HORROCKS
ENGINEERS

3111 Camino Del Rio North, Suite 550
San Diego, CA 92108
Office: 619.510.4560
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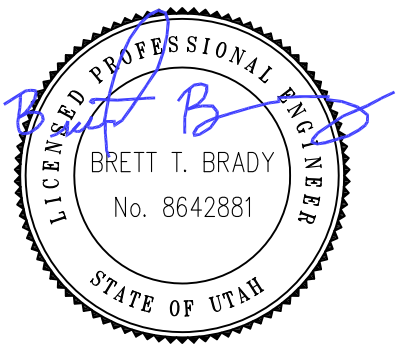
STRUCTURAL CALCULATIONS

MILLCREEK COMMON

FOR

EPG DESIGN

SUBJECT: **SHEET NO:**



Job No.: **UT-2009-1910** **Designed By:** **J.W.S.**

Date: **12/22/2020** **Checked By:** **B.B.**

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MILLCREEK COMMONS
RETAINING WALL – BASIS OF DESIGN

GOVERNING BUILDING CODE:

- International Building Code 2018 (IBC 2018)

SOIL PARAMETERS:

- Soils Report: #800055001 Dated June 18, 2020 By Ninyo & Moore
- Soil Unit Weight = 110 pcf (assumed)
- Allowable Bearing Pressure = 1,500 psf
- Increase bearing pressure by 250 psf / ft of additional width (12" min)
- Increase bearing pressure by 650 psf / ft of additional embedment (30" min)
- Maximum Allowable bearing pressure = 3,000 psf
- Increase bearing pressure by 1/3 for short term loading
- Minimum 30" embedment below lowest adjacent finished grade (frost protection)
- Minimum footing width = 12"
- Minimum (2)-#4 Top & Bottom in continuous footings
- Lateral Pressures (for wall heights 6' tall or less):
  - Active Pressure = 38 psf / ft
  - At-Rest Pressure = 58 psf / ft
  - Passive Pressure = 290 psf / ft (max = 2,900 psf)
  - Pressures above assume a level backfill
  - Lateral bearing capacity may be increased by 1/3 for short duration loads.
  - Passive assumes ground surface is level for 10' or 3x height of wall generating passive pressure.
- No Seismic loads from soils specified in the soils report
- Soil Site Class D
- Type II Cement, 4,000 psi concrete, w/c ratio = 0.50 by weight, 4" slump all recommended by soils report.
- Coefficient of friction = 0.53 (between soil & concrete cast-against-grade)
- Coefficient of friction = 0.35 (between soil & formed concrete)
- Passive & friction may be combined, but passive can't exceed ½ of total resistance
- Neglect upper 12" of soil for passive pressure if not protected by pavement.

SEISMIC PARAMETERS:

- Latitude = 40.7010, Longitude = -111.8524
- Ss = 1.405, S1 = 0.519
- Sms = 1.405, Sm1 = Null
- Sds = 0.937, Sd1 = Null
- Fa = 1.0, Fv = Null
- Wall self-weight seismic load = 0.3(Sds)(W) (Per eq 15.4-5 of ASCE 7-16)
- Seismic loads from soil = 15 pcf inverted triangle (Per Robert Gambrell via email 12/18/2020)

CONCRETE PROPERTIES

- F'c = 4,000 psi
- Rebar Fy = 60 ksi
- Type II, w/c ratio = 0.50, 4" slump

MASONRY PROPERTIES

- Use 8x8x16 Blocks, running bond, medium weight, solid grout all cells
- Mortar type S = 1,800 psi
- Grout = 2,000 psi
- Weight of wall = 78 psf
- F'm = 1,500 psi
- Rebar Fy = 60 ksi

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RETAINING WALL DESIGN NOTES:

- Neglect top 12” of unprotected soil for passive pressure
- No guardrail loads at top of concrete retaining wall design or Gravity retaining wall
- Guardrail loads occur at CMU wall retaining wall. 50 plf live load occurs 3.5’ above top of wall.
- Loading from light posts (reactions at base of light post, see enercalc results)
    - Seismic: V = 476#, M = 2860 #-ft.
        - Load distributed over 8’ wall section. v = V8’ = 60 plf
        - H = M/V = 2860 #-ft / 476# = 6’ above top of wall.
    - Wind: V = 466#, M = 4005 #-ft
        - Load distributed over 8’ wall section. V = V/8’ = 58 plf
        - H = M/V = 4005 #-ft / 466# = 8.6’ above top of wall.
- Sliding Factor of Safety = 1.5 for Dead + Live Loading
- Sliding Factor of Safety = 1.1 for Seismic Loading
- Surcharge loads of 50 psf live load at masonry & CIP retaining walls.
- Gravity retaining wall designed for 100 psf surcharge due to adjacent parking lot.
- A level backfill will be assumed on both sides.
- Designs considered: (height is from top of wall to finish grade)
    - Concrete CIP Retaining wall ,3.5’ tall
    - CMU Retaining wall, 5.5’ tall
    - CMU Retaining wall, 5.5’ tall with Light Post Loads.
    - Gravity Retaining wall, 2.5’ tall

ATC Hazards by Location

Search Information

Coordinates: 40.701, -111.8524

Elevation: 4410 ft

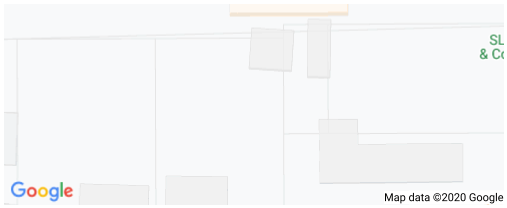
Timestamp: 2020-12-11T22:46:03.373Z

Hazard Type: Seismic

Reference Document: ASCE7-16

Risk Category: II

Site Class: D



Basic Parameters

Name	Value	Description
S_S	1.405	MCE_R ground motion (period=0.2s)
S_1	0.519	MCE_R ground motion (period=1.0s)
S_{MS}	1.405	Site-modified spectral acceleration value
S_{M1}	* null	Site-modified spectral acceleration value
S_{DS}	0.937	Numeric seismic design value at 0.2s SA
S_{D1}	* null	Numeric seismic design value at 1.0s SA

* See Section 11.4.8

Additional Information

Name	Value	Description
SDC	* null	Seismic design category
F_a	1	Site amplification factor at 0.2s
F_v	* null	Site amplification factor at 1.0s
CR_S	0.856	Coefficient of risk (0.2s)
CR_1	0.866	Coefficient of risk (1.0s)
PGA	0.638	MCE_G peak ground acceleration
F_{PGA}	1.1	Site amplification factor at PGA
PGA_M	0.701	Site modified peak ground acceleration
T_L	8	Long-period transition period (s)
SsRT	1.405	Probabilistic risk-targeted ground motion (0.2s)
SsUH	1.642	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	2.47	Factored deterministic acceleration value (0.2s)
S1RT	0.519	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.6	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	1.142	Factored deterministic acceleration value (1.0s)
PGAd	1.012	Factored deterministic acceleration value (PGA)

* See Section 11.4.8

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

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Hazards by Location

Search Information

Coordinates: 40.7010, -111.8524

Elevation: 4410 ft

Timestamp: 2020-12-14T21:18:59.237Z

Hazard Type: Wind

ASCE 7-16

MRI 10-Year	74 mph
MRI 25-Year	79 mph
MRI 50-Year	84 mph
MRI 100-Year	89 mph
Risk Category I	97 mph
Risk Category II	103 mph
Risk Category III	109 mph
Risk Category IV	113 mph

ASCE 7-10

MRI 10-Year	76 mph
MRI 25-Year	84 mph
MRI 50-Year	90 mph
MRI 100-Year	96 mph
Risk Category I	105 mph
Risk Category II	115 mph
Risk Category III-IV	120 mph

ASCE 7-05

ASCE 7-05 Wind Speed	90 mph

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are interpolated from data provided in ASCE 7 and rounded up to the nearest whole integer. Per ASCE 7, islands and coastal areas outside the last contour should use the last wind speed contour of the coastal area – in some cases, this website will extrapolate past the last wind speed contour and therefore, provide a wind speed that is slightly higher. NOTE: For queries near wind-borne debris region boundaries, the resulting determination is sensitive to rounding which may affect whether or not it is considered to be within a wind-borne debris region.

Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.

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Use menu item Settings > Printing & Title Block
to set these five lines of information
for your program.

Project Name/Number : millcreek
Title **G-1** :
Dsgnr: **Jimmy Sipes**
Description....
Gravity Wall - 2.5 ft

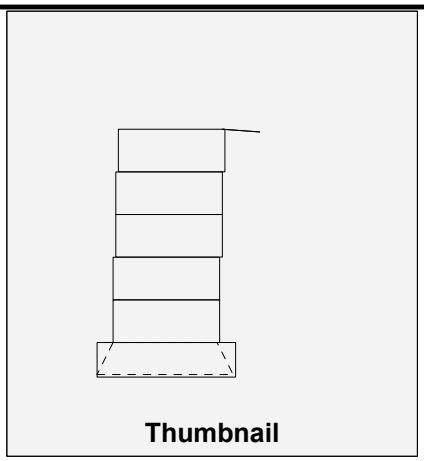
This Wall in File: c:\users\jamess\documents\office\temp projects\20-1211 - millcreek\calcs\millcree

Segmental Gravity Retaining Wall

Code: NCMA

Criteria

Wall height (retained height), ft	3.33
Backfill slope	Level
Backfill angle	0.0
Embedment	0.7



Soil data

External Soil, Phi_e	30
External soil density (In situ), pcf	110
Internal Soil, Phi_i	30
Internal soil density, pcf	110
Wall Soil Friction Angle	20
K_a(Horiz)	0.27

Stability

Overturning ratio	1.90
Sliding ratio	1.62
Overturning moment, ft-lbs	334
Resisting moment, ft-lbs	635
Total lateral/sliding force, lbs	255
Sliding Resistance, ft	413.77
Total vertical force, lbs	717
Base length, ft	1.67
Eccentricity on base, ft	0.41
Effective base length, ft	1.34
Soil bearing pressure, psf	535.24
Allowable soil bearing, psf	1,500.00
Soil Bearing Ratio	2.80

Segmental block data

Vendor selection	'Anchor Retaining Wall Systems'
Vendor ESR	'www.anchorwall.com'
Block selection type	'Vertica Pro'
Block height, in	8.00
Block depth, in	20.00
Offset per block, in	0.25
Batter angle	1.79
Wall weight, psf	215.00
Hinge height, ft	53.33

Loading

Dead load, psf	0
Live load, psf	100
Seismic Design Kh	0.00

Wall Analysis Table:

Block	Height above base Ft	In	Dec	Vert N	Lateral Static	Seismic	Shear Interface	S. F.
5	3'	4"	3.33				1,257.00	
4	2'	8"	2.67	143	25		1,271.33	51.59
3	2'	0"	2.00	287	63		1,285.67	20.57
2	1'	4"	1.33	430	114		1,300.00	11.44
1	0'	8"	0.67	573	178		1,314.33	7.39
Base	0'	0"	0.00	717	255		1,328.67	5.20

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Gravity Wall - 2.5 ft

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Segmental Gravity Retaining Wall

Code: NCMA

ASSUMPTIONS AND CRITERIA USED

1. References used include *Design Manual for Segmental Retaining Walls*, *2nd Edition*, and *Segmental Retaining Walls – Seismic Design Manual, 1st Edition*, both by NCMA.
2. Blocks are all same size and uniform offsets (batter) for full wall height.
3. Coulomb earth pressure theory used for earth pressures and failure plane angle.
4. Refer to geotechnical report for backfill material, compaction, and other design data and recommendations.
5. Cap blocks if used are above the retained height and neglected in this design.
6. Block sizes obtained from vendors' literature and may vary with locality.
7. Average weight of block and cell infill assumed to be 120 pcf.
8. See vendor web sites (on input screen) for more information and specifications.
9. Design height is limited to 12 feet or 18 blocks, whichever is less. Contact vendor for higher designs or special conditions.
10. Seismic design is per *Seismic Design Manua*l cited above. Also see *Methodology/Seismic Design* in *User's Manual*.
11. Vendor specifications or project specifications, whichever is more restrictive, to be followed for construction procedures.
12. Add notes and details for proper drainage.
13. See *User's Manual* Design Example #11 for methodology and sample verification calculations.
14. Final design responsibility is with the project Engineer-of-Record.

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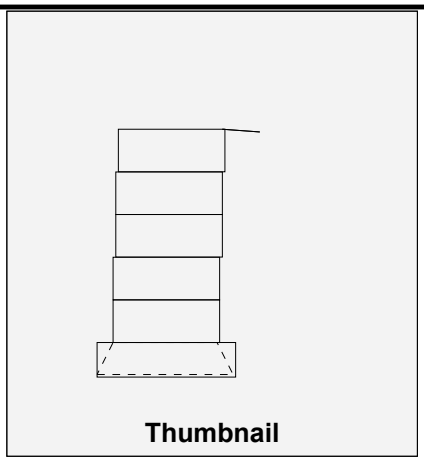
Segmental Gravity Retaining Wall

Code: NCMA

Criteria

Wall height (retained height), ft	3.33
Backfill slope	Level
Backfill angle	0.0
Embedment	0.7



Soil data

External Soil, Phi_e	30
External soil density (In situ), pcf	110
Internal Soil, Phi_i	30
Internal soil density, pcf	110
Wall Soil Friction Angle	20
K_a(Horiz)	0.27
K_AE(Horiz)	0.40

Stability

Overturning ratio	1.22
Sliding ratio	1.17
Overturning moment, ft-lbs	522
Resisting moment, ft-lbs	635
Total lateral/sliding force, lbs	352
Sliding Resistance, ft	413.77
Total vertical force, lbs	717
Base length, ft	1.67
Eccentricity on base, ft	0.68
Effective base length, ft	0.81
Soil bearing pressure, psf	879.94
Allowable soil bearing, psf	1,500.00
Soil Bearing Ratio	1.70

If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC 2009 or IBC 2012.

Segmental block data

Vendor selection	'Anchor Retaining Wall Systems'
Vendor ESR	'www.anchorwall.com'
Block selection type	'Vertica Pro'
Block height, in	8.00
Block depth, in	20.00
Offset per block, in	0.25
Batter angle	1.79
Wall weight, psf	215.00
Hinge height, ft	53.33

Loading

Dead load, psf	0
Live load, psf	0
Seismic Design Kh	0.15

Wall Analysis Table:

Block	Height above base Ft	In	Dec	Vert N	Lateral Static	Seismic	Shear Interface	S. F.
5	3'	4"	3.33				1,257.00	
4	2'	8"	2.67	143	7	45	1,271.33	24.61
3	2'	0"	2.00	287	26	86	1,285.67	11.41
2	1'	4"	1.33	430	60	124	1,300.00	7.10
1	0'	8"	0.67	573	106	157	1,314.33	5.00
Base	0'	0"	0.00	717	165	187	1,328.67	3.77

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Description....
Gravity Wall - 2.5 ft

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Segmental Gravity Retaining Wall

Code: NCMA

ASSUMPTIONS AND CRITERIA USED

1. References used include *Design Manual for Segmental Retaining Walls*, *2nd Edition*, and *Segmental Retaining Walls – Seismic Design Manual, 1st Edition*, both by NCMA.
2. Blocks are all same size and uniform offsets (batter) for full wall height.
3. Coulomb earth pressure theory used for earth pressures and failure plane angle.
4. Refer to geotechnical report for backfill material, compaction, and other design data and recommendations.
5. Cap blocks if used are above the retained height and neglected in this design.
6. Block sizes obtained from vendors' literature and may vary with locality.
7. Average weight of block and cell infill assumed to be 120 pcf.
8. See vendor web sites (on input screen) for more information and specifications.
9. Design height is limited to 12 feet or 18 blocks, whichever is less. Contact vendor for higher designs or special conditions.
10. Seismic design is per *Seismic Design Manua*l cited above. Also see *Methodology/Seismic Design* in *User's Manual*.
11. Vendor specifications or project specifications, whichever is more restrictive, to be followed for construction procedures.
12. Add notes and details for proper drainage.
13. See *User's Manual* Design Example #11 for methodology and sample verification calculations.
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Segmental Gravity Retaining Wall

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DESIGNER NOTES:

Seismic Check

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Project Name/Number : millcreek
Title **C-1** :
Dsgnr: **Jimmy Sipes**
Description....
Concrete Retaining Wall - 3.5'

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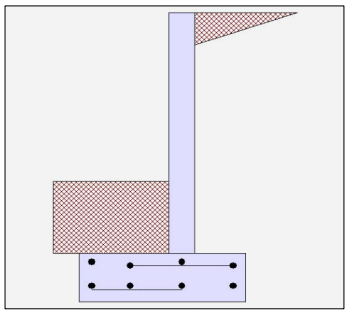
Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	5.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	0.0 ft



Load Factors

Building Code	IBC 2018,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Soil Data and Lateral Earth Pressure

Allow Soil Bearing	=	2,050.0 psf	Soil Density, Heel	=	110.00 pcf
Equivalent Fluid Pressure Method			Soil Density, Toe	=	110.00 pcf
Active Heel Pressure	=	38.0 psf/ft	Footing||Soil Friction	=	0.530
	=		Soil height to ignore for passive pressure	=	12.00 in
Passive Pressure	=	290.0 psf/ft			

Surcharge Loads

Surcharge Over Heel	=	50.0 psf	Surcharge Over Toe	=	0.0
Used To Resist Sliding & Overturning			Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs	Axial Load Eccentricity	=	0.0 in
Axial Live Load	=	0.0 lbs			

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)

Wind on Exposed Stem

Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs	Footing Type		Line Load
Footing Width	=	0.00 ft	Base Above/Below Soil		
Eccentricity	=	0.00 in	at Back of Wall	=	0.0 ft
Wall to Ftg CL Dist	=	0.00 ft	Poisson's Ratio	=	0.300

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Wall Design Summary

Stability Ratios

Overturning	=	2.05	OK
Sliding	=	2.14	OK

Soil Bearing

Total Bearing Load	=	1,751 lbs	
...resultant ecc.	=	7.40 in	
Soil Pressure @ Toe	=	1,158 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	2,050 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,621 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	7.8 psi	OK
Footing Shear @ Heel	=	6.3 psi	OK
Allowable	=	94.9 psi	

Sliding

Resisting Forces

Vertical Forces	Force	
Soil Over Heel (above water table, if any)	550.0	lbs
Soil Over Heel (below water table, if any)	0.0	
Water Over Heel	0.0	
Buoyant Force	0.0	
Sloped Soil Over Heel	0.0	
Surcharge Over Heel	50.0	
Adjacent Footing Load	0.0	
Axial Dead Load on Stem	0.0	
Axial Live Load on Stem *	Omit	
Soil Over Toe	288.8	
Surcharge Over Toe	0.0	
Stem Weight(s)	375.0	
Earth @ Stem Transitions	0.0	
Footing Weight	487.5	
Key Weight	0.0	
Vert. Component **	0.0	
Total Vertical Loads	1,751.3	lbs

Sliding Forces

Lateral Forces	Force	
Heel Active Pressure (above water table, if any)	684.0	lbs
Heel Active Pressure (below water table, if any)	0.0	
Hydrostatic Force	0.0	
* Heel Active Pressure	684.0	
Surcharge over Heel	103.6	
Adjacent Footing	0.0	
Surcharge Over Toe	0.0	
Load @ Stem Above Soil	0.0	
Added Lateral Load	0.0	
Seismic Load	0.0	
Seismic-Self-weight	0.0	
Lateral on Key	0.0	
Totals =	787.6	lbs

*Includes water table effect

* Axial live load NOT included in total displayed , or used for overturning
or sliding resistance, but is included for soil pressure calculations.

Sliding Calcs

Lateral Sliding Force	=		787.6 lbs	
less 100% Passive Force	=	-	761.3 lbs	
less 100% Friction Force	=	-	928.2 lbs	
Added Force Req'd	=		0.0 lbs	OK
....for 1.5 Stability	=		0.0 lbs	OK

Vertical component of active lateral soil pressure IS NOT considered in
the calculation of soil bearing pressures.

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Concrete Retaining Wall - 3.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Overturning

Resisting Moments

Resisting Moments	Force		Distance		Moment	
Soil Over Heel (above water table, if any)	550.0	lbs	2.75	ft	1,512.5	ft-#
Soil Over Heel (below water table, if any)	0.0		2.75			
Water Table	0.0		2.75			
Soil Over Heel	550.0		2.75		1,512.5	
Sloped Soil Over Heel	0.0					
Surcharge Over Heel	50.0		2.75		137.5	
Adjacent Footing Load	0.0					
Axial Dead Load on Stem	0.0					
Axial Live Load on Stem *	0.0					
Soil Over Toe	288.8		0.88		252.7	
Surcharge Over Toe	0.0					
Stem Weight(s)	375.0		2.00		750.0	
Earth @ Stem Transitions	0.0					
Footing Weight	487.5		1.63		792.2	
Key Weight	0.0					
Vert. Component	0.0					
Total Vertical Loads	1,751.3	lbs				
Resisting Moment					**3,444.8**	ft-#
Eccentricity					**7.4**	in

* Axial live load NOT included in total displayed, or used for overturning or sliding resistance, but is included for soil pressure calculations.

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Project Name/Number : millcreek
Title **C-1** :
Dsgnr: **Jimmy Sipes**
Description....
Concrete Retaining Wall - 3.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Overturning

Overturning Moments

Overturning Moments	Force		Distance		Moment	
Heel Active Pressure (above water table, if any)	684.0	lbs	2.00	ft	1,368.0	ft-#
Heel Active Pressure (below water table, if any)	0.0				848.2	
Hydrostatic Force	0.0					
Buoyant Force	0.0		1.63			
Heel Active Pressure	684.0		2.00		1,368.0	
Surcharge over Heel	103.6		3.00		310.9	
Adjacent Footing	0.0					
Surcharge Over Toe	0.0					
Load @ Stem Above Soil	0.0					
Added Lateral Load	0.0					
Seismic Load	0.0					
Seismic-Self-weight	0.0					
Totals =	787.6	lbs				
	Overturning Moment				1,678.9	ft-#

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Title **C-1** :
Dsgnr: **Jimmy Sipes**
Description....
Concrete Retaining Wall - 3.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Stem Design Summary

			Bottom
			Stem OK
Design Height Above Ftg	ft	=	0.00
Wall Material Above "Ht"		=	Concrete
Design Method		=	LRFD
Thickness		=	6.00
Rebar Size		=	# 5
Rebar Spacing		=	18.00
Rebar Placed at		=	Center
Design Data			
fb/FB + fa/Fa		=	**0.608**
Total Force @ Section			
Service Level	lbs	=	
Strength Level	lbs	=	898.2
Moment....Actual			
Service Level	ft-#	=	
Strength Level	ft-#	=	1,612.1
Moment.....Allowable		=	2,648.3
Shear.....Actual			
Service Level	psi	=	
Strength Level	psi	=	24.9
Shear.....Allowable	psi	=	94.9
Anet	in2	=	
Rebar Depth 'd'	in	=	3.00
Masonry Data			
f'm	psi	=	
Fs	psi	=	
Solid Grouting		=	
Modular Ratio 'n'		=	
Wall Weight	psf	=	75.0
Short Term Factor		=	
Equiv. Solid Thick.		=	
Masonry Block Type		=	Medium Weight
Masonry Design Method		=	ASD
Concrete Data			
f'c	psi	=	4,000.0
Fy	psi	=	60,000.0

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Project Name/Number : millcreek
Title **C-1** :
Dsgnr: **Jimmy Sipes**
Description....
Concrete Retaining Wall - 3.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.1336 in2/ft		
(4/3) * As :	0.1782 in2/ft	Min Stem T&S Reinf Area 0.720 in2	
200bd/fy : 200(12)(3)/60000 :	0.12 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.144 in2/ft	
0.0018bh : 0.0018(12)(6) :	0.1296 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.1336 in2/ft	#4@ 16.67 in	#4@ 33.33 in
Provided Area :	0.2067 in2/ft	#5@ 25.83 in	#5@ 51.67 in
Maximum Area :	0.6503 in2/ft	#6@ 36.67 in	#6@ 73.33 in

Toe Width	=	1.75	ft	f'c	=	4,000	psi
Heel Width	=	1.50		Fy	=	60,000	psi
Total Footing Width	=	3.25	ft	Footing Concrete Density	=	150.00	pcf
Footing Thickness	=	12.00	in	Min. As %	=	0.0018	
Key Width	=	0.00	in	Rebar Cover @ Top	=	3.00	in
Key Depth	=	0.00	in	@ Bottom	=	3.00	in
Key Distance from Toe	=	0.00	ft				

Footing Design Results

		Toe	Heel	
Factored Pressure	=	1,621	0	psf
Mu' : Upward	=	2,003	42	ft-#
Mu' : Downward	=	579	460	ft-#
Mu: Design	=	1,425	418	ft-#
Actual 1-Way Shear	=	7.79	6.33	psi
Allow 1-Way Shear	=	50.60	50.60	psi

Toe Reinforcing	=	# 4 @ 17.99 in
Heel Reinforcing	=	# 4 @ 17.99 in
Key Reinforcing	=	None Spec'd

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.34 in, #6@ 20.36 in, #7@ 27.77 in, #8@ 36.56 in, #9@ 46

Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm

Key: No key defined

Min footing T&S reinf Area	0.84	in2
Min footing T&S reinf Area per fo	0.26	in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.049	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,
because the wall would then tend to rotate into the retained soil.

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Project Name/Number : millcreek
Title **C-1s** :
Dsgnr: **Jimmy Sipes**
Description....
Concrete Retaining Wall - 3.5'

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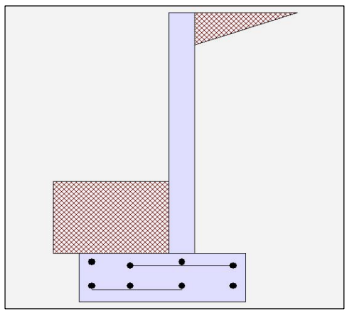
Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	5.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	0.0 ft



Load Factors

Building Code	IBC 2018,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Soil Data and Lateral Earth Pressure

Allow Soil Bearing	=	2,750.0 psf	Soil Density, Heel	=	110.00 pcf
Equivalent Fluid Pressure Method			Soil Density, Toe	=	110.00 pcf
Active Heel Pressure	=	38.0 psf/ft	Footing||Soil Friction	=	0.530
	=		Soil height to ignore for passive pressure	=	12.00 in
Passive Pressure	=	386.0 psf/ft			

Surcharge Loads

Surcharge Over Heel	=	0.0 psf	Surcharge Over Toe	=	0.0
Used To Resist Sliding & Overturning			Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs	Axial Load Eccentricity	=	0.0 in
Axial Live Load	=	0.0 lbs			

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Project Name/Number : millcreek
Title **C-1s** :
Dsgnr: **Jimmy Sipes**
Description....
Concrete Retaining Wall - 3.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Wind (W) (Service Level)

Wind on Exposed Stem

Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs	Footing Type	Line Load	
Footing Width	=	0.00 ft	Base Above/Below Soil		
Eccentricity	=	0.00 in	at Back of Wall	=	0.0 ft
Wall to Ftg CL Dist	=	0.00 ft	Poisson's Ratio	=	0.300

Earth Pressure Seismic Load

Method : Inverted Triangular

Load at top of Inverted Triangular Distribution	=	90.000 psf	Total Strength-Level Seismic Load.	=	270.000 lbs
(Strength-Level)			Total Service-Level Seismic Load.	=	189.000 lbs

Stem Weight Seismic Load

F_p / W_p Weight Multiplier	=	0.281 g	Added seismic base force	=	73.8 lbs

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Description....
Concrete Retaining Wall - 3.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Wall Design Summary

Stability Ratios

Overturning	=	1.39 Ratio < 1.5!
Sliding	=	2.02 OK

Soil Bearing

Total Bearing Load	=	1,701 lbs
...resultant ecc.	=	12.97 in
Soil Pressure @ Toe	=	2,086 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,750 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,920 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	13.4 psi OK
Footing Shear @ Heel	=	7.0 psi OK
Allowable	=	94.9 psi

Sliding

Resisting Forces

Vertical Forces	Force	
Soil Over Heel (above water table, if any)	550.0	lbs
Soil Over Heel (below water table, if any)	0.0	
Water Over Heel	0.0	
Buoyant Force	0.0	
Sloped Soil Over Heel	0.0	
Surcharge Over Heel	0.0	
Adjacent Footing Load	0.0	
Axial Dead Load on Stem	0.0	
Axial Live Load on Stem *	Omit	
Soil Over Toe	288.8	
Surcharge Over Toe	0.0	
Stem Weight(s)	375.0	
Earth @ Stem Transitions	0.0	
Footing Weight	487.5	
Key Weight	0.0	
Vert. Component **	0.0	
Total Vertical Loads	1,701.3	lbs

Sliding Forces

Lateral Forces	Force	
Heel Active Pressure (above water table, if any)	684.0	lbs
Heel Active Pressure (below water table, if any)	0.0	
Hydrostatic Force	0.0	
* Heel Active Pressure	684.0	
Surcharge over Heel	0.0	
Adjacent Footing	0.0	
Surcharge Over Toe	0.0	
Load @ Stem Above Soil	0.0	
Added Lateral Load	0.0	
Seismic Load	189.0	
Seismic-Self-weight	73.8	
Lateral on Key	0.0	
Totals =	946.8	lbs

*Includes water table effect

* Axial live load NOT included in total displayed , or used for overturning
or sliding resistance, but is included for soil pressure calculations.

Sliding Calcs

Lateral Sliding Force	=	946.8 lbs	
less 100% Passive Force	=	- 1,013.3 lbs	
less 100% Friction Force	=	- 901.7 lbs	
Added Force Req'd	=	0.0 lbs	OK
....for 1.5 Stability	=	0.0 lbs	OK

Vertical component of active lateral soil pressure IS NOT considered in
the calculation of soil bearing pressures.

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Project Name/Number : millcreek
Title **C-1s** :
Dsgnr: **Jimmy Sipes**
Description....
Concrete Retaining Wall - 3.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Overturning

Resisting Moments

Resisting Moments	Force		Distance		Moment	
Soil Over Heel (above water table, if any)	550.0	lbs	2.75	ft	1,512.5	ft-#
Soil Over Heel (below water table, if any)	0.0		2.75			
Water Table	0.0		2.75			
Soil Over Heel	550.0		2.75		1,512.5	
Sloped Soil Over Heel	0.0					
Surcharge Over Heel	0.0					
Adjacent Footing Load	0.0					
Axial Dead Load on Stem	0.0					
Axial Live Load on Stem *	0.0					
Soil Over Toe	288.8		0.88		252.7	
Surcharge Over Toe	0.0					
Stem Weight(s)	375.0		2.00		750.0	
Earth @ Stem Transitions	0.0					
Footing Weight	487.5		1.63		792.2	
Key Weight	0.0					
Vert. Component	0.0					
Total Vertical Loads	1,701.3	lbs				
Resisting Moment					**3,307.3**	ft-#
Eccentricity					**7.4**	in

* Axial live load NOT included in total displayed, or used for overturning or sliding resistance, but is included for soil pressure calculations.

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Project Name/Number : millcreek
Title **C-1s** :
Dsgnr: **Jimmy Sipes**
Description....
Concrete Retaining Wall - 3.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Overturning

Overturning Moments

Overturning Moments	Force		Distance		Moment	
Heel Active Pressure (above water table, if any)	684.0	lbs	2.00	ft	1,368.0	ft-#
Heel Active Pressure (below water table, if any)	0.0				848.2	
Hydrostatic Force	0.0					
Buoyant Force	0.0		1.63			
Heel Active Pressure	684.0		2.00		1,368.0	
Surcharge over Heel	0.0					
Adjacent Footing	0.0					
Surcharge Over Toe	0.0					
Load @ Stem Above Soil	0.0					
Added Lateral Load	0.0					
Seismic Load	189.0		4.00		756.0	
Seismic-Self-weight	73.8		3.50		258.2	
Totals =	946.8	lbs				
	Overturning Moment				2,382.2	ft-#

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Title **C-1s** :
Dsgnr: **Jimmy Sipes**
Description....
Concrete Retaining Wall - 3.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Stem Design Summary

			Bottom	
			Stem OK	
Design Height Above Ftg	ft	=	0.00	
Wall Material Above "Ht"		=	Concrete	
Design Method		=	LRFD	LRFD
Thickness		=	6.00	
Rebar Size		=	# 5	
Rebar Spacing		=	18.00	
Rebar Placed at		=	Center	
Design Data				
fb/FB + fa/Fa		=	**0.884**	
Total Force @ Section				
Service Level	lbs	=		
Strength Level	lbs	=	1,127.9	
Moment....Actual				
Service Level	ft-#	=		
Strength Level	ft-#	=	2,342.6	
Moment.....Allowable		=	2,648.3	
Shear.....Actual				
Service Level	psi	=		
Strength Level	psi	=	31.3	
Shear.....Allowable	psi	=	94.9	
Anet	in2	=		
Rebar Depth 'd'	in	=	3.00	
Masonry Data				
f'm	psi	=		
Fs	psi	=		
Solid Grouting		=		
Modular Ratio 'n'		=		
Wall Weight	psf	=	75.0	
Short Term Factor		=		
Equiv. Solid Thick.		=		
Masonry Block Type		=	Medium Weight	
Masonry Design Method		=	ASD	
Concrete Data				
f'c	psi	=	4,000.0	
Fy	psi	=	60,000.0	

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for your program.

Project Name/Number : millcreek
Title **C-1s** :
Dsgnr: **Jimmy Sipes**
Description....
Concrete Retaining Wall - 3.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.1942 in2/ft		
(4/3) * As :	0.2589 in2/ft	Min Stem T&S Reinf Area 0.720 in2	
200bd/fy : 200(12)(3)/60000 :	0.12 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.144 in2/ft	
0.0018bh : 0.0018(12)(6) :	0.1296 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.1942 in2/ft	#4@ 16.67 in	#4@ 33.33 in
Provided Area :	0.2067 in2/ft	#5@ 25.83 in	#5@ 51.67 in
Maximum Area :	0.6503 in2/ft	#6@ 36.67 in	#6@ 73.33 in

Toe Width	=	1.75	ft	f'c	=	4,000	psi
Heel Width	=	1.50		Fy	=	60,000	psi
Total Footing Width	=	3.25	ft	Footing Concrete Density	=	150.00	pcf
Footing Thickness	=	12.00	in	Min. As %	=	0.0018	
Key Width	=	0.00	in	Rebar Cover @ Top	=	3.00	in
Key Depth	=	0.00	in	@ Bottom	=	3.00	in
Key Distance from Toe	=	0.00	ft				

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,920	0	psf
Mu' : Upward	=	2,873	0	ft-#
Mu' : Downward	=	579	420	ft-#
Mu: Design	=	2,294	420	ft-#
Actual 1-Way Shear	=	13.40	7.00	psi
Allow 1-Way Shear	=	50.60	50.60	psi

Toe Reinforcing	=	# 4 @ 17.99 in
Heel Reinforcing	=	# 4 @ 17.99 in
Key Reinforcing	=	None Spec'd

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.34 in, #6@ 20.36 in, #7@ 27.77 in, #8@ 36.56 in, #9@ 46

Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm

Key: No key defined

Min footing T&S reinf Area	0.84	in2
Min footing T&S reinf Area per fo	0.26	in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 9.26 in	#4@ 18.52 in
#5@ 14.35 in	#5@ 28.70 in
#6@ 20.37 in	#6@ 40.74 in

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.089	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,
because the wall would then tend to rotate into the retained soil.

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Project Name/Number : millcreek
Title **M-1** :
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

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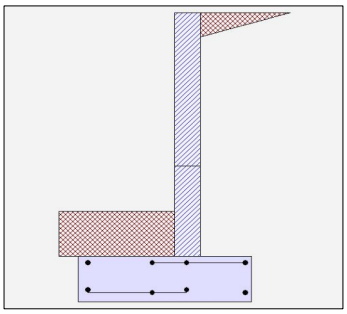
Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	6.75 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	15.00 in
Water height over heel	=	0.0 ft



Load Factors

Building Code	IBC 2018,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Soil Data and Lateral Earth Pressure

Allow Soil Bearing	=	2,375.0 psf	Soil Density, Heel	=	110.00 pcf
Equivalent Fluid Pressure Method			Soil Density, Toe	=	110.00 pcf
Active Heel Pressure	=	38.0 psf/ft	Footing||Soil Friction	=	0.530
	=		Soil height to ignore for passive pressure	=	12.00 in
Passive Pressure	=	290.0 psf/ft			

Surcharge Loads

Surcharge Over Heel	=	50.0 psf	Surcharge Over Toe	=	0.0 psf
Used To Resist Sliding & Overturning			Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs	Axial Load Eccentricity	=	0.0 in
Axial Live Load	=	0.0 lbs			

Use menu item Settings > Printing & Title Block
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for your program.

Project Name/Number : millcreek
Title **M-1** :
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Lateral Load Applied to Stem

Lateral Load	=	50.0 #/ft
...Height to Top	=	11.25 ft
...Height to Bottom	=	10.25 ft
Load Type	=	Live Load (L) (Service Level)

Wind on Exposed Stem

Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs	Footing Type		Line Load
Footing Width	=	0.00 ft	Base Above/Below Soil		
Eccentricity	=	0.00 in	at Back of Wall	=	0.0 ft
Wall to Ftg CL Dist	=	0.00 ft	Poisson's Ratio	=	0.300

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Project Name/Number : millcreek
Title **M-1** :
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Wall Design Summary

Stability Ratios

Overturning	=	1.89	OK
Sliding	=	1.65	OK

Soil Bearing

Total Bearing Load	=	2,929 lbs	
...resultant ecc.	=	10.93 in	
Soil Pressure @ Toe	=	1,458 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	2,375 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,041 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	15.4 psi	OK
Footing Shear @ Heel	=	9.0 psi	OK
Allowable	=	94.9 psi	

Sliding

Resisting Forces

Vertical Forces	Force	
Soil Over Heel (above water table, if any)	550.0	lbs
Soil Over Heel (below water table, if any)	0.0	
Water Over Heel	0.0	
Buoyant Force	0.0	
Sloped Soil Over Heel	0.0	
Surcharge Over Heel	66.7	
Adjacent Footing Load	0.0	
Axial Dead Load on Stem	0.0	
Axial Live Load on Stem *	Omit	
Soil Over Toe	343.8	
Surcharge Over Toe	0.0	
Stem Weight(s)	684.5	
Earth @ Stem Transitions	0.0	
Footing Weight	843.8	
Key Weight	0.0	
Vert. Component **	0.0	
Total Vertical Loads	2,928.6	lbs

Sliding Forces

Lateral Forces	Force	
Heel Active Pressure (above water table, if any)	684.0	lbs
Heel Active Pressure (below water table, if any)	0.0	
Hydrostatic Force	0.0	
* Heel Active Pressure	1,216.0	
Surcharge over Heel	138.2	
Adjacent Footing	0.0	
Surcharge Over Toe	0.0	
Load @ Stem Above Soil	0.0	
Added Lateral Load	50.0	
Seismic Load	0.0	
Seismic-Self-weight	0.0	
Lateral on Key	0.0	
Totals =	1,404.2	lbs

*Includes water table effect

* Axial live load NOT included in total displayed , or used for overturning
or sliding resistance, but is included for soil pressure calculations.

Sliding Calcs

Lateral Sliding Force	=		1,404.2 lbs	
less 100% Passive Force	=	-	761.3 lbs	
less 100% Friction Force	=	-	1,552.2 lbs	
Added Force Req'd	=		0.0 lbs	OK
....for 1.5 Stability	=		0.0 lbs	OK

Vertical component of active lateral soil pressure IS NOT considered in
the calculation of soil bearing pressures.

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Project Name/Number : millcreek
Title **M-1** :
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Overturning

Resisting Moments

Resisting Moments	Force		Distance		Moment	
Soil Over Heel (above water table, if any)	550.0	lbs	2.75	ft	3,795.0	ft-#
Soil Over Heel (below water table, if any)	0.0		2.75			
Water Table	0.0		2.75			
Soil Over Heel	990.0		3.83		3,795.0	
Sloped Soil Over Heel	0.0					
Surcharge Over Heel	66.7		3.83		255.6	
Adjacent Footing Load	0.0					
Axial Dead Load on Stem	0.0					
Axial Live Load on Stem *	0.0					
Soil Over Toe	343.8		1.25		429.7	
Surcharge Over Toe	0.0					
Stem Weight(s)	684.5		2.83		1,939.3	
Earth @ Stem Transitions	0.0					
Footing Weight	843.8		2.25		1,898.4	
Key Weight	0.0					
Vert. Component	0.0					
Total Vertical Loads	2,928.6	lbs				
Resisting Moment					**8,318.0**	ft-#
Eccentricity					**7.4**	in

* Axial live load NOT included in total displayed, or used for overturning or sliding resistance, but is included for soil pressure calculations.

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Overturning

Overturning Moments

Overturning Moments	Force		Distance		Moment	
Heel Active Pressure (above water table, if any)	684.0	lbs	2.00	ft	3,242.7	ft-#
Heel Active Pressure (below water table, if any)	0.0				848.2	
Hydrostatic Force	0.0					
Buoyant Force	0.0		1.63			
Heel Active Pressure	1,216.0		2.67		3,242.7	
Surcharge over Heel	138.2		4.00		552.7	
Adjacent Footing	0.0					
Surcharge Over Toe	0.0					
Load @ Stem Above Soil	0.0					
Added Lateral Load	50.0		12.00		600.0	
Seismic Load	0.0					
Seismic-Self-weight	0.0					
Totals =	1,404.2	lbs				
	Overturning Moment				4,395.4	ft-#

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Stem Design Summary

			2nd	Bottom
			Stem OK	Stem OK
Design Height Above Ftg	ft	=	2.50	0.00
Wall Material Above "Ht"		=	Masonry	Masonry
Design Method		=	LRFD	LRFD
Thickness		=	8.00	8.00
Rebar Size		=	# 4	# 6
Rebar Spacing		=	16.00	8.00
Rebar Placed at		=	Center	Center
Design Data				
fb/FB + fa/Fa		=	**0.734**	**0.697**
Total Force @ Section				
Service Level	lbs	=		
Strength Level	lbs	=	746.6	1,651.6
Moment....Actual				
Service Level	ft-#	=		
Strength Level	ft-#	=	1,687.5	4,606.1
Moment.....Allowable	ft-#	=	2,296.9	6,600.0
Shear.....Actual				
Service Level	psi	=		
Strength Level	psi	=	8.2	18.1
Shear.....Allowable	psi	=	69.7	69.7
Anet	in2	=	91.50	91.50
Rebar Depth 'd'	in	=	3.75	3.75
Masonry Data				
f'm	psi	=	1,500	1,500
Fy	psi	=	60,000	60,000
Solid Grouting		=	Yes	Yes
Modular Ratio 'n'		=	21.48	21.48
Wall Weight	psf	=	101.4	101.4
Equiv. Solid Thick.	in	=	7.60	7.60
Masonry Block Type		=	Medium Weight	
Masonry Design Method		=	LRFD	
Concrete Data				
f'c	psi	=		
Fy	psi	=		

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Title **M-1** :
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Toe Width	=	2.50 ft	f'c		=	4,000	psi
Heel Width	=	2.00	Fy		=	60,000	psi
Total Footing Width	=	4.50 ft	Footing Concrete Density		=	150.00	pcf
Footing Thickness	=	15.00 in	Min. As %		=	0.0018	
Key Width	=	0.00 in	Rebar Cover	@ Top	=	2.00	in
Key Depth	=	0.00 in		@ Bottom	=	3.00	in
Key Distance from Toe	=	0.00 ft					

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,041	0	psf
Mu' : Upward	=	5,055	52	ft-#
Mu' : Downward	=	1,381	1,329	ft-#
Mu: Design	=	3,674	1,277	ft-#
Actual 1-Way Shear	=	15.40	9.04	psi
Allow 1-Way Shear	=	50.60	50.60	psi

Toe Reinforcing	=	# 5 @ 17.99 in
Heel Reinforcing	=	# 5 @ 17.99 in
Key Reinforcing	=	None Spec'd

Other Acceptable Sizes & Spacings

Toe: #4@ 7.40 in, #5@ 11.47 in, #6@ 16.29 in, #7@ 22.21 in, #8@ 29.25 in, #9@ 37

Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm

Key: No key defined

Min footing T&S reinf Area	1.46	in2
Min footing T&S reinf Area per fo	0.32	in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 7.41 in	#4@ 14.81 in
#5@ 11.48 in	#5@ 22.96 in
#6@ 16.30 in	#6@ 32.59 in

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.061	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,
because the wall would then tend to rotate into the retained soil.

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Project Name/Number : millcreek
Title **M-1(2)**
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

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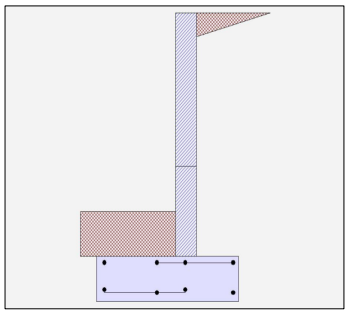
Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	6.75 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	15.00 in
Water height over heel	=	0.0 ft



Load Factors

Building Code	IBC 2018,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Soil Data and Lateral Earth Pressure

Allow Soil Bearing	=	2,375.0 psf	Soil Density, Heel	=	110.00 pcf
Equivalent Fluid Pressure Method			Soil Density, Toe	=	110.00 pcf
Active Heel Pressure	=	38.0 psf/ft	Footing||Soil Friction	=	0.530
	=		Soil height to ignore for passive pressure	=	12.00 in
Passive Pressure	=	290.0 psf/ft			

Surcharge Loads

Surcharge Over Heel	=	50.0 psf	Surcharge Over Toe	=	0.0 psf
Used To Resist Sliding & Overturning			Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs	Axial Load Eccentricity	=	0.0 in
Axial Live Load	=	0.0 lbs			

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Project Name/Number : millcreek
Title **M-1(2)**
Dsgnr: **Jimmy Slpes**
Description....
Masonry Retaining Wall - 5.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Lateral Load Applied to Stem

Lateral Load	=	58.0 #/ft
...Height to Top	=	15.85 ft
...Height to Bottom	=	14.85 ft
Load Type	=	Wind (W) (Strength Level)

Wind on Exposed Stem

Wind on Exposed Stem (Strength Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs	Footing Type	Line Load	
Footing Width	=	0.00 ft	Base Above/Below Soil		
Eccentricity	=	0.00 in	at Back of Wall	=	0.0 ft
Wall to Ftg CL Dist	=	0.00 ft	Poisson's Ratio	=	0.300

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Title **M-1(2)**
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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Wall Design Summary

Stability Ratios

Overturning	=	1.90	OK
Sliding	=	1.67	OK

Soil Bearing

Total Bearing Load	=	2,929 lbs	
...resultant ecc.	=	10.84 in	
Soil Pressure @ Toe	=	1,449 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	2,375 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,029 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	15.3 psi	OK
Footing Shear @ Heel	=	9.0 psi	OK
Allowable	=	94.9 psi	

Sliding

Resisting Forces

Vertical Forces	Force	
Soil Over Heel (above water table, if any)	990.0	lbs
Soil Over Heel (below water table, if any)	0.0	
Water Over Heel	0.0	
Buoyant Force	0.0	
Sloped Soil Over Heel	0.0	
Surcharge Over Heel	66.7	
Adjacent Footing Load	0.0	
Axial Dead Load on Stem	0.0	
Axial Live Load on Stem *	Omit	
Soil Over Toe	343.8	
Surcharge Over Toe	0.0	
Stem Weight(s)	684.5	
Earth @ Stem Transitions	0.0	
Footing Weight	843.8	
Key Weight	0.0	
Vert. Component **	0.0	
Total Vertical Loads	2,928.6	lbs

Sliding Forces

Lateral Forces	Force	
Heel Active Pressure (above water table, if any)	1,216.0	lbs
Heel Active Pressure (below water table, if any)	0.0	
Hydrostatic Force	0.0	
* Heel Active Pressure	1,216.0	
Surcharge over Heel	138.2	
Adjacent Footing	0.0	
Surcharge Over Toe	0.0	
Load @ Stem Above Soil	0.0	
Added Lateral Load	34.8	
Seismic Load	0.0	
Seismic-Self-weight	0.0	
Lateral on Key	0.0	
Totals =	1,389.0	lbs

*Includes water table effect

* Axial live load NOT included in total displayed , or used for overturning
or sliding resistance, but is included for soil pressure calculations.

Sliding Calcs

Lateral Sliding Force	=		1,389.0 lbs	
less 100% Passive Force	=	-	761.3 lbs	
less 100% Friction Force	=	-	1,552.2 lbs	
Added Force Req'd	=		0.0 lbs	OK
....for 1.5 Stability	=		0.0 lbs	OK

Vertical component of active lateral soil pressure IS NOT considered in
the calculation of soil bearing pressures.

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Project Name/Number : millcreek
Title **M-1(2)**
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Overturning

Resisting Moments

Resisting Moments	Force		Distance		Moment	
Soil Over Heel (above water table, if any)	990.0	lbs	3.83	ft	3,795.0	ft-#
Soil Over Heel (below water table, if any)	0.0		3.83			
Water Table	0.0		3.83			
Soil Over Heel	990.0		3.83		3,795.0	
Sloped Soil Over Heel	0.0					
Surcharge Over Heel	66.7		3.83		255.6	
Adjacent Footing Load	0.0					
Axial Dead Load on Stem	0.0					
Axial Live Load on Stem *	0.0					
Soil Over Toe	343.8		1.25		429.7	
Surcharge Over Toe	0.0					
Stem Weight(s)	684.5		2.83		1,939.3	
Earth @ Stem Transitions	0.0					
Footing Weight	843.8		2.25		1,898.4	
Key Weight	0.0					
Vert. Component	0.0					
Total Vertical Loads	2,928.6	lbs				
Resisting Moment					**8,318.0**	ft-#
Eccentricity					**10.8**	in

* Axial live load NOT included in total displayed, or used for overturning or sliding resistance, but is included for soil pressure calculations.

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Overturning

Overturning Moments

Overturning Moments	Force		Distance		Moment	
Heel Active Pressure (above water table, if any)	1,216.0	lbs	2.67	ft	3,242.7	ft-#
Heel Active Pressure (below water table, if any)	0.0				2,010.5	
Hydrostatic Force	0.0					
Buoyant Force	0.0		2.25			
Heel Active Pressure	1,216.0		2.67		3,242.7	
Surcharge over Heel	138.2		4.00		552.7	
Adjacent Footing	0.0					
Surcharge Over Toe	0.0					
Load @ Stem Above Soil	0.0					
Added Lateral Load	34.8		16.60		577.7	
Seismic Load	0.0					
Seismic-Self-weight	0.0					
Totals =	1,389.0	lbs				
	Overturning Moment				6,383.5	ft-#

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Description....
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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Stem Design Summary

			2nd	Bottom
			Stem OK	Stem OK
Design Height Above Ftg	ft	=	2.50	0.00
Wall Material Above "Ht"		=	Masonry	Masonry
Design Method		=	LRFD	LRFD
Thickness		=	8.00	8.00
Rebar Size		=	# 4	# 6
Rebar Spacing		=	16.00	8.00
Rebar Placed at		=	Center	Center
Design Data				
fb/FB + fa/Fa		=	**0.771**	**0.701**
Total Force @ Section				
Service Level	lbs	=		
Strength Level	lbs	=	724.6	1,629.6
Moment....Actual				
Service Level	ft-#	=		
Strength Level	ft-#	=	1,772.8	4,636.4
Moment.....Allowable	ft-#	=	2,296.9	6,600.0
Shear.....Actual				
Service Level	psi	=		
Strength Level	psi	=	7.9	17.8
Shear.....Allowable	psi	=	69.7	69.7
Anet	in2	=	91.50	91.50
Rebar Depth 'd'	in	=	3.75	3.75
Masonry Data				
f'm	psi	=	1,500	1,500
Fy	psi	=	60,000	60,000
Solid Grouting		=	Yes	Yes
Modular Ratio 'n'		=	21.48	21.48
Wall Weight	psf	=	101.4	101.4
Equiv. Solid Thick.	in	=	7.60	7.60
Masonry Block Type		=	Medium Weight	
Masonry Design Method		=	LRFD	
Concrete Data				
f'c	psi	=		
Fy	psi	=		

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Project Name/Number : millcreek
Title **M-1(2)**
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Toe Width	=	2.50 ft	f'c		=	4,000	psi
Heel Width	=	2.00	Fy		=	60,000	psi
Total Footing Width	=	4.50 ft	Footing Concrete Density		=	150.00	pcf
Footing Thickness	=	15.00 in	Min. As %		=	0.0018	
Key Width	=	0.00 in	Rebar Cover	@ Top	=	2.00	in
Key Depth	=	0.00 in		@ Bottom	=	3.00	in
Key Distance from Toe	=	0.00 ft					

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,029	0	psf
Mu' : Upward	=	5,034	56	ft-#
Mu' : Downward	=	1,381	1,329	ft-#
Mu: Design	=	3,652	1,273	ft-#
Actual 1-Way Shear	=	15.33	8.99	psi
Allow 1-Way Shear	=	50.60	50.60	psi

Toe Reinforcing	=	# 5 @ 17.99 in
Heel Reinforcing	=	# 5 @ 17.99 in
Key Reinforcing	=	None Spec'd

Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm

Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm

Key: No key defined

Min footing T&S reinf Area	1.46	in2
Min footing T&S reinf Area per fo	0.32	in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 7.41 in	#4@ 14.81 in
#5@ 11.48 in	#5@ 22.96 in
#6@ 16.30 in	#6@ 32.59 in

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.060	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,
because the wall would then tend to rotate into the retained soil.

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Project Name/Number : millcreek
Title **M-1s**:
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

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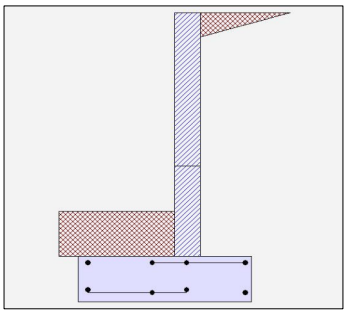
Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	6.75 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	15.00 in
Water height over heel	=	0.0 ft



Load Factors

Building Code	IBC 2018,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Soil Data and Lateral Earth Pressure

Allow Soil Bearing	=	3,166.0 psf	Soil Density, Heel	=	110.00 pcf
Equivalent Fluid Pressure Method			Soil Density, Toe	=	110.00 pcf
Active Heel Pressure	=	38.0 psf/ft	Footing||Soil Friction	=	0.530
	=		Soil height to ignore for passive pressure	=	12.00 in
Passive Pressure	=	290.0 psf/ft			

Surcharge Loads

Surcharge Over Heel	=	0.0 psf	Surcharge Over Toe	=	0.0 psf
Used To Resist Sliding & Overturning			Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs	Axial Load Eccentricity	=	0.0 in
Axial Live Load	=	0.0 lbs			

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Lateral Load Applied to Stem

Lateral Load	=	0.0 #/ft
...Height to Top	=	0.00 ft
...Height to Bottom	=	0.00 ft
Load Type	=	Live Load (L) (Service Level)

Wind on Exposed Stem

Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs	Footing Type	Line Load	
Footing Width	=	0.00 ft	Base Above/Below Soil		
Eccentricity	=	0.00 in	at Back of Wall	=	0.0 ft
Wall to Ftg CL Dist	=	0.00 ft	Poisson's Ratio	=	0.300

Earth Pressure Seismic Load

Method : Inverted Triangular

Load at top of Inverted Triangular Distribution	=	120.000 psf	Total Strength-Level Seismic Load.	=	480.000 lbs
(Strength-Level)			Total Service-Level Seismic Load.	=	336.000 lbs

Stem Weight Seismic Load

F_p / W_p Weight Multiplier	=	0.281 g	Added seismic base force	=	134.6 lbs

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Description....
Masonry Retaining Wall - 5.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Wall Design Summary

Stability Ratios

Overturning	=	1.43	Ratio < 1.5!
Sliding	=	1.35	Ratio < 1.5!

Soil Bearing

Total Bearing Load	=	2,862 lbs	
...resultant ecc.	=	16.92 in	
Soil Pressure @ Toe	=	2,270 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,166 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	3,179 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	18.6 psi	OK
Footing Shear @ Heel	=	9.5 psi	OK
Allowable	=	94.9 psi	

Sliding

Resisting Forces

Vertical Forces	Force	
Soil Over Heel (above water table, if any)	550.0	lbs
Soil Over Heel (below water table, if any)	0.0	
Water Over Heel	0.0	
Buoyant Force	0.0	
Sloped Soil Over Heel	0.0	
Surcharge Over Heel	0.0	
Adjacent Footing Load	0.0	
Axial Dead Load on Stem	0.0	
Axial Live Load on Stem *	Omit	
Soil Over Toe	343.8	
Surcharge Over Toe	0.0	
Stem Weight(s)	684.5	
Earth @ Stem Transitions	0.0	
Footing Weight	843.8	
Key Weight	0.0	
Vert. Component **	0.0	
Total Vertical Loads	2,862.0	lbs

Sliding Forces

Lateral Forces	Force	
Heel Active Pressure (above water table, if any)	684.0	lbs
Heel Active Pressure (below water table, if any)	0.0	
Hydrostatic Force	0.0	
* Heel Active Pressure	1,216.0	
Surcharge over Heel	0.0	
Adjacent Footing	0.0	
Surcharge Over Toe	0.0	
Load @ Stem Above Soil	0.0	
Added Lateral Load	0.0	
Seismic Load	336.0	
Seismic-Self-weight	134.6	
Lateral on Key	0.0	
Totals =	1,686.6	lbs

*Includes water table effect

* Axial live load NOT included in total displayed , or used for overturning
or sliding resistance, but is included for soil pressure calculations.

Sliding Calcs

Lateral Sliding Force	=		1,686.6 lbs	
less 100% Passive Force	=	-	761.3 lbs	
less 100% Friction Force	=	-	1,516.8 lbs	
Added Force Req'd	=		0.0 lbs	OK
....for 1.5 Stability	=		251.9 lbs	NG

Vertical component of active lateral soil pressure IS NOT considered in
the calculation of soil bearing pressures.

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Project Name/Number : millcreek
Title **M-1s**:
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Overturning

Resisting Moments

Resisting Moments	Force		Distance	Moment
Soil Over Heel (above water table, if any)	550.0	lbs	2.75 ft	3,795.0ft-#
Soil Over Heel (below water table, if any)	0.0		2.75	
Water Table	0.0		2.75	
Soil Over Heel	990.0		3.83	3,795.0
Sloped Soil Over Heel	0.0			
Surcharge Over Heel	0.0			
Adjacent Footing Load	0.0			
Axial Dead Load on Stem	0.0			
Axial Live Load on Stem *	0.0			
Soil Over Toe	343.8		1.25	429.7
Surcharge Over Toe	0.0			
Stem Weight(s)	684.5		2.83	1,939.3
Earth @ Stem Transitions	0.0			
Footing Weight	843.8		2.25	1,898.4
Key Weight	0.0			
Vert. Component	0.0			
Total Vertical Loads	2,862.0	lbs		
Resisting Moment				**8,062.4** ft-#
Eccentricity				**7.4** in

* Axial live load NOT included in total displayed, or used for overturning or sliding resistance, but is included for soil pressure calculations.

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Overturning

Overturning Moments

Overturning Moments	Force		Distance		Moment	
Heel Active Pressure (above water table, if any)	684.0	lbs	2.00	ft	3,242.7	ft-#
Heel Active Pressure (below water table, if any)	0.0				848.2	
Hydrostatic Force	0.0					
Buoyant Force	0.0		1.63			
Heel Active Pressure	1,216.0		2.67		3,242.7	
Surcharge over Heel	0.0					
Adjacent Footing	0.0					
Surcharge Over Toe	0.0					
Load @ Stem Above Soil	0.0					
Added Lateral Load	0.0					
Seismic Load	336.0		5.33		1,792.0	
Seismic-Self-weight	134.6		4.63		622.7	
Totals =	1,686.6	lbs				
	Overturning Moment				5,657.3	ft-#

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Description....
Masonry Retaining Wall - 5.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Stem Design Summary

			2nd	Bottom
			Stem OK	Stem OK
Design Height Above Ftg	ft	=	2.50	0.00
Wall Material Above "Ht"		=	Masonry	Masonry
Design Method		=	LRFD	LRFD
Thickness		=	8.00	8.00
Rebar Size		=	# 4	# 6
Rebar Spacing		=	16.00	8.00
Rebar Placed at		=	Center	Center
Design Data				
fb/FB + fa/Fa		=	**0.838**	**0.867**
Total Force @ Section				
Service Level	lbs	=		
Strength Level	lbs	=	1,044.7	2,045.7
Moment....Actual				
Service Level	ft-#	=		
Strength Level	ft-#	=	1,927.1	5,730.5
Moment.....Allowable	ft-#	=	2,296.9	6,600.0
Shear.....Actual				
Service Level	psi	=		
Strength Level	psi	=	11.4	22.4
Shear.....Allowable	psi	=	69.7	69.7
Anet	in2	=	91.50	91.50
Rebar Depth 'd'	in	=	3.75	3.75
Masonry Data				
f'm	psi	=	1,500	1,500
Fy	psi	=	60,000	60,000
Solid Grouting		=	Yes	Yes
Modular Ratio 'n'		=	21.48	21.48
Wall Weight	psf	=	101.4	101.4
Equiv. Solid Thick.	in	=	7.60	7.60
Masonry Block Type		=	Medium Weight	
Masonry Design Method		=	LRFD	
Concrete Data				
f'c	psi	=		
Fy	psi	=		

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Toe Width	=	2.50 ft	f'c		=	4,000	psi
Heel Width	=	2.00	Fy		=	60,000	psi
Total Footing Width	=	4.50 ft	Footing Concrete Density		=	150.00	pcf
Footing Thickness	=	15.00 in	Min. As %		=	0.0018	
Key Width	=	0.00 in	Rebar Cover	@ Top	=	2.00	in
Key Depth	=	0.00 in		@ Bottom	=	3.00	in
Key Distance from Toe	=	0.00 ft					

Footing Design Results

		Toe	Heel	
Factored Pressure	=	3,179	0	psf
Mu' : Upward	=	6,650	0	ft-#
Mu' : Downward	=	1,381	1,240	ft-#
Mu: Design	=	5,268	1,240	ft-#
Actual 1-Way Shear	=	18.55	9.54	psi
Allow 1-Way Shear	=	50.60	50.60	psi

Toe Reinforcing	=	# 5 @ 17.99 in
Heel Reinforcing	=	# 5 @ 17.99 in
Key Reinforcing	=	None Spec'd

Other Acceptable Sizes & Spacings

Toe: #4@ 7.40 in, #5@ 11.47 in, #6@ 16.29 in, #7@ 22.21 in, #8@ 29.25 in, #9@ 37

Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm

Key: No key defined

Min footing T&S reinf Area	1.46	in2
Min footing T&S reinf Area per fo	0.32	in2 /ft

If one layer of horizontal bars:
#4@ 7.41 in
#5@ 11.48 in
#6@ 16.30 in

If two layers of horizontal bars:
#4@ 14.81 in
#5@ 22.96 in
#6@ 32.59 in

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.095	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,
because the wall would then tend to rotate into the retained soil.

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Project Name/Number : millcreek
Title **M-1s(2)**
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

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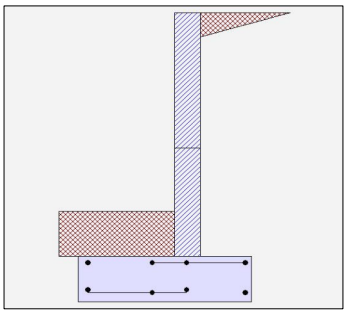
Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	6.75 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	15.00 in
Water height over heel	=	0.0 ft



Load Factors

Building Code	IBC 2018,ACI
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.000
Seismic, E	1.000

Soil Data and Lateral Earth Pressure

Allow Soil Bearing	=	3,166.0 psf	Soil Density, Heel	=	110.00 pcf
Equivalent Fluid Pressure Method			Soil Density, Toe	=	110.00 pcf
Active Heel Pressure	=	38.0 psf/ft	Footing||Soil Friction	=	0.530
	=		Soil height to ignore for passive pressure	=	12.00 in
Passive Pressure	=	290.0 psf/ft			

Surcharge Loads

Surcharge Over Heel	=	0.0 psf	Surcharge Over Toe	=	0.0 psf
Used To Resist Sliding & Overturning			Used for Sliding & Overturning		

Axial Load Applied to Stem

Axial Dead Load	=	0.0 lbs	Axial Load Eccentricity	=	0.0 in
Axial Live Load	=	0.0 lbs			

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Lateral Load Applied to Stem

Lateral Load	=	60.0 #/ft
...Height to Top	=	13.25 ft
...Height to Bottom	=	12.25 ft
Load Type	=	Seismic (E) (Strength Level)

Wind on Exposed Stem

Wind on Exposed Stem (Service Level)	=	0.0 psf

Adjacent Footing Load

Adjacent Footing Load	=	0.0 lbs	Footing Type		Line Load
Footing Width	=	0.00 ft	Base Above/Below Soil		
Eccentricity	=	0.00 in	at Back of Wall	=	0.0 ft
Wall to Ftg CL Dist	=	0.00 ft	Poisson's Ratio	=	0.300

Earth Pressure Seismic Load

Method : Inverted Triangular

Load at top of Inverted Triangular Distribution . . . . . = 120.000 psf (Strength-Level)

Total Strength-Level Seismic Load. . . . . = 480.000 lbs

Total Service-Level Seismic Load. . . . . = 336.000 lbs

Stem Weight Seismic Load

F_p / W_p Weight Multiplier	=	0.281 g	Added seismic base force	=	134.6 lbs

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Wall Design Summary

Stability Ratios

Overturning	=	1.29	Ratio < 1.5!
Sliding	=	1.32	Ratio < 1.5!

Soil Bearing

Total Bearing Load	=	2,862 lbs	
...resultant ecc.	=	19.38 in	
Soil Pressure @ Toe	=	3,005 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,166 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	4,207 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	21.0 psi	OK
Footing Shear @ Heel	=	9.5 psi	OK
Allowable	=	94.9 psi	

Sliding

Resisting Forces

Vertical Forces	Force	
Soil Over Heel (above water table, if any)	550.0	lbs
Soil Over Heel (below water table, if any)	0.0	
Water Over Heel	0.0	
Buoyant Force	0.0	
Sloped Soil Over Heel	0.0	
Surcharge Over Heel	0.0	
Adjacent Footing Load	0.0	
Axial Dead Load on Stem	0.0	
Axial Live Load on Stem *	Omit	
Soil Over Toe	343.8	
Surcharge Over Toe	0.0	
Stem Weight(s)	684.5	
Earth @ Stem Transitions	0.0	
Footing Weight	843.8	
Key Weight	0.0	
Vert. Component **	0.0	
Total Vertical Loads	2,862.0	lbs

Sliding Forces

Lateral Forces	Force	
Heel Active Pressure (above water table, if any)	684.0	lbs
Heel Active Pressure (below water table, if any)	0.0	
Hydrostatic Force	0.0	
* Heel Active Pressure	1,216.0	
Surcharge over Heel	0.0	
Adjacent Footing	0.0	
Surcharge Over Toe	0.0	
Load @ Stem Above Soil	0.0	
Added Lateral Load	42.0	
Seismic Load	336.0	
Seismic-Self-weight	134.6	
Lateral on Key	0.0	
Totals =	1,728.6	lbs

*Includes water table effect

* Axial live load NOT included in total displayed , or used for overturning
or sliding resistance, but is included for soil pressure calculations.

Sliding Calcs

Lateral Sliding Force	=		1,728.6 lbs	
less 100% Passive Force	=	-	761.3 lbs	
less 100% Friction Force	=	-	1,516.8 lbs	
Added Force Req'd	=		0.0 lbs	OK
....for 1.5 Stability	=		314.9 lbs	NG

Vertical component of active lateral soil pressure IS NOT considered in
the calculation of soil bearing pressures.

Overturning

Resisting Moments

Resisting Moments	Force		Distance		Moment	
Soil Over Heel (above water table, if any)	550.0	lbs	2.75	ft	3,795.0	ft-#
Soil Over Heel (below water table, if any)	0.0		2.75			
Water Table	0.0		2.75			
Soil Over Heel	990.0		3.83		3,795.0	
Sloped Soil Over Heel	0.0					
Surcharge Over Heel	0.0					
Adjacent Footing Load	0.0					
Axial Dead Load on Stem	0.0					
Axial Live Load on Stem *	0.0					
Soil Over Toe	343.8		1.25		429.7	
Surcharge Over Toe	0.0					
Stem Weight(s)	684.5		2.83		1,939.3	
Earth @ Stem Transitions	0.0					
Footing Weight	843.8		2.25		1,898.4	
Key Weight	0.0					
Vert. Component	0.0					
Total Vertical Loads	2,862.0	lbs				
Resisting Moment					**8,062.4**	ft-#
Eccentricity					**7.4**	in

* Axial live load NOT included in total displayed, or used for overturning or sliding resistance, but is included for soil pressure calculations.

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Title **M-1s(2)**
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Overturning

Overturning Moments

Overturning Moments	Force		Distance		Moment	
Heel Active Pressure (above water table, if any)	684.0	lbs	2.00	ft	3,242.7	ft-#
Heel Active Pressure (below water table, if any)	0.0				848.2	
Hydrostatic Force	0.0					
Buoyant Force	0.0		1.63			
Heel Active Pressure	1,216.0		2.67		3,242.7	
Surcharge over Heel	0.0					
Adjacent Footing	0.0					
Surcharge Over Toe	0.0					
Load @ Stem Above Soil	0.0					
Added Lateral Load	42.0		14.00		588.0	
Seismic Load	336.0		5.33		1,792.0	
Seismic-Self-weight	134.6		4.63		622.7	
Totals =	1,728.6	lbs				
	Overturning Moment				6,245.3	ft-#

Use menu item Settings > Printing & Title Block
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Title **M-1s(2)**
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Description....
Masonry Retaining Wall - 5.5'

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Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Stem Design Summary

			2nd	Bottom
			Stem OK	Stem OK
Design Height Above Ftg	ft	=	3.00	0.00
Wall Material Above "Ht"		=	Masonry	Masonry
Design Method		=	LRFD	LRFD
Thickness		=	8.00	8.00
Rebar Size		=	# 4	# 6
Rebar Spacing		=	16.00	8.00
Rebar Placed at		=	Center	Center
Design Data				
fb/FB + fa/Fa		=	**0.884**	**0.983**
Total Force @ Section				
Service Level	lbs	=		
Strength Level	lbs	=	938.9	2,105.7
Moment....Actual				
Service Level	ft-#	=		
Strength Level	ft-#	=	2,031.6	6,495.5
Moment.....Allowable	ft-#	=	2,296.9	6,600.0
Shear.....Actual				
Service Level	psi	=		
Strength Level	psi	=	10.3	23.0
Shear.....Allowable	psi	=	69.7	69.7
Anet	in2	=	91.50	91.50
Rebar Depth 'd'	in	=	3.75	3.75
Masonry Data				
f'm	psi	=	1,500	1,500
Fy	psi	=	60,000	60,000
Solid Grouting		=	Yes	Yes
Modular Ratio 'n'		=	21.48	21.48
Wall Weight	psf	=	101.4	101.4
Equiv. Solid Thick.	in	=	7.60	7.60
Masonry Block Type		=	Medium Weight	
Masonry Design Method		=	LRFD	
Concrete Data				
f'c	psi	=		
Fy	psi	=		

Use menu item Settings > Printing & Title Block
to set these five lines of information
for your program.

Project Name/Number : millcreek
Title **M-1s(2)**
Dsgnr: **Jimmy SIpes**
Description....
Masonry Retaining Wall - 5.5'

This Wall in File: c:\users\jamess\documents\office\temp projects\20-1211 - millcreek\calcs\millcree

RetainPro (c) 1987-2019, Build 11.19.03.08
License : KW-06064372
License To : Horrocks Engineers

Cantilevered Retaining Wall

Code: IBC 2018,ACI 318-14,TMS 402-16

Toe Width	=	2.50 ft	f'c		=	4,000	psi
Heel Width	=	2.00	Fy		=	60,000	psi
Total Footing Width	=	4.50 ft	Footing Concrete Density		=	150.00	pcf
Footing Thickness	=	15.00 in	Min. As %		=	0.0018	
Key Width	=	0.00 in	Rebar Cover	@ Top	=	2.00	in
Key Depth	=	0.00 in		@ Bottom	=	3.00	in
Key Distance from Toe	=	0.00 ft					

Footing Design Results

		Toe	Heel	
Factored Pressure	=	4,207	0	psf
Mu' : Upward	=	7,473	0	ft-#
Mu' : Downward	=	1,381	1,240	ft-#
Mu: Design	=	6,092	1,240	ft-#
Actual 1-Way Shear	=	20.97	9.54	psi
Allow 1-Way Shear	=	94.87	50.60	psi

Toe Reinforcing	=	# 5 @ 8.99 in
Heel Reinforcing	=	# 5 @ 17.99 in
Key Reinforcing	=	None Spec'd

Other Acceptable Sizes & Spacings

Toe: #4@ 7.40 in, #5@ 11.47 in, #6@ 16.29 in, #7@ 22.21 in, #8@ 29.25 in, #9@ 37

Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm

Key: No key defined

Min footing T&S reinf Area	1.46	in2
Min footing T&S reinf Area per fo	0.32	in2 /ft

If one layer of horizontal bars:
#4@ 7.41 in
#5@ 11.48 in
#6@ 16.30 in

If two layers of horizontal bars:
#4@ 14.81 in
#5@ 22.96 in
#6@ 32.59 in

Tilt

Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

Soil Spring Reaction Modulus	250.0	pci
Horizontal Defl @ Top of Wall (approximate only)	0.125	in

The above calculation is not valid if the heel soil bearing pressure exceeds that of the toe,
because the wall would then tend to rotate into the retained soil.

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Project: MILLCREEK COMMONS
Project No.: UT-2009-1910
By: J. SIPES
Date:
Subject:
Sheet:

DESIGN RAILING ON TOP OF CMU RETAINING WALL:
LIVE LOADS PER ASCE 7-16, SECTION 4.5.1

CHECK INTERMEDIATE RAILS (4.5.1.2)
- INTERMEDIATE RAILS ARE 5/8"Ø STEEL BARS @ 4" O.C., MAX
- MUST DESIGN FOR 50 # LOAD APPLIED OVER 12"x12" AREA
- MAX SPACING BETWEEN VERTICAL POSTS = 6'
- LIVE LOAD FACTOR = 1.6
- Pu = 1.6(50#) = 80#
- SINCE LOAD IS APPLIED OVER 12"x12" AREA AND SPACING OF RAILS IS 4" O.C., A MINIMUM OF 3 RAILS WILL CARRY THE LOAD.
- Pu = 80#/3 = 27# / RAIL
- Mu = Pu(L/4) = 27#(6'/4) = 41 #-FT
- CHECK 5/8" Ø ROUND BAR
  - S = (PI(D)^2)/32 = 3.14(5/8")^2/32 = 0.0383 IN^3
  - Z = (D^3) / 6 = (5/8")^3 / 6 = 0.0406 IN^3
  - Mn = Fy(Z) <= 1.6My = 1.6(Fy)(Sx)
    = (36 KSI)(0.0406 IN^3) = 1.46 K-IN
    <= 1.6My = 1.6(36 KSI)(0.0383) = 2.2 K-IN
  - Ø = 0.9
  - ØMn = 0.9(1.46 K-IN) = 1.31 K-IN
    = 109.5 #-FT

ØMn = 109.5 #-FT > Mu = 41 #-FT
THEREFORE 5/8" Ø ROUND BAR (FY = 36 KSI) IS ADEQUATE

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Project: MILLCREEK COMMONS **Project No.:** UT-2009-1910

By: J. SIPES **Date:**

Subject: **Sheet:**

DESIGN RAILING ON TOP OF CMU RETAINING WALL:
LIVE LOADS PER ASCE 7-16, SECTION 4.5.1

CHECK TOP RAIL
- TOP RAIL IS 1"x4" IPE WOOD
- MUST DESIGN FOR 200# POINT LOAD OR 50 PLF LIVE LOAD
- MAX SPACING BETWEEN VERTICAL POSTS = 6'

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DESIGN RAILING ON TOP OF CMU RETAINING WALL:
LIVE LOADS PER ASCE 7-16, SECTION 4.5.1

CHECK VERTICAL POSTS
- MUST DESIGN FOR 200# POINT LOAD OR 50 PLF LIVE LOAD
- MAX SPACING BETWEEN VERTICAL POSTS = 6'
- Pu = 50 PLF * 6' = 300# >200#, THEREFORE GOVERNS.
- TWO TYPES OF POSTS ARE USED IN THE RAILING:
  1) TYPICAL GUARDRAIL POST 3'-6" TALL
  2) 12' TALL LIGHT POST WITH STRING LIGHTS ATTACHED TO TOP

CHECK TYPE 1), TYPICAL GUARDRAIL POST 3'-6" TALL
- GUARDRAIL POST BASE PLATE SITS ON TOP OF CMU RETAINING WALL.
- BASE PLATE IS 6" BELOW FINISH GRADE.
- TOTAL HEIGHT OF TYP GUARDRAIL = 3.5' + 0.5' = 4'
- POST IS COMPRISED OF TWO CHANNELS (BACK-TO-BACK) WITH A 1"x6" IPE WOOD TRIM SANDWICHED BETWEEN THE TWO.
- TRY C4x5.4 CHANNELS (Fy = 36 KSI)
- Pu = 300# / POST
- Pu = 150# / CHANNEL (APPLIED 4' ABOVE FIXED BASE)

C4x5.4 POST IS ADEQUATE FOR BENDING IN EITHER DIRECTION.
(SEE ENERCALC RESULTS ON THE FOLLOWING PAGES)

Steel Column

Lic. # : KW-06000291
HORROCKS ENGINEERS, INC.

DESCRIPTION: 4' Railing post - Y-direction

Code References

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combinations Used : ASCE 7-16

General Information

Steel Section Name :	**C4x5.4**
Analysis Method :	Load Resistance Factor
Steel Stress Grade	
Fy : Steel Yield	36.0 ksi
E : Elastic Bending Modulus	29,000.0 ksi
Overall Column Height	4.0 ft
Top & Bottom Fixity	Top Free, Bottom Fixed

Brace condition for deflection (buckling) along columns :
X-X (width) axis :
Unbraced Length for buckling ABOUT Y-Y Axis = 4.0 ft, K = 2.1
Y-Y (depth) axis :
Unbraced Length for buckling ABOUT X-X Axis = 4.0 ft, K = 2.1

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 21.60 lbs * Dead Load Factor
BENDING LOADS . . .
Handrail load: Lat. Point Load at 4.0 ft creating Mx-x, L = 0.150 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.1571** : 1

Load Combination	+1.20D+1.60L
Location of max.above base	0.0 ft
At maximum location values are . . .	
Pu	0.02592 k
0.9 * Pn	6.925 k
Mu-x	-0.960 k-ft
0.9 * Mn-x :	6.183 k-ft
Mu-y	0.0 k-ft
0.9 * Mn-y :	1.197 k-ft

PASS Maximum Shear Stress Ratio = **0.02013** : 1

Load Combination	+1.20D+1.60L
Location of max.above base	0.0 ft
At maximum location values are . . .	
Vu : Applied	0.240 k
Vn * Phi : Allowable	11.923 k

Maximum Load Reactions . .

Top along X-X	0.0 k
Bottom along X-X	0.0 k
Top along Y-Y	0.0 k
Bottom along Y-Y	0.150 k

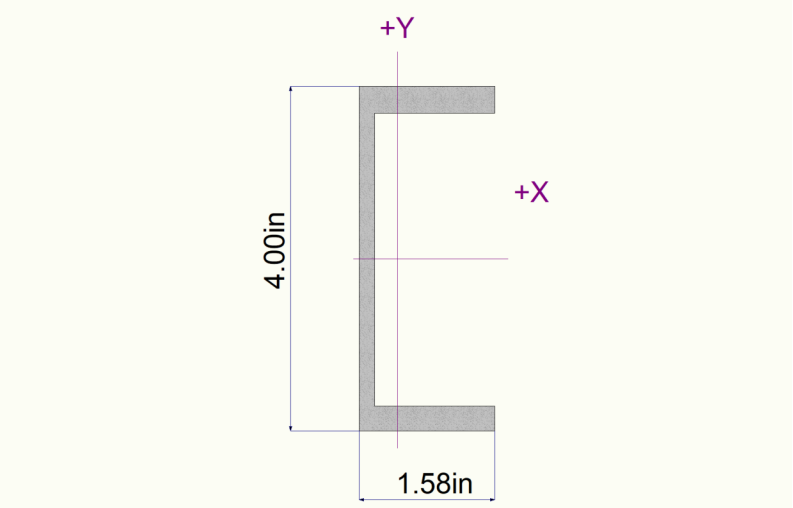
Maximum Load Deflections . . .

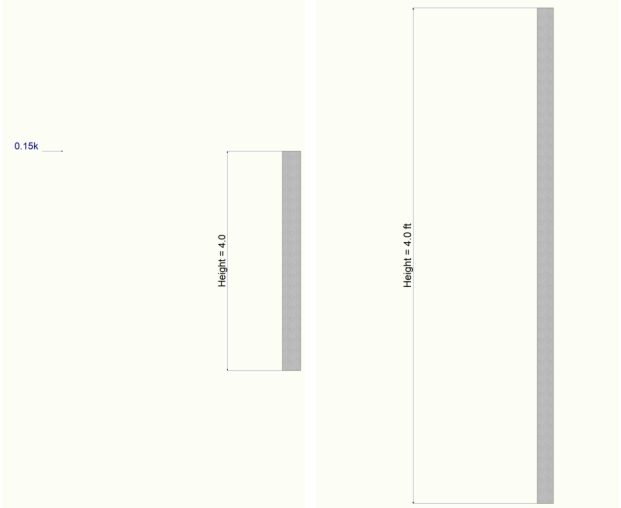
Along Y-Y 0.04928 in at 4.0 ft above base
for load combination : +D+L

Along X-X 0.0 in at 0.0 ft above base
for load combination :

X-X Slenderness Ratio kl/r > 200

Sketches





Steel Column

Lic. # : KW-06000291

HORROCKS ENGINEERS, INC.

DESCRIPTION: 4' Railing post -X-direction

Code References

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combinations Used : ASCE 7-16

General Information

Steel Section Name : **C4x5.4**
Analysis Method : Load Resistance Factor
Steel Stress Grade
Fy : Steel Yield 36.0 ksi
E : Elastic Bending Modulus 29,000.0 ksi

Overall Column Height 4.0 ft
Top & Bottom Fixity Top Free, Bottom Fixed
Brace condition for deflection (buckling) along columns :
X-X (width) axis :
Unbraced Length for buckling ABOUT Y-Y Axis = 4.0 ft, K = 2.1
Y-Y (depth) axis :
Unbraced Length for buckling ABOUT X-X Axis = 4.0 ft, K = 2.1

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 21.60 lbs * Dead Load Factor
BENDING LOADS . . .
Handrail load: Lat. Point Load at 4.0 ft creating My-y, L = 0.150 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.8041** : 1
Load Combination +1.20D+1.60L
Location of max.above base 0.0 ft
At maximum location values are . . .
Pu 0.02592 k
0.9 * Pn 6.925 k
Mu-x 0.0 k-ft
0.9 * Mn-x : 5.560 k-ft
Mu-y -0.960 k-ft
0.9 * Mn-y : 1.197 k-ft

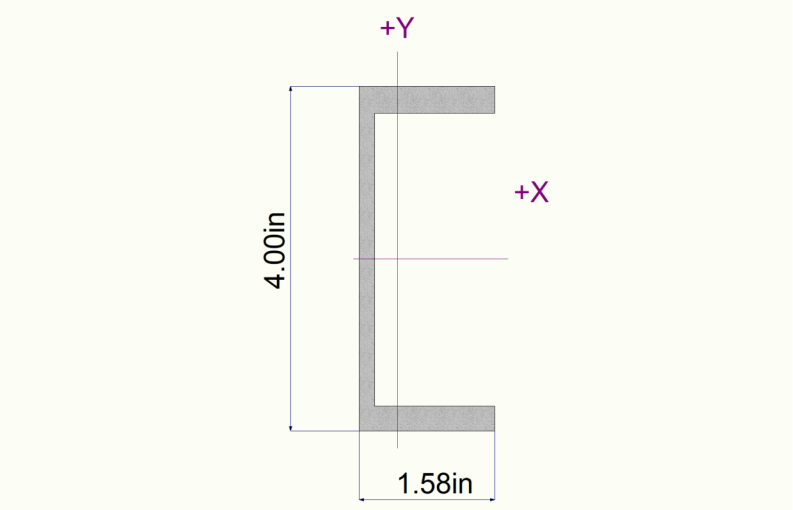
PASS Maximum Shear Stress Ratio = **0.03168** : 1
Load Combination +1.20D+1.60L
Location of max.above base 0.0 ft
At maximum location values are . . .
Vu : Applied 0.240 k
Vn * Phi : Allowable 7.576 k

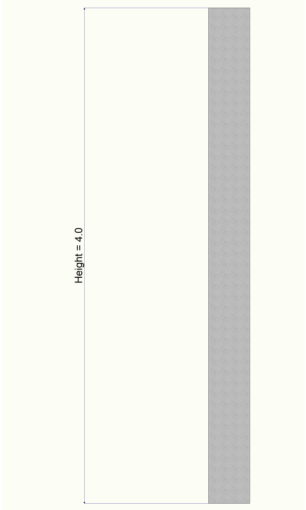
Maximum Load Reactions . .
Top along X-X 0.0 k
Bottom along X-X 0.150 k
Top along Y-Y 0.0 k
Bottom along Y-Y 0.0 k

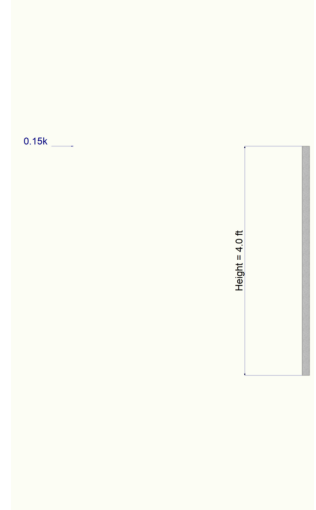
Maximum Load Deflections . . .
Along Y-Y 0.0 in at 0.0 ft above base
for load combination :
Along X-X 0.6081 in at 4.0 ft above base
for load combination : +D+L

X-X Slenderness Ratio kl/r > 200

Sketches







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Project No.: UT-2009-1910
By: J. SIPES
Date:
Subject:
Sheet:

DESIGN RAILING ON TOP OF CMU RETAINING WALL:
LIVE LOADS PER ASCE 7-16, SECTION 4.5.1

CHECK VERTICAL POSTS
- MUST DESIGN FOR 200# POINT LOAD OR 50 PLF LIVE LOAD
- MAX SPACING BETWEEN VERTICAL POSTS = 6'
- SPACING BETWEEN 12' TALL POSTS = 29'-10"
- Pu = 50 PLF * 6' = 300# >200#, THEREFORE GOVERNS.
- TWO TYPES OF POSTS ARE USED IN THE RAILING:
  1) TYPICAL GUARDRAIL POST 3'-6" TALL
  2) 12' TALL LIGHT POST WITH STRING LIGHTS ATTACHED TO TOP

CHECK TYPE 2), 12' LIGHT POST SUPPORTING STRING LIGHTS
- POST BASE PLATE SITS ON TOP OF CMU RETAINING WALL.
- BASE PLATE IS 6" BELOW FINISH GRADE.
- TOTAL HEIGHT OF TYP GUARDRAIL = 12' + 0.5' = 12.5'
- POST IS COMPRISED OF TWO CHANNELS (BACK-TO-BACK) WITH A 2"x6" IPE WOOD TRIM SANDWICHED BETWEEN THE TWO.
- TRY C4x7.25 CHANNELS (Fy = 36 KSI)

DETERMINE WEIGHTS OF RAILING SYSTEM:
- INTERMEDIATE RAILS: 5/8"Ø ROUND STEEL BARS
  - A = PI(r)^2 = 3.14(5/16")^2 = 0.307 IN^2 = 0.00213 FT^2
  - W = A * 490 PCF = 0.00213 FT^2 * 490 PCF = 1.044 PLF
- 2"x6" WOOD TRIM:
  - ASSUME WOOD IS 35 PCF
  - 35 PCF x 2/12 x 6/12 = 2.917 PLF
- 1"x4" WOOD CAP:
  - 35 PCF x 1"/12 x 4"/12 = 0.972 PLF
- 1"x6" WOOD TRIM
  - 35 PCF x 1"/12 x 5"/12 = 1.215 PLF
- STRING LIGHTS
  - ASSUME WEIGHS 1 PLF
- TOTAL HORIZONTAL RAILING WEIGHT:
  - W = 1.044 PLF * 10 + 0.972 PLF = 11.412 PLF
  - W = 11.412 PLF * 6' = 69#
- TOTAL WEIGHT OF LIGHT POSTS:
  - W = 7.25 PLF * 2 + 2.917 = 17.417 PLF
- TOTAL WEIGHT OF GUARDRAIL POSTS:
  - W = 5.4 PLF * 2 + 1.215 PLF = 12.015 PLF

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Project: MILLCREEK COMMONS Project No.: UT-2009-1910

By: J. SIPES Date:

Subject: Sheet:

DESIGN RAILING ON TOP OF CMU RETAINING WALL:
CHECK VERTICAL POSTS
CHECK TYPE 2), 12' LIGHT POST SUPPORTING STRING LIGHTS
DESIGN POST FOR WIND LOADS
DETERMINE WIND LOADS:
- WIND LOADS PER CHAPTER 29.4 OF ASCE 7-16
- qh = 16.7 psf (SEE FOLLOWING PAGES)

Y-DIRECTION

DETERMINE Cf COEFFICIENTS
- RAILING - OPEN FRAME PER FIG 29.4-2
  - E = 5/8" / 4" = 0.15625
  - 0.1 < E < 0.29
  - D*SQRT(qz) = 0.052'(SQRT(16.7 PSF))
    = 0.213 <= 2.5
  - Cf = 1.8 (FLAT SIDED MEMBERS)
  - Cf = 1.3 (ROUNDED MEMBERS)
- LIGHT STRING - OPEN FRAME PER FIG 29.4-2
  - LIGHTS ARE ASSUMED 12"Ø @ 24" O.C.
  - E = 0.5
  - 0.3 < E < 0.7
  - D*SQRT(qz) = 1'(SQRT(16.7 PSF))
    = 4.1 > 2.5
  - Cf = 1.6 (FLAT SIDED MEMBERS)
  - Cf = 1.1 (ROUNDED MEMBERS)

WIND DESIGN PER ASCE 7-16 SECTIONS 29.4.1

Risk Category =	II		(Table 1.5-1)	
Basic Wind Speed, V =	103	mph	(FIG. 26.5-1B)	
K_d =	0.85		(Table 26.6-1) (Open Frames)	
Exposure Cat.	C		(Section 26.7)	
Topographic factor, K_{zt} =	1		(Section 26.8 & Fig. 26.8-1)	
Ground Elevation, Z_g =	4410			
Ground Elev. Factor, K_e =	0.852		(Table 26.9-1)	
Gust-effect Factor, G =	1.00		(Section 26.11)	
Height above ground, z =	12	ft		
Velocity Pressure Exposure Coefficient, K_z =	0.85		(Table 26.10-1)	
Velocity Pressure, q_h =	16.7	psf	(EQ. 26.10-1)	$q_h = 0.00256(K_z)(K_{zt})(K_d)(K_e)(V^2)$

Lateral Load, $F_h = q_h(G)(Cf)(As)$ lbs (EQ 29.3.1)

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Sheet:

DESIGN RAILING ON TOP OF CMU RETAINING WALL:
CHECK VERTICAL POSTS
CHECK TYPE 2), 12' LIGHT POST SUPPORTING STRING LIGHTS
DESIGN POSTS FOR WIND LOADS:
Y-DIRECTION

- WIND LOAD 1: POST
  - A1 = (1.75"+2"+1.75") x 12'
    = 792 IN^2 = 5.5 FT^2
  - Cf1 = 1.8
  - F1 = (16.7 PSF)(1.0)(1.8)(5.5 FT^2)
    = 166 # / POST
- WIND LOAD 2: INTERMEDIATE 5/8"Ø ROUND BARS @ 4" O.C.
  - A2 = 5/8" x 10 BARS x 6'
    = 450 in^2 = 3.125 FT^2
  - Cf2 = 1.3
  - F2 = (16.7 PSF)(1.0)(1.3)(3.125 FT^2)
    = 68 # / POST
- WIND LOAD 3: CAP BAR - 1"x4" WOOD PLATE
  - A3 = 1" x 6' = 72 IN^2 = 0.5 FT^2
  - Cf3 = 1.8
  - F3 = (16.7 PSF)(1.0)(1.8)(0.5 FT^2)
    = 15 # / POST
- WIND LOAD 4: STRING LIGHTS
  - A4 = PI(R)^2 * 30'/2' = 3.14(0.5')^2 * 15 LIGHTS
    = 11.8 FT^2
  - Cf4 = 1.1
  - F4 = (16.7 PSF)(1.0)(1.1)(11.8 FT^2)
    = 217 # / POST

NOTE:
WIND LOADS ARE REDUCED BY 1/2 WHEN ANALYZING EACH CHANNEL INDIVIDUALLY
- 2 CHANNELS PER POST

BACK TO BACK C4x7.25 AT 12' TALL LIGHT POSTS ARE ADEQUATE FOR WIND LOADS COMBINED WITH LIVE LOAD FROM RAILING ACTING IN THE STRONG-AXIS.
(SEE ENERCALC RESULTS ON THE FOLLOWING PAGES)

Steel Column

Lic. # : KW-06000291 HORROCKS ENGINEERS, INC.

DESCRIPTION: 12' Light Post - Wind - Y-direction

Code References

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combinations Used : ASCE 7-16

General Information

Steel Section Name :	**C4x7.2**	Overall Column Height	12.50 ft
Analysis Method :	Load Resistance Factor	Top & Bottom Fixity	Top Free, Bottom Fixed
Steel Stress Grade			
Fy : Steel Yield	36.0 ksi		
E : Elastic Bending Modulus	29,000.0 ksi		

Brace condition for deflection (buckling) along columns :
X-X (width) axis :
Unbraced Length for buckling ABOUT Y-Y Axis = 12.50 ft, K = 2.1
Y-Y (depth) axis :
Unbraced Length for buckling ABOUT X-X Axis = 12.50 ft, K = 2.1

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 90.0 lbs * Dead Load Factor
AXIAL LOADS . . .
string lights: Axial Load at 12.50 ft, Xecc = 0.860 in, Yecc = 2.0 in, L = 0.0150 k
railing: Axial Load at 4.0 ft, D = 0.0350 k
BENDING LOADS . . .
Handrail load: Lat. Point Load at 4.0 ft creating Mx-x, L = 0.150 k
Tributary lateral load - F1: Lat. Point Load at 6.50 ft creating Mx-x, W = 0.0830 k
Tributary lateral load - F2: Lat. Point Load at 2.250 ft creating Mx-x, W = 0.0340 k
Tributary lateral load - F4: Lat. Point Load at 4.0 ft creating Mx-x, W = 0.0080 k
String Light Load - F5: Lat. Point Load at 12.50 ft creating Mx-x, W = 0.1090 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio =	**0.4266**	: 1
Load Combination	+1.20D+L+W	
Location of max.above base	0.0	ft
At maximum location values are . . .		
Pu	0.1650	k
0.9 * Pn	0.9690	k
Mu-x	-2.613	k-ft
0.9 * Mn-x :	7.668	k-ft
Mu-y	-0.001075	k-ft
0.9 * Mn-y :	1.456	k-ft
PASS Maximum Shear Stress Ratio =	**0.01846**	: 1
Load Combination	+1.20D+L+W	
Location of max.above base	0.0	ft
At maximum location values are . . .		
Vu : Applied	0.3840	k
Vn * Phi : Allowable	20.801	k

Maximum Load Reactions . .

Top along X-X	0.0 k
Bottom along X-X	0.0 k
Top along Y-Y	0.0 k
Bottom along Y-Y	0.2340 k

Maximum Load Deflections . . .

Along Y-Y 1.176 in at 12.50 ft above base
for load combination : W Only

Along X-X 0.01170 in at 12.50 ft above base
for load combination : +D+L

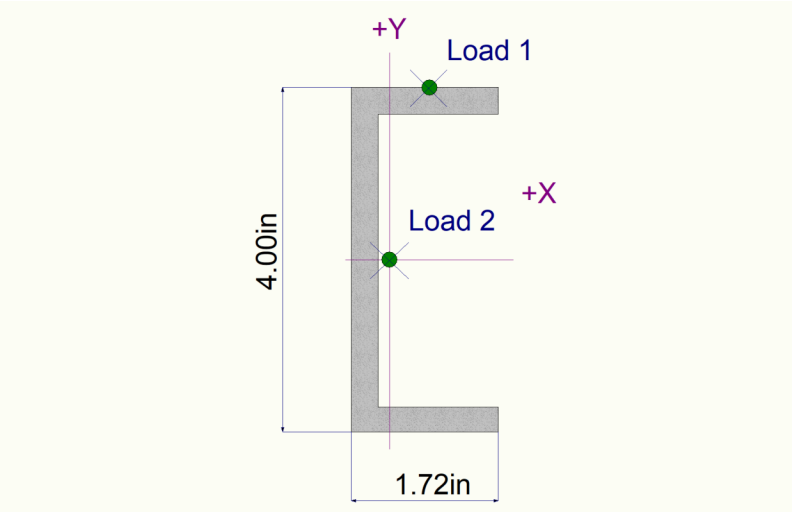
X-X Slenderness Ratio kl/r > 200

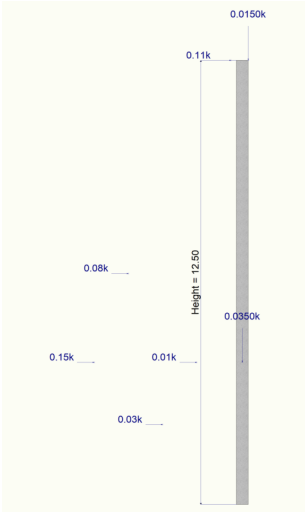
Steel Column

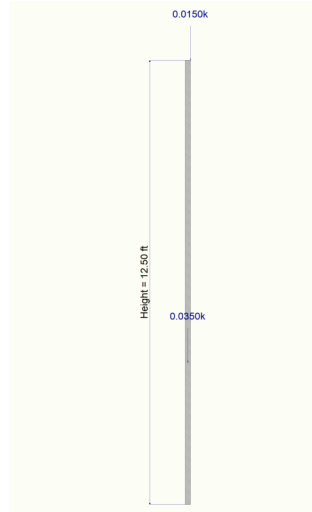
Lic. # : KW-06000291
HORROCKS ENGINEERS, INC.

DESCRIPTION: 12' Light Post - Wind - Y-direction

Sketches







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Project: MILLCREEK COMMONS Project No.: UT-2009-1910

By: J. SIPES Date:

Subject: Sheet:

DESIGN RAILING ON TOP OF CMU RETAINING WALL:
CHECK VERTICAL POSTS
CHECK TYPE 2), 12' LIGHT POST SUPPORTING STRING LIGHTS
X-DIRECTION
THE TWO CHANNEL SECTIONS WILL BE ANALYZED AS ONE SOLID MEMBER, IT IS ASSUMED THAT THE WOOD FILLER WILL BE ABLE TO TRANSFER THE SHEAR FORCES. (SEE ENERCALC RESULTS FOR THE SECTION PROPERTIES OF THE TWO CHANNELS COMBINED)

DESIGN POSTS FOR WIND LOADS:
- WIND LOAD 1: POST
  - A1 = 6" x 12'
    = 864 IN^2 = 6 FT^2
  - Cf1 = 1.8
  - F1 = (16.7 PSF)(1.0)(1.8)(6 FT^2)
    = 181 # / POST
- WIND LOAD 2: STRING LIGHTS
  - A2 = PI(R)^2 * 30'/2' = 3.14(0.5')^2 * 15
    = 11.8 FT^2
  - Cf2 = 1.1
  - F2 = (16.7 PSF)(1.0)(1.1)(11.8 FT^2)
    = 217 # / POST

BACK TO BACK C4x7.25 AT 12' TALL LIGHT POSTS ARE ADEQUATE FOR WIND LOADS COMBINED WITH LIVE LOAD FROM RAILING ACTING IN THE WEAK-AXIS. (SEE ENERCALC RESULTS ON THE FOLLOWING PAGES)

General Section Property Calculator

Lic. # : KW-06000291

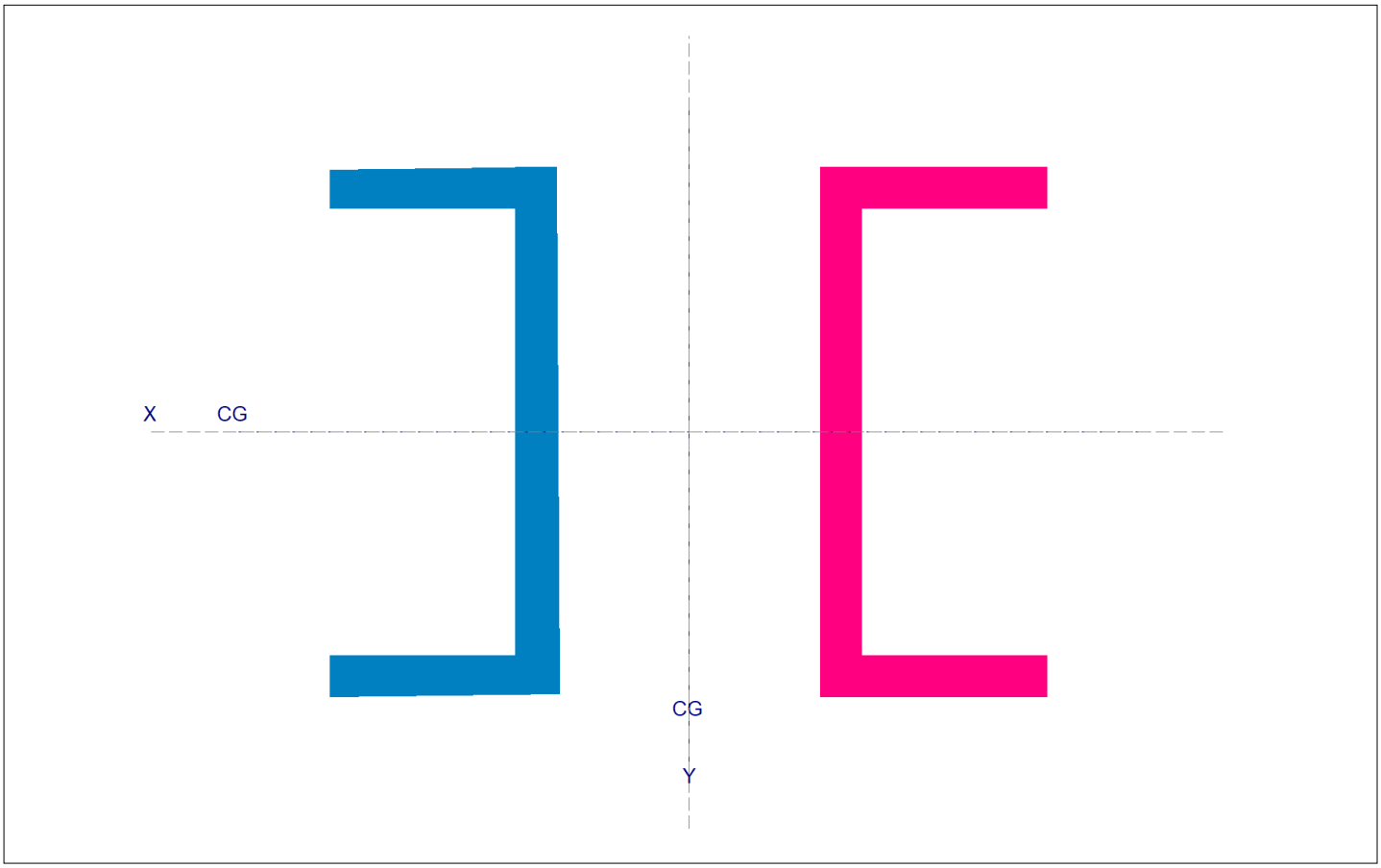
HORROCKS ENGINEERS, INC.

DESCRIPTION: 12' Light Post - Section Properties - back-to-back channels

Final Section Properties

Total Area	:	4.224 in^2	Ixx	:	9.117 in^4	Sxx : - Y	: 4.559 in^3
			Iyy	:	10.513 in^4	Sxx : +Y	: 4.559 in^3
Calculated final C.G. distance from Datum :						Syy : - X	: 3.865 in^3
X cg Dist.	:	0.0 in	Zxx	:	5.636 in^3	Syy : +X	: 3.865 in^3
Y cg Dist.	:	0.0 in	Zyy	:	6.327 in^3		
Edge Distances from CG. :						r xx	: 1.469 in
+X	:	2.720 in	+Y	:	2.0 in	r yy	: 1.578 in
-X	:	-2.720 in	-Y	:	in		

Rotation of All Components @ Angle : 0.00 deg CCW



Steel Shapes

C4x7.2 : 1	Area =	2.112 in^2	Rotation =	180 deg CCW
			Xcg =	-1.459 in
			Ycg =	0.000 in
C4x7.2 : 2	Area =	2.112 in^2	Rotation =	0 deg CCW
			Xcg =	1.459 in
			Ycg =	0.000 in

Steel Column

Lic. # : KW-06000291

HORROCKS ENGINEERS, INC.

DESCRIPTION: 12' Light Post - Wind - X-direction

Code References

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combinations Used : ASCE 7-16

General Information

Steel Section Name : **C_back to back channels**
Analysis Method : Load Resistance Factor
Steel Stress Grade
Fy : Steel Yield 36.0 ksi
E : Elastic Bending Modulus 29,000.0 ksi

Overall Column Height 12.50 ft
Top & Bottom Fixity Top Free, Bottom Fixed
Brace condition for deflection (buckling) along columns :
X-X (width) axis :
Unbraced Length for buckling ABOUT Y-Y Axis = 12.50 ft, K = 2.1
Y-Y (depth) axis :
Unbraced Length for buckling ABOUT X-X Axis = 12.50 ft, K = 2.1

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 217.750 lbs * Dead Load Factor
AXIAL LOADS . . .
string lights: Axial Load at 12.50 ft, Xecc = 0.860 in, Yecc = 2.0 in, L = 0.030 k
railing: Axial Load at 4.0 ft, D = 0.0690 k
BENDING LOADS . . .
Handrail load: Lat. Point Load at 4.0 ft creating My-y, L = 0.30 k
Tributary lateral load - F1: Lat. Point Load at 6.50 ft creating My-y, W = 0.1810 k
String Light Load - F5: Lat. Point Load at 12.50 ft creating My-y, W = 0.2170 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.3144** : 1
Load Combination +1.20D+L+W
Location of max.above base 0.0 ft
At maximum location values are . . .
Pu 0.3741 k
0.9 * Pn 20.753 k
Mu-x -0.0050 k-ft
0.9 * Mn-x : 11.387 k-ft
Mu-y -5.091 k-ft
0.9 * Mn-y : 16.697 k-ft

PASS Maximum Shear Stress Ratio = **0.08463** : 1
Load Combination +1.20D+L+W
Location of max.above base 0.0 ft
At maximum location values are . . .
Vu : Applied 0.6980 k
Vn * Phi : Allowable 8.248 k

Maximum Load Reactions . .
Top along X-X 0.0 k
Bottom along X-X 0.4041 k
Top along Y-Y 0.0 k
Bottom along Y-Y 0.0 k

Maximum Load Deflections . . .
Along Y-Y 0.002536 in at 12.50 ft above base
for load combination : +D+L
Along X-X 1.020 in at 12.50 ft above base
for load combination : W Only

Y-Y Slenderness Ratio kl/r > 200

Steel Column

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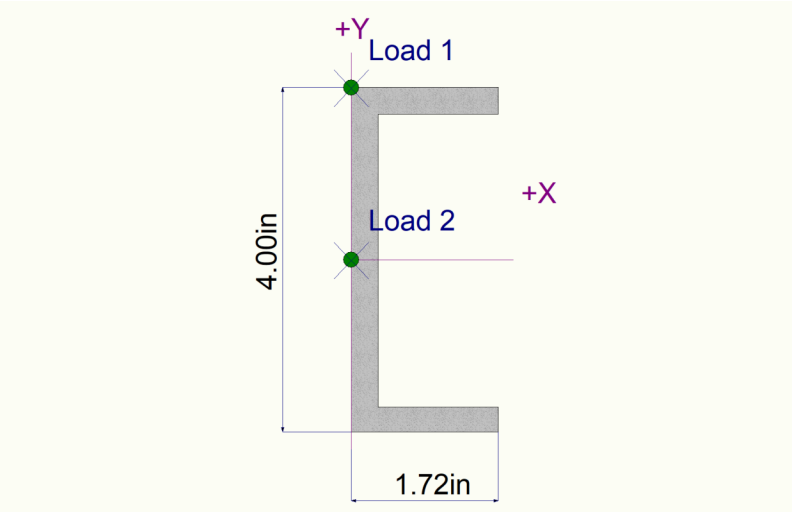
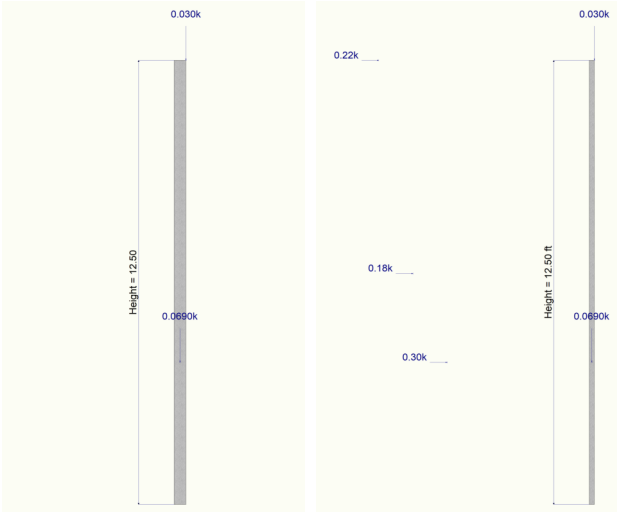
HORROCKS ENGINEERS, INC.

DESCRIPTION: 12' Light Post - Wind - X-direction

Sketches





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DESIGN RAILING ON TOP OF CMU RETAINING WALL:
CHECK VERTICAL POSTS
CHECK TYPE 2), 12' LIGHT POST SUPPORTING STRING LIGHTS
DESIGN POSTS FOR SEISMIC LOADS:
DETERMINE SEISMIC LOADS:

- SEISMIC LOADS PER CHAPTER 13 OF ASCE 7-16
- Fp = 1.5Wp (LATERAL SEISMIC LOADS)
- U = 0.187Wp (VERTICAL SEISMIC LOADS)
  (SEE FOLLOWING PAGES)

- SEISMIC LOAD 1: POST
  - W1 = 17.417 PLF
  - Fp1 = 17.417 * 1.5
    = 26.2 PLF / POST
- SEISMIC LOAD 2: INTERMEDIATE 5/8"Ø ROUND BARS @ 4" O.C.
  - W2 = 1.044 PLF * 10 * 6' = 63 #
  - Fp2 = 63# * 1.5
    = 94 # / POST
- SEISMIC LOAD 3: CAP BAR - 1"x4" WOOD PLATE
  - W3 = 0.972 PLF *6' = 6#
  - Fp3 = 6# * 1.5
    = 9# / POST
- SEISMIC LOAD 4: STRING LIGHTS
  - W4 = 1 PLF x 30' = 30#
  - Fp4 = 1.5 * 30#
    = 45 # / POST

NOTE:
SEISMIC LOADS ARE REDUCED BY 1/2 WHEN ANALYZING EACH CHANNEL INDIVIDUALLY
- 2 CHANNELS PER POST

BACK TO BACK C4x7.25 AT 12' TALL LIGHT POSTS ARE ADEQUATE FOR SEISMIC LOADS COMBINED WITH LIVE LOAD FROM RAILING ACTING IN THE STRONG-AXIS.
(SEE ENERCALC RESULTS ON THE FOLLOWING PAGES)

SEISMIC DESIGN PER ASCE 7-16 CHAPTER 13

Seismic Design Category:	D					(Same SDC as the supporting strucure)
Ip =	1.0					(Section 13.1.3)
ap=	2.5					(Table 13.5-1)
Rp=	1.5					(Table 13.5-1)
Ω =	1.5					(Table 13.5-1)
Sds=	0.937					(ATC Hazards map)
z=	12.0					(Ht in structure at point of attachment)
h=	12.0					(Average Roof height)
z/h =	1	≤ 1				
Lateral Force, Fp =	(0.4 ap Sds Wp)(1 + 2(z / h)) / (Rp / Ip)					(EQ 13.3-1)
=	1.874	Wp				
Fp, MIN=	0.3 Sds Ip Wp =			0.281	Wp	(EQ 13.3-2)
Fp, MAX=	1.6 Sds Ip Wp =			1.499	Wp	(EQ 13.3-3)
USE Fp =	**1.499**	**Wp**				
Vertical Force, U =	+/- 0.2(Sds)(Wp)					(Section 13.3.1.2)
U =	**0.187**	**Wp**				

Steel Column

Lic. # : KW-06000291

HORROCKS ENGINEERS, INC.

DESCRIPTION: 12' Light Post - Seismic - Y-direction

Code References

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combinations Used : ASCE 7-16

General Information

Steel Section Name : **C4x7.2**
Analysis Method : Load Resistance Factor
Steel Stress Grade
Fy : Steel Yield 36.0 ksi
E : Elastic Bending Modulus 29,000.0 ksi

Overall Column Height 12.50 ft
Top & Bottom Fixity Top Free, Bottom Fixed
Brace condition for deflection (buckling) along columns :
X-X (width) axis :
Unbraced Length for buckling ABOUT Y-Y Axis = 12.50 ft, K = 2.1
Y-Y (depth) axis :
Unbraced Length for buckling ABOUT X-X Axis = 12.50 ft, K = 2.1

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 90.0 lbs * Dead Load Factor
AXIAL LOADS . . .
string lights: Axial Load at 12.50 ft, Xecc = 0.860 in, Yecc = 2.0 in, L = 0.0150 k
railing: Axial Load at 4.0 ft, D = 0.0350 k
2X6 WOOD TRIM: Axial Load at 6.50 ft, D = 0.01750 k
BENDING LOADS . . .
Handrail load: Lat. Point Load at 4.0 ft creating Mx-x, L = 0.150 k
Tributary lateral load - Fp1: Lat. Uniform Load creating Mx-x, E = 0.01310 k/ft
Tributary lateral load - Fp2: Lat. Point Load at 2.250 ft creating Mx-x, E = 0.0470 k
Tributary lateral load - Fp3: Lat. Point Load at 4.0 ft creating Mx-x, E = 0.0050 k
String Light Load - Fp5: Lat. Point Load at 12.50 ft creating Mx-x, E = 0.0230 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.4566** : 1
Load Combination +1.387D+L+E
Location of max.above base 0.0 ft
At maximum location values are . . .
Pu 0.2127 k
0.9 * Pn 0.9690 k
Mu-x -2.039 k-ft
0.9 * Mn-x : 7.668 k-ft
Mu-y -0.001075 k-ft
0.9 * Mn-y : 1.456 k-ft

PASS Maximum Shear Stress Ratio = **0.01869** : 1
Load Combination +1.387D+L+E
Location of max.above base 0.0 ft
At maximum location values are . . .
Vu : Applied 0.3888 k
Vn * Phi : Allowable 20.801 k

Maximum Load Reactions . .
Top along X-X 0.0 k
Bottom along X-X 0.0 k
Top along Y-Y 0.0 k
Bottom along Y-Y 0.2388 k

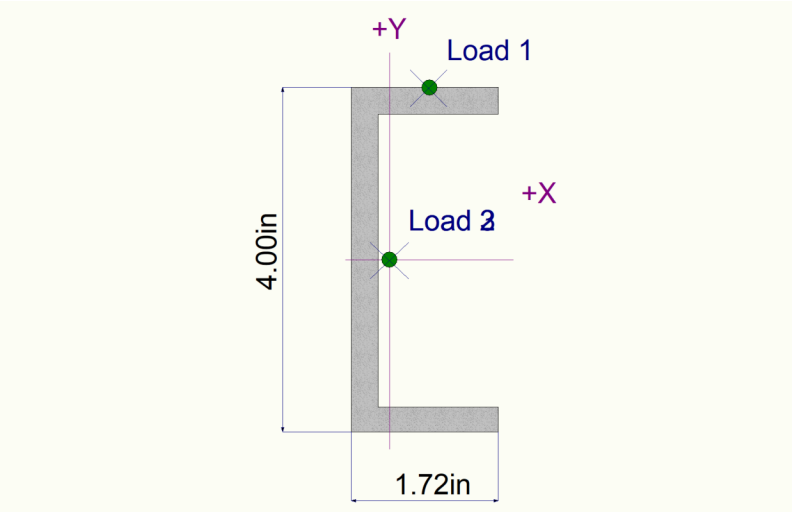
Maximum Load Deflections . . .
Along Y-Y 0.7355 in at 12.50 ft above base
for load combination : E Only
Along X-X 0.01170 in at 12.50 ft above base
for load combination : +D+L

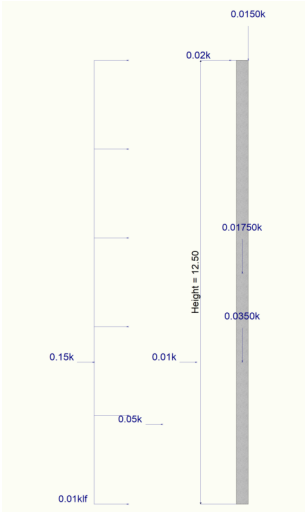
X-X Slenderness Ratio kl/r > 200

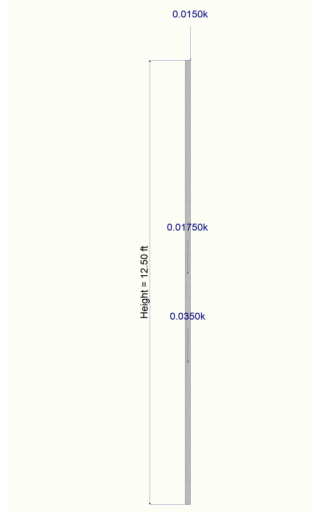
Steel Column

DESCRIPTION: 12' Light Post - Seismic - Y-direction

Sketches







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CHECK VERTICAL POSTS
CHECK TYPE 2), 12' LIGHT POST SUPPORTING STRING LIGHTS
DESIGN POSTS FOR SEISMIC LOADS:
X-DIRECTION
THE TWO CHANNEL SECTIONS WILL BE ANALYZED AS ONE SOLID MEMBER, IT IS ASSUMED THAT THE WOOD FILLER WILL BE ABLE TO TRANSFER THE SHEAR FORCES. (SEE ENERCALC RESULTS FOR THE SECTION PROPERTIES OF THE TWO CHANNELS COMBINED)

BACK TO BACK C4x7.25 AT 12' TALL LIGHT POSTS ARE ADEQUATE FOR SEISMIC LOADS COMBINED WITH LIVE LOAD FROM RAILING ACTING IN THE WEAK-AXIS. (SEE ENERCALC RESULTS ON THE FOLLOWING PAGES)

Steel Column

Lic. # : KW-06000291 HORROCKS ENGINEERS, INC.

DESCRIPTION: 12' Light Post - Seismic - X-direction

Code References

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combinations Used : ASCE 7-16

General Information

Steel Section Name : **C_back to back channels**
Analysis Method : Load Resistance Factor
Steel Stress Grade
Fy : Steel Yield 36.0 ksi
E : Elastic Bending Modulus 29,000.0 ksi

Overall Column Height 12.50 ft
Top & Bottom Fixity Top Free, Bottom Fixed
Brace condition for deflection (buckling) along columns :
X-X (width) axis :
Unbraced Length for buckling ABOUT Y-Y Axis = 12.50 ft, K = 2.1
Y-Y (depth) axis :
Unbraced Length for buckling ABOUT X-X Axis = 12.50 ft, K = 2.1

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 217.750 lbs * Dead Load Factor
AXIAL LOADS . . .
string lights: Axial Load at 12.50 ft, Xecc = 0.860 in, Yecc = 2.0 in, L = 0.030 k
railing: Axial Load at 4.0 ft, D = 0.0690 k
2X6 WOOD TRIM: Axial Load at 6.50 ft, D = 0.0350 k
BENDING LOADS . . .
Handrail load: Lat. Point Load at 4.0 ft creating My-y, L = 0.30 k
Tributary lateral load - Fp1: Lat. Uniform Load creating My-y, E = 0.02620 k/ft
Tributary lateral load - Fp2: Lat. Point Load at 2.250 ft creating My-y, E = 0.0940 k
Tributary lateral load - Fp3: Lat. Point Load at 4.0 ft creating My-y, E = 0.0090 k
String Light Load - Fp5: Lat. Point Load at 12.50 ft creating My-y, E = 0.0450 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.2550** : 1
Load Combination +1.387D+L+E
Location of max.above base 0.0 ft
At maximum location values are . . .
Pu 0.4764 k
0.9 * Pn 20.753 k
Mu-x -0.0050 k-ft
0.9 * Mn-x : 11.387 k-ft
Mu-y -4.059 k-ft
0.9 * Mn-y : 16.697 k-ft

PASS Maximum Shear Stress Ratio = **0.09403** : 1
Load Combination +1.387D+L+E
Location of max.above base 0.0 ft
At maximum location values are . . .
Vu : Applied 0.7755 k
Vn * Phi : Allowable 8.248 k

Maximum Load Reactions . .
Top along X-X 0.0 k
Bottom along X-X 0.4755 k
Top along Y-Y 0.0 k
Bottom along Y-Y 0.0 k

Maximum Load Deflections . . .
Along Y-Y 0.002536 in at 12.50 ft above base
for load combination : +D+L
Along X-X 0.6367 in at 12.50 ft above base
for load combination : E Only

Y-Y Slenderness Ratio kl/r > 200

Steel Column

Lic. # : KW-06000291
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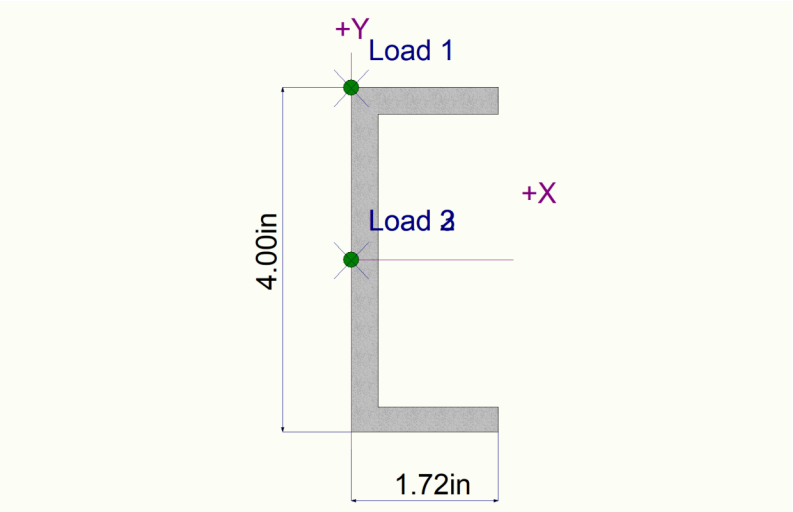
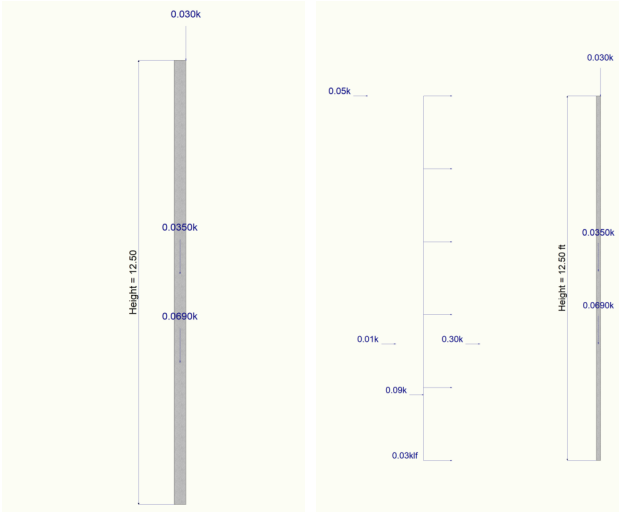
DESCRIPTION: 12' Light Post - Seismic - X-direction

Sketches





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DESIGN ANCHORAGE OF RAILING POSTS TO THE TOP OF THE CMU RETAINING WALLS:

DESIGN CONNECTION AT 12' TALL LIGHT POSTS

Y-DIRECTION:

POST REACTIONS (UNFACTORED):

WIND:

V = 466#

M = 4005 #-ft

SEISMIC:

V = 476#

M = 2860 #-ft

LIVE:

P = 30 #

V = 300#

M = 1200 #-FT

DEAD:

P = 286#

DESIGN ANCHORAGE PER TMS 530-11, SECTION 2.1.4.3

LOAD COMBINATIONS CONSIDERED:

0.6D + 0.6W

D + 0.75L + 0.45W

0.6D - 0.7Ev + 0.7Eh

1.0D + 0.525Ev + 0.525Eh + 0.75L

WORST CASE MOMENT:

D + 0.75L + 0.45W

M = 0.75(1200 #-FT) + 0.45(4005 #-FT)

= 2702 #-FT

CORRESPONDING V:

V = 0.75(300) + 0.45(466)

= 435#

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DESIGN CONNECTION AT 12' TALL LIGHT POSTS

Y-DIRECTION:

DESIGN ANCHORAGE PER TMS 530-11, SECTION 2.1.4.3

CHECK ANCHOR BOLTS FOR TENSION:

- TRY 7.625" x 10" WIDE PLATE WITH (4) - 5/8"Ø HEADED ANCHOR BOLTS, EMBEDDED 12". (3" GAGE)
  - BOLTS ARE F1554 GR. 36
  - MIN CLR = 1.375" FACE SHELL + 0.5" CLR = 1.875" CLR
- D = 0.8H = 0.8(7.625"/2 + 3"/2) = 4.25"
- T = M/D = 2702 #-FT * 12 IN/FT / 4.25" = 7629 #
- DESIGN PER 2.1.4.3.1.1
  - Bab = 1.25Apt*(f'm)^0.5 (EQ 2-1)
  - f'm = 1,500 psi
  - Apt = 28.5 * 7.625" = 217 IN^2
  - Bab = 1.25(217 IN^2)(1500 PSI)^0.5
    = 10,505 #
  - Bab = 10,505 # > T = 7629 #, THEREFORE OK

  - Bas = 0.6(Ab)(Fy) * (2) (EQ 2-2)
    = 0.6(0.307 IN^2)(36 KSI)
    = 13.26 K > T = 7629 #, THEREFORE 5/8" Ø BOLTS OK

CHECK ANCHOR BOLTS FOR SHEAR:

- DESIGN PER 2.1.4.3.2
  - Bvb = 1.25Apv*(f'm)^0.5 (EQ 2-6)
  - f'm = 1,500 psi
  - Check Apv for just 1 set of bolts, conservatively
  - Apv = (pi(Lbe)^2)/2
    = 3.14(5.3125")^2 / 2 = 44 IN^2
  - Bvb = 1.25(44 IN^2)(1500 PSI)^0.5
    = 2,130 #
  - Bvb = 2,130 # > V = 435 #, THEREFORE OK

  - Bvc = 350(f'm*Ab)^1/4 (EQ 2-7)
    = 350(1500 PSI * .307 IN^2 * 4)^1/4
    = 16.11 K > V = 435 #, THEREFORE OK

  - Bvpry = 2.0Bab = 2(10,505) = 21,010 #

  - Bvs = 0.36AbFy = 0.36(0.307 in^2)(4)(36 ksi)
    = 15.9 K > V = 435 #, THEREFORE OK

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DESIGN CONNECTION AT 12' TALL LIGHT POSTS

Y-DIRECTION:

CHECK ANCHOR BOLTS FOR COMBINED TENSION & SHEAR
- DESIGN PER 2.1.4.3.3
  - (ba / Ba) + (bv / Bv) <= 1
  - (7629#/10,505#) + (436#/2130#)
  = 0.73 + 0.21
  = 0.94 <= 1, THEREFORE OK FOR COMBINED T & V

X-DIRECTION:

SHEAR & TENSION FOR THE X-DIRECTION ARE OK BY INSPECTION:
- THE MOMENT ARM IS MUCH BIGGER FOR TENSION
- THE EDGE DISTANCE IS MUCH BIGGER FOR SHEAR

DESIGN CONNECTION AT 4' GUARDRAIL POSTS:

USE THE SAME DESIGN AS THE 12' TALL LIGHT POSTS.

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DESIGN ANCHORAGE OF RAILING POSTS TO THE TOP OF THE CMU RETAINING WALLS:

CHECK BASE PLATE IN BENDING:

12' LIGHT POST:

- USE 3/4" PLATE * 10" * 7.625"
- (SEE ENERCALC RESULTS ON THE FOLLOWING PAGES)

4' HANDRAIL POST:

- USE 1/2" PLATE * 10" * 7.625"
- (SEE ENERCALC RESULTS ON THE FOLLOWING PAGES)

CHECK WELD OF CHANNELS TO PLATE:

12' LIGHT POST:

TRY 1/4" FILLET ALL AROUND
M = 2702 #-FT
T = M / D = 2702 #-FT * 12 IN/FT / 4" = 8106 #
Rn/OMEGA = 0.928DL (AISC STL AN EQ 8-2b)
OMEGA = 2
Rn/OMEGA = 0.928(4)(1.75")(2)/2
= 6.496 K
LOAD ANGLE IS 90 DEGREES. THEREFORE CAN INCREASE CAPACITY OF WELD BY 50%
6.496 * 1.5 = 9.744 K > 8.106 K
THEREFORE 1/4" FILLET WELD ALL AROUND IS OK

4' HANDRAIL POST:

TRY 3/16" FILLET ALL AROUND
M = 1200 #-FT
T = M / D = 1200 #-FT * 12 IN/FT / 4" = 3600 #
Rn/OMEGA = 0.928DL (AISC STL AN EQ 8-2b)
OMEGA = 2
Rn/OMEGA = 0.928(3)(1.625")(2)/2
= 4.5 K
LOAD ANGLE IS 90 DEGREES. THEREFORE CAN INCREASE CAPACITY OF WELD BY 50%
4.5 * 1.5 = 6.7 K > 3.6 K
THEREFORE 3/16" FILLET WELD ALL AROUND IS OK

Steel Base Plate

DESCRIPTION: 12' LIGHT POST BASE PLATE

Code References

Calculations per AISC Design Guide # 1, IBC 2018, CBC 2019, ASCE 7-16, AISC 360-16
Load Combination Set : ASCE 7-16

General Information

Material Properties

AISC Design Method	Allowable Strength Design				
Steel Plate Fy	=	36 ksi			
Concrete Support f'c	=	1.50 ksi	Ω_c : ASD Safety Factor.		2.31
Assumed Bearing Area :	Full Bearing		Nominal Bearing Fp per J8		1.275 ksi

Column & Plate

Column Properties

Steel Section : C4x7.2

Depth	4 in	Area	2.13	in^2
Width	1.72 in	Ixx	4.58	in^4
Flange Thickness	0.296 in	Iyy	0.425	in^4
Web Thickness	0.321 in			

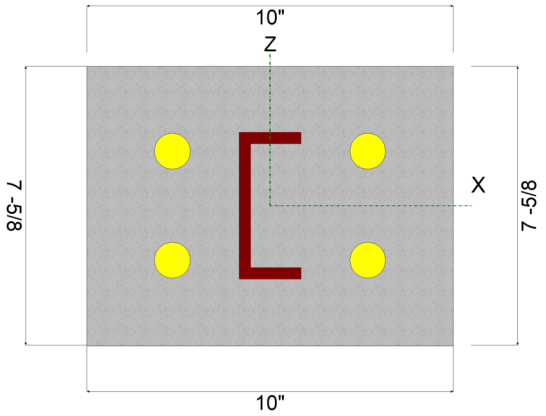


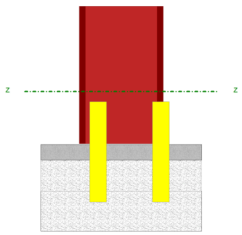
Plate Dimensions

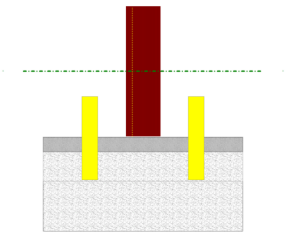
N : Length	7.625	in
B : Width	10.0	in
Thickness	0.750	in

Column assumed welded to base plate.

Support Dimensions

Width along "X"	7.625	in
Length along "Z'	10.0	in



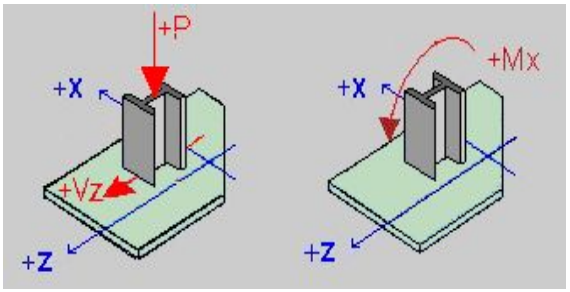


Applied Loads

	P-Y	V-Z	M-X
D : Dead Load	0.2860 k	k	k-ft
L : Live	0.030 k	k	k-ft
Lr : Roof Live	k	k	k-ft
S : Snow	k	k	k-ft
W : Wind	k	0.4660 k	4.005 k-ft
E : Earthquake	k	0.4760 k	2.860 k-ft
H : Lateral Earth	k	k	k-ft

" P " = Gravity load, "+" sign is downward.

"+" Moments create higher soil pressure at +Z edge.
"+" Shears push plate towards +Z edge.



Steel Base Plate

Lic. # : KW-06000291
HORROCKS ENGINEERS, INC.

DESCRIPTION: 12' LIGHT POST BASE PLATE

GOVERNING DESIGN LOAD CASE SUMMARY

Plate Design Summary

Design Method	**Allowable Strength Design**
Governing Load Combination	**+D+0.60W**
Governing Load Case Type	**Axial + Moment, L/2 < Eccentricity, Tension on**
Governing STRESS RATIO	**1.0**
Design Plate Size	**7 -5/8 x 10" x 0 -3/4"**

Pa : Axial Load	0.172	k
Ma : Moment	2.403	k-ft

Ma : Max. Moment	2.281	k-in
fb : Max. Bending Stress	16.219	ksi
Fb : Allowable :	21.557	ksi
Fy / Omega		
Bending Stress Ratio	0.752	

Bending Stress OK

fu : Max. Plate Bearing Stress	0.552	ksi
Fp : Allowable :	0.552	ksi
Bearing Stress Ratio	1.000	

Bearing Stress OK

Tension in each Bolt	3.120	
Allowable Bolt Tension	5.250	
Tension Stress Ratio	0.594	

Tension Stress OK

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Project: MILLCREEK COMMONS | Project No.: UT-2009-1910

By: J. SIPES | Date:

Subject: | Sheet:

DESIGN HANDRAIL AT CAST IN PLACE CONCRETE STAIRS

- MUST DESIGN FOR 50 PLF OR 200# POINT LOAD (LIVE)
- LVE LOADS PER ASCE 7-16, SECTION 4.5
- ASSUME 8' MAX SPACING OF VERTICAL POSTS
- LIVE LOAD FACTOR = 1.6
- USE STAINLESS STEEL
  - USE 316, Fy = 30 KSI
- TRY 2" DIAMETER (PER LANDSCAPE ARCH.)

CHECK HORIZONTAL HANDRAIL
- SPAN = 8'
- CHECK FOR POINT LOAD & UNIFORM LOAD CONDITION.

USE PIPE 2 STD (Fy = 30 KSI) STAINLESS STEEL 316
2" SCHEDULE 40 PIPE
(SEE ENERCALC RESULTS ON THE FOLLOWING PAGES)

CHECK VERTICAL POSTS
- POST IS 3' TALL ABOVE FINISH GRADE
- APPLY LIVE LOAD AT 3.5' ABOVE BASE.
- 50 PLF * 8' = 400# / POST

USE PIPE 2 X-STRONG (Fy = 30 KSI) STAINLESS STEEL 316
2" SCHEDULE 80 PIPE
(SEE ENERCALC RESULTS ON THE FOLLOWING PAGES)

Steel Beam

Lic. # : KW-06000291

HORROCKS ENGINEERS, INC.

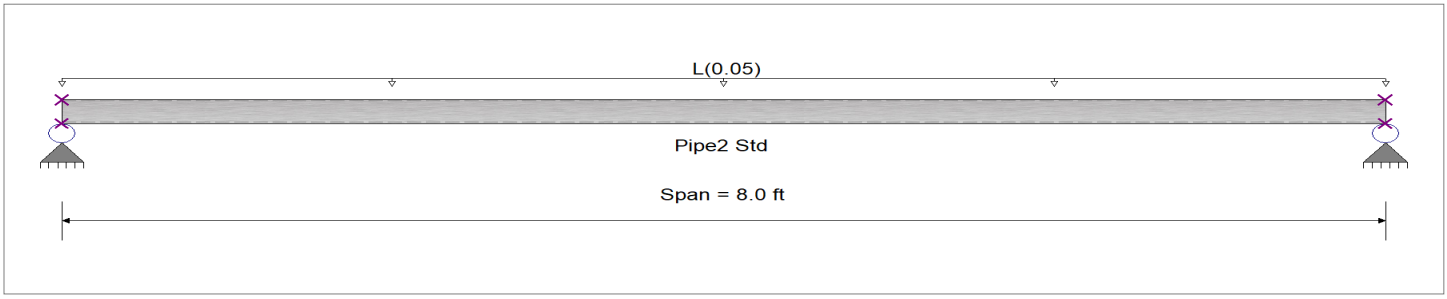
DESCRIPTION: STAIR HANDRAIL - CAP BAR

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : ASCE 7-16

Material Properties

Analysis Method :	Load Resistance Factor Design	Fy : Steel Yield :	30.0 ksi
Beam Bracing :	Completely Unbraced	E: Modulus :	29,000.0 ksi
Bending Axis :	Major Axis Bending		



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added
Uniform Load : L = 0.050 k/ft, Tributary Width = 1.0 ft, (HANDRAIL LIVE LOAD)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	0.399 : 1	Maximum Shear Stress Ratio =	0.040 : 1
Section used for this span	Pipe2 Std	Section used for this span	Pipe2 Std
Mu : Applied	0.640 k-ft	Vu : Applied	0.320 k
Mn * Phi : Allowable	1.604 k-ft	Vn * Phi : Allowable	8.10 k
Load Combination	+1.60L	Load Combination	+1.60L
Location of maximum on span	4.000 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.000 in	Ratio =	0 <180.0
Max Upward Transient Deflection	0.000 in	Ratio =	0 <180.0
Max Downward Total Deflection	0.255 in	Ratio =	377 >=120.
Max Upward Total Deflection	0.000 in	Ratio =	0 <120.0

Steel Beam

Lic. # : KW-06000291
HORROCKS ENGINEERS, INC.

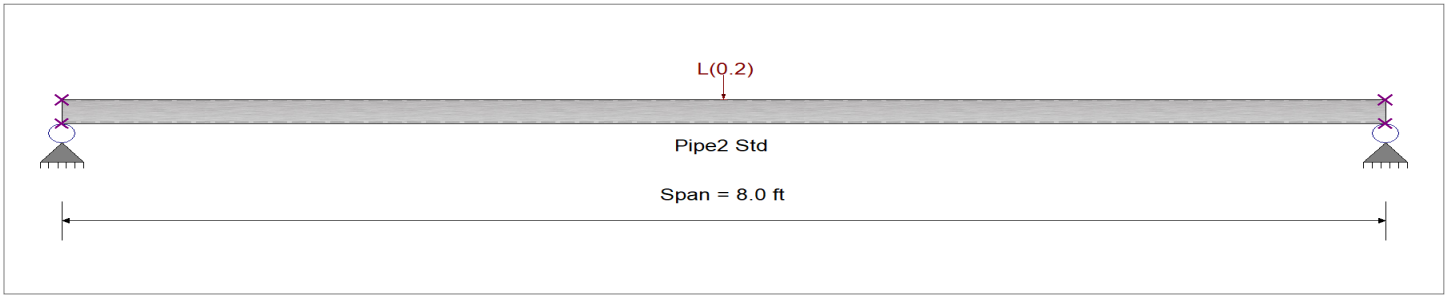
DESCRIPTION: STAIR HANDRAIL - CAP BAR

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : ASCE 7-16

Material Properties

Analysis Method :	Load Resistance Factor Design	Fy : Steel Yield :	30.0 ksi
Beam Bracing :	Completely Unbraced	E: Modulus :	29,000.0 ksi
Bending Axis :	Major Axis Bending		



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added
Load(s) for Span Number 1
Point Load : L = 0.20 k @ 4.0 ft, (HANDRAIL LIVE LOAD)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	0.399 : 1	Maximum Shear Stress Ratio =	0.020 : 1
Section used for this span	Pipe2 Std	Section used for this span	Pipe2 Std
Mu : Applied	0.640 k-ft	Vu : Applied	0.160 k
Mn * Phi : Allowable	1.604 k-ft	Vn * Phi : Allowable	8.10 k
Load Combination	+1.60L	Load Combination	+1.60L
Location of maximum on span	4.000 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.000 in	Ratio =	0 <180.0
Max Upward Transient Deflection	0.000 in	Ratio =	0 <180.0
Max Downward Total Deflection	0.204 in	Ratio =	471 >=120.
Max Upward Total Deflection	0.000 in	Ratio =	0 <120.0

Steel Column

Lic. # : KW-06000291 HORROCKS ENGINEERS, INC.

DESCRIPTION: Stair Handrail

Code References

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combinations Used : ASCE 7-16

General Information

Steel Section Name :	**Pipe2 x-Strong**
Analysis Method :	Allowable Strength
Steel Stress Grade	
Fy : Steel Yield	30.0 ksi
E : Elastic Bending Modulus	29,000.0 ksi

Overall Column Height	3.50 ft
Top & Bottom Fixity	Top Free, Bottom Fixed

Brace condition for deflection (buckling) along columns :
X-X (width) axis :
Fully braced against buckling ABOUT Y-Y Axis
Y-Y (depth) axis :
Fully braced against buckling ABOUT X-X Axis

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 17.786 lbs * Dead Load Factor
BENDING LOADS . . .
Handrail load: Lat. Point Load at 3.50 ft creating Mx-x, L = 0.40 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.9705** : 1

Load Combination	+D+L
Location of max.above base	0.0 ft
At maximum location values are . . .	
Pa : Axial	0.01779 k
Pn / Omega : Allowable	24.970 k
Ma-x : Applied	-1.40 k-ft
Mn-x / Omega : Allowable	1.443 k-ft
Ma-y : Applied	0.0 k-ft
Mn-y / Omega : Allowable	1.443 k-ft

PASS Maximum Shear Stress Ratio = **0.05340** : 1

Load Combination	+D+L
Location of max.above base	0.0 ft
At maximum location values are . . .	
Va : Applied	0.40 k
Vn / Omega : Allowable	7.491 k

Maximum Load Reactions . .

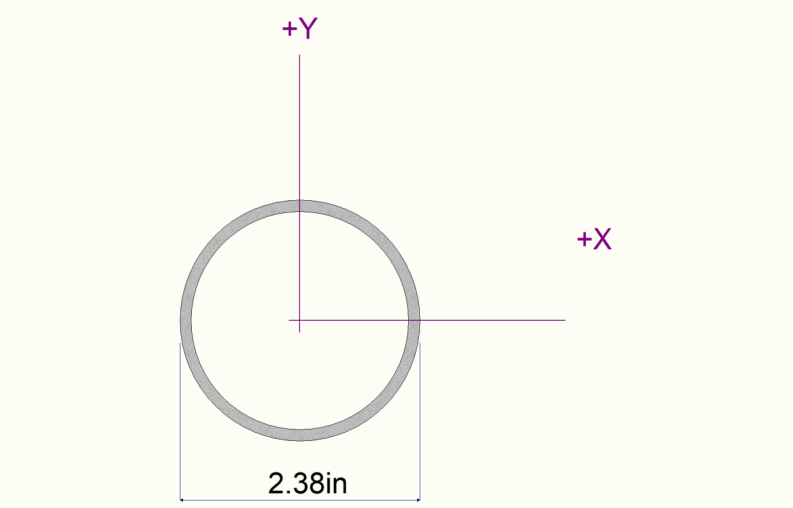
Top along X-X	0.0 k
Bottom along X-X	0.0 k
Top along Y-Y	0.0 k
Bottom along Y-Y	0.40 k

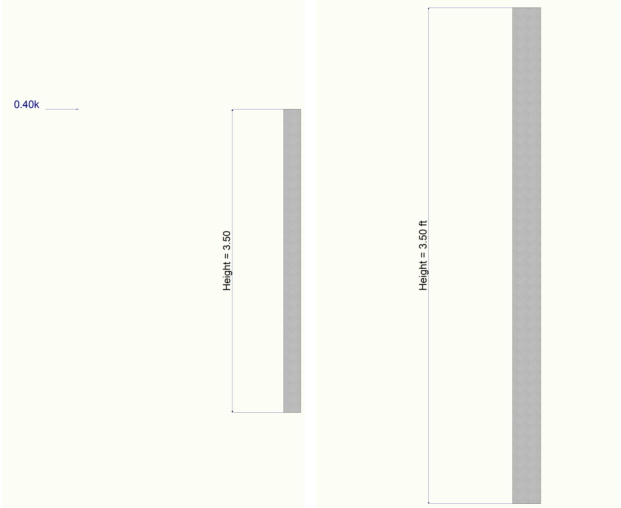
Maximum Load Deflections . . .

Along Y-Y 0.4098 in at 3.50 ft above base
for load combination : +D+L

Along X-X 0.0 in at 0.0 ft above base
for load combination :

Sketches





HORROCKS ENGINEERS

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Project: MILLCREEK COMMONS **Project No.:** UT-2009-1910

By: J. SIPES **Date:**

Subject: **Sheet:**

DESIGN HANDRAIL AT CAST IN PLACE CONCRETE STAIRS

CHECK HANDRAIL FOOTING:

- DESIGN A POLE FOOTING
- PASSIVE PRESSURE = 290 PSF/ FT
- RESTRAINED AT GROUND SURFACE

USE 12" Ø CONCRETE POLE FOOTING
EMBEDDED 2'-9".
(SEE ENERCALC RESULTS ON THE FOLLOWING PAGES)

Pole Footing Embedded in Soil

Lic. # : KW-06000291

HORROCKS ENGINEERS, INC.

DESCRIPTION: STAIR HANDRAIL FOOTING

Code References

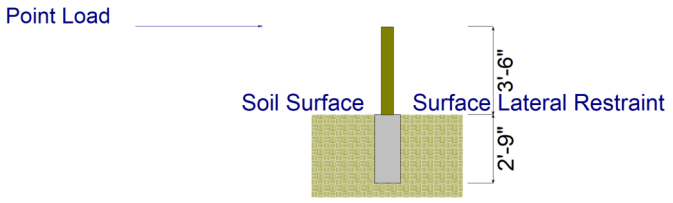
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16
Load Combinations Used : ASCE 7-16

General Information

Pole Footing Shape	Circular
Pole Footing Diameter	12.0 in
Calculate Min. Depth for Allowable Pressures	
Lateral Restraint at Ground Surface	
Allow Passive	290.0 pcf
Max Passive	2,900.0 psf

Controlling Values

Governing Load Combination :	L Only
Lateral Load	0.40 k
Moment	1.40 k-ft
Restraint @ Ground Surface	
Pressure at Depth	
Actual	**786.78** psf
Allowable	**797.50** psf
Surface Retraint Force	1,481.82 lbs
Minimum Required Depth	**2.750 ft**
Footing Base Area	0.7854 ft^2
Maximum Soil Pressure	0.0 ksf



Applied Loads

Lateral Concentrated Load (k)		Lateral Distributed Loads (klf)		Applied Moment (kft)	Vertical Load (k)
D : Dead Load	k		k/ft	k-ft	k
Lr : Roof Live	k		k/ft	k-ft	k
L : Live	0.40 k		k/ft	k-ft	k
S : Snow	k		k/ft	k-ft	k
W : Wind	k		k/ft	k-ft	k
E : Earthquake	k		k/ft	k-ft	k
H : Lateral Earth	k		k/ft	k-ft	k
Load distance above ground surface	3.50 ft	TOP of Load above ground surface	ft		
		BOTTOM of Load above ground surface	ft		

Load Combination Results

Load Combination	Forces @ Ground Surface Loads - (k)	Forces @ Ground Surface Moments - (ft-k)	Required Depth - (ft)	Pressure at Depth Actual - (psf)	Pressure at Depth Allow - (psf)	Soil Increase Factor
	0.000	0.000	0.13	0.0	36.3	1.000
L Only	0.400	1.400	2.75	786.8	797.5	1.000
+0.750L	0.300	1.050	2.50	714.0	725.0	1.000

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Project: MILLCREEK COMMONS
Project No.: UT-2009-1910
By: J. SIPES
Date:
Subject:
Sheet:

DESIGN VEHICLE BOLLARD

- MUST DESIGN FOR 6,000# LIVE LOAD APPLIED BETWEEN 1'-6" & 2'-3" ABOVE GROUND SURFACE.
- LIVE LODS PER ASCE 7-16, SECTION 4.5.3.
- LIVE LOAD FACTOR = 1.6
- TRY 8"x4" WIDE FLANGE BEAM (PER LANDSCAPE ARCH.)
- ASSUME FOOTING IS 3" BELOW SURFACE.
- THEREFORE APPLY LOAD AT 2.5' ABOVE SURFACE

CHECK VERTICAL STEEL POST:

USE W8x10 (Fy = 50 KSI)
(SEE ENERCALC RESULTS ON THE FOLLOWING PAGES)

CHECK FOOTING:
- DESIGN AS A POLE FOOTING
- TRY 27" Ø CIRCULAR FOOTING
- ALLOWABLE PASSIVE PRESSURE = 290 PSF / FT
- MAY BE INCREASED BY 1/3 FOR SHORT DURATION LOADS
- PASSIVE = 290 * 4/3 = 387 PSF / FT

USE 27"Ø CIRCULAR POLE FOOTING X 4'-3" DEEP

Steel Column

Lic. # : KW-06000291 HORROCKS ENGINEERS, INC.

DESCRIPTION: I-Beam Bollards

Code References

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combinations Used : ASCE 7-16

General Information

Steel Section Name : **W8x10**
Analysis Method : Load Resistance Factor
Steel Stress Grade
Fy : Steel Yield 50 ksi
E : Elastic Bending Modulus 29,000.0 ksi

Overall Column Height 2.50 ft
Top & Bottom Fixity Top Free, Bottom Fixed
Brace condition for deflection (buckling) along columns :
X-X (width) axis :
Unbraced Length for buckling ABOUT Y-Y Axis = 2.50 ft, K = 2.1
Y-Y (depth) axis :
Unbraced Length for buckling ABOUT X-X Axis = 2.50 ft, K = 2.1

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Column self weight included : 25.190 lbs * Dead Load Factor
BENDING LOADS . . .
Vehicle Barrior Load: Lat. Point Load at 2.50 ft creating Mx-x, L = 6.0 k

DESIGN SUMMARY

Bending & Shear Check Results

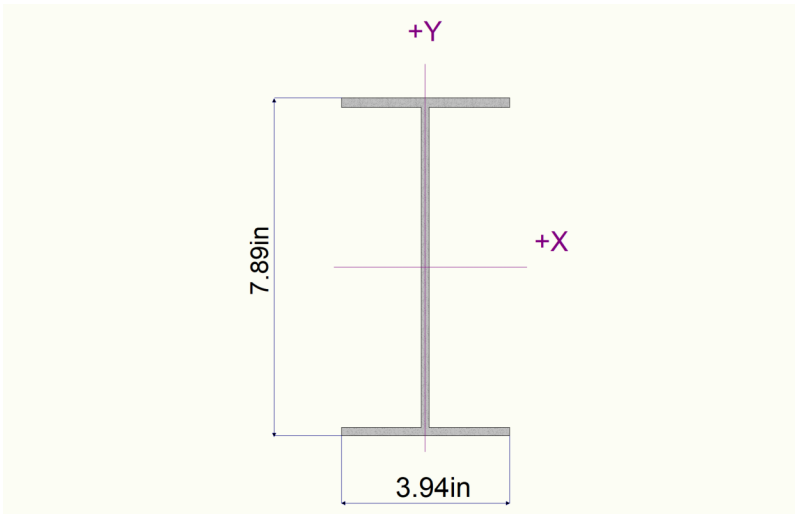
PASS Max. Axial+Bending Stress Ratio = **0.7303** : 1
Load Combination +1.20D+1.60L
Location of max.above base 0.0 ft
At maximum location values are . . .
Pu 0.03023 k
0.9 * Pn 88.371 k
Mu-x -24.0 k-ft
0.9 * Mn-x : 32.871 k-ft
Mu-y 0.0 k-ft
0.9 * Mn-y : 6.119 k-ft

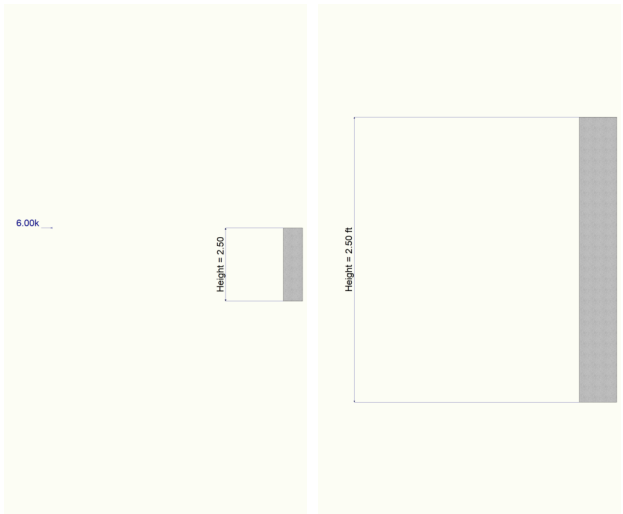
PASS Maximum Shear Stress Ratio = **0.2386** : 1
Load Combination +1.20D+1.60L
Location of max.above base 0.0 ft
At maximum location values are . . .
Vu : Applied 9.60 k
Vn * Phi : Allowable 40.239 k

Maximum Load Reactions . .
Top along X-X 0.0 k
Bottom along X-X 0.0 k
Top along Y-Y 0.0 k
Bottom along Y-Y 6.0 k

Maximum Load Deflections . . .
Along Y-Y 0.06015 in at 2.50 ft above base
for load combination : +D+L
Along X-X 0.0 in at 0.0 ft above base
for load combination :

Sketches





Pole Footing Embedded in Soil

Lic. # : KW-06000291 HORROCKS ENGINEERS, INC.

DESCRIPTION: I-Beam Bollard Footing

Code References

Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16
Load Combinations Used : ASCE 7-16

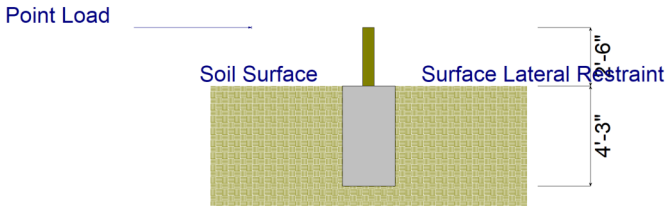
General Information

Pole Footing Shape	Circular
Pole Footing Diameter	27.0 in
Calculate Min. Depth for Allowable Pressures	
Lateral Restraint at Ground Surface	
Allow Passive	387.0 pcf
Max Passive	2,900.0 psf

Controlling Values

Governing Load Combination : L Only

Lateral Load	6.0 k
Moment	15.0 k-ft
Restraint @ Ground Surface	
Pressure at Depth	
Actual	**1,568.63** psf
Allowable	**1,644.75** psf
Surface Retraint Force	13,500.0 lbs
Minimum Required Depth	**4.250 ft**
Footing Base Area	3.976 ft^2
Maximum Soil Pressure	0.0 ksf



Applied Loads

Lateral Concentrated Load (k)		Lateral Distributed Loads (klf)		Applied Moment (kft)	Vertical Load (k)
D : Dead Load	k		k/ft	k-ft	k
Lr : Roof Live	k		k/ft	k-ft	k
L : Live	6.0 k		k/ft	k-ft	k
S : Snow	k		k/ft	k-ft	k
W : Wind	k		k/ft	k-ft	k
E : Earthquake	k		k/ft	k-ft	k
H : Lateral Earth	k		k/ft	k-ft	k
Load distance above ground surface	2.50 ft	TOP of Load above ground surface	ft		
		BOTTOM of Load above ground surface	ft		

Load Combination Results

Load Combination	Forces @ Ground Surface Loads - (k)	Moments - (ft-k)	Required Depth - (ft)	Pressure at Depth Actual - (psf)	Allow - (psf)	Soil Increase Factor
	0.000	0.000	0.13	0.0	48.4	1.000
L Only	6.000	15.000	4.25	1,568.6	1,644.8	1.000
+0.750L	4.500	11.250	3.88	1,415.2	1,499.6	1.000