THE NEEL COMPANY

SCOPE OF ENGINEERING

Date: 4/4/14 **Proj No:** TW4301

Project: RTFA Structure Replacement
Location: Fairfield, VT

Wall(s): _____ _____ _____
_____ _____ _____
_____ _____ _____

Design: The Neel Company has performed the following analyses for this wall(s).

- Overturning
- Sliding
- Pull out
- Applied bearing pressure

The Neel Company **has not** performed the following analyses for this wall(s). 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 wall)
- Slope stability analysis for temporary cut-slope
- Scour analysis

Project Engineer: Kamal Dixit

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info@neelco.com • www.neelco.com

TW4301
4/4/14

THE NEEL COMPANY

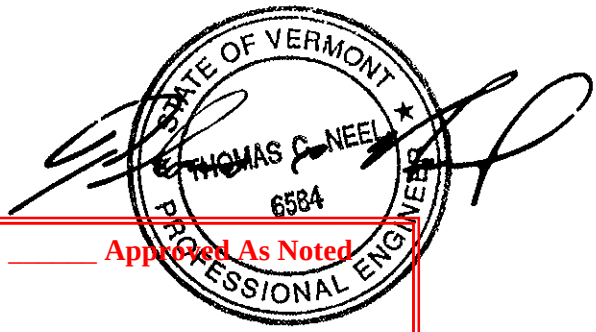
T-WALL® Retaining Wall System

Stability Calculations

RTFA Structure Replacement
Fairfield, VT

Wingwalls

Stability Calculations



X **Approved** **Approved As Noted**
Rejected

This review is only for general conformance with the design concept and the information given in the Construction Documents. Corrections or comments made on the shop drawings during the review do not relieve the Contractor from compliance with the requirements of the Plans and Specifications. Review of a specific item shall not include review of an assembly of which an item is a component. The Contractor is responsible for dimensions to be confirmed and corrected at the job site; information that pertains solely to the fabrication process or to the means, methods, techniques, sequences and procedures of construction; coordination of the Work with that of other trades and performing all Work in a safe and satisfactory manner.

Date 5/7/2014

By T. Traver

McFarland Johnson

8328-D Traford Lane • Springfield, VA 22152 • 703-913-7858 • Fax: 703-913-7859
E-mail: info@neelco.com • www.neelco.com

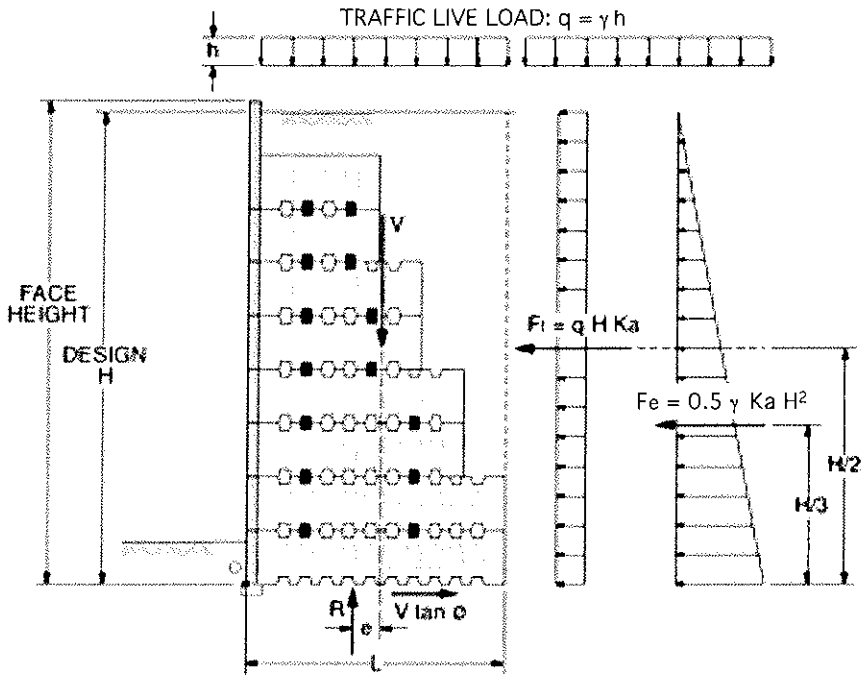
T-WALL Retaining Wall Calculations v11b (LRFD, HWY, 2.5x5.0 Units)
LIMIT STATE: **STRENGTH-I MIN**
PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (4th Ed, 2007)
Level Surcharge and Infinite Slope Condition

Revised BZY 3/3/12
The Neel Company
8328-D Traford Lane
Springfield, VA 22152
(703) 913-7858

Project Name: RTFA Structure Replacement
Location: Fairfield, VT
Comment: Wingwalls

Project No: TW4301
Date: 4/4/14
Designed By: KD
Checked by: TCN

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")

Σ Factored Resisting Moments = $\phi V \cdot x_o$ (x_o is the horiz. distance between V and O)

Σ Factored overturning Momen = $\gamma_e F_e (H/3) + \gamma_t F_t (H/2)$

Stability Against Sliding:

Σ Factored Resisting Force = $\phi V \tan \phi_F$

Σ Factored Driving Force = $\gamma_e F_e + \gamma_t F_t$

Bearing Pressure:

Factored Bearing Pressure = $(\gamma_1 V + \gamma_2 qL)/(L - 2e)$ (use factored e)

Eccentricity:

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)

T-WALL Retaining Wall Calculations v11b (LRFD, HWY, 2.5x5.0 Units)
Level Surcharge and Infinite Slope Condition
LIMIT STATE: STRENGTH-I MIN
PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (4th Ed, 2007)

Revised BZY 3/3/12
The Neel Company
8328-D Traford Lane
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Project No: TW4301
Project Name: RTFA Structure Replacement
Date: 4/4/14
Location: Fairfield, VT
By: KD
Wall Name: Wingwalls
Checked by: TCN

GRADING GEOMETRY

DISTANCE TO SLOPE (d) =	0	FT	
FILL SURCHARGE =	2	FT	
DISTANCE TO BREAK =	4	FT	
SLOPE ANGLE (ß1) =	26.6	DEG	
SLOPE ANGLE (I) =	3.8	DEG	
TRAFFIC SURCHARGE =	2	FT	

WALL GEOMETRY

HEIGHT (H) =	15.00	
BATTER ( ) =	0	
BASE (L) =	12	

BACKFILL SPECIFICATIONS

SELECT	INTERNAL FRICTION (Ø)=	34	DEG	Ka =	0.2933
	WEIGHT ( )=	120	PCF	Ko =	0.4408
	COHESION=	0	(assumed)		
UNCLASSIFIED	INTERNAL FRICTION (Ø)=	30	DEG	Ka =	0.3470
	WEIGHT ( )=	120	PCF		
	COHESION =	0	(assumed)		
FOUNDATION	FOUNDATION TYPE	S	(S for Soil, R for rock)		
	INTERNAL FRICTION (Øf) =	30	DEG	Kp =	3.0000

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)	0.58	(Ø is min of select fill and foundation)
PRECAST CONCRETE TO FOUNDATION =	0.46	(0.8*TAN Øf)

SHEAR KEY STRENGTH = 2460 lbs.

WATER PRESSURE

HEIGHT OF WATER TABLE BEHIND WALL =	0	FT	(From bottom of wall)
HEIGHT OF WATER TABLE BEFORE WALL =	0	FT	(From bottom of wall)

Date: 04/04/14
Designed By: KD
Checked by: TCN

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) :	0.90
EV (WEIGHT OF SOIL) :	1.00
EARTH PRESSURES (EH)	
HORIZONTAL COMPONENT :	1.50
VERTICAL COMPONENT :	1.50
LL (VEHICULAR LIVE LOAD), LS (LIVE LOAD SURCHARGE) :	1.75
WATER PRESSURE :	1.00

GLOBAL STABILITY

OVERTURNING

SUM FACTORED OVERTURNING MOMENTS	360412
SUM FACTORED RESISTING MOMENTS	844204
PERFORMANCE RATIO	2.34

SLIDING

SUM FACTORED HORIZONTAL FORCE	57409
FACTORED RESISTING FRICTION FORCE	73380
PERFORMANCE RATIO	1.28

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: Sv = SUM VERTICAL LOADS/(L-2e)

FACTORED SUM OF VERTICAL LOADS =	157208	LB/5 FT WIDTH		
FACTORED e =	1.96	≤ L/4 =	3.00	ft ON SOIL
FACTORED BEARING PRESSURE =	3892	PSF		
FACTORED BEARING RESISTANCE =	#N/A	PSF		
PERFORMANCE RATIO =	#N/A			

Date: 04/04/14
Designed By: KD
Checked by: TCN

PERFORMANCE RATIO AT EACH LEVEL

Live load is present behind the wall, but not on the wall

LEVEL	HEIGHT	STEM LENGTH	No. OF SHEAR KEYS		FACTORED LOAD EFFECT	FACTORED RESISTANCE	PERFORMANCE RATIO
1	5.00	6.00	2				
				OVERTURNING	35663	75338	2.11
				SLIDING	12734	19713	1.55
				PULLOUT	6053	9699	1.60
2	7.50	6.00	2				
				OVERTURNING	77401	105013	1.36
				SLIDING	20982	25959	1.24
				PULLOUT	5089	12197	2.40
3	10.00	8.00	2				
				OVERTURNING	142194	249430	1.75
				SLIDING	31177	42748	1.37
				PULLOUT	6571	18321	2.79
4	12.50	10.00	2				
				OVERTURNING	234908	487955	2.08
				SLIDING	43319	64382	1.49
				PULLOUT	8052	26111	3.24
5	15.00	12.00	2				
				OVERTURNING	360412	844204	2.34
				SLIDING	57409	73380	1.28
				PULLOUT	9534	29348	3.08
6	17.50	0.00	2				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
7	20.00	0.00	2				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
8	22.50	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
9	25.00	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
10	27.50	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
11	30.00	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
12	32.50	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A

Date: 04/04/14
Designed By: KD
Checked by: TCN

LEVEL 5

STEM LENGTH = 12.00 FT
HEIGHT = 17.00 FT

EARTH PRESSURE

Pa =	6016.30	plf
Feh =	30014.88	lbs.
Fev =	2000.99	lbs.

TRAFFIC SURCHARGE & WATER PRESSURE

Pt =	141S.60	plf
Ft =	7078.00	lbs.
Fw =	0.00	lbs.

STABILITY AGAINST SLIDING - LEVEL 5

SLIDING FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
Feh	30014.88	1.50	45022.3
Ft	7078.00	1.75	12386.5
Fw	0.00	1.00	0.0
TOTAL			57408.83

RESISTING FORCE

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
THRU SELECT FILL OR FOUNDATION	112902.15	1.00	0.58	1.00	65184.09
Fev	2000.99	1.50	0.58	1.00	1732.91
THRU JT. MAT'L OR FOUNDATION	17273.75	0.90	0.46	0.90	6462.51
SHEAR KEY (SHEAR STRENGTH)	0.00	#N/A	2	0.90	0.00
EMBEDMENT	0.00	#N/A	#N/A	0.50	0.00
TOTAL					73379.50

PERFORMANCE RATIO = 1.28

STABILITY AGAINST PULLOUT - LEVEL 5

PULLOUT FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
PULLOUT FORCE	5432.04	1.50	8148.05
TRAFFIC SURCHARGE FORCE	791.87	1.75	1385.77
WATER PRESSURE	0.00	1.00	0.00
TOTAL			9533.82

RESISTING FORCE Aeff. = 54.18 SF

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
ON STEM(SOIL TO SOIL IN Aeff)	11464.56	1.00	0.67	1.00	7732.95
ON STEM (SOIL TO CONCRETE IN A	33671.52	1.00	0.50	0.90	15152.18
CONC. UNIT WEIGHT (THROUGH JOINT MATERIAL)	17273.75	0.90	0.46	0.90	6462.51
SHEAR KEY (SHEAR STRENGTH)	0.00	#N/A	2	0.90	0.00
TOTAL					29347.64

PERFORMANCE RATIO = 3.08

Date: 04/04/14
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STABILITY AGAINST OVERTURNING - LEVEL 5

OVERTURNING MOMENT

	FORCE	MOMENT ARM	OVERTURNING MOMENT	LOAD FACTOR	FACTORED MOMENT
Feh	30014.88	5.67	170084.33	1.50	255126.50
Ft	7078.00	8.50	60163.02	1.75	105285.28
Fw	0.00	0.00	0.00	1.00	0.00
TOTAL					360411.78

RESISTING MOMENT

	WEIGHT	HORIZ. ARM	VERT. ARM	RESISTANCE FACTOR	FACTORED WEIGHT	FACTORED MOMENT
UNIT L1	2774.00	1.14	0.00	0.90	2496.60	2846.12
UNIT L2	1836.00	1.59	0.00	0.90	1652.40	2627.32
UNIT L3	2098.00	2.31	0.00	0.90	1888.20	4361.74
UNIT L4	2360.00	3.09	0.00	0.90	2124.00	6563.16
UNIT L5	2622.00	3.91	0.00	0.90	2359.80	9226.82
SELECT FILL L1	15781.20	3.25	0.00	1.00	15781.20	51288.90
SELECT FILL L2	7531.20	3.25	0.00	1.00	7531.20	24476.40
SELECT FILL L3	10321.20	4.25	0.00	1.00	10321.20	43865.10
SELECT FILL L4	13112.40	5.25	0.00	1.00	13112.40	68840.10
SELECT FILL L5	15902.40	6.25	0.00	1.00	15902.40	99390.00

Date: 04/04/14
Designed By: KD
Checked by: TCN

STABILITY AGAINST OVERTURNING - LEVEL 5 (CONTINUED)

	WEIGHT	HORIZ. ARM	VERT. ARM	RESISTANCE FACTOR	FACTORED WEIGHT	FACTORED MOMENT
STEP L2	0.00	6.00	0.00	1.00	0.00	0.00
STEP L3	9000.00	7.00	0.00	1.00	9000.00	63000.00
STEP L4	12000.00	9.00	0.00	1.00	12000.00	108000.00
STEP L5	15000.00	11.00	0.00	1.00	15000.00	165000.00
EARTH SURCHARGE	19837.50	8.00	0.00	1.00	19837.50	158700.00
Fev	2000.99	12.00	0.00	1.50	3001.49	36017.86
TOTAL					132008.39	844203.52

PERFORMANCE RATIO = 2.34

T-WALL Retaining Wall Calculations v11b (LRFD, HWY, 2.5x5.0 Units)
LIMIT STATE: STRENGTH-I MAX
PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (4th Ed, 2007)
Level Surcharge and Infinite Slope Condition

Revised BZY 3/3/12
The Neel Company
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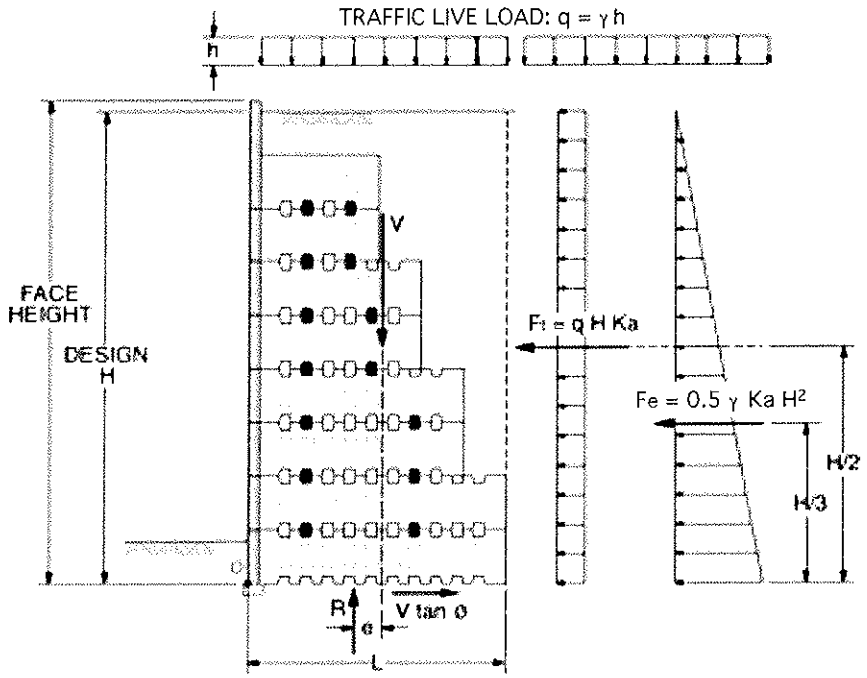
Project Name: RTFA Structure Replacement
Location: Fairfield, VT
Comment: Wingwalls

Project No: TW4301
Date: 4/4/14
Designed By: KD
Checked by: TCN

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")

Σ Factored Resisting Moments = $\phi V \cdot x_O$ (x_o is the horiz. distance between V and O)

Σ Factored overturning Momen = $Y_e F_e (H/3) + Y_t F_t (H/2)$

Stability Against Sliding:

Σ Factored Resisting Force = $\phi V \tan \phi_F$

Σ Factored Driving Force = $Y_e F_e + Y_t F_t$

Bearing Pressure:

Factored Bearing Pressure = $(Y_1 V + Y_2 qL)/(L - 2e)$ (use factored e)

Eccentricity:

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)

T-WALL Retaining Wall Calculations v11b (LRFD, HWY, 2.5x5.0 Units)
Level Surcharge and Infinite Slope Condition
LIMIT STATE: **STRENGTH-I MAX**
PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (4th Ed, 2007)

Revised BZY 3/3/12
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Project Name: RTFA Structure Replacement
Location: Fairfield, VT
Wall Name: Wingwalls

Project No: TW4301
Date: 4/4/14
By: KD
Checked by: TCN

GRADING GEOMETRY

DISTANCE TO SLOPE (d) =	0	FT
FILL SURCHARGE =	2	FT
DISTANCE TO BREAK =	4	FT
SLOPE ANGLE (ß1) =	26.6	DEG
SLOPE ANGLE (i) =	3.8	DEG
TRAFFIC SURCHARGE =	2	FT

WALL GEOMETRY

HEIGHT (H) =	15.00	
BATTER ( ) =	0	
BASE (L) =	12	

BACKFILL SPECIFICATIONS

SELECT	INTERNAL FRICTION (Ø)=	34	DEG	Ka =	0.2933
	WEIGHT ( )=	120	PCF	Ko =	0.4408
	COHESION=	0	(assumed)		
UNCLASSIFIED	INTERNAL FRICTION (Ø)=	30	DEG	Ka =	0.3470
	WEIGHT ( )=	120	PCF		
	COHESION =	0	(assumed)		
FOUNDATION	FOUNDATION TYPE	S	(S for Soil, R for rock)		
	INTERNAL FRICTION (Ø)=	30	DEG	Kp =	3.0000

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)	0.58	(Ø is min of select fill and foundation)
PRECAST CONCRETE TO FOUNDATION =	0.46	(0.8*TAN Øf)

SHEAR KEY STRENGTH = 2460 lbs.

WATER PRESSURE

HEIGHT OF WATER TABLE BEHIND WALL =	0	FT	(From bottom of wall)
HEIGHT OF WATER TABLE BEFORE WALL =	0	FT	(From bottom of wall)

Date: 04/04/14
Designed By: KD
Checked by: TCN

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
LL (VEHICULAR LIVE LOAD), LS (LIVE LOAD SURCHARGE) :	1.75
WATER PRESSURE :	1.00

GLOBAL STABILITY

OVERTURNING

SUM FACTORED OVERTURNING MOMENTS	360412
SUM FACTORED RESISTING MOMENTS	1128065
PERFORMANCE RATIO	3.13

SLIDING

SUM FACTORED HORIZONTAL FORCE	57409
FACTORED RESISTING FRICTION FORCE	98707
PERFORMANCE RATIO	1.72

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: Sv = SUM VERTICAL LOADS/(L-2e)

FACTORED SUM OF VERTICAL LOADS =	202770	LB/5 FT WIDTH		
FACTORED e =	1.47	≤ L/4 =	3.00	ft ON SOIL
FACTORED BEARING PRESSURE =	4475	PSF		
FACTORED BEARING RESISTANCE =	#N/A	PSF		
PERFORMANCE RATIO =	#N/A			

Date: 04/04/14
Designed By: KD
Checked by: TCN

PERFORMANCE RATIO AT EACH LEVEL

Live load is present behind the wall, but not on the wall

LEVEL	HEIGHT	STEM LENGTH	No. OF SHEAR KEYS		FACTORED LOAD EFFECT	FACTORED RESISTANCE	PERFORMANCE RATIO
1	5.00	6.00	2				
				OVERTURNING	35663	100749	2.83
				SLIDING	12734	25002	1.96
				PULLOUT	6053	11604	1.92
2	7.50	6.00	2				
				OVERTURNING	77401	140012	1.81
				SLIDING	20982	33368	1.59
				PULLOUT	5089	15011	2.95
3	10.00	8.00	2				
				OVERTURNING	142194	332925	2.34
				SLIDING	31177	55963	1.80
				PULLOUT	6571	23340	3.55
4	12.50	10.00	2				
				OVERTURNING	234908	651734	2.77
				SLIDING	43319	85083	1.96
				PULLOUT	8052	33933	4.21
5	15.00	12.00	2				
				OVERTURNING	360412	1128065	3.13
				SLIDING	57409	98707	1.72
				PULLOUT	9534	39871	4.18
6	17.50	0.00	2				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
7	20.00	0.00	2				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
8	22.50	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
9	25.00	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
10	27.50	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
11	30.00	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
12	32.50	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A

Date: 04/04/14
Designed By: KD
Checked by: TCN

LEVEL 5

STEM LENGTH = 12.00 FT
HEIGHT = 17.00 FT

EARTH PRESSURE

Pa = 6016.30 plf
Feh = 30014.88 lbs.
Fev = 2000.99 lbs.

TRAFFIC SURCHARGE & WATER PRESSURE

Pt = 1415.60 plf
Ft = 7078.00 lbs.
Fw = 0.00 lbs.

STABILITY AGAINST SLIDING - LEVEL 5

SLIDING FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
Feh	30014.88	1.50	45022.3
Ft	7078.00	1.75	12386.5
Fw	0.00	1.00	0.0
TOTAL			57408.83

RESISTING FORCE

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
THRU SELECT FILL OR FOUNDATION	112902.15	1.35	0.58	1.00	87998.52
Fev	2000.99	1.50	0.58	1.00	1732.91
THRU JT. MAT'L OR FOUNDATION	17273.75	1.25	0.46	0.90	8975.70
SHEAR KEY (SHEAR STRENGTH)	0.00	#N/A	2	0.90	0.00
EMBEDMENT	0.00	#N/A	#N/A	0.50	0.00
TOTAL					98707.13

PERFORMANCE RATIO = 1.72

STABILITY AGAINST PULLOUT - LEVEL 5

PULLOUT FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
PULLOUT FORCE	5432.04	1.50	8148.05
TRAFFIC SURCHARGE FORCE	791.87	1.75	1385.77
WATER PRESSURE	0.00	1.00	0.00
TOTAL			9533.82

RESISTING FORCE Aeff. = 54.18 SF

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
ON STEM(SOIL TO SOIL IN Aeff)	11464.56	1.35	0.67	1.00	10439.48
ON STEM (SOIL TO CONCRETE IN A	33671.52	1.35	0.50	0.90	20455.45
CONC. UNIT WEIGHT (THROUGH JOINT MATERIAL)	17273.75	1.25	0.46	0.90	8975.70
SHEAR KEY (SHEAR STRENGTH)	0.00	#N/A	2	0.90	0.00
TOTAL					39870.63

PERFORMANCE RATIO = 4.18

Date: 04/04/14
Designed By: KD
Checked by: TCN

STABILITY AGAINST OVERTURNING - LEVEL 5

OVERTURNING MOMENT

	FORCE	MOMENT ARM	OVERTURNING MOMENT	LOAD FACTOR	FACTORED MOMENT
Feh	30014.88	5.67	170084.33	1.50	255126.50
Ft	7078.00	8.50	60163.02	1.75	105285.28
Fw	0.00	0.00	0.00	1.00	0.00
TOTAL					360411.78

RESISTING MOMENT

	WEIGHT	HORIZ. ARM	VERT. ARM	RESISTANCE FACTOR	FACTORED WEIGHT	FACTORED MOMENT
UNIT L1	2774.00	1.14	0.00	1.25	3467.50	3952.95
UNIT L2	1836.00	1.59	0.00	1.25	2295.00	3649.05
UNIT L3	2098.00	2.31	0.00	1.25	2622.50	6057.98
UNIT L4	2360.00	3.09	0.00	1.25	2950.00	9115.50
UNIT L5	2622.00	3.91	0.00	1.25	3277.50	12815.03
SELECT FILL L1	15781.20	3.25	0.00	1.35	21304.62	69240.02
SELECT FILL L2	7531.20	3.25	0.00	1.35	10167.12	33043.14
SELECT FILL L3	10321.20	4.25	0.00	1.35	13933.62	59217.89
SELECT FILL L4	13112.40	5.25	0.00	1.35	17701.74	92934.14
SELECT FILL L5	15902.40	6.25	0.00	1.35	21468.24	134176.50

Date: 04/04/14
Designed By: KD
Checked by: TCN

STABILITY AGAINST OVERTURNING - LEVEL 5 (CONTINUED)

	WEIGHT	HORIZ. ARM	VERT. ARM	RESISTANCE FACTOR	FACTORED WEIGHT	FACTORED MOMENT
STEP L2	0.00	6.00	0.00	1.35	0.00	0.00
STEP L3	9000.00	7.00	0.00	1.35	12150.00	85050.00
STEP L4	12000.00	9.00	0.00	1.35	16200.00	145800.00
STEP L5	15000.00	11.00	0.00	1.35	20250.00	222750.00
EARTH SURCHARGE	19837.50	8.00	0.00	1.35	26780.63	214245.00
Fev	2000.99	12.00	0.00	1.50	3001.49	36017.86
TOTAL					177569.95	1128065.03

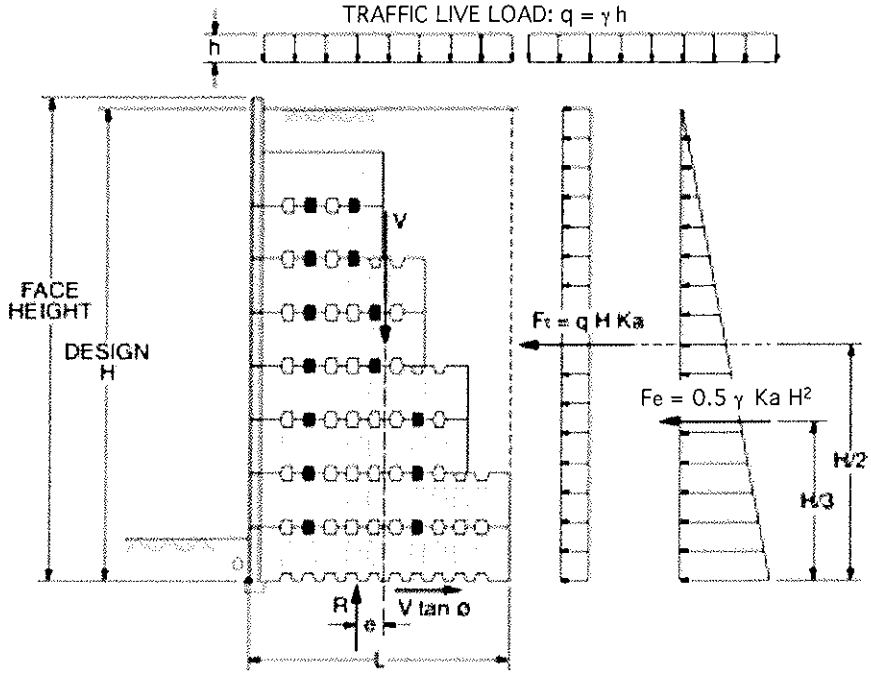
PERFORMANCE RATIO = 3.13

T-WALL Retaining Wall Calculations v11b (LRFD, HWY, 2.5x5.0 Units)
LIMIT STATE: **SERVICE-I**
PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (4th Ed, 2007)
Level Surcharge and Infinite Slope Condition

Project Name: RTFA Structure Replacement
Location: Fairfield, VT
Comment: Wingwalls

Revised BZY 3/3/12
The Neel Company
8328-D Traford Lane
Springfield, VA 22152
(703) 913-7858
Project No: TW4301
Date: 04/04/14
Designed By: KD
Checked by: TCN

Load Diagram:



Typical Section, All details may not apply

External Stability Calculation (SERVICE-I)

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

Σ Factored Resisting Moments = $\phi V \cdot x_o$ (x_o is the horiz. distance between V and O)

Σ Factored overturning Momen = $\gamma_e F_e (H/3) + \gamma_t F_t (H/2)$

Stability Against Sliding:

Σ Factored Resisting Force = $\phi V \tan \phi_F$

Σ Factored Driving Force = $\gamma_e F_e + \gamma_t F_t$

Bearing Pressure:

Factored Bearing Pressure = $(\gamma_1 V + \gamma_2 qL)/(L - 2e)$ (use factored e)

Eccentricity:

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)

T-WALL Retaining Wall Calculations v11b (LRFD, HWY, 2.5x5.0 Units)
Level Surcharge and Infinite Slope Condition
LIMIT STATE: **SERVICE-I**
PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (4th Ed, 2007)

Revised BZY 3/3/12
The Neel Company
8328-D Traford Lane
Springfield, VA 22152
(703) 913-7858

Project No: TW4301
Project Name: RTFA Structure Replacement
Date: 4/4/14
Location: Fairfield, VT
By: KD
Comment: Wingwalls
Checked by: TCN

GRADING GEOMETRY

DISTANCE TO SLOPE (d) =	0	FT	
FILL SURCHARGE =	2	FT	
DISTANCE TO BREAK =	4	FT	
SLOPE ANGLE (ß1) =	26.6	DEG	
SLOPE ANGLE (I) =	3.8	DEG	
TRAFFIC SURCHARGE =	2	FT	

WALL GEOMETRY

HEIGHT (H) =	15.00	
BATTER ( ) =	0	
BASE (L) =	12	

BACKFILL SPECIFICATIONS

SELECT	INTERNAL FRICTION (Ø)=	34	DEG	Ka =	0.2933
	WEIGHT ( )=	120	PCF	Ko =	0.4408
	COHESION=	0	(assumed)		
UNCLASSIFIED	INTERNAL FRICTION (Ø)=	30	DEG	Ka =	0.3470
	WEIGHT ( )=	120	PCF		
	COHESION =	0	(assumed)		
FOUNDATION	FOUNDATION TYPE	S	(S for Soil, R for rock)		
	INTERNAL FRICTION (Ø)=	30	DEG	Kp =	3.0000

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)	0.58	(Ø is min of select fill and foundation)
PRECAST CONCRETE TO FOUNDATION =	0.46	(0.8*TAN Øf)

SHEAR KEY STRENGTH = 2460 lbs.

WATER PRESSURE

HEIGHT OF WATER TABLE BEHIND WALL =	0	FT	(From bottom of wall)
HEIGHT OF WATER TABLE BEFORE WALL =	0	FT	(From bottom of wall)

WIND ON SOUND BARRIER/OTHER STRUCTURE

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

Date: 04/04/14
Designed By: KD
Checked by: TCN

RESISTANCE FACTORS

FRICTION BETWEEN SOIL & SOIL :	1.00	
FRICTION BETWEEN SOIL & CONC. :	1.00	
FRICTION 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
LL (VEHICULAR LIVE LOAD), LS (LIVE LOAD SURCHARGE) :	1.00
WATER PRESSURE :	1.00
WIND LOAD :	0.30

GLOBAL STABILITY

OVERTURNING

SUM FACTORED OVERTURNING MOMENTS:	230247
SUM FACTORED RESISTING MOMENTS:	835045
PERFORMANCE RATIO:	3.63

SLIDING

SUM FACTORED HORIZONTAL FORCE:	37093
FACTORED RESISTING FRICTION FORCE:	74318
PERFORMANCE RATIO:	2.00

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: σ_v = SUM VERTICAL LOADS/(L-2e)

FACTORED SUM OF VERTICAL LOADS =	146577	LB/5 FT WIDTH		
FACTORED e =	1.28	≤ L/4 =	3.00	ft ON SOIL
FACTORED BEARING PRESSURE =	3108	PSF		
FACTORED BEARING CAPACITY =	#N/A	PSF		
PERFORMANCE RATIO =	#N/A			

Date: 04/04/14
Designed By: KD
Checked by: TCN

FACTORS OF SAFETY AT EACH LEVEL

Live load is present behind the wall, but not on the wall

LEVEL	HEIGHT	STEM LENGTH	No. OF SHEAR KEYS		FACTORED LOAD EFFECT	FACTORED RESISTANCE	PERFORMANCE RATIO
1	5.00	6.00	2				
				OVERTURNING	22075	74637	3.38
				SLIDING	8003	20452	2.56
				PULLOUT	3757	10827	2.88
2	7.50	6.00	2				
				OVERTURNING	48470	103746	2.14
				SLIDING	13329	26808	2.01
				PULLOUT	3261	13651	4.19
3	10.00	8.00	2				
				OVERTURNING	89799	246535	2.75
				SLIDING	19952	43851	2.20
				PULLOUT	4249	20485	4.82
4	12.50	10.00	2				
				OVERTURNING	149310	482498	3.23
				SLIDING	27873	65787	2.36
				PULLOUT	5236	29162	5.57
5	15.00	12.00	2				
				OVERTURNING	230247	835045	3.63
				SLIDING	37093	74318	2.00
				PULLOUT	6224	32547	5.23
6	17.50	0.00	2				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
7	20.00	0.00	2				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
8	22.50	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
9	25.00	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
10	27.50	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
11	30.00	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
12	32.50	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A

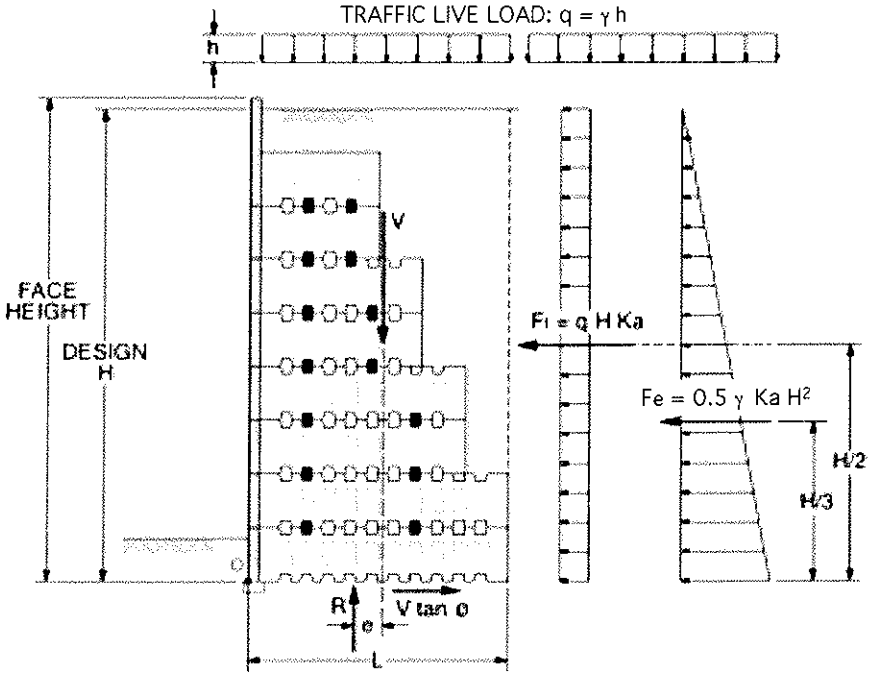
T-WALL Retaining Wall Calculations v11b (LRFD, HWY, 2.5x5.0 Units)
LIMIT STATE: EXTREME II
PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (4th Ed, 2007)
Level Surcharge and Infinite Slope Condition

Revised BZY 3/3/12
The Neel Company
8328-D Traford Lane
Springfield, VA 22152
(703) 913-7858

Project Name: RTFA Structure Replacement
Location: Fairfield, VT
Comment: Wingwalls

Project No: TW4301
Date: 04/04/14
Designed By: KD
Checked by: TCN

Load Diagram:



Typical Section, some details may not apply

External Stability Calculation (STRENGTH-I MIN)

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

Σ Factored Resisting Moments = $\phi V \cdot x_o$ (x_o is the horiz. distance between V and O)

Σ Factored overturning Momen = $Y_e F_e (H/3) + Y_t F_t (H/2)$

Stability Against Sliding:

Σ Factored Resisting Force = $\phi V \tan \phi_F$

Σ Factored Driving Force = $Y_e F_e + Y_t F_t$

Bearing Pressure:

Factored Bearing Pressure = $(Y_1 V + Y_2 qL)/(L - 2e)$ (use factored e)

Eccentricity:

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)

T-WALL Retaining Wall Calculations v11b (LRFD, HWY, 2.5x5.0 Units)
Level Surcharge and Infinite Slope Condition
LIMIT STATE: **EXTREME II**
PER AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (4th Ed, 2007)

Revised BZY 3/3/12
The Neel Company
8328-D Traford Lane
Springfield, VA 22152
(703) 913-7858

Project No: TW4301
Project Name: RTFA Structure Replacement
Location: Fairfield, VT
Wall Name: Wingwalls
Date: 4/4/14
By: KD
Checked by: TCN

GRADING GEOMETRY

DISTANCE TO SLOPE (d) =	0	FT
FILL SURCHARGE =	2	FT
DISTANCE TO BREAK =	4	FT
SLOPE ANGLE (ß1) =	26.6	DEG
SLOPE ANGLE (I) =	3.8	DEG
TRAFFIC SURCHARGE =	2	FT

WALL GEOMETRY

HEIGHT (H) =	15.00	
BATTER ( ) =	0	
BASE (L) =	12	

BACKFILL SPECIFICATIONS

SELECT	INTERNAL FRICTION (Ø)=	34	DEG	Ka =	0.2933
	WEIGHT ( )=	120	PCF	Ko =	0.4408
	COHESION=	0	(assumed)		
UNCLASSIFIED	INTERNAL FRICTION (Ø)=	30	DEG	Ka =	0.3470
	WEIGHT ( )=	120	PCF		
	COHESION =	0	(assumed)		
FOUNDATION	FOUNDATION TYPE	S	(S for Soil, R for rock)		
	INTERNAL FRICTION (Ø)=	30	DEG	Kp =	3.0000

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)	0.58	(Ø is min of select fill and foundation)
PRECAST CONCRETE TO FOUNDATION =	0.46	(0.8*TAN Øf)

SHEAR KEY STRENGTH = 2460 lbs.

WATER PRESSURE

HEIGHT OF WATER TABLE BEHIND WALL =	0	FT	(From bottom of wall)
HEIGHT OF WATER TABLE BEFORE WALL =	0	FT	(From bottom of wall)

BARRIER OR PARAPET

IMPACT FORCE ON BARRIER =	1500	LBS PER 5 FT
HEIGHT OF BARRIER =	3	FT

Date: 04/04/14
Designed By: KD
Checked by: TCN

RESISTANCE FACTORS

FRICTION BETWEEN SOIL & SOIL :	1.00	
FRICTION BETWEEN SOIL & CONC. :	1.00	
FRICTION 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
LL (VEHICULAR LIVE LOAD), LS (LIVE LOAD SURCHARGE) :	0.50
WATER PRESSURE :	1.00
VEHICLE COLLISION FORCE :	1.00

GLOBAL STABILITY

OVERTURNING

SUM FACTORED OVERTURNING MOMENTS:	285208
SUM FACTORED RESISTING MOMENTS:	844204
PERFORMANCE RATIO:	2.96

SLIDING

SUM FACTORED HORIZONTAL FORCE:	48561
FACTORED RESISTING FRICTION FORCE:	74098
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: Sv = SUM VERTICAL LOADS/(L-2e)

FACTORED SUM OF VERTICAL LOADS =	139208	LB/5 FT WIDTH		
FACTORED e =	1.67	≤ L/3 =	4.00	ft ON SOIL
FACTORED BEARING PRESSURE =	3218	PSF		
FACTORED BEARING RESISTANCE =	#N/A	PSF		
PERFORMANCE RATIO =	#N/A			

Date: 04/04/14
Designed By: KD
Checked by: TCN

FACTORS OF SAFETY AT EACH LEVEL

Live load is present behind the wall, but not on the wall

LEVEL	HEIGHT	STEM LENGTH	No. OF SHEAR KEYS		FACTORED LOAD EFFECT	FACTORED RESISTANCE	PERFORMANCE RATIO
1	5.00	6.00	2				
				OVERTURNING	37912	75338	1.99
				SLIDING	10591	20376	1.92
				PULLOUT	5463	10637	1.95
2	7.50	6.00	2				
				OVERTURNING	72666	105013	1.45
				SLIDING	17537	26720	1.52
				PULLOUT	5600	13352	2.38
3	10.00	8.00	2				
				OVERTURNING	104722	249430	2.38
				SLIDING	24931	43688	1.75
				PULLOUT	5581	19986	3.58
4	12.50	10.00	2				
				OVERTURNING	180196	487955	2.71
				SLIDING	35773	65539	1.83
				PULLOUT	7063	28423	4.02
5	15.00	12.00	2				
				OVERTURNING	285208	844204	2.96
				SLIDING	48561	74098	1.53
				PULLOUT	8544	31749	3.72
6	17.50	0.00	2				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
7	20.00	0.00	2				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
8	22.50	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
9	25.00	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
10	27.50	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
11	30.00	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A
12	32.50	0.00	0				
				OVERTURNING	0	0	#N/A
				SLIDING	0	0	#N/A
				PULLOUT	0	0	#N/A

Date: 04/04/14
Designed By: KD
Checked by: TCN

LEVEL 5

STEM LENGTH = 12.00 FT
HEIGHT = 17.00 FT

EARTH PRESSURE			TRAFFIC SURCHARGE & WATER PRESSURE		
Pa =	6016.30	plf	Pt =	1415.60	plf
Feh =	30014.88	lbs.	Ft =	7078.00	lbs.
Fev =	2000.99	lbs.	Fw =	0.00	lbs.

STABILITY AGAINST SLIDING - LEVEL 5

SLIDING FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
Feh	30014.88	1.50	45022.3
Ft	7078.00	0.50	3539.0
Fw	0.00	1.00	0.0
TOTAL			48561.32

RESISTING FORCE

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
THRU SELECT FILL OR FOUNDATION	112902.15	1.00	0.58	1.00	65184.09
Fev	2000.99	1.50	0.58	1.00	1732.91
THRU JT. MAT'L OR FOUNDATION	17273.75	0.90	0.46	1.00	7180.56
SHEAR KEY (SHEAR STRENGTH)	0.00	#N/A	2	1.00	0.00
EMBEDMENT	0.00	#N/A	#N/A	1.00	0.00
TOTAL					74097.56

PERFORMANCE RATIO = 1.53

STABILITY AGAINST PULLOUT - LEVEL 5

PULLOUT FORCE

	UNFACTORED	LOAD FACTOR	FACTORED
PULLOUT FORCE	5432.04	1.50	8148.05
TRAFFIC SURCHARGE FORCE	791.87	0.50	395.93
WATER PRESSURE	0.00	1.00	0.00
TOTAL			8543.99

RESISTING FORCE Aeff. = 54.18 SF

	WEIGHT	LOAD FACTOR	FRICTION FACTOR	RESISTANCE FACTOR	FACTORED RESISTANCE
ON STEM(SOIL TO SOIL IN Aeff)	11464.56	1.00	0.67	1.00	7732.95
ON STEM (SOIL TO CONCRETE IN A	33671.52	1.00	0.50	1.00	16835.76
THRU JT. MAT'L OR FOUNDATION	17273.75	0.90	0.46	1.00	7180.56
SHEAR KEY (SHEAR STRENGTH)	0.00	#N/A	2	1.00	0.00
TOTAL					31749.27

PERFORMANCE RATIO = 3.72

Date: 04/04/14
Designed By: KD
Checked by: TCN

STABILITY AGAINST OVERTURNING - LEVEL 5

OVERTURNING MOMENT

	FORCE	MOMENT ARM	OVERTURNING MOMENT	LOAD FACTOR	FACTORED MOMENT
Feh	30014.88	5.67	170084.33	1.50	255126.50
Ft	7078.00	8.50	60163.02	0.50	30081.51
Fw	0.00	0.00	0.00	1.00	0.00
TOTAL					285208.01

RESISTING MOMENT

	WEIGHT	HORIZ. ARM	VERT. ARM	RESISTANCE FACTOR	FACTORED WEIGHT	FACTORED MOMENT
UNIT L1	2774.00	1.14	0.00	0.90	2496.60	2846.12
UNIT L2	1836.00	1.59	0.00	0.90	1652.40	2627.32
UNIT L3	2098.00	2.31	0.00	0.90	1888.20	4361.74
UNIT L4	2360.00	3.09	0.00	0.90	2124.00	6563.16
UNIT L5	2622.00	3.91	0.00	0.90	2359.80	9226.82
SELECT FILL L1	15781.20	3.25	0.00	1.00	15781.20	51288.90
SELECT FILL L2	7531.20	3.25	0.00	1.00	7531.20	24476.40
SELECT FILL L3	10321.20	4.25	0.00	1.00	10321.20	43865.10
SELECT FILL L4	13112.40	5.25	0.00	1.00	13112.40	68840.10
SELECT FILL L5	15902.40	6.25	0.00	1.00	15902.40	99390.00

Date: 04/04/14
Designed By: KD
Checked by: TCN

STABILITY AGAINST OVERTURNING - LEVEL 5 (CONTINUED)

	WEIGHT	HORIZ. ARM	VERT. ARM	RESISTANCE FACTOR	FACTORED WEIGHT	FACTORED MOMENT
STEP L2	0.00	6.00	0.00	1.00	0.00	0.00
STEP L3	9000.00	7.00	0.00	1.00	9000.00	63000.00
STEP L4	12000.00	9.00	0.00	1.00	12000.00	108000.00
STEP L5	15000.00	11.00	0.00	1.00	15000.00	165000.00
EARTH SURCHARGE	19837.50	8.00	0.00	1.00	19837.50	158700.00
Fev	2000.99	12.00	0.00	1.50	3001.49	36017.86
TOTAL					132008.39	844203.52

PERFORMANCE RATIO = 2.96