

CK Engineering LLC.

19229 38th PL NE
Lake Forest Park, WA 98155

Phone: (206) 417-0670

STRUCTURAL CALCULATIONS

Lateral & Gravity Design
24-031



11/15/2024

FALKNER RESIDENCE (CARPORT)

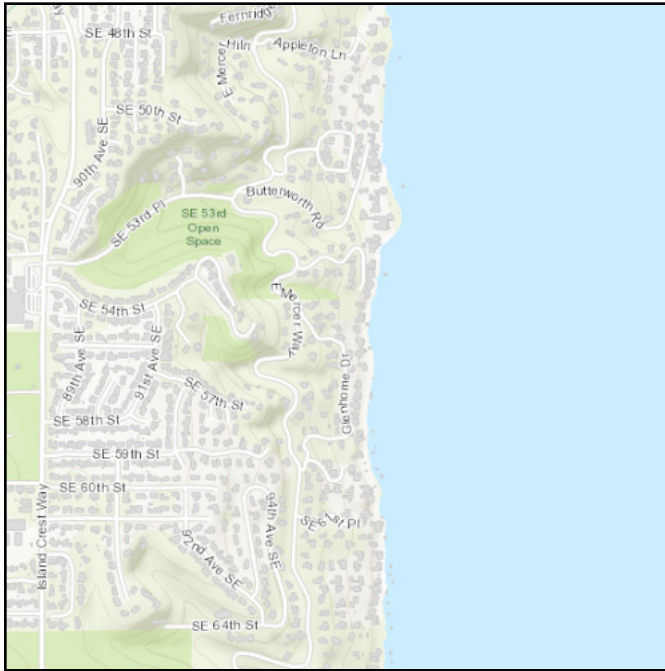
5602 E. Mercer Way
Mercer Island, WA 98040
November 15, 2024

ASCE Hazards Report

Address:
5602 E Mercer Way
Mercer Island, Washington
98040

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

Latitude: 47.552777
Longitude: -122.211083
Elevation: 79.21354291869156 ft (NAVD 88)



Wind

Results:

Wind Speed	92 Vmph
10-year MRI	67 Vmph
25-year MRI	74 Vmph
50-year MRI	78 Vmph
100-year MRI	83 Vmph

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

Date Accessed: Wed Nov 13 2024

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 15% probability of exceedance in 50 years (annual exceedance probability = 0.00333, MRI = 300 years).

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

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

Results:

S_S :	1.444	S_{D1} :	N/A
S_1 :	0.501	T_L :	6
F_a :	1.2	PGA :	0.618
F_v :	N/A	PGA _M :	0.742
S_{MS} :	1.732	F_{PGA} :	1.2
S_{M1} :	N/A	I_e :	1
S_{DS} :	1.155	C_v :	1.389

Ground motion hazard analysis may be required. See ASCE/SEI 7-16 Section 11.4.8.

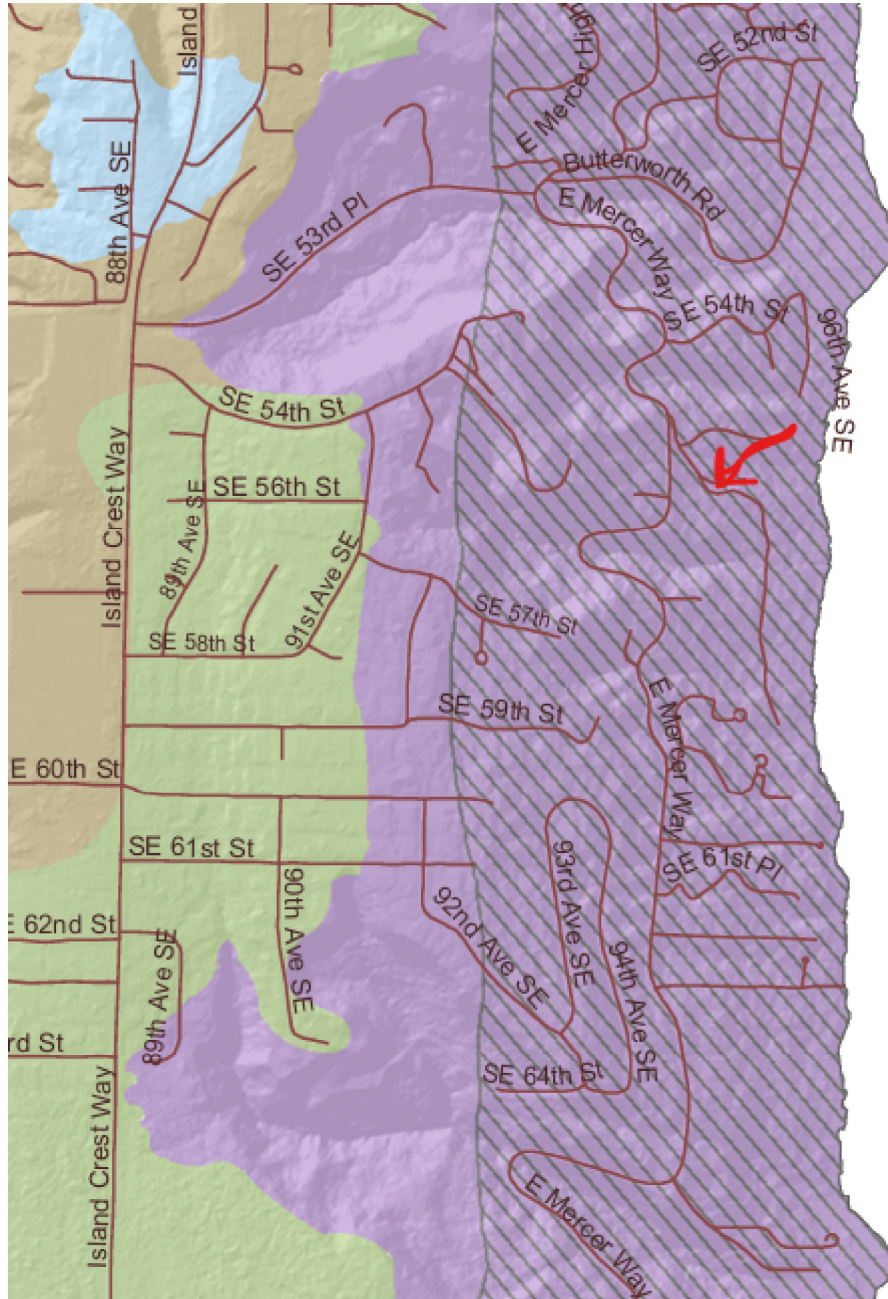
Data Accessed: Wed Nov 13 2024

Date Source: [USGS Seismic Design Maps](#)

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Design Criteria

Scope of Work:	Lateral & Gravity Design		
Site Address:	5602 E. Mercer Way Mercer Island, WA 98040		
Number of Stories:	1	Engineer:	PK

Roof Loading

Roofing	Composition	3.0
Sheathing	15/32" Plywood	1.5
Insulation	Roll/Batt	3.0
Ceiling	5/8" GWB	2.8
Framing	Rafters & Beams	3.0
Miscellaneous	fixtures, mechanical, electrical, etc.	1.7
TOTAL DEAD LOAD:		15.0 psf
ROOF SNOW LOAD:		25.0 psf

Main Floor Loading

Floor Covering	Carpet/Hardwood/Tile	3.0
Sheathing	3/4" T&G	2.3
Ceiling	1/2" GWB	2.2
Joists	I-Joists	2.1
Beams		4.0
Miscellaneous	fixtures, mechanical, electrical, etc.	1.4
TOTAL DEAD LOAD:		15.0 psf
FLOOR LIVE LOAD:		40.0 psf

Not Used

Floor Covering	Carpet/Hardwood/Tile	0.0
Sheathing	3/4" T&G	0.0
Ceiling	5/8" GWB	0.0
Joists	I-Joists	0.0
Beams		4.2
Miscellaneous	fixtures, mechanical, electrical, etc.	0.6
TOTAL DEAD LOAD:		4.8 psf
FLOOR LIVE LOAD:		0.0 psf

Soil Bearing Capacity:	3500 psf
Frost Depth:	18 in

Type of construction: **NEW**
 Applicable Building Codes: **IBC 2021, ASCE 7/SEI 7-16**

Location: **5602 E. Mercer Way
 Mercer Island, WA 98040**

Work performed :

Lateral & Gravity Design

WIND DESIGN:

$$P_s = \lambda_w P_{s30} K_{zt}$$

Exposure : **C** Wind Exposure Category as set forth in Section 26.7 of ASCE 7-16
 Wind Speed = **85 MPH** Basic Wind Speed (LRFD) as used in Figure 28.5 of ASCE 7-16 and converted to (ASD)
 $P_{s30} =$ Simplified design wind pressure for Exposure B, at $h = 30$ feet and for $I = 1.0$, from Figure 28.5-1
 $I_w =$ **1** Importance factor as defined in Table 1.5-2 of ASCE 7-16
 $\lambda =$ **1.21** Adjustment factor for building height and exposure from Figure 28.5-1 of ASCE 7-16
 $K_{zT} =$ **1.00** Adjustment factor for increased wind speed due to a hill or escarpment from Section 26.8 of ASCE 7-16

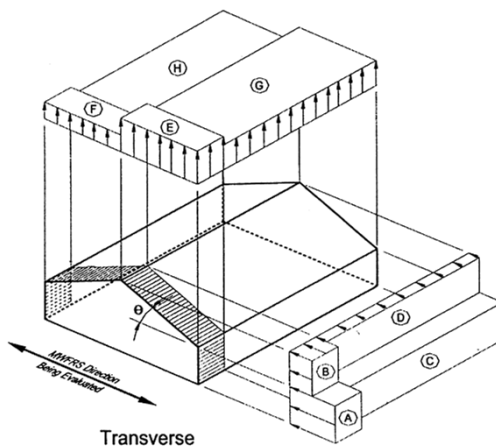
Roof slope :
 Front/Rear $\tan^{-1} \left(\frac{\text{rise}}{\text{run}} \right) = \tan^{-1} \left(\frac{2}{12} \right) = 9.5 \text{ degrees}$
 Left/Right $\tan^{-1} \left(\frac{2}{12} \right) = 9.5 \text{ degrees}$
 Mean Elevation **10 ft**

Number of floors: **1**

Average uplift (F/R) = **-9.7 psf** Based on wind zones 'G' and 'H'
 Average uplift (R/L) = **-9.7 psf** Based on wind zones 'G' and 'H'

	End zone of wall		End zone of roof	
	Front/Rear	Left/Right	Front/Rear	Left/Right
$P_{s30} =$	A = 12.7 psf	12.7 psf	B = -5.5 psf	-5.5 psf
$P_s =$	15.4 psf	15.4 psf	-6.6 psf	-6.6 psf

	Interior zone of wall		Interior zone of roof	
	Front/Rear	Left/Right	Front/Rear	Left/Right
$P_{s30} =$	C = 8.5 psf	8.5 psf	D = -3.1 psf	-3.1 psf
$P_s =$	10.3 psf	10.3 psf	-3.8 psf	-3.8 psf



WIND LOAD CALCULATIONS
FRONT → REAR

1V MAIN FLOOR =

WIND ZONE	A											
AVE. HEIGHT	2											
AVE. WIDTH	30											
P_s	15.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUBTOTAL	926	0	0	0	0	0	0	0	0	0	0	0
TOTAL	926 lbs											

NOT USED

WIND ZONE												
AVE. HEIGHT												
AVE. WIDTH												
P_s	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUBTOTAL	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0 lbs											

NOT USED

WIND ZONE												
AVE. HEIGHT												
AVE. WIDTH												
P_s	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUBTOTAL	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0 lbs											

WIND LOAD CALCULATIONS
LEFT → RIGHT

ΣV MAIN FLOOR =

WIND ZONE	A											
AVE. HEIGHT	2											
AVE. WIDTH	30											
Ps	15.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUBTOTAL	926	0	0	0	0	0	0	0	0	0	0	0
TOTAL	926 lbs											

NOT USED

WIND ZONE												
AVE. HEIGHT												
AVE. WIDTH												
Ps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUBTOTAL	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0 lbs											

NOT USED

WIND ZONE												
AVE. HEIGHT												
AVE. WIDTH												
Ps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUBTOTAL	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0 lbs											

ρ CALCS:

MAIN FLOOR CALCULATIONS:

Plate Height:	8.00 ft
Total length of Shearwall in Shortest Line:	5.50 ft
Length of Shortest Segment within Shear Line:	3.50 ft
Length of Longest Segment in Shear Line:	3.50 ft

Tributary Area:	1.0
Total Area:	2.0

$\rho = 1.00$
ASCE 7-16 12.3.4.2 a

NOT USED:

Plate Height:	8.00 ft
Total length of Shearwall in Shortest Line:	7.00 ft
Length of Shortest Shearwall within Shear Line:	3.50 ft
Length of Longest Wall in Shear Line:	3.50 ft

Tributary Area:	1.0
Total Area:	2.0

$\rho = NA$

NOT USED:

Plate Height:	9.00 ft
Total length of Shearwall in Shortest Line:	10.00 ft
Length of Shortest Shearwall within Shear Line:	4.50 ft
Length of Longest Wall in Shear Line:	5.50 ft

Tributary Area:	1.0
Total Area:	2.0

$\rho = NA$

All loads in pounds per square foot

SEISMIC DESIGN:

$E = E_h + E_v$

$E = \rho Q_E + .2S_{DS}D$

$Q_E = V = C_s W$

$\rho =$	1.00
Site Class =	D
$I_E =$	1
R =	6.5
$h_n =$	10

Geotech Report **Yes**
 Importance factor as defined in Table 11.5-1

Total height of structure

$V = 0.7S_{DS}I_E W / R$	$S_{DS} = 2/3 S_{MS}$	Ss =	144.4%	$S_{MS} = 173.3\%$	V =	0.124 W
$V_{max} = S_{D1}I_E W / T_g R$	$S_{MS} = (F_a)(S_s)$	Fa =	1.20	$S_{DS} = 115.5\%$	E =	0.124 W
$T_g = 0.02h_n^{0.75}$	$S_{D1} = 2/3 S_{M1}$	S1 =	50.1%	$S_{M1} = 75.2\%$	Cs =	0.124
$T_g = 0.11 s$	$S_{M1} = (F_v)(S_1)$	Fv =	1.50	$S_{D1} = 50.1\%$		

MAIN FLOOR DIAPHRAGM LOADING:

W (ROOF) =

LENGTH	WIDTH	LOAD	TOTAL
30	10	15.0	4500
30	22	15.0	9900
		15.0	0
		15.0	0
		15.0	0

Area = 960 Sub-Total= 14400

W (FLOOR) =

LENGTH	WIDTH	LOAD	TOTAL
		15.0	0
		15.0	0
		15.0	0
		15.0	0
		15.0	0

Area = 0 Sub-Total= 0

W (WALL) =

LENGTH	TRIB. HT.	LOAD	TOTAL
12	8	10.0	960
		10.0	0
		10.0	0
		10.0	0
		10.0	0

Area = 96 Sub-Total= 960

TOTAL = 15360 lb

NOT APPLICABLE

W (ROOF) =

LENGTH	WIDTH	LOAD	TOTAL
		15.0	0
		15.0	0
		15.0	0
		15.0	0
		15.0	0

Area = 0 Sub-Total= 0

W (FLOOR) =

LENGTH	WIDTH	LOAD	TOTAL
		15.0	0
		15.0	0
		15.0	0
		15.0	0
		15.0	0

Area = 0 Sub-Total= 0

W (WALL) =

LENGTH	TRIB. HT.	LOAD	TOTAL
		10.0	0
		10.0	0
		10.0	0
		10.0	0
		10.0	0

Area = 0 Sub-Total= 0

TOTAL = lb

NOT APPLICABLE

W (ROOF) =

LENGTH	WIDTH	LOAD	TOTAL
		15.0	0
		15.0	0
		15.0	0
		15.0	0
		15.0	0

Area = 0 Sub-Total= 0

W (FLOOR) =

LENGTH	WIDTH	LOAD	TOTAL
		4.8	0
		4.8	0
		4.8	0
		4.8	0
		4.8	0

Area = 0 Sub-Total= 0

W (WALL) =

LENGTH	TRIB. HT.	LOAD	TOTAL
		10.0	0
		10.0	0
		10.0	0
		10.0	0
		10.0	0

Area = 0 Sub-Total= 0

TOTAL = lb

V (MAIN FLOOR) = .124 x 15360 lb = 1911 lbs
 V () = .124 x lb = lbs
 V () = .124 x lb = lbs

REDISTRIBUTE:

$\Sigma V \times \rho$	height	$\Sigma V \times \text{height}$
1911 lb	8	15287
lb		0
lb		0

TOTAL = 1911 lb TOTAL = 15287

E (MAIN) = $\frac{\Sigma V \times \text{height} \times \Sigma V \text{ TOTAL}}{\Sigma V \times \text{height TOTAL}}$ = 1911 lbs

E () = NOT USED = 0 lbs

E () = NOT USED = 0 lbs

SUMMARY:

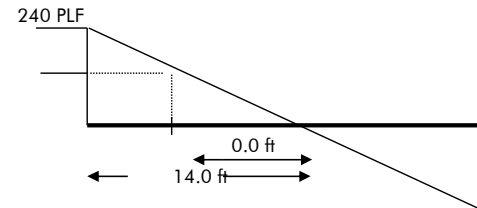
	WIND (front-rear)	WIND (left-right)	SEISMIC
ΣV (MAIN) =	926 lbs	926 lbs	1911 lbs
NOT APPLICABLE	0 lbs	0 lbs	0 lbs
NOT APPLICABLE	0 lbs	0 lbs	0 lbs
TOTAL =	926 lbs	926 lbs	1911 lbs

DIAPHRAGM SHEAR:

Total diaphragm length =	29.0 ft	Sub-diaphragm length =	29.0 ft
Diaphragm width =	28.0 ft	ΣV (MAIN) =	1,911 lbs

$$v = \frac{\Sigma V(\text{roof})}{(2)(\text{width})} = \frac{1911 \text{ lb}}{56 \text{ ft}} = 34 \text{ PLF}$$

IBC Table 2306.3.1 \longrightarrow 240 PLF



USE 15/32 CDX ROOF SHEATHING OR 3/4 T&G CDX SUBFLOORING w/8d AT 6 in o/c(PANEL EDGE), END 8d AT 12in o/c(PANEL FIELD)

CHORD:

Sub-diaphragm length =	29.0 ft	Total-diaphragm length =	29.0 ft
Sub-diaphragm width =	28.0 ft		

$$T = \frac{M}{B} = \frac{\Sigma V \times (\text{diaphragm length})}{8 \times (\text{diaphragm width})} = \frac{1911 \times 29 \text{ ft}}{8 \times 28 \text{ ft}} = 247 \text{ lbs}$$

Top Plate Size: 2x4 Species/Grade: HF #2

Area = 5.25 in² $F_t = 525 \text{ psi}$

Load duration (C_D) = 1.33 $T_{\text{allowable}} = \text{Area} \times C_D \times F_t = 3,666 \text{ lbs}$

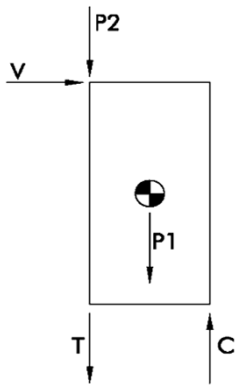
Since $T_{\text{allowable}}$ is greater than T_{applied} , OK.

SHEAR CAPACITY OF 10d COMMON NAIL = 102 lbs $102 \times C_d \times p = 136 \text{ lbs}$ 2018 NDS

$$\# \text{ OF NAILS PER 4 FT SPLICE} = \frac{247 \text{ lbs}}{136 \text{ lbs}} = 2$$

USE 2x4 HF #2 TOP PLATE W/ (8) 10d COMMON NAILS PER SPLICE.

Lateral Calculation Key



V = Shear, plf
 H = Height of shearwall
 L = Length of shearwall
 P1 = Weight of shearwall and connected framing
 P2 = Weight of adjacent wall

$T = V \times H - 0.5P1 - P2$ = Tension reaction to be resisted by holdown
 $C = V \times H + 0.5P1$ = Compression reaction

ASD Basic Load Combinations

For calculation of tension and compression forces in compliance with ASCE 7-16 2.4.1

Tension Equations (Uplift)

7. $0.6D + W$

8. $(0.6 - 0.14S_{Ds})D + E$ \longrightarrow $0.44 D + E$

*8. $(0.6 - 0.14S_{Ds})D + 2.5 E$ \longrightarrow $0.44 D + 2.5 E$

Compression Equations

5. $D + W$

5. $(1 + 0.14S_{Ds})D + E$ \longrightarrow $1.16 D + E$

6. $D + 0.75W + 0.75L + 0.75S$

6. $(1.0 + 0.105S_{Ds})D + 0.75E + 0.75L + 0.75S$ \longrightarrow $1.12 D + 0.75 E + 0.75 L + 0.75 S$

*5. $(1 + 0.14S_{Ds})D + 2.5E$ \longrightarrow $1.16 D + 2.5 E$

*6. $(1.0 + 0.105S_{Ds})D + 1.875E + 0.75L + 0.75S$ \longrightarrow $1.12 D + 1.875 E + 0.75 L + 0.75 S$

* Equations include overstrength factor.

Note: The 0.7 factor for Earthquake loading has already been incorporated into the calculation of the lateral design force E_h , but not E_v . Therefore this factor has been omitted from equations 5, 6 and 8 where appropriate.

MAIN FLOOR FRONT

SHEARWALL

WIND

SEISMIC

Floor Info

Main Floor Level, e.g. Upper, Main, Lower
Lt-Rt Load Direction, e.g. Left-Right, Front-Rear
 (For Left Wall, Use Front-Rear Load Direction)

CDX Sheathing type
 Values in accordance with AF&PA SDPWS-2015

Roof Resisting Dead Load
 (e.g. Roof, Upper Floor, Main Floor)

5.50 ft Total Length of Shearwalls

V(from upper)= 926 lb 1911 lb
 V(from main)= 0 lb 0 lb
 V(from lower)= 0 lb 0 lb
 Σ (Wind) = 926 lb Σ (Smc) = 1,911 lb
 v = 84 PLF v = 174 PLF

Tributary Width (Main Floor)

1.0 tributary width
 2.0 total width
 Not Used
 1.0 tributary width
 2.0 total width
 Not Used
 1.0 tributary width
 2.0 total width

Height of Shearwall = 8.0 ft
 Length of Shearwall = 5.5 ft

Aspect Ratio OK

Use alternate R factor for seismic? No

Tributary Area (Main Floor)

1.0 tributary area
 2.0 total area
 Not Used
 1.0 tributary area
 2.0 total area
 Not Used
 1.0 tributary area
 2.0 total area

Weight of Shearwall = 10.0 lbs
 Tributary width for dead load = 1.0 ft
 Length of adjoining wall = 1.0 ft

SDPWS, Table 4.3A → 0.93 x 242 = 225 PLF

USE SW6

Seismic controls shearwall design

C_{TOTAL} = (floor above) + (this floor) = + 973 lbs = 973 lbs Seismic controls
 T_{TOTAL} = (floor above) + (this floor) = + 1234 lbs = 1234 lbs Load case 8 controls - Seismic

Seismic controls holdown design

Where overstrength factor is applicable, use this value for E in equations 5, 6, and 8: E = 1390 lbs

USE SIMPSON DESIGNED HOLDOWN: CS14
 OR AT FOUNDATION / INTERIOR WALLS USE: LSTHD8/RJ

HDU4

MAIN FLOOR LEFT

SHEARWALL

WIND

SEISMIC

Floor Info

Main Floor Level, e.g. Upper, Main, Lower
Lt-Rt Load Direction, e.g. Left-Right, Front-Rear
 (For Left Wall, Use Front-Rear Load Direction)

CDX Sheathing type
 Values in accordance with AF&PA SDPWS-2015

Roof Resisting Dead Load
 (e.g. Roof, Upper Floor, Main Floor)

6.00 ft Total Length of Shearwalls

V(from upper)= 926 lb 1911 lb
 V(from main)= 0 lb 0 lb
 V(from lower)= 0 lb 0 lb
 Σ (Wind) = 926 lb Σ (Smc) = 1,911 lb
 v = 77 PLF v = 159 PLF

Tributary Width (Main Floor)

1.0 tributary width
 2.0 total width
 Not Used
 1.0 tributary width
 2.0 total width
 Not Used
 1.0 tributary width
 2.0 total width

Height of Shearwall = 8.0 ft
 Length of Shearwall = 6.0 ft

Aspect Ratio OK

Use alternate R factor for seismic? No

Tributary Area (Main Floor)

1.0 tributary area
 2.0 total area
 Not Used
 1.0 tributary area
 2.0 total area
 Not Used
 1.0 tributary area
 2.0 total area

Weight of Shearwall = 10.0 lbs
 Tributary width for dead load = 1.0 ft
 Length of adjoining wall = 1.0 ft

SDPWS, Table 4.3A → 0.93 x 242 = 225 PLF

USE SW6

Seismic controls shearwall design

C_{TOTAL} = (floor above) + (this floor) = + 892 lbs = 892 lbs Seismic controls
 T_{TOTAL} = (floor above) + (this floor) = + 1107 lbs = 1107 lbs Load case 8 controls - Seismic

Seismic controls holdown design

Where overstrength factor is applicable, use this value for E in equations 5, 6, and 8: E = 1274 lbs

USE SIMPSON DESIGNED HOLDOWN: CS14
 OR AT FOUNDATION / INTERIOR WALLS USE: LSTHD8/RJ

HDU4

Wood Beam

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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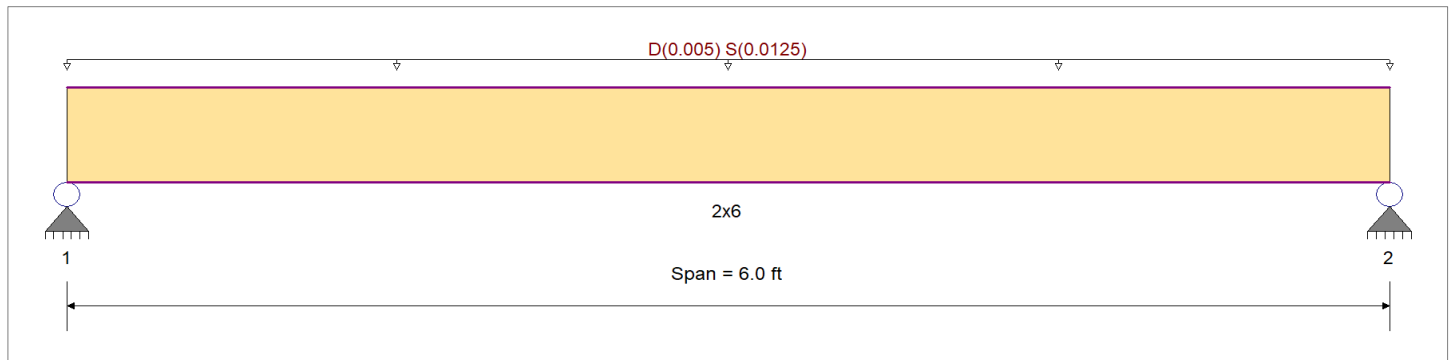
DESCRIPTION: CAR DECKING (check 1)

CODE REFERENCES

Calculations per NDS 2018, IBC 2021, SDPWS 2021
 Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Stress Design	Fb +	850.0 psi	<i>E : Modulus of Elasticity</i>	
Load Combination : IBC 2021	Fb -	850.0 psi	Ebend- xx	1,600.0ksi
	Fc - Prll	1,400.0 psi	Eminbend - xx	580.0ksi
Wood Species : Douglas Fir-Larch (North)	Fc - Perp	625.0 psi		
Wood Grade : No. 1/No. 2	Fv	180.0 psi		
	Ft	500.0 psi	Density	30.590pcf
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling				



Applied Loads

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

Beam self weight calculated and added to loading
 Uniform Load : D = 0.010, S = 0.0250 ksf, Tributary Width = 0.50 ft, (ROOF)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.397 : 1	Maximum Shear Stress Ratio	=	0.043 : 1
Section used for this span		2x6	Section used for this span		2x6
		(weak orientation)			(weak orientation)
fb: Actual	=	504.07psi	fv: Actual	=	8.97 psi
F'b	=	1,270.75psi	F'v	=	207.00 psi
Load Combination		+D+S	Load Combination		+D+S
Location of maximum on span	=	3.000ft	Location of maximum on span	=	0.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1
Maximum Deflection					
Max Downward Transient Deflection	0.148 in	Ratio = 486 >=360	Span: 1 : S Only		n/a
Max Upward Transient Deflection	0 in	Ratio = 0 <360			
Max Downward Total Deflection	0.228 in	Ratio = 315 >=240	Span: 1 : +D+S		n/a
Max Upward Total Deflection	0 in	Ratio = 0 <240			

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios									Moment Values			Shear Values				
			M	V	CD	CM	C _t	CLx	C _F	C _{fu}	C _i	C _r	M	fb	F'b	V	fv	F'v	
D Only	Length = 6.0 ft	1	0.178	0.019	0.90	1.00	1.00	1.00	1.300	1.00	1.00	1.00	0.03	176.8	994.5	0.0	0.00	0.0	0.0
+D+S	Length = 6.0 ft	1	0.397	0.043	1.15	1.00	1.00	1.00	1.300	1.00	1.00	1.00	0.09	504.1	1,270.8	0.0	0.00	9.0	207.0
+D+0.750S	Length = 6.0 ft	1	0.332	0.036	1.15	1.00	1.00	1.00	1.300	1.00	1.00	1.00	0.07	422.2	1,270.8	0.0	0.00	7.5	207.0
+0.60D	Length = 6.0 ft	1	0.060	0.007	1.60	1.00	1.00	1.00	1.300	1.00	1.00	1.00	0.02	106.1	1,768.0	0.0	0.00	1.9	288.0

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Wood Beam

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: CAR DECKING (check 1)

Overall Maximum Deflections

Span	Load Combination	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
1	+D+S	0.2281	3.022		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.058	0.058
Max Upward from Load Combinations	0.058	0.058
Max Upward from Load Cases	0.038	0.038
D Only	0.020	0.020
+D+S	0.058	0.058
+D+0.750S	0.048	0.048
+0.60D	0.012	0.012
S Only	0.038	0.038

Wood Beam

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: CAR DECKING (check 2)

CODE REFERENCES

Calculations per NDS 2018, IBC 2021, SDPWS 2021

Load Combination Set : IBC 2021

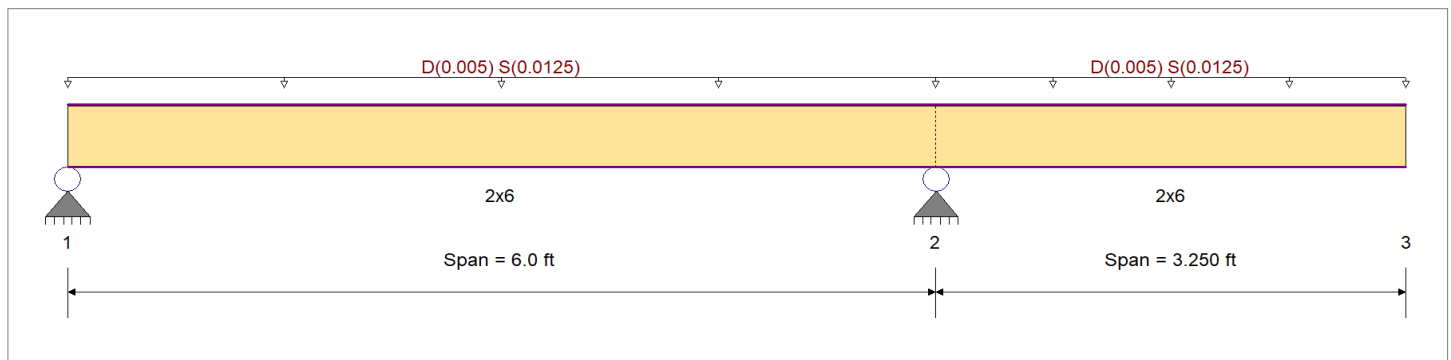
Material Properties

Analysis Method : Allowable Stress Design
 Load Combination : IBC 2021

Wood Species : Hem-Fir
 Wood Grade : No.2

Beam Bracing : Beam is Fully Braced against lateral-torsional buckling

Fb +	850 psi	E : Modulus of Elasticity	
Fb -	850 psi	Ebend- xx	1300ksi
Fc - Prll	1300 psi	Eminbend - xx	470ksi
Fc - Perp	405 psi		
Fv	150 psi		
Ft	525 psi	Density	26.84pcf



Applied Loads

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

Beam self weight calculated and added to loading

Load for Span Number 1

Uniform Load : D = 0.0050, S = 0.01250, Tributary Width = 1.0 ft, (ROOF)

Load for Span Number 2

Uniform Load : D = 0.010, S = 0.0250 ksf, Tributary Width = 0.50 ft, (ROOF)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.460 : 1	Maximum Shear Stress Ratio	=	0.069 : 1
Section used for this span		2x6	Section used for this span		2x6
		(weak orientation)			(weak orientation)
fb: Actual	=	584.98psi	fv: Actual	=	11.92 psi
F'b	=	1,270.75psi	F'v	=	172.50 psi
Load Combination		+D+S	Load Combination		+D+S
Location of maximum on span	=	6.000ft	Location of maximum on span	=	5.564 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1
Maximum Deflection					
Max Downward Transient Deflection	0.204 in	Ratio = 382 >=360	Span: 2 : S Only		
Max Upward Transient Deflection	-0.002 in	Ratio = 35896 >=360	Span: 1 : S Only		
Max Downward Total Deflection	0.310 in	Ratio = 250 >=240	Span: 2 : +D+S		
Max Upward Total Deflection	-0.003 in	Ratio = 23569 >=240	Span: 1 : +D+S		

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios										Moment Values			Shear Values				
			M	V	CD	CM	C _t	CLx	C _F	C _{fu}	C _i	C _r	M	fb	F'b	V	fv	F'v		
D Only																				
	Length = 6.0 ft	1	0.202	0.030	0.90	1.00	1.00	1.00	1.300	1.00	1.00	1.00	0.03	200.9	994.5	0.02	4.1	135.0		
	Length = 3.250 ft	2	0.202	0.030	0.90	1.00	1.00	1.00	1.300	1.00	1.00	1.00	0.03	200.9	994.5	0.02	4.1	135.0		
+D+S																				
	Length = 6.0 ft	1	0.460	0.069	1.15	1.00	1.00	1.00	1.300	1.00	1.00	1.00	0.10	585.0	1,270.8	0.07	11.9	172.5		
	Length = 3.250 ft	2	0.460	0.069	1.15	1.00	1.00	1.00	1.300	1.00	1.00	1.00	0.10	585.0	1,270.8	0.05	11.9	172.5		

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Wood Beam

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: CAR DECKING (check 2)

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios									Moment Values			Shear Values			
			M	V	CD	CM	C _t	CLx	C _F	C _{fu}	C _i	C _r	M	fb	F _b	V	fv	F _v
+D+0.750S						1.00	1.00	1.00	1.300	1.00	1.00	1.00			0.0	0.00	0.0	0.0
Length = 6.0 ft		1	0.385	0.058	1.15	1.00	1.00	1.00	1.300	1.00	1.00	1.00	0.08	489.0	1,270.8	0.05	10.0	172.5
Length = 3.250 ft		2	0.385	0.058	1.15	1.00	1.00	1.00	1.300	1.00	1.00	1.00	0.08	489.0	1,270.8	0.04	10.0	172.5
+0.60D						1.00	1.00	1.00	1.300	1.00	1.00	1.00			0.0	0.00	0.0	0.0
Length = 6.0 ft		1	0.068	0.010	1.60	1.00	1.00	1.00	1.300	1.00	1.00	1.00	0.02	120.5	1,768.0	0.01	2.5	240.0
Length = 3.250 ft		2	0.068	0.010	1.60	1.00	1.00	1.00	1.300	1.00	1.00	1.00	0.02	120.5	1,768.0	0.01	2.5	240.0

Overall Maximum Deflections

Span	Load Combination	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
1	+D+S	0.0898	2.380	+D+S	-0.0031	5.665
2	+D+S	0.3103	3.250		0.0000	5.665

Vertical Reactions

Support notation : Far left is #1

Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Max Upward from all Load Conditions	0.040	0.136	
Max Upward from Load Combinations	0.040	0.136	
Max Upward from Load Cases	0.026	0.089	
D Only	0.014	0.047	
+D+S	0.040	0.136	
+D+0.750S	0.034	0.113	
+0.60D	0.008	0.028	
S Only	0.026	0.089	

Wood Beam

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: BM#1

CODE REFERENCES

Calculations per NDS 2018, IBC 2021, SDPWS 2021

Load Combination Set : IBC 2021

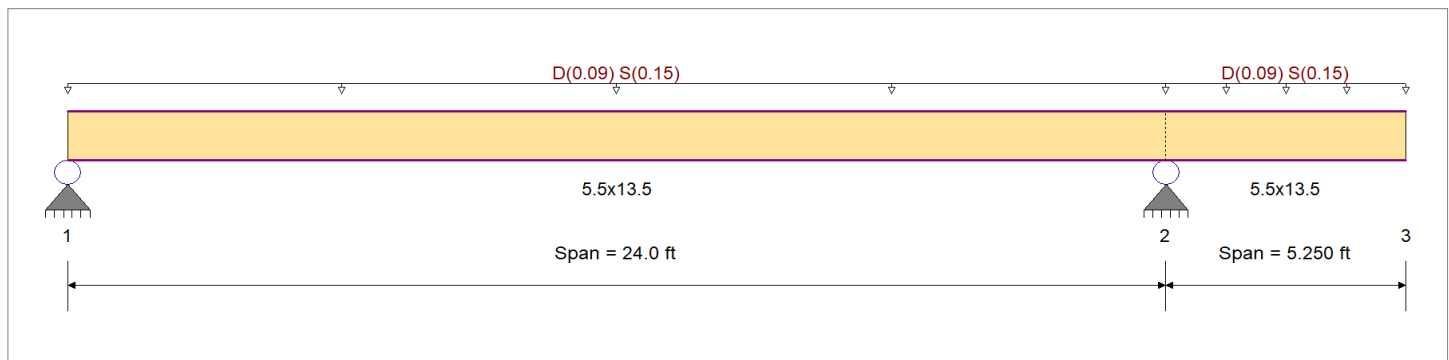
Material Properties

Analysis Method : Allowable Stress Design
 Load Combination : IBC 2021

Wood Species : DF/DF
 Wood Grade : 24F-V4

Beam Bracing : Beam is Fully Braced against lateral-torsional buckling

Fb +	2,400.0 psi	<i>E</i> : Modulus of Elasticity	
Fb -	1,850.0 psi	Ebend- xx	1,800.0ksi
Fc - Prll	1,650.0 psi	Eminbend - xx	950.0ksi
Fc - Perp	650.0 psi	Ebend- yy	1,600.0ksi
Fv	265.0 psi	Eminbend - yy	850.0ksi
Ft	1,100.0 psi	Density	31.210pcf



Applied Loads

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

Beam self weight calculated and added to loading

Load for Span Number 1

Uniform Load : D = 0.0150, S = 0.0250 ksf, Tributary Width = 6.0 ft, (ROOF)

Load for Span Number 2

Uniform Load : D = 0.0150, S = 0.0250 ksf, Tributary Width = 6.0 ft, (ROOF)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.449 < 1	Maximum Shear Stress Ratio	=	0.195 < 1
Section used for this span		5.5x13.5	Section used for this span		5.5x13.5
fb: Actual	=	1,200.71 psi	fv: Actual	=	59.50 psi
F'b	=	2,672.56psi	F'v	=	304.75 psi
Load Combination			Load Combination		
Location of maximum on span	=	11.397ft	Location of maximum on span	=	22.927 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1
Maximum Deflection					
Max Downward Transient Deflection		0.493 in	Ratio =	584 >=360	Span: 1 : S Only
Max Upward Transient Deflection		-0.300 in	Ratio =	418 >=360	Span: 2 : S Only
Max Downward Total Deflection		0.842 in	Ratio =	342 >=240	Span: 1 : +D+S
Max Upward Total Deflection		-0.512 in	Ratio =	244 >=240	Span: 2 : +D+S

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios										Moment Values			Shear Values				
			M	V	CD	CM	C _t	CLx	C _v	C _{fu}	C _i	C _r	M	fb	F'b	V	fv	F'v		
D Only																				
	Length = 24.0 ft	1	0.238	0.103	0.90	1.00	1.00	1.00	0.968	1.00	1.00	1.00	6.93	497.4	2,091.6	0.0	0.00	0.0	0.0	238.5
	Length = 5.250 ft	2	0.063	0.103	0.90	1.00	1.00	1.00	1.000	1.00	1.00	1.00	1.46	105.0	1,665.0	0.44	0.44	24.7	238.5	238.5
+D+S																				
	Length = 24.0 ft	1	0.449	0.195	1.15	1.00	1.00	1.00	0.968	1.00	1.00	1.00	16.72	1,200.7	2,672.6	2.95	2.95	59.5	304.8	304.8
	Length = 5.250 ft	2	0.119	0.195	1.15	1.00	1.00	1.00	1.000	1.00	1.00	1.00	3.53	253.5	2,127.5	1.06	1.06	59.5	304.8	304.8

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Wood Beam

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: BM#1

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios									Moment Values			Shear Values			
			M	V	CD	CM	C _t	CLx	C _v	C _{fu}	C _i	C _r	M	fb	F _b	V	fv	F _v
+D+0.750S						1.00	1.00	1.00	1.000	1.00	1.00	1.00			0.0	0.00	0.0	0.0
Length = 24.0 ft		1	0.383	0.167	1.15	1.00	1.00	1.00	0.968	1.00	1.00	1.00	14.27	1,024.9	2,672.6	2.51	50.8	304.8
Length = 5.250 ft		2	0.102	0.167	1.15	1.00	1.00	1.00	1.000	1.00	1.00	1.00	3.01	216.4	2,127.5	0.90	50.8	304.8
+0.60D						1.00	1.00	1.00	1.000	1.00	1.00	1.00			0.0	0.00	0.0	0.0
Length = 24.0 ft		1	0.080	0.035	1.60	1.00	1.00	1.00	0.968	1.00	1.00	1.00	4.16	298.5	3,718.3	0.73	14.8	424.0
Length = 5.250 ft		2	0.021	0.035	1.60	1.00	1.00	1.00	1.000	1.00	1.00	1.00	0.88	63.0	2,960.0	0.26	14.8	424.0

Overall Maximum Deflections

Span	Load Combination	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
1	+D+S	0.8416	11.799		0.0000	0.000
2		0.0000	11.799	+D+S	-0.5125	5.250

Vertical Reactions

Support notation : Far left is #1

Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Max Upward from all Load Conditions	2.926	4.565	
Max Upward from Load Combinations	2.926	4.565	
Max Upward from Load Cases	1.714	2.674	
D Only	1.212	1.891	
+D+S	2.926	4.565	
+D+0.750S	2.498	3.896	
+0.60D	0.727	1.135	
S Only	1.714	2.674	

Wood Beam

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: BM#2

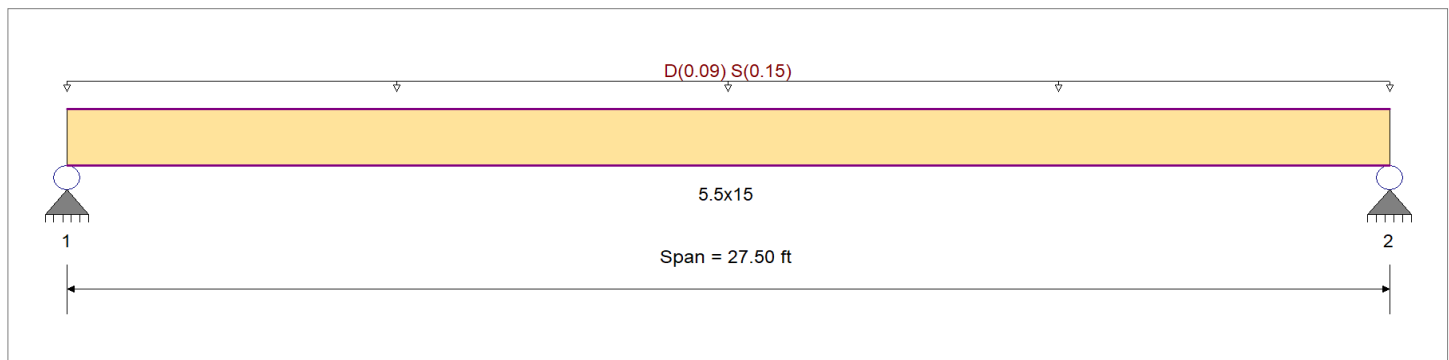
CODE REFERENCES

Calculations per NDS 2018, IBC 2021, SDPWS 2021

Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Stress Design	Fb +	2,400.0 psi	<i>E : Modulus of Elasticity</i>	
Load Combination : IBC 2021	Fb -	1,850.0 psi	Ebend- xx	1,800.0ksi
Wood Species : DF/DF	Fc - Prll	1,650.0 psi	Eminbend - xx	950.0ksi
Wood Grade : 24F-V4	Fc - Perp	650.0 psi	Ebend- yy	1,600.0ksi
	Fv	265.0 psi	Eminbend - yy	850.0ksi
	Ft	1,100.0 psi	Density	31.210pcf
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling				



Applied Loads

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

Beam self weight calculated and added to loading

Uniform Load : D = 0.0150, S = 0.0250 ksf, Tributary Width = 6.0 ft, (ROOF)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.544 : 1	Maximum Shear Stress Ratio	=	0.193 : 1
Section used for this span		5.5x15	Section used for this span		5.5x15
fb: Actual	=	1,418.34psi	fv: Actual	=	58.82 psi
F'b	=	2,608.79psi	F'v	=	304.75 psi
Load Combination		+D+S	Load Combination		+D+S
Location of maximum on span	=	13.750ft	Location of maximum on span	=	0.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1
Maximum Deflection					
Max Downward Transient Deflection	0.697 in	Ratio = 473 >=360	Span: 1 : S Only		n/a
Max Upward Transient Deflection	0 in	Ratio = 0 <360			
Max Downward Total Deflection	1.199 in	Ratio = 275 >=240	Span: 1 : +D+S		n/a
Max Upward Total Deflection	0 in	Ratio = 0 <240			

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios									Moment Values			Shear Values				
			M	V	CD	CM	C _t	CLx	C _v	C _{fu}	C _i	C _r	M	fb	F'b	V	fv	F'v	
D Only																			
	Length = 27.50 ft	1	0.291	0.103	0.90	1.00	1.00	1.00	0.945	1.00	1.00	1.00	10.20	593.3	2,041.7	0.0	0.00	0.0	0.0
+D+S																			
	Length = 27.50 ft	1	0.544	0.193	1.15	1.00	1.00	1.00	0.945	1.00	1.00	1.00	24.38	1,418.3	2,608.8	0.0	0.00	0.0	0.0
+D+0.750S																			
	Length = 27.50 ft	1	0.465	0.165	1.15	1.00	1.00	1.00	0.945	1.00	1.00	1.00	20.83	1,212.1	2,608.8	0.0	0.00	0.0	0.0
+0.60D																			
	Length = 27.50 ft	1	0.098	0.035	1.60	1.00	1.00	1.00	0.945	1.00	1.00	1.00	6.12	356.0	3,629.6	0.0	0.00	0.0	0.0

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Wood Beam

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: BM#2

Overall Maximum Deflections

Span	Load Combination	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
1	+D+S	1.1988	13.850		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	3.546	3.546
Max Upward from Load Combinations	3.546	3.546
Max Upward from Load Cases	2.063	2.063
D Only	1.483	1.483
+D+S	3.546	3.546
+D+0.750S	3.030	3.030
+0.60D	0.890	0.890
S Only	2.063	2.063

Wood Beam

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: BM#3

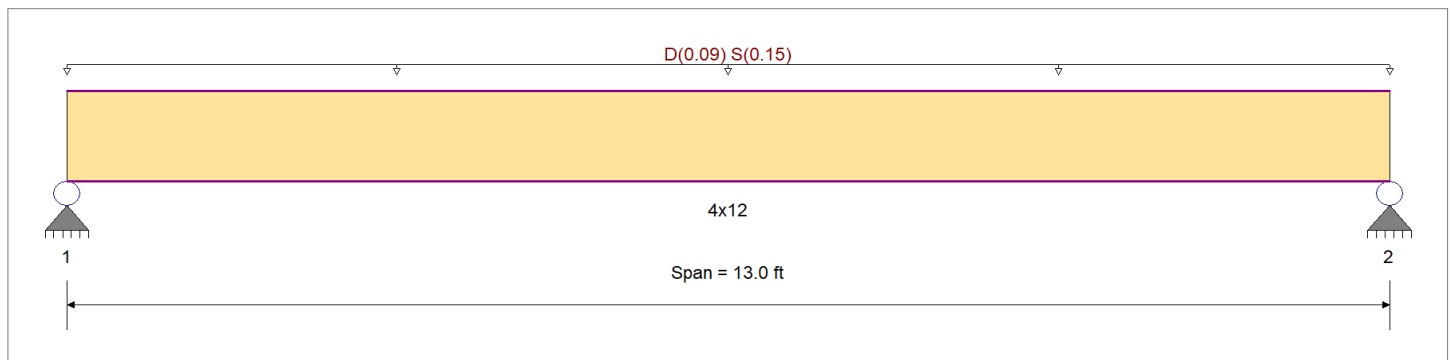
CODE REFERENCES

Calculations per NDS 2018, IBC 2021, SDPWS 2021

Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Stress Design	Fb +	875 psi	<i>E : Modulus of Elasticity</i>	
Load Combination : IBC 2021	Fb -	875 psi	Ebend- xx	1300ksi
	Fc - Prll	600 psi	Eminbend - xx	470ksi
Wood Species : Douglas Fir-Larch (North)	Fc - Perp	625 psi		
Wood Grade : No.2	Fv	170 psi		
	Ft	425 psi	Density	30.59pcf
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling				



Applied Loads

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

Beam self weight calculated and added to loading

Uniform Load : D = 0.0150, S = 0.0250 ksf, Tributary Width = 6.0 ft, (ROOF)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.770 : 1	Maximum Shear Stress Ratio	=	0.271 : 1
Section used for this span		4x12	Section used for this span		4x12
fb: Actual	=	852.80psi	fv: Actual	=	52.97 psi
F'b	=	1,106.88psi	F'v	=	195.50 psi
Load Combination		+D+S	Load Combination		+D+S
Location of maximum on span	=	6.500ft	Location of maximum on span	=	12.099 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1
Maximum Deflection					
Max Downward Transient Deflection	0.180 in	Ratio = 868 >=360	Span: 1 : S Only		n/a
Max Upward Transient Deflection	0 in	Ratio = 0 <360			
Max Downward Total Deflection	0.297 in	Ratio = 524 >=240	Span: 1 : +D+S		n/a
Max Upward Total Deflection	0 in	Ratio = 0 <240			

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios										Moment Values			Shear Values				
			M	V	CD	CM	C _t	CLx	C _F	C _{fu}	C _i	C _r	M	fb	F'b	V	fv	F'v		
D Only	Length = 13.0 ft	1	0.390	0.137	0.90	1.00	1.00	1.00	1.100	1.00	1.00	1.00	2.08	337.7	866.3	0.0	0.00	0.0	0.0	153.0
+D+S	Length = 13.0 ft	1	0.770	0.271	1.15	1.00	1.00	1.00	1.100	1.00	1.00	1.00	5.25	852.8	1,106.9	0.0	0.00	0.0	0.0	195.5
+D+0.750S	Length = 13.0 ft	1	0.654	0.230	1.15	1.00	1.00	1.00	1.100	1.00	1.00	1.00	4.45	724.0	1,106.9	0.0	0.00	0.0	0.0	195.5
+0.60D	Length = 13.0 ft	1	0.132	0.046	1.60	1.00	1.00	1.00	1.100	1.00	1.00	1.00	1.25	202.6	1,540.0	0.0	0.00	0.0	0.0	272.0

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Wood Beam

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: BM#3

Overall Maximum Deflections

Span	Load Combination	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
1	+D+S	0.2974	6.547		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	1.614	1.614
Max Upward from Load Combinations	1.614	1.614
Max Upward from Load Cases	0.975	0.975
D Only	0.639	0.639
+D+S	1.614	1.614
+D+0.750S	1.371	1.371
+0.60D	0.384	0.384
S Only	0.975	0.975

Wood Beam

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: RAFTERS

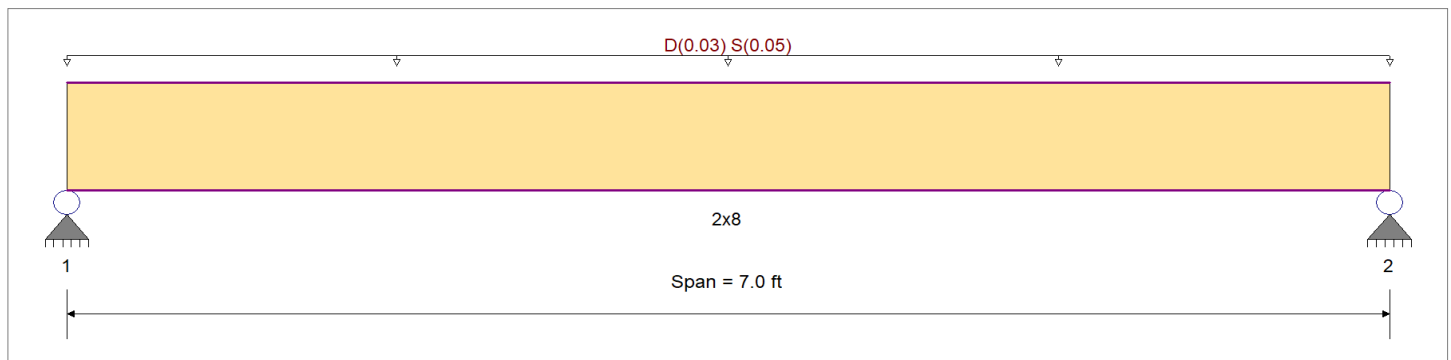
CODE REFERENCES

Calculations per NDS 2018, IBC 2021, SDPWS 2021

Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Stress Design	Fb +	675 psi	E : Modulus of Elasticity	
Load Combination : IBC 2021	Fb -	675 psi	Ebend- xx	1100ksi
	Fc - Prll	500 psi	Eminbend - xx	400ksi
Wood Species : Hem-Fir	Fc - Perp	405 psi		
Wood Grade : No.2	Fv	140 psi		
	Ft	350 psi	Density	26.84pcf
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling			Repetitive Member Stress Increase	



Applied Loads

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

Beam self weight calculated and added to loading

Uniform Load : D = 0.0150, S = 0.0250 ksf, Tributary Width = 2.0 ft, (ROOF)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.428 : 1	Maximum Shear Stress Ratio	=	0.205 : 1
Section used for this span		2x8	Section used for this span		2x8
fb: Actual	=	458.80psi	fv: Actual	=	32.95 psi
F'b	=	1,071.23psi	F'v	=	161.00 psi
Load Combination		+D+S	Load Combination		+D+S
Location of maximum on span	=	3.500ft	Location of maximum on span	=	6.412 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1
Maximum Deflection					
Max Downward Transient Deflection	0.052 in	Ratio = 1620 >=360	Span: 1 : S Only		
Max Upward Transient Deflection	0 in	Ratio = 0 <360	n/a		
Max Downward Total Deflection	0.085 in	Ratio = 987 >=240	Span: 1 : +D+S		
Max Upward Total Deflection	0 in	Ratio = 0 <240	n/a		

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios										Moment Values			Shear Values			
			M	V	CD	CM	C _t	CLx	C _F	C _{fu}	C _i	C _r	M	fb	F'b	V	fv	F'v	
D Only	Length = 7.0 ft	1	0.214	0.102	0.90	1.00	1.00	1.00	1.200	1.00	1.00	1.15	0.20	179.1	838.4	0.0	0.00	0.0	0.0
+D+S	Length = 7.0 ft	1	0.428	0.205	1.15	1.00	1.00	1.00	1.200	1.00	1.00	1.15	0.50	458.8	1,071.2	0.24	0.00	0.0	0.0
+D+0.750S	Length = 7.0 ft	1	0.363	0.173	1.15	1.00	1.00	1.00	1.200	1.00	1.00	1.15	0.43	388.9	1,071.2	0.20	0.00	0.0	0.0
+0.60D	Length = 7.0 ft	1	0.072	0.034	1.60	1.00	1.00	1.00	1.200	1.00	1.00	1.15	0.12	107.5	1,490.4	0.06	0.00	0.0	0.0

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Wood Beam

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

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DESCRIPTION: RAFTERS

Overall Maximum Deflections

Span	Load Combination	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
1	+D+S	0.0851	3.526		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.287	0.287
Max Upward from Load Combinations	0.287	0.287
Max Upward from Load Cases	0.175	0.175
D Only	0.112	0.112
+D+S	0.287	0.287
+D+0.750S	0.243	0.243
+0.60D	0.067	0.067
S Only	0.175	0.175

Wood Column

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: COL#1

Code References

Calculations per NDS 2018, IBC 2021, SDPWS 2021
 Load Combinations Used : IBC 2021

General Information

Analysis Method	Allowable Stress Design	Wood Section Name	6x6
End Fixities	Top & Bottom Pinned	Wood Grading/Manuf.	Graded Lumber
Overall Column Height	10 ft	Wood Member Type	Sawn
<i>(Used for non-slender calculations)</i>			
Wood Species	Douglas Fir-Larch (North)	Exact Width	5.50 in
Wood Grade	No.2	Exact Depth	5.50 in
Fb +	725 psi	Fv	170 psi
Fb -	725 psi	Ft	475 psi
Fc - Prll	700 psi	Density	30.59 pcf
Fc - Perp	625 psi		
E : Modulus of Elasticity . . .	x-x Bending	y-y Bending	Axial
	Basic	1300	1300
	Minimum	470	470
			1300 ksi
			Column Buckling Condition:
			ABOUT X-X Axis: Lux = 10 ft, Kx = 1.0
			ABOUT Y-Y Axis: Luy = 10 ft, Ky = 1.0

Applied Loads

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

Column self weight included : 64.260 lbs * Dead Load Factor

AXIAL LOADS . . .

BM#1: Axial Load at 10.0 ft, D = 1.90, S = 2.70 k

DESIGN SUMMARY

Bending & Shear Check Results

PASS Max. Axial+Bending Stress Ratio = **0.2761 : 1**
 Load Combination +D+S
 Governing NDS Formula Comp Only, fc/Fc'
 Location of max.above base 0.0 ft
 At maximum location values are .
 Applied Axial 4.664 k
 Applied Mx 0.0 k-ft
 Applied My 0.0 k-ft
 Fc : Allowable 558.50 psi

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

Maximum SERVICE Load Lateral Deflections . . .
 Along Y-Y 0.0 in at 0.0 ft above base
 for load combination : n/a
 Along X-X 0.0 in at 0.0 ft above base
 for load combination : n/a

PASS Maximum Shear Stress Ratio = **0.0 : 1**
 Load Combination +0.60D
 Location of max.above base 10.0 ft
 Applied Design Shear 0.0 psi
 Allowable Shear 272.0 psi

Other Factors used to calculate allowable stresses . . .
Bending Compression Tension

Load Combination Results

Load Combination	C _D	C _P	Maximum Axial + Bending Stress Ratios			Maximum Shear Ratios		
			Stress Ratio	Status	Location	Stress Ratio	Status	Location
D Only	0.900	0.771	0.1338	PASS	0.0 ft	0.0	PASS	10.0 ft
+D+S	1.150	0.694	0.2761	PASS	0.0 ft	0.0	PASS	10.0 ft
+D+0.750S	1.150	0.694	0.2361	PASS	0.0 ft	0.0	PASS	10.0 ft
+0.60D	1.600	0.572	0.06083	PASS	0.0 ft	0.0	PASS	10.0 ft

Maximum Reactions

Note: Only non-zero reactions are listed.

Load Combination	X-X Axis Reaction		Y-Y Axis Reaction		Axial Reaction	My - End Moments		Mx - End Moments	
	@ Base	@ Top	@ Base	@ Top	@ Base	@ Base	@ Top	@ Base	@ Top
D Only					1.964				
+D+S					4.664				
+D+0.750S					3.989				

Wood Column

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

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DESCRIPTION: COL#1

Maximum Reactions

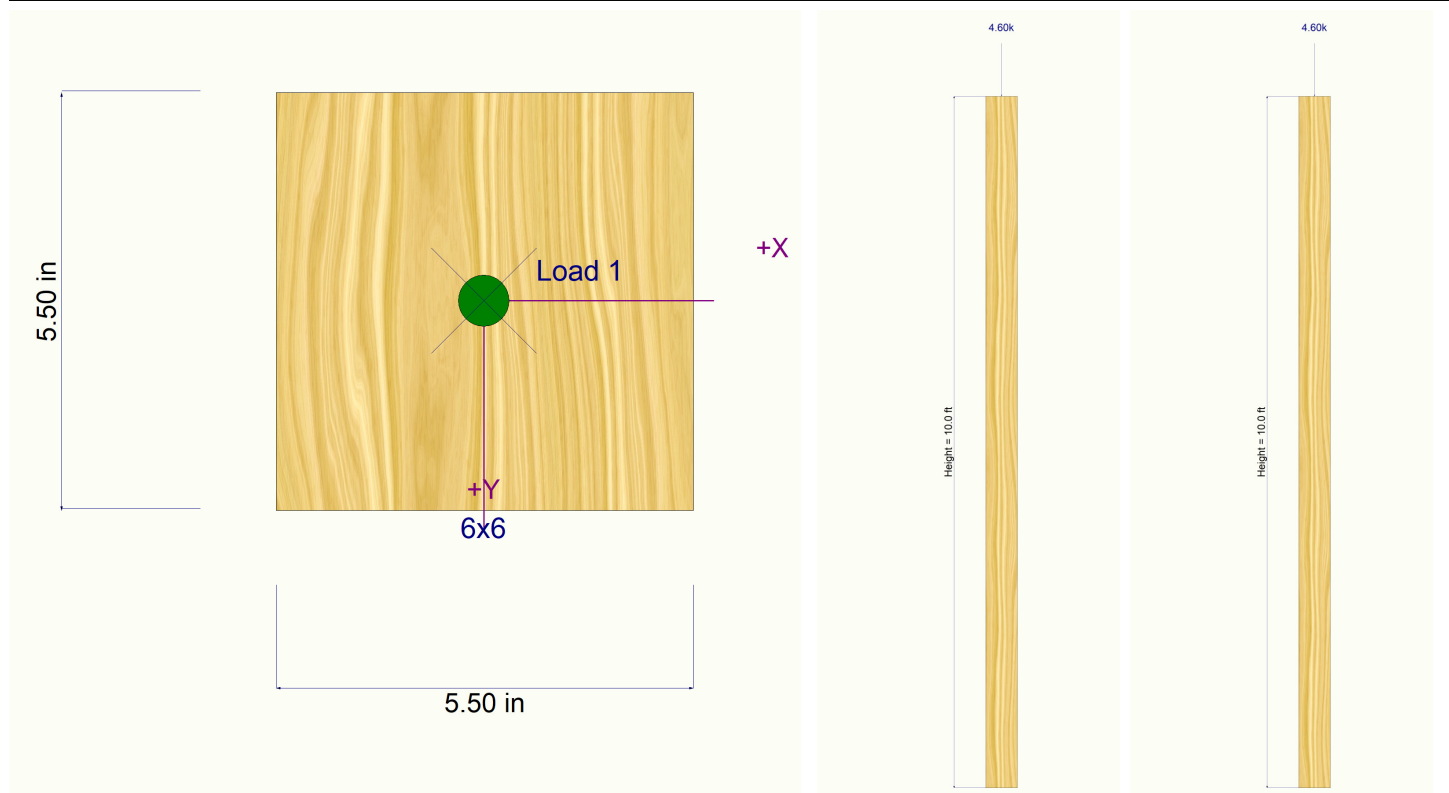
Note: Only non-zero reactions are listed.

Load Combination	X-X Axis Reaction		Y-Y Axis Reaction		Axial Reaction	My - End Moments		Mx - End Moments	
	@ Base	@ Top	@ Base	@ Top	@ Base	@ Base	@ Top	@ Base	@ Top
+0.60D					1.179				
S Only					2.700				

Maximum Deflections for Load Combinations

Load Combination	Max. X-X Deflection	Distance	Max. Y-Y Deflection	Distance
D Only	0.0000 in	0.000ft	0.000 in	0.000 ft
+D+S	0.0000 in	0.000ft	0.000 in	0.000 ft
+D+0.750S	0.0000 in	0.000ft	0.000 in	0.000 ft
+0.60D	0.0000 in	0.000ft	0.000 in	0.000 ft
S Only	0.0000 in	0.000ft	0.000 in	0.000 ft

Sketches



General Footing

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: FTNG#1

Code References

Calculations per ACI 318-19, IBC 2021
 Load Combinations Used : IBC 2021

General Information

Material Properties

f'c : Concrete 28 day strength	=	2.50 ksi
fy : Rebar Yield	=	40.0 ksi
Ec : Concrete Elastic Modulus	=	3,122.0 ksi
Concrete Density	=	145.0 pcf
φ Values Flexure	=	0.90
Shear	=	0.750

Soil Design Values

Allowable Soil Bearing	=	3.50 ksf
Soil Density	=	110.0 pcf
Increase Bearing By Footing Weight	=	No
Soil Passive Resistance (for Sliding)	=	350.0 pcf
Soil/Concrete Friction Coeff.	=	.5

Analysis Settings

Min Steel % Bending Reinf.	=	
Min Allow % Temp Reinf.	=	0.00180
Min. Overturning Safety Factor	=	1.0 : 1
Min. Sliding Safety Factor	=	1.0 : 1
Add Ftg Wt for Soil Pressure	:	Yes
Use ftg wt for stability, moments & shears	:	Yes
Add Pedestal Wt for Soil Pressure	:	No
Use Pedestal wt for stability, mom & shear	:	No

Increases based on footing depth

Footing base depth below soil surface	=	ft
Allow press. increase per foot of depth when footing base is below	=	ksf ft

Increases based on footing plan dimension

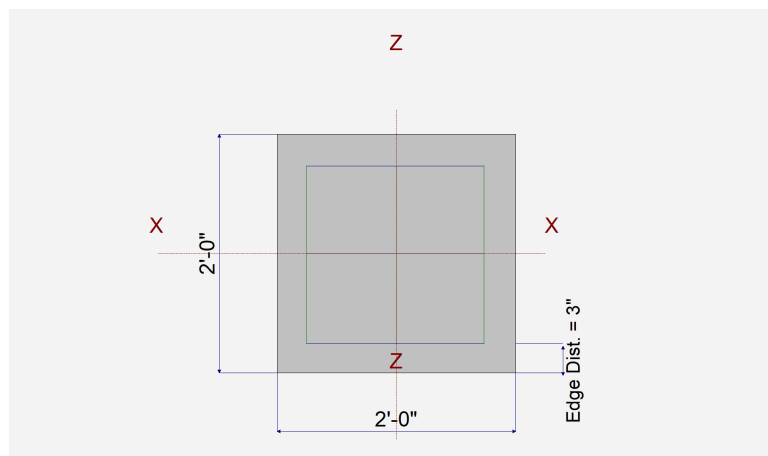
Allowable pressure increase per foot of depth when max. length or width is greater than	=	ksf ft
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Dimensions

Width parallel to X-X Axis	=	2.0 ft
Length parallel to Z-Z Axis	=	2.0 ft
Footing Thickness	=	10.0 in

Pedestal dimensions...

px : parallel to X-X Axis	=	in
pz : parallel to Z-Z Axis	=	in
Height	=	in
Rebar Centerline to Edge of Concrete... at Bottom of footing	=	3.0 in



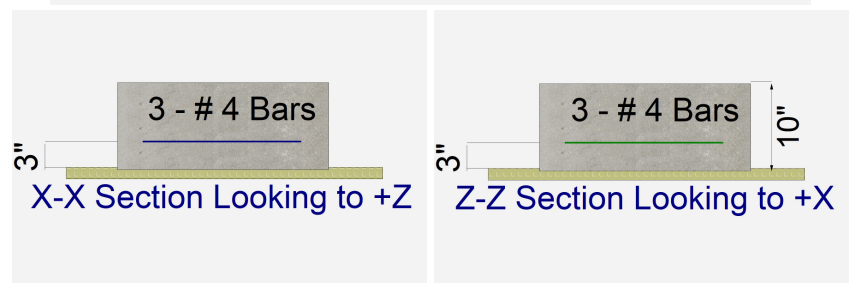
Reinforcing

Bars parallel to X-X Axis		
Number of Bars	=	3
Reinforcing Bar Size	=	# 4

Bars parallel to Z-Z Axis		
Number of Bars	=	3.0
Reinforcing Bar Size	=	# 4

Bandwidth Distribution Check (ACI 15.4.4.2)

Direction Requiring Closer Separation		
# Bars required within zone		n/a
# Bars required on each side of zone		n/a



Applied Loads

	D	Lr	L	S	W	E	H
P : Column Load	=	1.90			2.70		k
OB : Overburden	=						ksf
M-xx	=						k-ft
M-zz	=						k-ft
V-x	=						k
V-z	=						k

General Footing

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: FTNG#1

DESIGN SUMMARY

Design OK

	Min. Ratio	Item	Applied	Capacity	Governing Load Combination
PASS	0.3631	Soil Bearing	1.271 ksf	3.50 ksf	+D+S about Z-Z axis
PASS	n/a	Overturing - X-X	0.0 k-ft	0.0 k-ft	No Overturing
PASS	n/a	Overturing - Z-Z	0.0 k-ft	0.0 k-ft	No Overturing
PASS	n/a	Sliding - X-X	0.0 k	0.0 k	No Sliding
PASS	n/a	Sliding - Z-Z	0.0 k	0.0 k	No Sliding
PASS	n/a	Uplift	0.0 k	0.0 k	No Uplift
PASS	0.1355	Z Flexure (+X)	0.8250 k-ft/ft	6.088 k-ft/ft	+1.20D+1.60S
PASS	0.1355	Z Flexure (-X)	0.8250 k-ft/ft	6.088 k-ft/ft	+1.20D+1.60S
PASS	0.1355	X Flexure (+Z)	0.8250 k-ft/ft	6.088 k-ft/ft	+1.20D+1.60S
PASS	0.1355	X Flexure (-Z)	0.8250 k-ft/ft	6.088 k-ft/ft	+1.20D+1.60S
PASS	0.1799	1-way Shear (+X)	8.250 psi	45.857 psi	+1.20D+1.60S
PASS	0.1799	1-way Shear (-X)	8.250 psi	45.857 psi	+1.20D+1.60S
PASS	0.1799	1-way Shear (+Z)	8.250 psi	45.857 psi	+1.20D+1.60S
PASS	0.1799	1-way Shear (-Z)	8.250 psi	45.857 psi	+1.20D+1.60S
PASS	0.2043	2-way Punching	30.643 psi	150.0 psi	+1.20D+1.60S

Detailed Results

Soil Bearing

Rotation Axis & Load Combination...	Gross Allowable	Xecc	Zecc (in)	Actual Soil Bearing Stress @ Location				Actual / Allow Ratio
				Bottom, -Z	Top, +Z	Left, -X	Right, +X	
X-X, D Only	3.50	n/a	0.0	0.5958	0.5958	n/a	n/a	0.170
X-X, +D+S	3.50	n/a	0.0	1.271	1.271	n/a	n/a	0.363
X-X, +D+0.750S	3.50	n/a	0.0	1.102	1.102	n/a	n/a	0.315
X-X, +0.60D	3.50	n/a	0.0	0.3575	0.3575	n/a	n/a	0.102
Z-Z, D Only	3.50	0.0	n/a	n/a	n/a	0.5958	0.5958	0.170
Z-Z, +D+S	3.50	0.0	n/a	n/a	n/a	1.271	1.271	0.363
Z-Z, +D+0.750S	3.50	0.0	n/a	n/a	n/a	1.102	1.102	0.315
Z-Z, +0.60D	3.50	0.0	n/a	n/a	n/a	0.3575	0.3575	0.102

Overturing Stability

Rotation Axis & Load Combination...	Overturing Moment	Resisting Moment	Stability Ratio	Status
Footing Has NO Overturing				

All units k

Sliding Stability

Force Application Axis Load Combination...	Sliding Force	Resisting Force	Stability Ratio	Status
Footing Has NO Sliding				

Footing Flexure

Flexure Axis & Load Combination	Mu k-ft	Side	Tension Surface	As Req'd in^2	Gvrn. As in^2	Actual As in^2	Phi*Mn k-ft	Status
X-X, +1.40D	0.3325	+Z	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
X-X, +1.40D	0.3325	-Z	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
X-X, +1.20D	0.2850	+Z	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
X-X, +1.20D	0.2850	-Z	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
X-X, +1.20D+0.50S	0.4538	+Z	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
X-X, +1.20D+0.50S	0.4538	-Z	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
X-X, +1.20D+1.60S	0.8250	+Z	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
X-X, +1.20D+1.60S	0.8250	-Z	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
X-X, +1.20D+0.70S	0.5213	+Z	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
X-X, +1.20D+0.70S	0.5213	-Z	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
X-X, +0.90D	0.2138	+Z	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
X-X, +0.90D	0.2138	-Z	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
Z-Z, +1.40D	0.3325	-X	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
Z-Z, +1.40D	0.3325	+X	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
Z-Z, +1.20D	0.2850	-X	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
Z-Z, +1.20D	0.2850	+X	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
Z-Z, +1.20D+0.50S	0.4538	-X	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK

Project Title:
 Engineer:
 Project ID:
 Project Descr:

General Footing

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: FTNG#1

Footing Flexure

Flexure Axis & Load Combination	Mu k-ft	Side	Tension Surface	As Req'd in^2	Gvrn. As in^2	Actual As in^2	Phi*Mn k-ft	Status
Z-Z, +1.20D+0.50S	0.4538	+X	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
Z-Z, +1.20D+1.60S	0.8250	-X	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
Z-Z, +1.20D+1.60S	0.8250	+X	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
Z-Z, +1.20D+0.70S	0.5213	-X	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
Z-Z, +1.20D+0.70S	0.5213	+X	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
Z-Z, +0.90D	0.2138	-X	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK
Z-Z, +0.90D	0.2138	+X	Bottom	0.2160	ACI 7.6.1.1	0.30	6.088	OK

One Way Shear X

Load Combination...	Vu @ -X	Vu @ +X	Vu:Max	Phi Vn	Vu / Phi*Vn	Status
+1.40D	3.33 psi	3.33 psi	3.33 psi	45.86 psi	0.07	OK
+1.20D	2.85 psi	2.85 psi	2.85 psi	45.86 psi	0.06	OK
+1.20D+0.50S	4.54 psi	4.54 psi	4.54 psi	45.86 psi	0.10	OK
+1.20D+1.60S	8.25 psi	8.25 psi	8.25 psi	45.86 psi	0.18	OK
+1.20D+0.70S	5.21 psi	5.21 psi	5.21 psi	45.86 psi	0.11	OK
+0.90D	2.14 psi	2.14 psi	2.14 psi	45.86 psi	0.05	OK

One Way Shear Z

Load Combination...	Vu @ -Z	Vu @ +Z	Vu:Max	Phi Vn	Vu / Phi*Vn	Status
+1.40D	3.33 psi	3.33 psi	3.33 psi	45.86 psi	0.07	OK
+1.20D	2.85 psi	2.85 psi	2.85 psi	45.86 psi	0.06	OK
+1.20D+0.50S	4.54 psi	4.54 psi	4.54 psi	45.86 psi	0.10	OK
+1.20D+1.60S	8.25 psi	8.25 psi	8.25 psi	45.86 psi	0.18	OK
+1.20D+0.70S	5.21 psi	5.21 psi	5.21 psi	45.86 psi	0.11	OK
+0.90D	2.14 psi	2.14 psi	2.14 psi	45.86 psi	0.05	OK

Two-Way "Punching" Shear

Load Combination...	Vu	Phi*Vn	Vu / Phi*Vn	Status
+1.40D	12.35 psi	150.00psi	0.08233	OK
+1.20D	10.59 psi	150.00psi	0.07057	OK
+1.20D+0.50S	16.85 psi	150.00psi	0.1124	OK
+1.20D+1.60S	30.64 psi	150.00psi	0.2043	OK
+1.20D+0.70S	19.36 psi	150.00psi	0.1291	OK
+0.90D	7.94 psi	150.00psi	0.05293	OK

All units k

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: 4ft Wall

Code Reference:

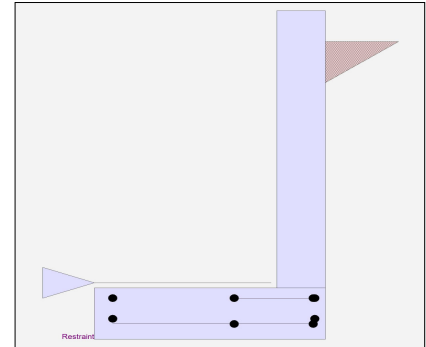
Calculations per IBC 2021, ACI 318-19, TMS 402-16

Criteria

Retained Height	=	4.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 in
Water table above bottom of footing	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	350.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 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

Earth Pressure Seismic Load

Method	:	Uniform
Multiplier Used	=	9.000
(Multiplier used on soil density)		

Stem Weight Seismic Load

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	=	0.0 psf (Strength Level)

Uniform Seismic Force	=	43.500
Total Seismic Force	=	210.250

F_p / W_p Weight Multiplier	=	0.200 g
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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

Added seismic base force	=	63.0 lbs
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Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: 4ft Wall

Design Summary

Wall Stability Ratios

Overturning	=	1.57	OK
Slab Resists All Sliding !			
Global Stability	=	1.48	
Total Bearing Load	=	1,026 lbs	
...resultant ecc.	=	9.17 in	
Eccentricity outside middle third			
Soil Pressure @ Toe	=	688 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,500 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	963 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	10.8 psi	OK
Footing Shear @ Heel	=	0.0 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	619.0 lbs
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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

Design Height Above Ftg	ft =	Stem OK	0.00
Wall Material Above "Ht"	=	Concrete	
Design Method	=	SD	SD SD
Thickness	=	8.00	
Rebar Size	=	# 4	
Rebar Spacing	=	12.00	
Rebar Placed at	=	Edge	

Design Data

fb/FB + fa/Fa	=	0.313
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Total Force @ Section

Service Level	lbs =	
Strength Level	lbs =	712.0

Moment....Actual

Service Level	ft-# =	
Strength Level	ft-# =	1,147.8

Moment.....Allowable	=	3,655.6
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Shear.....Actual

Service Level	psi =	
Strength Level	psi =	9.5

Shear.....Allowable	psi =	41.6
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Anet (Masonry)	in2 =	
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Wall Weight	psf =	100.0
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Rebar Depth 'd'	in =	6.25
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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 =	2,500.0
Fy	psi =	40,000.0

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 4ft Wall

Concrete Stem Rebar Area Details

Bottom Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>	
As (based on applied moment) :	0.0645 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	=====	<u>One layer of :</u> <u>Two layers of :</u>	
Required Area :	0.1728 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.2 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.27 in2/ft	#6@ 30.56 in	#6@ 61.11 in

Footing Data

Toe Width	=	2.50 ft
Heel Width	=	0.67
Total Footing Width	=	3.17
Footing Thickness	=	10.00 in
f'c =	2,500 psi	Fy = 40,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm.= 3.00 in

Footing Design Results

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	963	0	psf
Mu' : Upward	=	1,990	0	ft-#
Mu' : Downward	=	469	0	ft-#
Mu: Design	=	1,521	0	ft-#
φ Mn	=	4,724	OK - Flush	
Actual 1-Way Shear	=	10.79	0.00	psi
Allow 1-Way Shear	=	43.09	56.31	psi
Toe Reinforcing	=	# 4 @ 10.00 in		
Heel Reinforcing	=	Flush heel condition. No reinforcing required.		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu	=	0.00	0.00	ft-lbs
Footing Allow. Torsion, φ Tn	=	0.00	0.00	ft-lbs

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

Other Acceptable Sizes & Spacings

Toe: #4@ 11.11 in, #5@ 17.22 in, #6@ 24.44 in, #7@ 33.33 in, #8@ 43.88 in, #9@ 55.55 in, #10@ 70.55 in

Heel: Flush heel condition. No reinforcing required.

Key: No key defined

Min footing T&S reinf Area 0.68 in2
 Min footing T&S reinf Area per foot 0.22 in2 /ft

<u>If one layer of horizontal bars:</u>	<u>If two layers of horizontal bars:</u>
#4@ 11.11 in	#4@ 22.22 in
#5@ 17.22 in	#5@ 34.44 in
#6@ 24.44 in	#6@ 48.89 in

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 4ft Wall

Summary of Overturning & Resisting Forces & Moments

ItemOVERTURNING.....		RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	Force lbs	Distance ft	Moment ft-#	
HL Act Pres (ab water tbl)	408.8	1.61	658.7	Soil Over HL (ab. water tbl)	0.0	3.17	0.0
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		3.17	0.0
Hydrostatic Force				Water 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 =			
Seismic Earth Load =	147.2	2.42	355.7	Surcharge Over Toe =			
Seismic Stem Self Wt =	63.0	3.08	194.3	Stem Weight(s) =	450.0	2.83	1,275.0
				Earth @ Stem Transitions =			
Total =	619.0	O.T.M.	1,208.6	Footing Weight =	395.8	1.58	626.7
				Key Weight =			
				Vert. Component =			
Resisting/Overturning Ratio		=	1.57	Total =	845.9 lbs	R.M.=	1,901.8
Vertical Loads used for Soil Pressure =		1,026.3 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) 0.027 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.

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 4ft Wall

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #4 bar specified in this stem design segment (25.4.2.4a) =	15.60 in
Development length for #4 bar specified in this stem design segment =	12.00 in
Hooked embedment length into footing for #4 bar specified in this stem design segment =	6.00 in
As Provided =	0.2000 in ² /ft
As Required =	0.1728 in ² /ft

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

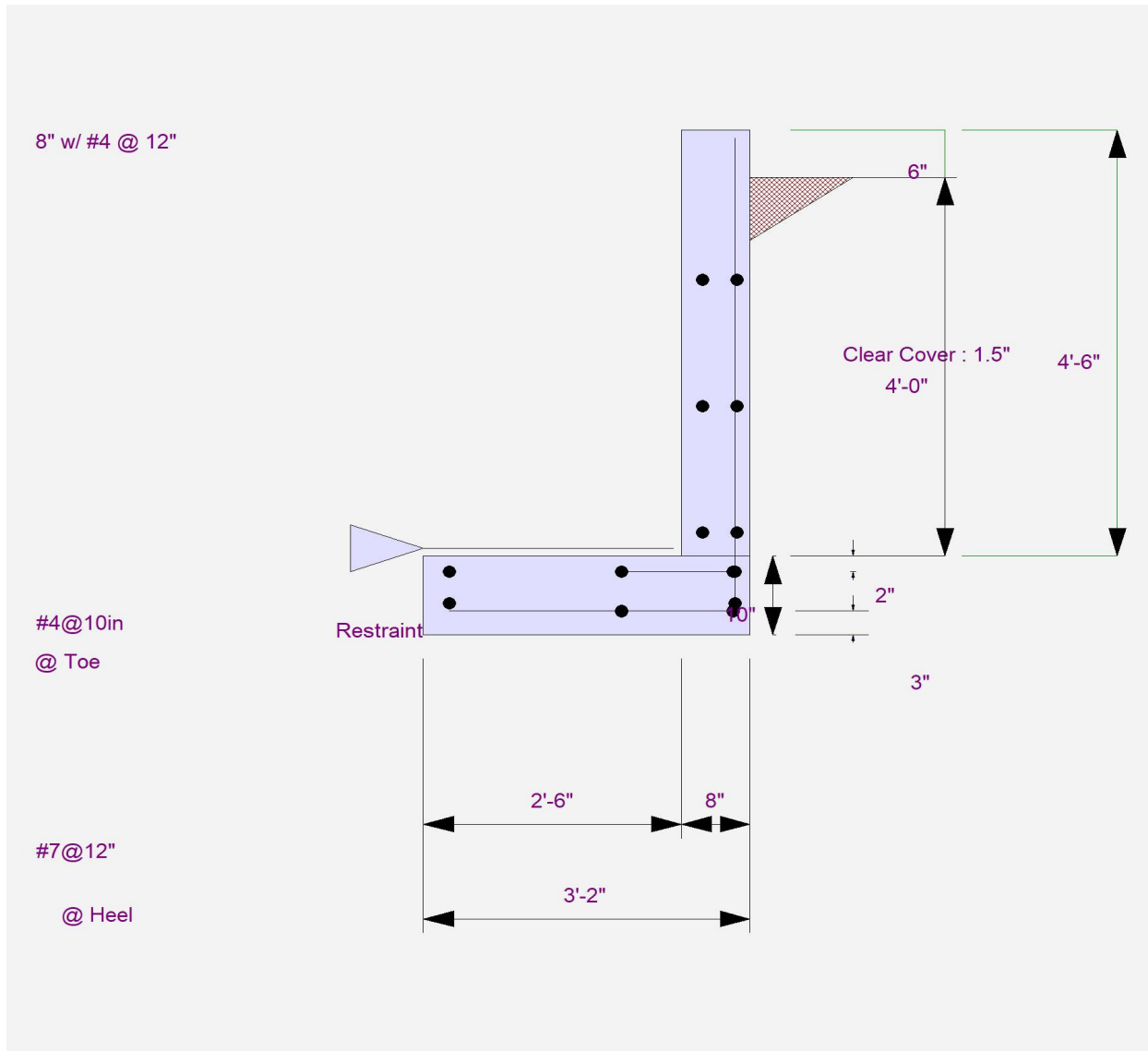
Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 4ft Wall



Cantilevered Retaining Wall

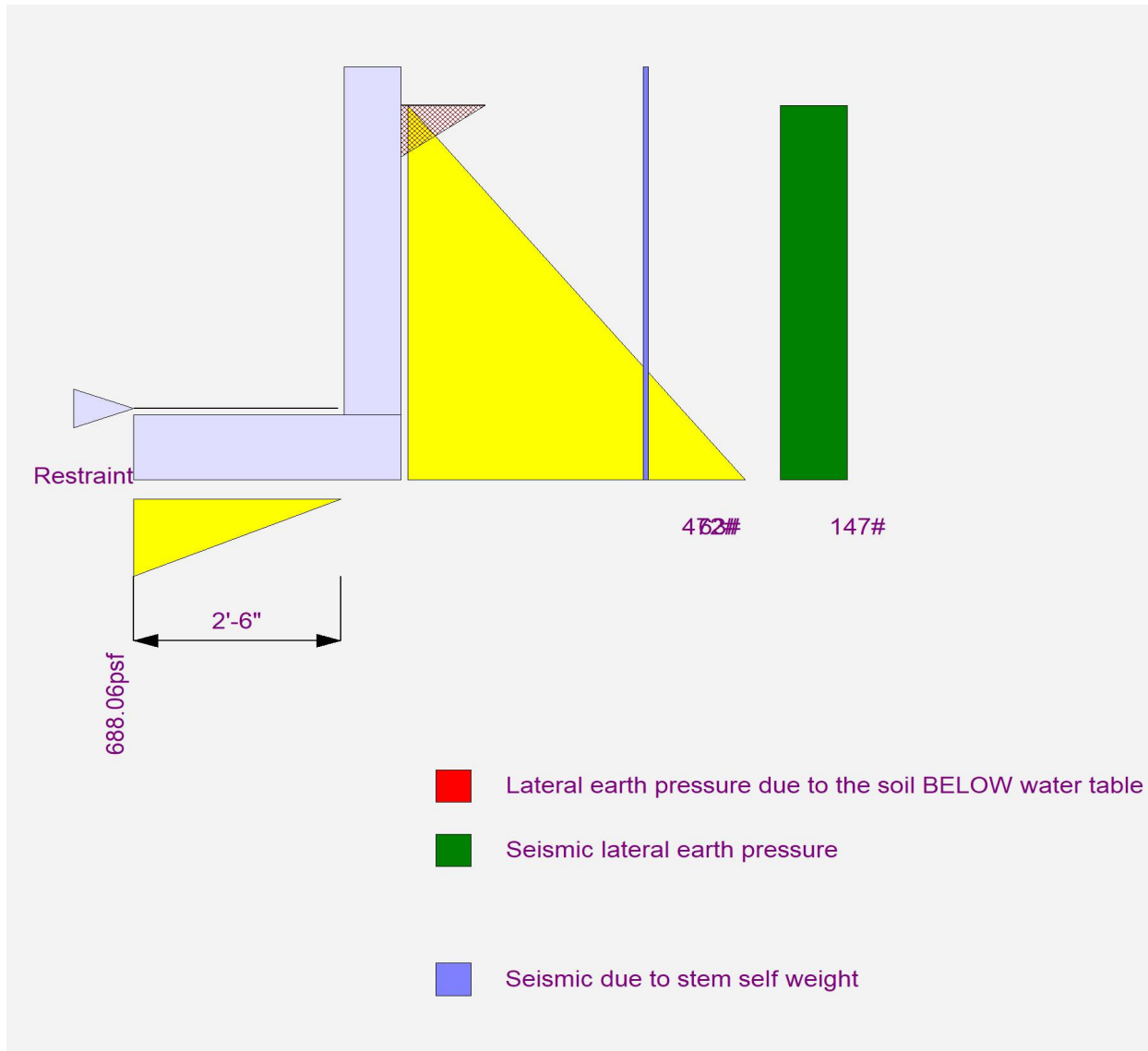
Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 4ft Wall



Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 6ft Wall

Code Reference:

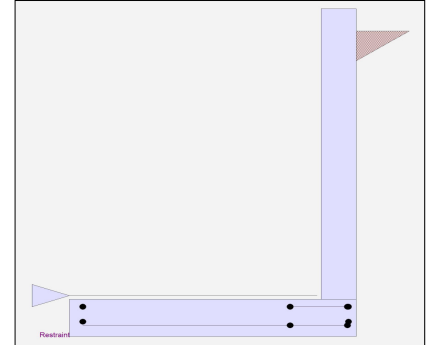
Calculations per IBC 2021, ACI 318-19, TMS 402-16

Criteria

Retained Height	=	6.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 in
Water table above bottom of footing	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	350.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 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

Earth Pressure Seismic Load

Method	:	Uniform
Multiplier Used	=	9.000
(Multiplier used on soil density)		

Stem Weight Seismic Load

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	=	0.0 psf (Strength Level)

Uniform Seismic Force	=	61.500
Total Seismic Force	=	420.250

F_p / W_p Weight Multiplier	=	0.200 g
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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

Added seismic base force	=	91.0 lbs
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Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 6ft Wall

Design Summary

Wall Stability Ratios

Overturning	=	1.59	OK
Slab Resists All Sliding !			
Global Stability	=	1.13	
Total Bearing Load	=	1,688 lbs	
...resultant ecc.	=	15.32 in	
Eccentricity outside middle third			
Soil Pressure @ Toe	=	618 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,500 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	865 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	15.7 psi	OK
Footing Shear @ Heel	=	0.0 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	1,202.3 lbs
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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

Design Height Above Ftg

ft =	Stem OK	0.00
Wall Material Above "Ht"	=	Concrete
Design Method	=	SD
Thickness	=	8.00
Rebar Size	=	# 4
Rebar Spacing	=	8.00
Rebar Placed at	=	Edge

Design Data

fb/FB + fa/Fa	=	0.655
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Total Force @ Section

Service Level	lbs =	
Strength Level	lbs =	1,507.0

Moment....Actual

Service Level	ft-# =	
Strength Level	ft-# =	3,545.5

Moment.....Allowable	=	5,412.6
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Shear.....Actual

Service Level	psi =	
Strength Level	psi =	20.1

Shear.....Allowable	psi =	47.6
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Anet (Masonry)	in2 =	
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Wall Weight	psf =	100.0
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Rebar Depth 'd'	in =	6.25
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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 =	2,500.0
Fy	psi =	40,000.0

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 6ft Wall

Concrete Stem Rebar Area Details

Bottom Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>	
As (based on applied moment) :	0.1993 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	=====	<u>One layer of :</u>	<u>Two layers of :</u>
Required Area :	0.1993 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.3 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	1.27 in2/ft	#6@ 30.56 in	#6@ 61.11 in

Footing Data

Toe Width	=	4.75 ft
Heel Width	=	0.67
Total Footing Width	=	5.42
Footing Thickness	=	10.00 in
f'c =	2,500 psi	Fy = 40,000 psi
Footing Concrete Density	=	150.00 pcf
Min. As %	=	0.0018
Cover @ Top	2.00	@ Btm.= 3.00 in

Footing Design Results

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	865	0	psf
Mu' : Upward	=	6,165	0	ft-#
Mu' : Downward	=	1,692	0	ft-#
Mu: Design	=	4,473	0	ft-#
φ Mn	=	6,269	OK - Flush	
Actual 1-Way Shear	=	15.72	0.00	psi
Allow 1-Way Shear	=	47.50	56.31	psi
Toe Reinforcing	=	# 4 @ 7.46 in		
Heel Reinforcing	=	Flush heel condition. No reinforcing required.		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu	=	0.00		ft-lbs
Footing Allow. Torsion, φ Tn	=	0.00		ft-lbs

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

Other Acceptable Sizes & Spacings

Toe: #4@ 7.46 in, #5@ 11.56 in, #6@ 16.41 in, #7@ 22.38 in, #8@ 29.47 in, #9@ 37.31 in, #10@ 47.38 in

Heel: Flush heel condition. No reinforcing required.

Key: No key defined

Min footing T&S reinf Area 1.17 in2
 Min footing T&S reinf Area per foot 0.22 in2 /ft

<u>If one layer of horizontal bars:</u>	<u>If two layers of horizontal bars:</u>
#4@ 11.11 in	#4@ 22.22 in
#5@ 17.22 in	#5@ 34.44 in
#6@ 24.44 in	#6@ 48.89 in

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 6ft Wall

Summary of Overturning & Resisting Forces & Moments

ItemOVERTURNING.....		RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	Force lbs	Distance ft	Moment ft-#	
HL Act Pres (ab water tbl)	817.2	2.28	1,861.3	Soil Over HL (ab. water tbl)	0.0	5.42	0.1
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		5.42	0.1
Hydrostatic Force				Water 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 =			
Seismic Earth Load =	294.2	3.42	1,005.1	Surcharge Over Toe =			
Seismic Stem Self Wt =	91.0	4.08	371.6	Stem Weight(s) =	650.0	5.08	3,304.2
				Earth @ Stem Transitions =			
Total =	1,202.3	O.T.M.	3,238.0	Footing Weight =	677.1	2.71	1,833.8
				Key Weight =			
				Vert. Component =			
Resisting/Overturning Ratio		=	1.59	Total =	1,327.1 lbs	R.M.=	5,138.1
Vertical Loads used for Soil Pressure =		1,687.8 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) 0.021 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.

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 6ft Wall

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #4 bar specified in this stem design segment (25.4.2.4a) =	15.60 in
Development length for #4 bar specified in this stem design segment =	12.00 in
Hooked embedment length into footing for #4 bar specified in this stem design segment =	6.00 in
As Provided =	0.3000 in ² /ft
As Required =	0.2657 in ² /ft

Cantilevered Retaining Wall

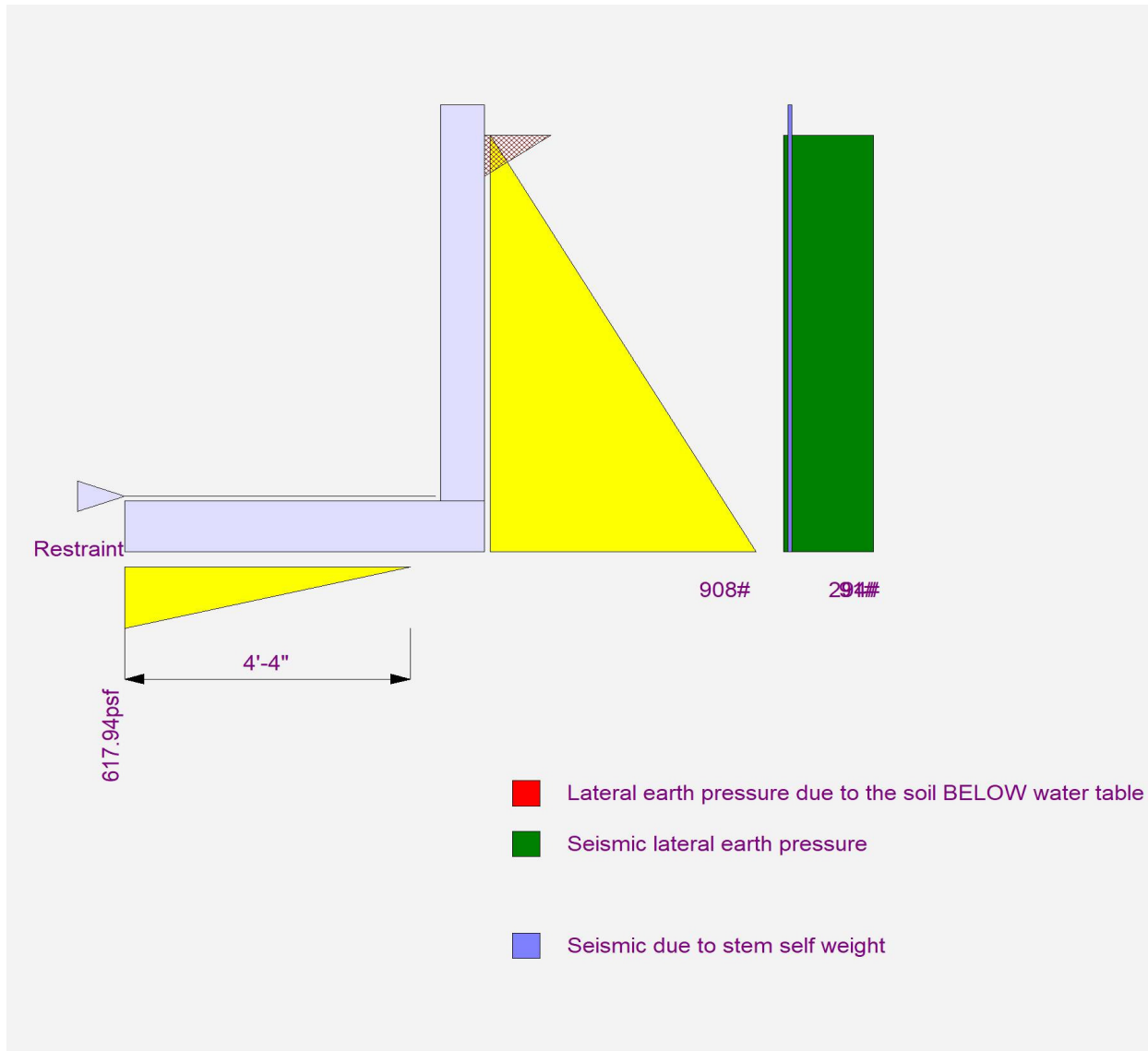
Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 6ft Wall



Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 8ft Wall

Code Reference:

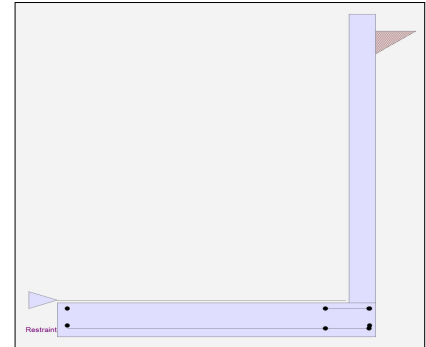
Calculations per IBC 2021, ACI 318-19, TMS 402-16

Criteria

Retained Height	=	8.00 ft
Wall height above soil	=	0.50 ft
Slope Behind Wall	=	0.00
Height of Soil over Toe	=	0.00 in
Water table above bottom of footing	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	350.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 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

Earth Pressure Seismic Load

Method	:	Uniform
Multiplier Used	=	9.000
(Multiplier used on soil density)		

Stem Weight Seismic Load

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	=	0.0 psf (Strength Level)

Uniform Seismic Force	=	81.000
Total Seismic Force	=	729.000

F_p / W_p Weight Multiplier	=	0.200 g
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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

Added seismic base force	=	119.0 lbs
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Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 8ft Wall

Design Summary

Wall Stability Ratios

Overturning	=	1.55	OK
Slab Resists All Sliding !			
Global Stability	=	0.96	
Total Bearing Load	=	2,663 lbs	
...resultant ecc.	=	24.10 in	
Eccentricity outside middle third			
Soil Pressure @ Toe	=	697 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,500 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	975 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	16.4 psi	OK
Footing Shear @ Heel	=	0.0 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	2,046.8 lbs
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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

Design Height Above Ftg	ft =	Stem OK	0.00
Wall Material Above "Ht"	=	Concrete	
Design Method	=	SD	SD SD
Thickness	=	8.00	
Rebar Size	=	# 5	
Rebar Spacing	=	12.00	
Rebar Placed at	=	Edge	

Design Data

fb/FB + fa/Fa	=	0.996
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Total Force @ Section

Service Level	lbs =	
Strength Level	lbs =	2,610.0

Moment....Actual

Service Level	ft-# =	
Strength Level	ft-# =	8,093.2

Moment.....Allowable	=	8,121.3
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Shear.....Actual

Service Level	psi =	
Strength Level	psi =	35.2

Shear.....Allowable	psi =	48.3
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Anet (Masonry)	in2 =	
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Wall Weight	psf =	100.0
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Rebar Depth 'd'	in =	6.19
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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 =	2,500.0
Fy	psi =	60,000.0

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 8ft Wall

Concrete Stem Rebar Area Details

Bottom Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>	
As (based on applied moment) :	0.3065 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	=====	<u>One layer of :</u> <u>Two layers of :</u>	
Required Area :	0.3065 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.31 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	0.8382 in2/ft	#6@ 30.56 in	#6@ 61.11 in

Footing Data

Toe Width	=	7.25 ft
Heel Width	=	0.67
Total Footing Width	=	7.92
Footing Thickness	=	12.00 in
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

		<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	975	0	psf
Mu' : Upward	=	15,119	0	ft-#
Mu' : Downward	=	4,731	0	ft-#
Mu: Design	=	10,388	0	ft-#
φ Mn	=	12,680	OK - Flush	
Actual 1-Way Shear	=	16.42	0.00	psi
Allow 1-Way Shear	=	44.49	52.07	psi
Toe Reinforcing	=	# 5 @ 10.94 in		
Heel Reinforcing	=	Flush heel condition. No reinforcing required.		
Key Reinforcing	=	None Spec'd		
Footing Torsion, Tu	=	0.00		ft-lbs
Footing Allow. Torsion, φ Tn	=	0.00		ft-lbs

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

Other Acceptable Sizes & Spacings

Toe: #4@ 7.05 in, #5@ 10.94 in, #6@ 15.52 in, #7@ 21.17 in, #8@ 27.88 in, #9@ 35.29 in, #10@ 44.82 in

Heel: Flush heel condition. No reinforcing required.

Key: No key defined

Min footing T&S reinf Area	2.05	in2
Min footing T&S reinf Area per foot	0.26	in2 /ft

If one layer of horizontal bars:

- #4@ 9.26 in
- #5@ 14.35 in
- #6@ 20.37 in

If two layers of horizontal bars:

- #4@ 18.52 in
- #5@ 28.70 in
- #6@ 40.74 in

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 8ft Wall

Summary of Overturning & Resisting Forces & Moments

ItemOVERTURNING.....		RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	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)	0.0	7.92	0.2
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		7.92	0.2
Hydrostatic Force				Water 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 =			
Seismic Earth Load =	510.3	4.50	2,296.4	Surcharge Over Toe =			
Seismic Stem Self Wt =	119.0	5.25	624.8	Stem Weight(s) =	850.0	7.58	6,445.8
				Earth @ Stem Transitions =			
Total =	2,046.8	O.T.M. =	7,173.6	Footing Weight =	1,187.5	3.96	4,700.6
				Key Weight =			
				Vert. Component =			
Resisting/Overturning Ratio =			1.55	Total =	2,037.5 lbs	R.M.=	11,146.6
Vertical Loads used for Soil Pressure =		2,663.2 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) 0.021 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.

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 8ft Wall

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.4a) = 23.40 in

Development length for #5 bar specified in this stem design segment = 18.00 in

Hooked embedment length into footing for #5 bar specified in this stem design segment = 8.27 in

As Provided = 0.3100 in²/ft

As Required = 0.3065 in²/ft

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

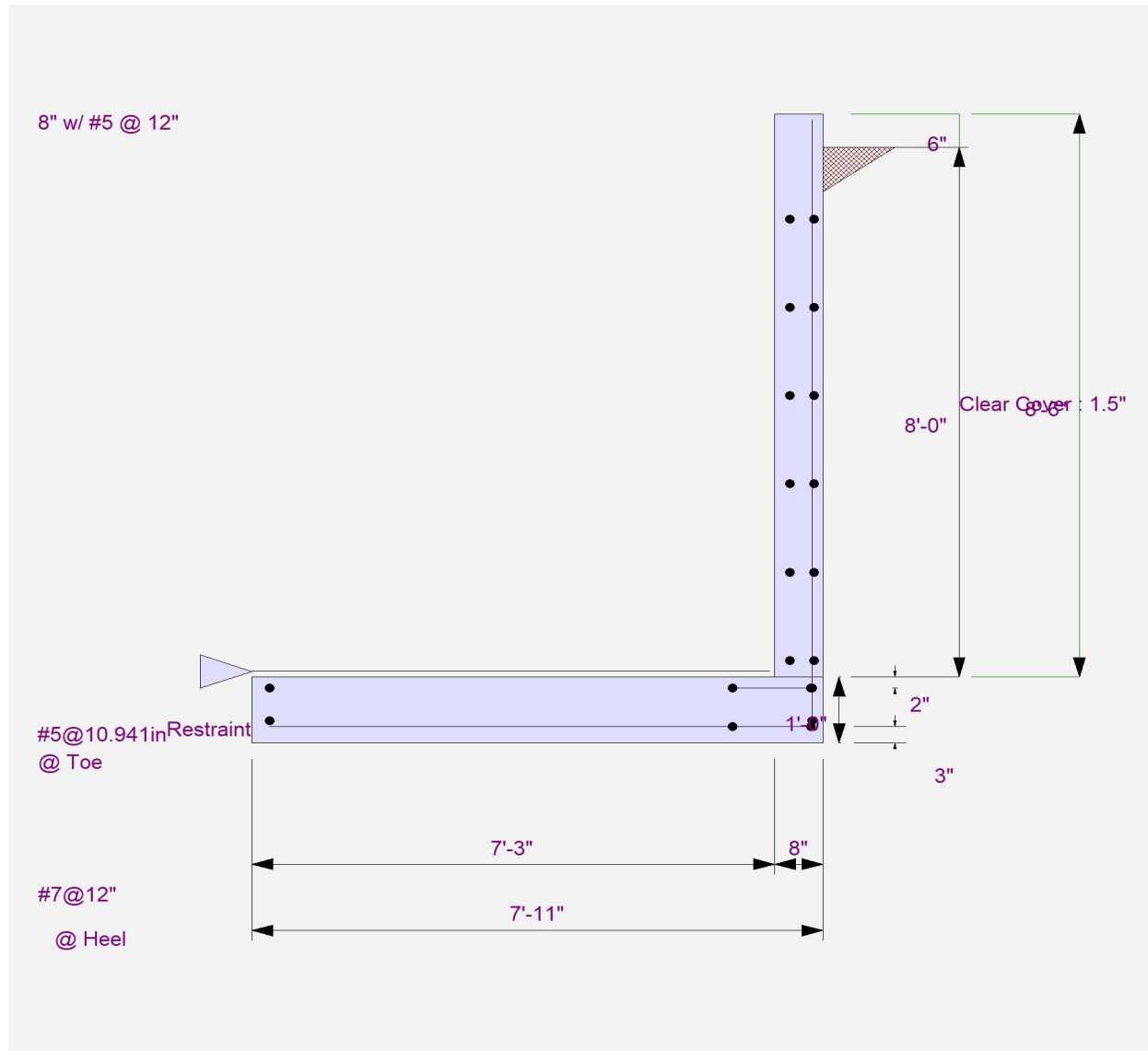
Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: 8ft Wall



Cantilevered Retaining Wall

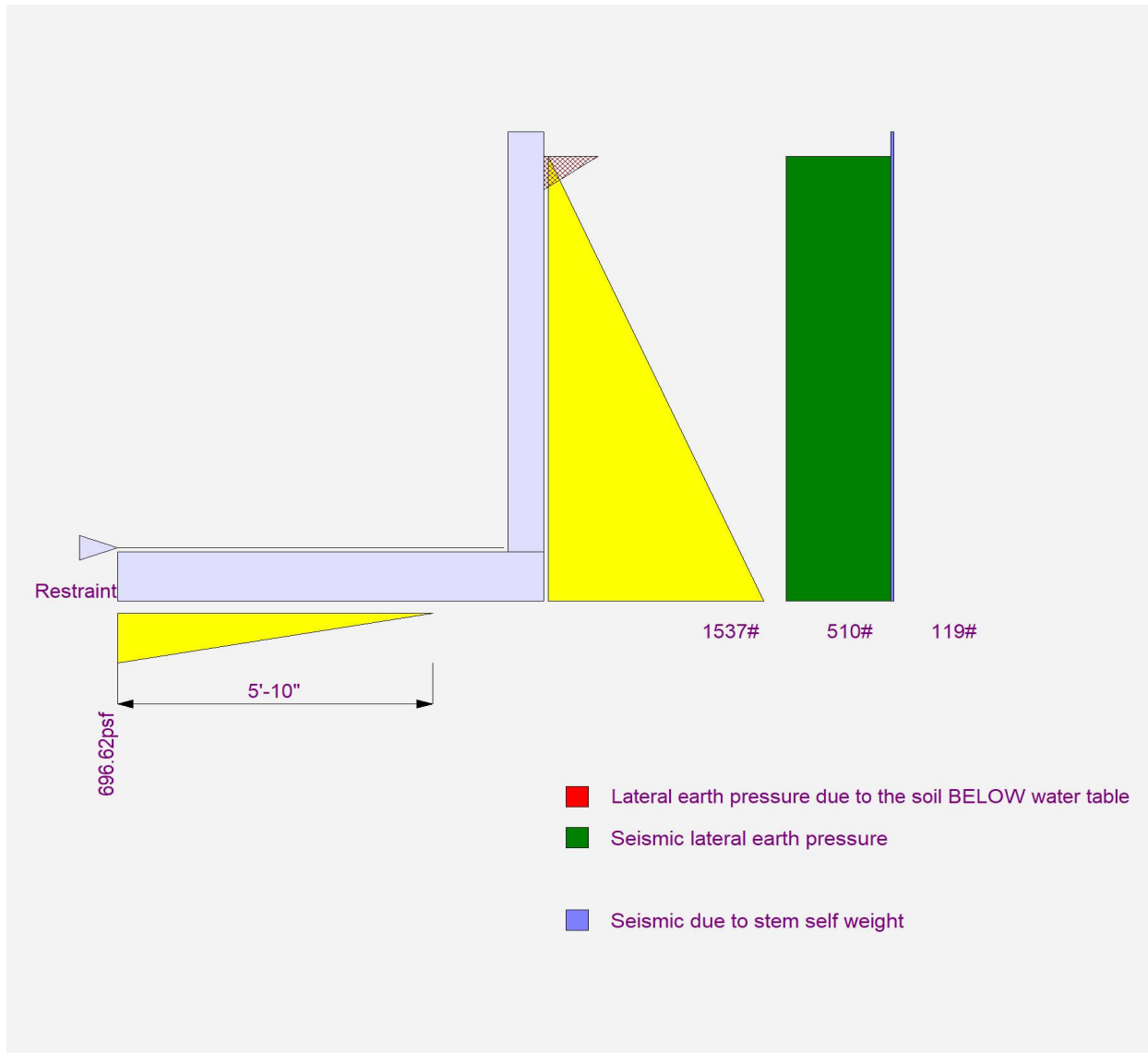
Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: 8ft Wall



Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 9ft Wall

Code Reference:

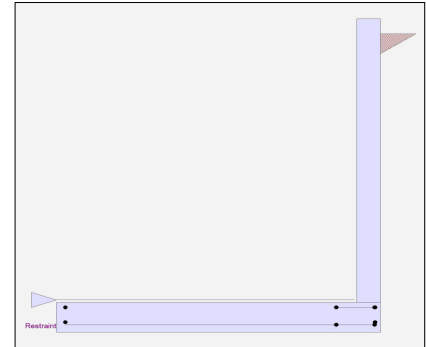
Calculations per IBC 2021, ACI 318-19, TMS 402-16

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 table above bottom of footing	=	0.0 ft

Soil Data

Allow Soil Bearing	=	3,500.0 psf
Equivalent Fluid Pressure Method		
Active Heel Pressure	=	35.0 psf/ft
	=	
Passive Pressure	=	350.0 psf/ft
Soil Density, Heel	=	110.00 pcf
Soil Density, Toe	=	110.00 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

Earth Pressure Seismic Load

Method	:	Uniform
Multiplier Used	=	9.000
(Multiplier used on soil density)		

Stem Weight Seismic Load

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	=	0.0 psf (Strength Level)

Uniform Seismic Force	=	90.000
Total Seismic Force	=	900.000

F_p / W_p Weight Multiplier	=	0.200 g
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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

Added seismic base force	=	133.0 lbs
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Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 9ft Wall

Design Summary

Wall Stability Ratios

Overturning	=	1.51	OK
Slab Resists All Sliding !			
Global Stability	=	0.86	
Total Bearing Load = 3,098 lbs			
...resultant ecc.	=	29.47 in	
Eccentricity outside middle third			
Soil Pressure @ Toe	=	729 psf	OK
Soil Pressure @ Heel	=	0 psf	OK
Allowable	=	3,500 psf	
Soil Pressure Less Than Allowable			
ACI Factored @ Toe	=	1,020 psf	
ACI Factored @ Heel	=	0 psf	
Footing Shear @ Toe	=	18.2 psi	OK
Footing Shear @ Heel	=	0.0 psi	OK
Allowable	=	75.0 psi	

Sliding Calcs

Lateral Sliding Force	=	2,513.0 lbs
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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

Design Height Above Ftg	ft =	Stem OK	0.00
Wall Material Above "Ht"	=	Concrete	
Design Method	=	SD	SD SD
Thickness	=	8.00	
Rebar Size	=	# 5	
Rebar Spacing	=	8.00	
Rebar Placed at	=	Edge	

Design Data

fb/FB + fa/Fa	=	0.962
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Total Force @ Section

Service Level	lbs =	
Strength Level	lbs =	3,268.0

Moment....Actual

Service Level	ft-# =	
Strength Level	ft-# =	11,351.5

Moment.....Allowable	=	11,799.2
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Shear.....Actual

Service Level	psi =	
Strength Level	psi =	44.0

Shear.....Allowable	psi =	55.3
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Anet (Masonry)	in2 =	
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Wall Weight	psf =	100.0
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Rebar Depth 'd'	in =	6.19
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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 =	2,500.0
Fy	psi =	60,000.0

Project Title:
 Engineer:
 Project ID:
 Project Descr:

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 9ft Wall

Concrete Stem Rebar Area Details

Bottom Stem	<u>Vertical Reinforcing</u>	<u>Horizontal Reinforcing</u>	
As (based on applied moment) :	0.4298 in2/ft		
0.0018bh : 0.0018(12)(8) :	0.1728 in2/ft	Horizontal Reinforcing Options :	
	=====	<u>One layer of :</u>	<u>Two layers of :</u>
Required Area :	0.4298 in2/ft	#4@ 13.89 in	#4@ 27.78 in
Provided Area :	0.465 in2/ft	#5@ 21.53 in	#5@ 43.06 in
Maximum Area :	0.8382 in2/ft	#6@ 30.56 in	#6@ 61.11 in

Footing Data

Toe Width	=	8.50 ft
Heel Width	=	0.67
Total Footing Width	=	9.17
Footing Thickness	=	12.00 in
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

	<u>Toe</u>	<u>Heel</u>	
Factored Pressure	=	1,020	0 psf
Mu' : Upward	=	20,744	0 ft-#
Mu' : Downward	=	6,503	0 ft-#
Mu: Design	=	14,241	0 ft-#
φ Mn	=	14,329	OK - Flush
Actual 1-Way Shear	=	18.16	0.00 psi
Allow 1-Way Shear	=	46.44	52.07 psi
Toe Reinforcing	=	# 5 @ 9.62 in	
Heel Reinforcing	=	Flush heel condition. No reinforcing required.	
Key Reinforcing	=	None Spec'd	
Footing Torsion, Tu	=	0.00 ft-lbs	
Footing Allow. Torsion, φ Tn	=	0.00 ft-lbs	

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

Other Acceptable Sizes & Spacings

Toe: #4@ 6.20 in, #5@ 9.61 in, #6@ 13.64 in, #7@ 18.61 in, #8@ 24.50 in, #9@ 31.02 in, #10@ 39.39 in

Heel: Flush heel condition. No reinforcing required.

Key: No key defined

Min footing T&S reinf Area 2.38 in2
 Min footing T&S reinf Area per foot 0.26 in2 /ft

If one layer of horizontal bars:

#4@ 9.26 in
 #5@ 14.35 in
 #6@ 20.37 in

If two layers of horizontal bars:

#4@ 18.52 in
 #5@ 28.70 in
 #6@ 40.74 in

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 9ft Wall

Summary of Overturning & Resisting Forces & Moments

ItemOVERTURNING.....		RESISTING.....			
	Force lbs	Distance ft	Moment ft-#	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)	0.0	9.17	0.3
HL Act Pres (be water tbl)				Soil Over HL (bel. water tbl)		9.17	0.3
Hydrostatic Force				Water 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 =			
Seismic Earth Load =	630.0	5.00	3,150.0	Surcharge Over Toe =			
Seismic Stem Self Wt =	133.0	5.75	764.8	Stem Weight(s) =	950.0	8.83	8,391.7
				Earth @ Stem Transitions =			
Total	= 2,513.0	O.T.M. =	9,748.1	Footing Weight =	1,375.0	4.58	6,302.1
				Key Weight =			
				Vert. Component =			
Resisting/Overturning Ratio		= 1.51		Total =	2,325.0 lbs	R.M.=	14,694.1
Vertical Loads used for Soil Pressure =		3,097.5 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) 0.021 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.

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

(c) ENERCALC, LLC 1982-2024

DESCRIPTION: 9ft Wall

Rebar Lap & Embedment Lengths Information

Stem Design Segment: Bottom

Stem Design Height: 0.00 ft above top of footing

Lap Splice length for #5 bar specified in this stem design segment (25.4.2.4a) = 23.40 in

Development length for #5 bar specified in this stem design segment = 18.00 in

Hooked embedment length into footing for #5 bar specified in this stem design segment = 8.27 in

As Provided = 0.4650 in²/ft

As Required = 0.4298 in²/ft

Project Title:
Engineer:
Project ID:
Project Descr:

Cantilevered Retaining Wall

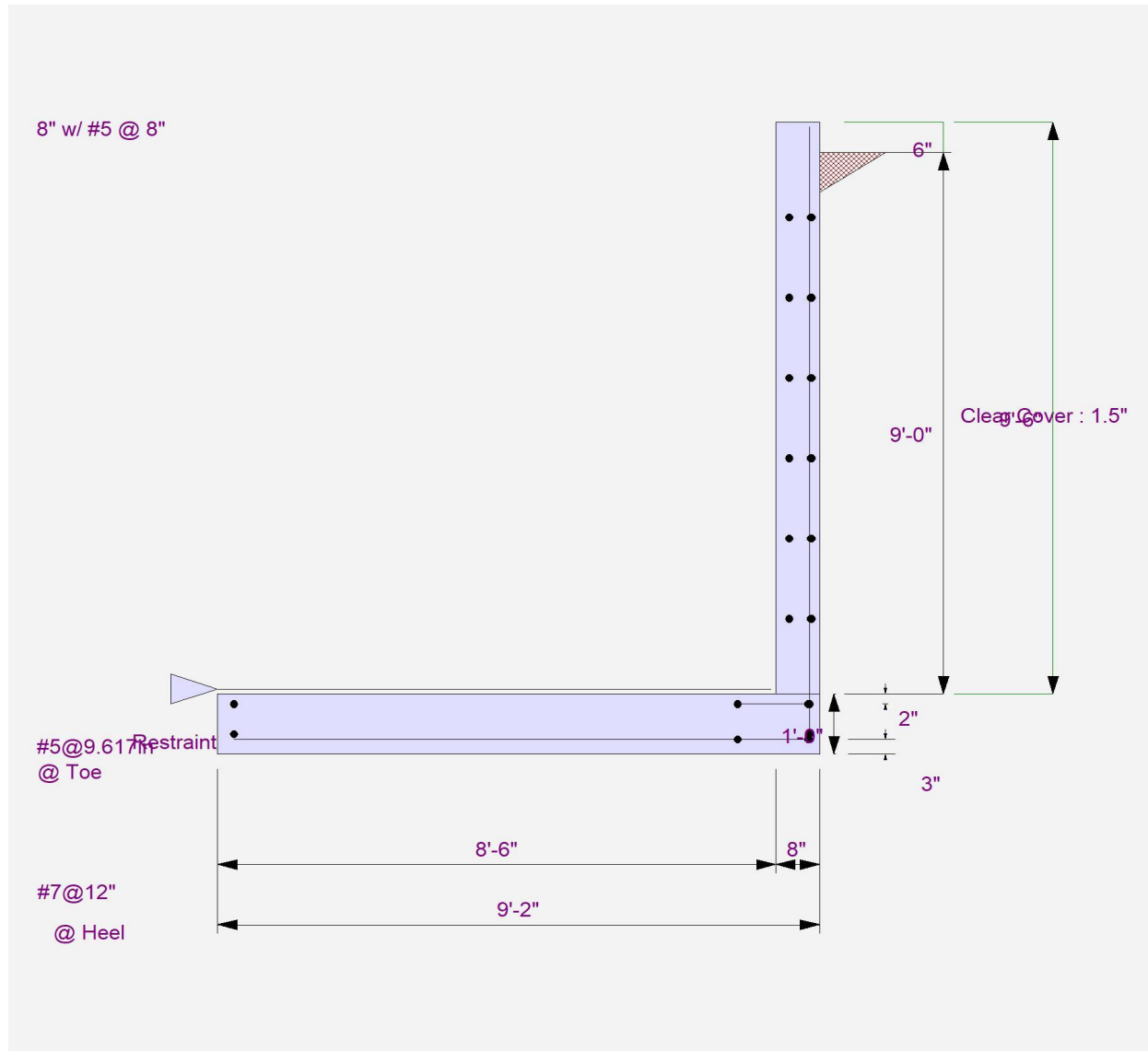
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DESCRIPTION: 9ft Wall



Cantilevered Retaining Wall

Project File: 24-031.ec6

LIC# : KW-06016495, Build:20.24.10.30

CK Engineering LLC

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DESCRIPTION: 9ft Wall

