STRUCTURAL CALCULATIONS

PRIVATE PERMANENT CONTROL MEASURE

RETAINING WALL

Project Location: **6855 CONSTITUTION AVE.**
COLORADO SPRINGS, CO 80915

Project No.: **JDA002**

PREPARED FOR:
JOHNSON DEVELOPMENT ASSOCIATES

PREPARED BY:
Galloway & Company, Inc.
6162 S. Willow Drive, Suite 320
Greenwood Village, CO 80126

DATE:
DECEMBER 22, 2022

TABLE OF CONTENTS

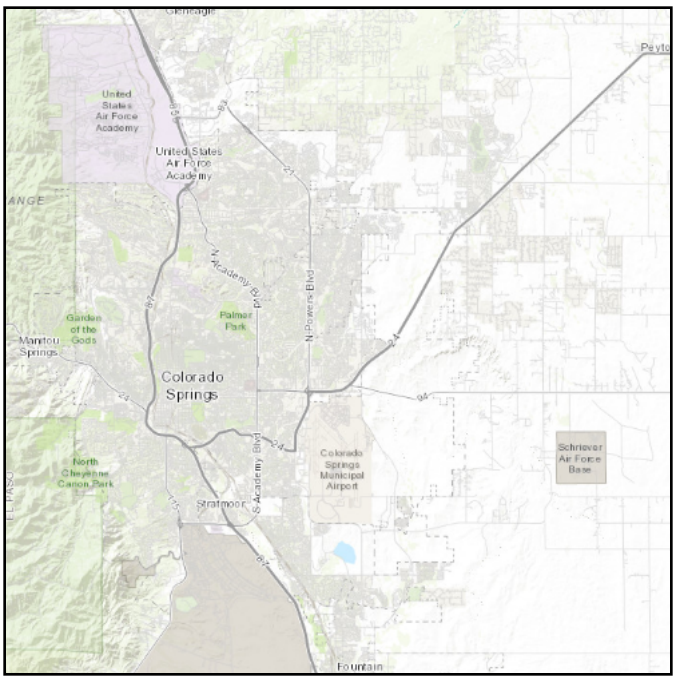
LOCAL INFORMATION

ASCE 7 Hazards Report

Address:
6855 Constitution Ave
Colorado Springs, Colorado
80915

Standard: ASCE/SEI 7-16
Risk Category: II
Soil Class: D - Default (see Section 11.4.3)

Elevation: 6523.78 ft (NAVD 88)
Latitude: 38.867308
Longitude: -104.699718



Wind

Results:

use AHJ

Wind Speed	106 Vmph
10-year MRI	77 Vmph
25-year MRI	84 Vmph
50-year MRI	88 Vmph
100-year MRI	93 Vmph

WIND LOADS

Basic wind speed

Category I/II: 130 mph (V_{ult})

Category III/IV: 140 mph (V_{ult})

Exposure category Exposure C required

Data Source: ASCE/SEI 7-16, Fig. 26.5-1B and Figs. CC.2-1–CC.2-4, and Section 26.5.2

Date Accessed: Tue Oct 25 2022

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-16 Standard. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (annual exceedance probability = 0.00143, MRI = 700 years).

Site is not in a hurricane-prone region as defined in ASCE/SEI 7-16 Section 26.2.

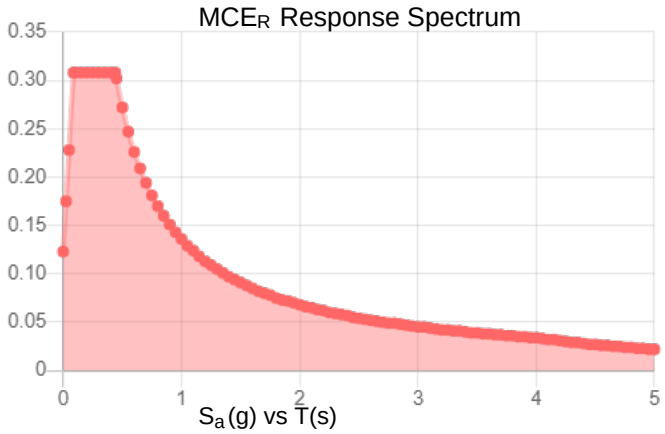
Seismic

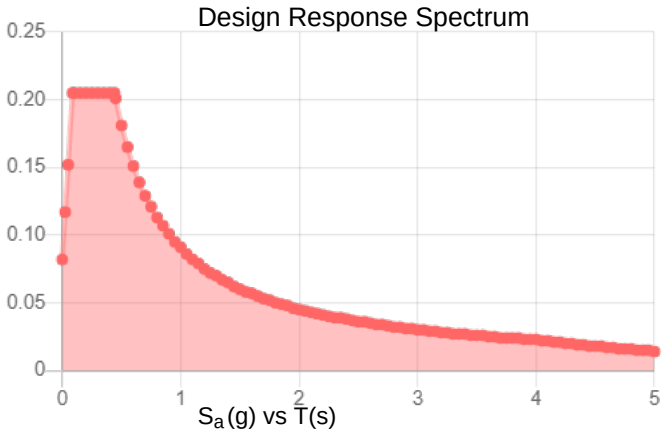
Site Soil Class: D - Default (see Section 11.4.3)

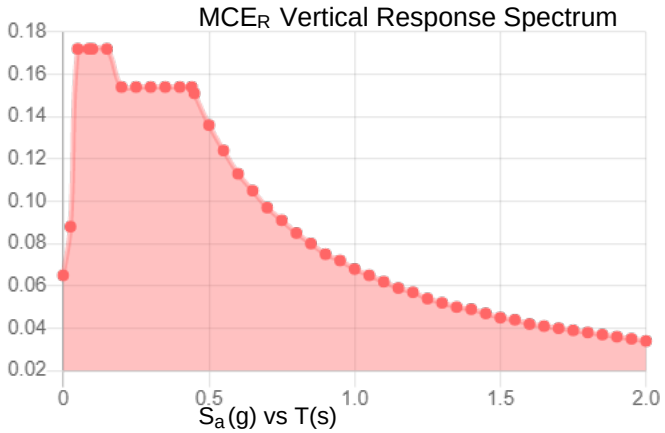
Results:

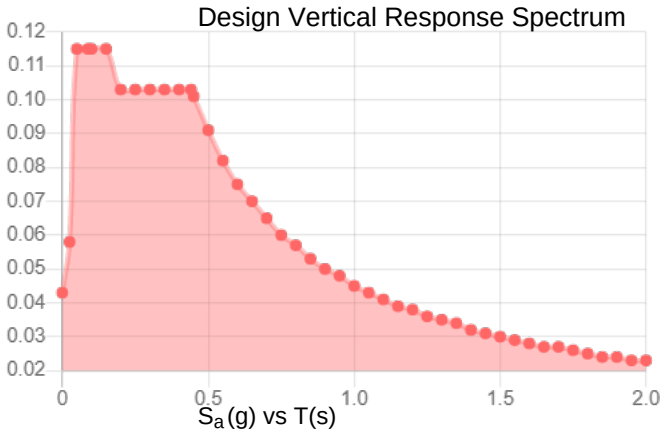
S_S :	0.192	S_{D1} :	0.091
S_1 :	0.057	T_L :	4
F_a :	1.6	PGA :	0.105
F_v :	2.4	PGA_M :	0.166
S_{MS} :	0.308	F_{PGA} :	1.591
S_{M1} :	0.136	I_e :	1
S_{DS} :	0.205	C_v :	0.7

Seismic Design Category B









Data Accessed: Tue Oct 25 2022

Date Source:

USGS Seismic Design Maps based on ASCE/SEI 7-16 and ASCE/SEI 7-16 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-16 Ch. 21 are available from USGS.

Snow

Results:

Elevation:

Data Source:

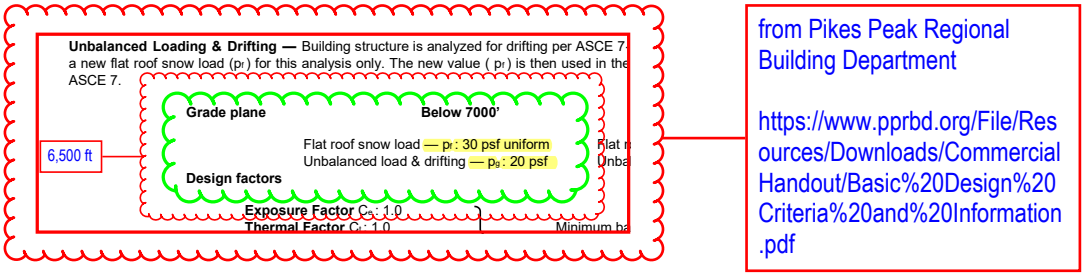
Date Accessed: Tue Oct 25 2022

In "Case Study" areas, site-specific case studies are required to establish ground snow loads. Extreme local variations in ground snow loads in these areas preclude mapping at this scale.

Ground snow load determination for such sites shall be based on an extreme value statistical analysis of data available in the vicinity of the site using a value with a 2 percent annual probability of being exceeded (50-year mean recurrence interval).

Site is outside ASCE/SEI 7-16, Table 7.2-2 boundaries. For ground snow loads in this area, see SEAC Snow Load Committee. (2016). Colorado Design Snow Loads, Structural Engineers Association of Colorado.

Statutory requirements of the Authority Having Jurisdiction are not included.



BASIC DESIGN INFORMATION

CODES

Jurisdictions served by Pikes Peak Regional Building Code have adopted the following codes:

2017 Pikes Peak Regional Building Code (PPRBC)

2015 International Building Code (IBC)

2015 International Existing Building Code (IEBC)

2015 International Energy Conservation Code (IECC)

2015 International Mechanical Code (IMC)

2015 International Fuel Gas Code (IFGC)

2018 International Plumbing Code (IPC)

2020 National Electrical Code (NEC)

2009 ICC/ANSI A117.1 Accessibility Standard

ASME A17.1, 2013 Edition, Safety Code for Elevators & Escalators

ASME A17.3, 2011 Edition, Safety Code for Existing Elevators & Escalators

The International Fire Code and amendments are adopted by the Fire authority. Plans are reviewed for compliance by the Zoning and Fire authorities. Contact those agencies directly for plan submittal requirements (see page 7).

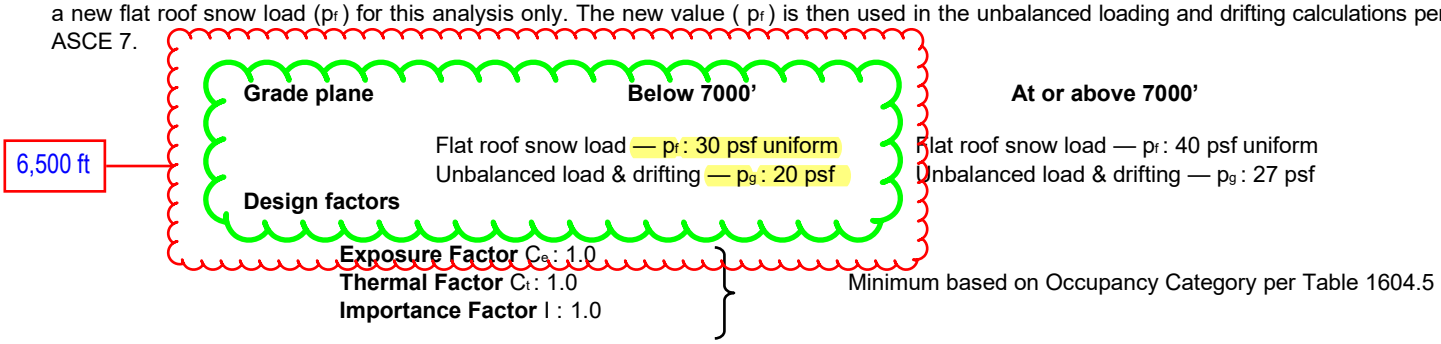
The following criteria must be included on contact documents:

SNOW LOADS

Grade Plane — Average elevation of finished ground level adjacent to the building at exterior walls.

Flat Roof Snow Load — Building structure is designed for the specified uniform snow load, and cannot act concurrently with unbalance loading and drifting. Load may be reduced for slope per ASCE 7-10, **no other reductions are permitted**.

Unbalanced Loading & Drifting — Building structure is analyzed for drifting per ASCE 7-10. The specified ground snow load (p_g) is used to establish a new flat roof snow load (p_f) for this analysis only. The new value (p_f) is then used in the unbalanced loading and drifting calculations per Section 7.6, ASCE 7.



WIND LOADS

Basic wind speed

Category I/II: 130 mph (V_{ult})

Category III/IV: 140 mph (V_{ult})

Exposure category Exposure C required

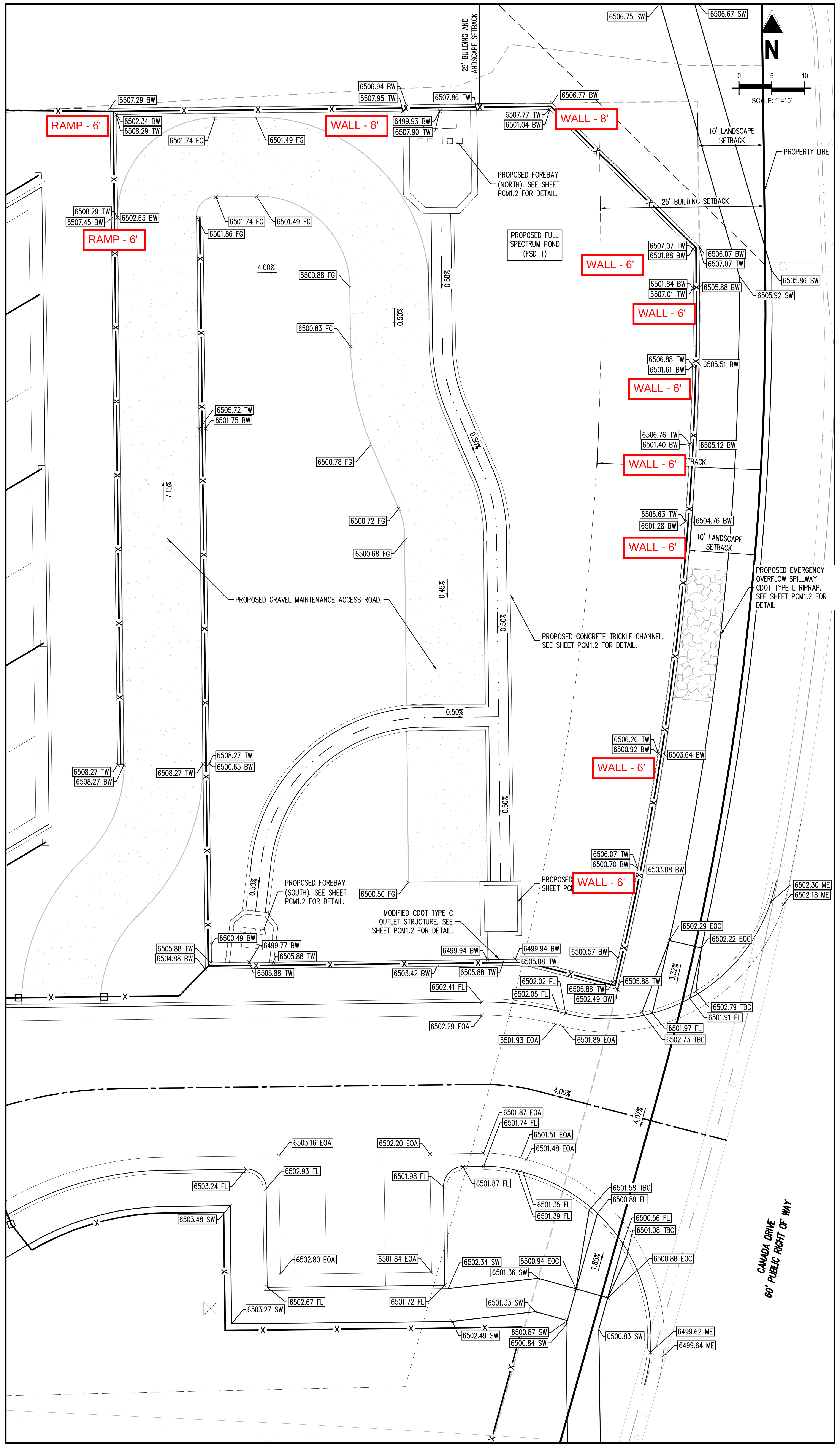
EARTHQUAKE LOADS *— Code sets spectral response factors and cannot be numerically less than the specified values.*

Short period spectral response S_s : 18.5%

1-Second spectral response S_1 : 5.9%

LIVE & DEAD LOADS *— Refer to Code*

KEYPLAN



EAST DRIVEWAY AND POND DETAIL
SCALE: 1" = 10'

Galloway
1155 Kelly Johnson Blvd., Suite 305
Colorado Springs, CO 80920
719.900.7220
GallowayUS.com

NOT FOR CONSTRUCTION

SITE DEVELOPMENT PLAN
CONSTITUTION STORAGE

JOHNSON DEVELOPMENT ASSOCIATES

6855 CONSTITUTION AVENUE
COLORADO SPRINGS, CO 80915

#	Date	Issue / Description	Init.

Project No:	JDA02
Drawn By:	ASA
Checked By:	RGD
Date:	SEPTEMBER 2022

DETAIL GRADING PLAN

C2.2
Sheet 5 of 9

RETAINING WALL CALCULATIONS

Cantilevered Retaining Wall

Project File: JDA02-CIVIL RW POND.ec6

LIC# : KW-06014894, Build:20.22.8.17 Galloway & Company, Inc.

DESCRIPTION: WALL 8'

Code Reference

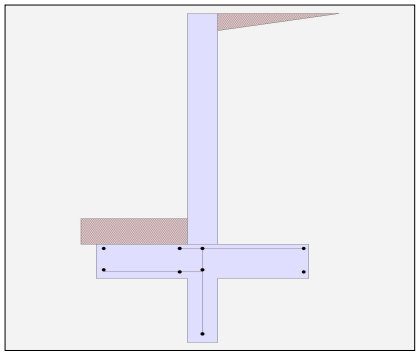
Calculations per IBC 2018 1807.3, CBC 2019, ASCE 7-16

Criteria

Retained Height	=	9.00 ft
Wall height above soil	=	0.00 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	12.00 in
Water height over heel	=	0.0 ft

Soil Data

Allow Soil Bearing	=	2,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	55.0 psf/ft
	=	
Passive Pressure	=	180.0 psf/ft
Soil Density, Heel	=	120.00 pcf
Soil Density, Toe	=	120.00 pcf
Footing||Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	0.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	0.0
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)	=	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		Spread Footing
Base Above/Below Soil at Back of Wall	=	0.0 ft
Poisson's Ratio	=	0.300

Cantilevered Retaining Wall

Project File: JDA02-CIVIL RW POND.ec6

LIC# : KW-06014894, Build:20.22.8.17 Galloway & Company, Inc.

DESCRIPTION: WALL 8'

Design Summary

Wall Stability Ratios

Overturning	=	2.90	OK
Sliding	=	1.60	OK
Global Stability	=	1.14	

Total Bearing Load	=	6,725	lbs
...resultant ecc.	=	7.77	in

Eccentricity within middle third

Soil Pressure @ Toe	=	1,494 psf	OK
Soil Pressure @ Heel	=	428 psf	OK
Allowable	=	2,500 psf	

Soil Pressure Less Than Allowable

ACI Factored @ Toe	=	2,091 psf	
ACI Factored @ Heel	=	599 psf	
Footing Shear @ Toe	=	18.9 psi	OK
Footing Shear @ Hee	=	11.4 psi	OK
Allowable	=	82.2 psi	

Sliding Calcs

Lateral Sliding Force	=	2,936.4 lbs	
less 100% Passive Force	-	2,012.5 lbs	
less 100% Friction Force	-	2,690.0 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	
Dead Load	1.200
Live Load	1.600
Earth, H	1.600
Wind, W	1.600
Seismic, E	1.000

Stem Construction

		Bottom		
		Stem OK		
Design Height Above Ftg	ft =	0.00		
Wall Material Above "Ht"	=	Concrete		
Design Method	=	SD	SD	SD
Thickness	=	12.00		
Rebar Size	=	# 8		
Rebar Spacing	=	12.00		
Rebar Placed at	=	Center		
Design Data				
fb/FB + fa/Fa	=	**0.575**		
Total Force @ Section				
Service Level	lbs =			
Strength Level	lbs =	3,564.0		
Moment....Actual				
Service Level	ft-# =			
Strength Level	ft-# =	10,692.0		
Moment.....Allowable	=	18,568.4		
Shear.....Actual				
Service Level	psi =			
Strength Level	psi =	49.5		
Shear.....Allowable	psi =	82.2		
Anet (Masonry)	in2 =			
Wall Weight	psf =	150.0		
Rebar Depth 'd'	in =	6.00		

Masonry Data

f'm	psi =	
Fs	psi =	
Solid Grouting	=	
Modular Ratio 'n'	=	
Equiv. Solid Thick.	=	
Masonry Block Type	=	
Masonry Design Method	=	ASD

Concrete Data

f'c	psi =	3,000.0
Fy	psi =	60,000.0

Cantilevered Retaining Wall

Project File: JDA02-CIVIL RW POND.ec6

LIC# : KW-06014894, Build:20.22.8.17 Galloway & Company, Inc.

DESCRIPTION: WALL 8'

Concrete Stem Rebar Area Details

Bottom Stem	Vertical Reinforcing	Horizontal Reinforcing
As (based on applied moment) :	0.4182 in2/ft	
(4/3) * As :	0.5576 in2/ft	Min Stem T&S Reinf Area 2.592 in2
200bd/fy : 200(12)(6)/60000 :	0.24 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.288 in2/ft
0.0018bh : 0.0018(12)(12) :	0.2592 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.4182 in2/ft	#4@ 8.33 in #4@ 16.67 in
Provided Area :	0.79 in2/ft	#5@ 12.92 in #5@ 25.83 in
Maximum Area :	0.9754 in2/ft	#6@ 18.33 in #6@ 36.67 in

Footing Data

Toe Width	=	3.00 ft
Heel Width	=	4.00
Total Footing Width	=	7.00
Footing Thickness	=	16.00 in
Key Width	=	12.00 in
Key Depth	=	30.00 in
Key Distance from Toe	=	3.00 ft

f'c = 3,000 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	=	2,091	599 psf	
Mu' : Upward	=	8,452	3,653 ft-#	
Mu' : Downward	=	1,728	6,912 ft-#	
Mu: Design	=	6,724 OK	3,259 ft-#	OK
phiMn	=	41,684	30,318 ft-#	
Actual 1-Way Shear	=	18.94	11.44 psi	
Allow 1-Way Shear	=	82.16	82.16 psi	

Toe Reinforcing = # 8 @ 12.00 in
Heel Reinforcing = # 8 @ 18.28 in
Key Reinforcing = # 8 @ 12.00 in
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@ 6.94 in, #5@ 10.76 in, #6@ 15.27 in, #7@ 20.83 in, #8@ 27.43 in, #9@ 34.72 in, #10@ 44.09 in

Heel: #4@ 6.94 in, #5@ 10.76 in, #6@ 15.27 in, #7@ 20.83 in, #8@ 27.43 in, #9@ 34.72 in, #10@ 44.09 in

Key: #4@ 10 in, #5@ 15.5 in, #6@ 18 in, #7@ 18 in,

Min footing T&S reinf Area 2.42 in2
Min footing T&S reinf Area per foot 0.35 in2 /ft

If one layer of horizontal bars:	If two layers of horizontal bars:
#4@ 6.94 in	#4@ 13.89 in
#5@ 10.76 in	#5@ 21.53 in
#6@ 15.28 in	#6@ 30.56 in

Cantilevered Retaining Wall

Project File: JDA02-CIVIL RW POND.ec6

LIC# : KW-06014894, Build:20.22.8.17 Galloway & Company, Inc.

DESCRIPTION: WALL 8'

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)		2,936.4	3.44	10,114.2	Soil Over HL (ab. water tbl)	3,240.0	5.50	17,820.0
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		5.50	17,820.0
Hydrostatic Force					Watre Table			
Buoyant Force	=				Sloped Soil Over Hee	=		
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	=	360.0	1.50	540.0
	=				Surcharge Over Toe	=		
					Stem Weight(s)	=	1,350.0	3.50	4,725.0
					Earth @ Stem Transitions	=			
					Footing Weight	=	1,400.0	3.50	4,900.0
					Key Weight	=	375.0	3.50	1,312.5
					Vert. Component	=			
Total	=	2,936.4	**O.T.M.** =	10,114.2	**Total =**		6,725.0 lbs	**R.M.=**	29,297.5

Resisting/Overturning Ratio = **2.90**

Vertical Loads used for Soil Pressure = 6,725.0 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)	0.053	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.

Cantilevered Retaining Wall

Project File: JDA02-CIVIL RW POND.ec6

LIC# : KW-06014894, Build:20.22.8.17 Galloway & Company, Inc.

DESCRIPTION: WALL 8'

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

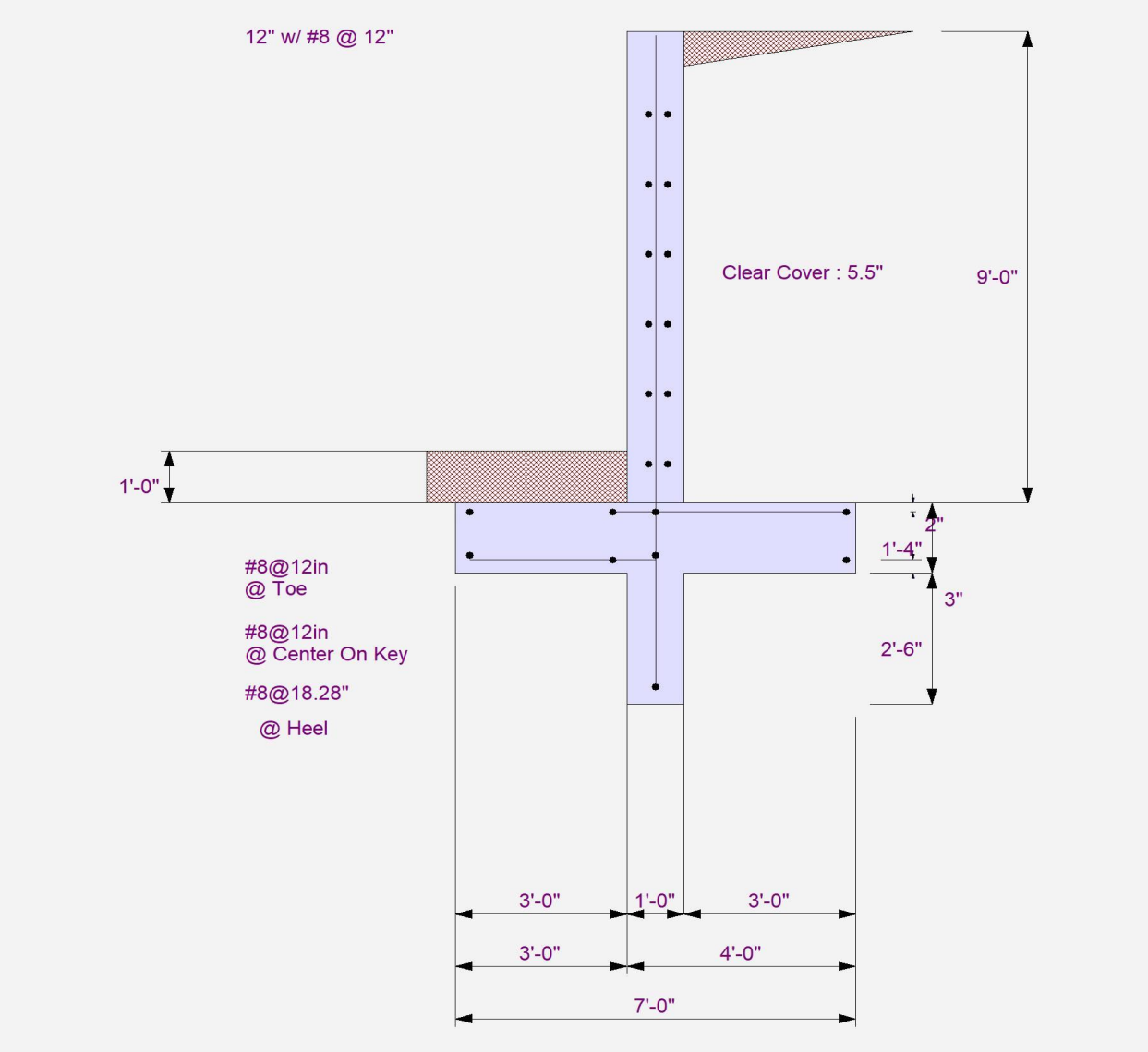
Lap Splice length for #8 bar specified in this stem design segment =	42.72 in
Development length for #8 bar specified in this stem design segment =	32.86 in
Hooked embedment length into footing for #8 bar specified in this stem design segment =	8.12 in
As Provided =	0.7900 in2/ft
As Required =	0.4182 in2/ft

Cantilevered Retaining Wall

Project File: JDA02-CIVIL RW POND.ec6

LIC# : KW-06014894, Build:20.22.8.17 Galloway & Company, Inc.

DESCRIPTION: WALL 8'



Cantilevered Retaining Wall

Project File: JDA02-CIVIL RW POND.ec6

LIC# : KW-06014894, Build:20.22.8.17 Galloway & Company, Inc.

DESCRIPTION: WALL 8'