED BEARING RESISTANCE = #NA PSF

WATER PRESSURE

HEIGHT OF WATER TABLE BEHIND WALL = 7.00 FT (From bottom of wall)
 HEIGHT OF WATER TABLE IN FRONT OF WALL = 4.00 FT (From bottom of wall)

SOUND WALL OR OTHER STRUCTURE

WEIGHT OF STRUCTURE = 0 LBS per 5.0ft (0.825 KLF)
 LOCATION OF GRAVITY = 0 FT (from face, + if overturn, - if stabilizing)
 WIND LOAD = 0 LBS per 5.0ft (37psf*10*-5 Dr-Wind on traffic b
 LOCATION OF WIND LOAD = 0 FT (from gutter line / pavement)

VEHICLE COLLISION FORCE OR GUARDRAIL

VEHICLE COLLISION FORCE = 2500 LBS per 5.0ft
 HEIGHT OF BARRIER = 3.50 FT (from gutter line / pavement)

SEISMIC

ACCELERATION COEFFICIENT (A) = 0.20
 FRICTION ANGLE BETWEEN SOIL AND WALL (δ) = 0 DEG
 VERTICAL COMP OF EARTHQUAKE ACCEL. COEFF = 0

LEVEL	H	STEM KEYS	STR I Min			STR I Max			STR II Min			STR II Max			Service			Est I			Est II			
			OT	SL	PO	OT	SL	PO	OT	SL	PO	OT	SL	PO	OT	SL	PO	OT	SL	PO	OT	SL	PO	
1	6.50	6.0	2.15	1.75	1.16	2.80	2.19	1.39						3.48	2.64	1.99				1.25	1.68	1.29		
2	9.00	8.0	1.93	1.39	2.19	2.62	1.78	2.72						2.69	2.10	3.19				1.52	1.57	1.91		
3	11.50	10.0	1.83	1.06	2.01	2.47	1.44	2.74						2.71	1.53	2.92			2.14	1.22	2.54	1.37	2.54	
4	14.00	0.0	0	0	0																			
5	16.50	0.0	0	0	0																			
6	19.00	0.0	0	0	0																			
7	21.50	0.0	0	0	0																			
8	24.00	0.0	0	0	0																			
9	26.50	0.0	0	0	0																			
10	29.00	0.0	0	0	0																			
11	31.50	0.0	0	0	0																			
12	34.00	0.0	0	0	0																			
13	36.50	0.0	0	0	0																			
14	39.00	0.0	0	0	0																			
15	41.50	0.0	0	0	0																			
16	44.00	0.0	0	0	0																			
17	46.50	0.0	0	0	0																			
18	49.00	0.0	0	0	0																			
19	51.50	0.0	0	0	0																			
20	54.00	0.0	0	0	0																			
Max. Brg Pressure			1,835			2,062									1,434			1,490			1,357			
			180			151			2.50			0.60			1.50			2.44			4.00			
			Ratio			Ratio			Ratio			Ratio			Ratio			Ratio			Ratio			

West Wall 100pcf Wet Case.xlsm - STR I MIN

T-WALL Retaining Wall Calculations v11c (LRFD, HWY, 2.5x5.0 Units) Revised BZY 3/3/2012
LIMIT STATE: STRENGTH-I MIN
 PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (7th Ed., 20

The Reinforced Earth Com
 12001 Sunrise Valley Drive
 Reston, VA 20191
 (703) 547-8797

Project No: TOS 19553

Date: 3/11/2019

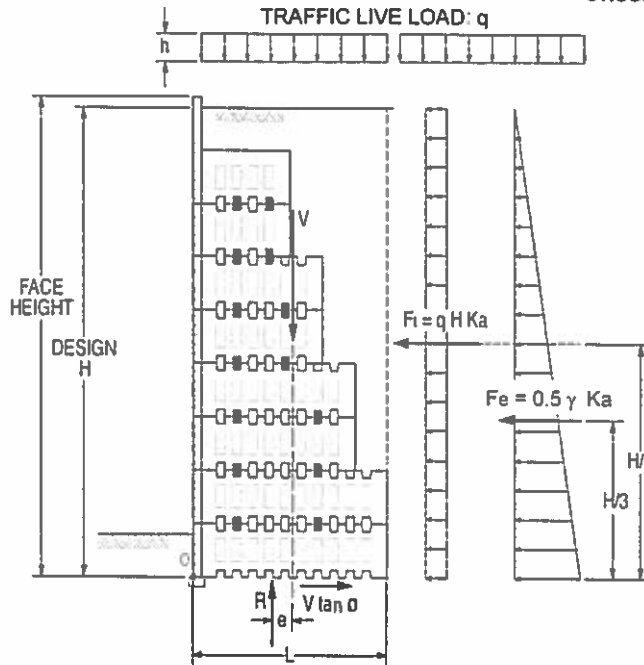
Revision: 0

Designed By: ABC

Checked by: KD

Wall Name West Wall - Wet Case

Load Diagram:



Typical Section (For illustration only, Some details may not apply)

External Stability Calculation (STRENGTH-I MIN)

Stability Against Overturning: (moments about point "O")

$$\Sigma \text{ Factored Resisting Mom} = \phi V \cdot x_o \quad (x_o \text{ is the horiz. distance between } V \text{ and } O)$$

$$\Sigma \text{ Factored overturning Mom} = Y_e F_c (H/3) + Y_t F_t (H/2)$$

Stability Against Sliding:

$$\Sigma \text{ Factored Resisting Force} = \phi V \tan \phi_F$$

$$\Sigma \text{ Factored Driving Force} = Y_e F_c + Y_t F_t$$

Bearing Pressure:

$$\text{Factored Bearing Pressure} = (Y_1 V + Y_2 qL) / (L - 2e) \quad (\text{use factored } e)$$

Eccentricity:

$$\text{Eccentricity } (e) = \frac{L}{2} - \frac{(V + qL)(L/2) - [F_v(H/3) + F_t(H/2)]}{V + qL}$$

(use factored V , qL , F_e , F_t for factored e)
 ($q=0$, $F_t=0$ for this case)

West Wall 100pcf Wet Case.xlsm - STR I MIN

T-WALL Retaining Wall Calculations v11c (LRFD, HWY, 2.5x5.0 Units) Revised BZY 3/3/2012
 Level Surcharge and Infinite Slope Condition
 LIMIT STATE: STRENGTH-I MIN
 PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (7th Ed., 2014)

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Project No: TOS 19553

Date: 3/11/2019

Revision: 0

Designed By: ABC

Checked by: KD

Wall Name West Wall - Wet Case

GRADING GEOMETRY

DISTANCE TO SLOPE (d) = 0 FT
 FILL SURCHARGE = 0 FT
 DISTANCE TO BREAK = 0 FT
 SLOPE ANGLE (β1) = 0.0 DEG
 SLOPE ANGLE (I) = 0.0 DEG
 TRAFFIC SURCHARGE = 2.4 FT

WALL GEOMETRY

HEIGHT (H) = 11.50
 BATTER () = 0
 BASE (L) = 10

BACKFILL SPECIFICATIONS

SELECT INTERNAL FRICTION (∅) = 34 DEG
 WEIGHT (γ) = 100 PCF
 COHESION = 0 (assumed)
 Ka = 0.2827
 Ko = 0.4408

UNCLASSIFIED INTERNAL FRICTION (∅) = 34 DEG
 WEIGHT (γ) = 100 PCF
 COHESION = 0 (assumed)
 Ka = 0.2827

FOUNDATION FOUNDATION TYPE = S (S for Soil, R for rock)
 INTERNAL FRICTION (∅f) = 34 DEG
 Kp = 3.5371

FRICTION FACTORS

JOINT MATERIAL TO CONCRETE = 0.59
 SELECT FILL TO CONCRETE = 0.50
 UNCLASSIFIED FILL TO CONCRETE = 0.50
 SELECT FILL TO FOUNDATION = tan(∅) = 0.67 (∅ is min of select fill and foundation)
 PRECAST CONCRETE TO FOUNDATION = 0.54 (0.8*TAN ∅f)

SHEAR KEY STRENGTH = 2460 lbs.

WATER PRESSURE

HEIGHT OF WATER TABLE BEHIND WALL = 7 FT (From bottom of wall)
 HEIGHT OF WATER TABLE BEFORE WALL = 4 FT (From bottom of wall)

Date: 3/11/2019
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RESISTANCE FACTORS

FRICION BETWEEN SOIL & SOIL :	1.00	
FRICION BETWEEN SOIL & CONC. :	0.90	
FRICION BETWEEN JOINT & CONC. :	0.90	
SHEAR THROUGH SHEAR KEY :	0.90	
PASSIVE PRESSURE AGAINST SLIDING :	0.50	(Not used for this project)
PASSIVE PRESSURE AGAINST OVERTURN. :	0.60	(Not used for this project)

LOAD FACTORS

DC (WEIGHT OF CONCRETE) :	0.90	
EV (WEIGHT OF SOIL) :	1.00	
EARTH PRESSURES (EH)		
HORIZONTAL COMPONENT :	1.50	
VERTICAL COMPONENT :	1.50	(Not used for this project)
CIRCULAR LIVE LOAD), LS (LIVE LOAD SURCHARGE) :	1.75	
WATER PRESSURE :	1.00	

LOCAL STABILITY

OVERTURNING

SUM FACTORED OVERTURNING MOMENT	99950
SUM FACTORED RESISTING MOMENT	182427
PERFORMANCE RATIO	1.83

SLIDING

SUM FACTORED HORIZONTAL FORCE	22755
FACTORED RESISTING FRICTION FORCE	24222
PERFORMANCE RATIO	1.06

MAXIMUM BEARING PRESSURE

Meyerhof distribution which considers a uniform base pressure distribution over an effective width of $B' = L - 2e$

Live load surcharge is present on the wall and behind the wall

MAXIMUM BEARING PRESSURE $S_v = \text{SUM VERTICAL LOADS}/(L-2e)$

FACTORED SUM OF VERTICAL LOADS =	58661	LB/5 FT WIDTH
FACTORED $e =$	1.80	$\leq L/4 =$ 2.50 ft ON SOIL
FACTORED BEARING PRESSURE =	1835	PSF
FACTORED BEARING RESISTANCE =	#NA	PSF
PERFORMANCE RATIO =	#VALUE!	

West Wall 100pcf Wet Case.xlsm - STR I MIN

Date: 3/11/2019

Revision: 0

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PERFORMANCE RATIO AT EACH LEVEL Live load is present behind the wall, but not on the wa

LEVEL	HEIGHT	ITEM LENGTH	No. OF SHEAR KEY	FACTORED LOAD EFFEC	FACTORED RESISTANCE	PERFORMA RATIO	
1	6.50	6.00	2	OVERTURN	22487	48241	2.15
				SLIDING	8698	15224	1.75
				PULLOUT	8377	9721	1.16
2	9.00	8.00	2	OVERTURN	52361	101296	1.93
				SLIDING	15399	21430	1.39
				PULLOUT	6142	13480	2.19
3	11.50	10.00	0	OVERTURN	99950	182427	1.83
				SLIDING	22755	24222	1.06
				PULLOUT	6664	13424	2.01

Date: 3/11/2019

Revision: 0

Designed By: ABC

Checked by: KD

LEVEL 3

STEM LENGTH = 10.00 FT
 HEIGHT = 11.50 FT

EARTH PRESSURE

Pa = 1437.24 plf
 Feh = 7186.19 lbs.
 Fev = 0.00 lbs.

TRAFFIC SURCHARGE & EARTH PRESSURE

Pt = 780.29 plf
 Ft = 3901.47 lbs.
 Fw = 5148.00 lbs.

STABILITY AGAINST SLIDING - LEVEL 3

SLIDING FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
Feh	7186.19	1.50	10779.28
Ft	3901.47	1.75	6827.57
Fw	5148.00	1.00	5148.00
TOTAL			22754.85

RESISTING FORCE

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
THRU SELECT FILL OR FOU	31702.14	1.00	0.67	1.00	21383.36
Fev	0.00	1.50	0.67	1.00	0.00
THRU JT. MAT'L OR FOUNDA	6493.80	0.90	0.54	0.90	2838.32
SHEAR KEY (SHEAR STREN	0.00	#N/A	0	0.90	0.00
EMBEDMENT	0.00	#N/A	#N/A	0.50	0.00
TOTAL					24221.68

PERFORMANCE RATIO = 1.06

STABILITY AGAINST PULLOUT - LEVEL 3

PULLOUT FORCE

	UNFACTORED LOAD	LOAD FACTOR	FACTORED
PULLOUT FORCE	1992.08	1.50	2988.12
TRAFFIC SURCHARGE F	763.33	1.75	1335.83
WATER PRESSURE	2340.00	1.00	2340.00
TOTAL			6663.95

RESISTING FORCE

Aeff. = 44.18 SF

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
ON STEM(SOIL TO SOIL IN A	5302.91	1.00	0.67	1.00	3576.86
ON STEM (SOIL TO CONCRE	15574.68	1.00	0.50	0.90	7008.60
THRU JT. MAT'L OR FOUNDA	6493.80	0.90	0.54	0.90	2838.32
SHEAR KEY (SHEAR STREN	0.00	#N/A	0	0.90	0.00
TOTAL					13423.78

PERFORMANCE RATIO = 2.01

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STABILITY AGAINST OVERTURNING - LEVEL 3

OVERTURNING MOMENT

	FORCE	MOMENT ARM	OVERTURNIN MOMENT	LOAD FACTOR	FACTORED MOMENT
Feh	7186.19	4.28	30788.67	1.50	46183.00
Ft	3901.47	5.75	22433.43	1.75	39258.50
Fw	5148.00	2.82	14508.00	1.00	14508.00
TOTAL					99949.50

RESISTING MOMENT

	WEIGHT	HORIZ. ARM	VERT. ARM	RESISTANCE FACTOR	FACTORED WEIGHT	FACTORED MOMENT
UNIT L1	2745.93	1.03	0.00	0.90	2471.34	2545.48
UNIT L2	1225.23	2.31	0.00	0.90	1102.71	2547.26
UNIT L3	1378.24	3.09	0.00	0.90	1240.42	3832.89
SELECT FILL L1	14060.01	3.25	0.00	1.00	14060.01	45695.03
SELECT FILL L2	3233.98	4.25	0.00	1.00	3233.98	13744.40
SELECT FILL L3	4108.55	5.25	0.00	1.00	4108.55	21569.90

Date: 3/11/2019

Revision: 0

Designed By: ABC

Checked by: KD

STABILITY AGAINST OVERTURNING - LEVEL 3 (CONTINUED)

	RESISTANCE FACTORED				FACTORED	
	WEIGHT	HORIZ. ARM	VERT. ARM	FACTOR	WEIGHT	MOMENT
STEP L2	5252.00	7.00	0.00	1.00	5252.00	36764.00
STEP L3	6192.00	9.00	0.00	1.00	6192.00	55728.00
EARTH SURCHARGE	0.00	0.00	0.00	1.00	0.00	0.00
Fev	0.00	10.00	0.00	1.50	0.00	0.00

TOTAL

37661.00	182426.94
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PERFORMANCE RATIO =

1.83

West Wall 100pcf Wet Case.xlsm - STR I MAX

T-WALL Retaining Wall Calculations v11c (LRFD, HWY, 2.5x5.0 Units) Revised BZY 3/3/2012
LIMIT STATE: STRENGTH-I MAX
 PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (7th Ed., 20

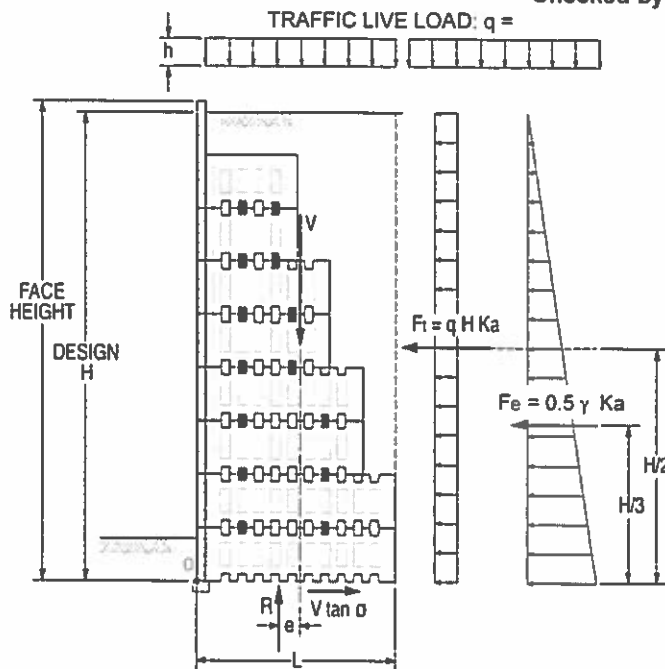
The Reinforced Earth Com
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Project No: TOS 19553
 Date: 3/11/2019

Wall Name West Wall - Wet Case

Revision: 0
 Designed By: ABC
 Checked by: KD

Load Diagram:



Typical Section (For illustration only, Some details may not apply)

External Stability Calculation (STRENGTH-I MAX)

Stability Against Overturning: (moments about point "O")

$$\Sigma \text{ Factored Resisting Mom} = \phi V \cdot x_o \quad (x_o \text{ is the horiz. distance between } V \text{ and } O)$$

$$\Sigma \text{ Factored overturning Mom} = Y_e F_e (H/3) + Y_t F_t (H/2)$$

Stability Against Sliding:

$$\Sigma \text{ Factored Resisting Force} = \phi V \tan \phi_F$$

$$\Sigma \text{ Factored Driving Force} = Y_e F_e + Y_t F_t$$

Bearing Pressure:

$$\text{Factored Bearing Pressure} = (Y_1 V + Y_2 qL) / (L - 2e); e \text{ factored } e$$

Eccentricity:

$$\text{Eccentricity } (e) = \frac{L}{2} - \frac{(V + qL)(L/2) - [F_v(H/3) + F_t(H/2)]}{V + qL}$$

(use factored V, qL, Fe, Ft for factored e)
 (q=0, Ft=0 for this case)

West Wall 100pcf Wet Case.xlsm - STR I MAX

T-WALL Retaining Wall Calculations v11c (LRFD, HWY, 2.5x5.0 Units) Revised BZY 3/3/2012
 Level Surcharge and Infinite Slope Condition
 LIMIT STATE: STRENGTH-I MAX
 PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (7th Ed., 20 Reston, VA 20191
 (703) 547-8797
 Project No: TOS 19553
 Date: 3/11/2019

Revision: 0
 Designed By: ABC
 Checked by: KD

Wall Name West Wall - Wet Case

GRADING GEOMETRY

DISTANCE TO SLOPE (d) = 0 FT
 FILL SURCHARGE = 0 FT
 DISTANCE TO BREAK = 0 FT
 SLOPE ANGLE (β1) = 0.0 DEG
 SLOPE ANGLE (I) = 0.0 DEG
 TRAFFIC SURCHARGE = 2.4 FT

WALL GEOMETRY

HEIGHT (H) = 11.50
 BATTER () = 0
 BASE (L) = 10

BACKFILL SPECIFICATIONS

SELECT INTERNAL FRICTION (∅) = 34 DEG
 WEIGHT () = 100 PCF
 COHESION = 0 (assumed)
 Ka = 0.2827
 Ko = 0.4408

UNCLASSIFIED INTERNAL FRICTION (∅) = 34 DEG
 WEIGHT () = 100 PCF
 COHESION = 0 (assumed)
 Ka = 0.2827

FOUNDATION FOUNDATION TYPE = S (S for Soil, R for rock)
 INTERNAL FRICTION (∅) = 34 DEG
 Kp = 3.5371

FRICTION FACTORS

JOINT MATERIAL TO CONCRETE = 0.59
 SELECT FILL TO CONCRETE = 0.50
 UNCLASSIFIED FILL TO CONCRETE = 0.50
 SELECT FILL TO FOUNDATION = tan(∅) = 0.67 (∅ is min of select fill and foundation)
 PRECAST CONCRETE TO FOUNDATION = 0.54 (0.8*TAN ∅)

SHEAR KEY STRENGTH = 2460 lbs.

WATER PRESSURE

HEIGHT OF WATER TABLE BEHIND WALL = 7 FT (From bottom of wall)
 HEIGHT OF WATER TABLE BEFORE WALL = 4 FT (From bottom of wall)

Date: 3/11/2019
 Revision: 0
 Designed By: ABC

RESISTANCE FACTORS

FRICTION BETWEEN SOIL & SOIL :	1.00	
FRICTION BETWEEN SOIL & CONC. :	0.90	
FRICTION BETWEEN JOINT & CONC. :	0.90	
SHEAR THROUGH SHEAR KEY :	0.90	
PASSIVE PRESSURE AGAINST SLIDING :	0.50	(Not used for this project)
PASSIVE PRESSURE AGAINST OVERTURN. :	0.60	(Not used for this project)

LOAD FACTORS

DC (WEIGHT OF CONCRETE) :	1.25	
EV (WEIGHT OF SOIL) :	1.35	
EARTH PRESSURES (EH)		
HORIZONTAL COMPONENT :	1.50	
VERTICAL COMPONENT :	1.50	(Not used for this project)
CIRCULAR LIVE LOAD), LS (LIVE LOAD SURCHARGE) :	1.75	
WATER PRESSURE :	1.00	

LOCAL STABILITY

OVERTURNING

SUM FACTORED OVERTURNING MOMENT	99950
SUM FACTORED RESISTING MOMENT	246623
PERFORMANCE RATIO	2.47

SLIDING

SUM FACTORED HORIZONTAL FORCE	22755
FACTORED RESISTING FRICTION FORCE	32810
PERFORMANCE RATIO	1.44

MAXIMUM BEARING PRESSURE

Meyerhof distribution which considers a uniform base pressure distribution over an effective width of $B' = L - 2e$

Live load surcharge is present on the wall and behind the wall

MAXIMUM BEARING PRESSURE $S_v = \text{SUM VERTICAL LOADS} / (L - 2e)$

FACTORED SUM OF VERTICAL LOADS =	72030	LB/5 FT WIDTH
FACTORED $e =$	1.51	$\leq L/4 =$ 2.50 ft ON SOIL
FACTORED BEARING PRESSURE =	2062	PSF
FACTORED BEARING RESISTANCE =	#NA	PSF
PERFORMANCE RATIO =	#VALUE!	

Date: 3/11/2019
 Revision: 0
 Designed By: ABC

PERFORMANCE RATIO AT EACH LEVEL Live load is present behind the wall, but not on the wa

LEVEL	HEIGHT	STEM LENGTH	No. OF SHEAR KEYS	FACTORED LOAD EFFECT	FACTORED RESISTANCE	PERFORMANCE RATIO
1	6.50	6.00	2	OVERTURN	22487	2.90
				SLIDING	8698	2.19
				PULLOUT	8377	1.39
2	9.00	8.00	2	OVERTURN	52361	2.62
				SLIDING	15399	1.78
				PULLOUT	6142	2.72
3	11.50	10.00	0	OVERTURN	99950	2.47
				SLIDING	22755	1.44
				PULLOUT	6664	2.74

Date: 3/11/2019
 Revision: 0
 Designed By: ABC

LEVEL 3

STEM LENGTH = 10.00 FT
 HEIGHT = 11.50 FT

EARTH PRESSURE		TRAFFIC SURCHARGE & EARTH PRESSURE	
Pa =	1437.24 plf	Pt =	780.29 plf
Feh =	7186.19 lbs.	Ft =	3901.47 lbs.
Fev =	0.00 lbs.	Fw =	5148.00 lbs.

STABILITY AGAINST SLIDING - LEVEL 3

SLIDING FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
Feh	7186.19	1.50	10779.28
Ft	3901.47	1.75	6827.57
Fw	5148.00	1.00	5148.00
TOTAL			22754.85

RESISTING FORCE

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
THRU SELECT FILL OR FOUR	31702.14	1.35	0.67	1.00	28867.54
Fev	0.00	1.50	0.67	1.00	0.00
THRU JT. MAT'L OR FOUNDA	6493.80	1.25	0.54	0.90	3942.11
SHEAR KEY (SHEAR STRENG	0.00	#N/A	0	0.90	0.00
EMBEDMENT	0.00	#N/A	#N/A	0.50	0.00
TOTAL					32809.65

PERFORMANCE RATIO = 1.44

STABILITY AGAINST PULLOUT - LEVEL 3

PULLOUT FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
PULLOUT FORCE	1992.08	1.50	2988.12
TRAFFIC SURCHARGE F	763.33	1.75	1335.83
WATER PRESSURE	2340.00	1.00	2340.00
TOTAL			6663.95

RESISTING FORCE

Aeff. = 44.18 SF

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
ON STEM(SOIL TO SOIL IN A	5302.91	1.35	0.67	1.00	4828.75
ON STEM (SOIL TO CONCRE	15574.68	1.35	0.50	0.90	9461.62
THRU JT. MAT'L OR FOUNDA	6493.80	1.25	0.54	0.90	3942.11
SHEAR KEY (SHEAR STRENG	0.00	#N/A	0	0.90	0.00
TOTAL					18232.48

PERFORMANCE RATIO = 2.74

STABILITY AGAINST OVERTURNING - LEVEL 3

OVERTURNING MOMENT

	FORCE	MOMENT ARM	OVERTURNING MOMENT	LOAD FACTOR	FACTORED MOMENT
Feh	7186.19	4.28	30788.67	1.50	46183.00
Ft	3901.47	5.75	22433.43	1.75	39258.50
Fw	5148.00	2.82	14508.00	1.00	14508.00
TOTAL					99949.50

RESISTING MOMENT

	WEIGHT	HORIZ. ARM	VERT. ARM	RESISTANCE FACTOR	FACTORED WEIGHT	FACTORED MOMENT
UNIT L1	2745.93	1.03	0.00	1.25	3432.41	3535.38
UNIT L2	1225.23	2.31	0.00	1.25	1531.54	3537.86
UNIT L3	1378.24	3.09	0.00	1.25	1722.80	5323.45
SELECT FILL L1	14060.01	3.25	0.00	1.35	18981.01	61688.29
SELECT FILL L2	3233.98	4.25	0.00	1.35	4365.87	18554.94
SELECT FILL L3	4108.55	5.25	0.00	1.35	5546.55	29119.36

Date: 3/11/2019

Revision: 0

Designed By: ABC

STABILITY AGAINST OVERTURNING - LEVEL 3 (CONTINUED)

	RESISTANCE FACTORED				FACTORED	
	WEIGHT	HORIZ. ARM	VERT. ARM	FACTOR	WEIGHT	MOMENT
STEP L2	5252.00	7.00	0.00	1.35	7090.20	49631.40
STEP L3	6192.00	9.00	0.00	1.35	8359.20	75232.80
EARTH SURCHARGE	0.00	0.00	0.00	1.35	0.00	0.00
Fev	0.00	10.00	0.00	1.50	0.00	0.00
TOTAL					51029.57	246623.48

PERFORMANCE RATIO = 2.47

West Wall 100pcf Wet Case.xlsm - SERVICE I

T-WALL Retaining Wall Calculations v11c (LRFD, HWY, 2.5x5.0 Units) Revised BZY 3/3/2012
 LIMIT STATE: SERVICE-I
 PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (7th Ed., 20

The Reinforced Earth Com
 12001 Sunrise Valley Drive
 Reston, VA 20191
 (703) 547-8797

Project No: TOS 19553

Date: 3/11/2019

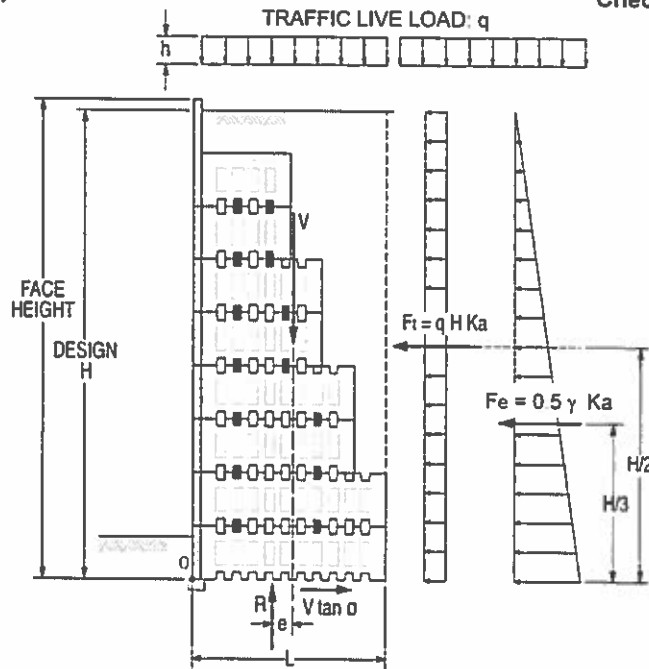
Revision: 0

Designed By: ABC

Checked by: KD

Wall Name West Wall - Wet Case

Load Diagram:



Typical Section, All details may not apply

External Stability Calculation (SERVICE-I)

Stability Against Overturning: (moments about point "O")

$$\Sigma \text{ Factored Resisting Mom} = \phi V \cdot x_o \quad (x_o \text{ is the horiz. distance between } V \text{ and } O)$$

$$\Sigma \text{ Factored overturning Mo} = Y_c F_c (H/3) + Y_t F_t (H/2)$$

Stability Against Sliding:

$$\Sigma \text{ Factored Resisting Force} = \phi V \tan \phi_F$$

$$\Sigma \text{ Factored Driving Force} = Y_c F_c + Y_t F_t$$

Bearing Pressure:

$$\text{Factored Bearing Pressure} = (Y_1 V + Y_2 qL) / (L - 2e); e \text{ factored } e$$

Eccentricity:

$$\text{Eccentricity } (e) = \frac{L}{2} - \frac{(V + qL)(L/2) - [F_v(H/3) + F_t(H/2)]}{V + qL}$$

(use factored V, qL, Fe, Ft for factored e)

West Wall 100pcf Wet Case.xlsm - SERVICE I

T-WALL Retaining Wall Calculations v11c (LRFD, HWY, 2.5x5.0 Units) Revised BZY 3/3/2012
 Level Surcharge and Infinite Slope Condition
 LIMIT STATE: SERVICE-I
 PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (7th Ed., 20

The Reinforced Earth Com
 12001 Sunrise Valley Drive
 Reston, VA 20191
 (703) 547-8797
 Project No: TOS 19553
 Date: 3/11/2019

Wall Name West Wall - Wet Case

Revision: 0
 Designed By: ABC
 Checked by: KD

GRADING GEOMETRY

DISTANCE TO SLOPE (d) = 0 FT
 FILL SURCHARGE = 0 FT
 DISTANCE TO BREAK = 0 FT
 SLOPE ANGLE (β1) = 0.0 DEG
 SLOPE ANGLE (I) = 0.0 DEG
 TRAFFIC SURCHARGE = 2.4 FT

WALL GEOMETRY

HEIGHT (H) = 11.50
 BATTER () = 0
 BASE (L) = 10

BACKFILL SPECIFICATIONS

SELECT INTERNAL FRICTION (Ø) = 34 DEG
 WEIGHT () = 100 PCF
 COHESION = 0 (assumed)
 Ka = 0.2827
 Ko = 0.4408

UNCLASSIFIED INTERNAL FRICTION (Ø) = 34 DEG
 WEIGHT () = 100 PCF
 COHESION = 0 (assumed)
 Ka = 0.2827

FOUNDATION FOUNDATION TYPE = S (S for Soil, R for rock)
 INTERNAL FRICTION (Ø) = 34 DEG
 Kp = 3.5371

FRICITION FACTORS

JOINT MATERIAL TO CONCRETE = 0.59
 SELECT FILL TO CONCRETE = 0.50
 UNCLASSIFIED FILL TO CONCRETE = 0.50
 SELECT FILL TO FOUNDATION = tan(Ø) = 0.67 (Ø is min of select fill and foundation)
 PRECAST CONCRETE TO FOUNDATION = 0.54 (0.8*TAN Øf)

SHEAR KEY STRENGTH = 2460 lbs.

WATER PRESSURE

IGHT OF WATER TABLE BEHIND WALL = 7 FT (From bottom of wall)
 GHT OF WATER TABLE BEFORE WALL = 4 FT (From bottom of wall)

WIND ON SOUND BARRIER/OTHER STRUCTURE

WIND FORCE = 0 LBS
 CE FROM TOP OF WALL/GUTTER LINE = 0 FT

Date: 3/11/2019
 Revision: 0
 Designed By: ABC

RESISTANCE FACTORS

FRICITION BETWEEN SOIL & SOIL :	1.00	
FRICITION BETWEEN SOIL & CONC. :	1.00	
FRICITION BETWEEN JOINT & CONC. :	1.00	
SHEAR THROUGH SHEAR KEY :	1.00	
PASSIVE PRESSURE AGAINST SLIDING :	1.00	(Not used for this project)
PASSIVE PRESSURE AGAINST OVERTURN. :	1.00	(Not used for this project)

LOAD FACTORS

DC (WEIGHT OF CONCRETE) :	1.00	
EV (WEIGHT OF SOIL) :	1.00	
EARTH PRESSURES (EH)		
HORIZONTAL COMPONENT :	1.00	
VERTICAL COMPONENT :	1.00	(Not used for this project)
CIRCULAR LIVE LOAD), LS (LIVE LOAD SURCHARGE) :	1.00	
WATER PRESSURE :	1.00	
WIND LOAD :	0.30	

LOCAL STABILITY

OVERTURNING

SUM FACTORED OVERTURNING MOMENT	67730
SUM FACTORED RESISTING MOMENT	183419
PERFORMANCE RATIO:	2.71

SLIDING

SUM FACTORED HORIZONTAL FORCE	16236
FACTORED RESISTING FRICTION FORCE	24887
PERFORMANCE RATIO:	1.53

MAXIMUM BEARING PRESSURE

Meyerhof distribution which considers a uniform base pressure distribution over an effective width of $B' = L - 2e$

Live load surcharge is present on the wall and behind the wall

MAXIMUM BEARING PRESSURE: $\sigma_v = \text{SUM VERTICAL LOADS}/(L-2e)$

FACTORED SUM OF VERTICAL LOADS =	50196	LB/5 FT WIDTH
FACTORED e =	1.50	$\leq L/4 = 2.50$ ft ON SOIL
FACTORED BEARING PRESSURE =	1434	PSF
FACTORED BEARING CAPACITY =	#NA	PSF
PERFORMANCE RATIO =	#VALUE!	

West Wall 100pcf Wet Case.xlsm - SERVICE I

Date: 3/11/2019

Revision: 0

Designed By: ABC

FACTORS OF SAFETY AT EACH LEVEL Live load is present behind the wall, but not on the wa

LEVEL	HEIGHT	ITEM LENGTH	No. OF SHEAR KEY	FACTORED LOAD	FACTORED RESISTANCE	PERFORMANCE RATIO	
1	6.50	6.00	2	OVERTURN	13935	48523	3.48
				SLIDING	5639	16024	2.84
				PULLOUT	5439	10813	1.99
2	9.00	8.00	2	OVERTURN	34138	101862	2.98
				SLIDING	10693	22426	2.10
				PULLOUT	4696	14984	3.19
3	11.50	10.00	0	OVERTURN	67730	183419	2.71
				SLIDING	16236	24887	1.53
				PULLOUT	5095	14868	2.92

Date: 3/11/2019
 Revision: 0
 Designed By: ABC

LEVEL 3

STEM LENGTH = 10.00 FT
 HEIGHT = 11.50 FT

EARTH PRESSURE		TRAFFIC SURCHARGE & WATER PRESSURE	
Pa =	1437.24 plf	Pt =	780.29 plf
Feh =	7186.19 lbs.	Ft =	3901.47 lbs.
Fev =	0.00 lbs.	Fw =	5148.00 lbs.

STABILITY AGAINST SLIDING - LEVEL 3

SLIDING FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
Feh	7186.19	1.00	7186.19
Ft	3901.47	1.00	3901.47
Fw	5148.00	1.00	5148.00
WIND LOAD	0.00	0.30	0.00
TOTAL			16235.66

RESISTING FORCE

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
THRU SELECT FILL OR FOU	31702.14	1.00	0.67	1.00	21383.4
Fev	0.00	1.00	0.67	1.00	0.0
THRU JT. MATERIAL OR FOU	6493.80	1.00	0.54	1.00	3504.1
SHEAR KEY (SHEAR STREN	0.00	#N/A	0	1.00	0.0
EMBEDMENT	0.00	#N/A	#N/A	1.00	0.0
TOTAL					24887.5

PERFORMANCE RATIO = 1.53

STABILITY AGAINST PULLOUT - LEVEL 3

PULLOUT FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
PULLOUT FORCE	1992.08	1.00	1992.08
TRAFFIC SURCHARGE F	763.33	1.00	763.33
WATER PRESSURE	2340.00	1.00	2340.00
TOTAL			5095.41

RESISTING FORCE

Aeff. = 44.18 SF

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
ON STEM(SOIL TO SOIL IN A	5302.91	1.00	0.67	1.00	3576.9
ON STEM (SOIL TO CONCRE	15574.68	1.00	0.50	1.00	7787.3
THRU JT. MATERIAL OR FOU	6493.80	1.00	0.54	1.00	3504.1
SHEAR KEY (SHEAR STREN	0.00	#N/A	0	1.00	0.0
TOTAL					14868.3

PERFORMANCE RATIO = 2.92

Date: 3/11/2019
 Revision: 0
 Designed By: ABC

STABILITY AGAINST OVERTURNING - LEVEL 3

OVERTURNING MOMENT

	FORCE	MOMENT ARM	OVERTURNING MOMENT	LOAD FACTOR	FACTORED MOMENT
Feh	7186.19	4.28	30788.7	1.00	30788.7
Ft	3901.47	5.75	22433.4	1.00	22433.4
Fw	5148.00	2.82	14508.0	1.00	14508.0
WIND LOAD	0.00	11.50	0.00	0.30	0.00
TOTAL					67730.1

RESISTING MOMENT

	WEIGHT	HORIZ. ARM	VERT. ARM	RESISTANCE FACTOR	FACTORED WEIGHT	FACTORED RESISTANCE
PANEL L1	2745.93	1.03	0.00	1.00	2745.9	2828.3
PANEL L2	1225.23	2.31	0.00	1.00	1225.2	2830.3
PANEL L3	1378.24	3.09	0.00	1.00	1378.2	4258.8
SELECT FILL L1	14060.01	3.25	0.00	1.00	14060.0	45695.0
SELECT FILL L2	3233.98	4.25	0.00	1.00	3234.0	13744.4
SELECT FILL L3	4108.55	5.25	0.00	1.00	4108.6	21569.9

Date: 3/11/2019
 Revision: 0
 Designed By: ABC

STABILITY AGAINST OVERTURNING - LEVEL 3 (CONTINUED)

	WEIGHT	HORIZ. ARM	VERT. ARM	RESISTANCE FACTORED		
				FACTOR	WEIGHT	RESISTANCE
STEP L2	5252.00	7.00	0.00	1.00	5252.0	36764.0
STEP L3	6192.00	9.00	0.00	1.00	6192.0	55728.0
EARTH SURCHARGE	0.00	0.00	0.00	1.00	0.0	0.0
Fev	0.00	10.00	0.00	1.00	0.0	0.0
TOTAL					38195.94	183418.68

PERFORMANCE RATIO = 2.71

West Wall 100pcf Wet Case.xlsm - EXT I

T-WALL Retaining Wall Calculations v11c (LRFD, HWY, 2.5x5.0 Units) Revised BZY 3/3/2012
LIMIT STATE: EXTREME I SEISMIC DESIGN
 PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (7th Ed., 2011) 12001 Sunrise Valley Drive
 Reston, VA 20191
 Level Surcharge and Infinite Slope Condition

(703) 547-8797

Project No: TOS 19553

Date: 3/11/2019

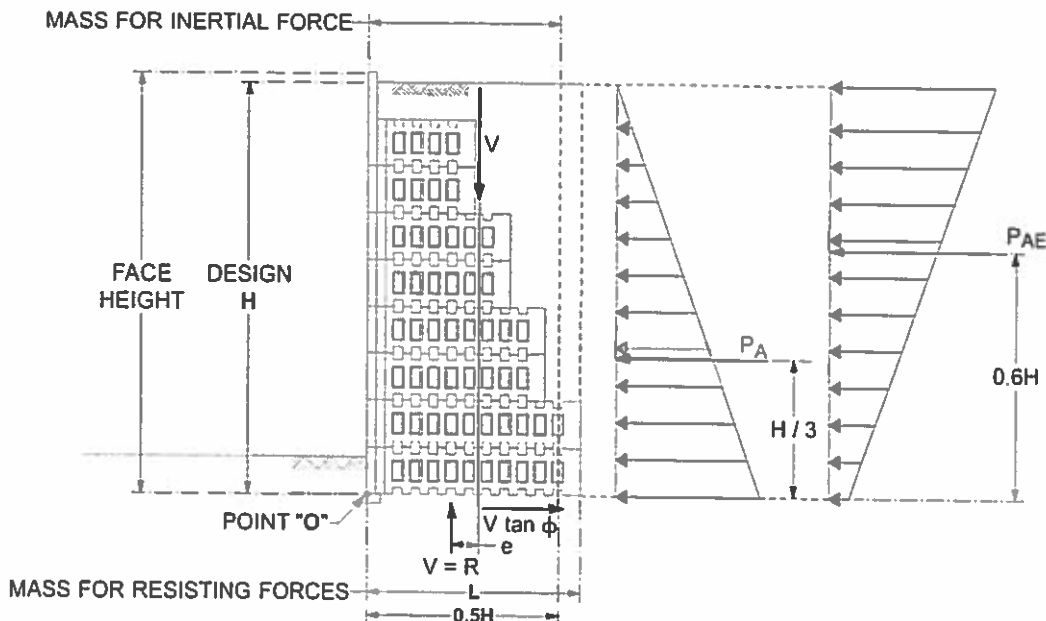
Revision: 0

Designed By: ABC

Checked by: KD

Wall Name West Wall - Wet Case

LOAD DIAGRAM



Typical Section (For illustration only, Some details may not apply)

GRADING GEOMETRY

DISTANCE TO SLOPE (d) =	0	FT
FILL SURCHARGE =	0	FT
DISTANCE TO BREAK =	0	FT
SLOPE ANGLE (b1) =	0.0	DEG
SLOPE ANGLE (l) =	0.0	DEG
TRAFFIC SURCHARGE =	2.4	FT

WALL GEOMETRY

HEIGHT (H)	11.50
BATTER () =	0
BASE (L)	10

Project Name: Nassau Expressway Operational Improvements
Location: Nassau, NY
Wall Name: West Wall - Wet Case

Project No: TOS 19553
Date: 3/11/2019
Revision: 0
Designed By: ABC
Checked by: KD

BACKFILL SPECIFICATIONS

SELECT INTERNAL FRICTION (ϕ)= 34 EG Ka = 0.2827
 WEIGHT ()= 100 CF Ko = 0.4408
 COHESION= 0 (assumed)

UNCLASSIFIED INTERNAL FRICTION (ϕ)= 34 EG Ka = 0.2827
 WEIGHT ()= 100 PCF
 COHESION = 0 (assumed)

FOUNDATION INTERNAL FRICTION (ϕ)= 34 EG Kp = 3.5371

FRICTION FACTORS

JOINT MATERIAL TO CONCRETE = 0.59
 SELECT FILL TO CONCRETE = 0.50
 UNCLASSIFIED FILL TO CONCRETE = 0.50
 SELECT FILL TO FOUNDATION = $\tan(\phi)$ = 0.67 (ϕ is min of select fill and foundation)
 RECAST CONCRETE TO FOUNDATION = 0.54 ($0.8 \cdot \tan \phi_f$)
 SHEAR KEY STRENGTH = 2460 lbs.

WATER PRESSURE

HEIGHT OF WATER TABLE BEHIND WALL = 7 FT (From bottom of wall)
 HEIGHT OF WATER TABLE BEFORE WALL = 4 FT (From bottom of wall)

RESISTANCE FACTORS

FRICITION BETWEEN SOIL & SOIL : 1.00
 FRICITION BETWEEN SOIL & CONC. : 1.00
 FRICITION BETWEEN JOINT & CONC. : 1.00
 SHEAR THROUGH SHEAR KEY : 1.00
 PASSIVE PRESSURE AGAINST SLIDING : 1.00 (Not used for this project)
 PASSIVE PRESSURE AGAINST OVERTURN. : 1.00 (Not used for this project)

LOAD FACTORS

DC (WEIGHT OF CONCRETE) : 1.00
 EV (WEIGHT OF SOIL) : 1.00
 LL (VEHICULAR LIVE LOAD) : 0.00
 EQ (SEISMIC PRESSURE AND INERTIA FORCE) : 1.00
 WATER PRESSURE : 1.00

Wall Name West Wall - Wet Case

SEISMIC ANALYSIS (Per 5 ft section)

Wall height at front face H = 11.50 ft
 Wall Height behind the stem h = 11.50 ft

SEISMIC ACTIVE EARTH PRESSURE (Combined static and seismic pressure)

Acceleration coefficient A = 0.2
 Angle of friction between soil and wall $\delta = 0$ deg.
 Angle of sloping backfill $i = 0.00$ deg.
 Wall batter $\beta = 0$ deg.
 Horizon. comp. of earthquake accel. coeff. $K_h = A/2 = 0.100$ (AASHTO A11.1.1.2)
 Vertical comp. of earthquake accel. coeff. $K_v = 0.00$
 $\theta = \text{atan}[K_h/(1-K_v)] = 5.71$ deg.

$$K_{AE} = \frac{\cos^2(\phi - \theta - \beta)}{\cos\theta \cos^2\beta \cos(\delta + \beta + \theta)} \times \left[1 + \frac{\sin(\phi + \delta)\sin(\phi - \theta - i)}{\cos(\delta + \beta + \theta)\cos(i - \beta)} \right]^2$$

= 0.341 (AASHTO 11.1.1.1-2)

Seismic earth pressure $E_{AE} = 0.5 \gamma h^2(1-k_v) K_{AE} = 2,253$ lbs/ft (AASHTO 11.1.1.1-1)

Static component $E_a = 0.5 \gamma h^2 K_a = 1,869$ lbs/ft
 Acting at $Y = h/3 = 3.83$ ft

Dynamic component $P_{AE} = E_{AE} - E_a = 384$ lbs/ft
 Acting at $Y = 0.6h = 6.90$ ft

Seismic earth pressure $E_{AE} = 11,265$ lbs per 5ft
 Acting at angle i and 4.36 ft from point "O"

SEISMIC INERTIA FORCE

Inertia force; rectangle(P_{IR}) = $K_h \cdot \text{Weight of Wall} = 3,820$ lbs
 Acting horizontally at = 5.75 ft
 Inertia force; triangle, (P_{IS}) = $K_h \cdot \text{Weight of Wall} = 0$ lbs
 Acting horizontally at = 11.50 ft
TOTAL INERTIA (P_{IR}) = 3,820 lbs
 Acting horizontally at = 5.75 ft

Project No: TOS 19553

Date: 3/11/2019

Revision: 0

Designed By: ABC

Checked by: KD

Wall Name West Wall - Wet Case

TRAFFIC SURCHARGE

TRAFFIC SURCHARGE (Pt) =	3,901	lbs
Acting parallel to slope (i) at	5.75	ft
HORIZONTAL COMPONENT =	3,901	lbs
VERTICAL COMPONENT =	0	lbs

WATER PRESSURE

WATER PRESSURE (Pw) =	5,148	lbs
Acting horizontally at	2.82	ft

SEISMIC LOCAL STABILITY

SLIDING

DRIVING FORCE

	UNFACTORED FORCE	OAD FACTOR	FACTORED FORCE
I. SEISMIC PRESSURE(EAE)	11,265	1.0	11,265
INERTIA (PIR)	3,820	1.0	3,820
Z. TRAFFIC SURCHARGE(Pt)	3,901	0.0	0
WATER PRESSURE(Pw)	5,148	1.0	5,148
	Total		20,233

RESISTING FORCE

	UNFACTORED RESISTANCE	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
WEIGHT OF SOIL	31,702	0.67	1.0	21,383
WEIGHT OF CONCRETE	6,494	0.50	1.0	3,247
VERT. COMPONENT OF EAE	0	0.67	1.0	0
VERT. COMPONENT OF Pt	0	0.67	0.0	0
	Total			24,630

PERFORMANCE RATIO AGAINST SLIDING = 1.22

Project No: TOS 19553

Date: 3/11/2019

Revision: 0

Designed By: ABC

Checked by: KD

Wall Name West Wall - Wet Case

OVERTURNING

OVERTURNING MOMENTS

	UNFACTORED		UNFACTORED		FACTORED
	FORCE	MOMENT ARM	MOMENT	OAD FACTOR	
I. SEISMIC PRESSURE(EAE)	11,265	4.36	49064.47	1.0	49,064
INERTIA (PIR)	3,820	5.75	21962.66	1.0	21,963
TRAFFICE SURCHARGE (Pt)	3,901	5.75	22433.43	0.0	0
WATER PRESSURE(Pw)	5,148	2.82	14508.00	1.0	14,508
		Total	93460.56		85,535

RESISTING MOMENTS

	UNFACTORED		UNFACTORED		FACTORED
	FORCE	MOMENT ARM	MOMENT	RESISTANCE FACTOR	
WEIGHT OF SOIL	31,702	5.47	173501.322	1.0	173,501
WEIGHT OF CONCRETE	6,494	1.53	9917	1.0	9,917
VERT. COMP. OF EAE	0	10.00	0	1.0	0
VERT. COMPONENT OF Pt	0	10.00	0	0.0	0
Total	38,196		183418.675		183,419

PERFORMANCE RATIO AGAINST OVERTURNING = 2.14

BEARING PRESSURE

Meyerhof distribution which considers a uniform base pressure distribution over an effective width of $B' = L - 2e$

MAXIMUM BEARING PRESSURE $S_v = \text{SUM VERTICAL LOADS} / (L - 2e)$

FACTORED SUM OF VERTICAL LOADS = 38196 LB/5 FT WIDTH
 FACTORED $e = \text{span style="border: 1px solid black; padding: 2px;">2.44$ $\leq 2L/5 = \text{span style="border: 1px solid black; padding: 2px;">4.00$
 FACTORED BEARING PRESSURE = 1490 PSF

FACTORED BEARING CAPACITY = #NA PSF

PERFORMANCE RATIO = #VALUE!

West Wall 100pcf Wet Case.xlsm - EXT II

T-WALL Retaining Wall Calculations v11c (LRFD, HWY, 2.5x5.0 Units) Revised BZY 3/3/2012
 LIMIT STATE: EXTREME II
 PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (7th Ed., 2011) 12001 Sunrise Valley Drive
 Level Surcharge and Infinite Slope Condition

The Reinforced Earth Com
 Reston, VA 20191
 (703) 547-8797

Project No: TOS 19553

Date: 3/11/2019

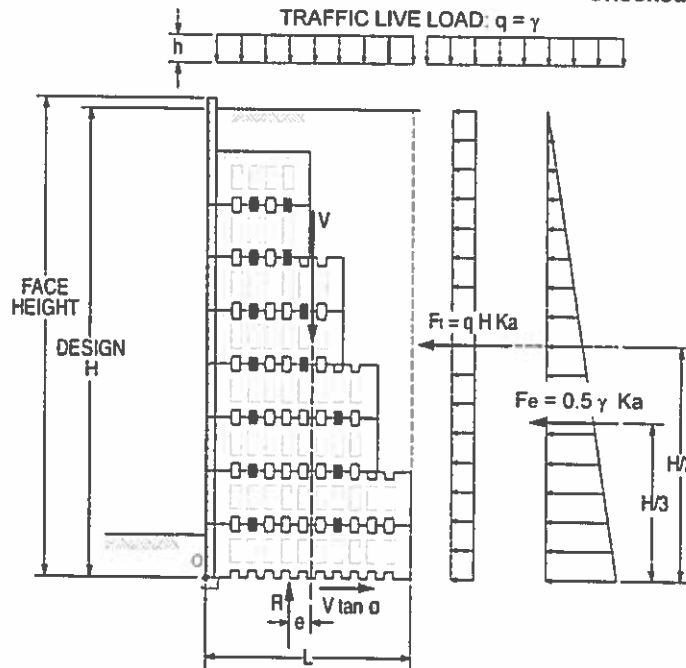
Revision: 0

Designed By: ABC

Checked by: KD

Wall Name West Wall - Wet Case

Load Diagram:



Typical Section, some details may not apply

External Stability Calculation (EXTREME II)

Stability Against Overturning: (moments about point "O")

$$\Sigma \text{ Factored Resisting Moment} = \phi V \cdot x_0 \quad (x_0 \text{ is the horiz. distance between } V \text{ and } O)$$

$$\Sigma \text{ Factored overturning Mo} = Y_e F_e (H/3) + Y_t F_t (H/2)$$

Stability Against Sliding:

$$\Sigma \text{ Factored Resisting Force} = \phi V \tan \phi_F$$

$$\Sigma \text{ Factored Driving Force} = Y_e F_e + Y_t F_t$$

Bearing Pressure:

$$\text{Factored Bearing Pressure} = (Y_1 V + Y_2 qL) / (L - 2e) \quad (e \text{ factored } e)$$

Eccentricity:

$$\text{Eccentricity (e)} = \frac{L}{2} - \frac{(V + qL)(L/2) - [F_e(H/3) + F_t(H/2)]}{V + qL}$$

(use factored V, qL, Fe, Ft for factored e)

West Wall 100pcf Wet Case.xlsm - EXT II

T-WALL Retaining Wall Calculations v11c (LRFD, HWY, 2.5x5.0 Units) Revised BZY 3/3/2012
 Level Surcharge and Infinite Slope Condition
 LIMIT STATE: EXTREME II
 PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (7th Ed., 2011) Reston, VA 20191
 (703) 547-8797
 Project No: TOS 19553
 Date: 3/11/2019

The Reinforced Earth Com
 12001 Sunrise Valley Drive
 Reston, VA 20191
 (703) 547-8797
 Project No: TOS 19553
 Date: 3/11/2019
 Revision: 0
 Designed By: ABC
 Checked by: KD

Wall Name West Wall - Wet Case

GRADING GEOMETRY

DISTANCE TO SLOPE (d) = FT
 FILL SURCHARGE = FT
 DISTANCE TO BREAK = FT
 SLOPE ANGLE (β1) = DEG
 SLOPE ANGLE (l) = DEG
 TRAFFIC SURCHARGE = FT

WALL GEOMETRY

HEIGHT (H) =
 BATTER () =
 BASE (L) =

BACKFILL SPECIFICATIONS

SELECT INTERNAL FRICTION (Ø) = DEG
 WEIGHT (γ) = PCF
 COHESION = (assumed)
 Ka =
 Ko =

UNCLASSIFIED INTERNAL FRICTION (Ø) = DEG
 WEIGHT (γ) = PCF
 COHESION = (assumed)
 Ka =

FOUNDATION FOUNDATION TYPE = (S for Soil, R for rock)
 INTERNAL FRICTION (Ø) = DEG
 Kp =

FRICTION FACTORS

JOINT MATERIAL TO CONCRETE = 0.59
 SELECT FILL TO CONCRETE = 0.50
 UNCLASSIFIED FILL TO CONCRETE = 0.50
 SELECT FILL TO FOUNDATION = tan(Ø) = (Ø is min of select fill and foundation)
 PRECAST CONCRETE TO FOUNDATION = (0.8*TAN Øf)

SHEAR KEY STRENGTH = 2460 lbs.

WATER PRESSURE

HEIGHT OF WATER TABLE BEHIND WALL = FT (From bottom of wall)
 HEIGHT OF WATER TABLE BEFORE WALL = FT (From bottom of wall)

BARRIER OR PARAPET

IMPACT FORCE ON BARRIER = LBS PER 5 FT
 HEIGHT OF BARRIER = FT

Date: 3/11/2019
 Revision: 0
 Designed By: ABC

RESISTANCE FACTORS

FRICITION BETWEEN SOIL & SOIL :	1.00	
FRICITION BETWEEN SOIL & CONC. :	1.00	
FRICITION BETWEEN JOINT & CONC. :	1.00	
SHEAR THROUGH SHEAR KEY :	1.00	
PASSIVE PRESSURE AGAINST SLIDING :	1.00	(Not used for this project)
PASSIVE PRESSURE AGAINST OVERTURN. :	1.00	(Not used for this project)

LOAD FACTORS

DC (WEIGHT OF CONCRETE) :	0.90	
EV (WEIGHT OF SOIL) :	1.00	
EARTH PRESSURES (EH)		
HORIZONTAL COMPONENT :	1.50	
VERTICAL COMPONENT :	1.50	(Not used for this project)
CIRCULAR LIVE LOAD), LS (LIVE LOAD SURCHARGE) :	0.50	
WATER PRESSURE :	1.00	
VEHICLE COLLISION FORCE :	1.00	

LOCAL STABILITY

OVERTURNING

SUM FACTORED OVERTURNING MOMENT	71908
SUM FACTORED RESISTING MOMENT	182427
PERFORMANCE RATIO:	2.54

SLIDING

SUM FACTORED HORIZONTAL FORCE	17878
FACTORED RESISTING FRICTION FORCE	24537
PERFORMANCE RATIO:	1.37

MAXIMUM BEARING PRESSURE

Meyerhof distribution which considers a uniform base pressure distribution over an effective width of $B' = L - 2e$

Live load surcharge is present on the wall and behind the wall

MAXIMUM BEARING PRESSURE $S_v = \text{SUM VERTICAL LOADS}/(L-2e)$

FACTORED SUM OF VERTICAL LOADS =	43661	LB/5 FT WIDTH
FACTORED $e =$	1.78	$\leq L/4 =$ 2.50 ft ON SOIL
FACTORED BEARING PRESSURE =	1357	PSF
FACTORED BEARING RESISTANCE =	#NA	PSF
PERFORMANCE RATIO =	#VALUE!	

Date: 3/11/2019
 Revision: 0
 Designed By: ABC

FACTORS OF SAFETY AT EACH LEVEL Live load is present behind the wall, but not on the wa

LEVEL	HEIGHT	STEM LENGTH	No. OF SHEAR KEYS	FACTORED LOAD EFFECT	FACTORED RESISTANCE	PERFORMANCE RATIO	
1	6.50	6.00	2	OVERTURNING	38528	48241	1.25
				SLIDING	8441	15862	1.88
				PULLOUT	8227	10651	1.29
2	9.00	8.00	2	OVERTURNING	66436	101296	1.52
				SLIDING	14082	22161	1.57
				PULLOUT	7688	14719	1.91
3	11.50	10.00	0	OVERTURNING	71908	182427	2.54
				SLIDING	17878	24537	1.37
				PULLOUT	5710	14518	2.54

Date: 3/11/2019
 Revision: 0
 Designed By: ABC

LEVEL 3

STEM LENGTH = 10.00 FT
 HEIGHT = 11.50 FT

EARTH PRESSURE
 Pa = 1437.24 plf
 Feh = 7186.19 lbs.
 Fev = 0.00 lbs.

TRAFFIC SURCHARGE & EARTH PRESSURE
 Pt = 780.29 plf
 Ft = 3901.47 lbs.
 Fw = 5148.00 lbs.

STABILITY AGAINST SLIDING - LEVEL 3

SLIDING FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
Feh	7186.19	1.50	10779.28
Ft	3901.47	0.50	1950.73
Fw	5148.00	1.00	5148.00
TOTAL			17878.02

RESISTING FORCE

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
THRU SELECT FILL OR FOU	31702.14	1.00	0.67	1.00	21383.36
Fev	0.00	1.50	0.67	1.00	0.00
THRU JT. MAT'L OR FOUNDA	6493.80	0.90	0.54	1.00	3153.69
SHEAR KEY (SHEAR STRENG	0.00	#N/A	0	1.00	0.00
EMBEDMENT	0.00	#N/A	#N/A	1.00	0.00
TOTAL					24537.05

PERFORMANCE RATIO = 1.37

STABILITY AGAINST PULLOUT - LEVEL 3

PULLOUT FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
PULLOUT FORCE	1992.08	1.50	2988.12
TRAFFIC SURCHARGE F	763.33	0.50	381.67
WATER PRESSURE	2340.00	1.00	2340.00
TOTAL			5709.79

RESISTING FORCE

Aeff. = 44.18 SF

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
ON STEM(SOIL TO SOIL IN A	5302.91	1.00	0.67	1.00	3576.86
ON STEM (SOIL TO CONCRE	15574.68	1.00	0.50	1.00	7787.34
THRU JT. MAT'L OR FOUNDA	6493.80	0.90	0.54	1.00	3153.69
SHEAR KEY (SHEAR STRENG	0.00	#N/A	0	1.00	0.00
TOTAL					14517.88

PERFORMANCE RATIO = 2.54

Date: 3/11/2019
 Revision: 0
 Designed By: ABC

STABILITY AGAINST OVERTURNING - LEVEL 3

OVERTURNING MOMENT

	FORCE	MOMENT ARM	OVERTURNING MOMENT	LOAD FACTOR	FACTORED MOMENT
Feh	7186.19	4.28	30788.67	1.50	46183.00
Ft	3901.47	5.75	22433.43	0.50	11216.71
Fw	5148.00	2.82	14508.00	1.00	14508.00
TOTAL					71907.72

RESISTING MOMENT

	WEIGHT	HORIZ. ARM	VERT. ARM	RESISTANCE FACTOR	FACTORED WEIGHT	FACTORED MOMENT
UNIT L1	2745.93	1.03	0.00	0.90	2471.34	2545.48
UNIT L2	1225.23	2.31	0.00	0.90	1102.71	2547.26
UNIT L3	1378.24	3.09	0.00	0.90	1240.42	3832.89
SELECT FILL L1	14060.01	3.25	0.00	1.00	14060.01	45695.03
SELECT FILL L2	3233.98	4.25	0.00	1.00	3233.98	13744.40
SELECT FILL L3	4108.55	5.25	0.00	1.00	4108.55	21569.90

Date: 3/11/2019
 Revision: 0
 Designed By: ABC

STABILITY AGAINST OVERTURNING - LEVEL 3 (CONTINUED)

	WEIGHT	HORIZ. ARM	VERT. ARM	RESISTANCE FACTORED FACTOR	FACTORED WEIGHT	FACTORED MOMENT
STEP L2	5252.00	7.00	0.00	1.00	5252.00	36764.00
STEP L3	6192.00	9.00	0.00	1.00	6192.00	55728.00
EARTH SURCHARGE	0.00	0.00	0.00	1.00	0.00	0.00
Fev	0.00	10.00	0.00	1.50	0.00	0.00
TOTAL					37661.00	182426.94

PERFORMANCE RATIO = 2.54

T-WALL® Retaining Wall System

Shop Drawing Calculations

West Wall - Dry Case

**Stability Calculations
100pcf**

PROJECT INFO

Wall Name: West Wall - Dry Case
 Project No: TOS 19553
 Date: 3/11/2019
 Designed By: ABC
 Checked by: KD

DESIGN CASES

Service: Yes
 Ext I: Yes
 Ext II: Yes

ASHTO LRFD Edition 7th Ed. 2014

PROGRAM VERSION

Name: T-WALL Retaining Wall Calculations
 Method: LRFD
 Loading: HWY
 Units: 2.5x5 0 Units
 Version: v11c
 Date: 3/2/2012
 By: BZY

SOIL PROPERTIES

STR I Min: Yes
 STR I Max: Yes
 STR II Min: No
 STR II Max: No
 STR V Min: No
 STR V Max: No

FACE DIMENSIONS

FACE WIDTH = 5 FT
 FACE THICKNESS = 0.5 FT
 STEM THICKNESS = 0.5 FT

LEVEL 1 DIMENSIONS

DEPTH TO MOMENT SLAB = 2.00 FT
 TOP UNIT FACE HEIGHT = 4.50 FT
 TOP UNIT STEM HEIGHT = 2.50 FT

WATER PRESSURE

HEIGHT OF WATER TABLE BEHIND WALL = 0.00 FT (From bottom of wall)
 HEIGHT OF WATER TABLE IN FRONT OF WALL = 0.00 FT (From bottom of wall)

SOIL PROPERTIES

INTERNAL FRICTION (φ) = 34 DEG
 WEIGHT (γ) = 100 PCF
 COHESION = 0 (assumed)

UNCLASSIFIED

INTERNAL FRICTION (φ) = 34 DEG
 WEIGHT (γ) = 100 PCF
 COHESION = 0 (assumed)

FOUNDATION

FOUNDATION TYPE = S (S for Soil, R for rock)
 INTERNAL FRICTION (φ) = 34 DEG
 FACTORED BEARING RESISTANCE = #NA PSF

WALL GEOMETRY

BATTER (1) = 0

GRADING GEOMETRY

DISTANCE TO SLOPE (d) = 0 FT
 FILL SURCHARGE = 0 FT
 DISTANCE TO BREAK = 0 FT
 SLOPE ANGLE (α1) = 0.0 DEG
 SLOPE ANGLE (α) = 0.0 DEG
 TRAFFIC SURCHARGE = 2.4 FT

SEISMIC

VEHICLE COLLISION FORCE = 2500 LBS per 5 ft
 HEIGHT OF BARRIER = 3.50 FT (from gutter line / pavement)

SOIL PROPERTIES

INTERNAL FRICTION (φ) = 34 DEG
 WEIGHT (γ) = 100 PCF
 COHESION = 0 (assumed)

UNCLASSIFIED

INTERNAL FRICTION (φ) = 34 DEG
 WEIGHT (γ) = 100 PCF
 COHESION = 0 (assumed)

FOUNDATION

FOUNDATION TYPE = S (S for Soil, R for rock)
 INTERNAL FRICTION (φ) = 34 DEG
 FACTORED BEARING RESISTANCE = #NA PSF

WALL GEOMETRY

BATTER (1) = 0

GRADING GEOMETRY

DISTANCE TO SLOPE (d) = 0 FT
 FILL SURCHARGE = 0 FT
 DISTANCE TO BREAK = 0 FT
 SLOPE ANGLE (α1) = 0.0 DEG
 SLOPE ANGLE (α) = 0.0 DEG
 TRAFFIC SURCHARGE = 2.4 FT

SEISMIC

VEHICLE COLLISION FORCE = 2500 LBS per 5 ft
 HEIGHT OF BARRIER = 3.50 FT (from gutter line / pavement)

SEISMIC

ACCELERATION COEFFICIENT (A) = 0.20
 FRICTION ANGLE BETWEEN SOIL AND WALL (δ) = 0 DEG
 VERTICAL COMP. OF EARTHQUAKE ACCEL. COEFF = 0

LEVEL	H	STEM KEYS	STR I MIN			STR I MAX			STR II MIN			STR II MAX			Service			Ext I			Ext II					
			OT	SL	PO	OT	SL	PO	OT	SL	PO	OT	SL	PO	OT	SL	PO	OT	SL	PO	OT	SL	PO			
1	6.50	6.0	2.67	2.12	1.26	3.61	2.66	1.51						4.38	3.57	2.25				1.55	2.27	1.40				
2	9.00	6.0	2.93	2.06	2.98	3.86	2.68	3.74						4.75	3.40	5.18				2.28	2.34	2.49				
3	11.50	10.0	3.13	1.84	2.65	4.23	2.49	3.60						5.02	2.98	4.56				3.50	2.25	4.48	2.43	3.39		
4	14.00	0.0																								
5	16.50	0.0																								
6	19.00	0.0																								
7	21.50	0.0																								
8	24.00	0.0																								
9	26.50	0.0																								
10	29.00	0.0																								
11	31.50	0.0																								
12	34.00	0.0																								
13	36.50	0.0																								
14	39.00	0.0																								
15	41.50	0.0																								
16	44.00	0.0																								
17	46.50	0.0																								
18	49.00	0.0																								
19	51.50	0.0																								
20	54.00	0.0																								
Max. Brg Pressure			2.126			2.532									1.764			1.726			1.665					
Ratio			#N/A			#N/A									#N/A			#N/A			#N/A					
L/4			1.23			2.50			0.49			1.00			2.50			0.40			1.08			2.50		
0.43																										

T-WALL® Retaining Wall System

Shop Drawing Calculations

West Wall - Wet Case

Stability Calculations
120pcf

T-WALL® Retaining Wall System

Shop Drawing Calculations

West Wall - Dry Case

**Stability Calculations
120pcf**

West Wall 120pcf Dry Case xism - Input

PROJECT INFO
 Wall Name: West Wall - Dry Case
 Project No: TOS 19553
 Date: 3/11/2019
 Designed By: ABC
 Checked by: MD

DESIGN CASES
 STR I Min: Yes
 STR I Max: Yes
 STR III Min: No
 STR III Max: No
 STR V Min: No
 STR V Max: No

SOIL PROPERTIES
 SELECT
 INTERNAL FRICTION (φ) = 34 DEG
 COHESION = 0 (assumed)
 UNCLASSIFIED
 INTERNAL FRICTION (φ) = 34 DEG
 COHESION = 0 (assumed)
 FOUNDATION
 FOUNDATION TYPE = S (S for Soil, R for rock)
 INTERNAL FRICTION (φ) = 34 DEG
 FACTORED BEARING RESISTANCE = #N/A PSF

FACE DIMENSIONS
 FACE WIDTH = 5 FT
 FACE THICKNESS = 0.5 FT
 STEM THICKNESS = 0.5 FT

LEVEL 1 DIMENSIONS
 DEPTH TO MOMENT SLAB = 2.00 FT
 TOP UNIT FACE HEIGHT = 4.50 FT
 TOP UNIT STEM HEIGHT = 2.50 FT

WALL GEOMETRY
 BATTER () = 0

GRADING GEOMETRY
 DISTANCE TO SLOPE (d) = 0 FT
 FILL SURCHARGE = 0 FT
 DISTANCE TO BREAK = 0 FT
 SLOPE ANGLE (β1) = 0.0 DEG
 SLOPE ANGLE (β) = 0.0 DEG
 TRAFFIC SURCHARGE = 2 FT

PROGRAM VERSION
 Name: T-Wall Retaining Wall Calculations
 Method: LRFD
 Loading: HWY
 Units: 2.5x5 0 Units
 Version: v11c
 Date: 3/3/2012
 By: BZY

WATER PRESSURE
 HEIGHT OF WATER TABLE BEHIND WALL = 0.00 FT (from bottom of wall)
 HEIGHT OF WATER TABLE IN FRONT OF WALL = 0.00 FT (from bottom of wall)

SOUND WALL OR OTHER STRUCTURE
 WEIGHT OF STRUCTURE = 0 LBS per 5 0ft (0.25 KLF)
 LOCATION OF GRAVITY = 0 FT (from face, + if overturn, - if stabilizing)
 WIND LOAD = 0 LBS per 5 0ft (37psf 10'-5' 0" Wind on traffic b
 LOCATION OF WIND LOAD = 0 FT (from gutter line / pavement)

BARRIER OR PARAPET OR GUARDRAIL
 VEHICLE COLLISION FORCE = 2500 LBS per 5 0ft
 HEIGHT OF BARRIER = 3.50 FT (from gutter line / pavement)

SEISMIC
 ACCELERATION COEFFICIENT (A) = 0.20
 FRICTION ANGLE BETWEEN SOIL AND WALL (δ) = 0 DEG
 VERTICAL COMP OF EARTHQUAKE ACCEL. COEFF = 0

STR I MIN
 STR I Max: Yes
 STR III Min: No
 STR III Max: No
 STR V Min: No
 STR V Max: No

STR I MAX
 STR I Max: Yes
 STR III Min: No
 STR III Max: No
 STR V Min: No
 STR V Max: No

STR III MIN
 STR III Min: No
 STR III Max: No
 STR V Min: No
 STR V Max: No

STR III MAX
 STR III Max: No
 STR V Min: No
 STR V Max: No

LEVEL	H	STEM KEYS		STR I MIN		STR I MAX		STR III MIN		STR III MAX		STR V MIN		STR V MAX		Service		Ext I		Ext II					
		OT	SL	OT	SL	PO	OT	SL	PO	OT	SL	PO	OT	SL	PO	OT	SL	PO	OT	SL	PO				
1	6.50	0.0	2	2.93	2.17	1.20	3.96	2.76	1.45								4.76	3.60	2.12		1.76	2.30	1.33		
2	9.00	0.0	2	3.16	2.11	2.81	4.27	2.76	3.55								5.08	3.45	4.85		2.51	2.37	2.42		
3	11.50	0.0	0	3.34	1.92	2.59	4.51	2.69	3.52								5.31	3.08	4.43	3.50	2.23	4.57	2.44	3.23	
4	14.00	0.0	0																						
5	16.50	0.0	0																						
6	19.00	0.0	0																						
7	21.50	0.0	0																						
8	24.00	0.0	0																						
9	26.50	0.0	0																						
10	29.00	0.0	0																						
11	31.50	0.0	0																						
12	34.00	0.0	0																						
13	36.50	0.0	0																						
14	39.00	0.0	0																						
15	41.50	0.0	0																						
16	44.00	0.0	0																						
17	46.50	0.0	0																						
18	49.00	0.0	0																						
19	51.50	0.0	0																						
20	54.00	0.0	0																						
Max. Brg Pressure		2.371		2.841		2.841		2.841		2.841		2.841		2.841		2.841		2.841		2.841		2.841		2.841	
Ratio		1.17		2.50		0.47		0.94		2.50		0.37		0.94		2.50		0.37		0.94		2.50		0.37	
L/4		1.17		2.50		0.47		0.94		2.50		0.37		0.94		2.50		0.37		0.94		2.50		0.37	
Ratio		1.17		2.50		0.47		0.94		2.50		0.37		0.94		2.50		0.37		0.94		2.50		0.37	