LEI
ENGINEERS
SURVEYORS
PLANNERS

October 13, 2021

Nate Brusik
Lighthouse Homes
PO Box 525
Riverton, Utah 84065
Natebrusik1@gmail.com
Cc: ryan@pepg.net
ryan.dummer@pepg.net

RE: Lighthouse Heights Subdivision - Site Retaining Wall (LEI #2021-2576)

To Whom It May Concern:

Our services have been requested to design the site retaining wall to be installed along the north side of the storm water retention basin in the Lighthouse Heights Subdivision in Elk Ridge, Utah. See the attached plan, details, and calculations for our recommendations.

All site and soil design (e.g. grading, drainage, etc.) is by others and LEI Engineers & Surveyors, Inc. assumes liability for the structural design of the aforementioned site retaining wall only. Information provided in the CMT Engineering Laboratories Geotechnical Engineering Study (project #15559 dated 11/24/2020) and the PEPG Consulting Lighthouse Heights Subdivision Grading & Drainage Plan (sheet C4.0 dated 8/11/2021) were used for the design of the site retaining wall.

Please call if you have any questions or concerns. Thank you.

Sincerely,

Jordan M. West, E.I.T.
LEI Consulting Engineers & Surveyors, Inc.

Attachments

Reviewed by:

Jared R. Palfreyman, P.E.
Principal

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

• Civil Engineering
• Structural Engineering
• Surveying
• Land Planning
• Landscape Architecture

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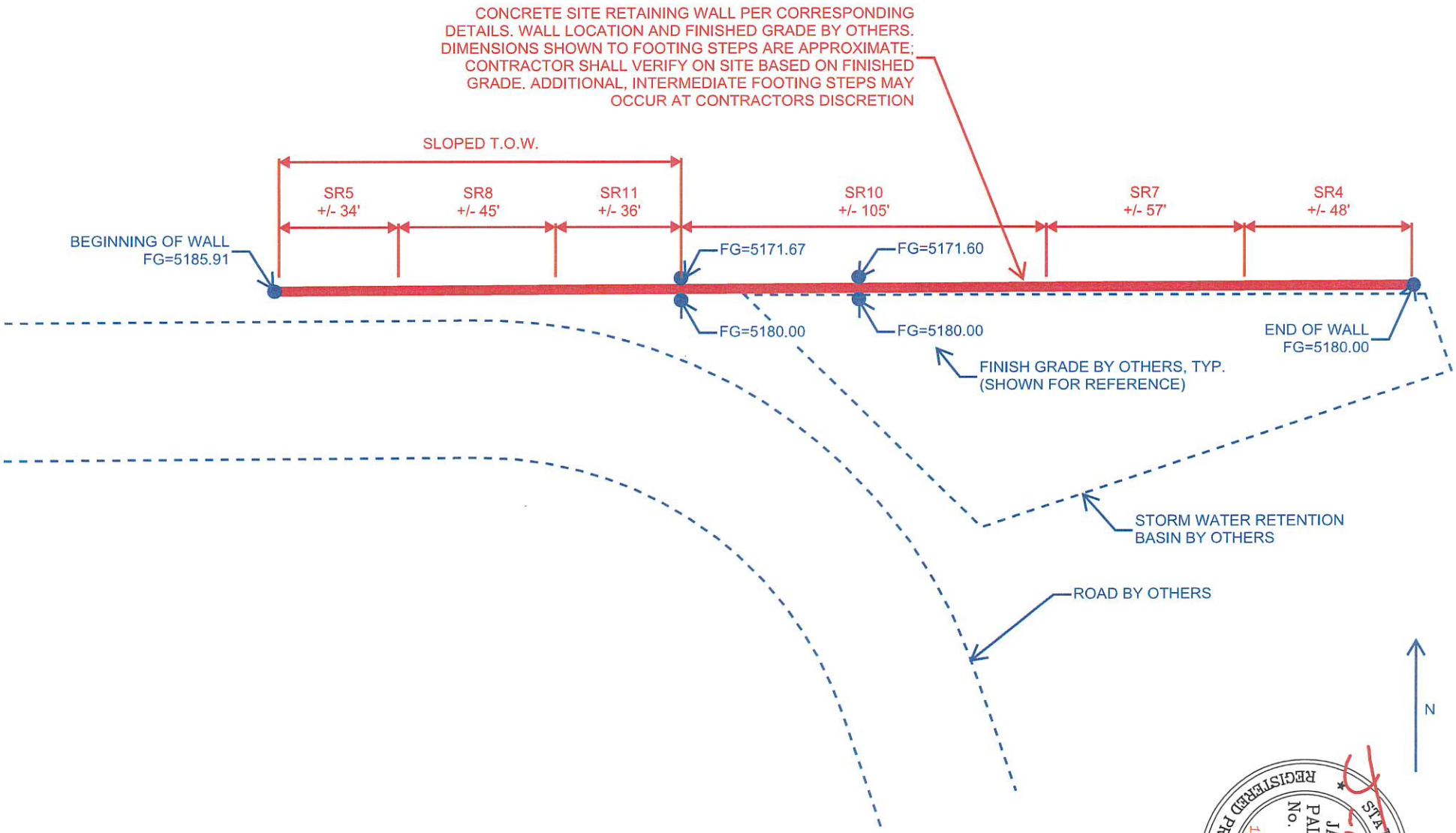
Corporate Office: 3302 N. Main Street • Spanish Fork, UT 84660 801.798.0555 801.798.9393



SITE RETAINING WALL PLAN

SCALE: 1" = 40'

REGISTERED PROFESSIONAL ENGINEER
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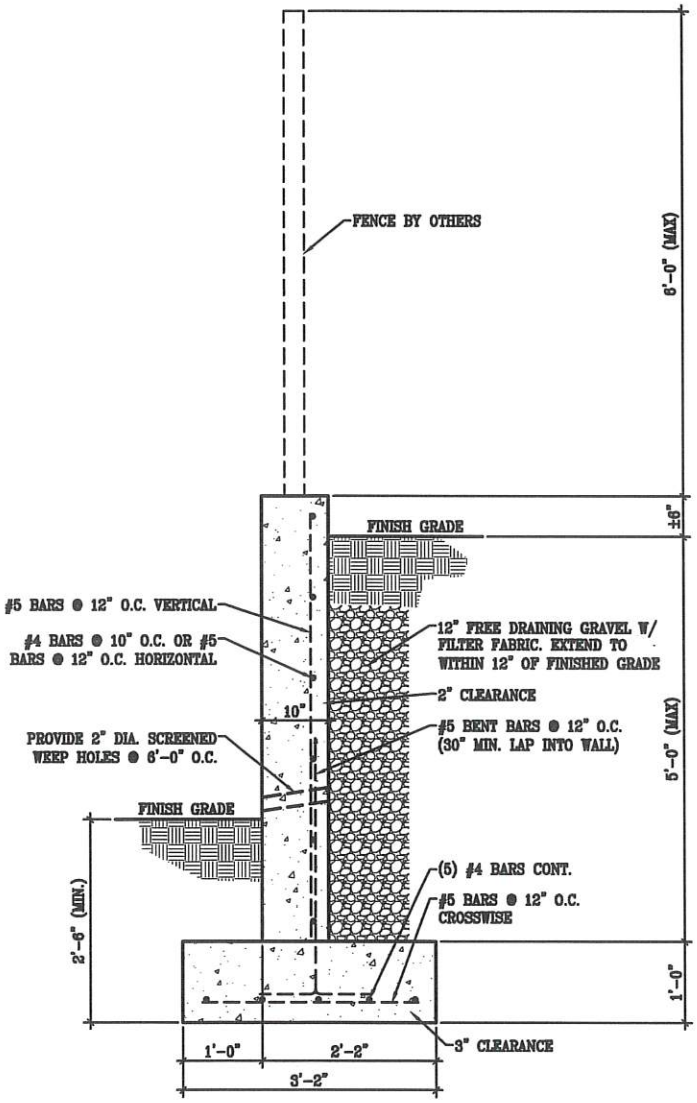
NOTES:
1. f'c (WALL) = 4,500 PSI
2. f'c (FOOTING) = 2,500 PSI
3. Fy = 60,000 PSI
4. FOOTINGS & FOUNDATIONS, EXCAVATIONS, GRADING, & FILL SHALL COMPLY WITH THE PROVISIONS OF THE GEOTECHNICAL REPORT
5. CONTRACTOR IS RESPONSIBLE FOR ALL REQUIRED WATER STOPS, FLASHING, WATER PROOFING, MOISTURE PROTECTION, ETC.



1 5'-0" RETAINING WALL

DIMENSIONS SHOWN ON THE STRUCTURAL PLANS ARE FOR CONVENIENCE ONLY. VERIFY ALL DIMENSIONS WITH THE CURRENT ARCHITECTURAL PLANS PRIOR TO CONSTRUCTION.

LIGHTHOUSE HEIGHTS SUBDIVISION

ELK RIDGE, UTAH

SITE RETAINING WALLS

DRAWN BY: JMW
SCALE: NTS
DATE: 10/12/2021

LEI PROJECT #: 2021-2576

SHEET: SR5

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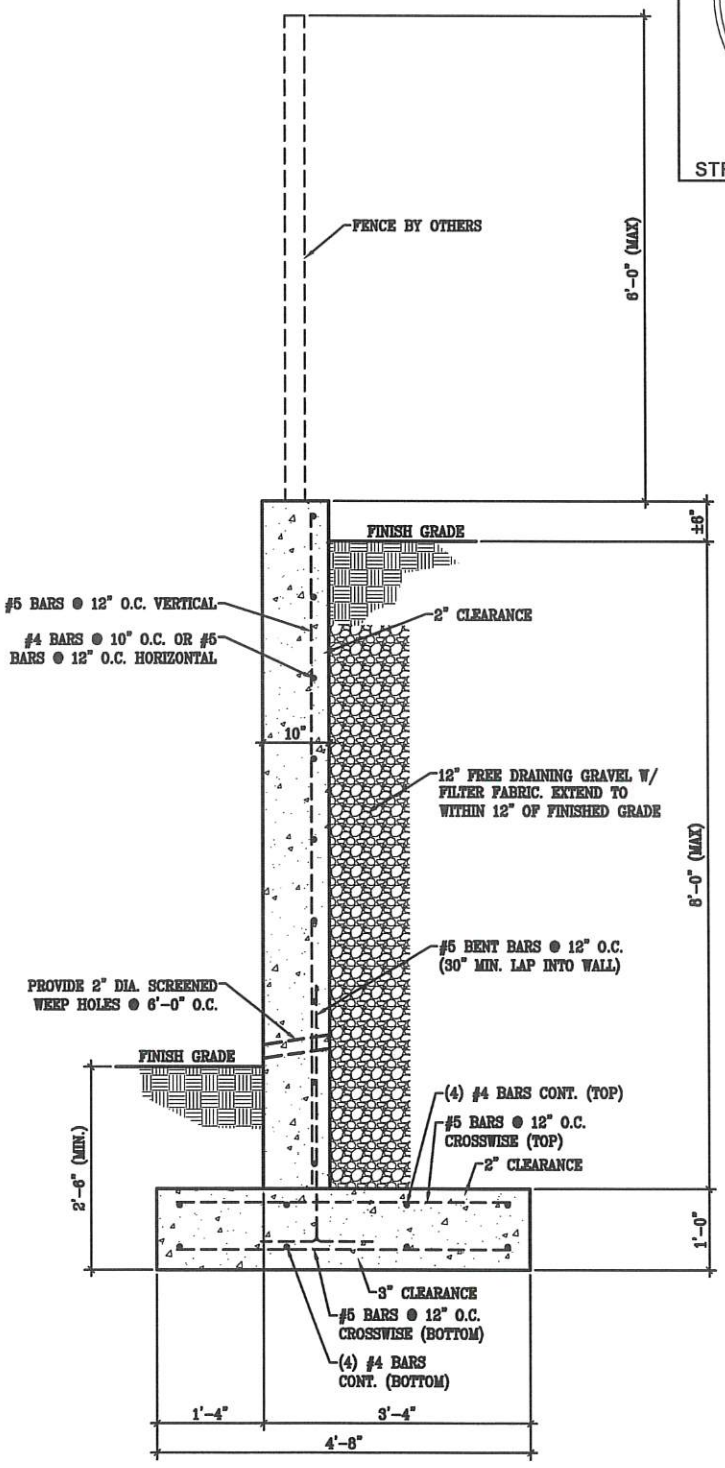

2 8'-0" RETAINING WALL

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ELK RIDGE, UTAH

SITE RETAINING WALLS

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SCALE: NTS
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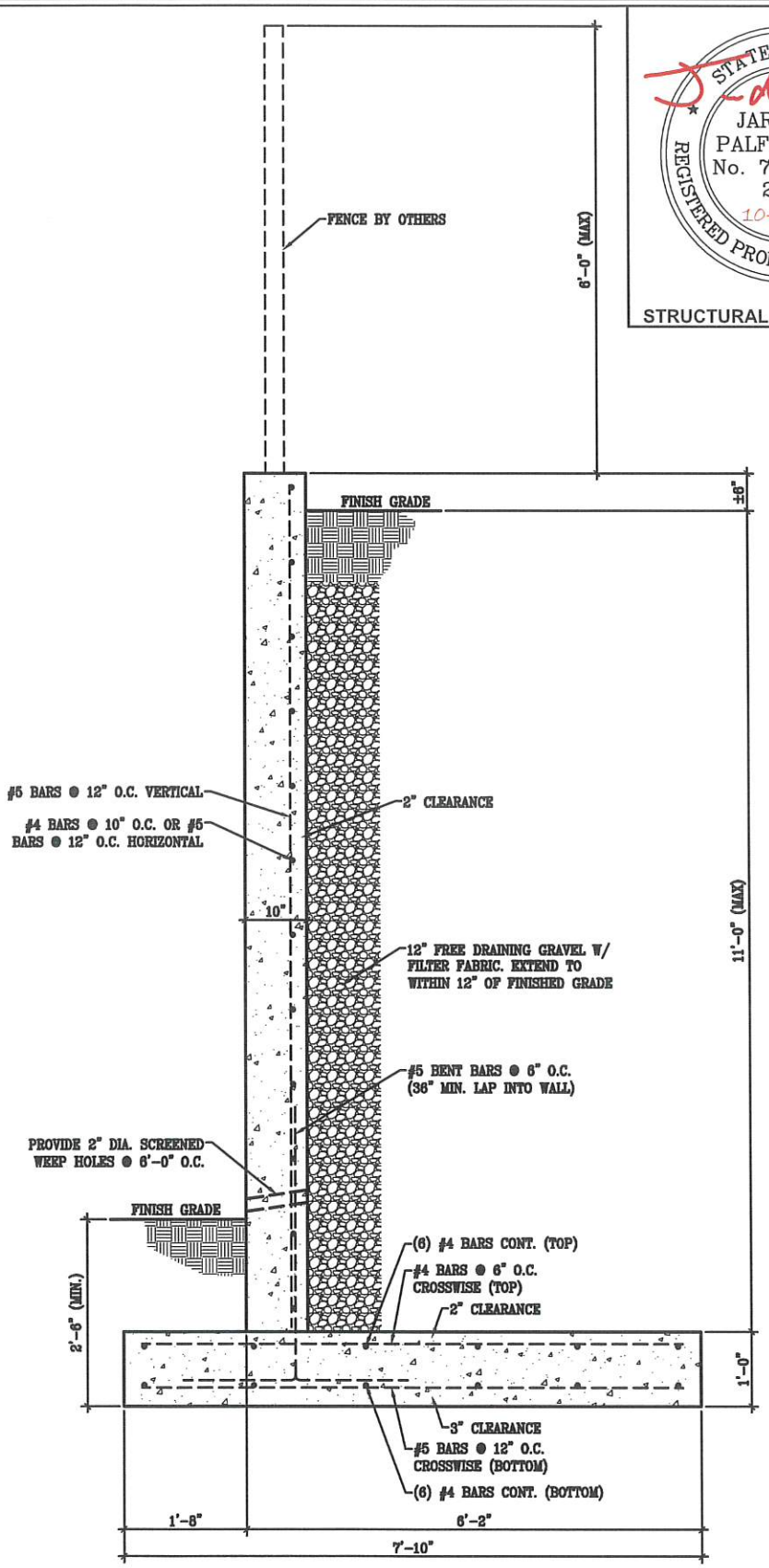
LEI PROJECT #: 2021-2576

SHEET: SR8



3 11'-0" RETAINING WALL

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SITE RETAINING WALLS

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SCALE: NTS

DATE: 10/12/2021

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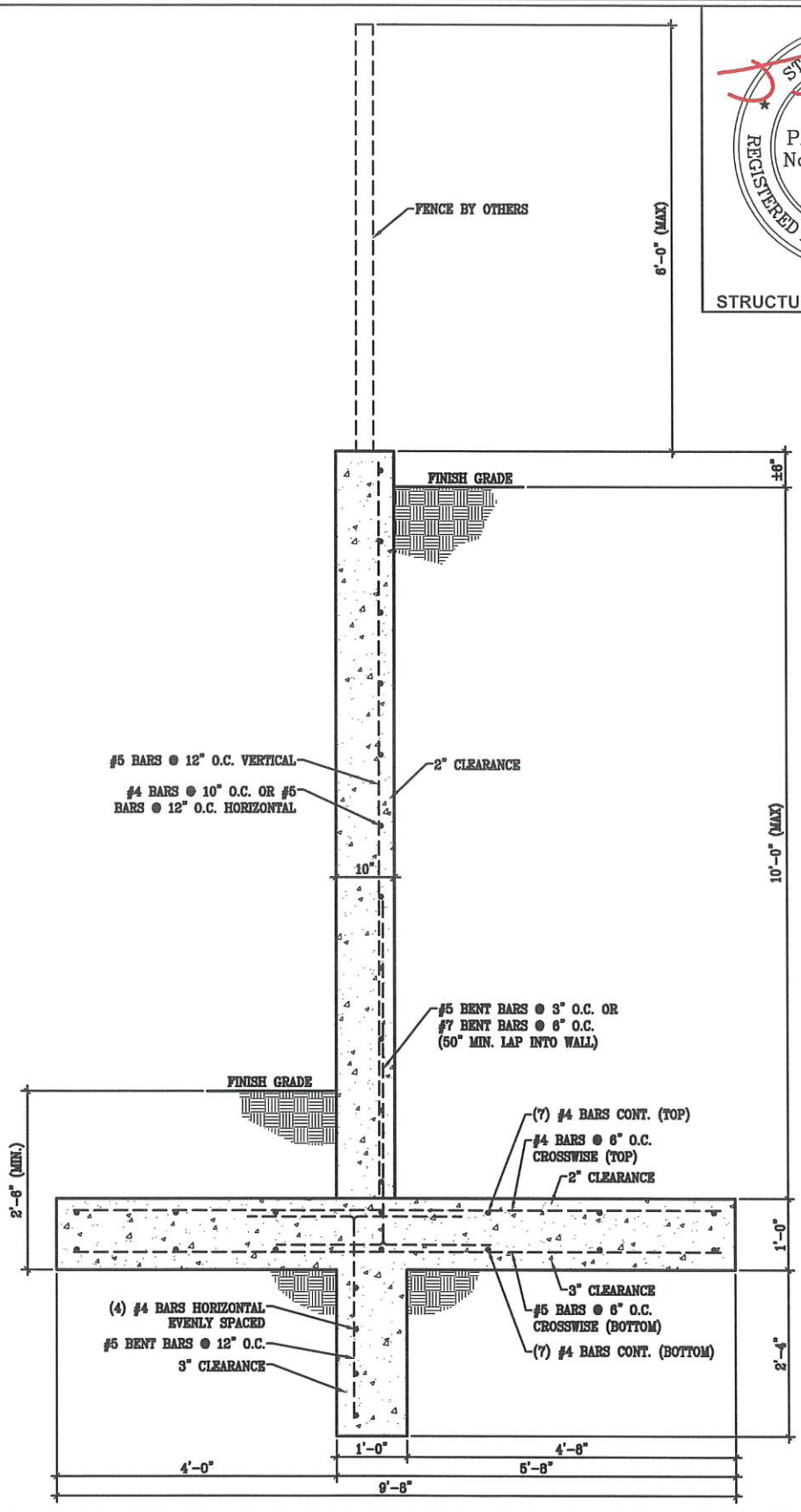
SHEET: SR11



4 10'-0" RETAINING WALL

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ELK RIDGE, UTAH

SITE RETAINING WALLS

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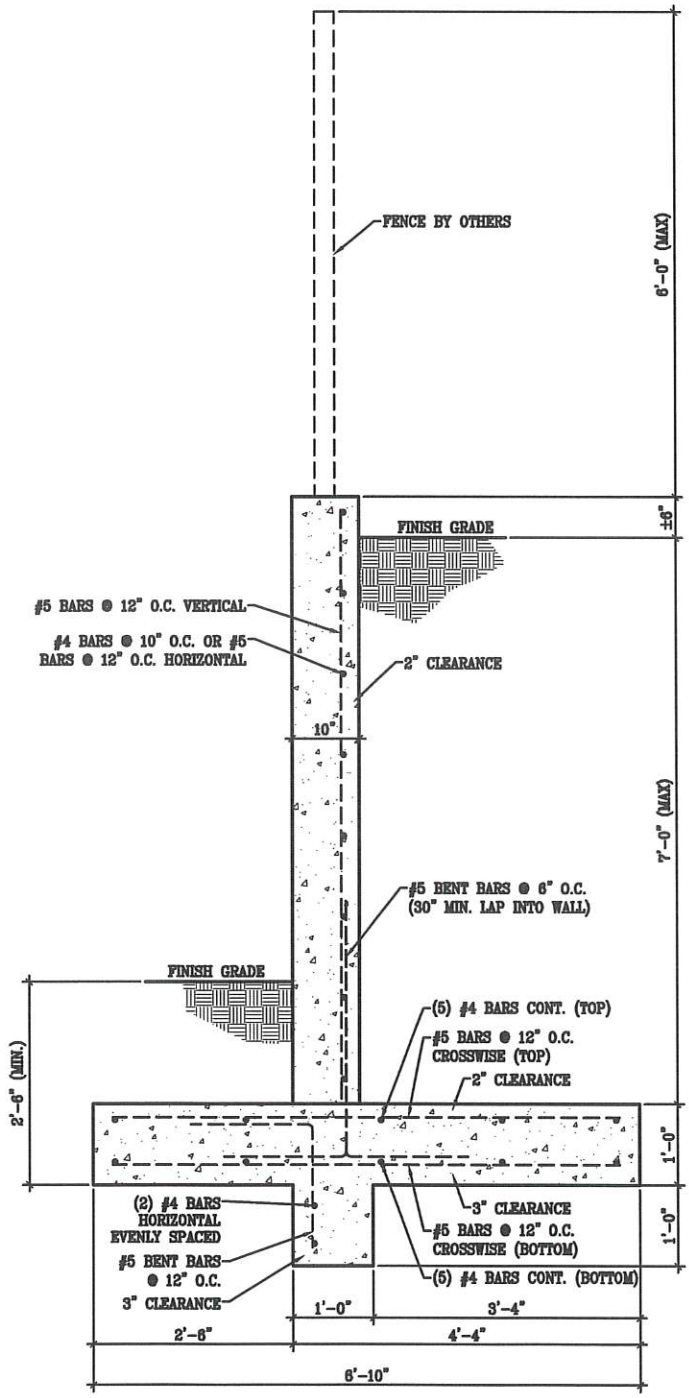
SHEET: SR10



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5 | 7'-0" RETAINING WALL

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ELK RIDGE, UTAH

SITE RETAINING WALLS

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DATE: 10/12/2021

LEI PROJECT #: 2021-2576

SHEET: SR7

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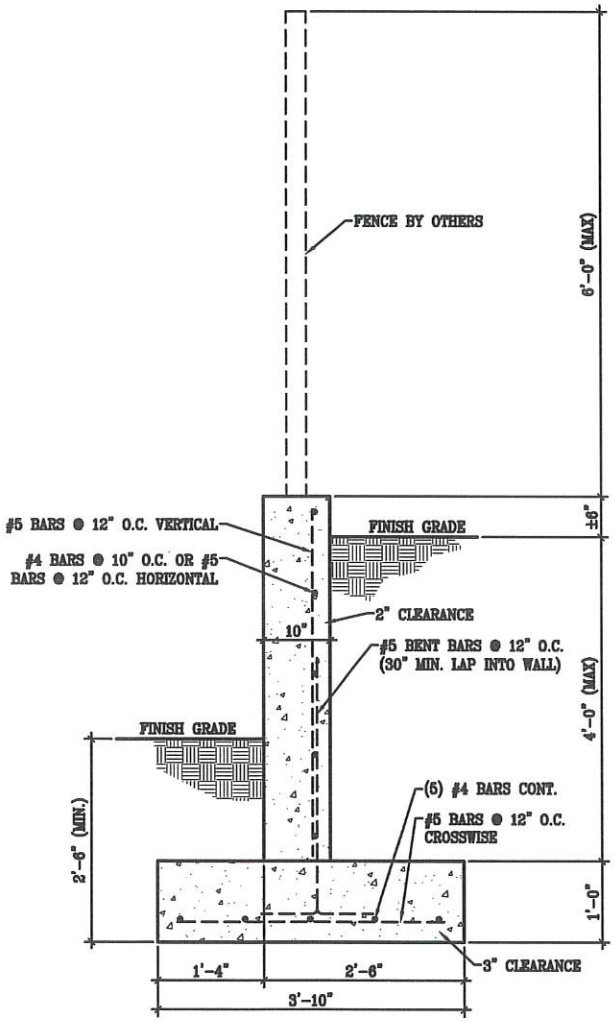

6 | 4'-0" RETAINING WALL

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LEI PROJECT #: 2021-2576

SHEET: SR4

WIND LOAD

$F = q_h G C_f A_s$

$= (20.4\ PSF)(0.85)(1.3)(1\ SQFT)$

$= 22.542$

$F = \underline{22.6\ PSF}$

$G = 0.85$

$C_f = 1.30$

$A_s = 1\ FT^2$

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$q_h = 0.00256\, k_z k_{zt} k_d k_e V^2$

$= 0.00256(0.849)(1.0)(0.85)(1.0)(105\ MPH)^2$

$= 20.367$

$= \underline{20.4\ PSF}$

$K_z = 2.01\,(z/z_g)^{2/\alpha}$

$= 2.01\,(15/900)^{2/9.5}$

$= \underline{0.849}$

$\alpha = 9.5$

$z_g = 900$

$K_{zt} = 1.00$

$k_d = 0.85$

$k_e = 1.00$

$V = 105\ MPH$

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Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 5'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT1 FW5

Date: 20 SEP 2021

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

RetainPro (c) 1987-2019, Build 11.20.03.31
License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

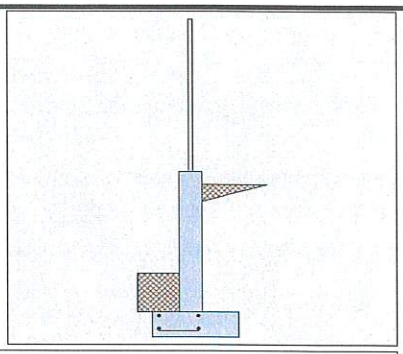
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	5.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	425.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

Axial Load Applied to Stem

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

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 (Strength Level)	=	22.6 psf

Adjacent Footing Load

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

Design Summary

Wall Stability Ratios

Overturning	=	2.32 OK
Sliding	=	2.64 OK
Total Bearing Load	=	1,895 lbs
...resultant ecc.	=	9.61 in
Soil Pressure @ Toe	=	1,615 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,262 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	4.8 psi OK
Footing Shear @ Heel	=	8.3 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	718.1 lbs
less 100% Passive Force	= -	1,328.1 lbs
less 100% Friction Force	= -	568.6 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

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

Stem Construction

		2nd	Bottom	
			Stem OK	
Design Height Above Ftg	ft =	5.50	0.00	
Wall Material Above "Ht"	=	Fence	Concrete	
Design Method	=		LRFD	LRFD
Thickness	=		10.00	
Rebar Size	=		# 5	
Rebar Spacing	=		12.00	
Rebar Placed at	=		Edge	
Design Data				
fb/FB + fa/Fa	=		0.217	
Total Force @ Section				
Service Level	lbs =	81.4		
Strength Level	lbs =		846.9	
Moment....Actual				
Service Level	ft-# =	244.1		
Strength Level	ft-# =		2,378.6	
Moment.....Allowable	ft-# =		10,911.3	
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =		8.6	
Shear.....Allowable	=		75.0	
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =		8.19	
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =		125.0	
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =		2,500.0	
Fy	psi =		60,000.0	

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Project Name/Number : 2021-2576
Title 5'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT1 FW5

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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) :	0.0672 in2/ft		
(4/3) * As :	0.0896 in2/ft	Min Stem T&S Reinf Area 1.320 in2	
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft	
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.216 in2/ft	#4@ 10.00 in	#4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in	#5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in	#6@ 44.00 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	2.17
Total Footing Width	=	3.17
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	2,262	0 psf
Mu' : Upward	=	11,642	22 ft-#
Mu' : Downward	=	2,268	746 ft-#
Mu: Design	=	781	724 ft-#
Actual 1-Way Shear	=	4.80	8.27 psi
Allow 1-Way Shear	=	75.00	40.00 psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: No key defined

Min footing T&S reinf Area	0.82	in2
Min footing T&S reinf Area per foot	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

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

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	630.0	2.00	1,260.0			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =	88.1	9.25	815.3			
=						
Soil Over HL (ab. water tbl)				733.0	2.50	1,832.2
Soil Over HL (bel. water tbl)					2.50	1,832.2
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.50	
Surcharge Over Toe =						
Stem Weight(s) =				687.5	1.42	974.0
Earth @ Stem Transitions =						
Footing Weight =				474.9	1.58	751.8
Key Weight =						
Vert. Component =						
Total =	718.1	**O.T.M.** =	2,075.3	**Total =** 1,895.4 lbs	**R.M.=**	4,805.8

Resisting/Overturning Ratio = **2.32**
Vertical Loads used for Soil Pressure = 1,895.4 lbs

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

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

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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)	0.163	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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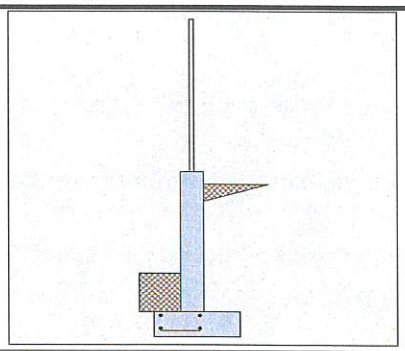
Criteria

Retained Height	=	5.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,667.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	925.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

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 (Strength Level)	=	0.0 psf

Adjacent Footing Load

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

Axial Load Applied to Stem

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

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	15.670
(Multiplier used on soil density)		
Uniform Seismic Force	=	94.020
Total Seismic Force	=	564.120

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Design Summary

Wall Stability Ratios

Overturning	=	1.97 OK
Sliding	=	3.38 OK
Total Bearing Load	=	1,895 lbs
...resultant ecc.	=	11.95 in
Soil Pressure @ Toe	=	2,151 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,667 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	3,012 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	6.6 psi OK
Footing Shear @ Heel	=	9.3 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	1,024.9 lbs
less 100% Passive Force	= -	2,890.6 lbs
less 100% Friction Force	= -	568.6 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

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

Stem Construction

		2nd	Bottom
			Stem OK
Design Height Above Ftg	ft =	5.50	0.00
Wall Material Above "Ht"	=	Fence	Concrete
Design Method	=		LRFD
Thickness	=		10.00
Rebar Size	=		# 5
Rebar Spacing	=		12.00
Rebar Placed at	=		Edge
Design Data			
fb/FB + fa/Fa	=		**0.214**
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =		1,170.1
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =		2,341.9
Moment.....Allowable	ft-# =		10,911.3
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =		11.9
Shear.....Allowable	=		75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =		8.19
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =		125.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=	Medium Weight	
Masonry Design Method	=	ASD	
Concrete Data			
f'c	psi =		2,500.0
Fy	psi =		60,000.0

LRFD

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 5'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT1 FW5 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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) :	0.0661 in2/ft	
(4/3) * As :	0.0882 in2/ft	Min Stem T&S Reinf Area 1.320 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.216 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	1.00 ft
Heel Width	=	2.17
Total Footing Width	=	3.17
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	3,012	0 psf
Mu' : Upward	=	14,652	0 ft-#
Mu' : Downward	=	2,268	746 ft-#
Mu: Design	=	1,032	746 ft-#
Actual 1-Way Shear	=	6.63	9.33 psi
Allow 1-Way Shear	=	75.00	40.00 psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: No key defined

Min footing T&S reinf Area 0.82 in2
Min footing T&S reinf Area per foot 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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 5'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT1 FW5 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	630.0	2.00	1,260.0			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =						
Seismic Earth Load =	394.9	3.00	1,184.7			
=						
Soil Over HL (ab. water tbl)				733.0	2.50	1,832.2
Soil Over HL (bel. water tbl)					2.50	1,832.2
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.50	
Surcharge Over Toe =						
Stem Weight(s) =				687.5	1.42	974.0
Earth @ Stem Transitions =						
Footing Weight =				474.9	1.58	751.8
Key Weight =						
Vert. Component =						
Total =	1,024.9	**O.T.M.** =	2,444.7	**Total =** 1,895.4 lbs	**R.M.=**	4,805.8

Resisting/Overturning Ratio = **1.97**
Vertical Loads used for Soil Pressure = 1,895.4 lbs

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

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

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

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)	0.217	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.

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 8'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT3 FW8

Date: 20 SEP 2021

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

RetainPro (c) 1987-2019, Build 11.20.03.31
License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

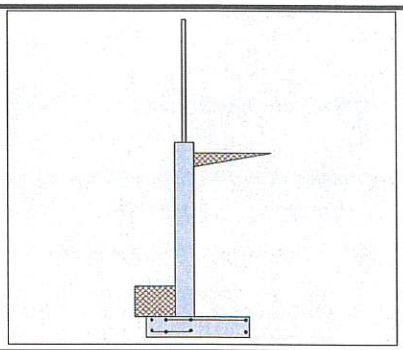
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	425.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

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 (Strength Level)	=	22.6 psf

Adjacent Footing Load

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

Axial Load Applied to Stem

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

Design Summary

Wall Stability Ratios

Overturning	=	3.52 OK
Sliding	=	1.67 OK
Total Bearing Load	=	3,962 lbs
...resultant ecc.	=	10.81 in
Soil Pressure @ Toe	=	1,844 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,582 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	11.9 psi OK
Footing Shear @ Heel	=	15.1 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	1,505.6 lbs
less 100% Passive Force	=	- 1,328.1 lbs
less 100% Friction Force	=	- 1,188.6 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

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

Stem Construction

		2nd	Bottom	
			Stem OK	
Design Height Above Ftg	ft =	8.50	0.00	
Wall Material Above "Ht"	=	Fence	Concrete	
Design Method	=		LRFD	LRFD
Thickness	=		10.00	
Rebar Size	=		# 5	
Rebar Spacing	=		12.00	
Rebar Placed at	=		Edge	
Design Data				
fb/FB + fa/Fa	=		0.589	
Total Force @ Section				
Service Level	lbs =	81.4		
Strength Level	lbs =		1,938.9	
Moment....Actual				
Service Level	ft-# =	244.1		
Strength Level	ft-# =		6,431.3	
Moment.....Allowable	ft-# =		10,911.3	
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =		19.7	
Shear.....Allowable	=		75.0	
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =		8.19	
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =		125.0	
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =		2,500.0	
Fy	psi =		60,000.0	

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 8'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT3 FW8

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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) :	0.1816 in2/ft		
(4/3) * As :	0.2422 in2/ft	Min Stem T&S Reinf Area 2.040 in2	
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft	
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.2422 in2/ft	#4@ 10.00 in	#4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in	#5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in	#6@ 44.00 in

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Footing Data

Toe Width	=	1.33 ft
Heel Width	=	3.33
Total Footing Width	=	4.67
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 75,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	2,582	0 psf
Mu' : Upward	=	24,682	968 ft-#
Mu' : Downward	=	4,030	3,861 ft-#
Mu: Design	=	1,721	2,893 ft-#
Actual 1-Way Shear	=	11.94	15.14 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = # 5 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Key: No key defined

Min footing T&S reinf Area	1.21	in2
Min footing T&S reinf Area per foot	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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 8'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT3 FW8

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

RetainPro (c) 1987-2019, Build 11.20.03.31
License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)		1,417.5	3.00	4,252.5	Soil Over HL (ab. water tbl)	2,199.7	3.42	7,514.6
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		3.42	7,514.6
Hydrostatic Force					Watre Table			
Buoyant Force	=				Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=	88.1	12.25	1,079.7	Soil Over Toe	=	0.67	
	=				Surcharge Over Toe	=		
					Stem Weight(s)	=	1,062.5	1.75	1,859.0
					Earth @ Stem Transitions	=		
					Footing Weight	=	699.9	2.33	1,632.9
					Key Weight	=			
					Vert. Component	=			
Total	=	1,505.6	**O.T.M.** =	5,332.2	**Total =**		3,962.1 lbs	**R.M.=**	18,776.9

Resisting/Overturning Ratio = **3.52**
Vertical Loads used for Soil Pressure = 3,962.1 lbs

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

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

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)	0.159	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.

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 8'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT3 FW8 - SEISMIC

Date: 20 SEP 2021

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

Cantilevered Retaining Wall

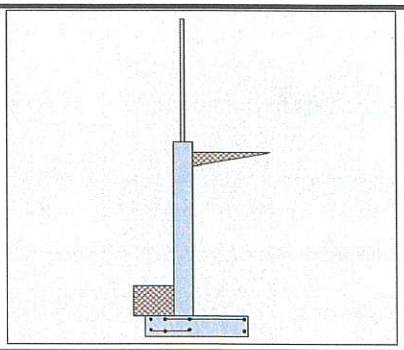
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,667.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	925.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

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 (Strength Level)	=	0.0 psf

Adjacent Footing Load

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

Axial Load Applied to Stem

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

Earth Pressure Seismic Load

Method : Uniform
Multiplier Used = 10.450
(Multiplier used on soil density)

Uniform Seismic Force = 94.050
Total Seismic Force = 846.450

Design Summary

Wall Stability Ratios

Overturning	=	2.71 OK
Sliding	=	2.03 OK
Total Bearing Load	=	3,962 lbs
...resultant ecc.	=	15.62 in
Soil Pressure @ Toe	=	2,560 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,667 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	3,584 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	17.0 psi OK
Footing Shear @ Heel	=	22.7 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	2,010.0 lbs
less 100% Passive Force	= -	2,890.6 lbs
less 100% Friction Force	= -	1,188.6 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

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

Stem Construction

		2nd	Bottom	
			Stem OK	
Design Height Above Ftg	ft =	8.50	0.00	
Wall Material Above "Ht"	=	Fence	Concrete	
Design Method	=		LRFD	LRFD
Thickness	=		10.00	
Rebar Size	=		# 5	
Rebar Spacing	=		12.00	
Rebar Placed at	=		Edge	
Design Data				
fb/FB + fa/Fa	=		**0.713**	
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =		2,544.4	
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =		7,788.3	
Moment.....Allowable	ft-# =		10,911.3	
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =		25.9	
Shear.....Allowable	=		75.0	
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =		8.19	
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =		125.0	
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =		2,500.0	
Fy	psi =		60,000.0	

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 8'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT3 FW8 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

RetainPro (c) 1987-2019, Build 11.20.03.31
License : KW-06060294
License To : LEI Engineers and Surveyors

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) :	0.2199 in2/ft	
(4/3) * As :	0.2933 in2/ft	Min Stem T&S Reinf Area 2.040 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2933 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	1.33 ft
Heel Width	=	3.33
Total Footing Width	=	4.67
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 75,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	3,584	0 psf
Mu' : Upward	=	32,728	155 ft-#
Mu' : Downward	=	4,030	3,861 ft-#
Mu: Design	=	2,392	3,707 ft-#
Actual 1-Way Shear	=	17.02	22.72 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = # 5 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Key: No key defined

Min footing T&S reinf Area 1.21 in2
Min footing T&S reinf Area per foot 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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 8'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT3 FW8 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)		1,417.5	3.00	4,252.5	Soil Over HL (ab. water tbl)	2,199.7	3.42	7,514.6
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		3.42	7,514.6
Hydrostatic Force					Watre Table			
Buoyant Force	=				Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=				Soil Over Toe	=	0.67	
Seismic Earth Load	=	592.5	4.50	2,666.3	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	1,062.5	1.75	1,859.0
					Earth @ Stem Transitions	=			
Total	=	2,010.0	**O.T.M.** =	6,918.8	Footing Weight	=	699.9	2.33	1,632.9
					Key Weight	=			
					Vert. Component	=			
					Total =		3,962.1 lbs	**R.M.=**	18,776.9

Resisting/Overturning Ratio = **2.71**
Vertical Loads used for Soil Pressure = 3,962.1 lbs

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

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

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

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)	0.221	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.

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 11'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT5 FW11

Date: 20 SEP 2021

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

Cantilevered Retaining Wall

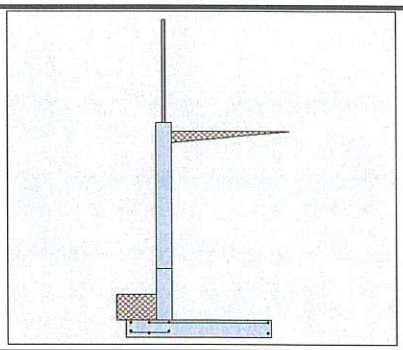
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	11.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	425.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

Axial Load Applied to Stem

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

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 (Service Level)	=	22.6 psf

Adjacent Footing Load

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

Design Summary

Wall Stability Ratios

Overturning	=	3.95 OK
Sliding	=	1.52 OK
Total Bearing Load	=	9,065 lbs
...resultant ecc.	=	9.12 in
Soil Pressure @ Toe	=	1,832 psf OK
Soil Pressure @ Heel	=	483 psf OK
Allowable	=	2,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,564 psf
ACI Factored @ Heel	=	677 psf
Footing Shear @ Toe	=	18.8 psi OK
Footing Shear @ Heel	=	14.6 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	2,666.9 lbs
less 100% Passive Force	=	- 1,328.1 lbs
less 100% Friction Force	=	- 2,719.4 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

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

Stem Construction

		3rd	2nd	Bottom
Design Height Above Ftg	ft =	11.50	Stem OK 3.00	Stem OK 0.00
Wall Material Above "Ht"	=	Fence	Concrete	Concrete
Design Method	=		LRFD	LRFD
Thickness	=		10.00	10.00
Rebar Size	=		# 5	# 5
Rebar Spacing	=		12.00	6.00
Rebar Placed at	=		Edge	Edge
Design Data				
fb/FB + fa/Fa	=		**0.589**	**0.697**
Total Force @ Section				
Service Level	lbs =	135.6		
Strength Level	lbs =		1,938.9	3,534.9
Moment....Actual				
Service Level	ft-# =	406.8		
Strength Level	ft-# =		6,431.3	14,516.0
Moment.....Allowable	ft-# =		10,911.3	20,802.0
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =		19.7	36.0
Shear.....Allowable	=		75.0	75.0
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =		8.19	8.19
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =		125.0	125.0
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =		2,500.0	2,500.0
Fy	psi =		60,000.0	60,000.0

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 11'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT5 FW11

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

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

Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.1816 in2/ft	
(4/3) * As :	0.2422 in2/ft	Min Stem T&S Reinf Area 2.040 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2422 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.4099 in2/ft	
(4/3) * As :	0.5466 in2/ft	Min Stem T&S Reinf Area 0.720 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.4099 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.62 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	1.67 ft
Heel Width	=	6.17
Total Footing Width	=	7.83
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	2,564	677 psf
Mu' : Upward	=	40,473	15,711 ft-#
Mu' : Downward	=	6,295	23,205 ft-#
Mu: Design	=	2,848	7,494 ft-#
Actual 1-Way Shear	=	18.82	14.63 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = # 4 @ 6.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Key: No key defined

Min footing T&S reinf Area 2.03 in2
Min footing T&S reinf Area per foot 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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
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Project Name/Number : 2021-2576
Title 11'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT5 FW11

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License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item	.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#	.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)	2,520.0	4.00	10,080.0			
HL Act Pres (be water tbl)						
Hydrostatic Force						
Buoyant Force =						
Surcharge over Heel =						
Surcharge Over Toe =						
Adjacent Footing Load =						
Added Lateral Load =						
Load @ Stem Above Soil =	146.9	15.25	2,240.2			
=						
Soil Over HL (ab. water tbl)				6,452.5	5.17	33,331.6
Soil Over HL (bel. water tbl)					5.17	33,331.6
Watre Table						
Sloped Soil Over Heel =						
Surcharge Over Heel =						
Adjacent Footing Load =						
Axial Dead Load on Stem =						
* Axial Live Load on Stem =						
Soil Over Toe =					0.83	
Surcharge Over Toe =						
Stem Weight(s) =				1,437.5	2.08	2,993.8
Earth @ Stem Transitions =						
Footing Weight =				1,174.8	3.92	4,600.5
Key Weight =						
Vert. Component =						
Total =	2,666.9	**O.T.M.** =	12,320.2	**Total =** 9,064.8 lbs	**R.M.=**	48,696.4

Resisting/Overturning Ratio = **3.95**
Vertical Loads used for Soil Pressure = 9,064.8 lbs

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

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

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)	0.114	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.

Jared Palfreyman
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3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 11'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT5 FW11 - SEISMIC

Date: 20 SEP 2021

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Cantilevered Retaining Wall

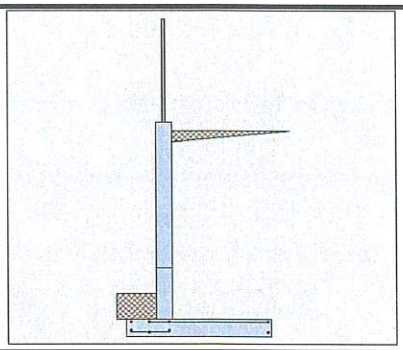
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	11.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,667.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	927.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

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 (Service Level)	=	0.0 psf

Adjacent Footing Load

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

Axial Load Applied to Stem

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

Earth Pressure Seismic Load

Method : Uniform
Multiplier Used = 7.840
(Multiplier used on soil density)

Uniform Seismic Force = 94.080
Total Seismic Force = 1,128.960

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
REGISTERED PROFESSIONAL ENGINEER
10-13-21

Design Summary

Wall Stability Ratios

Overturning	=	3.29 OK
Sliding	=	1.70 OK
Total Bearing Load	=	9,065 lbs
...resultant ecc.	=	12.44 in
Soil Pressure @ Toe	=	2,076 psf OK
Soil Pressure @ Heel	=	239 psf OK
Allowable	=	2,667 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,907 psf
ACI Factored @ Heel	=	334 psf
Footing Shear @ Toe	=	21.6 psi OK
Footing Shear @ Heel	=	19.7 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	3,310.3 lbs
less 100% Passive Force	= -	2,896.9 lbs
less 100% Friction Force	= -	2,719.4 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

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

Stem Construction

		3rd	2nd	Bottom
Design Height Above Ftg	ft =	11.50	Stem OK 3.00	Stem OK 0.00
Wall Material Above "Ht"	=	Fence	Concrete	Concrete
Design Method	=		LRFD	LRFD
Thickness	=		10.00	10.00
Rebar Size	=		# 5	# 5
Rebar Spacing	=		12.00	6.00
Rebar Placed at	=		Edge	Edge
Design Data				
fb/FB + fa/Fa	=		**0.713**	**0.870**
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =		2,544.6	4,422.9
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =		7,789.2	18,114.5
Moment.....Allowable	ft-# =		10,911.3	20,802.0
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =		25.9	45.0
Shear.....Allowable	=		75.0	75.0
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =		8.19	8.19
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =		125.0	125.0
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =		2,500.0	2,500.0
Fy	psi =		60,000.0	60,000.0

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 11'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT5 FW11 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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Cantilevered Retaining Wall

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

Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.22 in2/ft	
(4/3) * As :	0.2933 in2/ft	Min Stem T&S Reinf Area 2.040 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2933 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.5116 in2/ft	
(4/3) * As :	0.6821 in2/ft	Min Stem T&S Reinf Area 0.720 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.5116 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.62 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Footing Data

Toe Width	=	1.67 ft
Heel Width	=	6.17
Total Footing Width	=	7.83
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	2,907	334 psf
Mu' : Upward	=	45,369	13,052 ft-#
Mu' : Downward	=	6,295	23,205 ft-#
Mu: Design	=	3,256	10,153 ft-#
Actual 1-Way Shear	=	21.65	19.75 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = # 4 @ 6.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: #4@ 7.32 in, #5@ 11.35 in, #6@ 16.11 in, #7@ 21.97 in, #8@ 28.93 in, #9@ 36
Key: No key defined

Min footing T&S reinf Area 2.03 in2
Min footing T&S reinf Area per foot 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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 11'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT5 FW11 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)		2,520.0	4.00	10,080.0	Soil Over HL (ab. water tbl)	6,452.5	5.17	33,331.6
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		5.17	33,331.6
Hydrostatic Force					Watre Table			
Buoyant Force	=				Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=				Soil Over Toe	=	0.83	
Seismic Earth Load	=	790.3	6.00	4,741.6	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	1,437.5	2.08	2,993.8
					Earth @ Stem Transitions	=			
					Footing Weight	=	1,174.8	3.92	4,600.5
					Key Weight	=			
					Vert. Component	=			
Total	=	3,310.3	**O.T.M.** =	14,821.6	**Total =**		9,064.8 lbs	**R.M.=**	48,696.4

Resisting/Overturning Ratio = **3.29**
Vertical Loads used for Soil Pressure = 9,064.8 lbs

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

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

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

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)	0.129	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.

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 10'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT6 FW10

Date: 20 SEP 2021

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

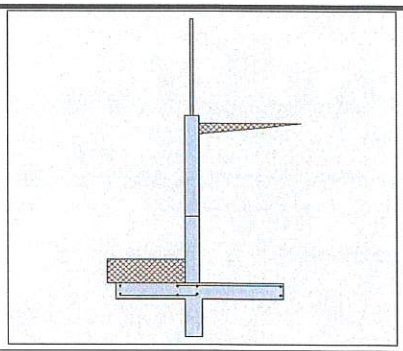
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	11.0 ft

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	425.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

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) (Strength Level)
Wind on Exposed Stem (Strength Level)	=	22.6 psf

Adjacent Footing Load

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

Axial Load Applied to Stem

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

Design Summary

Wall Stability Ratios

Overturning	=	2.63	OK
Sliding	=	1.51	OK
Total Bearing Load	=	9,424 lbs	
...resultant ecc.	=	19.68 in	
Soil Pressure @ Toe	=	1,968 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	2,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,464 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	51.5 psi	OK
Footing Shear @ Heel	=	38.2 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	5,176.2 lbs
less 100% Passive Force	= -	4,964.2 lbs
less 100% Friction Force	= -	2,827.2 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

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

Stem Construction

			3rd	2nd	Bottom
Design Height Above Ftg	ft =		10.50	Stem OK 4.17	Stem OK 0.00
Wall Material Above "Ht"	=		Fence	Concrete	Concrete
Design Method	=			LRFD	LRFD
Thickness	=			10.00	10.00
Rebar Size	=			# 5	# 5
Rebar Spacing	=			12.00	3.00
Rebar Placed at	=			Edge	Edge
Design Data					
fb/FB + fa/Fa	=			**0.682**	**0.716**
Total Force @ Section					
Service Level	lbs =		81.4		
Strength Level	lbs =			2,970.1	7,801.4
Moment....Actual					
Service Level	ft-# =		244.1		
Strength Level	ft-# =			7,444.2	29,079.7
Moment.....Allowable	ft-# =			10,911.3	40,583.3
Shear.....Actual					
Service Level	psi =				
Strength Level	psi =			30.2	79.4
Shear.....Allowable	=			75.0	94.9
Anet (Masonry)	in2 =				
Rebar Depth 'd'	in =			8.19	8.19
Masonry Data					
f'm	psi =				
Fs	psi =				
Solid Grouting	=				
Modular Ratio 'n'	=				
Wall Weight	psf =			125.0	125.0
Short Term Factor	=				
Equiv. Solid Thick.	=				
Masonry Block Type	=		Medium Weight		
Masonry Design Method	=		ASD		
Concrete Data					
f'c	psi =			2,500.0	4,000.0
Fy	psi =			60,000.0	60,000.0

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 10'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT6 FW10

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

RetainPro (c) 1987-2019, Build 11.20.03.31
License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

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

Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.2102 in2/ft	
(4/3) * As :	0.2803 in2/ft	Min Stem T&S Reinf Area 1.519 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2803 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.8212 in2/ft	
(4/3) * As :	1.095 in2/ft	Min Stem T&S Reinf Area 1.001 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.8212 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	1.24 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.7746 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	4.00 ft
Heel Width	=	5.67
Total Footing Width	=	9.67
Footing Thickness	=	12.00 in
Key Width	=	12.00 in
Key Depth	=	28.00 in
Key Distance from Toe	=	4.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	2,464	0 psf
Mu' : Upward	=	203,588	4,582 ft-#
Mu' : Downward	=	36,288	17,516 ft-#
Mu: Design	=	13,942	12,934 ft-#
Actual 1-Way Shear	=	51.52	38.18 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Toe Reinforcing = # 5 @ 6.00 in
Heel Reinforcing = # 4 @ 6.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 6.33 in, #5@ 9.82 in, #6@ 13.94 in, #7@ 19.01 in, #8@ 25.03 in, #9@ 31.
Heel: #4@ 6.31 in, #5@ 9.78 in, #6@ 13.89 in, #7@ 18.94 in, #8@ 24.94 in, #9@ 31.
Key: phiMn = phi'5'lambda'sqrt(fc)'Sm

Min footing T&S reinf Area 2.51 in2
Min footing T&S reinf Area per foot 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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 10'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT6 FW10

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License : KW-06060294
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Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)				20,017.3	Soil Over HL (ab. water tbl)			
HL Act Pres (be water tbl)		1,312.9	3.67	4,813.8	Soil Over HL (bel. water tbl)	3,295.9		
Hydrostatic Force		3,775.2	3.67		Watre Table	3,015.6	7.25	23,894.0
Buoyant Force	=	603.2	4.83		Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=	88.1	14.25	1,256.0	Soil Over Toe	=	2.00	
	=				Surcharge Over Toe	=		
					Stem Weight(s)	=	1,312.5	4.42	5,796.9
					Earth @ Stem Transitions	=		
					Footing Weight	=	1,449.9	4.83	7,007.4
					Key Weight	=	350.0	4.50	1,575.0
					Vert. Component	=			
Total	=	5,779.3	**O.T.M.** =	22,827.2	**Total =**	9,423.9 lbs	**R.M.=**	60,135.2

Resisting/Overturning Ratio = **2.63**
Vertical Loads used for Soil Pressure = 9,423.9 lbs

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

*Includes water table effect

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

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)	0.093	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.

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 10'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT6 FW10 - SEISMIC

Date: 20 SEP 2021

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License : KW-06060294
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Cantilevered Retaining Wall

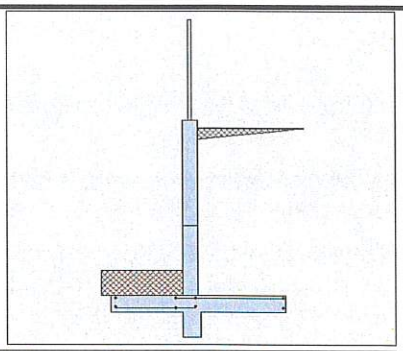
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	11.0 ft

Soil Data

Allow Soil Bearing	=	2,667.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	925.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

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) (Strength Level)
Wind on Exposed Stem (Strength Level)	=	0.0 psf

Adjacent Footing Load

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

Axial Load Applied to Stem

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

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	8.550
(Multiplier used on soil density)		
Uniform Seismic Force	=	94.050
Total Seismic Force	=	1,034.550

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Design Summary

Wall Stability Ratios

Overturning	=	2.33 OK
Sliding	=	1.75 OK
Total Bearing Load	=	9,299 lbs
...resultant ecc.	=	23.41 in
Soil Pressure @ Toe	=	2,151 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,667 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,689 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	55.9 psi OK
Footing Shear @ Heel	=	43.8 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	5,812.2 lbs
less 100% Passive Force	= -	7,400.0 lbs
less 100% Friction Force	= -	2,789.7 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

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

Stem Construction

			3rd	2nd	Bottom
Design Height Above Ftg	ft =		10.50	Stem OK 4.17	Stem OK 0.00
Wall Material Above "Ht"	=		Fence	Concrete	Concrete
Design Method	=			LRFD	LRFD
Thickness	=			10.00	10.00
Rebar Size	=			# 5	# 5
Rebar Spacing	=			12.00	3.00
Rebar Placed at	=			Edge	Edge
Design Data					
fb/FB + fa/Fa	=			**0.706**	**0.784**
Total Force @ Section					
Service Level	lbs =				
Strength Level	lbs =			3,371.6	8,595.0
Moment....Actual					
Service Level	ft-# =				
Strength Level	ft-# =			7,708.7	31,835.7
Moment.....Allowable	ft-# =			10,911.3	40,583.3
Shear.....Actual					
Service Level	psi =				
Strength Level	psi =			34.3	87.5
Shear.....Allowable	=			75.0	94.9
Anet (Masonry)	in2 =				
Rebar Depth 'd'	in =			8.19	8.19
Masonry Data					
f'm	psi =				
Fs	psi =				
Solid Grouting	=				
Modular Ratio 'n'	=				
Wall Weight	psf =			125.0	125.0
Short Term Factor	=				
Equiv. Solid Thick.	=				
Masonry Block Type	=	Medium Weight			
Masonry Design Method	=	ASD			
Concrete Data					
f'c	psi =			2,500.0	4,000.0
Fy	psi =			60,000.0	60,000.0

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 10'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT6 FW10 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

RetainPro (c) 1987-2019, Build 11.20.03.31
License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

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

Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.2177 in2/ft		
(4/3) * As :	0.2903 in2/ft	Min Stem T&S Reinf Area 1.519 in2	
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft	
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.2903 in2/ft	#4@ 10.00 in	#4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in	#5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in	#6@ 44.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing	
As (based on applied moment) :	0.8991 in2/ft		
(4/3) * As :	1.1988 in2/ft	Min Stem T&S Reinf Area 1.001 in2	
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft	
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :	
	==========	One layer of :	Two layers of :
Required Area :	0.8991 in2/ft	#4@ 10.00 in	#4@ 20.00 in
Provided Area :	1.24 in2/ft	#5@ 15.50 in	#5@ 31.00 in
Maximum Area :	1.7746 in2/ft	#6@ 22.00 in	#6@ 44.00 in

Footing Data

Toe Width	=	4.00 ft
Heel Width	=	5.67
Total Footing Width	=	9.67
Footing Thickness	=	12.00 in
Key Width	=	12.00 in
Key Depth	=	18.00 in
Key Distance from Toe	=	4.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel	
Factored Pressure	=	2,689	0	psf
Mu' : Upward	=	218,324	2,874	ft-#
Mu' : Downward	=	36,288	17,516	ft-#
Mu: Design	=	15,170	14,642	ft-#
Actual 1-Way Shear	=	55.93	43.76	psi
Allow 1-Way Shear	=	75.00	75.00	psi

Toe Reinforcing = # 5 @ 6.00 in
Heel Reinforcing = # 4 @ 6.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 5.82 in, #5@ 9.02 in, #6@ 12.81 in, #7@ 17.47 in, #8@ 23.00 in, #9@ 29.
Heel: #4@ 6.31 in, #5@ 9.78 in, #6@ 13.89 in, #7@ 18.94 in, #8@ 24.94 in, #9@ 31.
Key: phiMn = phi'5'lambda'sqrt(fc)'Sm

Min footing T&S reinf Area 2.51 in2
Min footing T&S reinf Area per foot 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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 10'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT6 FW10 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)				20,017.3	Soil Over HL (ab. water tbl)			
HL Act Pres (be water tbl)		1,312.9	3.67	4,813.8	Soil Over HL (bel. water tbl)	3,295.9		
Hydrostatic Force		3,775.2	3.67		Watre Table	3,015.6	7.25	23,894.0
Buoyant Force	=	603.2	4.83		Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=				Soil Over Toe	=	2.00	
Seismic Earth Load	=	724.2	5.50	3,983.0	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	1,312.5	4.42	5,796.9
					Earth @ Stem Transitions	=			
Total	=	6,415.4	**O.T.M.** =	25,554.3	Footing Weight	=	1,449.9	4.83	7,007.4
					Key Weight	=	225.0	4.50	1,012.5
					Vert. Component	=			
					Total =		9,298.9 lbs	**R.M.=**	59,572.7

Resisting/Overturning Ratio = 2.33
Vertical Loads used for Soil Pressure = 9,298.9 lbs

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

*Includes water table effect

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

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

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)	0.102	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.

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 10'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT6 FW10

Date: 20 SEP 2021

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

Cantilevered Retaining Wall

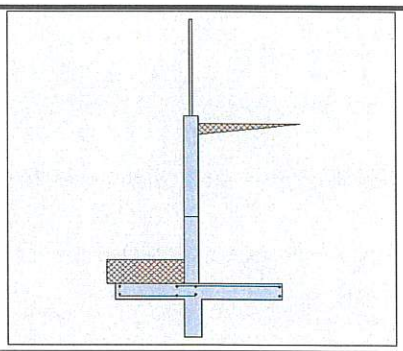
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	11.0 ft

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	425.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

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) (Strength Level)
Wind on Exposed Stem (Strength Level)	=	22.6 psf

Adjacent Footing Load

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

Axial Load Applied to Stem

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

Design Summary

Wall Stability Ratios

Overturning	=	2.63 OK
Sliding	=	1.51 OK
Total Bearing Load	=	9,424 lbs
...resultant ecc.	=	19.68 in
Soil Pressure @ Toe	=	1,968 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,464 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	51.5 psi OK
Footing Shear @ Heel	=	38.2 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	5,176.2 lbs
less 100% Passive Force	= -	4,964.2 lbs
less 100% Friction Force	= -	2,827.2 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

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

Stem Construction

			3rd	2nd	Bottom
Design Height Above Ftg	ft =		10.50	Stem OK 4.17	Stem OK 0.00
Wall Material Above "Ht"	=		Fence	Concrete	Concrete
Design Method	=			LRFD	LRFD
Thickness	=			10.00	10.00
Rebar Size	=			# 5	# 7
Rebar Spacing	=			12.00	6.00
Rebar Placed at	=			Edge	Edge
Design Data					
fb/FB + fa/Fa	=			**0.682**	**0.806**
Total Force @ Section					
Service Level	lbs =		81.4		
Strength Level	lbs =			2,970.1	7,801.4
Moment....Actual					
Service Level	ft-# =		244.1		
Strength Level	ft-# =			7,444.2	29,079.7
Moment.....Allowable	ft-# =			10,911.3	36,058.5
Shear.....Actual					
Service Level	psi =				
Strength Level	psi =			30.2	86.0
Shear.....Allowable	=			75.0	94.9
Anet (Masonry)	in2 =				
Rebar Depth 'd'	in =			8.19	7.56
Masonry Data					
f'm	psi =				
Fs	psi =				
Solid Grouting	=				
Modular Ratio 'n'	=				
Wall Weight	psf =			125.0	125.0
Short Term Factor	=				
Equiv. Solid Thick.	=				
Masonry Block Type	=		Medium Weight		
Masonry Design Method	=		ASD		
Concrete Data					
f'c	psi =			2,500.0	4,000.0
Fy	psi =			60,000.0	60,000.0

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 10'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT6 FW10

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

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

Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.2102 in2/ft	
(4/3) * As :	0.2803 in2/ft	Min Stem T&S Reinf Area 1.519 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2803 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.8921 in2/ft	
(4/3) * As :	1.1895 in2/ft	Min Stem T&S Reinf Area 1.001 in2
200bd/fy : 200(12)(7.5625)/60000 :	0.3025 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.8921 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	1.2 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.6392 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	4.00 ft
Heel Width	=	5.67
Total Footing Width	=	9.67
Footing Thickness	=	12.00 in
Key Width	=	12.00 in
Key Depth	=	28.00 in
Key Distance from Toe	=	4.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	2,464	0 psf
Mu' : Upward	=	203,588	4,582 ft-#
Mu' : Downward	=	36,288	17,516 ft-#
Mu: Design	=	13,942	12,934 ft-#
Actual 1-Way Shear	=	51.52	38.18 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Toe Reinforcing = # 5 @ 6.00 in
Heel Reinforcing = # 4 @ 6.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 6.33 in, #5@ 9.82 in, #6@ 13.94 in, #7@ 19.01 in, #8@ 25.03 in, #9@ 31.
Heel: #4@ 6.31 in, #5@ 9.78 in, #6@ 13.89 in, #7@ 18.94 in, #8@ 24.94 in, #9@ 31.
Key: phiMn = phi'5'lambda'sqrt(fc)'Sm

Min footing T&S reinf Area 2.51 in2
Min footing T&S reinf Area per foot 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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 10'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT6 FW10

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)				20,017.3	Soil Over HL (ab. water tbl)			
HL Act Pres (be water tbl)		1,312.9	3.67	4,813.8	Soil Over HL (bel. water tbl)	3,295.9		
Hydrostatic Force		3,775.2	3.67		Watre Table	3,015.6	7.25	23,894.0
Buoyant Force	=	603.2	4.83		Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
Surcharge Over Toe	=				Adjacent Footing Load =			
Adjacent Footing Load	=				Axial Dead Load on Stem =			
Added Lateral Load	=				* Axial Live Load on Stem =			
Load @ Stem Above Soil	=	88.1	14.25	1,256.0	Soil Over Toe =		2.00	
	=				Surcharge Over Toe =			
					Stem Weight(s) =	1,312.5	4.42	5,796.9
					Earth @ Stem Transitions =			
Total	=	5,779.3	O.T.M. =	22,827.2	Footing Weight =	1,449.9	4.83	7,007.4
					Key Weight =	350.0	4.50	1,575.0
					Vert. Component =			
					Total =	9,423.9 lbs	R.M.=	60,135.2

Resisting/Overturning Ratio = 2.63
Vertical Loads used for Soil Pressure = 9,423.9 lbs

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

*Includes water table effect

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

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)	0.093	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.

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 10'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT6 FW10 - SEISMIC

Date: 20 SEP 2021

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

Cantilevered Retaining Wall

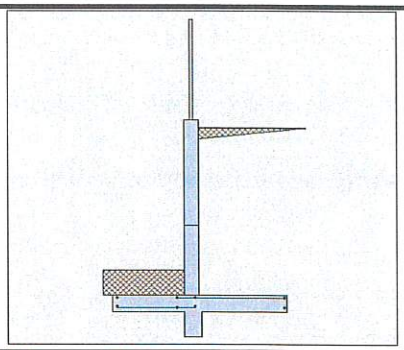
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	10.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	11.0 ft

Soil Data

Allow Soil Bearing	=	2,667.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	925.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

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) (Strength Level)
Wind on Exposed Stem (Strength Level)	=	0.0 psf

Adjacent Footing Load

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

Axial Load Applied to Stem

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

Earth Pressure Seismic Load

Method : Uniform
Multiplier Used = 8.550
(Multiplier used on soil density)

Uniform Seismic Force = 94.050
Total Seismic Force = 1,034.550

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
REGISTERED PROFESSIONAL ENGINEER
10-13-21

Design Summary

Wall Stability Ratios

Overturning	=	2.33 OK
Sliding	=	1.75 OK
Total Bearing Load	=	9,299 lbs
...resultant ecc.	=	23.41 in
Soil Pressure @ Toe	=	2,151 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,667 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,689 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	55.9 psi OK
Footing Shear @ Heel	=	43.8 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	5,812.2 lbs
less 100% Passive Force	= -	7,400.0 lbs
less 100% Friction Force	= -	2,789.7 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

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

Stem Construction

		3rd	2nd	Bottom
Design Height Above Ftg	ft =	10.50	Stem OK 4.17	Stem OK 0.00
Wall Material Above "Ht"	=	Fence	Concrete	Concrete
Design Method	=		LRFD	LRFD
Thickness	=		10.00	10.00
Rebar Size	=		# 5	# 7
Rebar Spacing	=		12.00	6.00
Rebar Placed at	=		Edge	Edge
Design Data				
fb/FB + fa/Fa	=		**0.706**	**0.882**
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =		3,371.6	8,595.0
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =		7,708.7	31,835.7
Moment.....Allowable	ft-# =		10,911.3	36,058.5
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =		34.3	94.7
Shear.....Allowable	=		75.0	94.9
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =		8.19	7.56
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =		125.0	125.0
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =		2,500.0	4,000.0
Fy	psi =		60,000.0	60,000.0

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 10'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT6 FW10 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

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

Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.2177 in2/ft	
(4/3) * As :	0.2903 in2/ft	Min Stem T&S Reinf Area 1.519 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.2903 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.9767 in2/ft	
(4/3) * As :	1.3022 in2/ft	Min Stem T&S Reinf Area 1.001 in2
200bd/fy : 200(12)(7.5625)/60000 :	0.3025 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.9767 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	1.2 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.6392 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	4.00 ft
Heel Width	=	5.67
Total Footing Width	=	9.67
Footing Thickness	=	12.00 in
Key Width	=	12.00 in
Key Depth	=	18.00 in
Key Distance from Toe	=	4.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	2,689	0 psf
Mu' : Upward	=	218,324	2,874 ft-#
Mu' : Downward	=	36,288	17,516 ft-#
Mu: Design	=	15,170	14,642 ft-#
Actual 1-Way Shear	=	55.93	43.76 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Toe Reinforcing = # 5 @ 6.00 in
Heel Reinforcing = # 4 @ 6.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 5.82 in, #5@ 9.02 in, #6@ 12.81 in, #7@ 17.47 in, #8@ 23.00 in, #9@ 29.
Heel: #4@ 6.31 in, #5@ 9.78 in, #6@ 13.89 in, #7@ 18.94 in, #8@ 24.94 in, #9@ 31.
Key: phiMn = phi'5'lambda'sqrt(fc)'Sm

Min footing T&S reinf Area 2.51 in2
Min footing T&S reinf Area per foot 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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 10'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT6 FW10 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)				20,017.3	Soil Over HL (ab. water tbl)			
HL Act Pres (be water tbl)		1,312.9	3.67	4,813.8	Soil Over HL (bel. water tbl)	3,295.9		
Hydrostatic Force		3,775.2	3.67		Watre Table	3,015.6	7.25	23,894.0
Buoyant Force	=	603.2	4.83		Sloped Soil Over Heel =			
Surcharge over Heel	=				Surcharge Over Heel =			
Surcharge Over Toe	=				Adjacent Footing Load =			
Adjacent Footing Load	=				Axial Dead Load on Stem =			
Added Lateral Load	=				* Axial Live Load on Stem =			
Load @ Stem Above Soil	=				Soil Over Toe =		2.00	
Seismic Earth Load	=	724.2	5.50	3,983.0	Surcharge Over Toe =			
	=				Stem Weight(s) =	1,312.5	4.42	5,796.9
					Earth @ Stem Transitions =			
Total	=	6,415.4	**O.T.M.** =	25,554.3	Footing Weight =	1,449.9	4.83	7,007.4
					Key Weight =	225.0	4.50	1,012.5
					Vert. Component =			
					Total =	9,298.9 lbs	**R.M.=**	59,572.7

Resisting/Overturning Ratio = **2.33**
Vertical Loads used for Soil Pressure = 9,298.9 lbs

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

*If seismic is included, the OTM and sliding ratios may be 1.1 per section 1807.2.3 of IBC. Includes water table effect

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

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)	0.102	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.

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 7'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT4 FW7

Date: 20 SEP 2021

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Cantilevered Retaining Wall

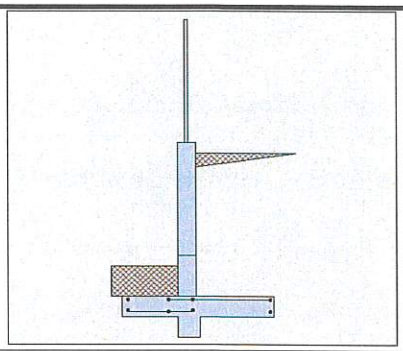
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	7.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	8.0 ft

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	425.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

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) (Strength Level)
Wind on Exposed Stem (Strength Level)	=	22.6 psf

Adjacent Footing Load

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

Axial Load Applied to Stem

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

Design Summary

Wall Stability Ratios

Overturning	=	2.38	OK
Sliding	=	1.51	OK
Total Bearing Load	=	5,312 lbs	
...resultant ecc.	=	16.69 in	
Soil Pressure @ Toe	=	1,748 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	2,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	2,215 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	25.4 psi	OK
Footing Shear @ Heel	=	21.9 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	2,779.3 lbs
less 100% Passive Force	= -	2,603.1 lbs
less 100% Friction Force	= -	1,593.6 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

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

Stem Construction

			3rd	2nd	Bottom
Design Height Above Ftg	ft =		7.50	Stem OK 2.00	Stem OK 0.00
Wall Material Above "Ht"	=		Fence	Concrete	Concrete
Design Method	=			LRFD	LRFD
Thickness	=			10.00	10.00
Rebar Size	=			# 5	# 5
Rebar Spacing	=			12.00	6.00
Rebar Placed at	=			Edge	Edge
Design Data					
fb/FB + fa/Fa	=			**0.482**	**0.555**
Total Force @ Section					
Service Level	lbs =		81.4		
Strength Level	lbs =			2,291.2	4,086.6
Moment....Actual					
Service Level	ft-# =		244.1		
Strength Level	ft-# =			5,267.2	11,554.2
Moment.....Allowable	ft-# =			10,911.3	20,802.0
Shear.....Actual					
Service Level	psi =				
Strength Level	psi =			23.3	41.6
Shear.....Allowable	=			75.0	75.0
Anet (Masonry)	in2 =				
Rebar Depth 'd'	in =			8.19	8.19
Masonry Data					
f'm	psi =				
Fs	psi =				
Solid Grouting	=				
Modular Ratio 'n'	=				
Wall Weight	psf =			125.0	125.0
Short Term Factor	=				
Equiv. Solid Thick.	=				
Masonry Block Type	=		Medium Weight		
Masonry Design Method	=		ASD		
Concrete Data					
f'c	psi =			2,500.0	2,500.0
Fy	psi =			60,000.0	60,000.0

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 7'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT4 FW7

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

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

Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.1488 in2/ft	
(4/3) * As :	0.1983 in2/ft	Min Stem T&S Reinf Area 1.320 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.216 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.3263 in2/ft	
(4/3) * As :	0.4351 in2/ft	Min Stem T&S Reinf Area 0.480 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.3275 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.62 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	2.50 ft
Heel Width	=	4.33
Total Footing Width	=	6.83
Footing Thickness	=	12.00 in
Key Width	=	12.00 in
Key Depth	=	12.00 in
Key Distance from Toe	=	2.50 ft

f'c = 2,500 psi Fy = 75,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	2,215	0 psf
Mu' : Upward	=	71,675	1,254 ft-#
Mu' : Downward	=	14,175	6,761 ft-#
Mu: Design	=	4,792	5,507 ft-#
Actual 1-Way Shear	=	25.37	21.86 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = # 5 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Key: phiMn = phi'5'lambda'sqrt(fc)'Sm

Min footing T&S reinf Area 1.77 in2
Min footing T&S reinf Area per foot 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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 7'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT4 FW7

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)				8,155.9	Soil Over HL (ab. water tbl)			
HL Act Pres (be water tbl)		694.4	2.67	1,851.7	Soil Over HL (bel. water tbl)	1,670.7		
Hydrostatic Force		1,996.8	2.67		Watre Table	1,528.7	5.08	8,492.7
Buoyant Force	=	426.4	3.42		Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=	88.1	11.25	991.6	Soil Over Toe	=	1.25	
	=				Surcharge Over Toe	=		
					Stem Weight(s)	=	937.5	2.92	2,734.4
					Earth @ Stem Transitions	=		
					Footing Weight	=	1,025.0	3.42	3,501.7
					Key Weight	=	150.0	3.00	450.0
					Vert. Component	=			
Total	=	3,205.7	**O.T.M.** =	9,624.8	**Total =**	5,311.8 lbs	**R.M.=**	22,949.2

Resisting/Overturning Ratio = **2.38**
Vertical Loads used for Soil Pressure = 5,311.8 lbs

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

*Includes water table effect

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

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)	0.096	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.

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 7'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT4 FW7 - SEISMIC

Date: 20 SEP 2021

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

Cantilevered Retaining Wall

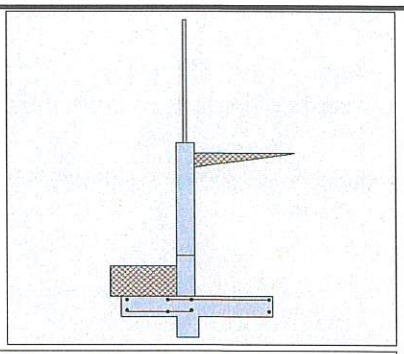
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	7.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	8.0 ft

Soil Data

Allow Soil Bearing	=	2,667.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	925.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

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) (Strength Level)
Wind on Exposed Stem (Strength Level)	=	0.0 psf

Adjacent Footing Load

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

Axial Load Applied to Stem

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

Earth Pressure Seismic Load

Method : Uniform
Multiplier Used = 11.750
(Multiplier used on soil density)

Uniform Seismic Force = 94.000
Total Seismic Force = 752.000

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Design Summary

Wall Stability Ratios

Overturning	=	2.14 OK
Sliding	=	2.26 OK
Total Bearing Load	=	5,312 lbs
...resultant ecc.	=	19.21 in
Soil Pressure @ Toe	=	1,950 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,667 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,471 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	28.5 psi OK
Footing Shear @ Heel	=	25.0 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	3,217.6 lbs
less 100% Passive Force	= -	5,665.6 lbs
less 100% Friction Force	= -	1,593.6 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

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

Stem Construction

		3rd	2nd	Bottom
Design Height Above Ftg	ft =	7.50	Stem OK 2.00	Stem OK 0.00
Wall Material Above "Ht"	=	Fence	Concrete	Concrete
Design Method	=		LRFD	LRFD
Thickness	=		10.00	10.00
Rebar Size	=		# 5	# 5
Rebar Spacing	=		12.00	6.00
Rebar Placed at	=		Edge	Edge
Design Data				
fb/FB + fa/Fa	=		**0.479**	**0.593**
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =		2,614.3	4,597.7
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =		5,230.3	12,351.5
Moment.....Allowable	ft-# =		10,911.3	20,802.0
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =		26.6	46.8
Shear.....Allowable	=		75.0	75.0
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =		8.19	8.19
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =		125.0	125.0
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =		2,500.0	2,500.0
Fy	psi =		60,000.0	60,000.0

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 7'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT4 FW7 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License : KW-06060294
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Cantilevered Retaining Wall

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

Concrete Stem Rebar Area Details

2nd Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.1477 in2/ft	
(4/3) * As :	0.1969 in2/ft	Min Stem T&S Reinf Area 1.320 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.216 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.3488 in2/ft	
(4/3) * As :	0.4651 in2/ft	Min Stem T&S Reinf Area 0.480 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.3488 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.62 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	2.50 ft
Heel Width	=	4.33
Total Footing Width	=	6.83
Footing Thickness	=	12.00 in
Key Width	=	12.00 in
Key Depth	=	12.00 in
Key Distance from Toe	=	2.50 ft

f'c = 2,500 psi Fy = 75,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	2,471	0 psf
Mu' : Upward	=	78,486	714 ft-#
Mu' : Downward	=	14,175	6,761 ft-#
Mu: Design	=	5,359	6,046 ft-#
Actual 1-Way Shear	=	28.47	25.00 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = # 5 @ 12.00 in
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Key: phiMn = phi'5'lambda'sqrt(fc)'Sm

Min footing T&S reinf Area 1.77 in2
Min footing T&S reinf Area per foot 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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 7'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT4 FW7 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)				8,155.9	Soil Over HL (ab. water tbl)			
HL Act Pres (be water tbl)		694.4	2.67	1,851.7	Soil Over HL (bel. water tbl)	1,670.7		
Hydrostatic Force		1,996.8	2.67		Watre Table	1,528.7	5.08	8,492.7
Buoyant Force	=	426.4	3.42		Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=				Soil Over Toe	=	1.25	
Seismic Earth Load	=	526.4	4.00	2,105.6	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	937.5	2.92	2,734.4
					Earth @ Stem Transitions	=		
					Footing Weight	=	1,025.0	3.42	3,501.7
					Key Weight	=	150.0	3.00	450.0
					Vert. Component	=			
Total	=	3,644.0	**O.T.M.** =	10,738.9	**Total =**	5,311.8 lbs	**R.M.=**	22,949.2

Resisting/Overturning Ratio = **2.14**
Vertical Loads used for Soil Pressure = 5,311.8 lbs

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

* Includes water table effect

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

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

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)	0.107	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.

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 4'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT2 FW4

Date: 20 SEP 2021

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

Cantilevered Retaining Wall

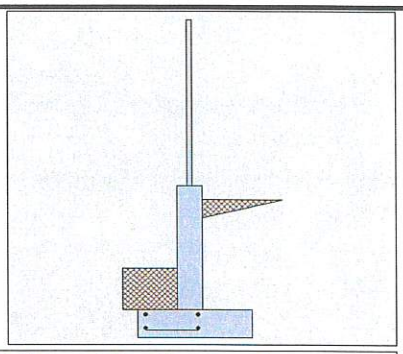
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	5.0 ft

Soil Data

Allow Soil Bearing	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	425.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

Axial Load Applied to Stem

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

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) (Strength Level)
Wind on Exposed Stem (Strength Level)	=	22.6 psf

Adjacent Footing Load

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

Design Summary

Wall Stability Ratios

Overturning	=	1.60 OK
Sliding	=	1.69 OK
Total Bearing Load	=	2,008 lbs
...resultant ecc.	=	14.94 in
Soil Pressure @ Toe	=	1,994 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,601 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	10.7 psi OK
Footing Shear @ Heel	=	9.8 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	1,139.4 lbs
less 100% Passive Force	=	- 1,328.1 lbs
less 100% Friction Force	=	- 602.4 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

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

Stem Construction

		2nd	Bottom	
			Stem OK	
Design Height Above Ftg	ft =	4.50	0.00	
Wall Material Above "Ht"	=	Fence	Concrete	
Design Method	=		LRFD	LRFD
Thickness	=		10.00	
Rebar Size	=		# 5	
Rebar Spacing	=		12.00	
Rebar Placed at	=		Edge	
Design Data				
fb/FB + fa/Fa	=		0.305	
Total Force @ Section				
Service Level	lbs =	81.4		
Strength Level	lbs =		1,597.9	
Moment....Actual				
Service Level	ft-# =	244.1		
Strength Level	ft-# =		3,334.0	
Moment.....Allowable	ft-# =		10,911.3	
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =		16.3	
Shear.....Allowable	=		75.0	
Anet (Masonry)	in2 =			
Rebar Depth 'd'	in =		8.19	
Masonry Data				
f'm	psi =			
Fs	psi =			
Solid Grouting	=			
Modular Ratio 'n'	=			
Wall Weight	psf =		125.0	
Short Term Factor	=			
Equiv. Solid Thick.	=			
Masonry Block Type	=	Medium Weight		
Masonry Design Method	=	ASD		
Concrete Data				
f'c	psi =		2,500.0	
Fy	psi =		60,000.0	

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 4'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT2 FW4

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License : KW-06060294
License To : LEI Engineers and Surveyors

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) :	0.0942 in2/ft	
(4/3) * As :	0.1255 in2/ft	Min Stem T&S Reinf Area 1.080 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.216 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Footing Data

Toe Width	=	1.33 ft
Heel Width	=	2.50
Total Footing Width	=	3.83
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	2,601	0 psf
Mu' : Upward	=	21,610	0 ft-#
Mu' : Downward	=	4,030	983 ft-#
Mu: Design	=	1,465	983 ft-#
Actual 1-Way Shear	=	10.74	9.83 psi
Allow 1-Way Shear	=	75.00	40.00 psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: No key defined

Min footing T&S reinf Area 0.99 in2
Min footing T&S reinf Area per foot 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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 4'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT2 FW4

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

RetainPro (c) 1987-2019, Build 11.20.03.31
License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)				2,260.8	Soil Over HL (ab. water tbl)			
HL Act Pres (be water tbl)		271.3	1.67	452.1	Soil Over HL (bel. water tbl)	454.7		
Hydrostatic Force		780.0	1.67		Watre Table	416.0	3.00	1,363.8
Buoyant Force	=	239.2	1.92		Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=	88.1	8.25	727.2	Soil Over Toe	=	0.67	
	=				Surcharge Over Toe	=		
					Stem Weight(s)	=	562.5	1.75	984.2
					Earth @ Stem Transitions	=		
					Footing Weight	=	575.0	1.92	1,101.9
					Key Weight	=		
					Vert. Component	=		
Total	=	1,378.6	**O.T.M.** =	2,937.6	**Total =**	2,008.1 lbs	**R.M.=**	4,697.8

Resisting/Overturning Ratio = **1.60**
Vertical Loads used for Soil Pressure = 2,008.1 lbs

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

*Includes water table effect

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

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)	0.152	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.

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 4'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT2 FW4 - SEISMIC

Date: 20 SEP 2021

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

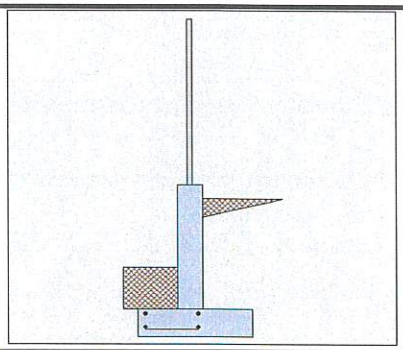
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	6.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	18.00 in
Water height over heel	=	5.0 ft

Soil Data

Allow Soil Bearing	=	2,667.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	925.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	0.00 pcf
Footing||Soil Friction	=	0.300
Soil height to ignore for passive pressure	=	0.00 in



Surcharge Loads

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

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) (Strength Level)
Wind on Exposed Stem (Strength Level)	=	0.0 psf

Adjacent Footing Load

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

Axial Load Applied to Stem

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

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	18.800
(Multiplier used on soil density)		
Uniform Seismic Force	=	94.000
Total Seismic Force	=	470.000

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

Design Summary

Wall Stability Ratios

Overturning	=	1.55 OK
Sliding	=	2.53 OK
Total Bearing Load	=	2,008 lbs
...resultant ecc.	=	15.51 in
Soil Pressure @ Toe	=	2,146 psf OK
Soil Pressure @ Heel	=	0 psf OK
Allowable	=	2,667 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,799 psf
ACI Factored @ Heel	=	0 psf
Footing Shear @ Toe	=	11.6 psi OK
Footing Shear @ Heel	=	9.8 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	1,380.3 lbs
less 100% Passive Force	= -	2,890.6 lbs
less 100% Friction Force	= -	602.4 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

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

Stem Construction

		2nd	Bottom
			Stem OK
Design Height Above Ftg	ft =	4.50	0.00
Wall Material Above "Ht"	=	Fence	Concrete
Design Method	=		LRFD
Thickness	=		10.00
Rebar Size	=		# 5
Rebar Spacing	=		12.00
Rebar Placed at	=		Edge
Design Data			
fb/FB + fa/Fa	=		**0.276**
Total Force @ Section			
Service Level	lbs =		
Strength Level	lbs =		1,827.0
Moment....Actual			
Service Level	ft-# =		
Strength Level	ft-# =		3,021.0
Moment.....Allowable	ft-# =		10,911.3
Shear.....Actual			
Service Level	psi =		
Strength Level	psi =		18.6
Shear.....Allowable	=		75.0
Anet (Masonry)	in2 =		
Rebar Depth 'd'	in =		8.19
Masonry Data			
f'm	psi =		
Fs	psi =		
Solid Grouting	=		
Modular Ratio 'n'	=		
Wall Weight	psf =		125.0
Short Term Factor	=		
Equiv. Solid Thick.	=		
Masonry Block Type	=	Medium Weight	
Masonry Design Method	=	ASD	
Concrete Data			
f'c	psi =		2,500.0
Fy	psi =		60,000.0

LRFD

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 4'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT2 FW4 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License : KW-06060294
License To : LEI Engineers and Surveyors

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) :	0.0853 in2/ft	
(4/3) * As :	0.1138 in2/ft	Min Stem T&S Reinf Area 1.080 in2
200bd/fy : 200(12)(8.1875)/60000 :	0.3275 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.240 in2/ft
0.0018bh : 0.0018(12)(10) :	0.216 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.216 in2/ft	#4@ 10.00 in #4@ 20.00 in
Provided Area :	0.31 in2/ft	#5@ 15.50 in #5@ 31.00 in
Maximum Area :	1.1092 in2/ft	#6@ 22.00 in #6@ 44.00 in

Footing Data

Toe Width	=	1.33 ft
Heel Width	=	2.50
Total Footing Width	=	3.83
Footing Thickness	=	12.00 in
Key Width	=	0.00 in
Key Depth	=	0.00 in
Key Distance from Toe	=	0.00 ft

f'c = 2,500 psi Fy = 60,000 psi
Footing Concrete Density = 150.00 pcf
Min. As % = 0.0018
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	2,799	0 psf
Mu' : Upward	=	22,754	0 ft-#
Mu' : Downward	=	4,030	983 ft-#
Mu: Design	=	1,560	983 ft-#
Actual 1-Way Shear	=	11.56	9.83 psi
Allow 1-Way Shear	=	75.00	40.00 psi

Toe Reinforcing = # 5 @ 12.00 in
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd
Footing Torsion, Tu = 0.00 ft-lbs
Footing Allow. Torsion, phi Tu = 0.00 ft-lbs

If torsion exceeds allowable, provide supplemental design for footing torsion.

Other Acceptable Sizes & Spacings

Toe: #4@ 9.25 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.77 in, #8@ 36.57 in, #9@ 46
Heel: phiMn = phi'5'lambda'sqrt(fc)'Sm
Key: No key defined

Min footing T&S reinf Area 0.99 in2
Min footing T&S reinf Area per foot 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

Jared Palfreyman
LEI Engineers and Surveyors, Inc
3302 N. Main St
Spanish Fork, UT 84660
801-798-0555

Project Name/Number : 2021-2576
Title 4'-0" RETAINING WALL
Dsgnr: JMW
Description....
FT2 FW4 - SEISMIC

This Wall in File: T:\Structural\2021 Structural Jobs\2021-2576_LHH Lighthouse Heights Retaining Wal

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License : KW-06060294
License To : LEI Engineers and Surveyors

Cantilevered Retaining Wall

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

Summary of Overturning & Resisting Forces & Moments

Item		.....OVERTURNING..... Force lbs	Distance ft	Moment ft-#		.....RESISTING..... Force lbs	Distance ft	Moment ft-#
HL Act Pres (ab water tbl)				2,260.8	Soil Over HL (ab. water tbl)			
HL Act Pres (be water tbl)		271.3	1.67	452.1	Soil Over HL (bel. water tbl)	454.7		
Hydrostatic Force		780.0	1.67		Watre Table	416.0	3.00	1,363.8
Buoyant Force	=	239.2	1.92		Sloped Soil Over Heel	=		
Surcharge over Heel	=				Surcharge Over Heel	=		
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	=		
Added Lateral Load	=				* Axial Live Load on Stem	=		
Load @ Stem Above Soil	=				Soil Over Toe	=	0.67	
Seismic Earth Load	=	329.0	2.50	822.5	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	562.5	1.75	984.2
					Earth @ Stem Transitions	=		
					Footing Weight	=	575.0	1.92	1,101.9
					Key Weight	=		
					Vert. Component	=		
Total	=	1,619.4	**O.T.M.** =	3,033.0	**Total =**	2,008.1 lbs	**R.M.=**	4,697.8

Resisting/Overturning Ratio = **1.55**
Vertical Loads used for Soil Pressure = 2,008.1 lbs

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

*Includes water table effect

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

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS NOT considered in the calculation of Overturning Resistance.

STATE OF UTAH
JARED R. PALFREYMAN
No. 7942895-2202
10-13-21
REGISTERED PROFESSIONAL ENGINEER

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)	0.163	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.