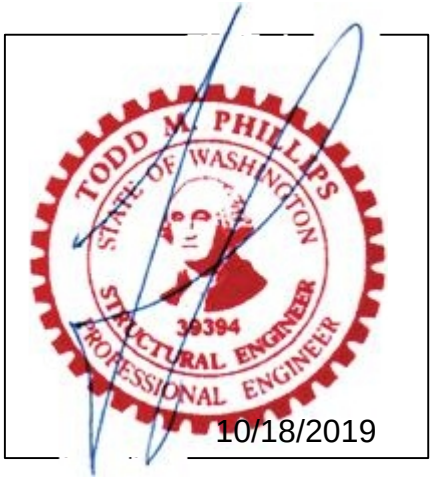
# SUPPLEMENTAL ANALYSIS
# FOR:
# MEI YOUNG
# SITE:
# 8251 WEST MERCER WAY
# MERCER ISLAND, WA 98040

ORIGINAL STAMP
MUST BE RED
TO BE VALID




10/18/2019

| DATE: | PLAN NUMBER: | | PHILLIPS STRUCTURAL ENGINEERING, PLLC<br>P.O. BOX 108, MILTON, WA 98354<br>Phone (253) 344-1666 | |
|---|---|---|---|---|
| OCT. 30, 2018 | WEN HU RESIDENCE | | | |

STRUCTURAL ENGINEERING CALCULATIONS

# PHILLIPS STRUCTURAL ENGINEERING

The enclosed documents are to be used in conjunction with the plans referenced on the cover page. It is imperative that the contractor study and understand the engineering requirements and required changes to the architectural plan prior to start of work. Modifications may include additional foundations or footings, beam size changes, sheathing changes etc.

Scope of Engineering: Engineering analysis and design to resist lateral and gravity loads in accordance with the 2015 IBC have been performed and incorporated into stamped "S" sheets. All analyses and calculations are included in this engineering report (see 8½x11 pages). Engineering assumptions are listed below. If the conditions listed below are not present at the site, all calculations and stamped drawings are void and *Phillips Structural Engineering* must be contacted immediately.

LOADING CRITERIA

| | |
|---|---|
| Building Code | 2015 International Building Code (IBC) |
| Seismic Design Catagory (SDC) | D |
| Ss (Short Period) | 1.47 |
| S1 (1 Second Period) | 0.56 |
| Response Mod. Coeff. (R) | 6.5 |
| Seismic Site Class | D |
| Basic Wind Speed (3 Sec) | 110 MPH Exposure C |

LIVE LOADS (psf) U.N.O.

| | |
|---|---|
| -Uninhabitable attics without storage | 10 |
| -Uninhabitable attics with storage | 20 |
| -Habitable attics and sleeping areas | 30 |
| -Deck Framing | 60 |
| -All other areas | 40 |

DEAD LOADS (psf) U.N.O.

| | |
|---|---|
| -Roof with composition roofing | 20 |
| -Floor | 15 |

SNOW LOADS (psf) U.N.O.

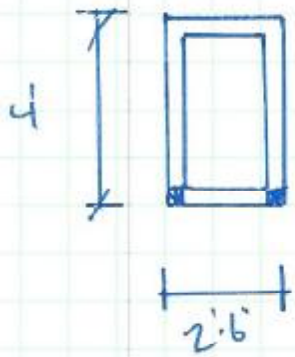
| | |
|---|---|
| -Flat Roof Snow (Reduced from Ground) | 30 |

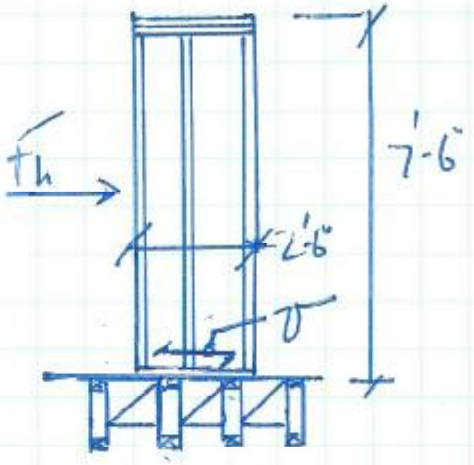
SOILS CRITERIA

| | |
|---|---|
| Soils Consultant | PanGEO |
| Soils Report # | 17-405 |
| Allowable Pressure Req'd | 3000 psf (Verify w/ Site Conditions) |
| Frost Bearing Depth | 18" |

PHILLIPS STRUCTURAL ENGINEERING, PLLC
P.O. BOX 108
MILTON, WA 98354
Phone (253) 344-1666

# CHIMNEY




(29.5-1) $F_h = q_z (GC_f) A_F$

$A_f = 4' \times 7.5' = 30\ \#$

$G = 0.85$

$h/D = 25'/2.5 = 10 \therefore C_f = 1.2$

$(z = 30')$ $q_z = 0.00256 K_z K_{zt} K_d V^2$

$K_z = 0.98$

$K_{zt} = 1.0$

$K_d = 0.9$

$V = 110$

$q_z = 27.3\ psf$

$F_h = 27.3(.85)(1.2)(30\ \#)$

$= 836\ \#$ (APPLIED @ MID-HT)

(502 # ASD)

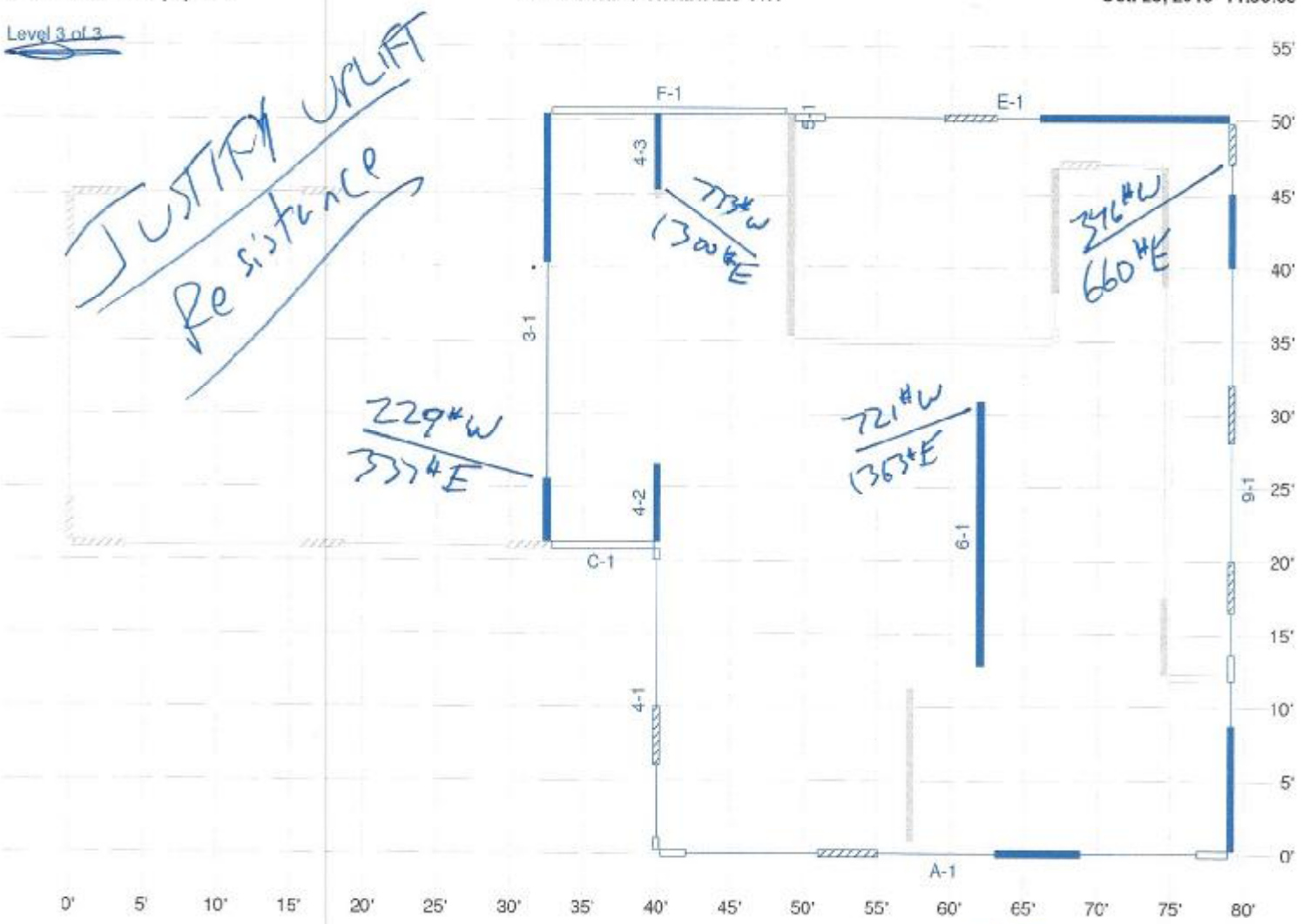
$M_{OTM} = 7.5'/2 \times 502\ \# = 1881\ ft\#$

$T_{UPLIFT} = 1881\ ft\#/2.5' = 752\ \#$ → (2) T22 dS

$V = 502\ \#/2\ slots \div 2.5' = 100\ RF$ (MINIMAL SHEAR REINFORCING)

Level 3 of 3

JUSTIFY UPLIFT Resistance




ASD LOAD COMBO $0.6W - 0.60$
$0.9W - 0.60$

LINE 3-1 $6LF \times [(15PSF \times 8') + 120LF] = 1440\# \times .6 < 864\#$ ✓

LINE 4-3 $8LF \times [(15PSF \times 8') + 120LF] = 1920\# \times .6 < 1152\#$

$1300 - 1152\# = 148\#$ ∴ WALLS Resist ∴ No STRAP Needed

LINE 6-1 $6LF \times [(15 \times 15') + 90LF] = 2520\# \times .6 = 1512\#$ ✓

LINE 9-1 $6LF \times [(15 \times 6') + 90LF] = 1080\# \times .6 = 648\#$ ✓

Segmented Perforated Non-shearwall Aspect factor Orange = Selected wall(s)

R1
Oct. 17, 2019 08:10

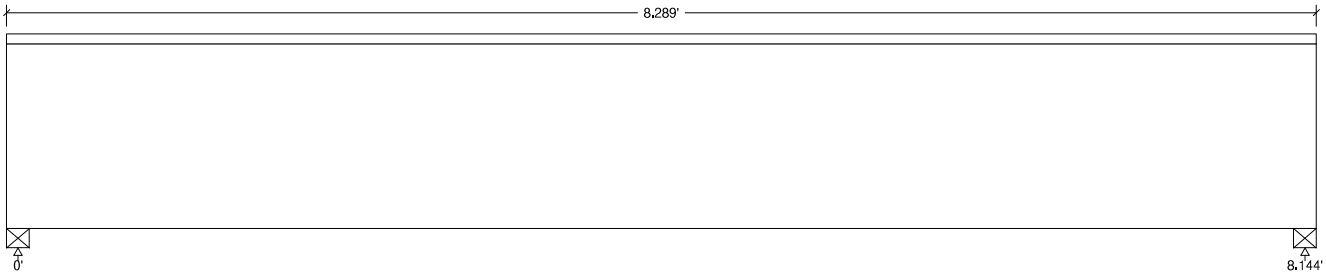
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 20.00(18.00') | | psf |
| Load2 | Snow | Full Area | | | | 30.00(18.00') | | psf |
| Self-weight | Dead | Full UDL | | | | 15.3 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 1554 | | 1554 |
| Snow | 2238 | | 2238 |
| Factored: | | | |
| Total | 3792 | | 3792 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 3792 | | 3792 |
| Support | 4199 | | 4199 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.90 | | 0.90 |
| Load comb | #2 | | #2 |
| Length | 1.73 | | 1.73 |
| Min req'd | 1.73 | | 1.73 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

## R1

**PSL, 2.0E, 2900Fb, 3-1/2"x14"**

Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 8.29'; Clear span: 8'; volume = 2.8 cu.ft.
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 79 | Fv' = 334 | psi | fv/Fv' = 0.24 |
| Bending(+) | fb = 797 | Fb' = 3335 | psi | fb/Fb' = 0.24 |
| Live Defl'n | 0.03 = <L/999 | 0.27 = L/360 | in | 0.12 |
| Total Defl'n | 0.07 = <L/999 | 0.41 = L/240 | in | 0.17 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CV | Cfu | Cr | Cfrt | Ci | Cn | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 290 | 1.15 | - | 1.00 | - | - | - | - | 1.00 | - | 1.00 | 2 |
| Fb'+ | 2900 | 1.15 | - | 1.00 | 1.000 | 1.00 | - | 1.00 | 1.00 | - | - | 2 |
| Fcp' | 625 | - | - | 1.00 | - | - | - | - | 1.00 | - | - | - |
| E' | 2.0 million | | - | 1.00 | - | - | - | - | 1.00 | - | - | 2 |
| Eminy' | 1.04 million | | - | 1.00 | - | - | - | - | 1.00 | - | - | 2 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #2 = D+S, V max = 3727, V design = 2593 lbs
Bending(+): LC #2 = D+S, M = 7589 lbs-ft
Deflection: LC #2 = D+S (live)
LC #2 = D+S (total)
D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
All LC's are listed in the Analysis output
Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
Deflection: EI = 1601e06 lb-in2
"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. SCL-BEAMS (Structural Composite Lumber): the attached SCL selection is for preliminary design only. For final member design contact your local SCL manufacturer.
4. Size factors vary from one manufacturer to another for SCL materials. They can be changed in the database editor.
5. FIRE RATING: LVL, PSL and LSL are not rated for fire endurance.

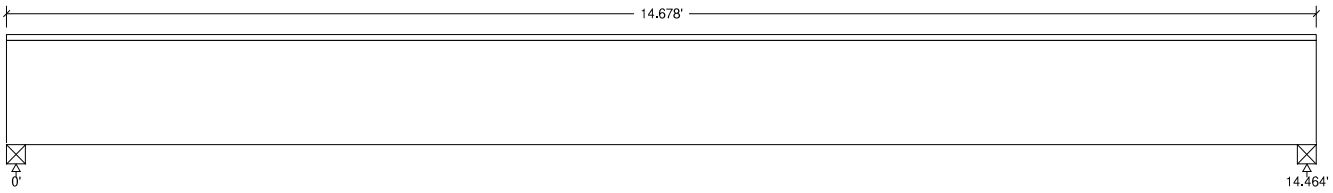
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 20.00(15.00') | | psf |
| Load2 | Snow | Full Area | | | | 30.00(15.00') | | psf |
| Self-weight | Dead | Full UDL | | | | 15.3 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 2312 | | 2312 |
| Snow | 3303 | | 3303 |
| Factored: | | | |
| Total | 5615 | | 5615 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 5615 | | 5615 |
| Support | 6217 | | 6217 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.90 | | 0.90 |
| Load comb | #2 | | #2 |
| Length | 2.57 | | 2.57 |
| Min req'd | 2.57 | | 2.57 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

### R2

**PSL, 2.0E, 2900Fb, 3-1/2"x14"**

Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 14.68'; Clear span: 14.25'; volume = 5.0 cu.ft.
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 140 | Fv' = 334 | psi | fv/Fv' = 0.42 |
| Bending(+) | fb = 2101 | Fb' = 3335 | psi | fb/Fb' = 0.63 |
| Live Defl'n | 0.28 = L/626 | 0.48 = L/360 | in | 0.57 |
| Total Defl'n | 0.57 = L/305 | 0.72 = L/240 | in | 0.79 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CV | Cfu | Cr | Cfrt | Ci | Cn | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 290 | 1.15 | - | 1.00 | - | - | - | - | 1.00 | - | 1.00 | 2 |
| Fb'+ | 2900 | 1.15 | - | 1.00 | 1.000 | 1.00 | - | 1.00 | 1.00 | - | - | 2 |
| Fcp' | 625 | - | - | 1.00 | - | - | - | - | 1.00 | - | - | - |
| E' | 2.0 million | | - | 1.00 | - | - | - | - | 1.00 | - | - | 2 |
| Eminy' | 1.04 million | | - | 1.00 | - | - | - | - | 1.00 | - | - | 2 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #2 = D+S, V max = 5535, V design = 4560 lbs
Bending(+): LC #2 = D+S, M = 20014 lbs-ft
Deflection: LC #2 = D+S (live)
LC #2 = D+S (total)
D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
All LC's are listed in the Analysis output
Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
Deflection: EI = 1601e06 lb-in2
"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. SCL-BEAMS (Structural Composite Lumber): the attached SCL selection is for preliminary design only. For final member design contact your local SCL manufacturer.
4. Size factors vary from one manufacturer to another for SCL materials. They can be changed in the database editor.
5. FIRE RATING: LVL, PSL and LSL are not rated for fire endurance.

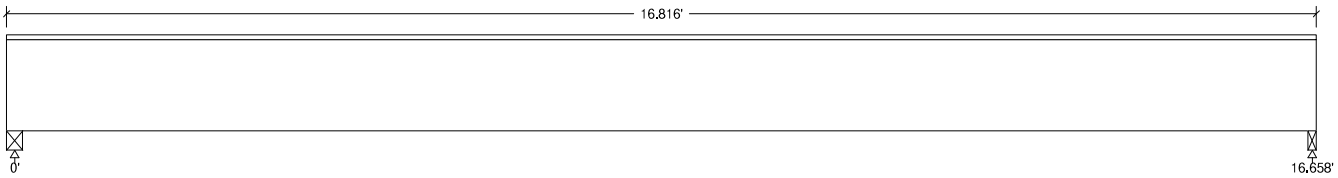
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 20.00(2.00') | | psf |
| Load2 | Snow | Full Area | | | | 30.00(2.00') | | psf |
| Load3 | Dead | Point | | 2.54 | | 314 | | lbs |
| Load4 | Snow | Point | | 2.54 | | 428 | | lbs |
| Load5 | Dead | Point | | 5.29 | | 2312 | | lbs |
| Load6 | Snow | Point | | 5.29 | | 3303 | | lbs |
| Self-weight | Dead | Full UDL | | | | 15.3 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 2325 | | 1228 |
| Snow | 3147 | | 1593 |
| Factored: | | | |
| Total | 5472 | | 2822 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 5472 | | 2822 |
| Support | 6058 | | 3124 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.90 | | 0.90 |
| Load comb | #2 | | #2 |
| Length | 2.50 | | 1.29 |
| Min req'd | 2.50 | | 1.29 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

### R3

**PSL, 2.0E, 2900Fb, 3-1/2"x14"**

Supports: All - Timber-soft Beam, D.Fir-L No.2

Total length: 16.82'; Clear span: 16.5'; volume = 5.7 cu.ft.

Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 163 | Fv' = 334 | psi | fv/Fv' = 0.49 |
| Bending(+) | fb = 2595 | Fb' = 3335 | psi | fb/Fb' = 0.78 |
| Live Defl'n | 0.37 = L/546 | 0.56 = L/360 | in | 0.66 |
| Total Defl'n | 0.77 = L/258 | 0.83 = L/240 | in | 0.93 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CV | Cfu | Cr | Cfrt | Ci | Cn | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 290 | 1.15 | - | 1.00 | - | - | - | - | 1.00 | - | 1.00 | 2 |
| Fb'+ | 2900 | 1.15 | - | 1.00 | 1.000 | 1.00 | - | 1.00 | 1.00 | - | - | 2 |
| Fcp' | 625 | - | - | 1.00 | - | - | - | - | 1.00 | - | - | - |
| E' | 2.0 million | | - | 1.00 | - | - | - | - | 1.00 | - | - | 2 |
| Eminy' | 1.04 million | | - | 1.00 | - | - | - | - | 1.00 | - | - | 2 |

CRITICAL LOAD COMBINATIONS:

Shear : LC #2 = D+S, V max = 5461, V design = 5315 lbs

Bending(+): LC #2 = D+S, M = 24724 lbs-ft

Deflection: LC #2 = D+S (live)

LC #2 = D+S (total)

D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake

All LC's are listed in the Analysis output

Load combinations: ASCE 7-10 / IBC 2015

CALCULATIONS:

Deflection: EI = 1601e06 lb-in2

"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)

Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. SCL-BEAMS (Structural Composite Lumber): the attached SCL selection is for preliminary design only. For final member design contact your local SCL manufacturer.
4. Size factors vary from one manufacturer to another for SCL materials. They can be changed in the database editor.
5. FIRE RATING: LVL, PSL and LSL are not rated for fire endurance.

R4
Oct. 17, 2019 08:10

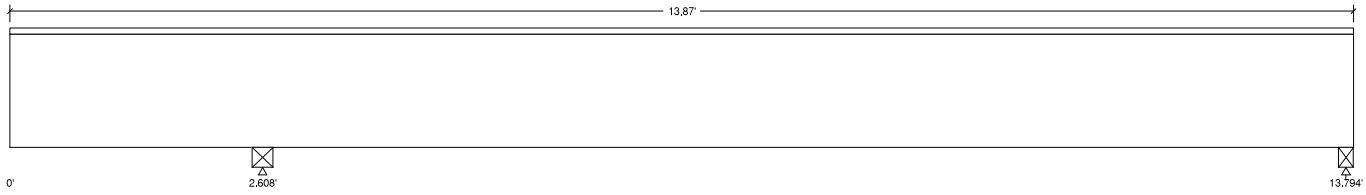
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | No | | | 20.00(14.50') | | psf |
| Load2 | Snow | Full Area | Yes | | | 30.00(14.50') | | psf |
| Self-weight | Dead | Full UDL | No | | | 15.3 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | | | |
|---|---|---|---|---|---|
| Unfactored: | | | | | |
| Dead | | | 2597 | | 1637 |
| Snow | | | 3700 | | 2400 |
| Factored: | | | | | |
| Total | | | 6296 | | 4037 |
| Bearing: | | | | | |
| Capacity | | | | | |
| Beam | | | 6507 | | 4037 |
| Support | | | 6296 | | 4470 |
| Des ratio | | | | | |
| Beam | | | 0.97 | | 1.00 |
| Support | | | 1.00 | | 0.90 |
| Load comb | | | #2 | | #4 |
| Length | | | 2.60 | | 1.85 |
| Min req'd | | | 2.60** | | 1.85 |
| Cb | | | 1.14 | | 1.00 |
| Cb min | | | 1.14 | | 1.00 |
| Cb support | | | 1.11 | | 1.11 |
| Fcp sup | | | 625 | | 625 |

**Minimum bearing length governed by the required width of the supporting member.
Maximum reaction on at least one support is from a different load combination than the critical one for bearing design, shown here, due to Kd factor. See Analysis results for reaction from critical load combination.

### R4

**PSL, 2.0E, 2900Fb, 3-1/2"x14"**

Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 13.87'; Clear span: 2.5', 11'; volume = 4.7 cu.ft.
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 105 | Fv' = 334 | psi | fv/Fv' = 0.31 |
| Bending(+) | fb = 1124 | Fb' = 3335 | psi | fb/Fb' = 0.34 |
| Bending(-) | fb = 264 | Fb' = 3043 | psi | fb/Fb' = 0.09 |
| Deflection: | | | | |
| Interior Live | 0.09 = <L/999 | 0.37 = L/360 | in | 0.24 |
| Total | 0.18 = L/758 | 0.56 = L/240 | in | 0.32 |
| Cantil. Live | -0.06 = L/502 | 0.17 = L/180 | in | 0.36 |
| Total | -0.12 = L/264 | 0.26 = L/120 | in | 0.45 |

### Additional Data:

```
FACTORS:    F/E(psi) CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt  Ci    Cn   LC#
 Fv'          290    1.15   -    1.00   -      -     -     -    1.00  -    1.00   2
 Fb'+        2900    1.15   -    1.00  1.000  1.00   -    1.00  1.00  -     -     4
 Fb'-        2900    1.15   -    1.00  0.912  1.00   -    1.00  1.00  -     -     2
 Fcp'         625     -     -    1.00   -      -     -     -    1.00  -     -     -
 E'          2.0 million   -    1.00   -      -     -     -    1.00  -     -     4
 Eminy'    1.04 million    -    1.00   -      -     -     -    1.00  -     -     4
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #2  = D+S, V max =   4365, V design =   3424 lbs
 Bending(+): LC #4  = D+S (pattern: sS), M =  10705 lbs-ft
 Bending(-): LC #2  = D+S, M =   2518 lbs-ft
 Deflection: LC #4  =   (live)
             LC #4  =   (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load Patterns: s=S/2,  X=L+S or L+Lr,  _=no pattern load in this span
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   1601e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(-):  Lu = 11.19'  Le = 19.63'  RB = 16.4; Lu based on full span
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. SCL-BEAMS (Structural Composite Lumber): the attached SCL selection is for preliminary design only. For final member design contact your local SCL manufacturer.
4. Size factors vary from one manufacturer to another for SCL materials. They can be changed in the database editor.
5. FIRE RATING: LVL, PSL and LSL are not rated for fire endurance.
6. The critical deflection value has been determined using maximum back-span deflection. Cantilever deflections do not govern design.

R5
Oct. 18, 2019 12:59

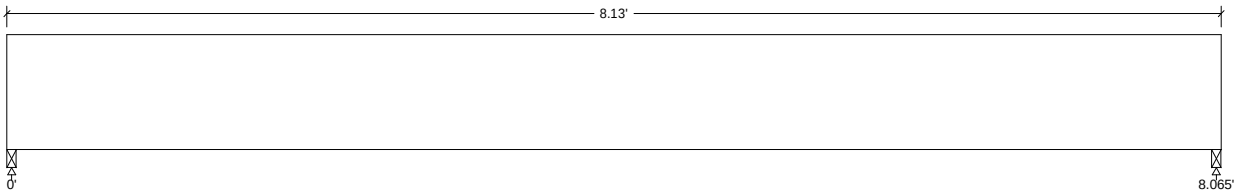
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 20.00(8.25') | | psf |
| Load2 | Snow | Full Area | | | | 30.00(8.25') | | psf |
| Self-weight | Dead | Full UDL | | | | 7.7 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 702 | | 702 |
| Snow | 1006 | | 1006 |
| Factored: | | | |
| Total | 1708 | | 1708 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 1708 | | 1708 |
| Support | 1891 | | 1891 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.90 | | 0.90 |
| Load comb | #2 | | #2 |
| Length | 0.78 | | 0.78 |
| Min req'd | 0.78 | | 0.78 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

### R5

**Lumber-soft, D.Fir-L, No.2, 4x10 (3-1/2"x9-1/4")**

Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 8.13'; Clear span: 8.0'; volume = 1.8 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 63 | Fv' = 207 | psi | fv/Fv' = 0.30 |
| Bending(+) | fb = 821 | Fb' = 1222 | psi | fb/Fb' = 0.67 |
| Live Defl'n | 0.06 = <L/999 | 0.27 = L/360 | in | 0.24 |
| Total Defl'n | 0.13 = L/741 | 0.40 = L/240 | in | 0.32 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CF | Cfu | Cr | Cfrt | Ci | Cn | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 180 | 1.15 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 2 |
| Fb'+ | 900 | 1.15 | 1.00 | 1.00 | 0.984 | 1.200 | 1.00 | 1.00 | 1.00 | 1.00 | - | 2 |
| Fcp' | 625 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | - |
| E' | 1.6 million | | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 2 |
| Emin' | 0.58 million | | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 2 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #2 = D+S, V max = 1694, V design = 1357 lbs
Bending(+): LC #2 = D+S, M = 3417 lbs-ft
Deflection: LC #2 = D+S (live)
LC #2 = D+S (total)
D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
All LC's are listed in the Analysis output
Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
Deflection: EI = 369e06 lb-in2
"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
Lateral stability(+): Lu = 8.06' Le = 15.44' RB = 11.8

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.

R6
Oct. 18, 2019 12:59

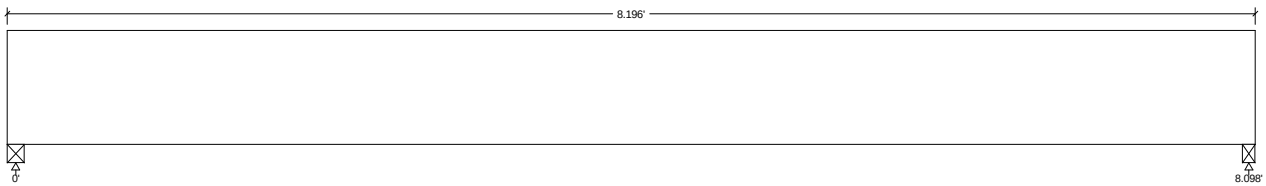
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Partial Area | | 0.11 | 3.11 | 20.00(7.00') | | psf |
| Load2 | Snow | Partial Area | | 0.18 | 3.18 | 30.00(7.00') | | psf |
| Load3 | Dead | Partial Area | | 3.11 | 8.11 | 20.00(5.75') | | psf |
| Load4 | Snow | Partial Area | | 3.11 | 8.11 | 30.00(5.75') | | psf |
| Load5 | Dead | Point | | 3.11 | | 1225 | | lbs |
| Load6 | Snow | Point | | 3.11 | | 1593 | | lbs |
| Self-weight | Dead | Full UDL | | | | 7.3 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 1312 | | 967 |
| Snow | 1766 | | 1319 |
| Factored: | | | |
| Total | 3078 | | 2286 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 3078 | | 2286 |
| Support | 3277 | | 2434 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.94 | | 0.94 |
| Load comb | #2 | | #2 |
| Length | 1.35 | | 1.00 |
| Min req'd | 1.35 | | 1.00 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

## R6

**Glulam-Unbal., West Species, 24F-V4 DF, 3-1/2"x9"**

6 laminations, 3-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 8.2'; Clear span: 8'; volume = 1.8 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 135 | Fv' = 305 | psi | fv/Fv' = 0.44 |
| Bending(+) | fb = 1991 | Fb' = 2685 | psi | fb/Fb' = 0.74 |
| Live Defl'n | 0.12 = L/807 | 0.27 = L/360 | in | 0.45 |
| Total Defl'n | 0.25 = L/382 | 0.40 = L/240 | in | 0.63 |

### Additional Data:

```
FACTORS:    F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'          265     1.15  1.00  1.00    -      -      -     -    1.00  1.00  1.00   2
 Fb'+        2400     1.15  1.00  1.00  0.973  1.000  1.00  1.00  1.00  1.00   -      2
 Fcp'         650      -    1.00  1.00    -      -      -     -    1.00   -     -      -
 E'          1.8 million  1.00  1.00    -      -      -     -    1.00   -     -      2
 Eminy'    0.85 million  1.00  1.00    -      -      -     -    1.00   -     -      2
CRITICAL LOAD COMBINATIONS:
 Shear      : LC #2  = D+S, V max =   3078, V design =   2827 lbs
 Bending(+): LC #2  = D+S, M =   7841 lbs-ft
 Deflection: LC #2  = D+S  (live)
             LC #2  = D+S  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =    383e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(+):  Lu = 8.13'  Le = 15.44'  RB = 11.7
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

R7
Oct. 18, 2019 12:59

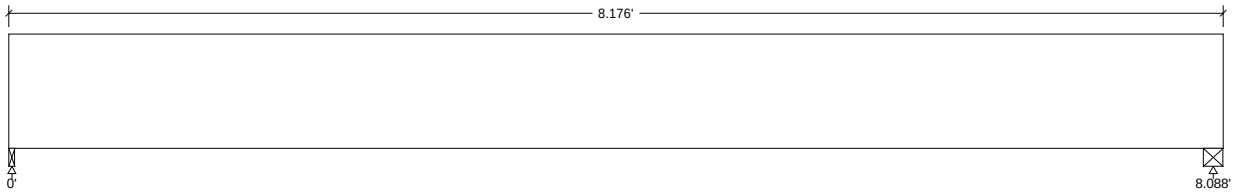
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 20.00(1.00') | | psf |
| Load2 | Snow | Full Area | | | | 30.00(1.00') | | psf |
| Load3 | Dead | Point | | 6.87 | | 1554 | | lbs |
| Load4 | Snow | Point | | 6.87 | | 2328 | | lbs |
| Self-weight | Dead | Full UDL | | | | 7.7 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 350 | | 1430 |
| Snow | 478 | | 2095 |
| Factored: | | | |
| Total | 828 | | 3525 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 1094 | | 3525 |
| Support | 1211 | | 3903 |
| Des ratio | | | |
| Beam | 0.76 | | 1.00 |
| Support | 0.68 | | 0.90 |
| Load comb | #2 | | #2 |
| Length | 0.50* | | 1.61 |
| Min req'd | 0.50* | | 1.61 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

*Minimum bearing length setting used: 1/2" for end supports

### R7

**Lumber-soft, D.Fir-L, No.2, 4x10 (3-1/2"x9-1/4")**

Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 8.18'; Clear span: 8.0'; volume = 1.8 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 161 | Fv' = 207 | psi | fv/Fv' = 0.78 |
| Bending(+) | fb = 1037 | Fb' = 1222 | psi | fb/Fb' = 0.85 |
| Live Defl'n | 0.06 = <L/999 | 0.27 = L/360 | in | 0.23 |
| Total Defl'n | 0.13 = L/762 | 0.40 = L/240 | in | 0.31 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CF | Cfu | Cr | Cfrt | Ci | Cn | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 180 | 1.15 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 2 |
| Fb'+ | 900 | 1.15 | 1.00 | 1.00 | 0.984 | 1.200 | 1.00 | 1.00 | 1.00 | 1.00 | - | 2 |
| Fcp' | 625 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | - |
| E' | 1.6 million | | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 2 |
| Emin' | 0.58 million | | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 2 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #2 = D+S, V max = 3522, V design = 3473 lbs
Bending(+): LC #2 = D+S, M = 4312 lbs-ft
Deflection: LC #2 = D+S (live)
LC #2 = D+S (total)
D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
All LC's are listed in the Analysis output
Load combinations: ASCE 7-10 / IBC 2015

CALCULATIONS:
Deflection: EI = 369e06 lb-in2
"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
Lateral stability(+): Lu = 8.06' Le = 15.50' RB = 11.8

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.

R8
Oct. 18, 2019 12:59

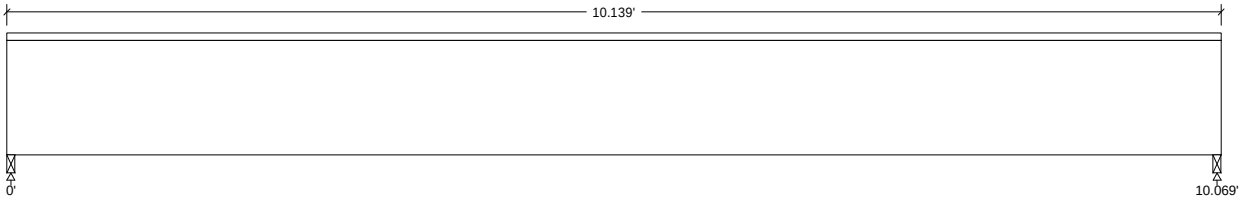
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 20.00(11.00') | | psf |
| Load2 | Snow | Full Area | | | | 30.00(11.00') | | psf |
| Self-weight | Dead | Full UDL | | | | 15.0 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 1191 | | 1191 |
| Snow | 1673 | | 1673 |
| Factored: | | | |
| Total | 2864 | | 2864 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 2864 | | 2864 |
| Support | 3059 | | 3059 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.94 | | 0.94 |
| Load comb | #2 | | #2 |
| Length | 0.83 | | 0.83 |
| Min req'd | 0.83 | | 0.83 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.07 | | 1.07 |
| Fcp sup | 625 | | 625 |

## R8

**Timber-soft, D.Fir-L, No.2, 6x12 (5-1/2"x11-1/2")**

Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 10.14'; Clear span: 10.0'; volume = 4.5 cu.ft.; Beam and stringer
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 54 | Fv' = 195 | psi | fv/Fv' = 0.28 |
| Bending(+) | fb = 709 | Fb' = 1006 | psi | fb/Fb' = 0.70 |
| Live Defl'n | 0.08 = <L/999 | 0.34 = L/360 | in | 0.25 |
| Total Defl'n | 0.17 = L/693 | 0.50 = L/240 | in | 0.35 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CF | Cfu | Cr | Cfrt | Ci | Cn | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 170 | 1.15 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 2 |
| Fb'+ | 875 | 1.15 | 1.00 | 1.00 | 1.000 | 1.000 | 1.00 | 1.00 | 1.00 | 1.00 | - | 2 |
| Fcp' | 625 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | - |
| E' | 1.3 million | | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 2 |
| Emin' | 0.47 million | | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 2 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #2 = D+S, V max = 2845, V design = 2284 lbs
Bending(+): LC #2 = D+S, M = 7161 lbs-ft
Deflection: LC #2 = D+S (live)
LC #2 = D+S (total)
D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
All LC's are listed in the Analysis output
Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
Deflection: EI = 906e06 lb-in2
"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.

SF1
Oct. 18, 2019 13:00

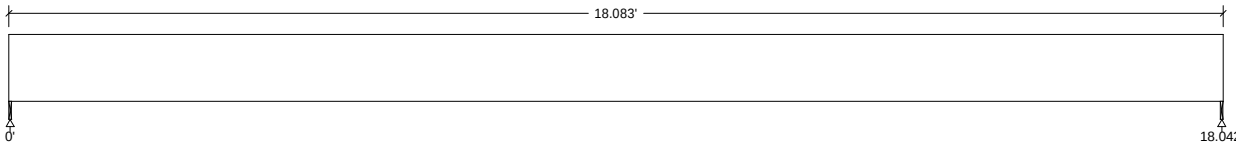
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 20.00(0.75') | | psf |
| Load2 | Live | Full Area | | | | 60.00(0.75') | | psf |
| Load3 | Snow | Full Area | | | | 30.00(0.75') | | psf |
| Self-weight | Dead | Full UDL | | | | 9.7 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 223 | | 223 |
| Live | 407 | | 407 |
| Snow | 203 | | 203 |
| Factored: | | | |
| Total | 681 | | 681 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 1137 | | 1137 |
| Support | 1211 | | 1211 |
| Des ratio | | | |
| Beam | 0.60 | | 0.60 |
| Support | 0.56 | | 0.56 |
| Load comb | #3 | | #3 |
| Length | 0.50* | | 0.50* |
| Min req'd | 0.50* | | 0.50* |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

*Minimum bearing length setting used: 1/2" for end supports

## SF1

**Glulam-Unbal., West Species, 24F-V4 DF, 3-1/2"x12"**

8 laminations, 3-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 18.08'; Clear span: 18'; volume = 5.3 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 20 | Fv' = 265 | psi | fv/Fv' = 0.08 |
| Bending(+) | fb = 438 | Fb' = 2191 | psi | fb/Fb' = 0.20 |
| Live Defl'n | 0.13 = <L/999 | 0.60 = L/360 | in | 0.22 |
| Total Defl'n | 0.23 = L/940 | 0.90 = L/240 | in | 0.26 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CV | Cfu | Cr | Cfrt | Notes | Cn*Cvr | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 265 | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 2 |
| Fb'+ | 2400 | 1.15 | 1.00 | 1.00 | 0.794 | 1.000 | 1.00 | 1.00 | 1.00 | 1.00 | - | 3 |
| Fcp' | 650 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | - | - | - |
| E' | 1.8 million | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | - | - | 3 |
| Eminy' | 0.85 million | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | - | - | 3 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #2 = D+L, V max = 628, V design = 557 lbs
Bending(+): LC #3 = D+.75(L+S), M = 3064 lbs-ft
Deflection: LC #3 = D+.75(L+S) (live)
LC #3 = D+.75(L+S) (total)
D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
All LC's are listed in the Analysis output
Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
Deflection: EI = 907e06 lb-in2
"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
Lateral stability(+): Lu = 18.06' Le = 33.19' RB = 19.8

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

SF2
Oct. 18, 2019 13:00

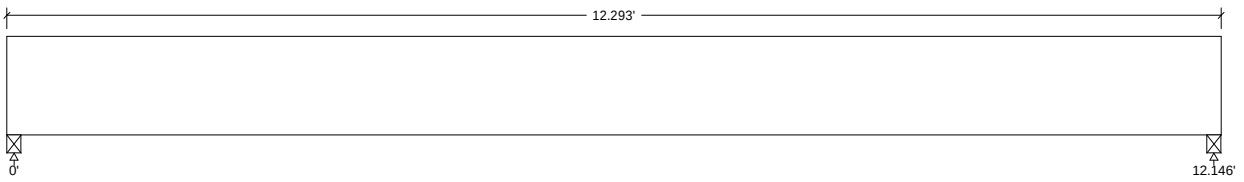
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 20.00(11.50') | | psf |
| Load2 | Live | Full Area | | | | 60.00(11.50') | | psf |
| Load3 | Snow | Full Area | | | | 30.00(11.50') | | psf |
| Self-weight | Dead | Full UDL | | | | 15.2 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 1506 | | 1506 |
| Live | 4241 | | 4241 |
| Snow | 2121 | | 2121 |
| Factored: | | | |
| Total | 6277 | | 6277 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 6277 | | 6277 |
| Support | 6447 | | 6447 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.97 | | 0.97 |
| Load comb | #3 | | #3 |
| Length | 1.76 | | 1.76 |
| Min req'd | 1.76 | | 1.76 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.07 | | 1.07 |
| Fcp sup | 625 | | 625 |

## SF2

**Glulam-Unbal., West Species, 24F-V4 DF, 5-1/2"x12"**

8 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 12.29'; Clear span: 12'; volume = 5.6 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 106 | Fv' = 265 | psi | fv/Fv' = 0.40 |
| Bending(+) | fb = 1568 | Fb' = 2360 | psi | fb/Fb' = 0.66 |
| Live Defl'n | 0.27 = L/546 | 0.40 = L/360 | in | 0.66 |
| Total Defl'n | 0.39 = L/370 | 0.61 = L/240 | in | 0.65 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CV | Cfu | Cr | Cfrt | Notes | Cn*Cvr | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 265 | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 2 |
| Fb'+ | 2400 | 1.00 | 1.00 | 1.00 | 0.984 | 1.000 | 1.00 | 1.00 | 1.00 | 1.00 | - | 2 |
| Fcp' | 650 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | - | - | - |
| E' | 1.8 million | 1.00 | 1.00 | - | - | - | - | - | 1.00 | - | - | 3 |
| Eminy' | 0.85 million | 1.00 | 1.00 | - | - | - | - | - | 1.00 | - | - | 3 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #2 = D+L, V max = 5680, V design = 4676 lbs
Bending(+): LC #2 = D+L, M = 17247 lbs-ft
Deflection: LC #3 = D+.75(L+S) (live)
LC #3 = D+.75(L+S) (total)
D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
All LC's are listed in the Analysis output
Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
Deflection: EI = 1426e06 lb-in2
"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
Lateral stability(+): Lu = 12.13' Le = 22.81' RB = 10.4

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

SF3
Oct. 18, 2019 13:00

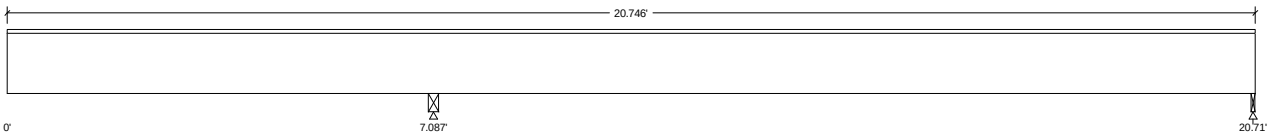
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | No | | | 15.00(5.75') | | psf |
| Load2 | Live | Full Area | Yes | | | 60.00(5.75') | | psf |
| Load3 | Snow | Full Area | Yes | | | 30.00(5.75') | | psf |
| Self-weight | Dead | Full UDL | No | | | 15.2 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | | | | |
|---|---|---|---|---|---|---|
| Unfactored: | | | | | | |
| Dead | | | 1597 | | | 507 |
| Live | | | 5431 | | | 2362 |
| Snow | | | 2716 | | | 1022 |
| Factored: | | | | | | |
| Uplift | | | | | | -117 |
| Total | | | 7707 | | | 3045 |
| Bearing: | | | | | | |
| Capacity | | | | | | |
| Beam | | | 8844 | | | 3045 |
| Support | | | 7707 | | | 3128 |
| Des ratio | | | | | | |
| Beam | | | 0.87 | | | 1.00 |
| Support | | | 1.00 | | | 0.97 |
| Load comb | | | #3 | | | #12 |
| Length | | | 2.10 | | | 0.85 |
| Min req'd | | | 2.10** | | | 0.85 |
| Cb | | | 1.18 | | | 1.00 |
| Cb min | | | 1.18 | | | 1.00 |
| Cb support | | | 1.07 | | | 1.07 |
| Fcp sup | | | 625 | | | 625 |

**Minimum bearing length governed by the required width of the supporting member.
Maximum reaction on at least one support is from a different load combination than the critical one for bearing design, shown here, due to Kd factor. See Analysis results for reaction from critical load combination.

**Glulam-Bal., West Species, 24F-V8 DF, 5-1/2"x12"**

8 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 20.75'; Clear span: 7', 13.5'; volume = 9.5 cu.ft.
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 77 | Fv' = 265 | psi | fv/Fv' = 0.29 |
| Bending(+) | fb = 829 | Fb' = 2400 | psi | fb/Fb' = 0.35 |
| Bending(-) | fb = 1019 | Fb' = 2361 | psi | fb/Fb' = 0.43 |
| Deflection: | | | | |
| Interior Live | 0.19 = L/868 | 0.45 = L/360 | in | 0.41 |
| Total | 0.22 = L/751 | 0.68 = L/240 | in | 0.32 |
| Cantil. Live | 0.47 = L/180 | 0.47 = L/180 | in | 1.00 |
| Total | 0.54 = L/157 | 0.71 = L/120 | in | 0.76 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'         265    1.00  1.00  1.00    -     -     -     -   1.00  1.00  1.00   2
 Fb'+       2400    1.00  1.00  1.00  1.000  1.000  1.00  1.00  1.00  1.00   -     6
 Fb'-       2400    1.00  1.00  1.00  0.984  1.000  1.00  1.00  1.00  1.00   -     2
 Fcp'        650     -    1.00  1.00    -      -     -     -    1.00   -     -     -
 E'      1.8 million  1.00  1.00    -      -     -     -    1.00   -     -    12
 Eminy'  0.85 million  1.00  1.00    -      -     -     -    1.00   -     -    12
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #2  = D+L, V max =   3864, V design =   3380 lbs
 Bending(+): LC #6  = D+L (pattern: _L), M =   9121 lbs-ft
 Bending(-): LC #2  = D+L, M =  11213 lbs-ft
 Deflection: LC #12 =   (live)
             LC #12 =   (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load Patterns: s=S/2,  X=L+S or L+Lr,  _=no pattern load in this span
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   1426e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(-):  Lu = 13.63'  Le = 22.63'  RB = 10.4; Lu based on full span
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. Grades with equal bending capacity in the top and bottom edges of the beam cross-section are recommended for continuous beams.
5. GLULAM: bxd = actual breadth x actual depth.
6. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
7. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).
8. The critical deflection value has been determined using maximum back-span deflection. Cantilever deflections do not govern design.

SF4
Oct. 18, 2019 13:00

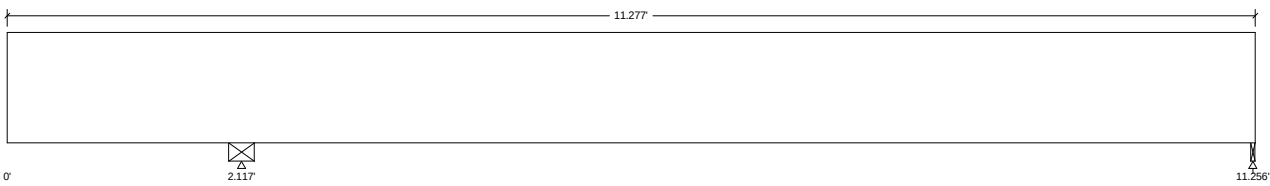
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | No | | | 15.00(1.33') | | psf |
| Load2 | Live | Full Area | Yes | | | 60.00(1.33') | | psf |
| Load3 | Dead | Point | No | 0.00 | | 1595 | | lbs |
| Load4 | Live | Point | Yes | 0.00 | | 5426 | | lbs |
| Load5 | Snow | Point | Yes | 0.00 | | 2716 | | lbs |
| Load6 | Snow | Full Area | Yes | | | 30.00(1.33') | | psf |
| Self-weight | Dead | Full UDL | No | | | 15.2 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | | | |
|---|---|---|---|---|---|
| Unfactored: | | | | | |
| Dead | | | 2209 | | 66 |
| Live | | | 7238 | | 367 |
| Snow | | | 3622 | | -547 |
| Factored: | | | | | |
| Uplift | | | | | -1584 |
| Total | | | 10353 | | 150 |
| Bearing: | | | | | |
| Capacity | | | | | |
| Beam | | | 11421 | | 1787 |
| Support | | | 10353 | | 1836 |
| Des ratio | | | | | |
| Beam | | | 0.91 | | 0.08 |
| Support | | | 1.00 | | 0.08 |
| Load comb | | | #3 | | #6 |
| Length | | | 2.82 | | 0.50* |
| Min req'd | | | 2.82** | | 0.50* |
| Cb | | | 1.13 | | 1.00 |
| Cb min | | | 1.13 | | 1.00 |
| Cb support | | | 1.07 | | 1.07 |
| Fcp sup | | | 625 | | 625 |

*Minimum bearing length setting used: 1/2" for end supports
**Minimum bearing length governed by the required width of the supporting member.
Maximum reaction on at least one support is from a different load combination than the critical one for bearing design, shown here, due to Kd factor. See Analysis results for reaction from critical load combination.

## SF4

**Glulam-Bal., West Species, 24F-V8 DF, 5-1/2"x12"**

8 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 11.28'; Clear span: 2', 9'; volume = 5.2 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 163 | Fv' = 265 | psi | fv/Fv' = 0.61 |
| Bending(+) | fb = 8 | Fb' = 2374 | psi | fb/Fb' = 0.00 |
| Bending(-) | fb = 1375 | Fb' = 2374 | psi | fb/Fb' = 0.58 |
| Deflection: | | | | |
| Interior Live | -0.08 = <L/999 | 0.30 = L/360 | in | 0.27 |
| Total | -0.11 = L/981 | 0.46 = L/240 | in | 0.24 |
| Cantil. Live | 0.13 = L/203 | 0.14 = L/180 | in | 0.89 |
| Total | 0.17 = L/148 | 0.21 = L/120 | in | 0.81 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'        265    1.00  1.00  1.00    -      -     -     -    1.00  1.00  1.00   2
 Fb'+      2400    1.00  1.00  1.00  0.989  1.000  1.00  1.00  1.00  1.00   -     6
 Fb'-      2400    1.00  1.00  1.00  0.989  1.000  1.00  1.00  1.00  1.00   -     2
 Fcp'       650    -     1.00  1.00   -      -      -     -    1.00   -     -     -
 E'        1.8 million  1.00  1.00    -      -      -     -    1.00   -     -    11
 Eminy'   0.85 million  1.00  1.00    -      -      -     -    1.00   -     -    11
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #2  = D+L, V max =   7265, V design =   7166 lbs
 Bending(+): LC #6  = D+L (pattern: _L), M =     83 lbs-ft
 Bending(-): LC #2  = D+L, M =   15125 lbs-ft
 Deflection: LC #11 =   (live)
             LC #11 =   (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load Patterns: s=S/2,  X=L+S or L+Lr,  _=no pattern load in this span
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   1426e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(+):  Lu = 9.13'  Le = 16.19'  RB = 8.8; Lu based on full span
 Lateral stability(-):  Lu = 9.13'  Le = 16.19'  RB = 8.8; Lu based on full span
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. Grades with equal bending capacity in the top and bottom edges of the beam cross-section are recommended for continuous beams.
5. GLULAM: bxd = actual breadth x actual depth.
6. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
7. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).
8. The critical deflection value has been determined using maximum back-span deflection. Cantilever deflections do not govern design.

SF5
Oct. 18, 2019 13:00

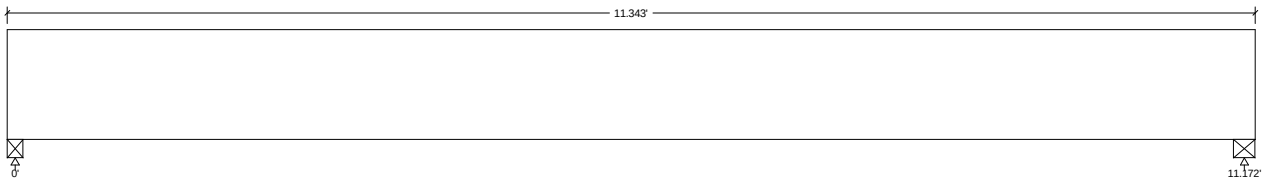
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 20.00(11.50') | | psf |
| Load2 | Live | Full Area | | | | 60.00(11.50') | | psf |
| Load3 | Dead | Partial Area | | 9.40 | 11.15 | 15.00(0.67') | | psf |
| Load4 | Live | Partial Area | | 9.40 | 11.15 | 60.00(0.67') | | psf |
| Load5 | Dead | Point | | 9.40 | | 507 | | lbs |
| Load6 | Live | Point | | 9.40 | | 2360 | | lbs |
| Load7 | Snow | Full Area | | | | 30.00(11.50') | | psf |
| Load8 | Snow | Partial Area | | 9.40 | 11.15 | 30.00(0.67') | | psf |
| Load9 | Snow | Point | | 9.40 | | 1022 | | lbs |
| Self-weight | Dead | Full UDL | | | | 15.2 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 1472 | | 1831 |
| Live | 4301 | | 5956 |
| Snow | 2125 | | 2846 |
| Factored: | | | |
| Total | 6291 | | 8433 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 6291 | | 8433 |
| Support | 6462 | | 8661 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.97 | | 0.97 |
| Load comb | #3 | | #3 |
| Length | 1.76 | | 2.36 |
| Min req'd | 1.76 | | 2.36 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.07 | | 1.07 |
| Fcp sup | 625 | | 625 |

## SF5

**Glulam-Unbal., West Species, 24F-V4 DF, 5-1/2"x12"**

8 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 11.34'; Clear span: 11'; volume = 5.2 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 151 | Fv' = 265 | psi | fv/Fv' = 0.57 |
| Bending(+) | fb = 1582 | Fb' = 2364 | psi | fb/Fb' = 0.67 |
| Live Defl'n | 0.23 = L/572 | 0.37 = L/360 | in | 0.63 |
| Total Defl'n | 0.34 = L/396 | 0.56 = L/240 | in | 0.60 |

### Additional Data:

```
FACTORS:    F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'          265     1.00  1.00  1.00    -      -      -    1.00  1.00  1.00   2
 Fb'+        2400     1.00  1.00  1.00  0.985  1.000  1.00  1.00  1.00  1.00    -     2
 Fcp'         650      -    1.00  1.00    -      -      -     -    1.00   -      -     -
 E'          1.8 million  1.00  1.00    -      -      -     -    1.00   -      -     3
 Eminy'   0.85 million  1.00  1.00    -      -      -     -    1.00   -      -     3
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #2  = D+L, V max =   7696, V design =   6624 lbs
 Bending(+): LC #2  = D+L, M =  17406 lbs-ft
 Deflection: LC #3  = D+.75(L+S)  (live)
             LC #3  = D+.75(L+S)  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   1426e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(+):  Lu = 11.19'  Le = 21.19'  RB = 10.0
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

SF6
Oct. 18, 2019 13:00

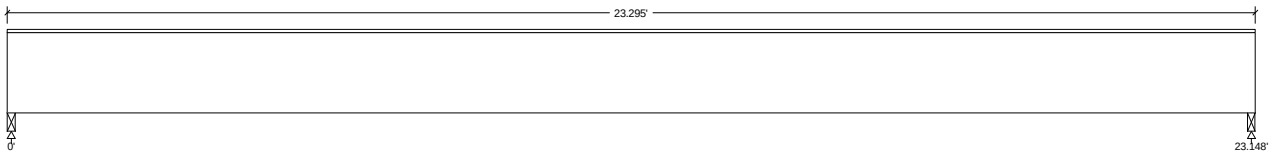
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 20.00(0.67') | | psf |
| Load2 | Live | Full Area | | | | 60.00(0.67') | | psf |
| Load3 | Dead | Partial Area | | 8.40 | 14.99 | 15.00(3.50') | | psf |
| Load4 | Live | Partial Area | | 8.40 | 14.99 | 40.00(3.50') | | psf |
| Load5 | Dead | Partial Area | | 0.15 | 4.28 | 20.00(8.00') | | psf |
| Load6 | Snow | Partial Area | | 0.15 | 4.28 | 30.00(8.00') | | psf |
| Load7 | Dead | Partial Area | | 8.28 | 9.11 | 20.00(8.00') | | psf |
| Load8 | Snow | Partial Area | | 8.28 | 9.11 | 30.00(8.00') | | psf |
| Load9 | Dead | Partial Area | | 14.28 | 15.11 | 20.00(8.00') | | psf |
| Load10 | Snow | Partial Area | | 14.28 | 15.11 | 30.00(8.00') | | psf |
| Load11 | Dead | Partial Area | | 19.11 | 23.15 | 20.00(4.75') | | psf |
| Load12 | Snow | Partial Area | | 19.11 | 23.15 | 30.00(4.75') | | psf |
| Load13 | Dead | Point | | 4.28 | | 339 | | lbs |
| Load14 | Snow | Point | | 4.28 | | 486 | | lbs |
| Load15 | Dead | Point | | 8.28 | | 339 | | lbs |
| Load16 | Snow | Point | | 8.28 | | 486 | | lbs |
| Load17 | Dead | Point | | 9.11 | | 422 | | lbs |
| Load18 | Snow | Point | | 9.11 | | 610 | | lbs |
| Load19 | Dead | Point | | 14.28 | | 422 | | lbs |
| Load20 | Snow | Point | | 14.28 | | 610 | | lbs |
| Load21 | Dead | Point | | 15.11 | | 339 | | lbs |
| Load22 | Snow | Point | | 15.11 | | 490 | | lbs |
| Load23 | Dead | Point | | 19.11 | | 339 | | lbs |
| Load24 | Snow | Point | | 19.11 | | 490 | | lbs |
| Load25 | Dead | Full UDL | | | | 100.0 | | plf |
| Load26 | Snow | Full Area | | | | 30.00(0.67') | | psf |
| Self-weight | Dead | Full UDL | | | | 22.8 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 3618 | | 3405 |
| Live | 925 | | 928 |
| Snow | 2962 | | 2644 |
| Factored: | | | |
| Total | 6580 | | 6084 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 6580 | | 6084 |
| Support | 6758 | | 6249 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.97 | | 0.97 |
| Load comb | #4 | | #3 |
| Length | 1.84 | | 1.70 |
| Min req'd | 1.84 | | 1.70 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.07 | | 1.07 |
| Fcp sup | 625 | | 625 |

## SF6

**Glulam-Unbal., West Species, 24F-V4 DF, 5-1/2"x18"**

12 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 23.3'; Clear span: 23'; volume = 16.0 cu.ft.
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 87 | Fv' = 305 | psi | fv/Fv' = 0.29 |
| Bending(+) | fb = 1562 | Fb' = 2606 | psi | fb/Fb' = 0.60 |
| Live Defl'n | 0.35 = L/791 | 0.77 = L/360 | in | 0.45 |
| Total Defl'n | 0.99 = L/281 | 1.16 = L/240 | in | 0.85 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CV | Cfu | Cr | Cfrt | Notes | Cn*Cvr | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 265 | 1.15 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 3 |
| Fb'+ | 2400 | 1.15 | 1.00 | 1.00 | 1.000 | 0.944 | 1.00 | 1.00 | 1.00 | 1.00 | - | 3 |
| Fcp' | 650 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | - | - | - |
| E' | 1.8 million | | 1.00 | 1.00 | - | - | - | - | 1.00 | - | - | 3 |
| Eminy' | 0.85 million | | 1.00 | 1.00 | - | - | - | - | 1.00 | - | - | 3 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #3 = D+.75(L+S), V max = 6521, V design = 5733 lbs
Bending(+): LC #3 = D+.75(L+S), M = 38652 lbs-ft
Deflection: LC #3 = D+.75(L+S) (live)
LC #3 = D+.75(L+S) (total)
D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
All LC's are listed in the Analysis output
Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
Deflection: EI = 4811e06 lb-in2
"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

SF7
Oct. 18, 2019 13:00

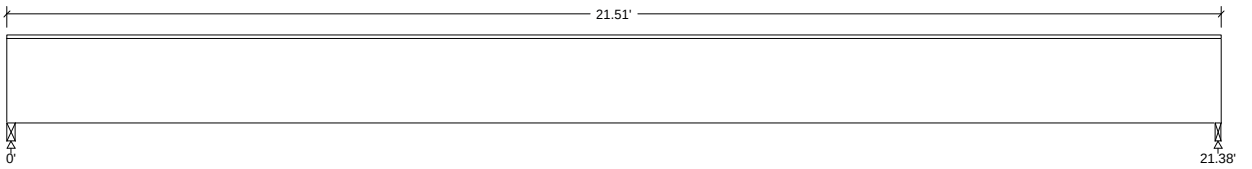
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 15.00(1.33') | | psf |
| Load2 | Live | Full Area | | | | 40.00(1.33') | | psf |
| Load3 | Dead | Point | | 8.66 | | 2597 | | lbs |
| Load4 | Snow | Point | | 8.57 | | 3700 | | lbs |
| Self-weight | Dead | Full UDL | | | | 14.5 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 1924 | | 1412 |
| Live | 573 | | 572 |
| Snow | 2230 | | 1470 |
| Factored: | | | |
| Total | 4154 | | 2944 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 4154 | | 2944 |
| Support | 4422 | | 3134 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.94 | | 0.94 |
| Load comb | #4 | | #3 |
| Length | 1.83 | | 1.29 |
| Min req'd | 1.83 | | 1.29 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

## SF7

**Glulam-Unbal., West Species, 24F-V4 DF, 3-1/2"x18"**

12 laminations, 3-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 21.51'; Clear span: 21.25'; volume = 9.4 cu.ft.
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 98 | Fv' = 305 | psi | fv/Fv' = 0.32 |
| Bending(+) | fb = 2162 | Fb' = 2748 | psi | fb/Fb' = 0.79 |
| Live Defl'n | 0.40 = L/638 | 0.71 = L/360 | in | 0.56 |
| Total Defl'n | 0.91 = L/283 | 1.07 = L/240 | in | 0.85 |

### Additional Data:

```
FACTORS:    F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'         265    1.15  1.00  1.00    -      -     -     -    1.00  1.00  1.00   4
 Fb'+       2400    1.15  1.00  1.00  1.000  0.996  1.00  1.00  1.00  1.00   -     4
 Fcp'        650     -    1.00  1.00    -      -     -     -    1.00   -     -     -
 E'          1.8 million  1.00  1.00    -      -     -     -    1.00   -     -     4
 Eminy'   0.85 million  1.00  1.00    -      -     -     -    1.00   -     -     4
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #4  = D+S, V max =   4152, V design =   4098 lbs
 Bending(+): LC #4  = D+S, M =  34047 lbs-ft
 Deflection: LC #4  = D+S  (live)
             LC #4  = D+S  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   3062e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

SF8
Oct. 18, 2019 13:00

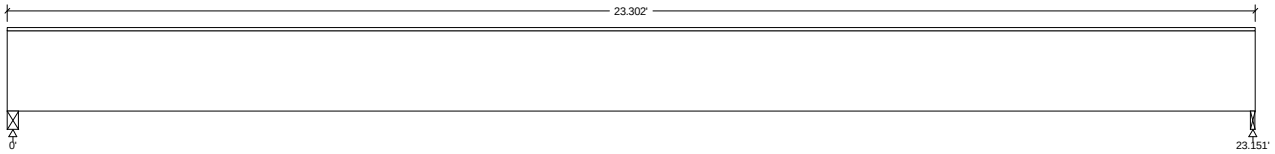
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Partial Area | | 0.21 | 8.46 | 15.00(10.75') | | psf |
| Load2 | Live | Partial Area | | 0.21 | 8.46 | 40.00(10.75') | | psf |
| Load3 | Dead | Partial Area | | 8.46 | 13.21 | 15.00(14.50') | | psf |
| Load4 | Live | Partial Area | | 8.46 | 13.21 | 40.00(14.50') | | psf |
| Load5 | Dead | Partial Area | | 13.21 | 15.55 | 15.00(7.75') | | psf |
| Load6 | Dead | Partial Area | | 13.21 | 15.55 | 40.00(7.75') | | psf |
| Load7 | Dead | Point | | 2.38 | | 1924 | | lbs |
| Load8 | Live | Point | | 2.38 | | 573 | | lbs |
| Load9 | Snow | Point | | 2.38 | | 2230 | | lbs |
| Self-weight | Dead | Full UDL | | | | 22.8 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 4021 | | 1788 |
| Live | 4894 | | 1982 |
| Snow | 2011 | | 219 |
| Factored: | | | |
| Total | 9200 | | 3770 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 9200 | | 3770 |
| Support | 9449 | | 3872 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.97 | | 0.97 |
| Load comb | #3 | | #2 |
| Length | 2.57 | | 1.05 |
| Min req'd | 2.57 | | 1.05 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.07 | | 1.07 |
| Fcp sup | 625 | | 625 |

## SF8

**Glulam-Unbal., West Species, 24F-V4 DF, 5-1/2"x18"**

12 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 23.3'; Clear span: 23'; volume = 16.0 cu.ft.
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 122 | Fv' = 265 | psi | fv/Fv' = 0.46 |
| Bending(+) | fb = 1596 | Fb' = 2266 | psi | fb/Fb' = 0.70 |
| Live Defl'n | 0.43 = L/644 | 0.77 = L/360 | in | 0.56 |
| Total Defl'n | 0.91 = L/303 | 1.16 = L/240 | in | 0.79 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'         265    1.00  1.00  1.00    -      -     -     -   1.00  1.00  1.00   2
 Fb'+       2400    1.00  1.00  1.00  1.000  0.944  1.00  1.00  1.00  1.00   -     2
 Fcp'        650     -    1.00  1.00    -      -     -     -    1.00   -     -     -
 E'          1.8 million  1.00  1.00    -      -     -     -    1.00   -     -     2
 Eminy'   0.85 million  1.00  1.00    -      -     -     -    1.00   -     -     2
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #2  = D+L, V max =   8915, V design =   8024 lbs
 Bending(+): LC #2  = D+L, M =  39510 lbs-ft
 Deflection: LC #2  = D+L  (live)
             LC #2  = D+L  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   4811e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

SF9
Oct. 18, 2019 13:01

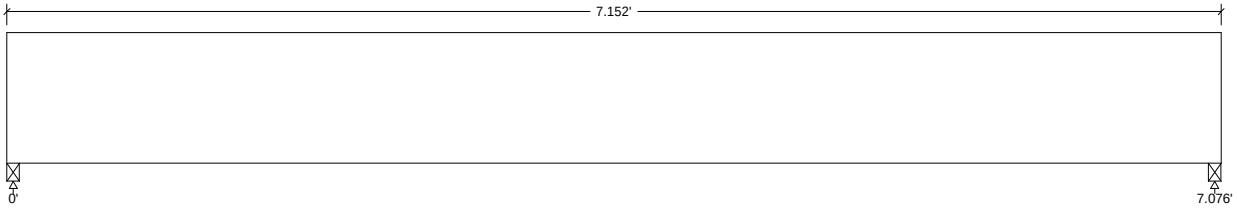
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 20.00(11.00') | | psf |
| Load2 | Snow | Full Area | | | | 30.00(11.00') | | psf |
| Self-weight | Dead | Full UDL | | | | 7.7 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 814 | | 814 |
| Snow | 1180 | | 1180 |
| Factored: | | | |
| Total | 1994 | | 1994 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 1994 | | 1994 |
| Support | 2208 | | 2208 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.90 | | 0.90 |
| Load comb | #2 | | #2 |
| Length | 0.91 | | 0.91 |
| Min req'd | 0.91 | | 0.91 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

## SF9

**Lumber-soft, D.Fir-L, No.2, 4x10 (3-1/2"x9-1/4")**

Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 7.15'; Clear span: 7.0'; volume = 1.6 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 71 | Fv' = 207 | psi | fv/Fv' = 0.34 |
| Bending(+) | fb = 839 | Fb' = 1225 | psi | fb/Fb' = 0.69 |
| Live Defl'n | 0.05 = <L/999 | 0.24 = L/360 | in | 0.21 |
| Total Defl'n | 0.10 = L/827 | 0.35 = L/240 | in | 0.29 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CF | Cfu | Cr | Cfrt | Ci | Cn | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 180 | 1.15 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 2 |
| Fb'+ | 900 | 1.15 | 1.00 | 1.00 | 0.986 | 1.200 | 1.00 | 1.00 | 1.00 | 1.00 | - | 2 |
| Fcp' | 625 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | - |
| E' | 1.6 million | | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 2 |
| Emin' | 0.58 million | | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 2 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #2 = D+S, V max = 1973, V design = 1522 lbs
Bending(+): LC #2 = D+S, M = 3491 lbs-ft
Deflection: LC #2 = D+S (live)
LC #2 = D+S (total)
D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
All LC's are listed in the Analysis output
Load combinations: ASCE 7-10 / IBC 2015

CALCULATIONS:
Deflection: EI = 369e06 lb-in2
"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
Lateral stability(+): Lu = 7.06' Le = 13.88' RB = 11.2

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.

SF10
Oct. 18, 2019 13:01

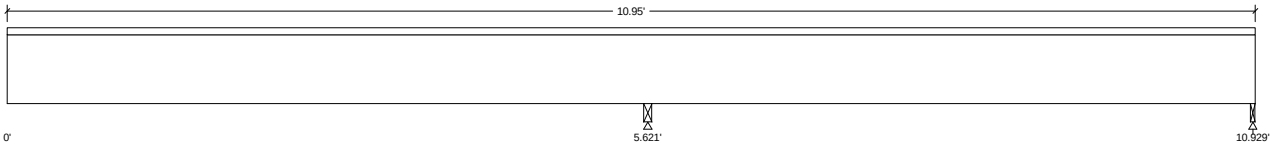
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | No | | | 20.00(16.0") | | psf |
| Load2 | Snow | Full Area | Yes | | | 30.00(16.0") | | psf |
| Self-weight | Dead | Full UDL | No | | | 2.2 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | | | | |
|---|---|---|---|---|---|---|
| Unfactored: | | | | | | |
| Dead | | | 325 | | | -9 |
| Snow | | | 450 | | | 47 |
| Factored: | | | | | | |
| Uplift | | | | | | -74 |
| Total | | | 775 | | | 39 |
| Bearing: | | | | | | |
| Capacity | | | | | | |
| Joist | | | 775 | | | 304 |
| Support | | | 1056 | | | 586 |
| Des ratio | | | | | | |
| Joist | | | 1.00 | | | 0.13 |
| Support | | | 0.73 | | | 0.07 |
| Load comb | | | #2 | | | #4 |
| Length | | | 0.90 | | | 0.50* |
| Min req'd | | | 0.90 | | | 0.50* |
| Cb | | | 1.42 | | | 1.00 |
| Cb min | | | 1.42 | | | 1.00 |
| Cb support | | | 1.25 | | | 1.25 |
| Fcp sup | | | 625 | | | 625 |

*Minimum bearing length setting used: 1/2" for end supports

Maximum reaction on at least one support is from a different load combination than the critical one for bearing design, shown here, due to Kd factor. See Analysis results for reaction from critical load combination.

## SF10

**Lumber-soft, Hem-Fir, No.2, 2x8 (1-1/2"x7-1/4")**

Supports: All - Timber-soft Beam, D.Fir-L No.2

Roof joist spaced at 16.0" c/c; Total length: 10.95'; Clear span: 5.583', 5.25'; volume = 0.8 cu.ft.

Lateral support: top= full, bottom= at supports; Repetitive factor: applied where permitted (refer to online help);

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 48 | Fv' = 172 | psi | fv/Fv' = 0.28 |
| Bending(+) | fb = 9 | Fb' = 1349 | psi | fb/Fb' = 0.01 |
| Bending(-) | fb = 994 | Fb' = 1147 | psi | fb/Fb' = 0.87 |
| Deflection: | | | | |
| Interior Live | -0.03 = <L/999 | 0.27 = L/240 | in | 0.10 |
| Total | -0.05 = <L/999 | 0.35 = L/180 | in | 0.14 |
| Cantil. Live | 0.30 = L/228 | 0.56 = L/120 | in | 0.53 |
| Total | 0.59 = L/113 | 0.75 = L/90 | in | 0.79 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CF    Cfu    Cr   Cfrt   Ci    Cn   LC#
 Fv'       150    1.15  1.00  1.00    -      -     -     -    1.00  1.00  1.00   2
 Fb'+      850    1.15  1.00  1.00  1.000  1.200  1.00  1.15  1.00  1.00   -     4
 Fb'-      850    1.15  1.00  1.00  0.850  1.200  1.00  1.15  1.00  1.00   -     2
 Fcp'      405     -    1.00  1.00    -      -     -     -    1.00  1.00   -     -
 E'       1.3 million  1.00  1.00    -      -     -     -    1.00  1.00   -     3
 Emin'    0.47 million  1.00  1.00    -      -     -     -    1.00  1.00   -     3
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #2  = D+S, V max =    387, V design =    346 lbs
 Bending(+): LC #4  = D+S (pattern: sS), M =     10 lbs-ft
 Bending(-): LC #2  = D+S, M =    1089 lbs-ft
 Deflection: LC #3  =   (live)
             LC #3  =   (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load Patterns: s=S/2,  X=L+S or L+Lr,  _=no pattern load in this span
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   61.9e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(-):  Lu = 5.63'  Le = 9.94'  RB = 19.6; Lu based on full span
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Continuous or Cantilevered Beams: NDS Clause 4.2.5.5 requires that normal grading provisions be extended to the middle 2/3 of 2 span beams and to the full length of cantilevers and other spans.
4. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.
5. The critical deflection value has been determined using maximum back-span deflection. Cantilever deflections do not govern design.

SF11
Oct. 18, 2019 13:01

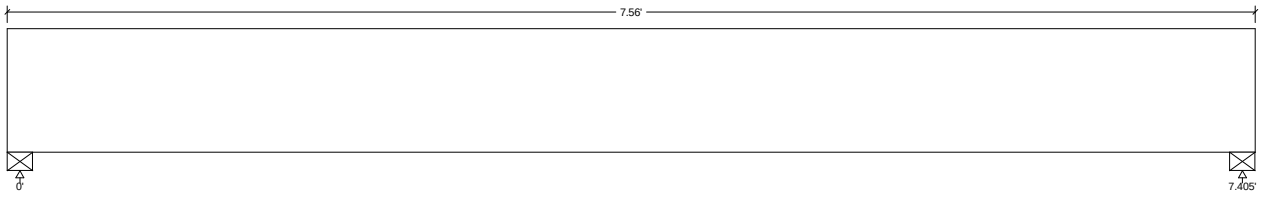
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full UDL | | | | 90.0 | | plf |
| Load2 | Dead | Full Area | | | | 15.00(5.75') | | psf |
| Load3 | Live | Full Area | | | | 60.00(5.75') | | psf |
| Load4 | Dead | Full Area | | | | 15.00(10.75') | | psf |
| Load5 | Live | Full Area | | | | 40.00(10.75') | | psf |
| Load6 | Snow | Full Area | | | | 30.00(5.75') | | psf |
| Self-weight | Dead | Full UDL | | | | 7.3 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 1303 | | 1303 |
| Live | 2930 | | 2930 |
| Snow | 652 | | 652 |
| Factored: | | | |
| Total | 4232 | | 4232 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 4232 | | 4232 |
| Support | 4505 | | 4505 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.94 | | 0.94 |
| Load comb | #2 | | #2 |
| Length | 1.86 | | 1.86 |
| Min req'd | 1.86 | | 1.86 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

## SF11

**Glulam-Unbal., West Species, 24F-V4 DF, 3-1/2"x9"**

6 laminations, 3-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 7.56'; Clear span: 7.25'; volume = 1.7 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 153 | Fv' = 265 | psi | fv/Fv' = 0.58 |
| Bending(+) | fb = 1949 | Fb' = 2352 | psi | fb/Fb' = 0.83 |
| Live Defl'n | 0.14 = L/648 | 0.25 = L/360 | in | 0.56 |
| Total Defl'n | 0.23 = L/389 | 0.37 = L/240 | in | 0.62 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'        265    1.00  1.00  1.00    -      -     -     -    1.00  1.00  1.00   2
 Fb'+      2400    1.00  1.00  1.00  0.980  1.000  1.00  1.00  1.00  1.00   -     2
 Fcp'       650     -    1.00  1.00    -      -     -     -    1.00   -     -     -
 E'        1.8 million  1.00  1.00    -      -     -     -    1.00   -     -     2
 Eminy'   0.85 million  1.00  1.00    -      -     -     -    1.00   -     -     2
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #2  = D+L, V max =   4146, V design =   3219 lbs
 Bending(+): LC #2  = D+L, M =   7675 lbs-ft
 Deflection: LC #2  = D+L  (live)
             LC #2  = D+L  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =    383e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(+):  Lu = 7.38'  Le = 14.31'  RB = 11.2
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

SF12
Oct. 18, 2019 13:01

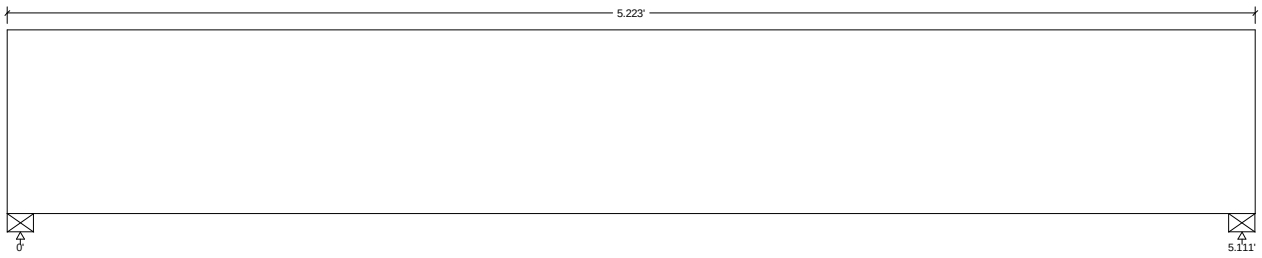
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full UDL | | | | 90.0 | | plf |
| Load2 | Dead | Full Area | | | | 15.00(5.75') | | psf |
| Load3 | Live | Full Area | | | | 60.00(5.75') | | psf |
| Load4 | Dead | Full Area | | | | 15.00(10.75') | | psf |
| Load5 | Live | Full Area | | | | 40.00(10.75') | | psf |
| Load6 | Snow | Full Area | | | | 30.00(5.75') | | psf |
| Self-weight | Dead | Full UDL | | | | 7.7 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 901 | | 901 |
| Live | 2024 | | 2024 |
| Snow | 450 | | 450 |
| Factored: | | | |
| Total | 2925 | | 2925 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 2925 | | 2925 |
| Support | 3238 | | 3238 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.90 | | 0.90 |
| Load comb | #2 | | #2 |
| Length | 1.34 | | 1.34 |
| Min req'd | 1.34 | | 1.34 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

## SF12

**Lumber-soft, D.Fir-L, No.2, 4x10 (3-1/2"x9-1/4")**

Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 5.22'; Clear span: 5.0'; volume = 1.2 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 90 | Fv' = 180 | psi | fv/Fv' = 0.50 |
| Bending(+) | fb = 880 | Fb' = 1071 | psi | fb/Fb' = 0.82 |
| Live Defl'n | 0.03 = <L/999 | 0.17 = L/360 | in | 0.19 |
| Total Defl'n | 0.05 = <L/999 | 0.26 = L/240 | in | 0.21 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CF | Cfu | Cr | Cfrt | Ci | Cn | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 180 | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 2 |
| Fb'+ | 900 | 1.00 | 1.00 | 1.00 | 0.991 | 1.200 | 1.00 | 1.00 | 1.00 | 1.00 | - | 2 |
| Fcp' | 625 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | - |
| E' | 1.6 million | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 2 |
| Emin' | 0.58 million | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 2 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #2 = D+L, V max = 2863, V design = 1937 lbs
Bending(+): LC #2 = D+L, M = 3658 lbs-ft
Deflection: LC #2 = D+L (live)
LC #2 = D+L (total)
D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
All LC's are listed in the Analysis output
Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
Deflection: EI = 369e06 lb-in2
"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
Lateral stability(+): Lu = 5.13' Le = 10.50' RB = 9.8

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.

SF13
Oct. 18, 2019 13:01

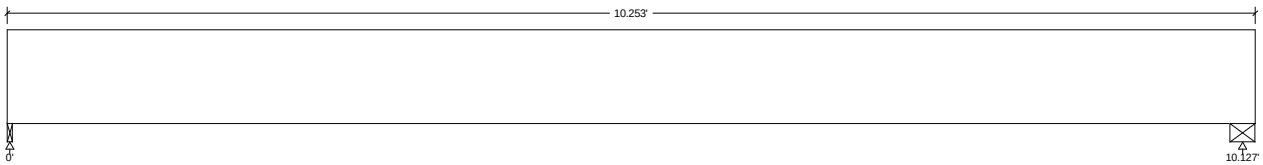
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full UDL | | | | 90.0 | | plf |
| Load2 | Dead | Full Area | | | | 15.00(0.67') | | psf |
| Load3 | Live | Full Area | | | | 40.00(0.67') | | psf |
| Load4 | Dead | Full Area | | | | 20.00(1.00') | | psf |
| Load5 | Snow | Full Area | | | | 30.00(1.00') | | psf |
| Load6 | Earthquake | Point | | 9.30 | | 7485 | | lbs |
| Self-weight | Dead | Full UDL | | | | 7.7 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 649 | | 659 |
| Live | 136 | | 138 |
| Snow | 153 | | 155 |
| Earthquake | 631 | | 6854 |
| Factored: | | | |
| Total | 1197 | | 5457 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 1197 | | 5457 |
| Support | 1325 | | 6041 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.90 | | 0.90 |
| Load comb | #5 | | #8 |
| Length | 0.55 | | 2.49 |
| Min req'd | 0.55 | | 2.49 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

## SF13

**Lumber-soft, D.Fir-L, No.2, 4x10 (3-1/2"x9-1/4")**

Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 10.25'; Clear span: 10.0'; volume = 2.3 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv* = 241 | Fv' = 288 | psi | fv*/Fv' = 0.84 |
| Bending(+) | fb = 1114 | Fb' = 1670 | psi | fb/Fb' = 0.67 |
| Live Defl'n | 0.14 = L/891 | 0.34 = L/360 | in | 0.40 |
| Total Defl'n | 0.26 = L/472 | 0.51 = L/240 | in | 0.51 |

*The effect of point loads within a distance d of the support has been included as per NDS 3.4.3.1

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CF    Cfu    Cr   Cfrt   Ci    Cn   LC#
 Fv'         180    1.60  1.00  1.00    -     -     -     -   1.00  1.00  1.00   8
 Fb'+        900    1.60  1.00  1.00  0.967  1.200  1.00  1.00  1.00  1.00   -     8
 Fcp'        625     -    1.00  1.00    -     -     -     -   1.00  1.00   -     -
 E'          1.6 million  1.00  1.00    -     -     -     -   1.00  1.00   -     8
 Emin'     0.58 million  1.00  1.00    -     -     -     -   1.00  1.00   -     8
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #8  = D+.7E, V max =   5444, V design* =   5204 lbs
 Bending(+): LC #8  = D+.7E, M =   4635 lbs-ft
 Deflection: LC #8  = D+.7E  (live)
             LC #8  = D+.7E  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =    369e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(+):  Lu = 10.13'  Le = 18.81'  RB = 13.1
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.

SF14
Oct. 18, 2019 13:01

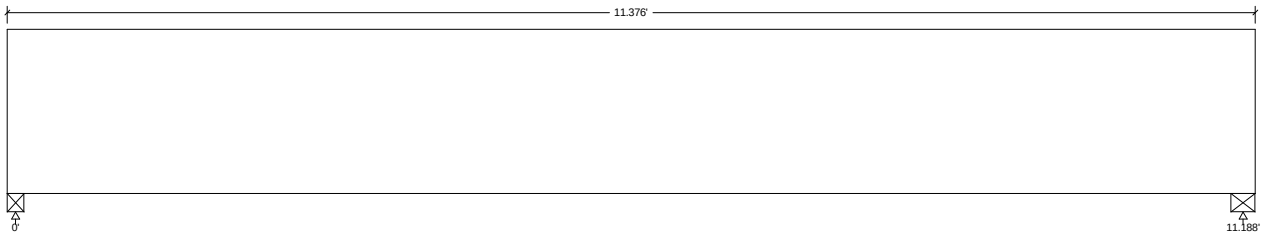
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 15.00(19.00') | | psf |
| Load2 | Live | Full Area | | | | 40.00(19.00') | | psf |
| Load3 | Dead | Partial Area | | 8.16 | 11.16 | 20.00(19.00') | | psf |
| Load4 | Snow | Partial Area | | 8.16 | 11.16 | 30.00(19.00') | | psf |
| Load5 | Dead | Point | | 8.16 | | 1554 | | lbs |
| Load6 | Snow | Point | | 8.16 | | 2328 | | lbs |
| Self-weight | Dead | Full UDL | | | | 22.8 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 2340 | | 3851 |
| Live | 4310 | | 4335 |
| Snow | 893 | | 3145 |
| Factored: | | | |
| Total | 6650 | | 9461 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 6650 | | 9461 |
| Support | 6831 | | 9717 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.97 | | 0.97 |
| Load comb | #2 | | #3 |
| Length | 1.86 | | 2.65 |
| Min req'd | 1.86 | | 2.65 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.07 | | 1.07 |
| Fcp sup | 625 | | 625 |

## SF14

**Glulam-Unbal., West Species, 24F-V4 DF, 5-1/2"x18"**

12 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 11.38'; Clear span: 11'; volume = 7.8 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 104 | Fv' = 305 | psi | fv/Fv' = 0.34 |
| Bending(+) | fb = 816 | Fb' = 2331 | psi | fb/Fb' = 0.35 |
| Live Defl'n | 0.06 = <L/999 | 0.37 = L/360 | in | 0.16 |
| Total Defl'n | 0.12 = <L/999 | 0.56 = L/240 | in | 0.22 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'        265    1.15  1.00  1.00    -      -     -     -    1.00  1.00  1.00   3
 Fb'+      2400    1.00  1.00  1.00  0.971  1.000  1.00  1.00  1.00  1.00   -     2
 Fcp'       650     -    1.00  1.00    -      -     -     -    1.00   -     -     -
 E'        1.8 million  1.00  1.00    -      -     -     -    1.00   -     -     3
 Eminy'   0.85 million  1.00  1.00    -      -     -     -    1.00   -     -     3
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #3  = D+.75(L+S), V max =   9367, V design =   6839 lbs
 Bending(+): LC #2  = D+L, M =  20207 lbs-ft
 Deflection: LC #3  = D+.75(L+S)  (live)
             LC #3  = D+.75(L+S)  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   4811e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(+):  Lu = 11.19'  Le = 22.75'  RB = 12.7
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

SF15
Oct. 18, 2019 13:01

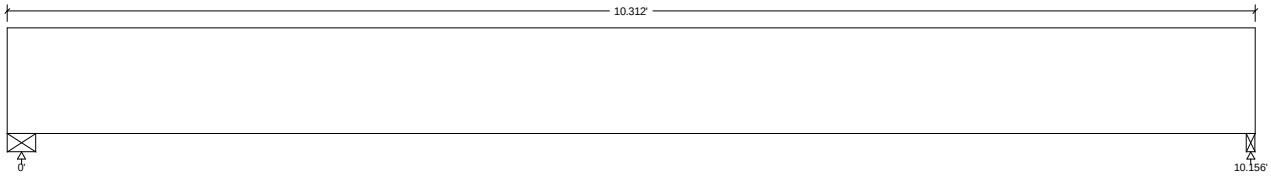
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full UDL | | | | 90.0 | | plf |
| Load2 | Dead | Full Area | | | | 15.00(0.67') | | psf |
| Load3 | Live | Full Area | | | | 40.00(0.67') | | psf |
| Load4 | Dead | Full Area | | | | 20.00(1.00') | | psf |
| Load5 | Snow | Full Area | | | | 30.00(1.00') | | psf |
| Load6 | Dead | Point | | 2.24 | | 2340 | | lbs |
| Load7 | Live | Point | | 2.24 | | 4310 | | lbs |
| Load8 | Snow | Point | | 2.24 | | 893 | | lbs |
| Load9 | Dead | Point | | 3.41 | | 1430 | | lbs |
| Load10 | Snow | Point | | 3.41 | | 2095 | | lbs |
| Load11 | Earthquake | Point | | 3.41 | | 8253 | | lbs |
| Load12 | Earthquake | Point | | 8.91 | | -8253 | | lbs |
| Self-weight | Dead | Full UDL | | | | 13.3 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 3510 | | 1633 |
| Live | 3550 | | 1036 |
| Snow | 2279 | | 1018 |
| Earthquake | 4469 | | -4469 |
| Factored: | | | |
| Uplift | | | -2149 |
| Total | 10228 | | 3174 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 10228 | | 3174 |
| Support | 10505 | | 3260 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.97 | | 0.97 |
| Load comb | #5 | | #3 |
| Length | 2.86 | | 0.89 |
| Min req'd | 2.86 | | 0.89 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.07 | | 1.07 |
| Fcp sup | 625 | | 625 |

## SF15

**Glulam-Unbal., West Species, 24F-V4 DF, 5-1/2"x10-1/2"**

7 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 10.31'; Clear span: 10'; volume = 4.1 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 179 | Fv' = 265 | psi | fv/Fv' = 0.67 |
| Bending(+) | fb = 3006 | Fb' = 3761 | psi | fb/Fb' = 0.80 |
| Live Defl'n | 0.24 = L/516 | 0.34 = L/360 | in | 0.70 |
| Total Defl'n | 0.44 = L/277 | 0.51 = L/240 | in | 0.86 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'        265    1.00  1.00  1.00    -     -     -     -    1.00  1.00  1.00   2
 Fb'+      2400    1.60  1.00  1.00  0.980  1.000  1.00  1.00  1.00  1.00    -     5
 Fcp'       650     -    1.00  1.00    -      -     -     -    1.00   -      -     -
 E'          1.8 million  1.00  1.00    -      -     -     -    1.00   -      -     5
 Eminy'   0.85 million  1.00  1.00    -      -     -     -    1.00   -      -     5
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #2  = D+L, V max =   7043, V design =   6884 lbs
 Bending(+): LC #5  = D+.75(L+S+.7E), M =  25313 lbs-ft
 Deflection: LC #5  = D+.75(L+S+.7E)  (live)
             LC #5  = D+.75(L+S+.7E)  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =    955e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(+):  Lu = 10.13'  Le = 19.19'  RB = 8.9
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

SF16
Oct. 18, 2019 13:01

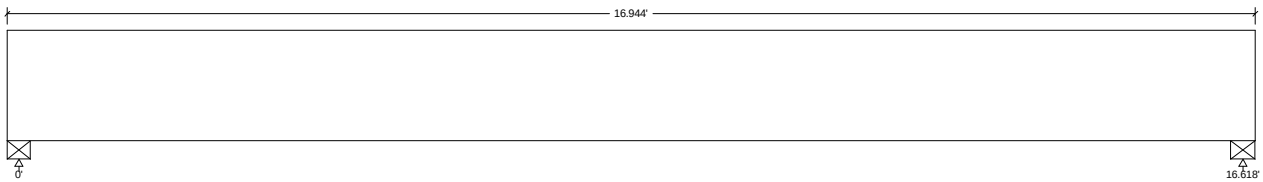
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 15.00(16.75') | | psf |
| Load2 | Live | Full Area | | | | 40.00(16.75') | | psf |
| Load3 | Dead | Partial Area | | 0.32 | 9.57 | 20.00(19.00') | | psf |
| Load4 | Snow | Partial Area | | 0.32 | 9.57 | 30.00(19.00') | | psf |
| Load5 | Dead | Partial Area | | 9.57 | 16.61 | 20.00(14.75') | | psf |
| Load6 | Snow | Partial Area | | 9.57 | 16.61 | 30.00(14.75') | | psf |
| Load7 | Dead | Point | | 12.07 | | 1412 | | lbs |
| Load8 | Live | Point | | 12.07 | | 572 | | lbs |
| Load9 | Snow | Point | | 12.07 | | 1470 | | lbs |
| Self-weight | Dead | Full UDL | | | | 22.8 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 5681 | | 5959 |
| Live | 5836 | | 6088 |
| Snow | 4862 | | 4995 |
| Factored: | | | |
| Total | 13705 | | 14272 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 13705 | | 14272 |
| Support | 14076 | | 14658 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.97 | | 0.97 |
| Load comb | #3 | | #3 |
| Length | 3.83 | | 3.99 |
| Min req'd | 3.83 | | 3.99 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.07 | | 1.07 |
| Fcp sup | 625 | | 625 |

## SF16

**Glulam-Unbal., West Species, 24F-V4 DF, 5-1/2"x18"**

12 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 16.94'; Clear span: 16.292'; volume = 11.6 cu.ft.
Lateral support: top= at supports, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 180 | Fv' = 305 | psi | fv/Fv' = 0.59 |
| Bending(+) | fb = 2398 | Fb' = 2587 | psi | fb/Fb' = 0.93 |
| Live Defl'n | 0.36 = L/556 | 0.55 = L/360 | in | 0.65 |
| Total Defl'n | 0.75 = L/267 | 0.83 = L/240 | in | 0.90 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'         265    1.15  1.00  1.00    -      -      -    -    1.00  1.00  1.00   3
 Fb'+       2400    1.15  1.00  1.00  0.937  0.976  1.00  1.00  1.00  1.00   -     3
 Fcp'        650     -    1.00  1.00    -      -      -    -    1.00   -     -     -
 E'          1.8 million  1.00  1.00    -      -      -    -    1.00   -     -     3
 Eminy'   0.85 million  1.00  1.00    -      -      -    -    1.00   -     -     3
Only the lesser of CL and CV is applied, as per NDS 5.3.6
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #3  = D+.75(L+S), V max =  14146, V design =  11899 lbs
 Bending(+): LC #3  = D+.75(L+S), M =  59347 lbs-ft
 Deflection: LC #3  = D+.75(L+S)  (live)
             LC #3  = D+.75(L+S)  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   4811e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(+):  Lu = 16.63'  Le = 31.56'  RB = 15.0
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

SF17
Oct. 18, 2019 13:01

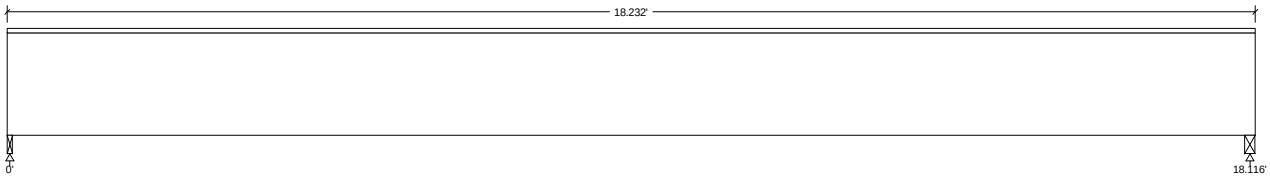
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full UDL | | | | 90.0 | | plf |
| Load2 | Dead | Full Area | | | | 15.00(0.67') | | psf |
| Load3 | Live | Full Area | | | | 40.00(0.67') | | psf |
| Load4 | Dead | Full Area | | | | 20.00(1.00') | | psf |
| Load5 | Snow | Full Area | | | | 30.00(1.00') | | psf |
| Load6 | Earthquake | Point | | 10.83 | | 4298 | | lbs |
| Load7 | Earthquake | Point | | 13.95 | | -4298 | | lbs |
| Load8 | Earthquake | Point | | 17.20 | | 5233 | | lbs |
| Self-weight | Dead | Full UDL | | | | 14.5 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 1224 | | 1228 |
| Live | 244 | | 245 |
| Snow | 273 | | 274 |
| Earthquake | 1016 | | 4217 |
| Factored: | | | |
| Total | 2145 | | 4180 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 2145 | | 4180 |
| Support | 2283 | | 4450 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.94 | | 0.94 |
| Load comb | #5 | | #8 |
| Length | 0.94 | | 1.84 |
| Min req'd | 0.94 | | 1.84 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 |

## SF17

**Glulam-Unbal., West Species, 24F-V4 DF, 3-1/2"x18"**

12 laminations, 3-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 18.23'; Clear span: 18'; volume = 8.0 cu.ft.
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv* = 70 | Fv' = 424 | psi | fv*/Fv' = 0.17 |
| Bending(+) | fb = 825 | Fb' = 3840 | psi | fb/Fb' = 0.21 |
| Live Defl'n | 0.11 = <L/999 | 0.60 = L/360 | in | 0.18 |
| Total Defl'n | 0.27 = L/801 | 0.91 = L/240 | in | 0.30 |

*The effect of point loads within a distance d of the support has been included as per NDS 3.4.3.1

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM   Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'        265    1.60  1.00  1.00    -      -      -    -    1.00  1.00  1.00   8
 Fb'+      2400    1.60  1.00  1.00  1.000  1.000  1.00  1.00  1.00  1.00   -      8
 Fcp'       650     -    1.00  1.00    -      -      -    -    1.00   -     -      -
 E'        1.8 million  1.00  1.00    -      -      -    -    1.00   -     -      5
 Eminy'   0.85 million  1.00  1.00    -      -      -    -    1.00   -     -      5
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #8  = D+.7E, V max =   2957, V design* =   2957 lbs
 Bending(+): LC #8  = D+.7E, M =  12994 lbs-ft
 Deflection: LC #5  = D+.75(L+S+.7E)  (live)
             LC #5  = D+.75(L+S+.7E)  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   3062e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

SF18
Oct. 18, 2019 13:02

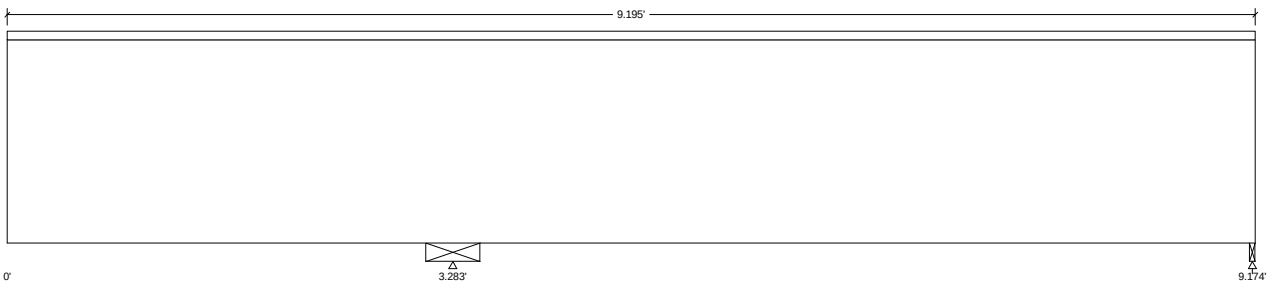
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | No | | | 15.00(12.50') | | psf |
| Load2 | Live | Full Area | Yes | | | 40.00(12.50') | | psf |
| Load3 | Dead | Point | No | 0.00 | | 1228 | | lbs |
| Load4 | Live | Point | Yes | 0.00 | | 245 | | lbs |
| Load5 | Snow | Point | Yes | 0.00 | | 274 | | lbs |
| Load6 | Earthquake | Point | No | 0.00 | | 4217 | | lbs |
| Load7 | Dead | Point | No | 0.00 | | 2310 | | lbs |
| Load8 | Snow | Point | Yes | 0.00 | | 3303 | | lbs |
| Self-weight | Dead | Full UDL | No | | | 22.8 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | 3.283' | | 9.174' |
|---|---|---|---|---|---|
| Unfactored: | | | | | |
| Dead | | | 7012 | | 46 |
| Live | | | 3953 | | 1483 |
| Snow | | | 5571 | | -1994 |
| Earthquake | | | 6567 | | -2350 |
| Factored: | | | | | |
| Uplift | | | | | -4270 |
| Total | | | 17603 | | 46 |
| Bearing: | | | | | |
| Capacity | | | | | |
| Beam | | | 18479 | | 1787 |
| Support | | | 17603 | | 1836 |
| Des ratio | | | | | |
| Beam | | | 0.95 | | 0.03 |
| Support | | | 1.00 | | 0.03 |
| Load comb | | | #5 | | #1 |
| Length | | | 4.79 | | 0.50* |
| Min req'd | | | 4.79** | | 0.50* |
| Cb | | | 1.08 | | 1.00 |
| Cb min | | | 1.08 | | 1.00 |
| Cb support | | | 1.07 | | 1.07 |
| Fcp sup | | | 625 | | 625 |

*Minimum bearing length setting used: 1/2" for end supports
**Minimum bearing length governed by the required width of the supporting member.
Maximum reaction on at least one support is from a different load combination than the critical one for bearing design, shown here, due to Kd factor. See Analysis results for reaction from critical load combination.

## SF18

**Glulam-Bal., West Species, 24F-V8 DF, 5-1/2"x18"**

12 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 9.19'; Clear span: 3.083', 5.67'; volume = 6.3 cu.ft.
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 115 | Fv' = 305 | psi | fv/Fv' = 0.38 |
| Bending(-) | fb = 990 | Fb' = 2724 | psi | fb/Fb' = 0.36 |
| Deflection: | | | | |
| Interior Live | -0.01 = <L/999 | 0.20 = L/360 | in | 0.07 |
| Total | -0.03 = <L/999 | 0.29 = L/240 | in | 0.09 |
| Cantil. Live | 0.06 = L/625 | 0.22 = L/180 | in | 0.29 |
| Total | 0.13 = L/307 | 0.33 = L/120 | in | 0.39 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'        265    1.15  1.00  1.00    -      -     -     -    1.00  1.00  1.00   3
 Fb'-      2400    1.15  1.00  1.00  0.987  1.000  1.00  1.00  1.00  1.00   -     4
 Fcp'       650     -    1.00  1.00    -      -     -     -    1.00   -     -     -
 E'        1.8 million  1.00  1.00    -      -     -     -    1.00   -     -     5
 Eminy'   0.85 million  1.00  1.00    -      -     -     -    1.00   -     -     5
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #3  = D+.75(L+S), V max =   8326, V design =   7579 lbs
 Bending(-): LC #4  = D+S, M =   24493 lbs-ft
 Deflection: LC #5  = D+.75(L+S+.7E)  (live)
             LC #5  = D+.75(L+S+.7E)  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load Patterns: s=S/2,  X=L+S or L+Lr,  _=no pattern load in this span
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   4811e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(-):  Lu = 5.88'  Le = 11.00'  RB = 8.9
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. Grades with equal bending capacity in the top and bottom edges of the beam cross-section are recommended for continuous beams.
5. GLULAM: bxd = actual breadth x actual depth.
6. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
7. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).
8. The critical deflection value has been determined using maximum back-span deflection. Cantilever deflections do not govern design.

FF1
Oct. 18, 2019 13:02

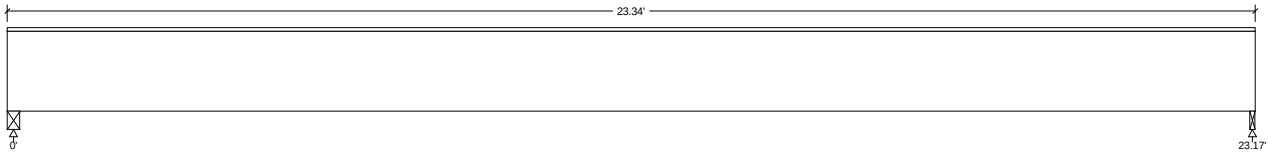
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full UDL | | | | 100.0 | | plf |
| Load2 | Dead | Full Area | | | | 15.00(0.67') | | psf |
| Load3 | Live | Full Area | | | | 40.00(0.67') | | psf |
| Load4 | Dead | Partial Area | | 0.24 | 2.74 | 20.00(0.67') | | psf |
| Load5 | Live | Partial Area | | 0.24 | 2.74 | 60.00(0.67') | | psf |
| Load6 | Dead | Partial Area | | 20.74 | 23.24 | 20.00(0.67') | | psf |
| Load7 | Live | Partial Area | | 20.74 | 23.24 | 60.00(0.67') | | psf |
| Load8 | Dead | Point | | 2.74 | | 201 | | lbs |
| Load9 | Live | Point | | 2.74 | | 407 | | lbs |
| Load10 | Earthquake | Point | | 2.74 | | 7585 | | lbs |
| Load11 | Dead | Point | | 20.74 | | 201 | | lbs |
| Load12 | Live | Point | | 20.74 | | 407 | | lbs |
| Load13 | Earthquake | Point | | 20.74 | | -7585 | | lbs |
| Self-weight | Dead | Full UDL | | | | 13.0 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 1672 | | 1666 |
| Live | 820 | | 821 |
| Earthquake | 5893 | | -5893 |
| Factored: | | | |
| Uplift | | | -3125 |
| Total | 5797 | | 2487 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 5797 | | 2487 |
| Support | 6243 | | 2678 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.93 | | 0.93 |
| Load comb | #4 | | #2 |
| Length | 2.85 | | 1.22 |
| Min req'd | 2.85 | | 1.22 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.12 | | 1.12 |
| Fcp sup | 625 | | 625 |

## FF1

**Glulam-Unbal., West Species, 24F-V4 DF, 3-1/8"x18"**

12 laminations, 3-1/8" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 23.34'; Clear span: 23'; volume = 9.1 cu.ft.
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 149 | Fv' = 424 | psi | fv/Fv' = 0.35 |
| Bending(+) | fb = 839 | Fb' = 2398 | psi | fb/Fb' = 0.35 |
| Live Defl'n | 0.12 = <L/999 | 0.77 = L/360 | in | 0.16 |
| Total Defl'n | 0.59 = L/474 | 1.16 = L/240 | in | 0.51 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'        265    1.60  1.00  1.00    -      -     -     -    1.00  1.00  1.00   4
 Fb'+      2400    1.00  1.00  1.00  1.000  0.999  1.00  1.00  1.00  1.00    -     2
 Fcp'       650     -    1.00  1.00    -      -     -     -    1.00   -      -     -
 E'        1.8 million  1.00  1.00    -      -     -     -    1.00   -      -     2
 Eminy'   0.85 million  1.00  1.00    -      -     -     -    1.00   -      -     2
CRITICAL LOAD COMBINATIONS.
 Shear     : LC #4  = D+.7E, V max =   5784, V design =   5571 lbs
 Bending(+): LC #2  = D+L, M =  11803 lbs-ft
 Deflection: LC #3  = D+.75(L+.7E)  (live)
             LC #2  = D+L  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS.
 Deflection:  EI =   2734e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

WoodWorks® SOFTWARE FOR WOOD DESIGN

PHILLIPS STRUCTURAL ENGINEERING

FF2 (ISF STEEL)
Oct. 16, 2018 13:56

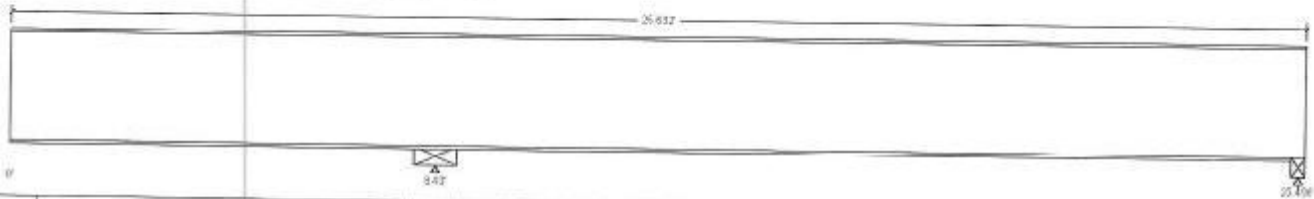
## Design Check Calculation Sheet

WoodWorks Suite 11.1

### Loads:

| Load | Type | Distribution | Pattern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | No | | | 103.8 | | psf |
| Load2 | Dead | Full Area | No | | | 15.00 (11.50') | | psf |
| Load3 | Live | Full Area | Yes | | | 60.00 (11.50') | | psf |
| Load4 | Dead | Partial Area | No | 0.00 | 3.75 | 20.00 (11.50') | | psf |
| Load5 | Live | Partial Area | Yes | 0.00 | 3.75 | 60.00 (11.50') | | psf |
| Load6 | Dead | Partial Area | No | 15.95 | 18.55 | 20.00 (11.50') | | psf |
| Load7 | Live | Partial Area | Yes | 15.95 | 18.55 | 60.00 (11.50') | | psf |
| Load8 | Dead | Point | No | 0.00 | | 4681 | | lbs |
| Load9 | Live | Point | Yes | 0.00 | | 820 | | lbs |
| Load10 | Earthquake | Point | No | 0.00 | | 5849 | | lbs |
| Load11 | Earthquake | Point | No | 0.00 | | -21380 | | lbs |
| Load12 | Earthquake | Point | No | 3.75 | | 21380 | | lbs |
| Load13 | Earthquake | Point | No | 18.55 | | -17415 | | lbs |
| Load14 | Earthquake | Point | No | 18.55 | | 17415 | | lbs |
| Load15 | Dead | Point | No | 3.75 | | 1500 | | lbs |
| Load16 | Live | Point | Yes | 3.75 | | 8232 | | lbs |
| Load17 | Dead | Point | No | 15.55 | | 1580 | | lbs |
| Load18 | Live | Point | Yes | 15.95 | | 9604 | | lbs |
| Load19 | Dead | Point | No | 16.95 | | 1575 | | lbs |
| Load20 | Live | Point | Yes | 16.95 | | 5093 | | lbs |
| Self-weight | Dead | Full UDL | No | | | 32.3 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | | | |
|---|---|---|---|---|---|
| Unfactored: | | | | | |
| Dead | | | 12829 | | 4681 |
| Live | | | 22791 | | 8232 |
| Earthquake | | | 1091 | | 5849 |
| Factored: | | | | | |
| Uplift | | | | | -1152 |
| Total | | | 36913 | | 11642 |
| Bearing: | | | | | |
| Capacity | | | | | |
| Beam | | | 25910 | | 11642 |
| Support | | | 37920 | | 11927 |
| Dem ratio | | | | | |
| Beam | | | 1.80 | | 1.80 |
| Support | | | 0.97 | | 0.97 |
| Load Comb | | | #2 | | #7 |
| Length | | | 18.00 | | 9.00 |
| Min req'd | | | 18.53 | | 9.00 |
| Cb | | | 1.00 | | 1.00 |
| Cb min | | | 1.00 | | 1.00 |
| Cb support | | | 1.00 | | 1.00 |
| Fcp esp | | | 427 | | 625 |

Maximum reaction on at least one support is from a different load combination than the critical one for bearing design, shown here, due to Kd factor. See Analysis results for reaction from critical load combination.

## FF2

**Glulam-Bal., West Species, 24F-V8 DF, 5-1/2"x25-1/2"**

7 laminations, 5-1/2" maximum width

Supports: All - Timber-cut Beam, D Fir-L No.2

Total length: 25.63'; Clear span: 0', 18.5'; volume = 25.0 cu.ft.

Lateral support: top: full, bottom= full,

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Units | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 101 | Fv' = 265 | psi | fv/Fv' = 0.38 |
| Bending(+) | fb = 1801 | Fb' = 2244 | psi | fb/Fb' = 0.52 |
| Bending(-) | fb = 1969 | Fb' = 2168 | psi | fb/Fb' = 0.91 |
| Deflection: | | | | |
| Interior Live | 0.15 = <L/999 | 0.57 = L/360 | in | 0.26 |
| Total | 0.19 = <L/999 | 0.85 = L/240 | in | 0.23 |
| Cantil. Live | 0.31 = L/203 | 0.56 = L/180 | in | 0.56 |
| Total | 0.39 = L/127 | 0.84 = L/120 | in | 0.47 |

### Additional Data:

| FACTORS: | E'/E [psi] | CD | CM | Ct | CL | CV | CFu | Cr | Cfrt | Notch | Cr*Cvr | Lcb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 265 | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 2 |
| Fb'+ | 2468 | 1.00 | 1.00 | 1.00 | 1.000 | 0.909 | 1.00 | 1.15 | 1.00 | 1.00 | - | 7 |
| Fb'- | 2468 | 1.00 | 1.00 | 1.00 | 1.000 | 0.903 | 1.00 | 1.15 | 1.00 | 1.00 | - | 6 |
| Fcp' | 654 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | - | - | - |
| E' | 1.8 million | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | - | - | Y |
| Emin' | 0.85 million | 1.00 | 1.00 | - | - | - | - | - | 1.00 | - | - | Y |

CRITICAL LOAD COMBINATIONS

Shear : LC #2 = D+L, V max = 18748, V design = 18956 lbs

Bending(+): LC #1 = D+L (pattern: 1), M = 51047 lbs-ft

Bending(-): LC #6 = D+L (pattern: 1), M = 47768 lbs-ft

Deflection: LC #1 = (Live)

LC #1 = (Total)

D=Dead L=Live S=Snow W=Wind I=Impact Lr=roof Live Lc=concentrated E=Earthquake

All LC's are listed in the Analysis output

Load Patterns: a=S/2, b=L/3 or 1ft, ... =no pattern load is this span

Load combinations: ASCE 7-10 / IBC 2015

CALCULATIONS:

Deflection: LL = 1.679485 lb-in2

"Live" deflection = Deflection from all non-dead loads (live, wind, snow.)

Total deflection = 1.50(dead load deflection) + Live Load deflection.

- SEE NEXT PAGE FOR STEEL BEAM CALCULATIONS

### Design Notes:

1. WoodWorks analysis and design are in accordance with the IBC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI A190.1-2012 and manufactured in accordance with ANSI A190.1-2012
4. Grades with equal bending capacity in the top and bottom edges of the beam cross-section are recommended for continuous beams.
5. GLULAM: bxd = actual breadth x actual depth
6. Lateral support shall be laterally supported according to the provisions of NDS Clause 3.3.3.
7. GLULAM: bearing length based on smaller of Fcperp(tension) Fcperp(comp)
8. The critical deflection value has been determined using maximum back-span deflection. Cantilever deflections do not govern design.

+ .19" @ INT. SPAN
+ .79" @ CANT.

WOOD EI: $1800^{k\text{-}in^2}(7600_{in^4}) = 13{,}680{,}000^{k\text{-}in^2}$

STEEL EI: $29000^{k\text{-}in^2}(I)$

$I_{rigid} = \frac{WOOD\ EI}{STEEL\ E} = 472^{in^4}$

W 14 x 48 $I = 484^{in^4}$ ✓ $b_f = 8"$

$M_{rx}/\Omega_b = 196^{k\text{-}ft} \geq M_{max} = 91.2^{k\text{-}ft}$ ✓

MAX RXN = 35.7$^k$

HSS 5 x 5 x 1/4 (HT = 9')

$P_{AXIAL\ ALLOW} = 96^k$ ✓

60" PAD $C_p = 1426\ psi$ ✓

WoodWorks®
SOFTWARE FOR WOOD DESIGN

PHILLIPS
STRUCTURAL ENGINEERING

FF3 (6.9F STFF1)
Oct 19, 2018 14:25

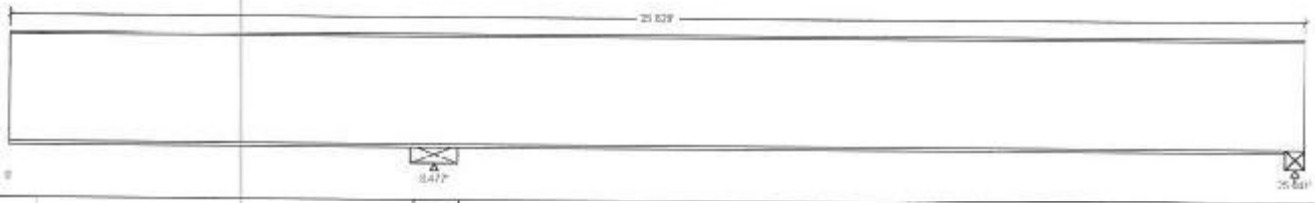
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude #/sf or | Pat | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Unif | Bo | | | 100.0 | | plf |
| Load2 | Dead | Full Area | Bo | | | 15.00(11.58') | | psf |
| Load3 | Live | Full Area | Top | | | 40.00(11.58') | | psf |
| Load4 | Dead | Partial Area | Bo | 0.00 | 3.75 | 20.00(11.58') | | psf |
| Load5 | Live | Partial Area | Top | 0.00 | 3.75 | 40.00(11.58') | | psf |
| Load6 | Dead | Partial Area | Bo | 16.00 | 19.88 | 20.00(11.58') | | psf |
| Load7 | Live | Partial Area | Top | 16.00 | 19.88 | 40.00(11.58') | | psf |
| Load8 | Dead | Point | Bo | 0.00 | | 1687 | | lbs |
| Load9 | Live | Point | Top | 0.00 | | 650 | | lbs |
| Load10 | Earthquake | Point | Bo | 0.00 | | 3857 | | lbs |
| Load11 | Earthquake | Point | Bo | 0.00 | | -18182 | | lbs |
| Load12 | Earthquake | Point | Bo | 2.75 | | 18182 | | lbs |
| Load13 | Earthquake | Point | Bo | 16.00 | | -8210 | | lbs |
| Load14 | Earthquake | Point | Bo | 19.88 | | 8210 | | lbs |
| Load15 | Dead | Point | Bo | 2.75 | | 1503 | | lbs |
| Load16 | Live | Point | Top | 2.75 | | 4032 | | lbs |
| Load17 | Dead | Point | Bo | 16.00 | | 1503 | | lbs |
| Load18 | Live | Point | Top | 16.00 | | 4032 | | lbs |
| Load19 | Dead | Point | Bo | 19.88 | | 1865 | | lbs |
| Load20 | Live | Point | Top | 19.88 | | 6291 | | lbs |
| Load21 | Dead | Partial Area | Bo | 9.83 | 25.21 | 15.00(6.75') | | psf |
| Load22 | Live | Partial Area | Top | 9.83 | 25.21 | 40.00(6.75') | | psf |
| Self-weight | Dead | Full Unif | Bo | | | 32.3 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | | | | |
|---|---|---|---|---|---|---|
| Maximum: | | | | | | |
| Dead | | | 12946 | | | 3892 |
| Live | | | 26983 | | | 12887 |
| Earthquake | | | 5146 | | | 763 |
| Factored: | | | | | | |
| Uplift | | | | | | -364 |
| Total | | | 48928 | | | 16079 |
| Bearing: | | | | | | |
| Capacity | | | | | | |
| Beam | | | 48928 | | | 16079 |
| Support | | | 42038 | | | 14435 |
| Dem ratio | | | | | | |
| Beam | | | 1.00 | | | 1.00 |
| Support | | | 0.95 | | | 0.93 |
| Load comb | | | 6 | | | 8 |
| Length | | | | | | |
| Min req'd | | | 11.42 | | | 4.38 |
| Cb | | | 11.42 | | | 4.50 |
| Cb min | | | 1.00 | | | 1.00 |
| Cb support | | | 1.00 | | | 1.00 |
| FCP, ksi | | | 1.83 | | | 1.37 |
| Length | | | 625 | | | 625 |

Maximum reaction on at least one support is from a different load combination than the critical one for bearing design shown here, due to Kd factor. See Analysis results for reaction from critical load combination.

**FF3**

**Glulam-Bal., West Species, 24F-V8 DF, 5-1/2"x25-1/2"**

37 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D Fir-L, No.2
Total length: 26.33', Clear span: 8', 19.5', volume = 25.2 cu.ft.
Lateral support: top= full, bottom= full,

### Analysis vs. Allowable Stress and Deflection (using NDS 2015) :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 2.6 | Fv' = 265 | psi | fv/Fv' = 0.01 |
| Bending(+) | fb = 1613 | Fb' = 2284 | psi | fb/Fb' = 0.71 |
| Bending(-) | fb = 1985 | Fb' = 2166 | psi | fb/Fb' = 0.92 |
| Deflection: | | | | |
| Interior Live | 0.26 = L/799 | 0.57 = L/360 | in | 0.45 |
| Total | 0.28 = L/727 | 0.86 = L/240 | in | 0.33 |
| Cantil. Live | 0.52 = L/357 | 0.57 = L/180 | in | 0.91 |
| Total | 0.77 = L/121 | 0.95 = L/120 | in | 0.81 |

### Additional Data:

| FACTORS: | F/E [psi] | CD | CM | Ct | CL | CV | Cfu | Cr | Cfrt | Notes | Cn | *CV' | LCN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 265 | | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.80 | 1.80 | 1.00 | 2 |
| Fb'+ | 2400 | | 1.00 | 1.00 | 1.00 | 0.952 | 0.952 | 1.00 | 1.10 | 1.80 | 1.80 | - | 1 |
| Fb'- | 2400 | | 1.00 | 1.00 | 1.00 | 0.952 | 0.952 | 1.00 | 1.10 | 1.80 | 1.80 | - | 5 |
| Fcp' | 650 | | - | 1.00 | 1.00 | - | - | - | - | 1.00 | | | - |
| E' | 1.8 million | | 1.00 | 1.00 | - | - | - | - | - | 1.00 | - | - | 7 |
| Emin' | 0.85 million | | 1.00 | 1.00 | - | - | - | - | - | 1.00 | - | - | 7 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #2 = D+L, V max = 22755, V design = 28159 lbs
Bending(+): LC #7 = D+L (pattern: L). M = 58142 lbs-ft
Bending(-): LC #6 = D+L (pattern: L). M = 58615 lbs-ft
Deflection: LC #7 = (Live)
LC #1 = (Total)
D=Dead L=Live S=Snow M=Wind I=Impact Lr=roof live Le=concentrated E=earthquake
All LC's are listed in the Analysis Output
Load Patterns: e=0/2, total or left, _=no pattern load in this span
Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
Deflection: EI = 13679e06 lb-in2
"Live" Deflection = Deflection from all non-dead loads (i.e. Wind, Snow)
Total Deflection = 1.5*(Dead Load Deflection) + Live Load Deflection.

See calculations nxt pg for steel Beam

### Design Notes:

1. WoodWorks analysis and design are in accordance with the 2015 International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117.2015 and manufactured in accordance with ANSI A190.1-2012.
4. Grades with equal bending capacity in the top and bottom edges of the beam cross-section are recommended for continuous beams.
5. GLULAM beam - actual breadth x actual depth
6. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
7. GLULAM bearing length based on smaller of Fcp(perp), Fc(comp)
8. The critical deflection value has been determined using maximum back span deflection. Cantilever deflections do not govern design.

△ + .26" @ INT SPAN

+ .77" @ CANT

W14×48 OK PER FF2

$M_{tot}/\Sigma L_L = 196 \geq M_{MAX} = 98.6^{k\text{-}ft}$

MAX RXN = 41^k HU 5×5¼ OK

↑ 66" PAD $q_a = 1355 psf$ ✓

FF4
Oct. 18, 2019 13:02

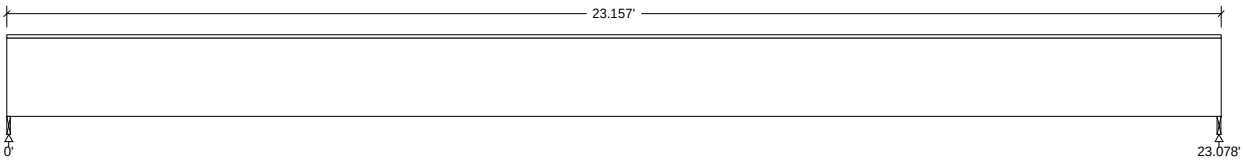
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Partial Area | | 0.08 | 13.58 | 15.00(4.25') | | psf |
| Load2 | Live | Partial Area | | 0.08 | 13.58 | 40.00(4.25') | | psf |
| Load3 | Dead | Partial Area | | 13.58 | 17.08 | 15.00(8.50') | | psf |
| Load4 | Live | Partial Area | | 13.58 | 17.08 | 40.00(8.50') | | psf |
| Load5 | Dead | Partial Area | | 17.08 | 23.08 | 15.00(4.25') | | psf |
| Load6 | Live | Partial Area | | 17.08 | 23.08 | 40.00(4.25') | | psf |
| Self-weight | Dead | Full UDL | | | | 22.8 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 1072 | | 1144 |
| Live | 2156 | | 2349 |
| Factored: | | | |
| Total | 3228 | | 3493 |
| Bearing: | | | |
| Capacity | | | |
| Beam | 3228 | | 3493 |
| Support | 3315 | | 3587 |
| Des ratio | | | |
| Beam | 1.00 | | 1.00 |
| Support | 0.97 | | 0.97 |
| Load comb | #2 | | #2 |
| Length | 0.90 | | 0.98 |
| Min req'd | 0.90 | | 0.98 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.07 | | 1.07 |
| Fcp sup | 625 | | 625 |

## FF4

**Glulam-Unbal., West Species, 24F-V4 DF, 5-1/2"x18"**

12 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 23.16'; Clear span: 23'; volume = 15.9 cu.ft.
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 47 | Fv' = 265 | psi | fv/Fv' = 0.18 |
| Bending(+) | fb = 825 | Fb' = 2267 | psi | fb/Fb' = 0.36 |
| Live Defl'n | 0.27 = <L/999 | 0.77 = L/360 | in | 0.35 |
| Total Defl'n | 0.47 = L/588 | 1.15 = L/240 | in | 0.41 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'       265    1.00  1.00  1.00    -      -     -     -    1.00  1.00  1.00   2
 Fb'+     2400    1.00  1.00  1.00  1.000  0.945  1.00  1.00  1.00  1.00   -     2
 Fcp'      650     -    1.00  1.00    -      -     -     -    1.00   -     -     -
 E'        1.8 million  1.00  1.00    -      -     -     -    1.00   -     -     2
 Eminy'   0.85 million  1.00  1.00    -      -     -     -    1.00   -     -     2
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #2  = D+L, V max =   3493, V design =   3107 lbs
 Bending(+): LC #2  = D+L, M =  20412 lbs-ft
 Deflection: LC #2  = D+L  (live)
             LC #2  = D+L  (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   4811e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. GLULAM: bxd = actual breadth x actual depth.
5. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
6. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).

FF5
Oct. 18, 2019 13:02

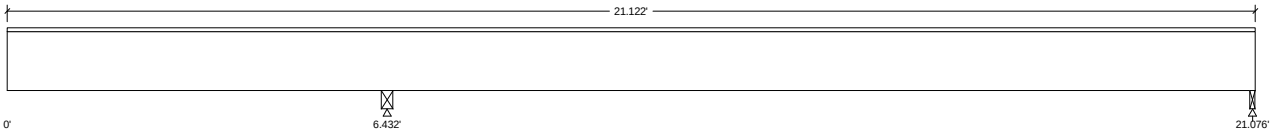
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | No | | | 15.00(6.75') | | psf |
| Load2 | Live | Full Area | Yes | | | 60.00(6.75') | | psf |
| Load3 | Snow | Full Area | Yes | | | 30.00(6.75') | | psf |
| Self-weight | Dead | Full UDL | No | | | 15.2 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | | | | |
|---|---|---|---|---|---|---|
| Unfactored: | | | | | | |
| Dead | | | 1766 | | | 693 |
| Live | | | 6142 | | | 2984 |
| Snow | | | 3071 | | | 1349 |
| Factored: | | | | | | |
| Total | | | 8676 | | | 3943 |
| Bearing: | | | | | | |
| Capacity | | | | | | |
| Beam | | | 9788 | | | 3943 |
| Support | | | 8676 | | | 4050 |
| Des ratio | | | | | | |
| Beam | | | 0.89 | | | 1.00 |
| Support | | | 1.00 | | | 0.97 |
| Load comb | | | #3 | | | #12 |
| Length | | | 2.36 | | | 1.10 |
| Min req'd | | | 2.36** | | | 1.10 |
| Cb | | | 1.16 | | | 1.00 |
| Cb min | | | 1.16 | | | 1.00 |
| Cb support | | | 1.07 | | | 1.07 |
| Fcp sup | | | 625 | | | 625 |

**Minimum bearing length governed by the required width of the supporting member.
Maximum reaction on at least one support is from a different load combination than the critical one for bearing design, shown here, due to Kd factor. See Analysis results for reaction from critical load combination.

## FF5

**Glulam-Bal., West Species, 24F-V8 DF, 5-1/2"x12"**

8 laminations, 5-1/2" maximum width,
Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 21.12'; Clear span: 6.333', 14.5'; volume = 9.7 cu.ft.
Lateral support: top= full, bottom= at supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 91 | Fv' = 265 | psi | fv/Fv' = 0.34 |
| Bending(+) | fb = 1164 | Fb' = 2400 | psi | fb/Fb' = 0.48 |
| Bending(-) | fb = 981 | Fb' = 2357 | psi | fb/Fb' = 0.42 |
| Deflection: | | | | |
| Interior Live | 0.31 = L/575 | 0.49 = L/360 | in | 0.63 |
| Total | 0.37 = L/470 | 0.73 = L/240 | in | 0.51 |
| Cantil. Live | 0.42 = L/182 | 0.43 = L/180 | in | 0.99 |
| Total | 0.43 = L/180 | 0.64 = L/120 | in | 0.67 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CV    Cfu    Cr   Cfrt Notes Cn*Cvr LC#
 Fv'        265    1.00  1.00  1.00    -      -     -     -    1.00  1.00  1.00   2
 Fb'+      2400    1.00  1.00  1.00  1.000  1.000  1.00  1.00  1.00  1.00   -     6
 Fb'-      2400    1.00  1.00  1.00  0.982  1.000  1.00  1.00  1.00  1.00   -     2
 Fcp'       650      -    1.00  1.00    -      -      -     -    1.00   -     -     -
 E'        1.8 million  1.00  1.00    -      -      -     -    1.00   -     -    12
 Eminy'   0.85 million  1.00  1.00    -      -      -     -    1.00   -     -    12
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #2  = D+L, V max =   4555, V design =   3984 lbs
 Bending(+): LC #6  = D+L (pattern: _L), M =  12799 lbs-ft
 Bending(-): LC #2  = D+L, M =  10786 lbs-ft
 Deflection: LC #12 =   (live)
             LC #12 =   (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load Patterns: s=S/2,  X=L+S or L+Lr,  _=no pattern load in this span
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =   1426e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(-):  Lu = 14.63'  Le = 24.06'  RB = 10.7; Lu based on full span
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Glulam design values are for materials conforming to ANSI 117-2015 and manufactured in accordance with ANSI A190.1-2012
4. Grades with equal bending capacity in the top and bottom edges of the beam cross-section are recommended for continuous beams.
5. GLULAM: bxd = actual breadth x actual depth.
6. Glulam Beams shall be laterally supported according to the provisions of NDS Clause 3.3.3.
7. GLULAM: bearing length based on smaller of Fcp(tension), Fcp(comp'n).
8. The critical deflection value has been determined using maximum back-span deflection. Cantilever deflections do not govern design.

FF6
Oct. 18, 2019 13:02

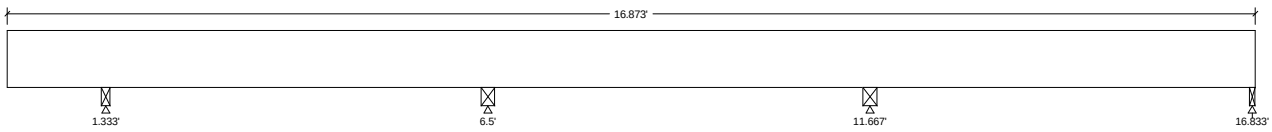
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | No | | | 15.00(16.50') | | psf |
| Load2 | Live | Full Area | Yes | | | 40.00(16.50') | | psf |
| Self-weight | Dead | Full UDL | No | | | 7.7 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unfactored: | | | | | | | | | | | |
| Dead | | | 923 | | | 1380 | | | 1468 | | 534 |
| Live | | | 2558 | | | 4092 | | | 4137 | | 1561 |
| Factored: | | | | | | | | | | | |
| Total | | | 3482 | | | 5472 | | | 5605 | | 2095 |
| Bearing: | | | | | | | | | | | |
| Capacity | | | | | | | | | | | |
| Beam | | | 3965 | | | 5763 | | | 5883 | | 2095 |
| Support | | | 3482 | | | 5472 | | | 5605 | | 2320 |
| Des ratio | | | | | | | | | | | |
| Beam | | | 0.88 | | | 0.95 | | | 0.95 | | 1.00 |
| Support | | | 1.00 | | | 1.00 | | | 1.00 | | 0.90 |
| Load comb | | | #13 | | | #8 | | | #15 | | #12 |
| Length | | | 1.44 | | | 2.26 | | | 2.31 | | 0.96 |
| Min req'd | | | 1.44** | | | 2.26** | | | 2.31** | | 0.96 |
| Cb | | | 1.26 | | | 1.17 | | | 1.16 | | 1.00 |
| Cb min | | | 1.26 | | | 1.17 | | | 1.16 | | 1.00 |
| Cb support | | | 1.11 | | | 1.11 | | | 1.11 | | 1.11 |
| Fcp sup | | | 625 | | | 625 | | | 625 | | 625 |

**Minimum bearing length governed by the required width of the supporting member.
Maximum reaction on at least one support is from a different load combination than the critical one for bearing design, shown here, due to Kd factor. See Analysis results for reaction from critical load combination.

## FF6

**Lumber-soft, D.Fir-L, No.2, 4x10 (3-1/2"x9-1/4")**

Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 16.87'; Clear span: 1.273', 5.013', 4.976', 5.03'; volume = 3.8 cu.ft.
Lateral support: top= at all supports, bottom= at all supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 98 | Fv' = 180 | psi | fv/Fv' = 0.55 |
| Bending(+) | fb = 557 | Fb' = 1072 | psi | fb/Fb' = 0.52 |
| Bending(-) | fb = 671 | Fb' = 1072 | psi | fb/Fb' = 0.63 |
| Deflection: | | | | |
| Interior Live | 0.02 = <L/999 | 0.17 = L/360 | in | 0.13 |
| Total | 0.03 = <L/999 | 0.26 = L/240 | in | 0.12 |
| Cantil. Live | -0.02 = L/845 | 0.09 = L/180 | in | 0.21 |
| Total | -0.02 = L/687 | 0.13 = L/120 | in | 0.17 |

### Additional Data:

```
FACTORS:   F/E(psi)CD    CM    Ct    CL     CF    Cfu    Cr   Cfrt   Ci    Cn   LC#
 Fv'        180    1.00  1.00  1.00    -      -     -     -    1.00  1.00  1.00  15
 Fb'+       900    1.00  1.00  1.00  0.992  1.200  1.00  1.00  1.00  1.00   -    12
 Fb'-       900    1.00  1.00  1.00  0.992  1.200  1.00  1.00  1.00  1.00   -    15
 Fcp'       625      -   1.00  1.00    -      -     -     -    1.00  1.00   -     -
 E'         1.6 million  1.00  1.00    -      -     -     -    1.00  1.00   -    12
 Emin'    0.58 million  1.00  1.00    -      -     -     -    1.00  1.00   -    12
CRITICAL LOAD COMBINATIONS:
 Shear     : LC #15 = D+L (pattern: L_LL), V max =   2904, V design =   2119 lbs
 Bending(+): LC #12 = D+L (pattern: _L_L), M =   2316 lbs-ft
 Bending(-): LC #15 = D+L (pattern: L_LL), M =   2791 lbs-ft
 Deflection: LC #12 =   (live)
             LC #12 =   (total)
 D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
 All LC's are listed in the Analysis output
 Load Patterns: s=S/2,  X=L+S or L+Lr,  _=no pattern load in this span
 Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
 Deflection:  EI =    369e06 lb-in2
 "Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
 Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
 Lateral stability(+):  Lu = 5.19'  Le = 9.69'  RB = 9.4; Lu based on full span
 Lateral stability(-):  Lu = 5.19'  Le = 9.69'  RB = 9.4; Lu based on full span
```

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Continuous or Cantilevered Beams: NDS Clause 4.2.5.5 requires that normal grading provisions be extended to the middle 2/3 of 2 span beams and to the full length of cantilevers and other spans.
4. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.
5. The critical deflection value has been determined using maximum back-span deflection. Cantilever deflections do not govern design.

FF7 (deck joist)
Oct. 18, 2019 13:02

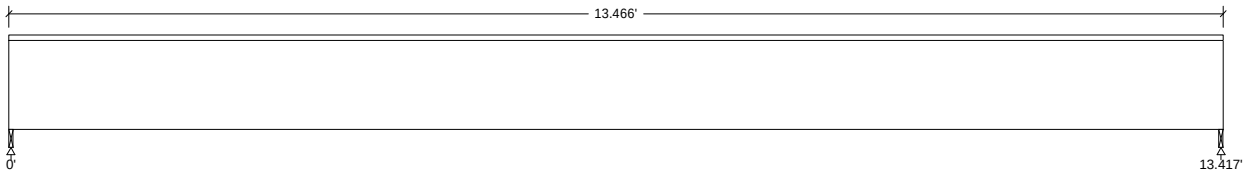
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | | | | 15.00(16.0") | | psf |
| Load2 | Live | Full Area | | | | 60.00(16.0") | | psf |
| Load3 | Snow | Full Area | | | | 30.00(16.0") | | psf |
| Self-weight | Dead | Full UDL | | | | 6.0 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | |
|---|---|---|---|
| Unfactored: | | | |
| Dead | 175 | | 175 |
| Live | 539 | | 539 |
| Snow | 269 | | 269 |
| Factored: | | | |
| Total | 781 | | 781 |
| Bearing: | | | |
| Capacity | | | |
| Joist | 781 | | 781 |
| Support | 790 | | 790 |
| Des ratio | | | |
| Joist | 1.00 | | 1.00 |
| Support | 0.99 | | 0.99 |
| Load comb | #3 | | #3 |
| Length | 0.59 | | 0.59 |
| Min req'd | 0.59 | | 0.59 |
| Cb | 1.00 | | 1.00 |
| Cb min | 1.00 | | 1.00 |
| Cb support | 1.21 | | 1.21 |
| Fcp sup | 625 | | 625 |

## FF7

**LVL n-ply, 1.8E, 2600Fb, 1-3/4"x11-7/8", 1-ply**

Supports: All - Timber-soft Beam, D.Fir-L No.2
Floor joist spaced at 16" c/c; Total length: 13.47'; Clear span: 13.367'; volume = 1.9 cu.ft.
Lateral support: top= full, bottom= at supports; Repetitive factor: applied where permitted (refer to online help);

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 44 | Fv' = 285 | psi | fv/Fv' = 0.15 |
| Bending(+) | fb = 696 | Fb' = 2707 | psi | fb/Fb' = 0.26 |
| Live Defl'n | 0.15 = <L/999 | 0.45 = L/360 | in | 0.33 |
| Total Defl'n | 0.21 = L/752 | 0.67 = L/240 | in | 0.32 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CV | Cfu | Cr | Cfrt | Ci | Cn | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 285 | 1.00 | - | 1.00 | - | - | - | - | 1.00 | - | 1.00 | 2 |
| Fb'+ | 2600 | 1.00 | - | 1.00 | 1.000 | 1.00 | - | 1.04 | 1.00 | - | - | 2 |
| Fcp' | 750 | - | - | 1.00 | - | - | - | - | 1.00 | - | - | - |
| E' | 1.8 million | | - | 1.00 | - | - | - | - | 1.00 | - | - | 3 |
| Eminy' | 0.93 million | | - | 1.00 | - | - | - | - | 1.00 | - | - | 3 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #2 = D+L, V max = 711, V design = 603 lbs
Bending(+): LC #2 = D+L, M = 2385 lbs-ft
Deflection: LC #3 = D+.75(L+S) (live)
LC #3 = D+.75(L+S) (total)
D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
All LC's are listed in the Analysis output
Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
Deflection: EI = 440e06 lb-in2
"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. System factor KH may not apply to field-assembled multi-ply beams.
4. FIRE RATING: Joists, wall studs, and multi-ply members are not rated for fire endurance.

B1
Oct. 18, 2019 13:03

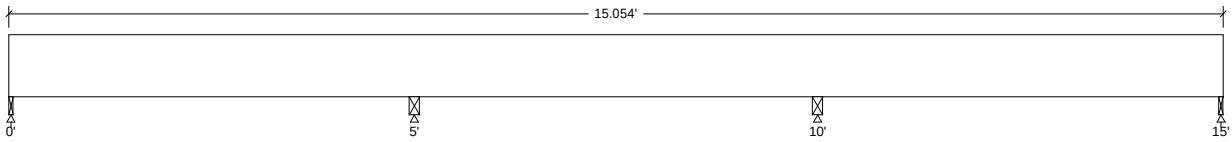
## Design Check Calculation Sheet

WoodWorks Sizer 11.1

### Loads:

| Load | Type | Distribution | Pat-tern | Location [ft] Start | End | Magnitude Start | End | Unit |
|---|---|---|---|---|---|---|---|---|
| Load1 | Dead | Full Area | No | | | 15.00(11.50') | | psf |
| Load2 | Live | Full Area | Yes | | | 40.00(11.50') | | psf |
| Self-weight | Dead | Full UDL | No | | | 7.7 | | plf |

### Maximum Reactions (lbs), Bearing Capacities (lbs) and Bearing Lengths (in) :




| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Unfactored: | | | | | | | | |
| Dead | 365 | | 991 | | 991 | | 365 |
| Live | 1047 | | 2760 | | 2760 | | 1047 |
| Factored: | | | | | | | | |
| Total | 1412 | | 3751 | | 3751 | | 1412 |
| Bearing: | | | | | | | | |
| Capacity | | | | | | | | |
| Beam | 1412 | | 4208 | | 4208 | | 1412 |
| Support | 1564 | | 3751 | | 3751 | | 1564 |
| Des ratio | | | | | | | | |
| Beam | 1.00 | | 0.89 | | 0.89 | | 1.00 |
| Support | 0.90 | | 1.00 | | 1.00 | | 0.90 |
| Load comb | #7 | | #5 | | #8 | | #7 |
| Length | 0.65 | | 1.55 | | 1.55 | | 0.65 |
| Min req'd | 0.65 | | 1.55** | | 1.55** | | 0.65 |
| Cb | 1.00 | | 1.24 | | 1.24 | | 1.00 |
| Cb min | 1.00 | | 1.24 | | 1.24 | | 1.00 |
| Cb support | 1.11 | | 1.11 | | 1.11 | | 1.11 |
| Fcp sup | 625 | | 625 | | 625 | | 625 |

**Minimum bearing length governed by the required width of the supporting member.

### B1

**Lumber-soft, D.Fir-L, No.2, 4x10 (3-1/2"x9-1/4")**

Supports: All - Timber-soft Beam, D.Fir-L No.2
Total length: 15.05'; Clear span: 4.909', 4.871', 4.909'; volume = 3.4 cu.ft.
Lateral support: top= at all supports, bottom= at all supports;

### Analysis vs. Allowable Stress and Deflection using NDS 2015 :

| Criterion | Analysis Value | Design Value | Unit | Analysis/Design |
|---|---|---|---|---|
| Shear | fv = 66 | Fv' = 180 | psi | fv/Fv' = 0.37 |
| Bending(+) | fb = 366 | Fb' = 1071 | psi | fb/Fb' = 0.34 |
| Bending(-) | fb = 431 | Fb' = 1071 | psi | fb/Fb' = 0.40 |
| Live Defl'n | 0.01 = <L/999 | 0.17 = L/360 | in | 0.08 |
| Total Defl'n | 0.02 = <L/999 | 0.25 = L/240 | in | 0.08 |

### Additional Data:

| FACTORS: | F/E(psi) | CD | CM | Ct | CL | CF | Cfu | Cr | Cfrt | Ci | Cn | LC# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fv' | 180 | 1.00 | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | 1.00 | 5 |
| Fb'+ | 900 | 1.00 | 1.00 | 1.00 | 0.992 | 1.200 | 1.00 | 1.00 | 1.00 | 1.00 | - | 7 |
| Fb'- | 900 | 1.00 | 1.00 | 1.00 | 0.992 | 1.200 | 1.00 | 1.00 | 1.00 | 1.00 | - | 5 |
| Fcp' | 625 | - | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | - |
| E' | 1.6 million | | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 7 |
| Emin' | 0.58 million | | 1.00 | 1.00 | - | - | - | - | 1.00 | 1.00 | - | 7 |

CRITICAL LOAD COMBINATIONS:
Shear : LC #5 = D+L (pattern: LL_), V max = 1959, V design = 1428 lbs
Bending(+): LC #7 = D+L (pattern: L_L), M = 1521 lbs-ft
Bending(-): LC #5 = D+L (pattern: LL_), M = 1792 lbs-ft
Deflection: LC #7 = (live)
LC #7 = (total)
D=dead L=live S=snow W=wind I=impact Lr=roof live Lc=concentrated E=earthquake
All LC's are listed in the Analysis output
Load Patterns: s=S/2, X=L+S or L+Lr, _=no pattern load in this span
Load combinations: ASCE 7-10 / IBC 2015
CALCULATIONS:
Deflection: EI = 369e06 lb-in2
"Live" deflection = Deflection from all non-dead loads (live, wind, snow…)
Total Deflection = 1.50(Dead Load Deflection) + Live Load Deflection.
Lateral stability(+): Lu = 5.00' Le = 10.31' RB = 9.7; Lu based on full span
Lateral stability(-): Lu = 5.00' Le = 10.31' RB = 9.7; Lu based on full span

### Design Notes:

1. WoodWorks analysis and design are in accordance with the ICC International Building Code (IBC 2015), the National Design Specification (NDS 2015), and NDS Design Supplement.
2. Please verify that the default deflection limits are appropriate for your application.
3. Continuous or Cantilevered Beams: NDS Clause 4.2.5.5 requires that normal grading provisions be extended to the middle 2/3 of 2 span beams and to the full length of cantilevers and other spans.
4. Sawn lumber bending members shall be laterally supported according to the provisions of NDS Clause 4.4.1.

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# Cantilevered Retaining Wall

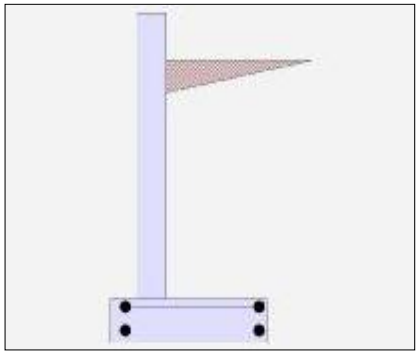
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 5.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.450 |
| 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 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 41.417 |
| Total Seismic Force | = | 245.049 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 2.72 | OK |
| Sliding | = | 1.51 | OK |
| Total Bearing Load | = | 3,399 lbs | |
| ...resultant ecc. | = | 8.27 in | |
| Soil Pressure @ Toe | = | 2,136 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |
| Soil Pressure Less Than Allowable | | | |
| ACI Factored @ Toe | = | 2,991 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 0.1 psi | OK |
| Footing Shear @ Heel | = | 18.2 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | | |
|---|---|---|---|
| Lateral Sliding Force | = | 784.2 lbs | |
| less 100% Passive Force | = - | 20.0 lbs | |
| less 100% Friction Force | = - | 1,205.5 lbs | |
| Added Force Req'd | = | 0.0 lbs | OK |
| ....for 1.5 Stability | = | 0.0 lbs | OK |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 = | 16.00 |
| Rebar Placed at = | Edge |
| **Design Data** | |
| fb/FB + fa/Fa = | **0.411** |
| **Total Force @ Section** | |
| Service Level lbs = | |
| Strength Level lbs = | 907.1 |
| **Moment....Actual** | |
| Service Level ft-# = | |
| Strength Level ft-# = | 1,684.4 |
| Moment.....Allowable = | 4,099.3 |
| **Shear.....Actual** | |
| Service Level psi = | |
| Strength Level psi = | 12.1 |
| 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 2015,ACI 318-14,ACI 530-13

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.0631 in2/ft | |
| (4/3) * As : | 0.0841 in2/ft | Min Stem T&S Reinf Area 1.152 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.1344 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.15 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 0.58 ft |
| Heel Width | = | 2.92 |
| Total Footing Width | = | 3.50 |
| Footing Thickness | = | 11.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 2,991 | 0 psf |
| Mu' : Upward | = | 477 | 0 ft-# |
| Mu' : Downward | = | 28 | 2,089 ft-# |
| Mu: Design | = | 449 | 2,089 ft-# |
| Actual 1-Way Shear | = | 0.06 | 18.20 psi |
| Allow 1-Way Shear | = | 40.00 | 75.00 psi |

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 4 @ 10.10 in
Key Reinforcing = None Spec'd

Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: #4@ 10.10 in, #5@ 15.66 in, #6@ 22.22 in, #7@ 30.30 in, #8@ 39.90 in, #9@ 5
Key: No key defined

Min footing T&S reinf Area 0.83 in2
Min footing T&S reinf Area per foot 0.24 in2 /ft

| If one layer of horizontal bars: | If two layers of horizontal bars: |
|---|---|
| #4@ 10.10 in | #4@ 20.20 in |
| #5@ 15.66 in | #5@ 31.31 in |
| #6@ 22.22 in | #6@ 44.44 in |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| Heel Active Pressure | = | 612.6 | 1.97 | 1,208.2 | Soil Over Heel | = | 1,237.7 | 2.37 | 2,939.3 |
| Surcharge over Heel | = | | | | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | | | |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 0.92 | 329.9 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 0.92 | 659.8 |
| Seismic Earth Load | = | 171.5 | 2.96 | 507.5 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 784.2 | **O.T.M.** | 1,715.7 | Stem Weight(s) | = | 600.0 | 0.92 | 549.8 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 481.3 | 1.75 | 842.2 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 2,678.9 lbs | **R.M.=** | 4,661.2 |

**Resisting/Overturning Ratio = 2.72**
Vertical Loads used for Soil Pressure = 3,398.9 lbs

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

If seismic is included, the OTM and sliding ratios be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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

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

## Tilt

### Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

| | | |
|---|---|---|
| Soil Spring Reaction Modulus | 250.0 | pci |
| Horizontal Defl @ Top of Wall (approximate only) | 0.102 | in |

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

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# Cantilevered Retaining Wall

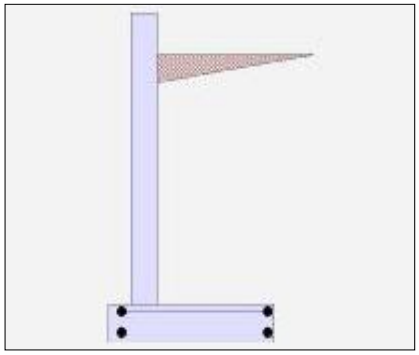
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 6.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.450 |
| 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 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 48.417 |
| Total Seismic Force | = | 334.882 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 2.80 | OK |
| Sliding | = | 1.50 | OK |
| Total Bearing Load | = | 4,347 lbs | |
| ...resultant ecc. | = | 10.09 in | |
| Soil Pressure @ Toe | = | 2,255 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |
| Soil Pressure Less Than Allowable | | | |
| ACI Factored @ Toe | = | 3,156 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 0.1 psi | OK |
| Footing Shear @ Heel | = | 28.2 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | | |
|---|---|---|---|
| Lateral Sliding Force | = | 1,071.6 lbs | |
| less 100% Passive Force | = - | 20.0 lbs | |
| less 100% Friction Force | = - | 1,632.1 lbs | |
| Added Force Req'd | = | 0.0 lbs | OK |
| ....for 1.5 Stability | = | 0.0 lbs | OK |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 = | 15.00 |
| Rebar Placed at = | Edge |
| **Design Data** | |
| fb/FB + fa/Fa = | **0.662** |
| **Total Force @ Section** | |
| Service Level lbs = | |
| Strength Level lbs = | 1,298.5 |
| **Moment....Actual** | |
| Service Level ft-# = | |
| Strength Level ft-# = | 2,887.5 |
| Moment.....Allowable = | 4,364.1 |
| **Shear.....Actual** | |
| Service Level psi = | |
| Strength Level psi = | 17.3 |
| 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 2015,ACI 318-14,ACI 530-13

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.1082 in2/ft | |
| (4/3) * As : | 0.1442 in2/ft | Min Stem T&S Reinf Area 1.344 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.1442 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.16 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 0.58 ft |
| Heel Width | = | 3.67 |
| Total Footing Width | = | 4.25 |
| Footing Thickness | = | 11.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 3,156 | 0 psf |
| Mu' : Upward | = | 509 | 0 ft-# |
| Mu' : Downward | = | 28 | 4,316 ft-# |
| Mu: Design | = | 481 | 4,316 ft-# |
| Actual 1-Way Shear | = | 0.06 | 28.18 psi |
| Allow 1-Way Shear | = | 40.00 | 75.00 psi |

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 4 @ 10.10 in
Key Reinforcing = None Spec'd

### Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: #4@ 10.10 in, #5@ 15.66 in, #6@ 22.22 in, #7@ 30.30 in, #8@ 39.90 in, #9@ 5
Key: No key defined

Min footing T&S reinf Area 1.01 in2
Min footing T&S reinf Area per foot 0.24 in2 /ft

| If one layer of horizontal bars: | If two layers of horizontal bars: |
|---|---|
| #4@ 10.10 in | #4@ 20.20 in |
| #5@ 15.66 in | #5@ 31.31 in |
| #6@ 22.22 in | #6@ 44.44 in |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| **Item** | | | | | | | | | |
| Heel Active Pressure | = | 837.2 | 2.31 | 1,930.2 | Soil Over Heel | = | 1,982.2 | 2.75 | 5,453.7 |
| Surcharge over Heel | = | | | | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | | | |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 0.92 | 329.9 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 0.92 | 659.8 |
| Seismic Earth Load | = | 234.4 | 3.46 | 810.7 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 1,071.6 | **O.T.M.** | 2,740.9 | Stem Weight(s) | = | 700.0 | 0.92 | 641.4 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 584.8 | 2.13 | 1,243.6 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 3,627.0 lbs | **R.M.=** | 7,668.6 |

**Resisting/Overturning Ratio = 2.80**
Vertical Loads used for Soil Pressure = 4,347.0 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.103 | in |

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

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# Cantilevered Retaining Wall

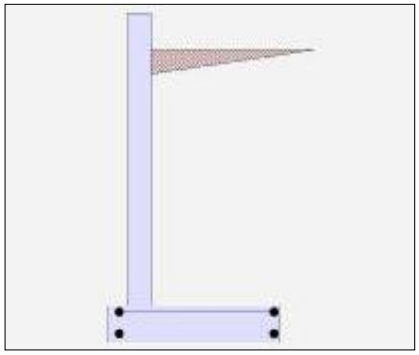
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 7.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.450 |
| 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 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 56.000 |
| Total Seismic Force | = | 448.000 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 2.82 | OK |
| Sliding | = | 1.51 | OK |
| Total Bearing Load | = | 5,521 lbs | |
| ...resultant ecc. | = | 11.77 in | |
| Soil Pressure @ Toe | = | 2,420 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |
| Soil Pressure Less Than Allowable | | | |
| ACI Factored @ Toe | = | 3,389 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 0.2 psi | OK |
| Footing Shear @ Heel | = | 36.3 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | | |
|---|---|---|---|
| Lateral Sliding Force | = | 1,433.6 lbs | |
| less 100% Passive Force | = - | 0.0 lbs | |
| less 100% Friction Force | = - | 2,160.2 lbs | |
| Added Force Req'd | = | 0.0 lbs | OK |
| ....for 1.5 Stability | = | 0.0 lbs | OK |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 10.00 | |
| Rebar Placed at | = | Edge | |
| **Design Data** | | | |
| fb/FB + fa/Fa | = | **0.710** | |
| **Total Force @ Section** | | | |
| Service Level | lbs = | | |
| Strength Level | lbs = | 1,764.0 | |
| **Moment....Actual** | | | |
| Service Level | ft-# = | | |
| Strength Level | ft-# = | 4,573.3 | |
| Moment.....Allowable | = | 6,444.1 | |
| **Shear.....Actual** | | | |
| Service Level | psi = | | |
| Strength Level | psi = | 23.5 | |
| 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 2015,ACI 318-14,ACI 530-13

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.1713 in2/ft | |
| (4/3) * As : | 0.2285 in2/ft | Min Stem T&S Reinf Area 1.536 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.2285 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.24 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 0.58 ft |
| Heel Width | = | 4.42 |
| Total Footing Width | = | 5.00 |
| Footing Thickness | = | 12.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 3,389 | 0 psf |
| Mu' : Upward | = | 551 | 0 ft-# |
| Mu' : Downward | = | 31 | 7,776 ft-# |
| Mu: Design | = | 521 | 7,776 ft-# |
| Actual 1-Way Shear | = | 0.19 | 36.35 psi |
| Allow 1-Way Shear | = | 40.00 | 75.00 psi |

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 4 @ 9.26 in
Key Reinforcing = None Spec'd

### Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: #4@ 9.26 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.78 in, #8@ 36.57 in, #9@ 46
Key: No key defined

Min footing T&S reinf Area 1.30 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 |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| Heel Active Pressure | = | 1,120.0 | 2.67 | 2,986.7 | Soil Over Heel | = | 2,890.1 | 3.13 | 9,035.3 |
| Surcharge over Heel | = | | | | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | | | |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 0.92 | 329.9 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 0.92 | 659.8 |
| Seismic Earth Load | = | 313.6 | 4.00 | 1,254.4 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 1,433.6 | **O.T.M.** | 4,241.1 | Stem Weight(s) | = | 800.0 | 0.92 | 733.1 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 750.5 | 2.50 | 1,877.3 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 4,800.5 lbs | **R.M.=** | 11,975.5 |

**Resisting/Overturning Ratio = 2.82**
Vertical Loads used for Soil Pressure = 5,520.5 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.108 | in |

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

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# Cantilevered Retaining Wall

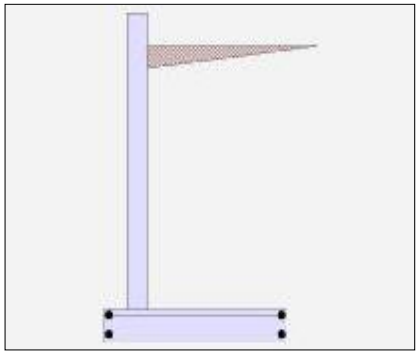
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 8.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.450 |
| 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 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 63.000 |
| Total Seismic Force | = | 567.000 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 3.07 | OK |
| Sliding | = | 1.52 | OK |
| Total Bearing Load | = | 6,831 lbs | |
| ...resultant ecc. | = | 12.20 in | |
| Soil Pressure @ Toe | = | 2,344 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |
| Soil Pressure Less Than Allowable | | | |
| ACI Factored @ Toe | = | 3,281 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 1.1 psi | OK |
| Footing Shear @ Heel | = | 48.8 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | | |
|---|---|---|---|
| Lateral Sliding Force | = | 1,814.4 lbs | |
| less 100% Passive Force | = - | 0.0 lbs | |
| less 100% Friction Force | = - | 2,749.9 lbs | |
| Added Force Req'd | = | 0.0 lbs | OK |
| ....for 1.5 Stability | = | 0.0 lbs | OK |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 9.00 | |
| Rebar Placed at | = | Edge | |
| **Design Data** | | | |
| fb/FB + fa/Fa | = | **0.954** | |
| **Total Force @ Section** | | | |
| Service Level | lbs = | | |
| Strength Level | lbs = | 2,296.0 | |
| **Moment....Actual** | | | |
| Service Level | ft-# = | | |
| Strength Level | ft-# = | 6,794.7 | |
| Moment.....Allowable | = | 7,122.4 | |
| **Shear.....Actual** | | | |
| Service Level | psi = | | |
| Strength Level | psi = | 30.6 | |
| 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 2015,ACI 318-14,ACI 530-13

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.2546 in2/ft | |
| (4/3) * As : | 0.3394 in2/ft | Min Stem T&S Reinf Area 1.728 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.2546 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.2667 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 0.75 ft |
| Heel Width | = | 5.17 |
| Total Footing Width | = | 5.92 |
| Footing Thickness | = | 12.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 3,281 | 0 psf |
| Mu' : Upward | = | 883 | 0 ft-# |
| Mu' : Downward | = | 51 | 12,533 ft-# |
| Mu: Design | = | 833 | 12,533 ft-# |
| Actual 1-Way Shear | = | 1.07 | 48.83 psi |
| Allow 1-Way Shear | = | 40.00 | 75.00 psi |

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 4 @ 6.32 in
Key Reinforcing = None Spec'd

### Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: #4@ 6.32 in, #5@ 9.79 in, #6@ 13.89 in, #7@ 18.95 in, #8@ 24.95 in, #9@ 31.
Key: No key defined

Min footing T&S reinf Area 1.53 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 |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| **Item** | | | | | | | | | |
| Heel Active Pressure | = | 1,417.5 | 3.00 | 4,252.5 | Soil Over Heel | = | 3,962.9 | 3.67 | 14,537.4 |
| Surcharge over Heel | = | | | | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | | | |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 1.08 | 390.0 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 1.08 | 780.0 |
| Seismic Earth Load | = | 396.9 | 4.50 | 1,786.1 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 1,814.4 | **O.T.M.** | 6,038.6 | Stem Weight(s) | = | 900.0 | 1.08 | 975.0 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 888.0 | 2.96 | 2,628.5 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 6,110.9 lbs | **R.M.=** | 18,530.8 |

**Resisting/Overturning Ratio = 3.07**
Vertical Loads used for Soil Pressure = 6,830.9 lbs

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

If seismic is included, the OTM and sliding ratios be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.099 | in |

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

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# Cantilevered Retaining Wall

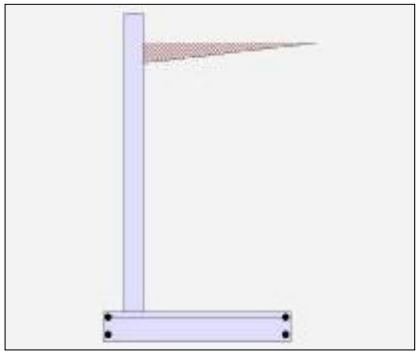
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 9.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.450 |
| 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 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 3.12 | OK |
| Sliding | = | 1.52 | OK |
| Total Bearing Load | = | 8,281 lbs | |
| ...resultant ecc. | = | 13.45 in | |
| Soil Pressure @ Toe | = | 2,494 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |
| Soil Pressure Less Than Allowable | | | |
| ACI Factored @ Toe | = | 3,491 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 1.1 psi | OK |
| Footing Shear @ Heel | = | 63.0 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | | |
|---|---|---|---|
| Lateral Sliding Force | = | 2,240.0 lbs | |
| less 100% Passive Force | = - | 0.0 lbs | |
| less 100% Friction Force | = - | 3,402.6 lbs | |
| Added Force Req'd | = | 0.0 lbs | OK |
| ....for 1.5 Stability | = | 0.0 lbs | OK |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 8.00 | |
| Rebar Placed at | = | Edge | |
| **Design Data** | | | |
| fb/FB + fa/Fa | = | **0.817** | |
| **Total Force @ Section** | | | |
| Service Level | lbs = | | |
| Strength Level | lbs = | 2,898.0 | |
| **Moment....Actual** | | | |
| Service Level | ft-# = | | |
| Strength Level | ft-# = | 9,639.0 | |
| Moment.....Allowable | = | 11,799.2 | |
| **Shear.....Actual** | | | |
| Service Level | psi = | | |
| Strength Level | psi = | 39.0 | |
| 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 2015,ACI 318-14,ACI 530-13

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing | |
|---|---|---|---|
| As (based on applied moment) : | 0.365 in2/ft | | |
| (4/3) * As : | 0.4866 in2/ft | Min Stem T&S Reinf Area 1.920 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 | |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : | |
| | ========== | One layer of : | Two layers of : |
| Required Area : | 0.365 in2/ft | #4@ 12.50 in | #4@ 25.00 in |
| Provided Area : | 0.465 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 0.75 ft |
| Heel Width | = | 5.92 |
| Total Footing Width | = | 6.67 |
| Footing Thickness | = | 12.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 3,491 | 0 psf |
| Mu' : Upward | = | 945 | 0 ft-# |
| Mu' : Downward | = | 51 | 18,877 ft-# |
| Mu: Design | = | 894 | 18,877 ft-# |
| Actual 1-Way Shear | = | 1.15 | 63.04 psi |
| Allow 1-Way Shear | = | 40.00 | 75.00 psi |

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 4 @ 5.25 in
Key Reinforcing = None Spec'd

### Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: #4@ 5.25 in, #5@ 8.14 in, #6@ 11.56 in, #7@ 15.76 in, #8@ 20.75 in, #9@ 26.
Key: No key defined

Min footing T&S reinf Area 1.73 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 |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| **Item** | | | | | | | | | |
| Heel Active Pressure | = | 1,750.0 | 3.33 | 5,833.3 | Soil Over Heel | = | 5,200.8 | 4.04 | 21,028.6 |
| Surcharge over Heel | = | | | | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | | | |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 1.08 | 390.0 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 1.08 | 780.0 |
| Seismic Earth Load | = | 490.0 | 5.00 | 2,450.0 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 2,240.0 | **O.T.M.** | 8,283.3 | Stem Weight(s) | = | 1,000.0 | 1.08 | 1,083.3 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 1,000.5 | 3.34 | 3,336.7 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 7,561.3 lbs | **R.M.=** | 25,838.6 |

**Resisting/Overturning Ratio = 3.12**
Vertical Loads used for Soil Pressure = 8,281.3 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.104 | in |

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

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# Cantilevered Retaining Wall

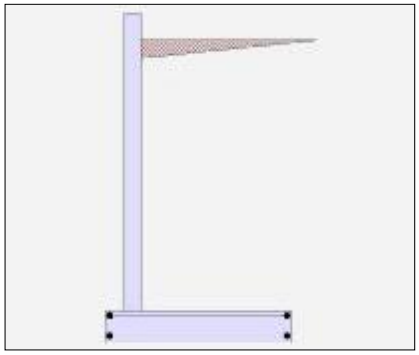
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 10.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.450 |
| 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 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 78.167 |
| Total Seismic Force | = | 872.861 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 3.01 | OK |
| Sliding | = | 1.51 | OK |
| Total Bearing Load | = | 9,967 lbs | |
| ...resultant ecc. | = | 15.11 in | |
| Soil Pressure @ Toe | = | 2,762 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |
| Soil Pressure Less Than Allowable | | | |
| ACI Factored @ Toe | = | 3,867 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 0.2 psi | OK |
| Footing Shear @ Heel | = | 65.6 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | | |
|---|---|---|---|
| Lateral Sliding Force | = | 2,793.2 lbs | |
| less 100% Passive Force | = - | 45.1 lbs | |
| less 100% Friction Force | = - | 4,161.3 lbs | |
| Added Force Req'd | = | 0.0 lbs | OK |
| ....for 1.5 Stability | = | 0.0 lbs | OK |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 7.00 | |
| Rebar Placed at | = | Edge | |
| **Design Data** | | | |
| fb/FB + fa/Fa | = | **0.996** | |
| **Total Force @ Section** | | | |
| Service Level | lbs = | | |
| Strength Level | lbs = | 3,581.7 | |
| **Moment....Actual** | | | |
| Service Level | ft-# = | | |
| Strength Level | ft-# = | 13,241.7 | |
| Moment.....Allowable | = | 13,297.3 | |
| **Shear.....Actual** | | | |
| Service Level | psi = | | |
| Strength Level | psi = | 48.2 | |
| 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 2015,ACI 318-14,ACI 530-13

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.5014 in2/ft | |
| (4/3) * As : | 0.6685 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.5014 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.5314 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 0.75 ft |
| Heel Width | = | 6.58 |
| Total Footing Width | = | 7.33 |
| Footing Thickness | = | 14.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 3,867 | 0 psf |
| Mu' : Upward | = | 1,050 | 0 ft-# |
| Mu' : Downward | = | 59 | 26,750 ft-# |
| Mu: Design | = | 991 | 26,750 ft-# |
| Actual 1-Way Shear | = | 0.18 | 65.56 psi |
| Allow 1-Way Shear | = | 40.00 | 75.00 psi |

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 5 @ 6.00 in
Key Reinforcing = None Spec'd

### Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: #4@ 4.51 in, #5@ 7.00 in, #6@ 9.93 in, #7@ 13.54 in, #8@ 17.83 in, #9@ 22.5
Key: No key defined

Min footing T&S reinf Area 2.22 in2
Min footing T&S reinf Area per foot 0.30 in2 /ft

| If one layer of horizontal bars: | If two layers of horizontal bars: |
|---|---|
| #4@ 7.94 in | #4@ 15.87 in |
| #5@ 12.30 in | #5@ 24.60 in |
| #6@ 17.46 in | #6@ 34.92 in |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| Heel Active Pressure | = | 2,182.2 | 3.72 | 8,122.5 | Soil Over Heel | = | 6,504.7 | 4.37 | 28,447.1 |
| Surcharge over Heel | = | | | | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | | | |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 1.08 | 390.0 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 1.08 | 780.0 |
| Seismic Earth Load | = | 611.0 | 5.58 | 3,411.4 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 2,793.2 | **O.T.M.** | 11,533.9 | Stem Weight(s) | = | 1,100.0 | 1.08 | 1,191.7 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 1,282.8 | 3.67 | 4,701.3 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 9,247.4 lbs | **R.M.=** | 34,730.0 |

**Resisting/Overturning Ratio = 3.01**
Vertical Loads used for Soil Pressure = 9,967.4 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.115 | in |

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

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# Cantilevered Retaining Wall

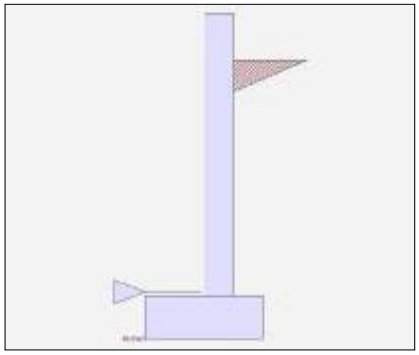
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 5.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.525 |
| Soil height to ignore for passive pressure | = | 12.00 in |



## Surcharge Loads

| | | |
|---|---|---|
| Surcharge Over Heel | = | 40.0 psf |
| Used To Resist Sliding & Overturning | | |
| Surcharge Over Toe | = | 40.0 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 41.417 |
| Total Seismic Force | = | 245.049 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 1.59 | OK |

Slab Resists All Sliding !

| | | | |
|---|---|---|---|
| Total Bearing Load | = | 2,490 lbs | |
| ...resultant ecc. | = | 4.68 in | |
| Soil Pressure @ Toe | = | 1,759 psf | OK |
| Soil Pressure @ Heel | = | 113 psf | OK |
| Allowable | = | 3,000 psf | |

Soil Pressure Less Than Allowable

| | | | |
|---|---|---|---|
| ACI Factored @ Toe | = | 2,463 psf | |
| ACI Factored @ Heel | = | 159 psf | |
| Footing Shear @ Toe | = | 12.6 psi | OK |
| Footing Shear @ Heel | = | 2.7 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | |
|---|---|---|
| Lateral Sliding Force | = | 841.7 lbs |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 16.00 |
| Rebar Placed at | = | Edge |
| **Design Data** | | |
| fb/FB + fa/Fa | = | **0.473** |
| **Total Force @ Section** | | |
| Service Level | lbs = | |
| Strength Level | lbs = | 1,008.9 |
| **Moment....Actual** | | |
| Service Level | ft-# = | |
| Strength Level | ft-# = | 1,938.9 |
| Moment.....Allowable | = | 4,099.3 |
| **Shear.....Actual** | | |
| Service Level | psi = | |
| Strength Level | psi = | 13.5 |
| 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 2015,ACI 318-14,ACI 530-13

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.0726 in2/ft | |
| (4/3) * As : | 0.0969 in2/ft | Min Stem T&S Reinf Area 1.152 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.1344 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.15 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 1.33 ft |
| Heel Width | = | 1.33 |
| Total Footing Width | = | 2.66 |
| Footing Thickness | = | 11.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 2,463 | 159 psf |
| Mu' : Upward | = | 1,839 | 77 ft-# |
| Mu' : Downward | = | 203 | 196 ft-# |
| Mu: Design | = | 1,636 | 119 ft-# |
| Actual 1-Way Shear | = | 12.59 | 2.72 psi |
| Allow 1-Way Shear | = | 40.00 | 40.00 psi |
| Toe Reinforcing | = | None Spec'd | |
| Heel Reinforcing | = | None Spec'd | |
| Key Reinforcing | = | None Spec'd | |

Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Key: No key defined

Min footing T&S reinf Area 0.63 in2
Min footing T&S reinf Area per foot 0.24 in2 /ft

| If one layer of horizontal bars: | If two layers of horizontal bars: |
|---|---|
| #4@ 10.10 in | #4@ 20.20 in |
| #5@ 15.66 in | #5@ 31.31 in |
| #6@ 22.22 in | #6@ 44.44 in |

## Summary of Overturning & Resisting Forces & Moments

| Item | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|
| Heel Active Pressure | = | 612.6 | 1.97 | 1,208.2 | Soil Over Heel | = | 364.8 | 2.33 | 849.5 |
| Surcharge over Heel | = | 57.5 | 2.96 | 170.2 | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | 26.5 | 2.33 | 61.8 |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 1.66 | 598.8 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 1.66 | 1,197.6 |
| Seismic Earth Load | = | 171.5 | 2.96 | 507.5 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 841.7 | **O.T.M.** | 1,885.9 | Stem Weight(s) | = | 600.0 | 1.66 | 998.0 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 365.8 | 1.33 | 486.4 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 1,717.1 lbs | **R.M.=** | 2,994.5 |

**Resisting/Overturning Ratio = 1.59**
Vertical Loads used for Soil Pressure = 2,490.3 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.110 | in |

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

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# Cantilevered Retaining Wall

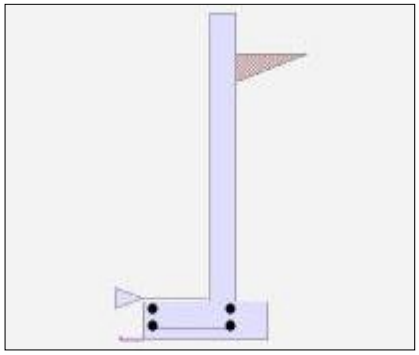
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 6.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.525 |
| Soil height to ignore for passive pressure | = | 12.00 in |



## Surcharge Loads

| | | |
|---|---|---|
| Surcharge Over Heel | = | 40.0 psf |
| Used To Resist Sliding & Overturning | | |
| Surcharge Over Toe | = | 40.0 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 48.417 |
| Total Seismic Force | = | 334.882 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 1.54 | OK |

Slab Resists All Sliding !

| | | | |
|---|---|---|---|
| Total Bearing Load | = | 2,880 lbs | |
| ...resultant ecc. | = | 6.27 in | |
| Soil Pressure @ Toe | = | 1,741 psf | OK |
| Soil Pressure @ Heel | = | 31 psf | OK |
| Allowable | = | 3,000 psf | |

Soil Pressure Less Than Allowable

| | | | |
|---|---|---|---|
| ACI Factored @ Toe | = | 2,438 psf | |
| ACI Factored @ Heel | = | 44 psf | |
| Footing Shear @ Toe | = | 22.4 psi | OK |
| Footing Shear @ Heel | = | 5.2 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | |
|---|---|---|
| Lateral Sliding Force | = | 1,138.9 lbs |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 14.00 |
| Rebar Placed at | = | Edge |
| **Design Data** | | |
| fb/FB + fa/Fa | = | **0.697** |
| **Total Force @ Section** | | |
| Service Level | lbs = | |
| Strength Level | lbs = | 1,420.7 |
| **Moment....Actual** | | |
| Service Level | ft-# = | |
| Strength Level | ft-# = | 3,254.0 |
| Moment.....Allowable | = | 4,665.4 |
| **Shear.....Actual** | | |
| Service Level | psi = | |
| Strength Level | psi = | 18.9 |
| 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 |

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.1219 in2/ft | |
| (4/3) * As : | 0.1626 in2/ft | Min Stem T&S Reinf Area 1.344 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.1626 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.1714 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 1.75 ft |
| Heel Width | = | 1.50 |
| Total Footing Width | = | 3.25 |
| Footing Thickness | = | 11.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 2,438 | 44 psf |
| Mu' : Upward | = | 3,075 | 86 ft-# |
| Mu' : Downward | = | 351 | 355 ft-# |
| Mu: Design | = | 2,724 | 268 ft-# |
| Actual 1-Way Shear | = | 22.43 | 5.17 psi |
| Allow 1-Way Shear | = | 75.00 | 40.00 psi |

Toe Reinforcing = # 4 @ 10.10 in
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd

Other Acceptable Sizes & Spacings

Toe: #4@ 10.10 in, #5@ 15.66 in, #6@ 22.22 in, #7@ 30.30 in, #8@ 39.90 in, #9@ 5
Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Key: No key defined

Min footing T&S reinf Area 0.77 in2
Min footing T&S reinf Area per foot 0.24 in2 /ft

| If one layer of horizontal bars: | If two layers of horizontal bars: |
|---|---|
| #4@ 10.10 in | #4@ 20.20 in |
| #5@ 15.66 in | #5@ 31.31 in |
| #6@ 22.22 in | #6@ 44.44 in |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| Heel Active Pressure | = | 837.2 | 2.31 | 1,930.2 | Soil Over Heel | = | 550.0 | 2.83 | 1,558.3 |
| Surcharge over Heel | = | 67.2 | 3.46 | 232.6 | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | 33.3 | 2.83 | 94.4 |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 2.08 | 750.0 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 2.08 | 1,500.0 |
| Seismic Earth Load | = | 234.4 | 3.46 | 810.7 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 1,138.9 | **O.T.M.** | 2,973.5 | Stem Weight(s) | = | 700.0 | 2.08 | 1,458.3 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 446.9 | 1.63 | 726.2 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 2,090.2 lbs | **R.M.=** | 4,587.3 |

**Resisting/Overturning Ratio = 1.54**
Vertical Loads used for Soil Pressure = 2,880.2 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.104 | in |

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

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# Cantilevered Retaining Wall

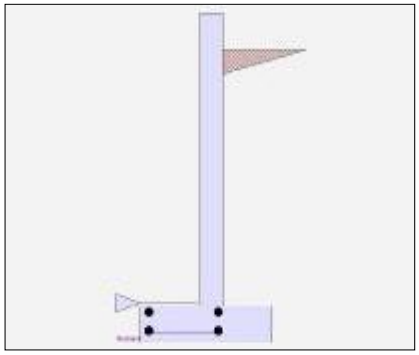
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 7.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.525 |
| Soil height to ignore for passive pressure | = | 12.00 in |



## Surcharge Loads

| | | |
|---|---|---|
| Surcharge Over Heel | = | 40.0 psf |
| Used To Resist Sliding & Overturning | | |
| Surcharge Over Toe | = | 40.0 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 56.000 |
| Total Seismic Force | = | 448.000 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 1.56 | OK |

Slab Resists All Sliding !

| | | | |
|---|---|---|---|
| Total Bearing Load | = | 3,669 lbs | |
| ...resultant ecc. | = | 9.57 in | |
| Soil Pressure @ Toe | = | 2,188 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |

Soil Pressure Less Than Allowable

| | | | |
|---|---|---|---|
| ACI Factored @ Toe | = | 3,064 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 23.9 psi | OK |
| Footing Shear @ Heel | = | 10.4 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | |
|---|---|---|
| Lateral Sliding Force | = | 1,511.4 lbs |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 9.00 |
| Rebar Placed at | = | Edge |
| **Design Data** | | |
| fb/FB + fa/Fa | = | **0.712** |
| **Total Force @ Section** | | |
| Service Level | lbs = | |
| Strength Level | lbs = | 1,906.5 |
| **Moment....Actual** | | |
| Service Level | ft-# = | |
| Strength Level | ft-# = | 5,072.2 |
| Moment.....Allowable | = | 7,122.4 |
| **Shear.....Actual** | | |
| Service Level | psi = | |
| Strength Level | psi = | 25.4 |
| 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 2015,ACI 318-14,ACI 530-13

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.19 in2/ft | |
| (4/3) * As : | 0.2534 in2/ft | Min Stem T&S Reinf Area 1.536 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.25 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.2667 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 1.75 ft |
| Heel Width | = | 2.08 |
| Total Footing Width | = | 3.83 |
| Footing Thickness | = | 12.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 3,064 | 0 psf |
| Mu' : Upward | = | 3,875 | 125 ft-# |
| Mu' : Downward | = | 374 | 1,167 ft-# |
| Mu: Design | = | 3,502 | 1,041 ft-# |
| Actual 1-Way Shear | = | 23.94 | 10.42 psi |
| Allow 1-Way Shear | = | 75.00 | 40.00 psi |

Toe Reinforcing = # 4 @ 9.26 in
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd

Other Acceptable Sizes & Spacings

Toe: #4@ 9.26 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.78 in, #8@ 36.57 in, #9@ 46
Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Key: No key defined

Min footing T&S reinf Area 0.99 in2
Min footing T&S reinf Area per foot 0.26 in2 /ft

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

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| Heel Active Pressure | = | 1,120.0 | 2.67 | 2,986.7 | Soil Over Heel | = | 1,088.3 | 3.12 | 3,399.0 |
| Surcharge over Heel | = | 77.8 | 4.00 | 311.1 | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | 56.5 | 3.12 | 176.6 |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 2.08 | 750.0 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 2.08 | 1,500.0 |
| Seismic Earth Load | = | 313.6 | 4.00 | 1,254.4 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 1,511.4 | **O.T.M.** | 4,552.2 | Stem Weight(s) | = | 800.0 | 2.08 | 1,666.7 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 574.5 | 1.92 | 1,100.2 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 2,879.3 lbs | **R.M.=** | 7,092.4 |

**Resisting/Overturning Ratio = 1.56**
Vertical Loads used for Soil Pressure = 3,669.3 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.127 | in |

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

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# Cantilevered Retaining Wall

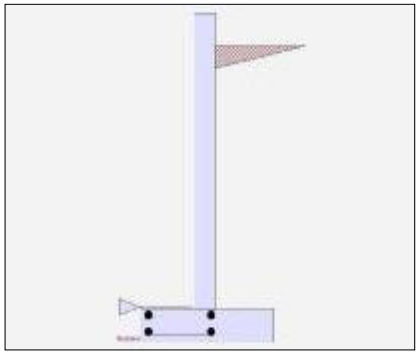
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 8.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.525 |
| Soil height to ignore for passive pressure | = | 12.00 in |



## Surcharge Loads

| | | |
|---|---|---|
| Surcharge Over Heel | = | 40.0 psf |
| Used To Resist Sliding & Overturning | | |
| Surcharge Over Toe | = | 40.0 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 63.000 |
| Total Seismic Force | = | 567.000 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 1.55 | OK |

Slab Resists All Sliding !

| | | | |
|---|---|---|---|
| Total Bearing Load | = | 4,460 lbs | |
| ...resultant ecc. | = | 12.26 in | |
| Soil Pressure @ Toe | = | 2,601 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |

Soil Pressure Less Than Allowable

| | | | |
|---|---|---|---|
| ACI Factored @ Toe | = | 3,641 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 29.0 psi | OK |
| Footing Shear @ Heel | = | 16.2 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | |
|---|---|---|
| Lateral Sliding Force | = | 1,901.9 lbs |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 8.00 |
| Rebar Placed at | = | Edge |
| **Design Data** | | |
| fb/FB + fa/Fa | = | **0.936** |
| **Total Force @ Section** | | |
| Service Level | lbs = | |
| Strength Level | lbs = | 2,458.9 |
| **Moment....Actual** | | |
| Service Level | ft-# = | |
| Strength Level | ft-# = | 7,446.3 |
| Moment.....Allowable | = | 7,959.6 |
| **Shear.....Actual** | | |
| Service Level | psi = | |
| Strength Level | psi = | 32.8 |
| 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 2015,ACI 318-14,ACI 530-13

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.279 in2/ft | |
| (4/3) * As : | 0.372 in2/ft | Min Stem T&S Reinf Area 1.728 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.279 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.3 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 1.75 ft |
| Heel Width | = | 2.58 |
| Total Footing Width | = | 4.33 |
| Footing Thickness | = | 12.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 3,641 | 0 psf |
| Mu' : Upward | = | 4,627 | 184 ft-# |
| Mu' : Downward | = | 374 | 2,380 ft-# |
| Mu: Design | = | 4,254 | 2,196 ft-# |
| Actual 1-Way Shear | = | 29.05 | 16.19 psi |
| Allow 1-Way Shear | = | 75.00 | 40.00 psi |

Toe Reinforcing = # 4 @ 9.26 in
Heel Reinforcing = None Spec'd
Key Reinforcing = None Spec'd

Other Acceptable Sizes & Spacings

Toe: #4@ 9.26 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.78 in, #8@ 36.57 in, #9@ 46
Heel: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Key: No key defined

Min footing T&S reinf Area 1.12 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 |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| Heel Active Pressure | = | 1,417.5 | 3.00 | 4,252.5 | Soil Over Heel | = | 1,683.7 | 3.37 | 5,679.8 |
| Surcharge over Heel | = | 87.5 | 4.50 | 393.8 | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | 76.5 | 3.37 | 258.2 |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 2.08 | 750.0 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 2.08 | 1,500.0 |
| Seismic Earth Load | = | 396.9 | 4.50 | 1,786.1 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 1,901.9 | **O.T.M.** | 6,432.3 | Stem Weight(s) | = | 900.0 | 2.08 | 1,875.0 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 649.5 | 2.17 | 1,406.2 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 3,669.8 lbs | **R.M.=** | 9,969.1 |

**Resisting/Overturning Ratio = 1.55**
Vertical Loads used for Soil Pressure = 4,459.8 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.150 | in |

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

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# Cantilevered Retaining Wall

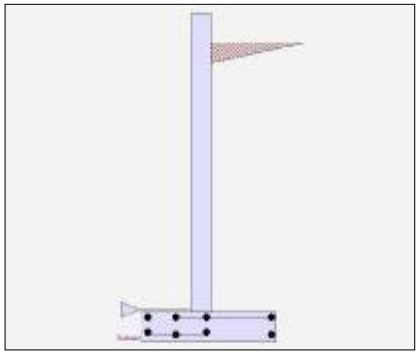
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 9.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.525 |
| Soil height to ignore for passive pressure | = | 12.00 in |



## Surcharge Loads

| | | |
|---|---|---|
| Surcharge Over Heel | = | 40.0 psf |
| Used To Resist Sliding & Overturning | | |
| Surcharge Over Toe | = | 40.0 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 1.54 OK |

Slab Resists All Sliding !

| | | |
|---|---|---|
| Total Bearing Load | = | 5,281 lbs |
| ...resultant ecc. | = | 14.55 in |
| Soil Pressure @ Toe | = | 2,927 psf OK |
| Soil Pressure @ Heel | = | 0 psf OK |
| Allowable | = | 3,000 psf |

Soil Pressure Less Than Allowable

| | | |
|---|---|---|
| ACI Factored @ Toe | = | 4,098 psf |
| ACI Factored @ Heel | = | 0 psf |
| Footing Shear @ Toe | = | 35.4 psi OK |
| Footing Shear @ Heel | = | 23.2 psi OK |
| Allowable | = | 75.0 psi |

**Sliding Calcs**

| | | |
|---|---|---|
| Lateral Sliding Force | = | 2,337.2 lbs |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 8.00 |
| Rebar Placed at | = | Edge |
| **Design Data** | | |
| fb/FB + fa/Fa | = | **0.887** |
| **Total Force @ Section** | | |
| Service Level | lbs = | |
| Strength Level | lbs = | 3,081.3 |
| **Moment....Actual** | | |
| Service Level | ft-# = | |
| Strength Level | ft-# = | 10,463.7 |
| Moment.....Allowable | = | 11,799.2 |
| **Shear.....Actual** | | |
| Service Level | psi = | |
| Strength Level | psi = | 41.5 |
| 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 |

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.3962 in2/ft | |
| (4/3) * As : | 0.5283 in2/ft | Min Stem T&S Reinf Area 1.920 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.3962 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.465 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 1.83 ft |
| Heel Width | = | 3.00 |
| Total Footing Width | = | 4.83 |
| Footing Thickness | = | 12.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 4,098 | 0 psf |
| Mu' : Upward | = | 5,702 | 260 ft-# |
| Mu' : Downward | = | 409 | 3,898 ft-# |
| Mu: Design | = | 5,294 | 3,638 ft-# |
| Actual 1-Way Shear | = | 35.38 | 23.16 psi |
| Allow 1-Way Shear | = | 75.00 | 75.00 psi |

Toe Reinforcing = # 5 @ 14.00 in
Heel Reinforcing = # 4 @ 9.26 in
Key Reinforcing = None Spec'd

Other Acceptable Sizes & Spacings

Toe: #4@ 9.26 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.78 in, #8@ 36.57 in, #9@ 46
Heel: #4@ 9.26 in, #5@ 14.35 in, #6@ 20.37 in, #7@ 27.78 in, #8@ 36.57 in, #9@ 46
Key: No key defined

Min footing T&S reinf Area 1.25 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 |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| Heel Active Pressure | = | 1,750.0 | 3.33 | 5,833.3 | Soil Over Heel | = | 2,310.0 | 3.66 | 8,462.3 |
| Surcharge over Heel | = | 97.2 | 5.00 | 486.1 | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | 93.3 | 3.66 | 341.9 |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 2.16 | 778.8 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 2.16 | 1,557.6 |
| Seismic Earth Load | = | 490.0 | 5.00 | 2,450.0 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 2,337.2 | **O.T.M.** | 8,769.4 | Stem Weight(s) | = | 1,000.0 | 2.16 | 2,163.3 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 724.5 | 2.42 | 1,749.7 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 4,487.8 lbs | **R.M.=** | 13,496.0 |

**Resisting/Overturning Ratio = 1.54**
Vertical Loads used for Soil Pressure = 5,281.0 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.168 | in |

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

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# Cantilevered Retaining Wall

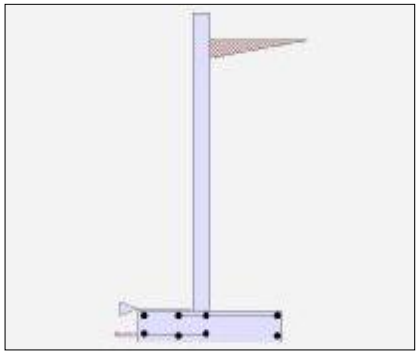
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 10.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.525 |
| Soil height to ignore for passive pressure | = | 12.00 in |



## Surcharge Loads

| | | |
|---|---|---|
| Surcharge Over Heel | = | 40.0 psf |
| Used To Resist Sliding & Overturning | | |
| Surcharge Over Toe | = | 40.0 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 78.167 |
| Total Seismic Force | = | 872.861 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 1.66 | OK |

Slab Resists All Sliding !

| | | | |
|---|---|---|---|
| Total Bearing Load | = | 6,489 lbs | |
| ...resultant ecc. | = | 15.60 in | |
| Soil Pressure @ Toe | = | 2,818 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |

Soil Pressure Less Than Allowable

| | | | |
|---|---|---|---|
| ACI Factored @ Toe | = | 3,945 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 32.0 psi | OK |
| Footing Shear @ Heel | = | 23.0 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | |
|---|---|---|
| Lateral Sliding Force | = | 2,901.7 lbs |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 6.00 |
| Rebar Placed at | = | Edge |
| **Design Data** | | |
| fb/FB + fa/Fa | = | **0.937** |
| **Total Force @ Section** | | |
| Service Level | lbs = | |
| Strength Level | lbs = | 3,785.3 |
| **Moment....Actual** | | |
| Service Level | ft-# = | |
| Strength Level | ft-# = | 14,259.8 |
| Moment.....Allowable | = | 15,222.0 |
| **Shear.....Actual** | | |
| Service Level | psi = | |
| Strength Level | psi = | 51.0 |
| 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 |

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.54 in2/ft | |
| (4/3) * As : | 0.7199 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.54 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.62 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 2.17 ft |
| Heel Width | = | 3.50 |
| Total Footing Width | = | 5.67 |
| Footing Thickness | = | 14.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 3,945 | 0 psf |
| Mu' : Upward | = | 7,829 | 791 ft-# |
| Mu' : Downward | = | 645 | 6,398 ft-# |
| Mu: Design | = | 7,184 | 5,608 ft-# |
| Actual 1-Way Shear | = | 32.03 | 23.01 psi |
| Allow 1-Way Shear | = | 75.00 | 75.00 psi |

Toe Reinforcing = # 5 @ 12.30 in
Heel Reinforcing = # 4 @ 7.94 in
Key Reinforcing = None Spec'd

### Other Acceptable Sizes & Spacings

Toe: #4@ 7.94 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.81 in, #8@ 31.35 in, #9@ 39
Heel: #4@ 7.94 in, #5@ 12.30 in, #6@ 17.46 in, #7@ 23.81 in, #8@ 31.35 in, #9@ 39
Key: No key defined

Min footing T&S reinf Area 1.71 in2
Min footing T&S reinf Area per foot 0.30 in2 /ft

| If one layer of horizontal bars: | If two layers of horizontal bars: |
|---|---|
| #4@ 7.94 in | #4@ 15.87 in |
| #5@ 12.30 in | #5@ 24.60 in |
| #6@ 17.46 in | #6@ 34.92 in |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|
| Heel Active Pressure | = | 2,182.2 | 3.72 | 8,122.5 | Soil Over Heel | = 3,116.7 | 4.25 | 13,256.2 |
| Surcharge over Heel | = | 108.6 | 5.58 | 606.2 | Sloped Soil Over Heel | = | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = 113.3 | 4.25 | 482.0 |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = 360.0 | 2.50 | 901.2 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = 720.0 | 2.50 | 1,802.4 |
| Seismic Earth Load | = | 611.0 | 5.58 | 3,411.4 | Soil Over Toe | = | | |
| | = | | | | Surcharge Over Toe | = | | |
| **Total** | | 2,901.7 | **O.T.M.** | 12,140.0 | Stem Weight(s) | = 1,100.0 | 2.50 | 2,753.7 |
| | = | | = | | Earth @ Stem Transitions | = | | |
| | | | | | Footing Weight | = 992.3 | 2.84 | 2,813.0 |
| | | | | | Key Weight | = | | |
| | | | | | Vert. Component | = | | |
| | | | | | **Total =** | 5,682.3 lbs | **R.M.=** | 20,206.2 |

**Resisting/Overturning Ratio = 1.66**
Vertical Loads used for Soil Pressure = 6,489.1 lbs

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

If seismic is included, the OTM and sliding ratios be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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.

This Wall in File: Q:\0-PROJECTS\2015\PB Architectural\Wen Hu Residence\Retaining Wall Calcs\cantile



## Tilt

### Horizontal Deflection at Top of Wall due to settlement of soil

(Deflection due to wall bending not considered)

| | | |
|---|---|---|
| Soil Spring Reaction Modulus | 250.0 | pci |
| Horizontal Defl @ Top of Wall (approximate only) | 0.152 | in |

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

This Wall in File: Q:\0-PROJECTS\2015\PB Architectural\Wen Hu Residence\Retaining Wall Calcs\cantile

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# Cantilevered Retaining Wall

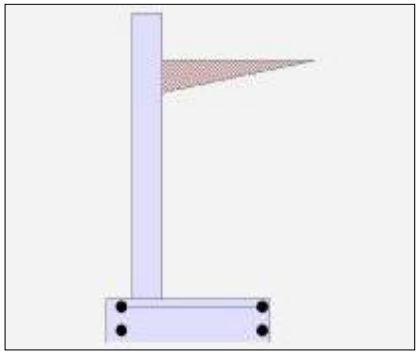
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 5.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.450 |
| Soil height to ignore for passive pressure | = | 12.00 in |



## Surcharge Loads

| | | |
|---|---|---|
| Surcharge Over Heel | = | 40.0 psf |
| Used To Resist Sliding & Overturning | | |
| Surcharge Over Toe | = | 0.0 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 41.417 |
| Total Seismic Force | = | 245.049 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 2.81 | OK |
| Sliding | = | 1.52 | OK |
| Total Bearing Load | = | 3,608 lbs | |
| ...resultant ecc. | = | 8.43 in | |
| Soil Pressure @ Toe | = | 2,130 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |
| Soil Pressure Less Than Allowable | | | |
| ACI Factored @ Toe | = | 2,982 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 0.1 psi | OK |
| Footing Shear @ Heel | = | 21.0 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | | |
|---|---|---|---|
| Lateral Sliding Force | = | 841.7 lbs | |
| less 100% Passive Force | = - | 20.0 lbs | |
| less 100% Friction Force | = - | 1,299.4 lbs | |
| Added Force Req'd | = | 0.0 lbs | OK |
| ....for 1.5 Stability | = | 0.0 lbs | OK |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 16.00 |
| Rebar Placed at | = | Edge |
| **Design Data** | | |
| fb/FB + fa/Fa | = | **0.473** |
| **Total Force @ Section** | | |
| Service Level | lbs = | |
| Strength Level | lbs = | 1,008.9 |
| **Moment....Actual** | | |
| Service Level | ft-# = | |
| Strength Level | ft-# = | 1,938.9 |
| Moment.....Allowable | = | 4,099.3 |
| **Shear.....Actual** | | |
| Service Level | psi = | |
| Strength Level | psi = | 13.5 |
| 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 |

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.0726 in2/ft | |
| (4/3) * As : | 0.0969 in2/ft | Min Stem T&S Reinf Area 1.152 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.1344 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.15 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 0.58 ft |
| Heel Width | = | 3.08 |
| Total Footing Width | = | 3.66 |
| Footing Thickness | = | 11.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 2,982 | 0 psf |
| Mu' : Upward | = | 478 | 0 ft-# |
| Mu' : Downward | = | 28 | 2,589 ft-# |
| Mu: Design | = | 450 | 2,589 ft-# |
| Actual 1-Way Shear | = | 0.06 | 21.03 psi |
| Allow 1-Way Shear | = | 40.00 | 75.00 psi |

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 4 @ 10.10 in
Key Reinforcing = None Spec'd

### Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: #4@ 10.10 in, #5@ 15.66 in, #6@ 22.22 in, #7@ 30.30 in, #8@ 39.90 in, #9@ 5
Key: No key defined

Min footing T&S reinf Area 0.87 in2
Min footing T&S reinf Area per foot 0.24 in2 /ft

| If one layer of horizontal bars: | If two layers of horizontal bars: |
|---|---|
| #4@ 10.10 in | #4@ 20.20 in |
| #5@ 15.66 in | #5@ 31.31 in |
| #6@ 22.22 in | #6@ 44.44 in |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| **Item** | | | | | | | | | |
| Heel Active Pressure | = | 612.6 | 1.97 | 1,208.2 | Soil Over Heel | = | 1,327.3 | 2.46 | 3,260.4 |
| Surcharge over Heel | = | 57.5 | 2.96 | 170.2 | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | 96.5 | 2.46 | 237.1 |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 0.92 | 329.9 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 0.92 | 659.8 |
| Seismic Earth Load | = | 171.5 | 2.96 | 507.5 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 841.7 | **O.T.M.** | 1,885.9 | Stem Weight(s) | = | 600.0 | 0.92 | 549.8 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 503.7 | 1.83 | 922.5 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 2,887.5 lbs | **R.M.=** | 5,299.6 |

**Resisting/Overturning Ratio = 2.81**
Vertical Loads used for Soil Pressure = 3,607.5 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.097 | in |

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

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# Cantilevered Retaining Wall

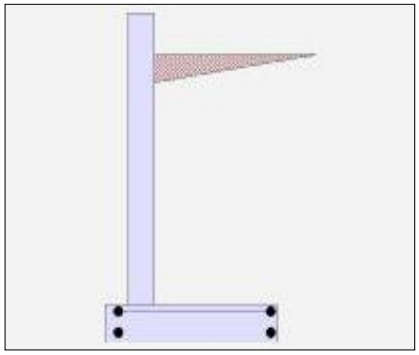
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 6.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.450 |
| Soil height to ignore for passive pressure | = | 12.00 in |



## Surcharge Loads

| | | |
|---|---|---|
| Surcharge Over Heel | = | 40.0 psf |
| Used To Resist Sliding & Overturning | | |
| Surcharge Over Toe | = | 0.0 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 48.417 |
| Total Seismic Force | = | 334.882 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 2.89 | OK |
| Sliding | = | 1.52 | OK |
| Total Bearing Load | = | 4,601 lbs | |
| ...resultant ecc. | = | 10.14 in | |
| Soil Pressure @ Toe | = | 2,252 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |
| Soil Pressure Less Than Allowable | | | |
| ACI Factored @ Toe | = | 3,153 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 0.1 psi | OK |
| Footing Shear @ Heel | = | 31.7 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | | |
|---|---|---|---|
| Lateral Sliding Force | = | 1,138.9 lbs | |
| less 100% Passive Force | = - | 20.0 lbs | |
| less 100% Friction Force | = - | 1,746.5 lbs | |
| Added Force Req'd | = | 0.0 lbs | OK |
| ....for 1.5 Stability | = | 0.0 lbs | OK |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 14.00 |
| Rebar Placed at | = | Edge |
| **Design Data** | | |
| fb/FB + fa/Fa | = | **0.697** |
| **Total Force @ Section** | | |
| Service Level | lbs = | |
| Strength Level | lbs = | 1,420.7 |
| **Moment....Actual** | | |
| Service Level | ft-# = | |
| Strength Level | ft-# = | 3,254.0 |
| Moment.....Allowable | = | 4,665.4 |
| **Shear.....Actual** | | |
| Service Level | psi = | |
| Strength Level | psi = | 18.9 |
| 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 |

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.1219 in2/ft | |
| (4/3) * As : | 0.1626 in2/ft | Min Stem T&S Reinf Area 1.344 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.1626 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.1714 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 0.58 ft |
| Heel Width | = | 3.83 |
| Total Footing Width | = | 4.41 |
| Footing Thickness | = | 11.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 3,153 | 0 psf |
| Mu' : Upward | = | 510 | 0 ft-# |
| Mu' : Downward | = | 28 | 5,108 ft-# |
| Mu: Design | = | 482 | 5,108 ft-# |
| Actual 1-Way Shear | = | 0.06 | 31.66 psi |
| Allow 1-Way Shear | = | 40.00 | 75.00 psi |

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 4 @ 10.10 in
Key Reinforcing = None Spec'd

### Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: #4@ 10.10 in, #5@ 15.66 in, #6@ 22.22 in, #7@ 30.30 in, #8@ 39.90 in, #9@ 5
Key: No key defined

Min footing T&S reinf Area 1.05 in2
Min footing T&S reinf Area per foot 0.24 in2 /ft

| If one layer of horizontal bars: | If two layers of horizontal bars: |
|---|---|
| #4@ 10.10 in | #4@ 20.20 in |
| #5@ 15.66 in | #5@ 31.31 in |
| #6@ 22.22 in | #6@ 44.44 in |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| Heel Active Pressure | = | 837.2 | 2.31 | 1,930.2 | Soil Over Heel | = | 2,087.8 | 2.83 | 5,911.3 |
| Surcharge over Heel | = | 67.2 | 3.46 | 232.6 | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | 126.5 | 2.83 | 358.3 |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 0.92 | 329.9 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 0.92 | 659.8 |
| Seismic Earth Load | = | 234.4 | 3.46 | 810.7 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 1,138.9 | **O.T.M.** | 2,973.5 | Stem Weight(s) | = | 700.0 | 0.92 | 641.4 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 606.8 | 2.21 | 1,338.9 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 3,881.1 lbs | **R.M.=** | 8,579.7 |

**Resisting/Overturning Ratio = 2.89**
Vertical Loads used for Soil Pressure = 4,601.1 lbs

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

If seismic is included, the OTM and sliding ratios be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.099 | in |

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

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# Cantilevered Retaining Wall

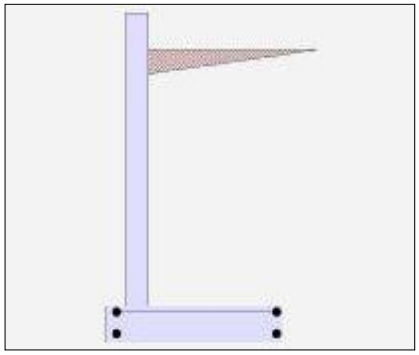
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 7.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.450 |
| Soil height to ignore for passive pressure | = | 12.00 in |



## Surcharge Loads

| | | |
|---|---|---|
| Surcharge Over Heel | = | 40.0 psf |
| Used To Resist Sliding & Overturning | | |
| Surcharge Over Toe | = | 0.0 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 56.000 |
| Total Seismic Force | = | 448.000 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 2.91 | OK |
| Sliding | = | 1.52 | OK |
| Total Bearing Load | = | 5,824 lbs | |
| ...resultant ecc. | = | 11.75 in | |
| Soil Pressure @ Toe | = | 2,423 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |
| Soil Pressure Less Than Allowable | | | |
| ACI Factored @ Toe | = | 3,392 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 0.2 psi | OK |
| Footing Shear @ Heel | = | 40.1 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | | |
|---|---|---|---|
| Lateral Sliding Force | = | 1,511.4 lbs | |
| less 100% Passive Force | = - | 0.0 lbs | |
| less 100% Friction Force | = - | 2,296.9 lbs | |
| Added Force Req'd | = | 0.0 lbs | OK |
| ....for 1.5 Stability | = | 0.0 lbs | OK |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 = | 9.00 |
| Rebar Placed at = | Edge |
| **Design Data** | |
| fb/FB + fa/Fa = | **0.712** |
| **Total Force @ Section** | |
| Service Level lbs = | |
| Strength Level lbs = | 1,906.5 |
| **Moment....Actual** | |
| Service Level ft-# = | |
| Strength Level ft-# = | 5,072.2 |
| Moment.....Allowable = | 7,122.4 |
| **Shear.....Actual** | |
| Service Level psi = | |
| Strength Level psi = | 25.4 |
| 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 |

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing | |
|---|---|---|---|
| As (based on applied moment) : | 0.19 in2/ft | | |
| (4/3) * As : | 0.2534 in2/ft | Min Stem T&S Reinf Area 1.536 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 | |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : | |
| | ========== | One layer of : | Two layers of : |
| Required Area : | 0.25 in2/ft | #4@ 12.50 in | #4@ 25.00 in |
| Provided Area : | 0.2667 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 0.58 ft |
| Heel Width | = | 4.58 |
| Total Footing Width | = | 5.16 |
| Footing Thickness | = | 12.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 3,392 | 0 psf |
| Mu' : Upward | = | 553 | 0 ft-# |
| Mu' : Downward | = | 31 | 8,943 ft-# |
| Mu: Design | = | 523 | 8,943 ft-# |
| Actual 1-Way Shear | = | 0.19 | 40.09 psi |
| Allow 1-Way Shear | = | 40.00 | 75.00 psi |

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 4 @ 8.00 in
Key Reinforcing = None Spec'd

### Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: #4@ 8.32 in, #5@ 12.89 in, #6@ 18.29 in, #7@ 24.95 in, #8@ 32.85 in, #9@ 41
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 |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| **Item** | | | | | | | | | |
| Heel Active Pressure | = | 1,120.0 | 2.67 | 2,986.7 | Soil Over Heel | = | 3,013.3 | 3.21 | 9,661.5 |
| Surcharge over Heel | = | 77.8 | 4.00 | 311.1 | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | 156.5 | 3.21 | 501.9 |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 0.92 | 329.9 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 0.92 | 659.8 |
| Seismic Earth Load | = | 313.6 | 4.00 | 1,254.4 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 1,511.4 | **O.T.M.** | 4,552.2 | Stem Weight(s) | = | 800.0 | 0.92 | 733.1 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 774.5 | 2.58 | 1,999.2 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 5,104.3 lbs | **R.M.=** | 13,225.6 |

**Resisting/Overturning Ratio = 2.91**
Vertical Loads used for Soil Pressure = 5,824.3 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.104 | in |

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

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# Cantilevered Retaining Wall

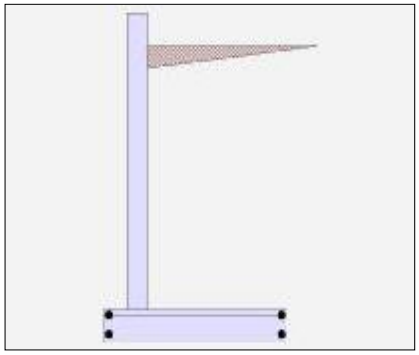
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 8.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.450 |
| Soil height to ignore for passive pressure | = | 12.00 in |



## Surcharge Loads

| | | |
|---|---|---|
| Surcharge Over Heel | = | 40.0 psf |
| Used To Resist Sliding & Overturning | | |
| Surcharge Over Toe | = | 0.0 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 63.000 |
| Total Seismic Force | = | 567.000 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 3.07 | OK |
| Sliding | = | 1.52 | OK |
| Total Bearing Load | = | 6,831 lbs | |
| ...resultant ecc. | = | 12.20 in | |
| Soil Pressure @ Toe | = | 2,344 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |
| Soil Pressure Less Than Allowable | | | |
| ACI Factored @ Toe | = | 3,281 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 1.1 psi | OK |
| Footing Shear @ Heel | = | 48.8 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | | |
|---|---|---|---|
| Lateral Sliding Force | = | 1,814.4 lbs | |
| less 100% Passive Force | = - | 0.0 lbs | |
| less 100% Friction Force | = - | 2,749.9 lbs | |
| Added Force Req'd | = | 0.0 lbs | OK |
| ....for 1.5 Stability | = | 0.0 lbs | OK |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | | 9.00 |
| Rebar Placed at | = | | Edge |
| **Design Data** | | | |
| fb/FB + fa/Fa | = | | **0.954** |
| **Total Force @ Section** | | | |
| Service Level | lbs = | | |
| Strength Level | lbs = | | 2,296.0 |
| **Moment....Actual** | | | |
| Service Level | ft-# = | | |
| Strength Level | ft-# = | | 6,794.7 |
| Moment.....Allowable | = | | 7,122.4 |
| **Shear.....Actual** | | | |
| Service Level | psi = | | |
| Strength Level | psi = | | 30.6 |
| 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 |

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing |
|---|---|---|
| As (based on applied moment) : | 0.2546 in2/ft | |
| (4/3) * As : | 0.3394 in2/ft | Min Stem T&S Reinf Area 1.728 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 |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : |
| | ========== | One layer of : Two layers of : |
| Required Area : | 0.2546 in2/ft | #4@ 12.50 in #4@ 25.00 in |
| Provided Area : | 0.2667 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 0.75 ft |
| Heel Width | = | 5.17 |
| Total Footing Width | = | 5.92 |
| Footing Thickness | = | 12.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 3,281 | 0 psf |
| Mu' : Upward | = | 883 | 0 ft-# |
| Mu' : Downward | = | 51 | 12,533 ft-# |
| Mu: Design | = | 833 | 12,533 ft-# |
| Actual 1-Way Shear | = | 1.07 | 48.83 psi |
| Allow 1-Way Shear | = | 40.00 | 75.00 psi |

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 4 @ 6.32 in
Key Reinforcing = None Spec'd

### Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: #4@ 6.32 in, #5@ 9.79 in, #6@ 13.89 in, #7@ 18.95 in, #8@ 24.95 in, #9@ 31.
Key: No key defined

Min footing T&S reinf Area 1.53 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 |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| **Item** | | | | | | | | | |
| Heel Active Pressure | = | 1,417.5 | 3.00 | 4,252.5 | Soil Over Heel | = | 3,962.9 | 3.67 | 14,537.4 |
| Surcharge over Heel | = | | | | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | | | |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 1.08 | 390.0 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 1.08 | 780.0 |
| Seismic Earth Load | = | 396.9 | 4.50 | 1,786.1 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 1,814.4 | **O.T.M.** | 6,038.6 | Stem Weight(s) | = | 900.0 | 1.08 | 975.0 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 888.0 | 2.96 | 2,628.5 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 6,110.9 lbs | **R.M.=** | 18,530.8 |

**Resisting/Overturning Ratio = 3.07**
Vertical Loads used for Soil Pressure = 6,830.9 lbs

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

If seismic is included, the OTM and sliding ratios be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.099 | in |

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

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# Cantilevered Retaining Wall

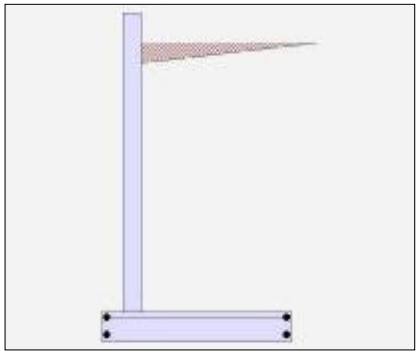
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 9.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.450 |
| Soil height to ignore for passive pressure | = | 12.00 in |



## Surcharge Loads

| | | |
|---|---|---|
| Surcharge Over Heel | = | 40.0 psf |
| Used To Resist Sliding & Overturning | | |
| Surcharge Over Toe | = | 0.0 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 3.12 | OK |
| Sliding | = | 1.51 | OK |
| Total Bearing Load | = | 8,586 lbs | |
| ...resultant ecc. | = | 13.48 in | |
| Soil Pressure @ Toe | = | 2,542 psf | OK |
| Soil Pressure @ Heel | = | 2 psf | OK |
| Allowable | = | 3,000 psf | |
| Soil Pressure Less Than Allowable | | | |
| ACI Factored @ Toe | = | 3,559 psf | |
| ACI Factored @ Heel | = | 3 psf | |
| Footing Shear @ Toe | = | 1.2 psi | OK |
| Footing Shear @ Heel | = | 67.0 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | | |
|---|---|---|---|
| Lateral Sliding Force | = | 2,337.2 lbs | |
| less 100% Passive Force | = - | 0.0 lbs | |
| less 100% Friction Force | = - | 3,539.6 lbs | |
| Added Force Req'd | = | 0.0 lbs | OK |
| ....for 1.5 Stability | = | 0.0 lbs | OK |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 8.00 |
| Rebar Placed at | = | Edge |
| **Design Data** | | |
| fb/FB + fa/Fa | = | **0.887** |
| **Total Force @ Section** | | |
| Service Level | lbs = | |
| Strength Level | lbs = | 3,081.3 |
| **Moment....Actual** | | |
| Service Level | ft-# = | |
| Strength Level | ft-# = | 10,463.7 |
| Moment.....Allowable | = | 11,799.2 |
| **Shear.....Actual** | | |
| Service Level | psi = | |
| Strength Level | psi = | 41.5 |
| 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 |

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing | |
|---|---|---|---|
| As (based on applied moment) : | 0.3962 in2/ft | | |
| (4/3) * As : | 0.5283 in2/ft | Min Stem T&S Reinf Area 1.920 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 | |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : | |
| | ========== | One layer of : | Two layers of : |
| Required Area : | 0.3962 in2/ft | #4@ 12.50 in | #4@ 25.00 in |
| Provided Area : | 0.465 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 0.75 ft |
| Heel Width | = | 6.00 |
| Total Footing Width | = | 6.75 |
| Footing Thickness | = | 12.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel |
|---|---|---|---|
| Factored Pressure | = | 3,559 | 3 psf |
| Mu' : Upward | = | 964 | 0 ft-# |
| Mu' : Downward | = | 51 | 20,366 ft-# |
| Mu: Design | = | 913 | 20,366 ft-# |
| Actual 1-Way Shear | = | 1.17 | 66.99 psi |
| Allow 1-Way Shear | = | 40.00 | 75.00 psi |

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 5 @ 7.50 in
Key Reinforcing = None Spec'd

### Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: #4@ 4.87 in, #5@ 7.55 in, #6@ 10.71 in, #7@ 14.61 in, #8@ 19.23 in, #9@ 24.
Key: No key defined

Min footing T&S reinf Area 1.75 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 |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| Heel Active Pressure | = | 1,750.0 | 3.33 | 5,833.3 | Soil Over Heel | = | 5,280.0 | 4.08 | 21,560.0 |
| Surcharge over Heel | = | 97.2 | 5.00 | 486.1 | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | 213.3 | 4.08 | 871.1 |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 1.08 | 390.0 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 1.08 | 780.0 |
| Seismic Earth Load | = | 490.0 | 5.00 | 2,450.0 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 2,337.2 | **O.T.M.** | 8,769.4 | Stem Weight(s) | = | 1,000.0 | 1.08 | 1,083.3 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 1,012.5 | 3.38 | 3,417.2 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 7,865.8 lbs | **R.M.=** | 27,321.6 |

**Resisting/Overturning Ratio = 3.12**
Vertical Loads used for Soil Pressure = 8,585.8 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.105 | in |

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

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# Cantilevered Retaining Wall

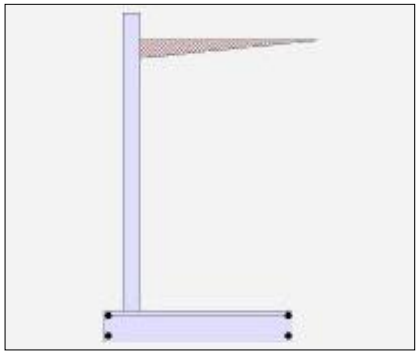
Code: IBC 2015,ACI 318-14,ACI 530-13

## Criteria

| | | |
|---|---|---|
| Retained Height | = | 10.00 ft |
| Wall height above soil | = | 1.00 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 | = | 3,000.0 psf |
| Equivalent Fluid Pressure Method | | |
| Active Heel Pressure | = | 35.0 psf/ft |
| | = | |
| Passive Pressure | = | 250.0 psf/ft |
| Soil Density, Heel | = | 110.00 pcf |
| Soil Density, Toe | = | 0.00 pcf |
| Footing\|\|Soil Friction | = | 0.450 |
| Soil height to ignore for passive pressure | = | 12.00 in |



## Surcharge Loads

| | | |
|---|---|---|
| Surcharge Over Heel | = | 40.0 psf |
| Used To Resist Sliding & Overturning | | |
| Surcharge Over Toe | = | 0.0 |
| NOT 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 | = | 360.0 lbs |
| Axial Live Load | = | 720.0 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 | = | 78.167 |
| Total Seismic Force | = | 872.861 |

## Design Summary

**Wall Stability Ratios**

| | | | |
|---|---|---|---|
| Overturning | = | 3.02 | OK |
| Sliding | = | 1.50 | OK |
| Total Bearing Load | = | 10,322 lbs | |
| ...resultant ecc. | = | 15.13 in | |
| Soil Pressure @ Toe | = | 2,810 psf | OK |
| Soil Pressure @ Heel | = | 0 psf | OK |
| Allowable | = | 3,000 psf | |
| Soil Pressure Less Than Allowable | | | |
| ACI Factored @ Toe | = | 3,934 psf | |
| ACI Factored @ Heel | = | 0 psf | |
| Footing Shear @ Toe | = | 0.2 psi | OK |
| Footing Shear @ Heel | = | 69.3 psi | OK |
| Allowable | = | 75.0 psi | |

**Sliding Calcs**

| | | | |
|---|---|---|---|
| Lateral Sliding Force | = | 2,901.7 lbs | |
| less 100% Passive Force | = - | 45.1 lbs | |
| less 100% Friction Force | = - | 4,321.0 lbs | |
| Added Force Req'd | = | 0.0 lbs | OK |
| ....for 1.5 Stability | = | 0.0 lbs | OK |

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

**Load Factors**

| | |
|---|---|
| Building Code | IBC 2015,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 | = | 6.00 |
| Rebar Placed at | = | Edge |
| **Design Data** | | |
| fb/FB + fa/Fa | = | **0.937** |
| **Total Force @ Section** | | |
| Service Level | lbs = | |
| Strength Level | lbs = | 3,785.3 |
| **Moment....Actual** | | |
| Service Level | ft-# = | |
| Strength Level | ft-# = | 14,259.8 |
| Moment.....Allowable | = | 15,222.0 |
| **Shear.....Actual** | | |
| Service Level | psi = | |
| Strength Level | psi = | 51.0 |
| 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 |

## Concrete Stem Rebar Area Details

| Bottom Stem | Vertical Reinforcing | Horizontal Reinforcing | |
|---|---|---|---|
| As (based on applied moment) : | 0.54 in2/ft | | |
| (4/3) * As : | 0.7199 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 | |
| 0.0014bh : 0.0014(12)(8) : | 0.1344 in2/ft | Horizontal Reinforcing Options : | |
| | ========== | One layer of : | Two layers of : |
| Required Area : | 0.54 in2/ft | #4@ 12.50 in | #4@ 25.00 in |
| Provided Area : | 0.62 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 Dimensions & Strengths

| | | |
|---|---|---|
| Toe Width | = | 0.75 ft |
| Heel Width | = | 6.67 |
| Total Footing Width | = | 7.42 |
| Footing Thickness | = | 14.00 in |
| Key Width | = | 0.00 in |
| Key Depth | = | 0.00 in |
| Key Distance from Toe | = | 0.00 ft |

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

## Footing Design Results

| | | Toe | Heel | |
|---|---|---|---|---|
| Factored Pressure | = | 3,934 | 0 | psf |
| Mu' : Upward | = | 1,069 | 0 | ft-# |
| Mu' : Downward | = | 59 | 28,724 | ft-# |
| Mu: Design | = | 1,010 | 28,724 | ft-# |
| Actual 1-Way Shear | = | 0.18 | 69.34 | psi |
| Allow 1-Way Shear | = | 40.00 | 75.00 | psi |

Toe Reinforcing = None Spec'd
Heel Reinforcing = # 5 @ 6.00 in
Key Reinforcing = None Spec'd

### Other Acceptable Sizes & Spacings

Toe: Not req'd: Mu < phi*5*lambda*sqrt(f'c)*Sm
Heel: #4@ 4.20 in, #5@ 6.52 in, #6@ 9.25 in, #7@ 12.61 in, #8@ 16.61 in, #9@ 21.0
Key: No key defined

Min footing T&S reinf Area 2.24 in2
Min footing T&S reinf Area per foot 0.30 in2 /ft

| If one layer of horizontal bars: | If two layers of horizontal bars: |
|---|---|
| #4@ 7.94 in | #4@ 15.87 in |
| #5@ 12.30 in | #5@ 24.60 in |
| #6@ 17.46 in | #6@ 34.92 in |

## Summary of Overturning & Resisting Forces & Moments

| | | .....OVERTURNING..... Force lbs | Distance ft | Moment ft-# | | | .....RESISTING..... Force lbs | Distance ft | Moment ft-# |
|---|---|---|---|---|---|---|---|---|---|
| **Item** | | | | | | | | | |
| Heel Active Pressure | = | 2,182.2 | 3.72 | 8,122.5 | Soil Over Heel | = | 6,603.7 | 4.42 | 29,177.2 |
| Surcharge over Heel | = | 108.6 | 5.58 | 606.2 | Sloped Soil Over Heel | = | | | |
| Surcharge Over Toe | = | | | | Surcharge Over Heel | = | 240.1 | 4.42 | 1,061.0 |
| Adjacent Footing Load | = | | | | Adjacent Footing Load | = | | | |
| Added Lateral Load | = | | | | Axial Dead Load on Stem | = | 360.0 | 1.08 | 390.0 |
| Load @ Stem Above Soil | = | | | | * Axial Live Load on Stem | = | 720.0 | 1.08 | 780.0 |
| Seismic Earth Load | = | 611.0 | 5.58 | 3,411.4 | Soil Over Toe | = | | | |
| | = | | | | Surcharge Over Toe | = | | | |
| **Total** | | 2,901.7 | **O.T.M.** | 12,140.0 | Stem Weight(s) | = | 1,100.0 | 1.08 | 1,191.7 |
| | = | | = | | Earth @ Stem Transitions | = | | | |
| | | | | | Footing Weight | = | 1,298.5 | 3.71 | 4,817.4 |
| | | | | | Key Weight | = | | | |
| | | | | | Vert. Component | = | | | |
| | | | | | **Total =** | | 9,602.3 lbs | **R.M.=** | 36,637.3 |

**Resisting/Overturning Ratio = 3.02**
Vertical Loads used for Soil Pressure = 10,322.3 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 be 1.1 per section 1807.2.3 of IBC 2009 or IBC 201

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) | 0.116 | 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.