John S. Apolis, P.E. **CSES, Inc.** Job number: **2020.050**

Project: **Zahr** Date: 1-Sep-21

Architect: Page number: R16

Dowel-Type Fastener Design (single shear)

2018 International Building Code (IBC) **2018 NDS**

Connection Description: ACUTE GLB-GLB CONNECTION JOISTS TO VALLEY BEAM

Dowel Properties:

D	0.5 in	Dowel Diameter	Fyb	45000 psi	dowel bending yield strength

Member Properties:

	Main member	Side Member		Single Shear
L	4.5	3.5	in	dowel bearing length
Fell	5600	5600	psi	dowel bearing strength
FeT	3158	3158	psi	dowel bearing strength
Feθ	3157.56	3158	psi	dowel bearing strength
Cd	1.15	1.15		Load Duration Factor
Ctn	1	1		Toenail Factor
CΔ	1	1		Geometry Factor
θ	90	90		maximum angle of load to grain (0 to 90)
Rd1	5.0	5.0		reduction term (see table 11.3.1B NDS)
Rd2	4.5	4.5		reduction term (see table 11.3.1B NDS)
Rd3	4.0	4.0		reduction term (see table 11.3.1B NDS)
k1	0.48	0.48		NDS pg. 71
k2	1.09	1.09		NDS pg. 71
k3	1.14	1.14		NDS pg. 71
Re	1.00	1.00		Fem/Fs
Rt	1.29	1.29		Lm/Ls
NDS EQ.				Failure mechanism (NDS fig. I1)
11.3-1	1634	1634	lbs	Im
11.3-2	1271	1271	lbs	Is
11.3-3	677	677	lbs	II
11.3-4	739	739	lbs	IIIm
11.3-5	604	604	lbs	IIIs
11.3-6	495	495	lbs	IV
Z	495	495	lbs	

Shear Capacity: Main Member: 495 # Side Member: 495 #

DEMAND = 11' x 45 plf = 495# < 990# (2 SCREWS)

John S. Apolis, P.E.	**CSES, Inc.**	Job number:	**2020.050**
Project:	**Zahr**	Date:	28-Sep-21
Architect:		Page number:	D1

BEAM DESIGN (Uniform Load+Concentrated Load)

2018 International Building Code (IBC) **2018 NDS**

Beam Description: DECK BEAMS

Fully Supported:	1	Snow Load:		Wind Load:	
Repetitive Member:		P.T. Lumber:	1	Wet Use:	

Geometry and Loads:

Span:	10 ft	Tributary Width:	2 ft	P Location:	10 ft
Add'l uniform DL:		DL unit load:	15 psf	Concentrated DL:	
Add'l uniform LL:		LL unit load:	60 psf	Concentrated LL:	
Add'l uniform SL:		SL unit load:		Concentrated SL:	
Add'l uniform WL:		WL unit load:		Concentrated WL:	

DL Reaction 1:	150 lbs	DL Reaction 2:	150 lbs	Note: Design automatically uses
LL Reaction 1:	600 lbs	LL Reaction 2:	600 lbs	ASD load combinations
SL Reaction 1:	0 lbs	SL Reaction 2:	0 lbs	
WL Reaction 1:	0 lbs	WL Reaction 2:	0 lbs	
Total Reaction 1:	**750 lbs**	Total Reaction 2:	**750 lbs**	

Material Properties:

E	1.6 msi	E'	1.52 msi
Fb	900 psi	Fb'	864 psi
Fv	180 psi	Fv'	144 psi
Fc perp	625 psi	Fc perp'	625 psi
Emin	0.58 msi	Emin'	0.551 msi

Deflection analysis:

For total load: Allowed deflection criteria, span/		240	
For LL only: Allowed deflection criteria, span/		480	
Max. allowed total defl:	0.5 in	Max LL defl:	0.25 in
Total defl. * I:	22.2 in^4	Required I:	44.41 in^4
LL defl. * I:	17.76 in^4	Required I:	71.05 in^4
Actual deflections:	TOTAL: 0.1 in		0.08 in

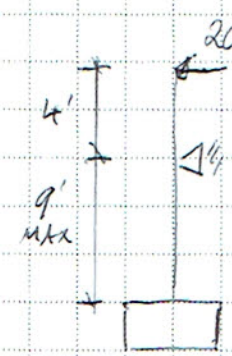
Force analysis:

Max. moment:	1875 ft-lb	Max Shear:	750 lbs

Selected Member:	(1) DF #2	**3.5**	x	**9.25**

Member properties:	**Provided:**		**Required:**
Moment of inertia:	230.84 in^4		71.05 in^4
Section Modulus:	49.91 in^3		26.04 in^3
Section Area:	32.38 in^2		7.81 in^2
Bearing Area:			1.2 in^2
Minimum bearing dimensions:	3.5 in	x	0.34 in

STAIR DESIGN - EXTERIOR STAIR



WALL - BLOCKING: 289# < 340# A34

BLOCKING - STRINGER: 289# < 330# SDS 1/4"x4 1/2" SCREWS

STRINGER - TREAD: 289# < 400# (2) SDS SCREWS

SEE S2 FOR STUD DESIGN

PARAPET DESIGN

$M = 1{,}800 \frac{in\text{-}\#}{FT}$

SDS SCREW DEMAND = $\frac{1{,}800}{4.25"} = 424\#/FT$

SDS CAP = 395#/SCREW, SAY 8" o.c.
= 593 #/FT > 424 #/FT OK

CONSULTING STRUCTURAL ENGINEERING SERVICES
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Project No. 2020.050 Date 9/16/21
Project Name ZAHR
Comments
Revision Page 51

John S. Apolis, P.E. **CSES, Inc.** Job number: **2020.050**

Project: **Zahr** Date: 16-Sep-21

Architect: Page number: S2

BEAM DESIGN (Cantilever, Uniform Load+Concentrated Load)

2018 International Building Code (IBC)(concentrated load at tip of cantilever **2018 NDS**

Beam Description: STAIR STRINGERS

Enter '1' for snow load:
Enter '1' for repetitive member: 1
Enter '1' for wet use:

Geometry and Loads:

Span:	9	ft	Tributary Width:	1.33	ft
DL unit load:	0	psf	LL unit load:	0	psf
Add'l unif. DL:		lb/ft	Add'l unif. LL:		lb/ft
Concentrated DL:		lbs	Concentrated LL:	67	lbs
Cantilever a:	4	ft			
			Total point load:	66.5	lbs
DL uniform load:	0	lb/ft	Max DL reaction:	0	lbs
LL uniform load:	0	lb/ft	Max LL reaction:	96	lbs
Total load:	0	lb/ft	Max Total reaction:	96	lbs
			Rsmall	-30	lbs

Material Properties:

E	1.3	x 10^6 psi	E'	1.495	x 10^6 psi
Fb	850	psi	Fb'	924	psi
Fv	150	psi	Fv'	150	psi
Fc perp	405	psi	Fc perp'	405	psi
Emin	0.47	x 10^6 psi	Emin'	0.47	x 10^6 psi

Deflection analysis:

For total load: Allowed deflection criteria, span/ 240
For LL only: Allowed deflection criteria, span/ 360

Max. allowed total defl:	0.45	in	Max LL defl:	0.3	in
Cantilever Deflections, TL:	0.4	in	LL:	0.2666667	in
Total Required I:	7	in^4	LL Required I:	20	in^4
Actual midspan δ:	TOTAL:	0.000 inches	LL	0.000	inches
Actual Cantilever δ:	TOTAL:	0.128 inches	LL	0.256	inches

Force analysis:

Max. moment:	266	ft-lb	Max Shear:	67	lbs
			Shear @ d =	67	lbs

Selected Member:	(1) HF #2	1.5	x	5.5

Member properties:	**Provided:**			**Required:**	
Moment of inertia:	20.8	in^4		20.0	in^4
Section Modulus:	7.6	in^3		3.5	in^3
Section Area:	8.3	in^2		0.7	in^2
Bearing Area:				0.2	in^2
Minimum bearing dimensions:	1.5		x	0.2	inches

HOUSE & DADU RETAINING WALLS

This Wall in File: c:\Users\episo\Documents\RetainPro 10 Project Files\zahr.RPX

Cantilevered Retaining Wall

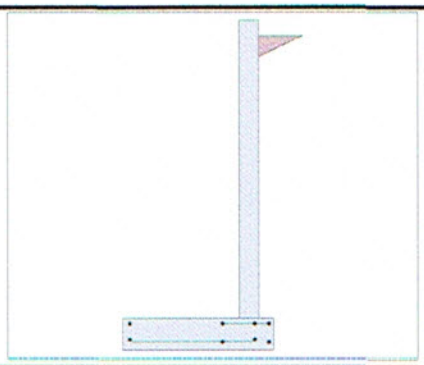
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	9.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 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	=	350.0 psf/ft
Soil Density, Heel	=	130.00 pcf
Soil Density, Toe	=	130.00 pcf
Footing||Soil Friction	=	0.400
Soil height to ignore for passive pressure	=	12.00 in



Surcharge Loads

Surcharge Over Heel	=	50.0 psf
Used To Resist Sliding & Overturning		
Surcharge Over Toe	=	300.0
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	=	200.0 lbs
Axial Live Load	=	340.0 lbs
Axial Load Eccentricity	=	0.0 in

Earth Pressure Seismic Load

Method : Uniform

Multiplier Used	=	7.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	70.000
Total Seismic Force	=	700.000

Design Summary

Wall Stability Ratios

Overturning	=	1.91	OK
Sliding	=	1.52	OK
Total Bearing Load	=	4,988 lbs	
...resultant ecc.	=	2.67 in	
Soil Pressure @ Toe	=	993 psf	OK
Soil Pressure @ Heel	=	585 psf	OK
Allowable	=	2,000 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,390 psf	
ACI Factored @ Heel	=	819 psf	
Footing Shear @ Toe	=	17.7 psi	OK
Footing Shear @ Heel	=	16.4 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	2,374.6 lbs	
less 100% Passive Force	= -	1,739.6 lbs	
less 100% Friction Force	= -	1,859.4 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 considered in the calculation of soil bearing pressures.

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

		Bottom
		Stem OK
Design Height Above Ftg	ft =	0.00
Wall Material Above "Ht"	=	Concrete
Design Method	=	LRFD
Thickness	=	8.00
Rebar Size	=	# 4
Rebar Spacing	=	5.75
Rebar Placed at	=	Edge
Design Data		
fb/FB + fa/Fa	=	**0.972**
Total Force @ Section		
Service Level	lbs =	
Strength Level	lbs =	3,091.8
Moment....Actual		
Service Level	ft-# =	
Strength Level	ft-# =	10,511.3
Moment.....Allowable	=	10,814.0
Shear.....Actual		
Service Level	psi =	
Strength Level	psi =	41.2
Shear.....Allowable	psi =	75.0
Anet (Masonry)	in2 =	
Rebar Depth 'd'	in =	6.25
Masonry Data		
f'm	psi =	
Fs	psi =	
Solid Grouting	=	
Modular Ratio 'n'	=	
Wall Weight	psf =	100.0
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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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) :	0.3938 in2/ft	
(4/3) * As :	0.5251 in2/ft	Min Stem T&S Reinf Area 1.824 in2
200bd/fy : 200(12)(6.25)/60000 :	0.25 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0012bh : 0.0012(12)(8) :	0.1152 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.3938 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.4174 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8467 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	4.00 ft
Heel Width	=	1.17
Total Footing Width	=	5.17
Footing Thickness	=	12.00 in
Key Width	=	12.00 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 % = 0.0012
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	1,390	819 psf
Mu' : Upward	=	119,278	105 ft-#
Mu' : Downward	=	63,360	939 ft-#
Mu: Design	=	4,660	834 ft-#
Actual 1-Way Shear	=	17.68	16.40 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Toe Reinforcing = # 4 @ 5.75 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@ 13.88 in, #5@ 21.52 in, #6@ 30.55 in, #7@ 41.66 in, #8@ 54.86 in, #9@ 6
Heel: #4@ 13.88 in, #5@ 21.52 in, #6@ 30.55 in, #7@ 41.66 in, #8@ 54.86 in, #9@ 6
Key: No key defined

Min footing T&S reinf Area 1.34 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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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)		1,750.0	3.33	5,833.3	Soil Over HL (ab. water tbl)	585.4	4.92	2,878.3
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		4.92	2,878.3
Hydrostatic Force					Watre Table			
Buoyant Force	=				Sloped Soil Over Heel	=		
Surcharge over Heel	=	134.6	5.00	673.1	Surcharge Over Heel	= 25.0	4.92	123.0
Surcharge Over Toe	=				Adjacent Footing Load	=		
Adjacent Footing Load	=				Axial Dead Load on Stem	= 540.0	4.33	866.7
Added Lateral Load	=				* Axial Live Load on Stem	= 340.0	4.33	1,473.3
Load @ Stem Above Soil	=				Soil Over Toe	=		
Seismic Earth Load	=	490.0	5.00	2,450.0	Surcharge Over Toe	= 1,200.0	2.00	2,400.0
	=				Stem Weight(s)	= 950.0	4.33	4,116.7
					Earth @ Stem Transitions	=		
					Footing Weight	= 775.1	2.58	2,002.3
					Key Weight	=	0.50	
					Vert. Component	= 912.9	5.17	4,717.1
Total	=	2,374.6	**O.T.M.** =	8,956.4	**Total** =	4,648.4 lbs	**R.M.**=	17,104.1

Resisting/Overturning Ratio = **1.91**
Vertical Loads used for Soil Pressure = 4,988.4 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 considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS 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)	0.051	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.

TALL SITE RETAINING WALL

This Wall in File: c:\users\episo\documents\retainpro 10 project files\zahr.rpx

Cantilevered Retaining Wall

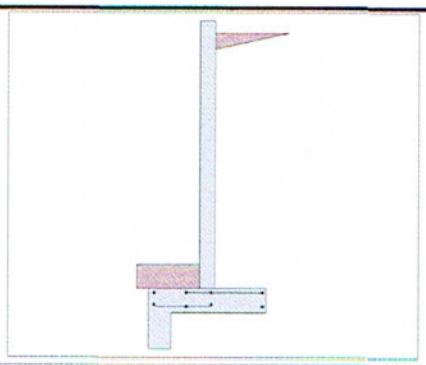
Code: IBC 2018,ACI 318-14,TMS 402-16

Criteria

Retained Height	=	10.50 ft
Wall height above soil	=	0.50 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	=	2,000.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	350.0 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		

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	=	7.000
(Multiplier used on soil density)		
Uniform Seismic Force	=	80.500
Total Seismic Force	=	925.750

Design Summary

Wall Stability Ratios

Overturning	=	1.78 OK
Sliding	=	1.52 OK
Total Bearing Load	=	6,320 lbs
...resultant ecc.	=	8.22 in
Soil Pressure @ Toe	=	1,809 psf OK
Soil Pressure @ Heel	=	206 psf OK
Allowable	=	2,000 psf
Soil Pressure Less Than Allowable		
ACI Factored @ Toe	=	2,533 psf
ACI Factored @ Heel	=	288 psf
Footing Shear @ Toe	=	27.6 psi OK
Footing Shear @ Heel	=	33.7 psi OK
Allowable	=	75.0 psi

Sliding Calcs

Lateral Sliding Force	=	2,962.4 lbs
less 100% Passive Force	= -	1,968.8 lbs
less 100% Friction Force	= -	2,528.0 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 considered in the calculation of soil bearing pressures.

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

Bottom

		Stem OK
Design Height Above Ftg	ft =	0.00
Wall Material Above "Ht"	=	Concrete
Design Method	=	LRFD
Thickness	=	8.00
Rebar Size	=	# 5
Rebar Spacing	=	5.00
Rebar Placed at	=	Edge
Design Data		
fb/FB + fa/Fa	=	0.857
Total Force @ Section		
Service Level	lbs =	
Strength Level	lbs =	3,932.3
Moment....Actual		
Service Level	ft-# =	
Strength Level	ft-# =	15,242.1
Moment.....Allowable	=	17,776.5
Shear.....Actual		
Service Level	psi =	
Strength Level	psi =	53.0
Shear.....Allowable	psi =	75.0
Anet (Masonry)	in2 =	
Rebar Depth 'd'	in =	6.19
Masonry Data		
f'm	psi =	
Fs	psi =	
Solid Grouting	=	
Modular Ratio 'n'	=	
Wall Weight	psf =	100.0
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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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) :	0.5771 in2/ft	
(4/3) * As :	0.7695 in2/ft	Min Stem T&S Reinf Area 2.112 in2
200bd/fy : 200(12)(6.1875)/60000 :	0.2475 in2/ft	Min Stem T&S Reinf Area per ft of stem Height : 0.192 in2/ft
0.0012bh : 0.0012(12)(8) :	0.1152 in2/ft	Horizontal Reinforcing Options :
	==========	One layer of : Two layers of :
Required Area :	0.5771 in2/ft	#4@ 12.50 in #4@ 25.00 in
Provided Area :	0.744 in2/ft	#5@ 19.38 in #5@ 38.75 in
Maximum Area :	0.8382 in2/ft	#6@ 27.50 in #6@ 55.00 in

Footing Data

Toe Width	=	2.25 ft
Heel Width	=	2.92
Total Footing Width	=	5.17
Footing Thickness	=	12.00 in
Key Width	=	12.00 in
Key Depth	=	18.00 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 % = 0.0012
Cover @ Top 2.00 @ Btm.= 3.00 in

Footing Design Results

		Toe	Heel
Factored Pressure	=	2,533	288 psf
Mu' : Upward	=	67,036	1,555 ft-#
Mu' : Downward	=	9,842	8,297 ft-#
Mu: Design	=	4,766	6,742 ft-#
Actual 1-Way Shear	=	27.60	33.71 psi
Allow 1-Way Shear	=	75.00	75.00 psi

Toe Reinforcing = # 4 @ 5.00 in
Heel Reinforcing = # 4 @ 10.00 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@ 13.88 in, #5@ 21.52 in, #6@ 30.55 in, #7@ 41.66 in, #8@ 54.86 in, #9@ 6
Heel: #4@ 11.02 in, #5@ 17.09 in, #6@ 24.26 in, #7@ 33.08 in, #8@ 43.56 in, #9@ 5
Key: phiMn = phi'5'lambda'sqrt(fc)'Sm

Min footing T&S reinf Area 1.34 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

This Wall in File: c:\users\episo\documents\retainpro 10 project files\zahr.rpx

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)		2,314.4	3.83	8,871.8	Soil Over HL (ab. water tbl)	2,835.4	4.04	11,460.3
HL Act Pres (be water tbl)					Soil Over HL (bel. water tbl)		4.04	11,460.3
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	=	270.0	1.13	303.8
Seismic Earth Load	=	648.0	5.75	3,726.1	Surcharge Over Toe	=		
	=				Stem Weight(s)	=	1,100.0	2.58	2,841.7
					Earth @ Stem Transitions	=			
					Footing Weight	=	775.1	2.58	2,002.3
					Key Weight	=	225.0	0.50	112.5
					Vert. Component	=	1,114.5	5.17	5,758.5
Total	=	2,962.4	O.T.M. =	12,597.9	Total =		6,320.0 lbs	R.M.=	22,479.1

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

Resisting/Overturning Ratio = **1.78**
Vertical Loads used for Soil Pressure = 6,320.0 lbs

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 considered in the calculation of Sliding Resistance.

Vertical component of active lateral soil pressure IS 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)	0.107	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.

SHEAR WALL DESIGN - UPPER FLOOR - SOUTH ENTRY WALL L=3.75' h=8'

$P_{WE} = \frac{44^2}{64} \times (5.5' \times 8.64 psf) - \frac{44^2}{64} \times 27' \times 1.61 psf + 16' \times 10' \times 10.46 psf \times \frac{34}{32}$

$+ 16' \times 10.5' \times 10.46 psf + 15' \times 14.5' \times 2.93 psf = 4,296^{\#}$

P_{WW} = DITTO, EXCHANGE W/W/LW LOADS, ROOF SIGNS = $6,159^{\#} < 6,439^{\#}$ OK

$V = \frac{6,439^{\#}}{3.75'} = 1,718 plf < 1,740 plf$ SW 7x5

UPLIFT = $1,718 plf \times 8' = 13,744^{\#} < 15,510^{\#}$ 6x6 DF POST W/ HDQ9

• LRFD LOADING = $22,907^{\#}$ SEE PAGES L8-L12

GARAGE/BATHROOM WALL - L = 13.5'

P_{WW} (CONTROLS BY INSPECTION) = $15' \times 11' \times 8.64 psf - 15' \times 12' \times 1.61 psf + 15' \times 27' \times 2.93 psf$

$+ 15' \times 5.5' \times 10.46 psf = 3,186^{\#} < 4,070^{\#}$ OK

$V = \frac{4,070^{\#}}{13.5'} = 302 plf < 350 plf$ SW2

UPLIFT = $302 plf \times 10' = 3,015^{\#} < 4,585^{\#}$ CMSTC16

$< 4,065^{\#}$ HDU5

UPLIFT INCREASE FROM SPAN STRUT = $4,070^{\#} \times TAN(9°) = 644^{\#}$ $3,015^{\#} + 644^{\#} = 3,659^{\#} < 4,585^{\#}$ OK

TOP OF WALL END STRAPS:

UPLIFT = $6,439^{\#} / 3.75' \times 1' = 1,717^{\#} < 2,835^{\#}$ HRS 416Z

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John S. Apolis, P.E. **CSES, Inc.** Job number: **2020.050**

Project: **Zahr** Date: 19-May-21

Architect: Page number: L3-6

Post Design (Combined Axial and Moment Loading)

2018 International Building Code (IBC) **2018 NDS**

Beam Description: ENTRY JAMB STUD DESIGN

Enter '1' for **wind load**: 1

Enter '1' for **repetitive member**:

Enter '1' for **wet use**:

Geometry and loads:

Height	10 ft	w(d)	13.92 plf
P	13744 lbs	w(b)	0 plf
Le(d)	10 ft	Le(b)	1 ft

Material Properties:

Fb1	900 psi	Fb(d)'	1035 psi
Fb2	900 psi	Fb(b)'	1035 psi
Fc	1350 psi	Fc'	819 psi
E	1.6 x10^6psi	E'	1.6 x10^6psi
Emin	0.58 x10^6psi	Emin'	0.58 x10^6psi

Selected Member: DF #2 5.5 (b) x 5.5 (d)

Member properties:		**Variables:**	
Section Modulus (d):	27.7 in^3	Rb(d)	4.67
Section Modulus (b):	27.7 in^3	Rb(b)	1.48
Section Area:	30.3 in^2	c	0.8

Member stresses:	Provided		Required	
FcE(d)	1002 psi	>	fc	454 psi
FcE(b)	100153 psi	>	fc	454 psi
FbE	31900 psi	>	fb(d)	75 psi
FbE	31900 psi	>	fb(b)	0 psi

Bending and Axial Compression Check:

NDS 2010 EQ 3.9-3 0.44 < 1.0

GARAGE WEST WALL - L=16'

$P_W = 22' \times 7.5' \times 8.64\,psf + 16.5' \times 6' \times 10.46\,psf + 27' \times 22' \times 2.93\,psf = 4,220\#$

$V = \frac{4,220\#}{16'} = 264\,plf < 350\,plf$ SW2

UPLIFT = 264 plf x 11' = 2,901# < 4,065# HDU5

ENTRY EAST WALL - L = 17' + 5'

$P_W = 7' \times 6' \times 10.46\,psf = 440\# < 1,008\#$ SEE L5

ENTRY/GREATROOM WALL - L = 12.25' + 19.75' + 14.5' = 46.5'

$P_W = (7' \times 6' + 8.5' \times 11') \times 8.64\,psf + (9' \times 7.5' + 8.5' \times 11') \times 10.46\,psf = 2,855\#$

CANTILEVER COLUMN R=1.5

STONE VENEER

$P_E = (6' \times 52' + 10.5' \times 61') \times 3.19\,psf \times \frac{6.5}{1.5} = 13,169\# + 61' \times 13' \times 6.5\,psf \times 0.15 \times 0.7 \times \frac{6.5}{1.5} = 15,514\#$

FORCE/COLUMN = $10.5' \times 61' \times 3.19\,psf \times \frac{6.5}{1.5} \times 1.5 / 9$ columns = 1,476# < 1,705# CS16

SEE L5-B FOR POST CALCULATION

$V = \frac{15,514\#}{46.5'} = 334\,plf < 350\,plf$ SW2

UPLIFT = 334 plf x 12' = 4,004 # < 4,565# CMSTC16

WEST WALL - L = 4.33' + 4.67'

$P_W = 11' \times 7.5' \times (8.64 + 10.46) = 1,576\# < 2,725\#$ SEE L5

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SOUTH ENTRY WALL - LOWER FLOOR (DRAG STRUT)

$P_W = \frac{44.5^2}{64} \times 10' \times 10.46\,psf + \frac{36^2}{47} \times 5' \times 8.64\,psf = 4{,}428^{\#}$

$4{,}428^{\#} < 4{,}585^{\#}$ CMSTC16

$4{,}428^{\#}/6' = 738\,plf < 1{,}740\,plf$ CONNECTION UNDER ENTRY DOOR OK

NORTH BEDROOM WALL - L = 13'

$P_W = 24' \times 10' \times 10.46\,psf + 16' \times 5' \times 8.64\,psf + 4{,}070^{\#} = 7{,}272^{\#}$

$V = \frac{7{,}272^{\#}}{13'} = 559\,plf < 710\,plf$ SW3x

UPLIFT = $559\,plf \times 10' = 5{,}594^{\#} < 7{,}870^{\#}$ HDU8

UPLIFT = $5{,}594^{\#} + 3{,}015^{\#} = 8{,}609^{\#} < 9{,}335^{\#}$ HDU11

$8{,}609^{\#} + 644^{\#} = 9{,}253^{\#} < 9{,}335^{\#}$ OK

NORTH SHEAR WALL - L = 13.75'

$P_W = 11' \times 9.5' \times 10.46\,psf + 5.5' \times 9.5' \times 8.64\,psf + 2{,}484^{\#} = 4{,}029^{\#}$

$P_E = 11' \times 27' \times 1.66\,psf \times \frac{6.5}{13} + 4{,}293^{\#} = 6{,}429^{\#}$

$V = \frac{6{,}429^{\#}}{13.75'} = 468\,plf < 550\,plf$ SW3

UPLIFT = $468\,plf \times 10' = 4{,}676^{\#} < 6{,}580^{\#}$ HDU8

DIAPHRAGM CHECK - $\frac{4{,}293^{\#}}{13.75'} = 312\,plf < 350\,plf$ SW2

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WEST SHEAR WALL - LOWER FLOOR - L = 7.25 + 9 = 16.25'

$P_W = (10.5' \times 10.5' + 8' \times 8') \times (8.64\,psf + 10.46\,psf) + 1{,}576^{\#} = 4{,}904^{\#}$

$4{,}904^{\#} < 5{,}554^{\#}$ SEE L7

CENTRAL WALL - LOWER FLOOR - L = 12' + 14.5' + 13' = 39.5'

$P_W = (10.5' \times 12.5' + 8.5' \times 8.5') \times 8.64\,psf + (10.5' \times 12.5' \times 8.5' \times 6') \times 10.46\,psf$

$+ 2{,}855^{\#} = 6{,}519^{\#}$

STONE VENEER

$P_E = (10.5' \times 62' + 6' \times 47') \times 1.66\,psf \times \frac{6.5}{1.5} + 15{,}514^{\#}$ REFL5-A $+ 61' \times 80' \times 12.5\,psf \times 0.15 \times 0.7 \times \frac{6.5}{1.5} = 25{,}695^{\#}$

$V = \frac{25{,}695}{39.5'} = 651\,plf < 710\,plf$ SW 3x

$UPLIFT = 651\,plf \times 10' = 6{,}505^{\#} < 7{,}870^{\#}$ HDU8

DEAD LOAD × 2/3

$UPLIFT\,2 = 6{,}505^{\#} + 4{,}004^{\#} = 10{,}509^{\#} - 22' \times 20'\,psf \times 8' \times \frac{2}{3} = 8{,}162^{\#} < 9{,}535^{\#}$ HDU11

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L8

SIMPSON Strong-Tie

Anchor Designer™ Software
Version 2.9.7376.23

Company:		Date:	9/8/2021
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Project:			
Address:			
Phone:			
E-mail:			

1.Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment:

Project description: 2020.050
Location:
Fastening description: ZAHR

2. Input Data & Anchor Parameters

General
Design method:ACI 318-14
Units: Imperial units

Anchor Information:
Anchor type: Cast-in-place
Material: AB
Diameter (inch): 1.000
Effective Embedment depth, h_{ef} (inch): 13.000
Anchor category: -
Anchor ductility: Yes
h_{min} (inch): 15.63
C_{min} (inch): 6.00
S_{min} (inch): 6.00

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 16.00
State: Cracked
Compressive strength, f'_c (psi): 2500
$\Psi_{c,V}$: 1.0
Reinforcement condition: A tension, A shear
Supplemental reinforcement: Not applicable
Reinforcement provided at corners: Yes
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Ignore 6do requirement: No
Build-up grout pad: No

Recommended Anchor
Anchor Name: PAB Pre-Assembled Anchor Bolt - PAB8 (1"Ø)

PAB ANCHORS INTO TALL RETAINING WALL

SIMPSON Strong-Tie

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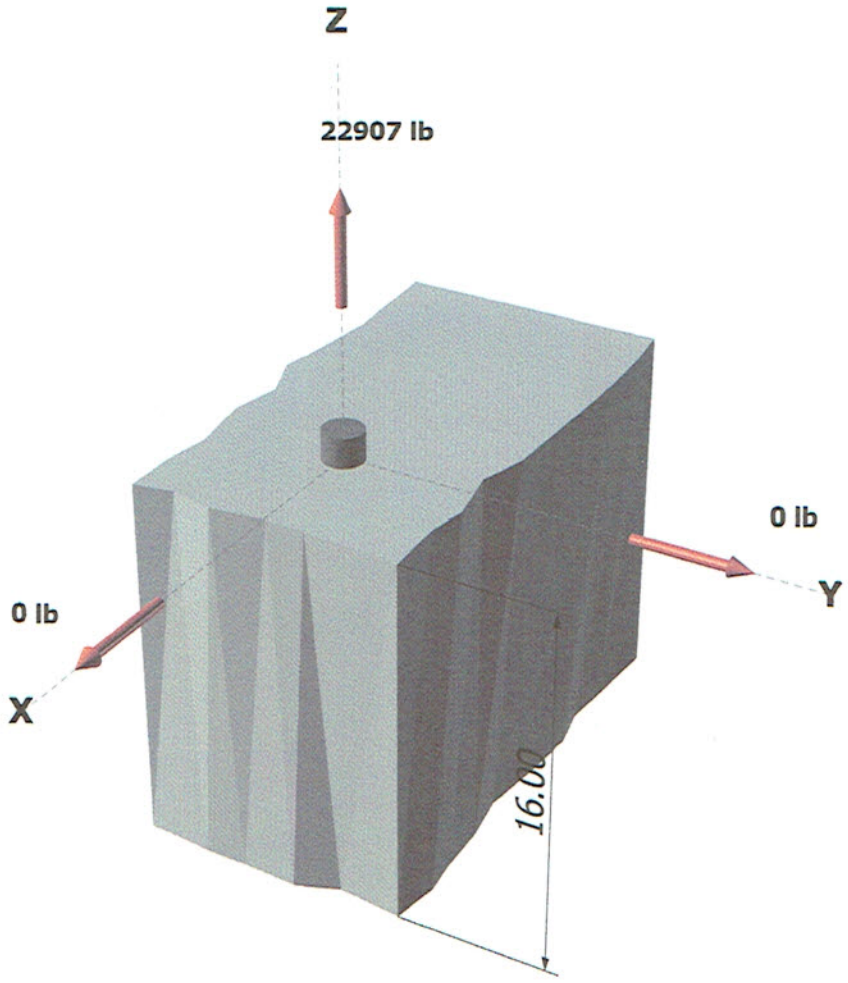
Load and Geometry
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: Yes
Anchors subjected to sustained tension: Not applicable
Ductility section for tension: 17.2.3.4.2 not applicable
Ductility section for shear: 17.2.3.5.2 not applicable
Ω_0 factor: not set
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: Yes

Strength level loads:

N_{ua} [lb]: 22907
V_{uax} [lb]: 0
V_{uay} [lb]: 0

<Figure 1>



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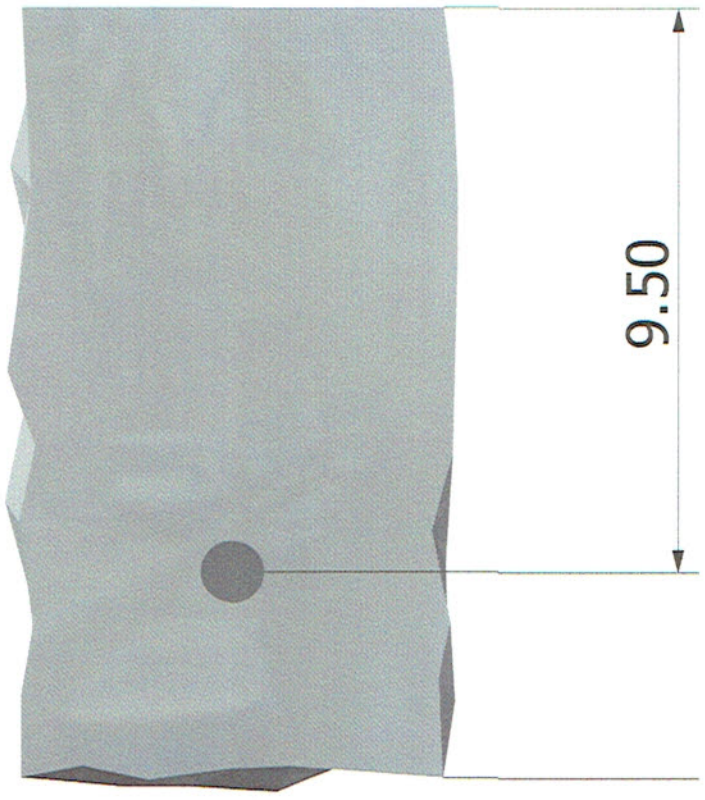
<Figure 2>



SIMPSON Strong-Tie® Anchor Designer™ Software Version 2.9.7376.23

Company:		Date:	9/8/2021
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3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	22907.0	0.0	0.0	0.0
Sum	22907.0	0.0	0.0	0.0

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 22907
Resultant compression force (lb): 0
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00

4. Steel Strength of Anchor in Tension (Sec. 17.4.1)

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
35150	0.75	26363

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.4.2)

$N_b = 16\lambda_a\sqrt{f'_c}h_{ef}^{5/3}$ (Eq. 17.4.2.2b)

λ_a	f'_c (psi)	h_{ef} (in)	N_b (lb)
1.00	2500	13.000	57499

$0.75\phi N_{cb} = 0.75\phi\,(A_{Nc}/A_{Nco})\,\Psi_{ed,N}\,\Psi_{c,N}\,\Psi_{cp,N}N_b$ (Sec. 17.3.1 & Eq. 17.4.2.1a)

A_{Nc} (in²)	A_{Nco} (in²)	$c_{a,min}$ (in)	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	$0.75\phi N_{cb}$ (lb)
1268.16	1521.00	9.50	0.846	1.00	1.000	57499	0.75	22818

6. Pullout Strength of Anchor in Tension (Sec. 17.4.3)

$0.75\phi N_{pn} = 0.75\phi\Psi_{c,P}N_p = 0.75\phi\Psi_{c,P}8A_{brg}f'_c$ (Sec. 17.3.1, Eq. 17.4.3.1 & 17.4.3.4)

$\Psi_{c,P}$	A_{brg} (in²)	f'_c (psi)	ϕ	$0.75\phi N_{pn}$ (lb)
1.0	5.15	2500	0.70	54117

SIMPSON Strong-Tie

Anchor Designer™ Software
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11. Results

11. Interaction of Tensile and Shear Forces (Sec. D.7)?

Tension	Factored Load, N_{ua} (lb)	Design Strength, ϕN_n (lb)	Ratio	Status
Steel	22907	26363	0.87	Pass
Concrete breakout	**22907**	**22818**	**1.00**	**Pass (Governs)**
Pullout	22907	54117	0.42	Pass

PAB8 (1"Ø) with hef = 13.000 inch meets the selected design criteria.

12. Warnings

- Per designer input, the tensile component of the strength-level earthquake force applied to anchors does not exceed 20 percent of the total factored anchor tensile force associated with the same load combination. Therefore the ductility requirements of ACI 318 17.2.3.4.2 for tension need not be satisfied – designer to verify.

- Per designer input, the shear component of the strength-level earthquake force applied to anchors does not exceed 20 percent of the total factored anchor shear force associated with the same load combination. Therefore the ductility requirements of ACI 318 17.2.3.5.2 for shear need not be satisfied – designer to verify.

- Designer must exercise own judgement to determine if this design is suitable.

NORTH DRAG STRUT DESIGN

$P_W = 12.25 \times 8' \times 8.64\ psf + 4' \times 8' \times 10.46\ psf = 1{,}182^{\#} < 1{,}705^{\#}$ CS16

$1{,}182^{\#} / 575^{\#/A35} \cong 2.06$ SAY (3) A35

SEE DETAIL D9

CONNECTION ANGLE IS $\sim 9°$

UPLIFT = $1{,}182^{\#} \times \tan(9°) = 187^{\#}$ WITH $\Omega = 2.5$, UPLIFT = $468^{\#}$

WEIGHT = $\left(\frac{9' \times 12'}{4} + \frac{5' \times 3'}{4}\right) \times 16\ psf \times 0.6 = 296^{\#}$

$468^{\#} - 296^{\#} = 172^{\#} < 495^{\#}$ H GA 10

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