ENGINEERING

STRUCTURAL CALCULATIONS

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I. SEISMIC

Lateral Analysis shall be based on 2018 "International Building Code" (IBC), Section 1613, ASC/SEI 7-16 "Minimum Design Loads for Buildings and Other Structures", Ch. 26 - 30), and Special Design Provision for Wind and Seismic (AWC SDPWS-2015)

Design Criteria:

Occupancy Category II - Residential

Importance Factor: $I_E := 1.00$ $I_W := 1.00$

Site Class D

Seismic Use Group I

Seismic Design Category D - Residential

Spectral Accelerations for short periods: $S_S := 1.411$

Spectral Accelerations for a 1-second period: $S_1 := 0.491$

Site Coefficient - table 1613.3.2 (1&2) $F_a := 1.4$ $F_v := 1.5$

$S_{MS} := F_a \cdot S_S$ $S_{MS} = 1.98$ (16-36)

$S_{M1} := F_v \cdot S_1$ $S_{M1} = 0.74$ (16-37)

Spectral Response Parameters $S_{DS} := \frac{2}{3} S_{MS}$ (16-38) $S_{DS} = 1.32$ (16-39)

Design Coefficient (ASCE Table 12.2-1):

$R := 6.5$ $\Omega_o := 3$ $C_d := 2$ $S_{D1} := \frac{2}{3} S_{M1}$ $S_{D1} = 0.49$

Earthquake Load Combination - Allowable Stress Design (ASCE 12.4-3 & 12.4-4a)

$E_h := \rho \cdot Q_E$ $E_v := 0.20 \cdot S_{DS} \cdot D$ $\rho := 1.3$

$LC_5 := (1.0 + 0.14 S_{DS}) \cdot D + H + F + 0.70 \rho \cdot Q_E$

$LC_6 := (1.0 + 0.105 \cdot S_{DS}) D + H + F + 0.525 \cdot \rho \cdot Q_E + 0.75L + 0.75 \cdot S$

$LC_8 := (0.6 - 0.14 \cdot S_{DS}) D + 0.70 \rho \cdot Q_E + H$

Earthquake Load Combination with Over-strength Factor Ω_o - Allowable Stress Design (ASCE 12.4.3.2)

$LC_{5.os} := (1.0 + 0.14 S_{DS}) \cdot D + H + F + 0.70 \Omega_o \cdot Q_E$

$LC_{6.os} := (1.0 + 0.105 \cdot S_{DS}) D + H + F + 0.525 \cdot \Omega_o \cdot Q_E + 0.75L + 0.75 \cdot S$

$LC_{8.os} := (0.6 - 0.14 \cdot S_{DS}) D + 0.70 \Omega_o \cdot Q_E + H$

Seismic Base Shear (ASCE 12.14-12) $V := \frac{F' \cdot S_{DS}}{R} W$

$F' = 1.1$

F' = 1.0 for one story
1.1 for two story
1.2 for three story

A. Determine Seismic Dead Loads (***D***):

$fr := 15psf$	Framing Dead Load
$p_{to} := 0psf$	Concrete Topping (Floors)
$p_{ti} := 0psf$	Roof Tile
$p_w := 7psf$	Wall

*Total Floor Dead Load (**D**):* $D_f := fr + p_{to}$ $D_f = 15 \cdot psf$

*Total Roof Dead Load (**D**):* $D_r := fr + p_{ti}$ $D_r = 15 \cdot psf$

B. Determine Seismic Weight (**W**):

Exterior Wall Dimensions (ft):

Overall Building Dimensions :

$h_1 := 10ft$ Height of First Floor Walls

$h_2 := 9ft$ Height of Second Floor Walls

$w_2 := L8$ Average width of second floor

$l_2 := L7$ Average length of second floor

$w_r := L4$ Average width of roof

$l_r := L3$ Average length of roof

$L1 := 18.5ft$ $L7 := 68.5ft$

$L2 := 46.5ft$ $L8 := 42.5ft$

$L3 := 65ft$ $L9 := 7ft$

$L4 := 42.5ft$ $L10 := 22ft$

$L5 := 22ft$ $L11 := 17ft$

$L6 := 46.5ft$ $L12 := 13ft$

$L13 := 17ft$

$L14 := 13ft$

Total Floor/Roof Areas $\left(ft^2\right)$

$A_R := 1471ft^2$ $A_R = 1471\,ft^2$ Roof

$A_2 := 1971ft^2$ $A_2 = 1971\,ft^2$ Second Floor + Low Roof

$A_B := 1207ft^2$ $A_B = 1207\,ft^2$ First Floor

TOTAL WEIGHTS - ROOF DIAPH. + (1/2) 2nd WALLS :

$W_r := A_R \cdot D_r + \left[.5 \cdot h_2 \cdot \left(l_r + w_r\right) \cdot 2\right] \cdot p_w$ $W_r = 28.84 \cdot k$

TOTAL WEIGHTS - 2nd FLR. DIAPH. + (1/2) 2nd WALLS + (1/2) 1st WALLS :

$W_2 := A_2 \cdot D_f + \left[\left[p_w \cdot \left(h_2 + h_1\right) \cdot .5\right] \cdot l_2\right] + \left[p_w \cdot \left(h_2 + h_1\right) \cdot .5\right] \cdot w_2$ $W_2 = 36.95 \cdot k$

TOTAL WEIGHTS - ROOF + FLOOR + WALLS

$W := W_2 + W_r$ $W = 65.78 \cdot k$

C. Determine Seismic Base Shear (ASCE 12.14-12): $V_{max} := \frac{F' \cdot S_{DS}}{R} W$ $V_{max} = 14.66 \cdot k$

D. **Vertical Distribution of Lateral Forces (ASCE 12.14-13)** $F_x := \frac{W_x}{W} V_{max}$

Longitudinal Direction

$F_{1long} := \frac{W_2}{W} V_{max}$ $F_{1long} = 8.23 \cdot k$

$F_{rlong} := \frac{W_r}{W} V_{max}$ $F_{rlong} = 6.43 \cdot k$

$V_{rlong} := F_{rlong}$ $V_{rlong} = 6.43 \cdot k$ Upper Story Shear Longitudinal

$V_{2long} := F_{rlong} + F_{1long}$ $V_{2long} = 14.66 \cdot k$ Lower Story Shear Longitudinal

Lateral Direction

$F_{1lat} := \frac{W_2}{W} V_{max}$ $F_{1lat} = 8.23 \cdot k$

$F_{rlat} := \frac{W_r}{W} V_{max}$ $F_{rlat} = 6.43 \cdot k$

$V_{rlat} := F_{rlong}$ $V_{rlat} = 6.43 \cdot k$ Upper Story Shear Lateral

$V_{2lat} := F_{rlong} + F_{1long}$ $V_{2lat} = 14.66 \cdot k$ Lower Story Shear Lateral

$w5' := \frac{V_{rlong}}{w_r}$ $w5' = 151.22 \cdot plf$

$w6' := \frac{V_{2long}}{w_2}$ $w6' = 344.96 \cdot plf$

$w7' := \frac{V_{rlat}}{l_r}$ $w7' = 98.88 \cdot plf$

$w8' := \frac{V_{2lat}}{l_2}$ $w8' = 214.03 \cdot plf$

E. Determine Building Redundancy ρ $\rho = 1.3$

Second Floor:

WALL AA

Laa := 22ft Vaa := (L1·.5)·w7' Vaa = 914.6 lb

WALL BB

Lbb := 13.3333ft Vbb := (L1 + L2)·.5·w7' Vbb = 3213.44 lb

WALL CC

Lcc := 26.5ft Vcc := (L2)·.5·w7' Vcc = 2298.85 lb Vaa + Vbb + Vcc = 6426.89 lb

WALL DD

Ldd := 47ft Vdd := (L4)·.5·w5' Vdd = 3213.44 lb

WALL EE

Lee := 21.1667ft Vee := (L4)·.5·w5' Vee = 3213.44 lb Vdd + Vee = 6426.89 lb

First Floor:

WALL A

La := 24.5ft Va := (L5)·.5·w8' Va = 2354.32 lb

WALL B

Lb := 20.3333ft Vb := (L5 + L6)·.5·w8' Vb = 7330.5 lb

WALL C

Lc := 18.5833ft Vc := (L6)·.5·w8' Vc = 4976.18 lb Va + Vb + Vc = 14660.99 lb

WALL D

Ld := 31.75ft Vd := (L8)·.5·w6' Vd = 7330.5 lb

WALL E

Le := 12ft Ve := (L8)·.5·w6' Ve = 7330.5 lb Ve + Ve = 14660.99 lb

F. **Calculate Earthquake Forces**

$E_{long} := 0.70\rho \cdot V_{max}$	$E_{long} = 13.34 \cdot k$	Base Shear Longitudnal
$E_{lat} := 0.70\rho \cdot V_{max}$	$E_{lat} = 13.34 \cdot k$	Base Shear Lateral
$E_{rlong} := 0.70\rho \cdot F_{rlong}$	$E_{rlong} = 5.85 \cdot k$	Upper Floor Story Shear
$E_{2long} := 0.70\rho \cdot F_{rlong}$	$E_{2long} = 5.85 \cdot k$	Lower Floor Force
$V_{rlong} := E_{rlong}$	$V_{rlong} = 5.85 \cdot k$	Upper Story Shear Longitudinal
$V_{2long} := E_{rlong} + E_{2long}$	$V_{2long} = 11.7 \cdot k$	Lower Story Shear Longitudinal
$V_{rlat} := E_{rlong}$	$V_{rlat} = 5.85 \cdot k$	Upper Story Shear Lateral
$V_{2lat} := E_{rlong} + E_{2long}$	$V_{2lat} = 11.7 \cdot k$	Lower Story Shear Lateral

Uniform Loads to Roof/Floor Diaphragm (seismic)
(Adjusted to working stress level)

$w5 := \frac{E_{rlong}}{w_r}$	$w5 = 137.61 \cdot plf$	Uniform Load Seismic (Roof Diaph. Longit.)
$w6 := \frac{E_{2long}}{w_2}$	$w6 = 137.61 \cdot plf$	Uniform Load Seismic (2nd Floor Diaph. Longit.)
$w7 := \frac{E_{rlong}}{l_r}$	$w7 = 89.98 \cdot plf$	Uniform Load Seismic (Roof Diaph. Lat.)
$w8 := \frac{E_{2long}}{l_2}$	$w8 = 85.38 \cdot plf$	Uniform Load Seismic (2nd Floor Diaph. Lat.)

E. Earthquake Loads (Working Stress)

Second Floor:

WALL AA

Laa = 22 ft Vaa := (L1·.5)·w7 Vaa = 832.28 lb

WALL BB

Lbb = 13.33 ft Vbb := (L1 + L2)·.5·w7 Vbb = 2924.23 lb

WALL CC

Lcc = 26.5 ft Vcc := (L2)·.5·w7 Vcc = 2091.95 lb Vaa + Vbb + Vcc = 5848.47 lb

WALL DD

Ldd = 47 ft Vdd := (L4)·.5·w5 Vdd = 2924.23 lb

WALL EE

Lee = 21.17 ft Vee := (L4)·.5·w5 Vee = 2924.23 lb Vdd + Vee = 5848.47 lb

First Floor:

WALL A

La = 24.5 ft Va := (L5)·.5·w8 Va = 939.17 lb

WALL B

Lb = 20.33 ft Vb := (L5 + L6)·.5·w8 Vb = 2924.23 lb

WALL C

Lc = 18.58 ft Vc := (L6)·.5·w8 Vc = 1985.06 lb Va + Vb + Vc = 5848.47 lb

WALL D

Ld = 31.75 ft Vd := (L8)·.5·w6 Vd = 2924.23 lb

WALL E

Le = 12 ft Ve := (L8)·.5·w6 Ve = 2924.23 lb Ve + Ve = 5848.47 lb

II. Wind on Buildings MWFRS- Part 2 Enclosed Simple Diaphragm Low-Rise Buildings (ASCE Ch. 28)

$p_s := \lambda \cdot K_{zt} \cdot p_{S30}$ (ASCE Eqn. 28.5-1)

Lateral Analysis shall be based on 2018 "International Building Code" (IBC), Section 1613 and ASC/SEI 7-16 "Minimum Design Loads for Buildings and Other Structures", Ch. 26 - 30), Special Design Provision for Wind and Seismic (AWC SDPWS-2015)

Simplified Design Wind Pressure, P_{S30} (psf)

Design Criteria: V_{ult}=110 mph Ultimate
V_{asd} = 85 mph Nominal
Wind Speed (IBC Table 1609.3.1)

Exposure B
Height (h) < 60ft

Occupancy Category: II
Height < least width horizontal dimension

$K_{zt} := 1.0$

$p_{S30.A} := 15.9psf \cdot K_{zt}$	Horizontal Pressure	End Zone of Wall
$p_{S30.B} := 4.2psf \cdot K_{zt}$	Horizontal Pressure	End Zone of Roof
$p_{S30.C} := 10.6psf \cdot K_{zt}$	Horizontal Pressure	Interior Zone of Wall
$p_{S30.D} := 2.3psf \cdot K_{zt}$	Horizontal Pressure	Interior Zone of Roof
$p_{S30.E} := -13.8psf \cdot K_{zt}$	Vertical Pressure	End Zone Windward Roof
$p_{S30.F} := -9.6psf \cdot K_{zt}$	Vertical Pressure	End Zone Leeward Roof
$p_{S30.G} := -9.6psf \cdot K_{zt}$	Vertical Pressure	Interior Zone Windward Roof
$p_{S30.H} := -7.3psf \cdot K_{zt}$	Vertical Pressure	Interior Zone Leeward Roof
$p_{S30.Eoh} := -19.3psf \cdot K_{zt}$	Vertical Pressure	Overhang @ End Zone Windward Roof
$p_{S30.Goh} := -15.1psf \cdot K_{zt}$	Vertical Pressure	Overhang @ Interior Zone Windward Roof

Height Above Ground (ft.)	λ
0' to 15'	$\lambda_{15} := 1.00$
15' to 20'	$\lambda_{20} := 1.00$
20' to 25'	$\lambda_{25} := 1.00$
25' to 30'	$\lambda_{30} := 1.00$
30' to 35'	$\lambda_{35} := 1.05$
35' to 40'	$\lambda_{40} := 1.09$

A. DETERMINE BASE FORCES

Height Above Ground (ft.)	Wind Pressure (Horiz.) (Wall End)	Wind Pressure (Horiz.) (Roof End)	Wind Pressure (Horiz.) (Wall Interior)	Wind Pressure (Horiz.) (Roof Interior)
0' to 15'	$P1_A := \lambda_{15} \cdot I \cdot p_{S30.A}$ $P1_A = 15.9 \cdot psf$	$P1_B := \lambda_{15} \cdot I \cdot p_{S30.B}$ $P1_B = 4.2 \cdot psf$	$P1_C := \lambda_{15} \cdot I \cdot p_{S30.C}$ $P1_C = 10.6 \cdot psf$	$P1_D := \lambda_{15} \cdot I \cdot p_{S30.D}$ $P1_D = 2.3 \cdot psf$
15' to 20'	$P2_A := \lambda_{20} \cdot I \cdot p_{S30.A}$ $P2_A = 15.9 \cdot psf$	$P2_B := \lambda_{20} \cdot I \cdot p_{S30.B}$ $P2_B = 4.2 \cdot psf$	$P2_C := \lambda_{20} \cdot I \cdot p_{S30.C}$ $P2_C = 10.6 \cdot psf$	$P2_D := \lambda_{20} \cdot I \cdot p_{S30.D}$ $P2_D = 2.3 \cdot psf$
20' to 25'	$P3_A := \lambda_{25} \cdot I \cdot p_{S30.A}$ $P3_A = 15.9 \cdot psf$	$P3_B := \lambda_{25} \cdot I \cdot p_{S30.B}$ $P3_B = 4.2 \cdot psf$	$P3_C := \lambda_{25} \cdot I \cdot p_{S30.C}$ $P3_C = 10.6 \cdot psf$	$P3_D := \lambda_{25} \cdot I \cdot p_{S30.D}$ $P3_D = 2.3 \cdot psf$
25' to 30'	$P4_A := \lambda_{30} \cdot I \cdot p_{S30.A}$ $P4_A = 15.9 \cdot psf$	$P4_B := \lambda_{30} \cdot I \cdot p_{S30.B}$ $P4_B = 4.2 \cdot psf$	$P4_C := \lambda_{30} \cdot I \cdot p_{S30.C}$ $P4_C = 10.6 \cdot psf$	$P4_D := \lambda_{30} \cdot I \cdot p_{S30.D}$ $P4_D = 2.3 \cdot psf$
30' to 35'	$P5_A := \lambda_{35} \cdot I \cdot p_{S30.A}$ $P5_A = 16.7 \cdot psf$	$P5_B := \lambda_{35} \cdot I \cdot p_{S30.B}$ $P5_B = 4.41 \cdot psf$	$P5_C := \lambda_{35} \cdot I \cdot p_{S30.C}$ $P5_C = 11.13 \cdot psf$	$P5_D := \lambda_{35} \cdot I \cdot p_{S30.D}$ $P5_D = 2.42 \cdot psf$
35' to 40'	$P6_A := \lambda_{40} \cdot I \cdot p_{S30.A}$ $P6_A = 17.33 \cdot psf$	$P6_B := \lambda_{40} \cdot I \cdot p_{S30.B}$ $P6_B = 4.58 \cdot psf$	$P6_C := \lambda_{40} \cdot I \cdot p_{S30.C}$ $P6_C = 11.55 \cdot psf$	$P6_D := \lambda_{40} \cdot I \cdot p_{S30.D}$ $P6_D = 2.51 \cdot psf$

Height Above Ground (ft.)	Wind Pressure (Vert.)	Wind Pressure (Vert.)	Wind Pressure (Vert..)	Wind Pressure (Vert.)
0' to 15'	$P1_E := \lambda_{15} \cdot I \cdot p_{S30.E}$ $P1_E = -13.8 \cdot psf$	$P1_F := \lambda_{15} \cdot I \cdot p_{S30.F}$ $P1_F = -9.6 \cdot psf$	$P1_G := \lambda_{15} \cdot I \cdot p_{S30.G}$ $P1_G = -9.6 \cdot psf$	$P1_H := \lambda_{15} \cdot I \cdot p_{S30.H}$ $P1_H = -7.3 \cdot psf$
15' to 20'	$P2_E := \lambda_{20} \cdot I \cdot p_{S30.E}$ $P2_E = -13.8 \cdot psf$	$P2_F := \lambda_{20} \cdot I \cdot p_{S30.F}$ $P2_F = -9.6 \cdot psf$	$P2_G := \lambda_{20} \cdot I \cdot p_{S30.G}$ $P2_G = -9.6 \cdot psf$	$P2_H := \lambda_{20} \cdot I \cdot p_{S30.H}$ $P2_H = -7.3 \cdot psf$
20' to 25'	$P3_E := \lambda_{25} \cdot I \cdot p_{S30.E}$ $P3_E = -13.8 \cdot psf$	$P3_F := \lambda_{25} \cdot I \cdot p_{S30.F}$ $P3_F = -9.6 \cdot psf$	$P3_G := \lambda_{25} \cdot I \cdot p_{S30.G}$ $P3_G = -9.6 \cdot psf$	$P3_H := \lambda_{25} \cdot I \cdot p_{S30.H}$ $P3_H = -7.3 \cdot psf$
25' to 30'	$P4_E := \lambda_{30} \cdot I \cdot p_{S30.E}$ $P4_E = -13.8 \cdot psf$	$P4_F := \lambda_{30} \cdot I \cdot p_{S30.F}$ $P4_F = -9.6 \cdot psf$	$P4_G := \lambda_{30} \cdot I \cdot p_{S30.G}$ $P4_G = -9.6 \cdot psf$	$P4_H := \lambda_{30} \cdot I \cdot p_{S30.H}$ $P4_H = -7.3 \cdot psf$
30' to 35'	$P5_E := \lambda_{35} \cdot I \cdot p_{S30.E}$ $P5_E = -14.49 \cdot psf$	$P5_F := \lambda_{35} \cdot I \cdot p_{S30.F}$ $P5_F = -10.08 \cdot psf$	$P5_G := \lambda_{35} \cdot I \cdot p_{S30.G}$ $P5_G = -10.08 \cdot psf$	$P5_H := \lambda_{35} \cdot I \cdot p_{S30.H}$ $P5_H = -7.67 \cdot psf$
35' to 40'	$P6_E := \lambda_{40} \cdot I \cdot p_{S30.E}$ $P6_E = -15.04 \cdot psf$	$P6_F := \lambda_{40} \cdot I \cdot p_{S30.F}$ $P6_F = -10.46 \cdot psf$	$P6_G := \lambda_{40} \cdot I \cdot p_{S30.G}$ $P6_G = -10.46 \cdot psf$	$P6_H := \lambda_{40} \cdot I \cdot p_{S30.H}$ $P6_H = -7.96 \cdot psf$

Height Above Ground (ft.)	Wind Pressure (Vert.) (Overhangs)	Wind Pressure (Vert.) (Overhangs)
0' to 15'	$P1_{Eoh} := \lambda_{15} \cdot I \cdot p_{S30.Eoh}$ $P1_{Eoh} = -19.3 \cdot psf$	$P1_{Goh} := \lambda_{15} \cdot I \cdot p_{S30.Goh}$ $P1_{Goh} = -15.1 \cdot psf$
15' to 20'	$P2_{Eoh} := \lambda_{20} \cdot I \cdot p_{S30.Eoh}$ $P2_{Eoh} = -19.3 \cdot psf$	$P2_{Goh} := \lambda_{20} \cdot I \cdot p_{S30.Goh}$ $P2_{Goh} = -15.1 \cdot psf$
20' to 25'	$P3_{Eoh} := \lambda_{25} \cdot I \cdot p_{S30.Eoh}$ $P3_{Eoh} = -19.3 \cdot psf$	$P3_{Goh} := \lambda_{25} \cdot I \cdot p_{S30.Goh}$ $P3_{Goh} = -15.1 \cdot psf$
25' to 30'	$P4_{Eoh} := \lambda_{30} \cdot I \cdot p_{S30.Eoh}$ $P4_{Eoh} = -19.3 \cdot psf$	$P4_{Goh} := \lambda_{30} \cdot I \cdot p_{S30.Goh}$ $P4_{Goh} = -15.1 \cdot psf$
30' to 35'	$P5_{Eoh} := \lambda_{35} \cdot I \cdot p_{S30.Eoh}$ $P5_{Eoh} = -20.27 \cdot psf$	$P5_{Goh} := \lambda_{35} \cdot I \cdot p_{S30.Goh}$ $P5_{Goh} = -15.86 \cdot psf$
35' to 40'	$P6_{Eoh} := \lambda_{40} \cdot I \cdot p_{S30.Eoh}$ $P6_{Eoh} = -21.04 \cdot psf$	$P6_{Goh} := \lambda_{40} \cdot I \cdot p_{S30.Goh}$ $P6_{Goh} = -16.46 \cdot psf$

ridge := 27ft — total height projected area (lateral direction measured)

plate2 := 8ft — second floor plate ht

plate1 := 8ft + 12in plate1 = 9·ft — first floor 8ft plate ht + 12in joist depth

plate1 + plate2 = 17·ft — total height to second floor plate

y1 := (ridge − plate1 − plate2).5 y1 = 5·ft — ave distance to center trapazoid

plate1 + plate2 + y1 = 22·ft — total average longit height (longitudinal direction)

Determine Uniform Wind Loads:

w1 := $P1_C$·2ft + $P2_C$·5ft + $P3_C$·2ft + $P4_C$·0ft + $P5_C$·0ftt w1 = 95.4·plf Uniform Load Wind (Roof Diaph Longit)

w2 := $P1_C$·9ft + $P2_C$·0ft + $P3_C$·0ft + $P4_C$·0ft + $P5_C$·0ftft w2 = 95.4·plf Uniform Load Wind (2nd Floor Diaph Longit)

w3 := $P1_C$·2ft + $P2_C$·5ft + $P3_C$·5ft + $P4_C$·2ft + $P5_C$·0ftt w3 = 148.4·plf Uniform Load Wind (Roof Diaph Lat)

w4 := $P1_C$·10.5ft + $P2_C$·5ft + $P3_C$·0ft + $P4_C$·0ft + $P5_C$·0ft w4 = 164.3·plf Uniform Load Wind (Roof Diaph. Garage)

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w_{lat} := w3 + w2 w_{lat} = 243.8·plf TOTAL WIND LOAD PER LIN FT. OF BLDG.

w_{long} := w1 + w2 w_{long} = 190.8·plf

V_{wlong} := w_{long}·w_2 V_{wlong} = 8.11·k **WIND BASE SHEAR - LONGITUDINAL DIRECTION**

V_{wlat} := w_{lat}·l_2 V_{wlat} = 16.7·k **WIND BASE SHEAR - LATERAL DIRECTION**

C. STORY SHEAR -WIND

LONGITUDINAL DIRECTION

$V_{r.long.wind}$:= w1·w_r $V_{r.long.wind}$ = 4.05·k

$V_{2.long.wind}$:= w2·w_2 + $V_{r.long.wind}$ $V_{2.long.wind}$ = 8.11·k

LATERAL DIRECTION

$V_{r.lat.wind}$:= w3·l_r $V_{r.lat.wind}$ = 9.65·k

$V_{2.lat.wind}$:= w2·l_2 + $V_{r.lat.wind}$ $V_{2.lat.wind}$ = 16.18·k

III. SUMMARY OF STORY SHEARS Vx :

	SEISMIC		WIND	
	LONGITUDINAL	LATERAL	LONGITUDINAL	LATERAL
ROOF	$V_{rlong} = 5.85 \cdot k$	$V_{rlat} = 5.85 \cdot k$	$V_{r.long.wind} = 4.05 \cdot k$	$V_{r.lat.wind} = 9.65 \cdot k$
SECOND	$V_{2long} = 11.7 \cdot k$	$V_{2lat} = 11.7 \cdot k$	$V_{2.long.wind} = 8.11 \cdot k$	$V_{2.lat.wind} = 16.18 \cdot k$

(Controlling uniform load/shears)

	LONGITUDINAL	LATERAL
ROOF	$V_{r.long}$ = "w5-eq"	$V_{r.lat}$ = "w3-wind"
SECOND	$V_{2.long}$ = "w6-eq"	$V_{2.lat}$ = "w2-wind"

A. SUMMARY UNIFORM LOADS:

$w1 = 95.4 \cdot plf$	WIND (Roof Diaph. Longit.)
$w2 = 95.4 \cdot plf$	WIND (2nd Flr. Diaph.Longit./Lat.)
$w3 = 148.4 \cdot plf$	WIND (Roof Diaph. Lat.)
$w4 = 164.3 \cdot plf$	WIND (Roof Diaph.)
$w5 = 137.61 \cdot plf$	SEISMIC (Roof Diaph. Longit.)
$w6 = 137.61 \cdot plf$	SEISMIC (2nd Flr. Diaph.Longit.)
$w7 = 89.98 \cdot plf$	SEISMIC (Roof Diaph. Lat.)
$w8 = 85.38 \cdot plf$	SEISMIC (2nd Flr. Diaph.Lat.)

IV. SHEAR ON SHEAR WALLS (Earthquake)

2ND FLOOR

Wall AA :

$Laa = 22\,ft$

$vaa := \frac{(L1 \cdot .5) \cdot w7}{Laa}$

$vaa = 37.83 \cdot plf$

Wall BB :

$Lbb = 13.33\,ft$

$vbb := \frac{(L1 + L2) \cdot .5 \cdot w7}{Lbb}$

$vbb = 219 \cdot plf$

Wall CC :

$Lcc = 26.5\,ft$

$vcc := \frac{(L2) \cdot .5 \cdot w7}{Lcc}$

$vcc = 79 \cdot plf$

Wall DD :

$Ldd = 47\,ft$

$vdd := \frac{(L4) \cdot .5 \cdot w5}{Ldd}$

$vdd = 62.22 \cdot plf$

Wall EE :

$Lee = 21.17\,ft$

$vee := \frac{(L4) \cdot .5 \cdot w5}{Lee}$

$vee = 138.15 \cdot plf$

1ST FLOOR

Wall A

$La = 24.5\,ft$

$va := \frac{(L5) \cdot .5 \cdot w8 + vaa \cdot Laa}{La}$

$va = 72 \cdot plf$

Wall B

$Lb = 20.33\,ft$

$vb := \frac{(L5 + L6) \cdot .5 \cdot w8 + vbb \cdot Lbb}{Lb}$

$vb = 288 \cdot plf$

Wall C :

$Lc = 18.58\,ft$

$vc := \frac{(L6) \cdot .5 \cdot w8 + vcc \cdot Lcc}{Lc}$

$vc = 219 \cdot plf$

Wall D :

$Ld = 31.75\,ft$

$vd := \frac{(L8) \cdot .5 \cdot w6 + vdd \cdot Ldd}{Ld}$

$vd = 184 \cdot plf$

Wall E :

$Le = 12\,ft$

$ve := \frac{(L8) \cdot .5 \cdot w6 + vee \cdot Lee}{Le}$

$ve = 487.37 \cdot plf$

V. SHEAR WALL STRENGTH

A. OVERTURNING MOMENT ON WALLS

1st Floor Walls $HW := h_1$

Wall	Length	Overturning Moments	
A	$La1 := 24.5\,ft$	$OTMa1 := va \cdot La1 \cdot HW$	$OTMa1 = 17714.52\,ft \cdot lb$
B	$Lb1 := 3.125\,ft$	$OTMb1 := vb \cdot Lb1 \cdot HW$	$OTMb1 = 8988.44\,ft \cdot lb$
C	$Lc1 := 2.75 \cdot ft$	$OTMc1 := vc \cdot Lc1 \cdot HW$	$OTMc1 = 6033.26\,ft \cdot lb$
D	$Ld1 := 3.125 \cdot ft$	$OTMd1 := vd \cdot Ld1 \cdot HW$	$OTMd1 = 5756.37\,ft \cdot lb$
E	$Le1 := 3 \cdot ft$	$OTMe1 := ve \cdot Le1 \cdot HW$	$OTMe1 = 14621.17\,ft \cdot lb$

2nd Floor Walls $HW := h_2$

AA	$Laa1 := 22 \cdot ft$	$OTMaa1 := vaa \cdot Laa1 \cdot HW$	$OTMaa1 = 7490.54\,ft \cdot lb$
BB	$Lbb1 := 13.3333 \cdot ft$	$OTMbb1 := vbb \cdot Lbb1 \cdot HW$	$OTMbb1 = 26318\,ft \cdot lb$
CC	$Lcc1 := 4.75 \cdot ft$	$OTMcc1 := vcc \cdot Lcc1 \cdot HW$	$OTMcc1 = 3374.75\,ft \cdot lb$
DD	$Ldd1 := 3.5 \cdot ft$	$OTMdd1 := vdd \cdot Ldd1 \cdot HW$	$OTMdd1 = 1959.86\,ft \cdot lb$
EE	$Lee1 := 2.8333 \cdot ft$	$OTMee1 := vee \cdot Lee1 \cdot HW$	$OTMee1 = 3522.85\,ft \cdot lb$

B. SHEAR WALL DEAD LOAD RESISTING MOMENT (cont.)

15 psf for dl used to take into account of loads from adjacent walls.

2nd Floor Shear Walls $HW := h_2$

Dead Load on Shear Wall

Shear Wall	Roof / Floor Weights	Wall Weights	Dead Load Resisting Moment
AA1	$DLRFaa1 := 5.5 \cdot ft \cdot \left(\frac{2}{3} \cdot D_r\right) \cdot Laa1$ $DLRFaa1 = 1210\,lb$	$DLWLaa1 := HW \cdot p_w \cdot Laa1$ $DLWLaa1 = 1386\,lb$	$DLaa1 := DLWLaa1 + DLRFaa1$ $DLaa1 = 2596\,lb$ $DLRMaa1 := DLaa1 \cdot Laa1 \cdot .5$ $DLRMaa1 = 28556\,ft \cdot lb$
BB1	$DLRFbb1 := 3 \cdot ft \cdot \left(\frac{2}{3} \cdot D_r\right) \cdot Lbb1$ $DLRFbb1 = 400\,lb$	$DLWLbb1 := HW \cdot p_w \cdot Lbb1$ $DLWLbb1 = 840\,lb$	$DLbb1 := DLWLbb1 + DLRFbb1$ $DLbb1 = 1240\,lb$ $DLRMbb1 := DLbb1 \cdot Lbb1 \cdot .5$ $DLRMbb1 = 8266.63\,ft \cdot lb$
CC1	$DLRFcc1 := 5.5 \cdot ft \cdot \left(\frac{2}{3} \cdot D_r\right) \cdot Lcc1$ $DLRFcc1 = 261.25\,lb$	$DLWLcc1 := HW \cdot p_w \cdot Lcc1$ $DLWLcc1 = 299.25\,lb$	$DLcc1 := DLWLcc1 + DLRFcc1$ $DLcc1 = 560.5\,lb$ $DLRMcc1 := DLcc1 \cdot Lcc1 \cdot .5$ $DLRMcc1 = 1331.19\,ft \cdot lb$
DD1	$DLRFdd1 := 18 \cdot ft \cdot \left(\frac{2}{3} \cdot D_r\right) \cdot Ldd1$ $DLRFdd1 = 630\,lb$	$DLWLdd1 := HW \cdot p_w \cdot Ldd1$ $DLWLdd1 = 220.5\,lb$	$DLdd1 := DLWLdd1 + DLRFdd1$ $DLdd1 = 850.5\,lb$ $DLRMdd1 := DLdd1 \cdot Ldd1 \cdot .5$ $DLRMdd1 = 1488.37\,ft \cdot lb$
EE1	$DLRFee1 := 18 \cdot ft \cdot \left(\frac{2}{3} \cdot D_r\right) \cdot Lee1$ $DLRFee1 = 509.99\,lb$	$DLWLee1 := HW \cdot p_w \cdot Lee1$ $DLWLee1 = 178.5\,lb$	$DLee1 := DLWLee1 + DLRFee1$ $DLee1 = 688.49\,lb$ $DLRMee1 := DLee1 \cdot Lee1 \cdot .5$ $DLRMee1 = 975.35\,ft \cdot lb$

B. SHEAR WALL DEAD LOAD RESISTING MOMENT (cont.)

1st Floor Shear Walls $HW := h_1$

Dead Load on Shear Wall

Shear Wall	Roof / Floor Weights	Wall Weights	Dead Load Resisting Moment
A1	$DLRFa1 := 3.5 \cdot ft \cdot \left(\frac{2}{3} \cdot D_f\right) \cdot La1$ $DLRFa1 = 857.5\ lb$	$DLWLa1 := HW \cdot p_w \cdot La1$ $DLWLa1 = 1715\ lb$	$DLa1 := DLWLa1 + DLRFa1$ $DLa1 = 2572.5\ lb$ $DLRMa1 := DLa1 \cdot La1 \cdot .5$ $DLRMa1 = 31513.12\ ft \cdot lb$
B1	$DLRFb1 := 3 \cdot ft \cdot \left(\frac{2}{3} \cdot D_f\right) \cdot Lb1$ $DLRFb1 = 93.75\ lb$	$DLWLb1 := HW \cdot p_w \cdot Lb1$ $DLWLb1 = 218.75\ lb$	$DLb1 := DLWLb1 + DLRFb1$ $DLb1 = 312.5\ lb$ $DLRMb1 := DLb1 \cdot Lb1 \cdot .5$ $DLRMb1 = 488.28\ ft \cdot lb$
C1	$DLRFc1 := 10 \cdot ft \cdot \left(\frac{2}{3} \cdot D_f\right) \cdot Lc1$ $DLRFc1 = 275\ lb$	$DLWLc1 := HW \cdot p_w \cdot Lc1$ $DLWLc1 = 192.5\ lb$	$DLc1 := DLWLc1 + DLRFc1$ $DLc1 = 467.5\ lb$ $DLRMc1 := DLc1 \cdot Lc1 \cdot .5$ $DLRMc1 = 642.81\ ft \cdot lb$
D1	$DLRFd1 := 3 \cdot ft \cdot \left(\frac{2}{3} \cdot D_f\right) \cdot Ld1$ $DLRFd1 = 93.75\ lb$	$DLWLd1 := HW \cdot p_w \cdot Ld1$ $DLWLd1 = 218.75\ lb$	$DLd1 := DLWLd1 + DLRFd1$ $DLd1 = 312.5\ lb$ $DLRMd1 := DLd1 \cdot Ld1 \cdot .5$ $DLRMd1 = 488.28\ ft \cdot lb$
E1	$DLRFe1 := 3 \cdot ft \cdot \left(\frac{2}{3} \cdot D_f\right) \cdot Le1$ $DLRFe1 = 90\ lb$	$DLWLe1 := HW \cdot p_w \cdot Le1$ $DLWLe1 = 210\ lb$	$DLe1 := DLWLe1 + DLRFe1$ $DLe1 = 300\ lb$ $DLRMe1 := DLe1 \cdot Le1 \cdot .5$ $DLRMe1 = 450\ ft \cdot lb$

C. HOLDOWN FORCES ON WALLS

Second Floor

AA1 $HDFaa1 := \frac{OTMaa1 - DLRMaa1}{Laa1}$ $HDFaa1 = -957.52\,lb$

BB1 $HDFbb1 := \frac{OTMbb1 - DLRMbb1}{Lbb1}$ $HDFbb1 = 1353.86\,lb$

CC1 $HDFcc1 := \frac{OTMcc1 - DLRMcc1}{Lcc1}$ $HDFcc1 = 430.22\,lb$

DD1 $HDFdd1 := \frac{OTMdd1 - DLRMdd1}{Ldd1}$ $HDFdd1 = 134.71\,lb$

EE1 $HDFee1 := \frac{OTMee1 - DLRMee1}{Lee1}$ $HDFee1 = 899.13\,lb$

First Floor

A1 $HDFa1 := \frac{OTMa1 - DLRMa1}{La1} + HDFaa1$ $HDFa1 = -1520.73\,lb$

B1 $HDFb1 := \frac{OTMb1 - DLRMb1}{Lb1} + HDFbb1$ $HDFb1 = 4073.91\,lb$

C1 $HDFc1 := \frac{OTMc1 - DLRMc1}{Lc1} + HDFcc1$ $HDFc1 = 2390.39\,lb$

D1 $HDFd1 := \frac{OTMd1 - DLRMd1}{Ld1} + HDFdd1$ $HDFd1 = 1820.5\,lb$

E1 $HDFe1 := \frac{OTMe1 - DLRMe1}{Le1} + HDFee1$ $HDFe1 = 5622.85\,lb$

D. ALLOWABLE ANCHOR BOLT SPACING

Table 8.2E (1997 NDS) 5/8 " DIA. Anchor Bolt w/ 1 1/2" Side Member (Hem-Fir)

$Z_B := 830lb \cdot 1.33$ $Z_B = 1103.9\,lb$ Allow. Load on 5/8" Dia. Bolt in shear 1ft spacing.

$\frac{Z_B}{4ft} = 275.98 \cdot plf$ Allow Shear/ft for 4' max spacing

E. SHEAR STRESS AROUND OPENINGS:

WALL		SHEAR STRESS	A.B. SPACING		HORIZ. STRAP FORCE
First Floor					
A	$va_1 := \frac{va \cdot La}{La - 0 \cdot ft}$	$va_1 = 72.3 \cdot plf$	$s_{a1} := \frac{Z_B}{va_1}$	$Pa := (va_1 - va) \cdot 0 \cdot ft$	$Pa = 0$
B	$vb_1 := \frac{vb \cdot Lb}{Lb - 0 \cdot ft}$	$vb_1 = 287.63 \cdot plf$	$s_{b1} := \frac{Z_B}{vb_1}$	$Pb := (vb_1 - vb) \cdot 0 \cdot ft$	$Pb = 0$
C	$vc_1 := \frac{vc \cdot Lc}{Lc - 0 \cdot ft}$	$vc_1 = 219.39 \cdot plf$	$s_{c1} := \frac{Z_B}{vc_1}$	$Pc := (vc_1 - vc) \cdot 0 \cdot ft$	$Pc = 0$
D	$vd_1 := \frac{vd \cdot Ld}{Ld - 0 \cdot ft}$	$vd_1 = 184.2 \cdot plf$	$s_{d1} := \frac{Z_B}{vd_1}$	$Pd := (vd_1 - vd) \cdot 0 \cdot ft$	$Pd = 0$
E	$ve_1 := \frac{ve \cdot Le}{Le - 0 \cdot ft}$	$ve_1 = 487.37 \cdot plf$	$s_{e1} := \frac{Z_B}{ve_1}$	$Pe := (ve_1 - ve) \cdot 0 \cdot ft$	$Pe = 0$

E. SHEAR STRESS AROUND OPENINGS (cont.):

$C_D := 1.33$ $Z := 122lb$ (NDS TBL 12.3B - 16d COMMON NAILS, 1-1/2" SIDE MEMBER THICKNESS)

$Z' := Z \cdot C_D$ $Z' = 162.26\,lb$ PER NAIL

WALL		SHEAR STRESS	Sole Plate Nail Spacing		HORIZ. STRAP FORCE
2nd Floor					
AA	$vaa_1 := \frac{vaa \cdot Laa}{Laa - 0 \cdot ft}$	$vaa_1 = 37.83 \cdot plf$	$s_{aa1} := \frac{Z'}{vaa_1}$	$Paa := (vaa_1 - vaa) \cdot 0 \cdot ft$	$Paa = 0$
BB	$vbb_1 := \frac{vbb \cdot Lbb}{Lbb - 0 \cdot ft}$	$vbb_1 = 219.32 \cdot plf$	$s_{bb1} := \frac{Z'}{vbb_1}$	$Pbb := (vbb_1 - vbb) \cdot 0 \cdot ft$	$Pbb = 0$
CC	$vcc_1 := \frac{vcc \cdot Lcc}{Lcc - 0 \cdot ft}$	$vcc_1 = 78.94 \cdot plf$	$s_{cc1} := \frac{Z'}{vcc_1}$	$Pcc := (vcc_1 - vcc) \cdot 0 \cdot ft$	$Pcc = 0$
DD	$vdd_1 := \frac{vdd \cdot Ldd}{Ldd - 0 \cdot ft}$	$vdd_1 = 62.22 \cdot plf$	$s_{dd1} := \frac{Z'}{vdd_1}$	$Pdd := (vdd_1 - vdd) \cdot 0 \cdot ft$	$Pdd = 0$
EE	$vee_1 := \frac{vee \cdot Lee}{Lee - 0 \cdot ft}$	$vee_1 = 138.15 \cdot plf$	$s_{ee1} := \frac{Z'}{vee_1}$	$Pee := (vee_1 - vee) \cdot 0 \cdot ft$	$Pee = 0$

B. Shear Wall to diaphragm nailing (Sole Plate): NDS Table12.3B: 16d Common Nails 1 1/2" side member thickness

$C_D := 1.33$ $C_{di} := 1.1$ $Z := 122lb$

$Z' := Z \cdot C_D \cdot C_{di}$ $Z' = 178.49\,lb$ Per Nail

$\frac{Z'}{16in} = 133.86 \cdot plf$ Allowable load for 16" nail spacing (max)

VII. SHEAR WALL SUMMARY

First Floor

Mk	Wall Type	Shear Stress	Anchor bolt Spacing	Holdown Force	Edge Nailing	Holdown Type.
A**	01	$va_1 = 72.3 \cdot plf$ $va_1 \cdot 1.12 = 80.98 \cdot plf$	$s_a = 48 \cdot in$	$HDFa1 = -1.52 \cdot k$	8d @ 6" o.c.	No Hold Downs
B	1	$vb_1 = 287.63 \cdot plf$ $vb_1 \cdot 1.12 = 322.15 \cdot plf$	$s_b = 46.05 \cdot in$	$HDFb1 = 4.07 \cdot k$	8d @ 3" o.c.	HDQ8 4x6 Post
C**	2	$vc_1 = 219.39 \cdot plf$ $vc_1 \cdot 1.12 = 245.72 \cdot plf$	$s_c = 48 \cdot in$	$HDFc1 = 2.39 \cdot k$	8d @ 3" o.c.	STHD14RJ
D	3	$vd_1 = 184.2 \cdot plf$	$s_d = 48 \cdot in$	$HDFd1 = 1.82 \cdot k$	8d @ 4" o.c.	STHD14RJ
E	4	$ve_1 = 487.37 \cdot plf$	$s_e = 27.18 \cdot in$	$HDFe1 = 5.62 \cdot k$	8d @ 4" o.c. 15/32 PW ES	HHDQ11 4x6 Post

2nd Floor $\frac{w1}{w5} = 0.69$ $\frac{w3}{w7} = 1.65$

Mk	Wall Type	Shear Stress	Sole Plate Nail Spacing	Holdown Force	Edge Nailing	Holdown Type.
AA	0	$vaa_1 = 37.83 \cdot plf$ $vaa_1 \cdot 1.65 = 62.42 \cdot plf$	$s_{aa} = 16 \cdot in$	$HDFaa1 = -0.96 \cdot k$	8d @ 6" o.c.	No Straps
BB	5	$vbb_1 = 219.32 \cdot plf$ $vbb_1 \cdot 1.65 = 361.87 \cdot plf$	$s_{bb} = 8.88 \cdot in$	$HDFbb1 = 1.35 \cdot k$	8d @ 4" o.c.	MST37
CC	6	$vcc_1 = 78.94 \cdot plf$ $vcc_1 \cdot 1.65 = 130.25 \cdot plf$	$s_{cc} = 16 \cdot in$	$HDFcc1 = 0.43 \cdot k$	8d @ 6" o.c.	MST37
DD	7	$vdd_1 = 62.22 \cdot plf$	$s_{dd} = 16 \cdot in$	$HDFdd1 = 0.13 \cdot k$	8d @ 6" o.c.	MST37
EE	8	$vee_1 = 138.15 \cdot plf$	$s_{ee} = 14.09 \cdot in$	$HDFee1 = 0.9 \cdot k$	8d @ 4" o.c.	MSTC40 or MSTC66B3Z

****Reduced Shear Capacity AWC-SDPWS-2015**

Table 4.3A Nominal Unit Shear Capacities Wood Frame Shear Wall AWC SDPWS-2015 - Adusted

Allowable Stress (ASD) Adjustment Factor (4.3.3): 1/2

Aspect Ratio Factor "WSP" for (h/b_s) greater than 2:1 (4.3.4.2) : $WSP := 1.25 - \left(0.125 \cdot \frac{h}{b_s}\right)$

Specific Gravity Adjustment Factor for Hem-Fir (Footnote 3) "SG_{adj}" $G = 0.43$ $SG_{adj} := 1 - (0.50 - G)$ $SG_{adj} = 0.93$

Adjusted Unit Shear Capacity (Allowable Stress) for Hem-Fir = (1/2) (SG_{adj}) (WSP) (1) (v_s) (Note sheathing one side)

Adjusted Unit Shear Capacity (Allowable Stress) for Doug-Fir = (1/2) (1) (WSP) (1) (v_s) (Note sheathing one side)

Wall B Seismic

h = 10 b_s = 3.125

$$\left(\frac{1}{2}\right)\cdot(1)\left[1.25 - .125\left(\frac{10}{3.125}\right)\right](1)\cdot 900\text{plf} = 382.5\cdot\text{plf}$$

Fastener Spacing - Shtg Size

8d @ 3" O.C. 15/32" PW (1 side)

Wall C Seismic

h = 10 b_s = 2.75

$$\left(\frac{1}{2}\right)\cdot\left(SG_{adj}\right)\left[1.25 - .125\left(\frac{10}{2.75}\right)\right](1)\cdot 900\text{plf} = 332.9\cdot\text{plf}$$

Fastener Spacing - Shtg Size

8d @ 3" O.C. 15/32" OSB (1 sides)

Wall D Seismic

h = 10 b_s = 3.125

$$\left(\frac{1}{2}\right)\cdot\left(SG_{adj}\right)\left[1.25 - .125\left(\frac{10}{3.125}\right)\right](1)\cdot 700\text{plf} = 276.68\cdot\text{plf}$$

Fastener Spacing - Shtg Size

8d @ 4" O.C. 15/32" OSB (1 sides)

Wall C Seismic

h = 8.75 b_s = 2.75

$$\left(\frac{1}{2}\right)\cdot(1)\left[1.25 - .125\left(\frac{8.75}{2.75}\right)\right](2)\cdot 700\text{plf} = 596.59\cdot\text{plf}$$

Fastener Spacing - Shtg Size

8d @ 4" O.C. 15/32" OSB (2 sides)

Wall D Seismic

h = 8.75 b_s = 2.75

$$\left(\frac{1}{2}\right)\cdot\left(SG_{adj}\right)\left[1.25 - .125\left(\frac{8.75}{2.75}\right)\right](1)\cdot 480\text{plf} = 190.23\cdot\text{plf}$$

Fastener Spacing - Shtg Size

8d @ 6" O.C. 15/32" PW (1 sides)

Wall E Seismic

h = 10 b_s = 3

$$\left(\frac{1}{2}\right)\cdot(1)\left[1.25 - .125\left(\frac{10}{3}\right)\right](2)\cdot 700\text{plf} = 583.33\cdot\text{plf}$$

Fastener Spacing - Shtg Size

8d @ 4" O.C. 15/32" PW (2 sides)

Table 4.3A Nominal Unit Shear Capacities Wood Frame Shear Wall AWC SDPWS-2015 - (Cont.)

Wall DD Seismic h = 9 b_s = 3.5

$$\left(\frac{1}{2}\right)\cdot\left(SG_{adj}\right)\left[1.25 - .125\left(\frac{9}{3.5}\right)\right](1)\cdot 480\text{plf} = 207.26\cdot\text{plf}$$

Fastener Spacing - Shtg Size

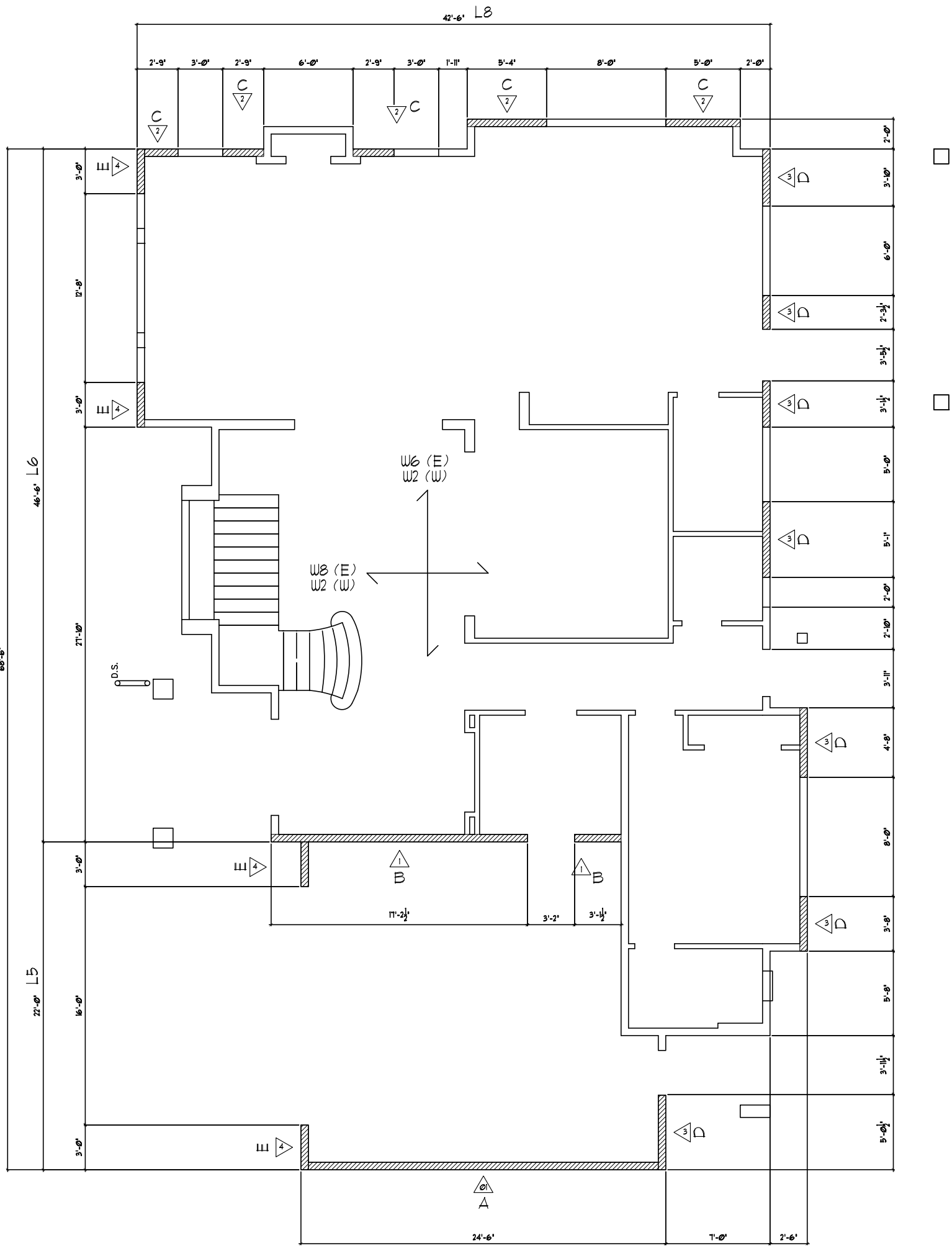
8d @ 6" O.C. 15/32" PW (1 sides)

Wall EE Seismic h = 9 b_s = 2.8333

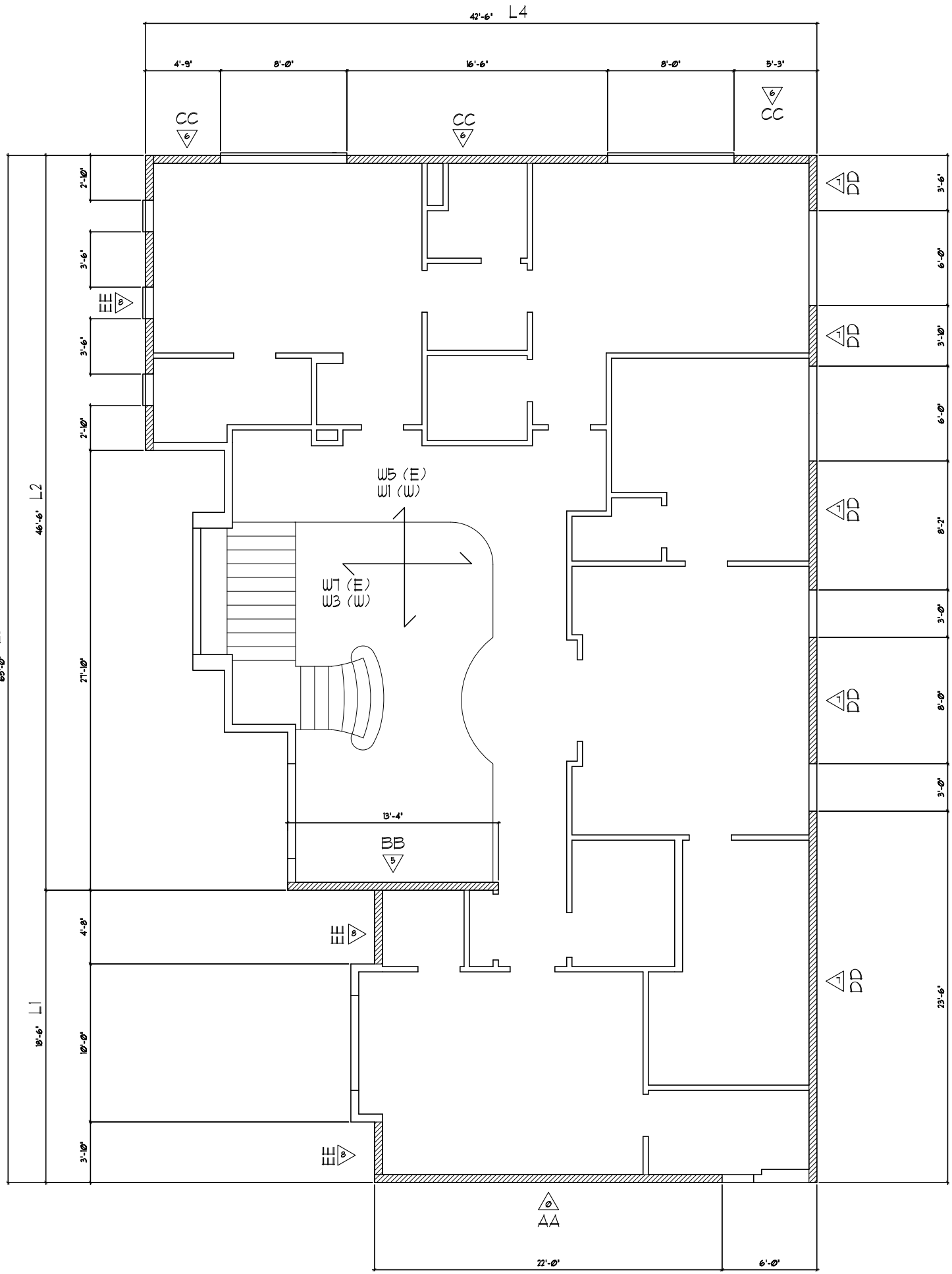
$$\left(\frac{1}{2}\right)\cdot\left(SG_{adj}\right)\left[1.25 - .125\left(\frac{9}{2.8333}\right)\right](1)\cdot 480\text{plf} = 190.38\cdot\text{plf}$$

Fastener Spacing - Shtg Size

8d @ 4" O.C. 15/32" PW (2 sides)



MAIN FLOOR SHEAR WALLS



SECOND FLOOR SHEAR WALLS

FRONT ELEVATION SHEAR WALLS

III. Gravity Load Analysis

Gravity Analysis shall be based on 2018 "International Building Code" (IBC), and ASCE/SEI 7-16 Sect. 7.3 - 7.4 and "Minimum Design Loads for Buildings and Other Structures", Section 3.0 - 6.0.

Design Criteria:

A. Determine Dead Loads (***D***) (1606):

Uniform Dead Loads (psf):

$fr := 15psf$	Framing Dead Load (or actual)	
$p_{to} = 0 \cdot psf$	Concrete Topping (Floors)	$thk = 0 \cdot in$
$p_{ti} := 0psf$	Roof Tile	
$p_w := 1.1psf$	Wall	

B.1 Determine FLoor Live Loads (***L***) (IBC Table 1607.1 & ASCE Table 4-1):

$ll_f := 40psf$	Floor Live Load	$ll_g := 55psf$	Garage Slab on Grade
$ll_d := 60psf$	Deck Live Load	$ll_{gc} := 3000lb$	Garage Concentated Load (4.5in x 4.5in area)
$ll_a := 100psf$	Assembly Areas	$ll'_{gc} := 2250lb$	Garage Concentated Load (per wheel) - storage

B.2 Determine Adjusted Uniform Snow Loads (***L***) (ASCE Ch. 7)

Roof Snow Load - (Ground Snow load $p_g \le 20psf$; Site elevation < 700ft)

$p_f := 0.7 \cdot C_e \cdot C_t \cdot I \cdot p_g$ ***Flat Roof Snow Load (ASCE Eqn. 7-1)***

$C_e := 1.0$ - Exposure B Table 7-2

$C_t := 1.1$ - Table 7-3 Obstructed non-slippery surface
- Heated space (ventilated)

$I := 1.0$ - Importance Table 7-4; Category II per table 1-1

$p_g := 20psf$ ***(Ground Snow load per ASCE Fig. 7-1)***

$w := 25psf$ ***(Min. Roof Snow load per local jurisdiction)***

$p_f := 0.7 \cdot C_e \cdot C_t \cdot I \cdot p_g$ $p_f = 15.4 \cdot psf$

$p'_f = if\left[p_g \le 20psf, (I \cdot p_g), (20psf \cdot I)\right]$ $p'_f = 20 \cdot psf$ min.

$p''_f := if(p_f > w, p_f, w)$ $p''_f = 25 \cdot psf$ min.

$p_s := C_s \cdot p_f$ ***Sloped Roof Snow Load (ASCE Eqn. 7-2 Warm Roofs)***

$C_s := 1.0$ (ASCE Table 7-2a; < 4:12 to 7:12 roof pitch

$p'_s = 25 \cdot psf$ Min. (Heated Ventilated space)

Floor Dead Load ***(D_f)***: $D_f = 15 \cdot psf$ ***Floor Live Load*** ***(L_f)***: $L_f = 40 \cdot psf$

Roof Dead Load ***(D_r)***: $D_r = 15 \cdot psf$ ***Roof Live Load*** ***(L_r)***: $L_r = 25 \cdot psf$

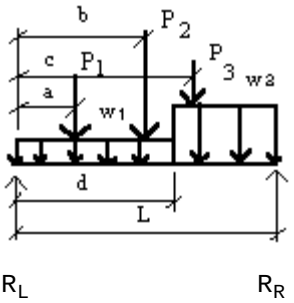
TOTAL FLOOR LOAD ***(TL_f)***: $TL_f = 55 \cdot psf$

TOTAL DECK LOAD ***(TL_d)***: $TL_d = 75 \cdot psf$

TOTAL ROOF LOAD ***(TL_r)***: $TL_r = 40 \cdot psf$

Micro-lam LVL Beam - B1

$L := 8 \cdot ft$



$P_1 := 5.7k$ $a := 1 \cdot ft$

$P_2 := 0lb$ $b := 4 \cdot ft$

$P_3 := 0lb$ $c := 6 \cdot ft$

$d := 1 \cdot ft$

$D_r = 15 \cdot psf$ $L_r = 25 \cdot psf$ $TL_r = 40 \cdot psf$

$w_1 := TL_r \cdot 4.5 \cdot ft$ $w_1 = 180 \cdot plf$

$w_2 := TL_r \cdot 5.5 \cdot ft$ $w_2 = 220 \cdot plf$

==========

Parallam Beam Properties -

$F_b := 2900 \cdot psi$ $F_v := 290 \cdot psi$ $E' := 2000000 \cdot psi$ $C_D := 1.15$ $C_F := 1$

$C_M := 1$ $C_t := 1$

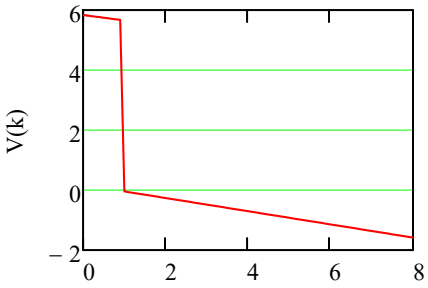
$C_H := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 3335 \cdot psi$

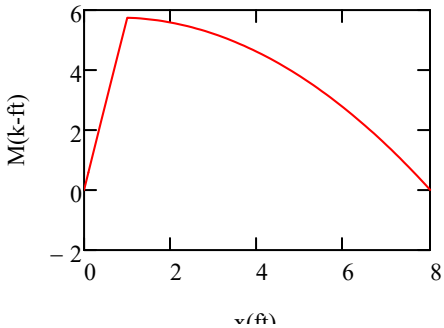
$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 334 \cdot psi$

==========

Shear Diagram



Moment Diagram



$R_L = 5.8 \cdot k$ $R_R = 1.6 \cdot k$

$M_{max} = 5.7 \cdot k \cdot ft$

$V_{max} = 5.8 \cdot k$

==========

BEAM SELECTION

$t := 3.5 \cdot in$ (beam thickness)

$h := 11.25 \cdot in$ (beam depth)

==========

USE $t = 3.5 \cdot in$

x $h = 11.25 \cdot in$ **BEAM**

==========

$\Delta_{TL} := \frac{L}{240}$

$S_{req} = 20.65 \cdot in^3$ ≤ $S = 74 \cdot in^3$ **OK**

$\Delta_{TL} := \frac{5 \cdot w_{eq} \cdot L^4}{384 \cdot E' \cdot I}$ $\Delta_{TL} = 0.08 \cdot in$

$A_{req} = 26.22 \cdot in^2$ ≤ $A = 39 \cdot in^2$ **OK**

Beam Stresses

$f_v = 66.6 \cdot \%$ $f_b = 28 \cdot \%$ $\frac{I_{req}}{I} = 19.9 \cdot \%$

$I_{req} = 82.66 \cdot in^4$ ≤ $I = 415 \cdot in^4$ **OK**

4x8 Sawn Beam - B2
(w/ 2" Rigid Insulation)

$L := 8 \cdot ft$ $t := 3.5in$ $h := 7.25in$

$D_r = 15 \cdot psf$ $L_r = 25 \cdot psf$ $TL_r = 40 \cdot psf$ $t_w := 5.5ft$

$w := TL_r \cdot t_w$ $w = 220 \cdot plf$ $w_{DL} := D_r \cdot t_w$ $w_{DL} = 83 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 1760\,ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 747.08 \cdot lb$ $R_{max} = 880 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 875 \cdot psi$ $F_v := 170 \cdot psi$ $C_D := 1.15$ $C_M := 1$ $C_t := 1$ $C_L := 1.0$ $C_F := 1.2$ $C_{fu} := 1$ $C_i := 1.0$ $C_r := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_{fu} \cdot C_i \cdot C_r$ $F'_b = 1207 \cdot psi$ $C'_i := 1.0$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i$ $F'_v = 195 \cdot psi$ $\Delta_{TL} := \frac{L}{240}$

$E' := 1600000 \cdot psi \cdot C'_i$ $E' = 1600000 \cdot psi$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 17.49 \cdot in^3$ $\leq$ $S = 31 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 57.04 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 5.73 \cdot in^2$ $\leq$ $A = 25 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 22.59 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 31.68 \cdot in^4$ $\leq$ $I = 111 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 28.5 \cdot \%$

4x10 Sawn Beam - B3
(w/ 2" Rigid Insulation)

$L := 6 \cdot ft$ $t := 3.5in$ $h := 9.25in$

$D_r = 15 \cdot psf$ $L_r = 25 \cdot psf$ $TL_r = 40 \cdot psf$ $t_w := 20ft$

$w := TL_r \cdot t_w$ $w = 800 \cdot plf$ $w_{DL} := D_r \cdot t_w$ $w_{DL} = 300 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 3600\,ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 1783.33 \cdot lb$ $R_{max} = 2400 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 875 \cdot psi$ $F_v := 170 \cdot psi$ $C_D := 1.15$ $C_M := 1$ $C_t := 1$ $C_L := 1.0$ $C_F := 1.2$ $C_{fu} := 1$ $C_i := 1.0$ $C_r := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_{fu} \cdot C_i \cdot C_r$ $F'_b = 1207 \cdot psi$ $C'_i := 1.0$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i$ $F'_v = 195 \cdot psi$ $\Delta_{TL} := \frac{L}{240}$

$E' := 1600000 \cdot psi \cdot C'_i$ $E' = 1600000 \cdot psi$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 35.78 \cdot in^3$ $\leq$ $S = 50 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 71.68 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 13.68 \cdot in^2$ $\leq$ $A = 32 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 42.26 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 48.6 \cdot in^4$ $\leq$ $I = 231 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 21.05 \cdot \%$

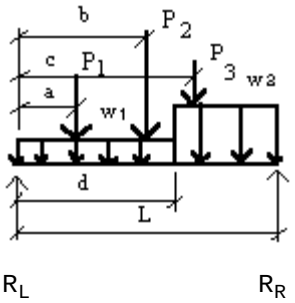
Micro-lam LVL Beam - B4

$L := 6 \cdot ft$

$D_r = 15 \cdot psf$ $L_r = 25 \cdot psf$ $TL_r = 40 \cdot psf$

$w_1 := TL_r \cdot 20 \cdot ft$ $w_1 = 800 \cdot plf$

$w_2 := TL_r \cdot 5.5 \cdot ft$ $w_2 = 220 \cdot plf$



$P_1 := 3.7k$ $a := 2 \cdot ft$

$P_2 := 0lb$ $b := 4 \cdot ft$

$P_3 := 0lb$ $c := 6 \cdot ft$

$d := 2 \cdot ft$

==========

Parallam Beam Properties -

$F_b := 2900 \cdot psi$ $F_v := 290 \cdot psi$ $E' := 2000000 \cdot psi$ $C_D := 1.15$ $C_F := 1$

$C_M := 1$ $C_t := 1$

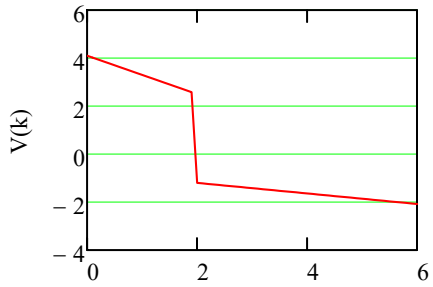
$C_H := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 3335 \cdot psi$

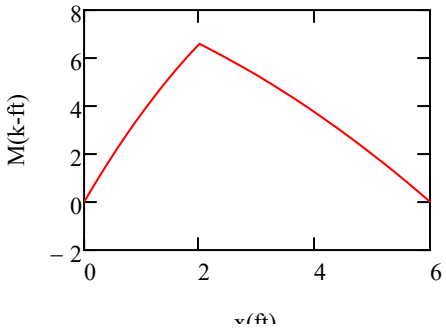
$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 334 \cdot psi$

==========

Shear Diagram



Moment Diagram



$R_L = 4.1 \cdot k$ $R_R = 2.1 \cdot k$

$M_{max} = 6.6 \cdot k \cdot ft$

$V_{max} = 4.1 \cdot k$

==========

BEAM SELECTION

$t := 3.5 \cdot in$ (beam thickness)

$h := 9.25 \cdot in$ (beam depth)

==========

USE $t = 3.5 \cdot in$

x $h = 9.25 \cdot in$ **BEAM**

==========

$\Delta_{TL} := \frac{L}{240}$

$S_{req} = 23.7 \cdot in^3$ **≤** $S = 50 \cdot in^3$ **OK**

$\Delta_{TL} := \frac{5 \cdot w_{eq} \cdot L^4}{384 \cdot E' \cdot I}$ $\Delta_{TL} = 0.09 \cdot in$

$A_{req} = 18.41 \cdot in^2$ **≤** $A = 32 \cdot in^2$ **OK**

Beam Stresses

$f_v = 56.9 \cdot \%$ $f_b = 47.5 \cdot \%$ $\frac{I_{req}}{I} = 30.82 \cdot \%$

$I_{req} = 71.14 \cdot in^4$ **≤** $I = 231 \cdot in^4$ **OK**

4x10 Sawn Beam - B5
(w/ 2" Rigid Insulation)

$L := 6\cdot ft$ $t := 3.5in$ $h := 9.25in$

$D_r = 15\cdot psf$ $L_r = 25\cdot psf$ $TL_r = 40\cdot psf$ $t_w := 18ft$

$w := TL_r\cdot t_w$ $w = 720\cdot plf$ $w_{DL} := D_r\cdot t_w$ $w_{DL} = 270\cdot plf$

$M_{max} := \frac{w\cdot L^2}{8}$ $M_{max} = 3240\,ft\cdot lb$ $V_{max} := w\cdot\left(\frac{L}{2} - h\right)$ $V_{max} = 1605\cdot lb$ $R_{max} = 2160\cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 875\cdot psi$ $F_v := 170\cdot psi$ $C_D := 1.15$ $C_M := 1$ $C_t := 1$ $C_L := 1.0$ $C_F := 1.2$ $C_{fu} := 1$ $C_i := 1.0$ $C_r := 1$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_L\cdot C_F\cdot C_{fu}\cdot C_i\cdot C_r$ $F'_b = 1207\cdot psi$ $C'_i := 1.0$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t\cdot C_i$ $F'_v = 195\cdot psi$ $\Delta_{TL} := \frac{L}{240}$

$E' := 1600000\cdot psi\cdot C'_i$ $E' = 1600000\cdot psi$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 32.2\cdot in^3$ $\leq$ $S = 50\cdot in^3$ **OK** $\frac{S_{req}}{S} = 64.51\cdot\%$

$A_{req} := \frac{V_{max}\cdot 1.5}{F'_v}$ $A_{req} = 12.31\cdot in^2$ $\leq$ $A = 32\cdot in^2$ **OK** $\frac{A_{req}}{A} = 38.04\cdot\%$

$I_{req} := \frac{5\cdot w\cdot L^4}{384\cdot E'\cdot \Delta_{TL}}$ $I_{req} = 43.74\cdot in^4$ $\leq$ $I = 231\cdot in^4$ **OK** $\frac{I_{req}}{I} = 18.95\cdot\%$

3-1/2 x 9-1/4 Microllam Beam (LVL) - B6

$L := 8\cdot ft$ $t := 3.5in$ $h := 9.25in$

$D_r = 15\cdot psf$ $L_r = 25\cdot psf$ $TL_r = 40\cdot psf$ $t_w := 20.5ft$

$w := TL_r\cdot t_w$ $w = 820\cdot plf$ $w_{DL} := D_r\cdot t_w$ $w_{DL} = 308\cdot plf$

$M_{max} := \frac{w\cdot L^2}{8}$ $M_{max} = 6560\,ft\cdot lb$ $V_{max} := w\cdot\left(\frac{L}{2} - h\right)$ $V_{max} = 2647.92\cdot lb$ $R_{max} = 3280\cdot lb$

Allowable Stresses (adjusted)

$F_b := 2600\cdot psi$ $F_v := 285\cdot psi$ $E' := 1900000\cdot psi$ $C_D := 1.15$ $C_F := 1$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_F$ $F'_b = 2990\cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t\cdot C_H$ $F'_v = 328\cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 26.33\cdot in^3$ $\leq$ $S = 50\cdot in^3$ **OK** $\frac{S_{req}}{S} = 52.75\cdot\%$

$A_{req} := \frac{V_{max}\cdot 1.5}{F'_v}$ $A_{req} = 12.12\cdot in^2$ $\leq$ $A = 32\cdot in^2$ **OK** $\frac{A_{req}}{A} = 37.43\cdot\%$

$I_{req} := \frac{5\cdot w\cdot L^4}{384\cdot E'\cdot \Delta_{TL}}$ $I_{req} = 99.44\cdot in^4$ $\leq$ $I = 231\cdot in^4$ **OK** $\frac{I_{req}}{I} = 43.08\cdot\%$

4x10 Sawn Beam - B7
(w/ 2" Rigid Insulation)

$L := 8\cdot ft$ $t := 3.5in$ $h := 9.25in$

$D_r = 15\cdot psf$ $L_r = 25\cdot psf$ $TL_r = 40\cdot psf$ $t_w := 2.5ft$

$w := TL_r\cdot t_w$ $w = 100\cdot plf$ $w_{DL} := D_r\cdot t_w$ $w_{DL} = 38\cdot plf$

$M_{max} := \frac{w\cdot L^2}{8}$ $M_{max} = 800\ ft\cdot lb$ $V_{max} := w\cdot\left(\frac{L}{2} - h\right)$ $V_{max} = 322.92\cdot lb$ $R_{max} = 400\cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 875\cdot psi$ $F_v := 170\cdot psi$ $C_D := 1.15$ $C_M := 1$ $C_t := 1$ $C_L := 1.0$ $C_F := 1.2$ $C_{fu} := 1$ $C_i := 1.0$ $C_r := 1$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_L\cdot C_F\cdot C_{fu}\cdot C_i\cdot C_r$ $F'_b = 1207\cdot psi$ $C'_i := 1.0$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t\cdot C_i$ $F'_v = 195\cdot psi$ $\Delta_{TL} := \frac{L}{240}$

$E' := 1600000\cdot psi\cdot C'_i$ $E' = 1600000\cdot psi$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 7.95\cdot in^3$ $\le$ $S = 50\cdot in^3$ **OK** $\frac{S_{req}}{S} = 15.93\cdot\%$

$A_{req} := \frac{V_{max}\cdot 1.5}{F'_v}$ $A_{req} = 2.48\cdot in^2$ $\le$ $A = 32\cdot in^2$ **OK** $\frac{A_{req}}{A} = 7.65\cdot\%$

$I_{req} := \frac{5\cdot w\cdot L^4}{384\cdot E'\cdot \Delta_{TL}}$ $I_{req} = 14.4\cdot in^4$ $\le$ $I = 231\cdot in^4$ **OK** $\frac{I_{req}}{I} = 6.24\cdot\%$

5-1/2 x 10-1/2 Glu-Lam Beam - B8

$L := 16.5\cdot ft$ $t := 5.5in$ $h := 10.5in$

$D_f = 15\cdot psf$ $L_f = 40\cdot psf$ $TL_f = 55\cdot psf$ $TL_r = 40\cdot psf$ $t_{wr} := 7.5ft$ (roof)

$w := TL_r\cdot t_{wr}$ $w = 300\cdot plf$ $w_{DL} := D_r\cdot t_{wr}$ $w_{DL} = 112\cdot plf$ $\Delta_{TL} := \frac{L}{240}$

$M_{max} := \frac{w\cdot L^2}{8}$ $M_{max} = 10209.38\ ft\cdot lb$ $V_{max} := w\cdot\left(\frac{L}{2} - h\right)$ $V_{max} = 2212.5\cdot lb$ $R_{max} := w\cdot L\cdot .5$ $R_{max} = 2475\cdot lb$

Allowable Stresses (adjusted)

$F_b := 2400\cdot psi$ $F_v := 265\cdot psi$ $E' := 1800000\cdot psi\cdot C_t$ $C_D := 1.15$ $C_M := 1$ $C_t := 1$ $C_L := 1.0$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_L\cdot C_v\cdot C_{fu}\cdot C_c$ $F'_b = 2760\cdot psi$ $C_v := 1$ $C_{fu} := 1$ $C_c := 1$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t$ $F'_v = 305\cdot psi$ $C_{vact} = 1.031$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 44.39\cdot in^3$ $\le$ $S = 101\cdot in^3$ **OK** $\frac{S_{req}}{S} = 43.92\cdot\%$ $\Delta_{TL} = 0.83\cdot in$

$A_{req} := \frac{V_{max}\cdot 1.5}{F'_v}$ $A_{req} = 10.89\cdot in^2$ $\le$ $A = 58\cdot in^2$ **OK** $\frac{A_{req}}{A} = 18.86\cdot\%$ $\Delta_{DL} = 0.31\cdot in$

$I_{req} := \frac{5\cdot w\cdot L^4}{384\cdot E'\cdot \Delta_{TL}}$ $I_{req} = 336.91\cdot in^4$ $\le$ $I = 531\cdot in^4$ **OK** $\frac{I_{req}}{I} = 63.5\cdot\%$ **Assumed OK**

4x8 Sawn Beam - B9

$L := 5 \cdot ft$ $t := 3.5in$ $h := 7.25in$

$D_r = 15 \cdot psf$ $L_r = 25 \cdot psf$ $TL_r = 40 \cdot psf$ $t_w := 3ft$

$w := TL_r \cdot t_w$ $w = 120 \cdot plf$ $w_{DL} := D_r \cdot t_w$ $w_{DL} = 45 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 375\ ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 227.5 \cdot lb$ $R_{max} = 300 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 875 \cdot psi$ $F_v := 170 \cdot psi$ $C_D := 1.15$ $C_M := 1$ $C_t := 1$ $C_L := 1.0$ $C_F := 1.2$ $C_{fu} := 1$ $C_i := 1.0$ $C_r := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_{fu} \cdot C_i \cdot C_r$ $F'_b = 1207 \cdot psi$ $C'_i := 1.0$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i$ $F'_v = 195 \cdot psi$ $\Delta_{TL} := \frac{L}{240}$

$E' := 1600000 \cdot psi \cdot C'_i$ $E' = 1600000 \cdot psi$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 3.73 \cdot in^3$ $\leq$ $S = 31 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 12.15 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 1.75 \cdot in^2$ $\leq$ $A = 25 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 6.88 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 4.22 \cdot in^4$ $\leq$ $I = 111 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 3.8 \cdot \%$

4x8 Sawn Beam - B10

$L := 8 \cdot ft$ $t := 3.5in$ $h := 7.25in$

$D_r = 15 \cdot psf$ $L_r = 25 \cdot psf$ $TL_r = 40 \cdot psf$ $t_w := 3ft$

$w := TL_r \cdot t_w$ $w = 120 \cdot plf$ $w_{DL} := D_r \cdot t_w$ $w_{DL} = 45 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 960\ ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 407.5 \cdot lb$ $R_{max} = 480 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 875 \cdot psi$ $F_v := 170 \cdot psi$ $C_D := 1.15$ $C_M := 1$ $C_t := 1$ $C_L := 1.0$ $C_F := 1.2$ $C_{fu} := 1$ $C_i := 1.0$ $C_r := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_{fu} \cdot C_i \cdot C_r$ $F'_b = 1207 \cdot psi$ $C'_i := 1.0$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i$ $F'_v = 195 \cdot psi$ $\Delta_{TL} := \frac{L}{240}$

$E' := 1600000 \cdot psi \cdot C'_i$ $E' = 1600000 \cdot psi$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 9.54 \cdot in^3$ $\leq$ $S = 31 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 31.12 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 3.13 \cdot in^2$ $\leq$ $A = 25 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 12.32 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 17.28 \cdot in^4$ $\leq$ $I = 111 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 15.55 \cdot \%$

5-1/4 x 11-7/8 LVL Micro-lam Beam (LVL) - B11

$L := 4 \cdot ft$ $t := 5.25in$ $h := 9.5in$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$ $TL_r = 40 \cdot psf$ $t_{wf} := 10ft$ (floor) $t_{wr} := 0ft$ (roof)

$w := TL_f \cdot t_{wf} + TL_r \cdot t_{wr}$ $w = 550 \cdot plf$ $w_{DL} := D_f \cdot t_{wf} + D_r \cdot t_{wr}$ $w_{DL} = 150 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 1100\,ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 664.58 \cdot lb$ $R_{max} = 1100 \cdot lb$

Allowable Stresses (adjusted)

$F_b := 2600 \cdot psi$ $F_v := 285 \cdot psi$ $E' := 1900000 \cdot psi$ $C_D := 1$ $C_F := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 2600 \cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 285 \cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 5.08 \cdot in^3$ $\leq$ $S = 79 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 6.43 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 3.5 \cdot in^2$ $\leq$ $A = 50 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 7.01 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 8.34 \cdot in^4$ $\leq$ $I = 375 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 2.22 \cdot \%$

6x12 Sawn Beam - B12

$L := 16 \cdot ft$ $t := 5.5in$ $h := 11.25in$

$D_r = 15 \cdot psf$ $L_r = 25 \cdot psf$ $TL_r = 40 \cdot psf$ $t_w := 3.5ft$

$w := TL_r \cdot t_w$ $w = 140 \cdot plf$ $w_{DL} := D_r \cdot t_w$ $w_{DL} = 53 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 4480\,ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 988.75 \cdot lb$ $R_{max} = 1120 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 875 \cdot psi$ $F_v := 170 \cdot psi$ $C_D := 1.15$ $C_M := 1$ $C_t := 1$ $C_L := 1.0$ $C_F := 1.2$ $C_{fu} := 1$ $C_i := 1.0$ $C_r := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_{fu} \cdot C_i \cdot C_r$ $F'_b = 1207 \cdot psi$ $C'_i := 1.0$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i$ $F'_v = 195 \cdot psi$ $\Delta_{TL} := \frac{L}{240}$

$E' := 1600000 \cdot psi \cdot C'_i$ $E' = 1600000 \cdot psi$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 44.52 \cdot in^3$ $\leq$ $S = 116 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 38.38 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 7.59 \cdot in^2$ $\leq$ $A = 62 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 12.26 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 161.28 \cdot in^4$ $\leq$ $I = 653 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 24.71 \cdot \%$

6x10 Sawn Beam - B13

$L := 10 \cdot ft$ $t := 5.5in$ $h := 9.25in$

$D_r = 15 \cdot psf$ $L_r = 25 \cdot psf$ $TL_r = 40 \cdot psf$ $t_w := 5.5ft$

$w := TL_r \cdot t_w$ $w = 220 \cdot plf$ $w_{DL} := D_r \cdot t_w$ $w_{DL} = 83 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 2750\,ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 930.42 \cdot lb$ $R_{max} = 1100 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 875 \cdot psi$ $F_v := 170 \cdot psi$ $C_D := 1.15$ $C_M := 1$ $C_t := 1$ $C_L := 1.0$ $C_F := 1.2$ $C_{fu} := 1$ $C_i := 1.0$ $C_r := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_L \cdot C_F \cdot C_{fu} \cdot C_i \cdot C_r$ $F'_b = 1207 \cdot psi$ $C'_i := 1.0$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_i$ $F'_v = 195 \cdot psi$ $\Delta_{TL} := \frac{L}{240}$

$E' := 1600000 \cdot psi \cdot C'_i$ $E' = 1600000 \cdot psi$

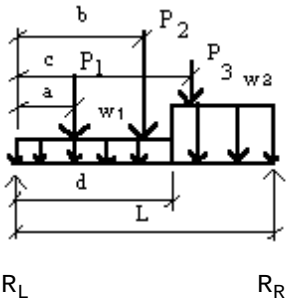
$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 27.33 \cdot in^3$ $\leq$ $S = 78 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 34.84 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 7.14 \cdot in^2$ $\leq$ $A = 51 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 14.03 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 61.88 \cdot in^4$ $\leq$ $I = 363 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 17.06 \cdot \%$

Micro-Lam (LVL) Beam - B14

$L := 3 \cdot ft$



$P_1 := 5.8k$ $a := 2 \cdot ft$

$P_2 := 0lb$ $b := 4 \cdot ft$

$P_3 := 0lb$ $c := 6 \cdot ft$

$d := 2 \cdot ft$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$

$w_1 := TL_f \cdot 9 \cdot ft + 220plf$ $w_1 = 715 \cdot plf$

$w_2 := TL_f \cdot 9 \cdot ft$ $w_2 = 495 \cdot plf$

==========

Microllam Beam Properties -

$F_b := 2600 \cdot psi$ $F_v := 285 \cdot psi$ $E' := 1900000 \cdot psi$ $C_D := 1$ $C_F := 1$

$C_M := 1$ $C_t := 1$

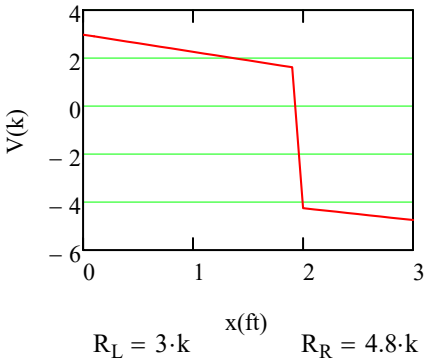
$C_H := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 2600 \cdot psi$

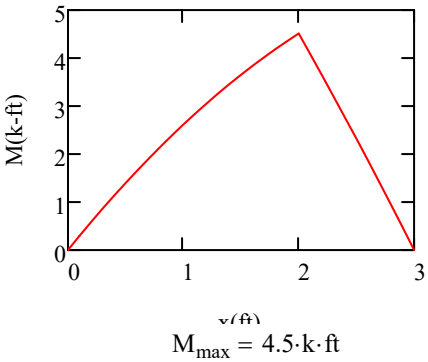
$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 285 \cdot psi$

==========

Shear Diagram



Moment Diagram



$R_L = 3 \cdot k$ $R_R = 4.8 \cdot k$

$M_{max} = 4.5 \cdot k \cdot ft$

$V_{max} = 4.8 \cdot k$

==========

BEAM SELECTION

$t := 3.5 \cdot in$ (beam thickness)

$h := 11.25 \cdot in$ (beam depth)

==========

USE $t = 3.5 \cdot in$

x $h = 11.25 \cdot in$ **BEAM**

==========

$\Delta_{TL} := \frac{L}{240}$

$S_{req} = 20.81 \cdot in^3$ ≤ $S = 74 \cdot in^3$ **OK**

$\Delta_{TL} := \frac{5 \cdot w_{eq} \cdot L^4}{384 \cdot E' \cdot I}$ $\Delta_{TL} = 0.01 \cdot in$

$A_{req} = 25.03 \cdot in^2$ ≤ $A = 39 \cdot in^2$ **OK**

Beam Stresses

$f_v = 63.6 \cdot \%$ $f_b = 28.2 \cdot \%$ $\frac{I_{req}}{I} = 6.17 \cdot \%$

$I_{req} = 25.63 \cdot in^4$ ≤ $I = 415 \cdot in^4$ **OK**

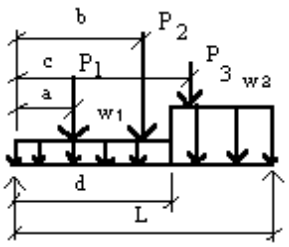
Micro-Lam (LVL) Beam - B15

$L := 6 \cdot ft$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$

$w_1 := TL_f \cdot 9 \cdot ft$ $w_1 = 495 \cdot plf$

$w_2 := TL_f \cdot 9 \cdot ft + 370plf$ $w_2 = 865 \cdot plf$



$P_1 := 1.6k$ $a := 4.5 \cdot ft$

$P_2 := 0lb$ $b := 4 \cdot ft$

$P_3 := 0lb$ $c := 6 \cdot ft$

$d := 4.5 \cdot ft$

==========

Microllam Beam Properties -

$F_b := 2600 \cdot psi$ $F_v := 285 \cdot psi$ $E' := 1900000 \cdot psi$ $C_D := 1$ $C_F := 1$

$C_M := 1$ $C_t := 1$

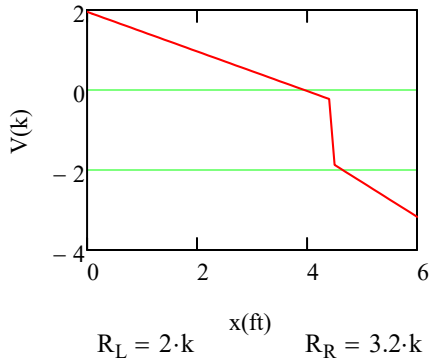
$C_H := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 2600 \cdot psi$

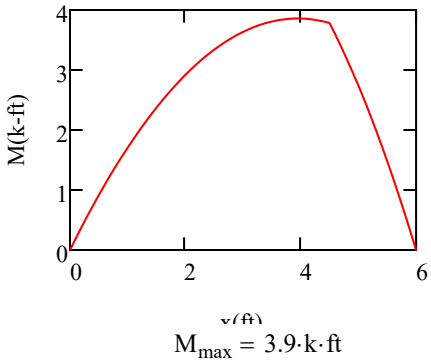
$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 285 \cdot psi$

==========

Shear Diagram



Moment Diagram



$R_L = 2 \cdot k$ $R_R = 3.2 \cdot k$

$M_{max} = 3.9 \cdot k \cdot ft$

$V_{max} = 3.2 \cdot k$

==========

BEAM SELECTION

$t := 5.25 \cdot in$ (beam thickness)

$h := 11.875 \cdot in$ (beam depth)

==========

USE $t = 5.25 \cdot in$

x $h = 11.88 \cdot in$ **BEAM**

==========

$\Delta_{TL} := \frac{L}{240}$

$S_{req} = 17.8 \cdot in^3$ ≤ $S = 123 \cdot in^3$ **OK**

$\Delta_{TL} := \frac{5 \cdot w_{eq} \cdot L^4}{384 \cdot E' \cdot I}$ $\Delta_{TL} = 0.02 \cdot in$

$A_{req} = 16.69 \cdot in^2$ ≤ $A = 62 \cdot in^2$ **OK**

Beam Stresses

$f_v = 26.8 \cdot \%$ $f_b = 14.4 \cdot \%$ $\frac{I_{req}}{I} = 5.99 \cdot \%$

$I_{req} = 43.85 \cdot in^4$ ≤ $I = 733 \cdot in^4$ **OK**

5-1/2 x 16-1/2 Glu-Lam Beam - B16

$L := 19\cdot ft$ $t := 5.5in$ $h := 16.5in$

$D_f = 15\cdot psf$ $L_f = 40\cdot psf$ $TL_f = 55\cdot psf$ $TL_r = 40\cdot psf$ $t_{wf} := 9.5ft$ (floor) $t_{wr} := 7ft$ (roof)

$w := TL_f\cdot t_{wf} + TL_r\cdot t_{wr}$ $w = 802\cdot plf$ $w_{DL} := D_f\cdot t_{wf} + D_r\cdot t_{wr}$ $w_{DL} = 247\cdot plf$ $\Delta_{TL} := \frac{L}{240}$

$M_{max} := \frac{w\cdot L^2}{8}$ $M_{max} = 36212.81\ ft\cdot lb$ $V_{max} := w\cdot\left(\frac{L}{2} - h\right)$ $V_{max} = 6520.31\cdot lb$ $R_{max} := w\cdot L\cdot .5$ $R_{max} = 7623.75\cdot lb$

Allowable Stresses (adjusted)

$F_b := 2400\cdot psi$ $F_v := 265\cdot psi$ $E' := 1800000\cdot psi\cdot C_t$ $C_D := 1$ $C_M := 1$ $C_t := 1$ $C_L := 1.0$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_L\cdot C_v\cdot C_{fu}\cdot C_c$ $F'_b = 2400\cdot psi$ $C_v := 1$ $C_{fu} := 1$ $C_c := 1$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t$ $F'_v = 265\cdot psi$ $C_{vact} = 0.972$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 181.06\cdot in^3$ ≤ $S = 250\cdot in^3$ **OK** $\frac{S_{req}}{S} = 72.55\cdot\%$ $\Delta_{TL} = 0.95\cdot in$

$A_{req} := \frac{V_{max}\cdot 1.5}{F'_v}$ $A_{req} = 36.91\cdot in^2$ ≤ $A = 91\cdot in^2$ **OK** $\frac{A_{req}}{A} = 40.67\cdot\%$ $\Delta_{DL} = 0.29\cdot in$

$I_{req} := \frac{5\cdot w\cdot L^4}{384\cdot E'\cdot \Delta_{TL}}$ $I_{req} = 1376.09\cdot in^4$ ≤ $I = 2059\cdot in^4$ **OK** $\frac{I_{req}}{I} = 66.84\cdot\%$ **Assumed OK**

4x10 Sawn Beam - B17

$L := 7\cdot ft$ $t := 3.5in$ $h := 9.25in$

$D_f = 15\cdot psf$ $L_f = 40\cdot psf$ $TL_f = 55\cdot psf$ $TL_r = 40\cdot psf$ $t_{wf} := 1.3333ft$ (floor) $t_{wr} := 6.5ft$ (roof)

$w := TL_f\cdot t_{wf} + TL_r\cdot t_{wr}$ $w = 333\cdot plf$ $w_{DL} := D_f\cdot t_{wf} + D_r\cdot t_{wr}$ $w_{DL} = 117\cdot plf$

$M_{max} := \frac{w\cdot L^2}{8}$ $M_{max} = 2041.66\ ft\cdot lb$ $V_{max} := w\cdot\left(\frac{L}{2} - h\right)$ $V_{max} = 909.72\cdot lb$ $R_{max} = 1166.66\cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 850\cdot psi$ $F_v := 180\cdot psi$ $E' := 1600000\cdot psi$ $C_D := 1$ $C_F := 1.2$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_F$ $F'_b = 1020\cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t\cdot C_H$ $F'_v = 180\cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 24.02\cdot in^3$ ≤ $S = 50\cdot in^3$ **OK** $\frac{S_{req}}{S} = 48.12\cdot\%$

$A_{req} := \frac{V_{max}\cdot 1.5}{F'_v}$ $A_{req} = 7.58\cdot in^2$ ≤ $A = 32\cdot in^2$ **OK** $\frac{A_{req}}{A} = 23.42\cdot\%$

$I_{req} := \frac{5\cdot w\cdot L^4}{384\cdot E'\cdot \Delta_{TL}}$ $I_{req} = 32.16\cdot in^4$ ≤ $I = 231\cdot in^4$ **OK** $\frac{I_{req}}{I} = 13.93\cdot\%$

3-1/2 x 9-1/4 LVL Micro-lam Beam (LVL) - B18

$L := 5 \cdot ft$ $t := 3.5in$ $h := 9.25in$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$ $TL_r = 40 \cdot psf$ $t_{wf} := 5.5ft$ (floor) $t_{wr} := 20ft$ (roof)

$w := TL_f \cdot t_{wf} + TL_r \cdot t_{wr}$ $w = 1103 \cdot plf$ $w_{DL} := D_f \cdot t_{wf} + D_r \cdot t_{wr}$ $w_{DL} = 383 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 3445.31\ ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 1906.41 \cdot lb$ $R_{max} = 2756.25 \cdot lb$

Allowable Stresses (adjusted)

$F_b := 2600 \cdot psi$ $F_v := 285 \cdot psi$ $E' := 1900000 \cdot psi$ $C_D := 1$ $C_F := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 2600 \cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 285 \cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 15.9 \cdot in^3$ $\leq$ $S = 50 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 31.86 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 10.03 \cdot in^2$ $\leq$ $A = 32 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 30.99 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 32.64 \cdot in^4$ $\leq$ $I = 231 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 14.14 \cdot \%$

4x10 Sawn Beam - B19

$L := 4 \cdot ft$ $t := 3.5in$ $h := 9.25in$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$ $TL_r = 40 \cdot psf$ $t_{wf} := 10.5ft$ (floor) $t_{wr} := 21.5ft$ (roof)

$w := TL_f \cdot t_{wf} + TL_r \cdot t_{wr}$ $w = 1438 \cdot plf$ $w_{DL} := D_f \cdot t_{wf} + D_r \cdot t_{wr}$ $w_{DL} = 480 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 2875\ ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 1766.93 \cdot lb$ $R_{max} = 2875 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 850 \cdot psi$ $F_v := 180 \cdot psi$ $E' := 1600000 \cdot psi$ $C_D := 1$ $C_F := 1.2$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 1020 \cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 180 \cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

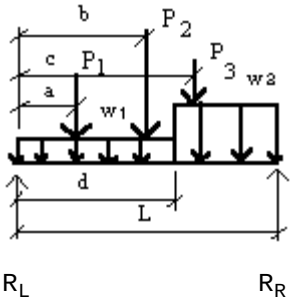
$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 33.82 \cdot in^3$ $\leq$ $S = 50 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 67.77 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 14.72 \cdot in^2$ $\leq$ $A = 32 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 45.48 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 25.88 \cdot in^4$ $\leq$ $I = 231 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 11.21 \cdot \%$

Glu-Lam Beam - B20

$L := 16 \cdot ft$



$P_1 := 2k$ $a := 3 \cdot ft$

$P_2 := 0lb$ $b := 2 \cdot ft$

$P_3 := 0lb$ $c := 0 \cdot ft$

$d := 3 \cdot ft$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$

$w_1 := TL_f \cdot 10 \cdot ft + 120plf + 460plf$ $w_1 = 1130 \cdot plf$

$w_2 := TL_f \cdot 10 \cdot ft + 120plf + 600plf$ $w_2 = 1270 \cdot plf$

Glu-Lam Beam Properties

$F_b := 2400 \cdot psi$ $F_v := 210 \cdot psi$ $E' := 1800000 \cdot psi$ $C_D := 1$ $C_v := 0.9$

$C_M := 1$ $C_t := 1$

$C_H := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_v$ $F'_b = 2160 \cdot psi$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 210 \cdot psi$

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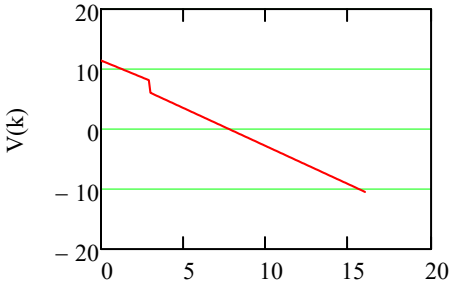
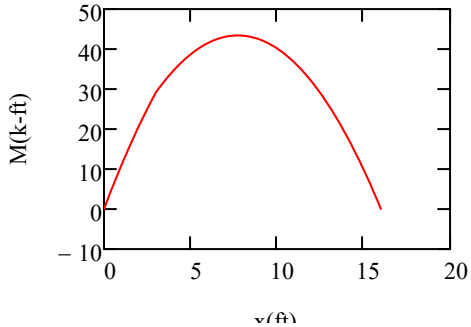
Shear Diagram



Moment Diagram



$R_L = 11.4 \cdot k$ $R_R = 10.5 \cdot k$

$M_{max} = 43.4 \cdot k \cdot ft$

$V_{max} = 11.4 \cdot k$

==========

BEAM SELECTION $t := 5.5 \cdot in$ (beam thickness)

$h := 21in$

$\Delta_{TL} := \frac{5 \cdot w_{eq} \cdot L^4}{384 \cdot E' \cdot I}$ $\Delta_{TL} = 0.26 \cdot in$

$\Delta_{DL} := \frac{D_f}{TL_f} \cdot \Delta_{TL}$ $\Delta_{DL} = 0.07 \cdot in$

$C_{vact} = 0.965$ $\geq$ $C_v = 0.9$ Assumed **OK**

Beam Stresses

$f_v = 70.5 \cdot \%$ $f_b = 59.6 \cdot \%$ $\frac{I_{req}}{I} = 32.7 \cdot \%$

$\Delta_{TL} := \frac{L}{240}$

==========

USE $t = 5.5 \cdot in$

x $h = 21 \cdot in$ **GLB**

==========

$Camber := 1.5 \cdot \Delta_{DL}$ $Camber = 0.107 \cdot in$

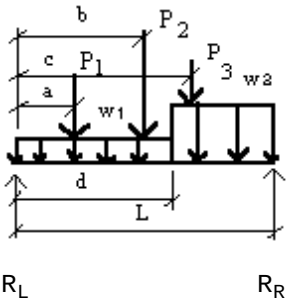
$S_{req} = 240.94 \cdot in^3$ $\leq$ $S = 404 \cdot in^3$ **OK**

$A_{req} = 81.46 \cdot in^2$ $\leq$ $A = 116 \cdot in^2$ **OK**

$I_{req} = 1387.79 \cdot in^4$ $\leq$ $I = 4245 \cdot in^4$ **OK**

Micro-Lam (LVL) Beam - B21

$L := 2 \cdot ft$



$P_1 := 2k$ $a := .5 \cdot ft$

$P_2 := 0lb$ $b := 4 \cdot ft$

$P_3 := 0lb$ $c := 6 \cdot ft$

$d := .5 \cdot ft$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$

$w_1 := TL_f \cdot 14 \cdot ft + 290plf$ $w_1 = 1060 \cdot plf$

$w_2 := TL_f \cdot 14 \cdot ft + 530plf$ $w_2 = 1300 \cdot plf$

==========

Microllam Beam Properties -

$F_b := 2600 \cdot psi$ $F_v := 285 \cdot psi$ $E' := 1900000 \cdot psi$ $C_D := 1$ $C_F := 1$

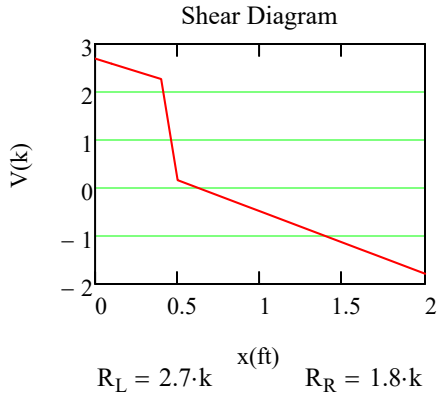
$C_M := 1$ $C_t := 1$

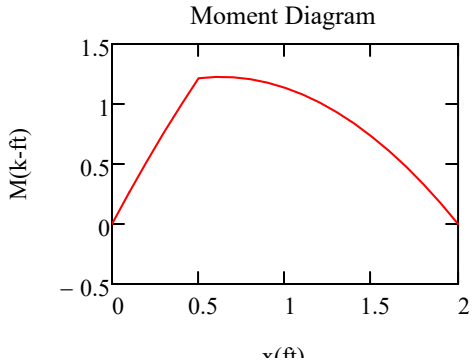
$C_H := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 2600 \cdot psi$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 285 \cdot psi$

==========





$R_L = 2.7 \cdot k$ $R_R = 1.8 \cdot k$

$V_{max} = 2.7 \cdot k$

$M_{max} = 1.2 \cdot k \cdot ft$

==========

BEAM SELECTION

$t := 3.5 \cdot in$ (beam thickness)

$h := 9.25 \cdot in$ (beam depth)

==========

USE $t = 3.5 \cdot in$

x $h = 9.25 \cdot in$ **BEAM**

==========

$\Delta_{TL} := \frac{L}{240}$

$S_{req} = 5.65 \cdot in^3$ **≤** $S = 50 \cdot in^3$ **OK**

$\Delta_{TL} := \frac{5 \cdot w_{eq} \cdot L^4}{384 \cdot E' \cdot I}$ $\Delta_{TL} = 0 \cdot in$

$A_{req} = 14.18 \cdot in^2$ **≤** $A = 32 \cdot in^2$ **OK**

Beam Stresses

$f_v = 43.8 \cdot \%$ $f_b = 11.3 \cdot \%$ $\frac{I_{req}}{I} = 2.01 \cdot \%$

$I_{req} = 4.64 \cdot in^4$ **≤** $I = 231 \cdot in^4$ **OK**

6x8 Sawn Beam - B22

$L := 6 \cdot ft$ $t := 5.5in$ $h := 7.25in$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$ $TL_r = 40 \cdot psf$ $t_{wf} := 3.5ft$ (floor) $t_{wr} := 5.5ft$ (roof)

$w := TL_f \cdot t_{wf} + TL_r \cdot t_{wr}$ $w = 413 \cdot plf$ $w_{DL} := D_f \cdot t_{wf} + D_r \cdot t_{wr}$ $w_{DL} = 135 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 1856.25\ ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 988.28 \cdot lb$ $R_{max} = 1237.5 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 875 \cdot psi$ $F_v := 170 \cdot psi$ $E' := 1600000 \cdot psi$ $C_D := 1$ $C_F := 1.2$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 1050 \cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 170 \cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 21.21 \cdot in^3$ ≤ $S = 48 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 44.03 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 8.72 \cdot in^2$ ≤ $A = 40 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 21.87 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 25.06 \cdot in^4$ ≤ $I = 175 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 14.35 \cdot \%$

6x8 Sawn Beam - B23

$L := 7 \cdot ft$ $t := 5.5in$ $h := 7.25in$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$ $TL_r = 40 \cdot psf$ $t_{wf} := 1.3333ft$ (floor) $t_{wr} := 5.5ft$ (roof)

$w := TL_f \cdot t_{wf} + TL_r \cdot t_{wr}$ $w = 293 \cdot plf$ $w_{DL} := D_f \cdot t_{wf} + D_r \cdot t_{wr}$ $w_{DL} = 102 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 1796.66\ ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 849.44 \cdot lb$ $R_{max} = 1026.66 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 875 \cdot psi$ $F_v := 170 \cdot psi$ $E' := 1600000 \cdot psi$ $C_D := 1$ $C_F := 1.2$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 1050 \cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 170 \cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 20.53 \cdot in^3$ ≤ $S = 48 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 42.62 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 7.5 \cdot in^2$ ≤ $A = 40 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 18.8 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 28.3 \cdot in^4$ ≤ $I = 175 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 16.2 \cdot \%$

4x10 Sawn Beam - B24

$L := 3 \cdot ft$ $t := 3.5in$ $h := 9.25in$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$ $TL_r = 40 \cdot psf$ $t_{wf} := 14ft$ (floor) $t_{wr} := 0ft$ (roof)

$w := TL_f \cdot t_{wf} + TL_r \cdot t_{wr}$ $w = 770 \cdot plf$ $w_{DL} := D_f \cdot t_{wf} + D_r \cdot t_{wr}$ $w_{DL} = 210 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 866.25\ ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h \right)$ $V_{max} = 561.46 \cdot lb$ $R_{max} = 1155 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 850 \cdot psi$ $F_v := 180 \cdot psi$ $E' := 1600000 \cdot psi$ $C_D := 1$ $C_F := 1.2$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 1020 \cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 180 \cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

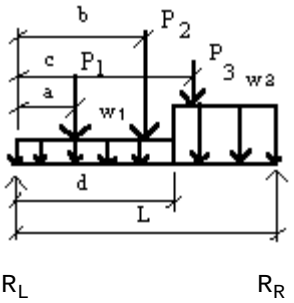
$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 10.19 \cdot in^3$ ≤ $S = 50 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 20.42 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 4.68 \cdot in^2$ ≤ $A = 32 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 14.45 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 5.85 \cdot in^4$ ≤ $I = 231 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 2.53 \cdot \%$

Glu-Lam Beam - B25

$L := 21 \cdot ft$



$P_1 := 1k$ $a := 8 \cdot ft$

$P_2 := 0lb$ $b := 2 \cdot ft$

$P_3 := 0lb$ $c := 0 \cdot ft$

$d := 8 \cdot ft$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$

$w_1 := TL_f \cdot 1.3333 \cdot ft + 370plf$ $w_1 = 443 \cdot plf$

$w_2 := TL_f \cdot 1.3333 \cdot ft + 290plf$ $w_2 = 363.33 \cdot plf$

Glu-Lam Beam Properties

$F_b := 2400 \cdot psi$ $F_v := 210 \cdot psi$ $E' := 1800000 \cdot psi$ $C_D := 1$ $C_v := 0.9$

$C_M := 1$ $C_t := 1$

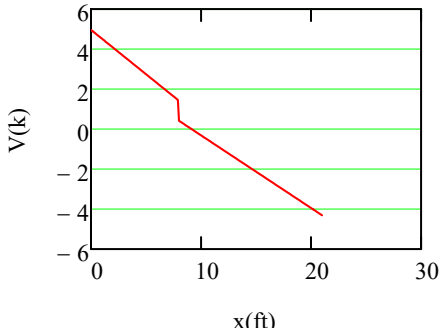
$C_H := 1$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_v$ $F'_b = 2160 \cdot psi$

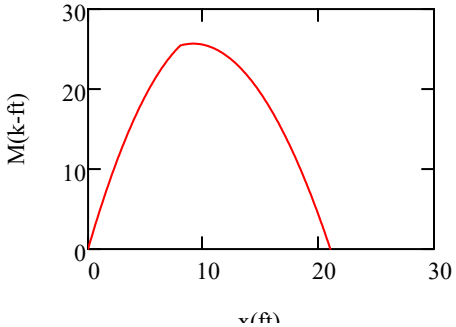
$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 210 \cdot psi$

==========

Shear Diagram



Moment Diagram



$R_L = 5 \cdot k$ $R_R = 4.3 \cdot k$

$M_{max} = 25.7 \cdot k \cdot ft$

$V_{max} = 5 \cdot k$

==========

BEAM SELECTION

$t := 5.5 \cdot in$ (beam thickness)

$h := 15in$

$\Delta_{TL} := \frac{5 \cdot w_{eq} \cdot L^4}{384 \cdot E' \cdot I}$ $\Delta_{TL} = 0.73 \cdot in$

$\Delta_{DL} := \frac{D_f}{TL_f} \cdot \Delta_{TL}$ $\Delta_{DL} = 0.2 \cdot in$

$C_{vact} = 0.971$ $\geq$ $C_v = 0.9$ Assumed **OK**

Beam Stresses

$f_v = 42.9 \cdot \%$ $f_b = 69.1 \cdot \%$ $\frac{I_{req}}{I} = 69.66 \cdot \%$

$\Delta_{TL} := \frac{L}{240}$

==========

USE $t = 5.5 \cdot in$

x $h = 15 \cdot in$ **GLB**

==========

$Camber := 1.5 \cdot \Delta_{DL}$ $Camber = 0.299 \cdot in$

$S_{req} = 142.54 \cdot in^3$ $\leq$ $S = 206 \cdot in^3$ **OK**

$A_{req} = 35.37 \cdot in^2$ $\leq$ $A = 82 \cdot in^2$ **OK**

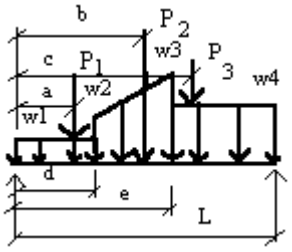
$I_{req} = 1077.58 \cdot in^4$ $\leq$ $I = 1547 \cdot in^4$ **OK**

Glu-Lam Beam - B26

$L := 22\cdot ft$

$D_f = 15\cdot psf$ $L_f = 40\cdot psf$ $TL_f = 55\cdot psf$

$w_1 := 820\cdot plf$
$w_2 := 925\cdot plf$
$w_3 := 925\cdot plf$
$w_4 := 1165\cdot plf$



$P_1 := 4.5k$
$P_2 := 3.5k$
$P_3 := 0\cdot lb$

$a := 4\cdot ft$
$b := 12\cdot ft$
$c := 20\cdot ft$
$d := 9.5\cdot ft$
$e := 18\cdot ft$

Allowable Stresses (adjusted)

$F_b := 2400\cdot psi$ $F_v := 265\cdot psi$ $E' := 1800000\cdot psi\cdot C_t$

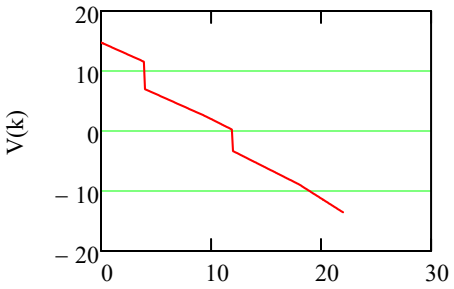
$C_D := 1$ $C_M := 1$ $C_t := 1$ $C_L := 1.0$

$C_v := 1$ $C_{fu} := 1$ $C_c := 1$

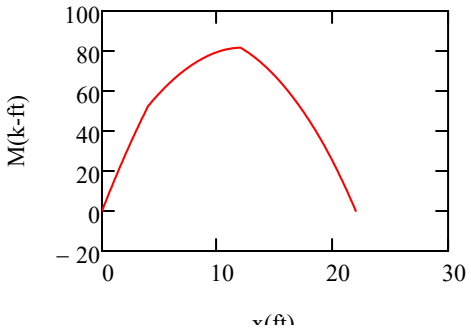
$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_L\cdot C_v\cdot C_{fu}\cdot C_c$ $F'_b = 2400\cdot psi$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t$ $F'_v = 265\cdot psi$

Shear Diagram



Moment Diagram



$R_L = 14.8\cdot k$ $R_R = 13.6\cdot k$

$M_{max} = 81.7\cdot k\cdot ft$

$V_{max} = 14.8\cdot k$

==========

BEAM SELECTION

$t := 6.75\cdot in$ (beam thickness)

$h := 24in$

$\Delta_{TL} := \frac{L}{240}$

==========

$\Delta_{TL} := \frac{5\cdot w_{eq}\cdot L^4}{384\cdot E'\cdot I}$ $\Delta_{TL} = 0.51\cdot in$

USE $t = 6.75\cdot in$
x $h = 24\cdot in$ **GLB**

==========

$\Delta_{DL} := \frac{D_f}{TL_f}\cdot \Delta_{TL}$ $\Delta_{DL} = 0.14\cdot in$

$Camber := 1.5\cdot \Delta_{DL}$ $Camber = 0.208\cdot in$

$S_{req} = 408.33\cdot in^3$ ≤ $S = 648\cdot in^3$ **OK**

$C_{vact} = 0.903$ ≥ $C_v = 1$ Assumed **OK**

$A_{req} = 83.51\cdot in^2$ ≤ $A = 162\cdot in^2$ **OK**

Beam Stresses

$f_v = 51.5\cdot \%$ $f_b = 63\cdot \%$ $\frac{I_{req}}{I} = 46.21\cdot \%$

$I_{req} = 3593.32\cdot in^4$ ≤ $I = 7776\cdot in^4$ **OK**

6x10 Sawn Beam - B27

$L := 6\cdot ft$ $t := 5.5in$ $h := 9.25in$

$D_f = 15\cdot psf$ $L_f = 40\cdot psf$ $TL_f = 55\cdot psf$ $TL_r = 40\cdot psf$ $t_{wf} := 0ft$ (floor) $t_{wr} := 4ft$ (roof)

$w := TL_f\cdot t_{wf} + TL_r\cdot t_{wr}$ $w = 160\cdot plf$ $w_{DL} := D_f\cdot t_{wf} + D_r\cdot t_{wr}$ $w_{DL} = 60\cdot plf$

$M_{max} := \frac{w\cdot L^2}{8}$ $M_{max} = 720\ ft\cdot lb$ $V_{max} := w\cdot\left(\frac{L}{2} - h\right)$ $V_{max} = 356.67\cdot lb$ $R_{max} = 480\cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 875\cdot psi$ $F_v := 170\cdot psi$ $E' := 1600000\cdot psi$ $C_D := 1$ $C_F := 1.2$

$C_M := 1$ $C_t := 1$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_F$ $F'_b = 1050\cdot psi$

$C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t\cdot C_H$ $F'_v = 170\cdot psi$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 8.23\cdot in^3$ ≤ $S = 78\cdot in^3$ **OK** $\frac{S_{req}}{S} = 10.49\cdot\%$

$A_{req} := \frac{V_{max}\cdot 1.5}{F'_v}$ $A_{req} = 3.15\cdot in^2$ ≤ $A = 51\cdot in^2$ **OK** $\frac{A_{req}}{A} = 6.19\cdot\%$

$I_{req} := \frac{5\cdot w\cdot L^4}{384\cdot E'\cdot \Delta_{TL}}$ $I_{req} = 9.72\cdot in^4$ ≤ $I = 363\cdot in^4$ **OK** $\frac{I_{req}}{I} = 2.68\cdot\%$

5-1/2 x 12 Glu-Lam Beam - B28

$L := 7\cdot ft$ $t := 5.5in$ $h := 12in$

$D_f = 15\cdot psf$ $L_f = 40\cdot psf$ $TL_f = 55\cdot psf$ $TL_r = 40\cdot psf$ $t_{wf} := 12.5ft$ (floor) $t_{wr} := 0ft$ (roof)

$w := TL_f\cdot t_{wf} + TL_r\cdot t_{wr}$ $w = 688\cdot plf$ $w_{DL} := D_f\cdot t_{wf} + D_r\cdot t_{wr}$ $w_{DL} = 188\cdot plf$ $R_{max} := w\cdot L\cdot .5$

$M_{max} := \frac{w\cdot L^2}{8}$ $M_{max} = 4210.94\ ft\cdot lb$ $V_{max} := w\cdot\left(\frac{L}{2} - h\right)$ $V_{max} = 1718.75\cdot lb$ $R_{max} = 2406.25\cdot lb$

Allowable Stresses (adjusted)

$F_b := 2400\cdot psi$ $F_v := 265\cdot psi$ $E' := 1800000\cdot psi\cdot C_t$

$C_D := 1$ $C_M := 1$ $C_t := 1$ $C_L := 1.0$

$C_v := 1$ $C_{fu} := 1$ $C_c := 1$ $\Delta_{TL} := \frac{L}{240}$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_L\cdot C_v\cdot C_{fu}\cdot C_c$ $F'_b = 2400\cdot psi$

$C_{vact} = 1.108$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t$ $F'_v = 265\cdot psi$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 21.05\cdot in^3$ ≤ $S = 132\cdot in^3$ **OK** $\frac{S_{req}}{S} = 15.95\cdot\%$ $\Delta_{TL} = 0.35\cdot in$

$A_{req} := \frac{V_{max}\cdot 1.5}{F'_v}$ $A_{req} = 9.73\cdot in^2$ ≤ $A = 66\cdot in^2$ **OK** $\frac{A_{req}}{A} = 14.74\cdot\%$ $\Delta_{DL} = 0.1\cdot in$

$I_{req} := \frac{5\cdot w\cdot L^4}{384\cdot E'\cdot \Delta_{TL}}$ $I_{req} = 58.95\cdot in^4$ ≤ $I = 792\cdot in^4$ **OK** $\frac{I_{req}}{I} = 7.44\cdot\%$

Assumed OK

6x10 Sawn Beam - B29

$L := 6\cdot ft$ $t := 5.5in$ $h := 9.25in$

$D_f = 15\cdot psf$ $L_f = 40\cdot psf$ $TL_f = 55\cdot psf$ $TL_r = 40\cdot psf$ $t_{wf} := 0ft$ (floor) $t_{wr} := 4ft$ (roof)

$w := TL_f\cdot t_{wf} + TL_r\cdot t_{wr}$ $w = 160\cdot plf$ $w_{DL} := D_f\cdot t_{wf} + D_r\cdot t_{wr}$ $w_{DL} = 60\cdot plf$

$M_{max} := \frac{w\cdot L^2}{8}$ $M_{max} = 720\,ft\cdot lb$ $V_{max} := w\cdot\left(\frac{L}{2} - h\right)$ $V_{max} = 356.67\cdot lb$ $R_{max} = 480\cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 875\cdot psi$ $F_v := 170\cdot psi$ $E' := 1600000\cdot psi$ $C_D := 1$ $C_F := 1.2$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_F$ $F'_b = 1050\cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t\cdot C_H$ $F'_v = 170\cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 8.23\cdot in^3$ $\leq$ $S = 78\cdot in^3$ **OK** $\frac{S_{req}}{S} = 10.49\cdot\%$

$A_{req} := \frac{V_{max}\cdot 1.5}{F'_v}$ $A_{req} = 3.15\cdot in^2$ $\leq$ $A = 51\cdot in^2$ **OK** $\frac{A_{req}}{A} = 6.19\cdot\%$

$I_{req} := \frac{5\cdot w\cdot L^4}{384\cdot E'\cdot \Delta_{TL}}$ $I_{req} = 9.72\cdot in^4$ $\leq$ $I = 363\cdot in^4$ **OK** $\frac{I_{req}}{I} = 2.68\cdot\%$

3-1/2 x 11-7/8 LVL Micro-lam Beam (LVL) - B31

$L := 12\cdot ft$ $t := 3.5in$ $h := 11.875in$

$D_f = 15\cdot psf$ $L_f = 40\cdot psf$ $TL_f = 55\cdot psf$ $TL_r = 40\cdot psf$ $t_{wf} := 10ft$ (floor) $t_{wr} := 0ft$ (roof)

$w := TL_f\cdot t_{wf} + TL_r\cdot t_{wr}$ $w = 550\cdot plf$ $w_{DL} := D_f\cdot t_{wf} + D_r\cdot t_{wr}$ $w_{DL} = 150\cdot plf$

$M_{max} := \frac{w\cdot L^2}{8}$ $M_{max} = 9900\,ft\cdot lb$ $V_{max} := w\cdot\left(\frac{L}{2} - h\right)$ $V_{max} = 2755.73\cdot lb$ $R_{max} = 3300\cdot lb$

Allowable Stresses (adjusted)

$F_b := 2600\cdot psi$ $F_v := 285\cdot psi$ $E' := 1900000\cdot psi$ $C_D := 1$ $C_F := 1$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_F$ $F'_b = 2600\cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t\cdot C_H$ $F'_v = 285\cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 45.69\cdot in^3$ $\leq$ $S = 82\cdot in^3$ **OK** $\frac{S_{req}}{S} = 55.55\cdot\%$

$A_{req} := \frac{V_{max}\cdot 1.5}{F'_v}$ $A_{req} = 14.5\cdot in^2$ $\leq$ $A = 42\cdot in^2$ **OK** $\frac{A_{req}}{A} = 34.9\cdot\%$

$I_{req} := \frac{5\cdot w\cdot L^4}{384\cdot E'\cdot \Delta_{TL}}$ $I_{req} = 225.09\cdot in^4$ $\leq$ $I = 488\cdot in^4$ **OK** $\frac{I_{req}}{I} = 46.09\cdot\%$

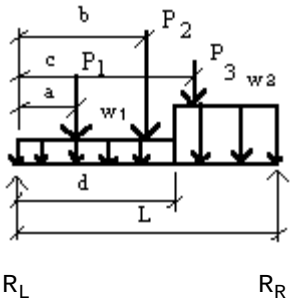
Glu-Lam Beam - B30

$L := 12\cdot ft$

$D_f = 15\cdot psf$ $L_f = 40\cdot psf$ $TL_f = 55\cdot psf$

$w_1 := TL_f\cdot 10\cdot ft$ $w_1 = 550\cdot plf$

$w_2 := TL_f\cdot 15.5\cdot ft$ $w_2 = 852.5\cdot plf$



$P_1 := 0k$ $a := 12\cdot ft$

$P_2 := 0lb$ $b := 2\cdot ft$

$P_3 := 0lb$ $c := 0\cdot ft$

$d := 8.5\cdot ft$

Glu-Lam Beam Properties

$F_b := 2400\cdot psi$ $F_v := 210\cdot psi$ $E' := 1800000\cdot psi$ $C_D := 1$ $C_v := 0.9$

$C_M := 1$ $C_t := 1$

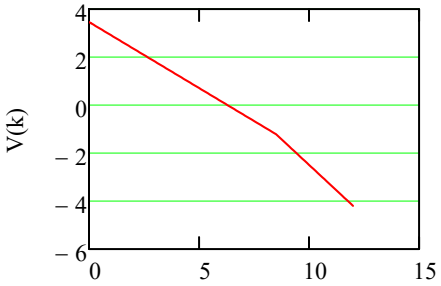
$C_H := 1$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_v$ $F'_b = 2160\cdot psi$

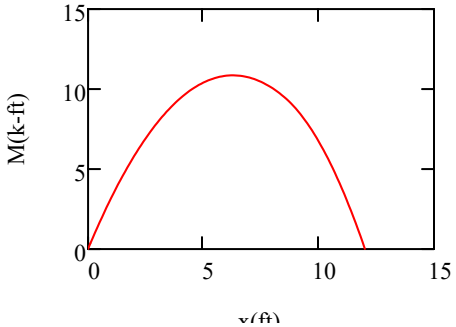
$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t\cdot C_H$ $F'_v = 210\cdot psi$

==========

Shear Diagram



Moment Diagram



$R_L = 3.5\cdot k$ $R_R = 4.2\cdot k$

$V_{max} = 4.2\cdot k$

$M_{max} = 10.8\cdot k\cdot ft$

==========

BEAM SELECTION

$t := 5.5\cdot in$ (beam thickness)

$h := 12in$

$\Delta_{TL} := \frac{5\cdot w_{eq}\cdot L^4}{384\cdot E'\cdot I}$ $\Delta_{TL} = 0.2\cdot in$

$\Delta_{DL} := \frac{D_f}{TL_f}\cdot \Delta_{TL}$ $\Delta_{DL} = 0.05\cdot in$

$C_{vact} = 1.05$ $\geq$ $C_v = 0.9$ Assumed **OK**

Beam Stresses

$f_v = 45.5\cdot \%$ $f_b = 45.7\cdot \%$ $\frac{I_{req}}{I} = 32.87\cdot \%$

$\Delta_{TL} := \frac{L}{240}$

==========

USE $t = 5.5\cdot in$

x $h = 12\cdot in$ **GLB**

==========

$Camber := 1.5\cdot \Delta_{DL}$ $Camber = 0.081\cdot in$

$S_{req} = 60.27\cdot in^3$ $\leq$ $S = 132\cdot in^3$ **OK**

$A_{req} = 30.03\cdot in^2$ $\leq$ $A = 66\cdot in^2$ **OK**

$I_{req} = 260.35\cdot in^4$ $\leq$ $I = 792\cdot in^4$ **OK**

4x10 Sawn Beam - B32

$L := 6\cdot ft$ $t := 3.5in$ $h := 9.25in$

$D_f = 15\cdot psf$ $L_f = 40\cdot psf$ $TL_f = 55\cdot psf$ $TL_r = 40\cdot psf$ $t_{wf} := 1.3333ft$ (floor) $t_{wr} := 5ft$ (roof)

$w := TL_f\cdot t_{wf} + TL_r\cdot t_{wr}$ $w = 273\cdot plf$ $w_{DL} := D_f\cdot t_{wf} + D_r\cdot t_{wr}$ $w_{DL} = 95\cdot plf$

$M_{max} := \frac{w\cdot L^2}{8}$ $M_{max} = 1229.99\ ft\cdot lb$ $V_{max} := w\cdot\left(\frac{L}{2} - h\right)$ $V_{max} = 609.3\cdot lb$ $R_{max} = 819.99\cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 850\cdot psi$ $F_v := 180\cdot psi$ $E' := 1600000\cdot psi$ $C_D := 1$ $C_F := 1.2$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_F$ $F'_b = 1020\cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t\cdot C_H$ $F'_v = 180\cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 14.47\cdot in^3$ ≤ $S = 50\cdot in^3$ **OK** $\frac{S_{req}}{S} = 28.99\cdot\%$

$A_{req} := \frac{V_{max}\cdot 1.5}{F'_v}$ $A_{req} = 5.08\cdot in^2$ ≤ $A = 32\cdot in^2$ **OK** $\frac{A_{req}}{A} = 15.68\cdot\%$

$I_{req} := \frac{5\cdot w\cdot L^4}{384\cdot E'\cdot \Delta_{TL}}$ $I_{req} = 16.6\cdot in^4$ ≤ $I = 231\cdot in^4$ **OK** $\frac{I_{req}}{I} = 7.19\cdot\%$

4x12 Sawn Beam - B33

$L := 6.1667\cdot ft$ $t := 3.5in$ $h := 11.25in$

$D_f = 15\cdot psf$ $L_f = 40\cdot psf$ $TL_f = 55\cdot psf$ $TL_r = 40\cdot psf$ $t_{wf} := 9.3333ft$ (floor) $t_{wr} := 0ft$ (roof)

$w := TL_f\cdot t_{wf} + TL_r\cdot t_{wr}$ $w = 513\cdot plf$ $w_{DL} := D_f\cdot t_{wf} + D_r\cdot t_{wr}$ $w_{DL} = 140\cdot plf$

$M_{max} := \frac{w\cdot L^2}{8}$ $M_{max} = 2440.13\ ft\cdot lb$ $V_{max} := w\cdot\left(\frac{L}{2} - h\right)$ $V_{max} = 1101.53\cdot lb$ $R_{max} = 1582.78\cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 850\cdot psi$ $F_v := 180\cdot psi$ $E' := 1600000\cdot psi$ $C_D := 1$ $C_F := 1.2$

$F'_b := F_b\cdot C_D\cdot C_M\cdot C_t\cdot C_F$ $F'_b = 1020\cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v\cdot C_D\cdot C_M\cdot C_t\cdot C_H$ $F'_v = 180\cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 28.71\cdot in^3$ ≤ $S = 74\cdot in^3$ **OK** $\frac{S_{req}}{S} = 38.88\cdot\%$

$A_{req} := \frac{V_{max}\cdot 1.5}{F'_v}$ $A_{req} = 9.18\cdot in^2$ ≤ $A = 39\cdot in^2$ **OK** $\frac{A_{req}}{A} = 23.31\cdot\%$

$I_{req} := \frac{5\cdot w\cdot L^4}{384\cdot E'\cdot \Delta_{TL}}$ $I_{req} = 33.86\cdot in^4$ ≤ $I = 415\cdot in^4$ **OK** $\frac{I_{req}}{I} = 8.15\cdot\%$

4x12 Sawn Beam - B34

$L := 5.75 \cdot ft$ $t := 3.5in$ $h := 11.25in$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$ $TL_r = 40 \cdot psf$ $t_{wf} := 13.5ft$ (floor) $t_{wr} := 0ft$ (roof)

$w := TL_f \cdot t_{wf} + TL_r \cdot t_{wr}$ $w = 743 \cdot plf$ $w_{DL} := D_f \cdot t_{wf} + D_r \cdot t_{wr}$ $w_{DL} = 203 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 3068.61\ ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 1438.59 \cdot lb$ $R_{max} = 2134.69 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 850 \cdot psi$ $F_v := 180 \cdot psi$ $E' := 1600000 \cdot psi$ $C_D := 1$ $C_F := 1.2$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 1020 \cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 180 \cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 36.1 \cdot in^3$ ≤ $S = 74 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 48.9 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 11.99 \cdot in^2$ ≤ $A = 39 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 30.45 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 39.7 \cdot in^4$ ≤ $I = 415 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 9.56 \cdot \%$

4x12 Sawn Beam - B35

$L := 4.8333 \cdot ft$ $t := 3.5in$ $h := 11.25in$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$ $TL_r = 40 \cdot psf$ $t_{wf} := 20ft$ (floor) $t_{wr} := 0ft$ (roof)

$w := TL_f \cdot t_{wf} + TL_r \cdot t_{wr}$ $w = 1100 \cdot plf$ $w_{DL} := D_f \cdot t_{wf} + D_r \cdot t_{wr}$ $w_{DL} = 300 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 3212.11\ ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 1627.07 \cdot lb$ $R_{max} = 2658.32 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 850 \cdot psi$ $F_v := 180 \cdot psi$ $E' := 1600000 \cdot psi$ $C_D := 1$ $C_F := 1.2$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 1020 \cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 180 \cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 37.79 \cdot in^3$ ≤ $S = 74 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 51.19 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 13.56 \cdot in^2$ ≤ $A = 39 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 34.44 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 34.93 \cdot in^4$ ≤ $I = 415 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 8.41 \cdot \%$

4x12 Sawn Beam - B36

$L := 5.9167 \cdot ft$ $t := 3.5in$ $h := 11.25in$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$ $TL_r = 40 \cdot psf$ $t_{wf} := 18ft$ (floor) $t_{wr} := 0ft$ (roof)

$w := TL_f \cdot t_{wf} + TL_r \cdot t_{wr}$ $w = 990 \cdot plf$ $w_{DL} := D_f \cdot t_{wf} + D_r \cdot t_{wr}$ $w_{DL} = 270 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 4332.16\ ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 2000.64 \cdot lb$ $R_{max} = 2928.77 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 850 \cdot psi$ $F_v := 180 \cdot psi$ $E' := 1600000 \cdot psi$ $C_D := 1$ $C_F := 1.2$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 1020 \cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 180 \cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 50.97 \cdot in^3$ ≤ $S = 74 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 69.03 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 16.67 \cdot in^2$ ≤ $A = 39 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 42.34 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 57.67 \cdot in^4$ ≤ $I = 415 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 13.89 \cdot \%$

4x12 Sawn Beam - B37

$L := 5.6667 \cdot ft$ $t := 3.5in$ $h := 11.25in$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$ $TL_r = 40 \cdot psf$ $t_{wf} := 20ft$ (floor) $t_{wr} := 0ft$ (roof)

$w := TL_f \cdot t_{wf} + TL_r \cdot t_{wr}$ $w = 1100 \cdot plf$ $w_{DL} := D_f \cdot t_{wf} + D_r \cdot t_{wr}$ $w_{DL} = 300 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 4415.33\ ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 2085.43 \cdot lb$ $R_{max} = 3116.68 \cdot lb$

Allowable Stresses (adjusted) DF#2

$F_b := 850 \cdot psi$ $F_v := 180 \cdot psi$ $E' := 1600000 \cdot psi$ $C_D := 1$ $C_F := 1.2$

$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 1020 \cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 180 \cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 51.95 \cdot in^3$ ≤ $S = 74 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 70.36 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 17.38 \cdot in^2$ ≤ $A = 39 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 44.14 \cdot \%$

$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 56.3 \cdot in^4$ ≤ $I = 415 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 13.56 \cdot \%$

3-1/2 x 11-7/8 LVL Micro-lam Beam (LVL) - B38

$L := 5 \cdot ft$ $t := 3.5in$ $h := 9.5in$

$D_f = 15 \cdot psf$ $L_f = 40 \cdot psf$ $TL_f = 55 \cdot psf$ $TL_r = 40 \cdot psf$ $t_{wf} := 10ft$ (floor) $t_{wr} := 0ft$ (roof)

$w := TL_f \cdot t_{wf} + TL_r \cdot t_{wr}$ $w = 550 \cdot plf$ $w_{DL} := D_f \cdot t_{wf} + D_r \cdot t_{wr}$ $w_{DL} = 150 \cdot plf$

$M_{max} := \frac{w \cdot L^2}{8}$ $M_{max} = 1718.75\ ft \cdot lb$ $V_{max} := w \cdot \left(\frac{L}{2} - h\right)$ $V_{max} = 939.58 \cdot lb$ $R_{max} = 1375 \cdot lb$

Allowable Stresses (adjusted)

$F_b := 2600 \cdot psi$ $F_v := 285 \cdot psi$ $E' := 1900000 \cdot psi$ $C_D := 1$ $C_F := 1$

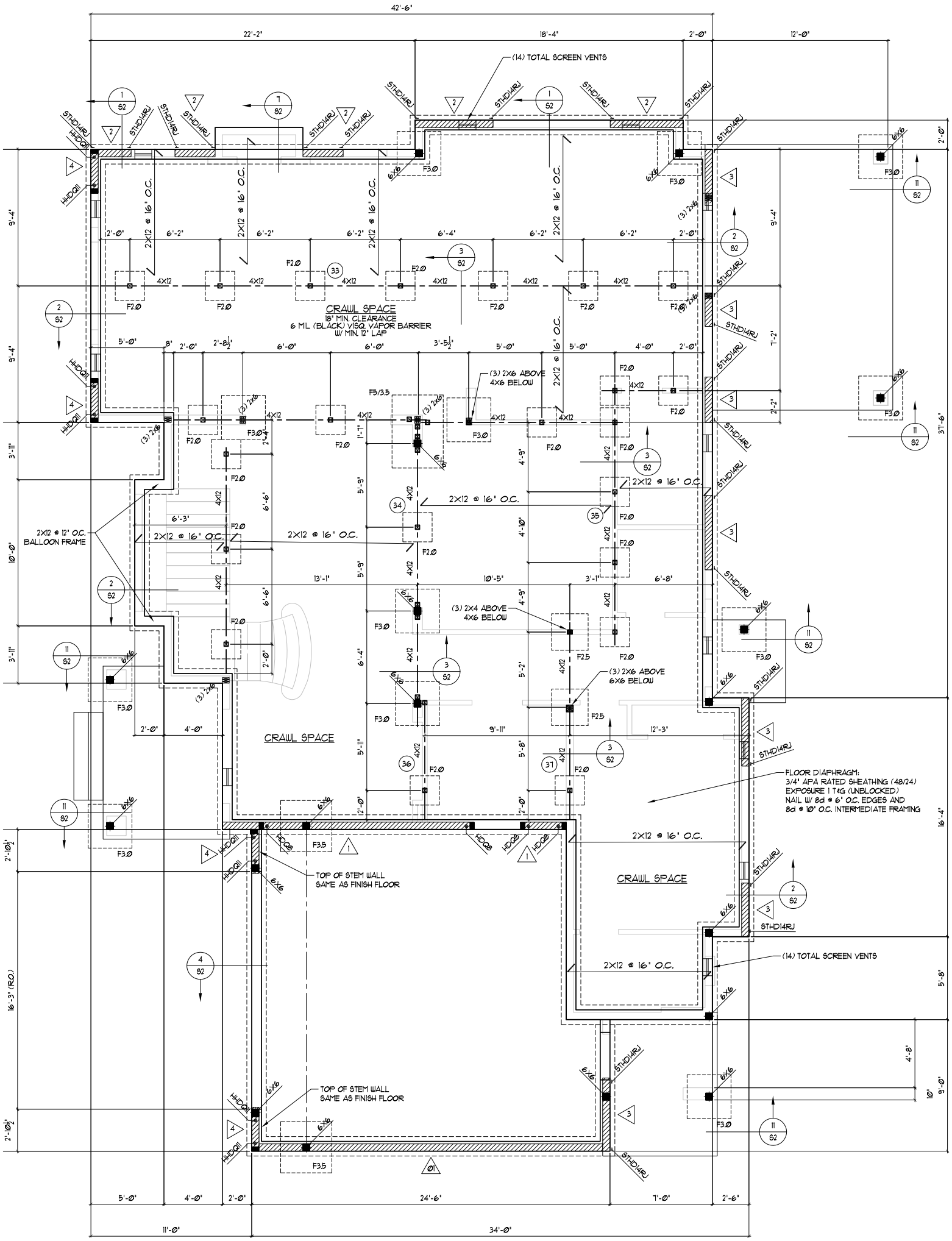
$F'_b := F_b \cdot C_D \cdot C_M \cdot C_t \cdot C_F$ $F'_b = 2600 \cdot psi$ $C_M := 1$ $C_t := 1$

$F'_v := F_v \cdot C_D \cdot C_M \cdot C_t \cdot C_H$ $F'_v = 285 \cdot psi$ $C_H := 1$ $\Delta_{TL} := \frac{L}{240}$

$S_{req} := \frac{M_{max}}{F'_b}$ $S_{req} = 7.93 \cdot in^3$ $\leq$ $S = 53 \cdot in^3$ **OK** $\frac{S_{req}}{S} = 15.07 \cdot \%$

$A_{req} := \frac{V_{max} \cdot 1.5}{F'_v}$ $A_{req} = 4.95 \cdot in^2$ $\leq$ $A = 33 \cdot in^2$ **OK** $\frac{A_{req}}{A} = 14.87 \cdot \%$

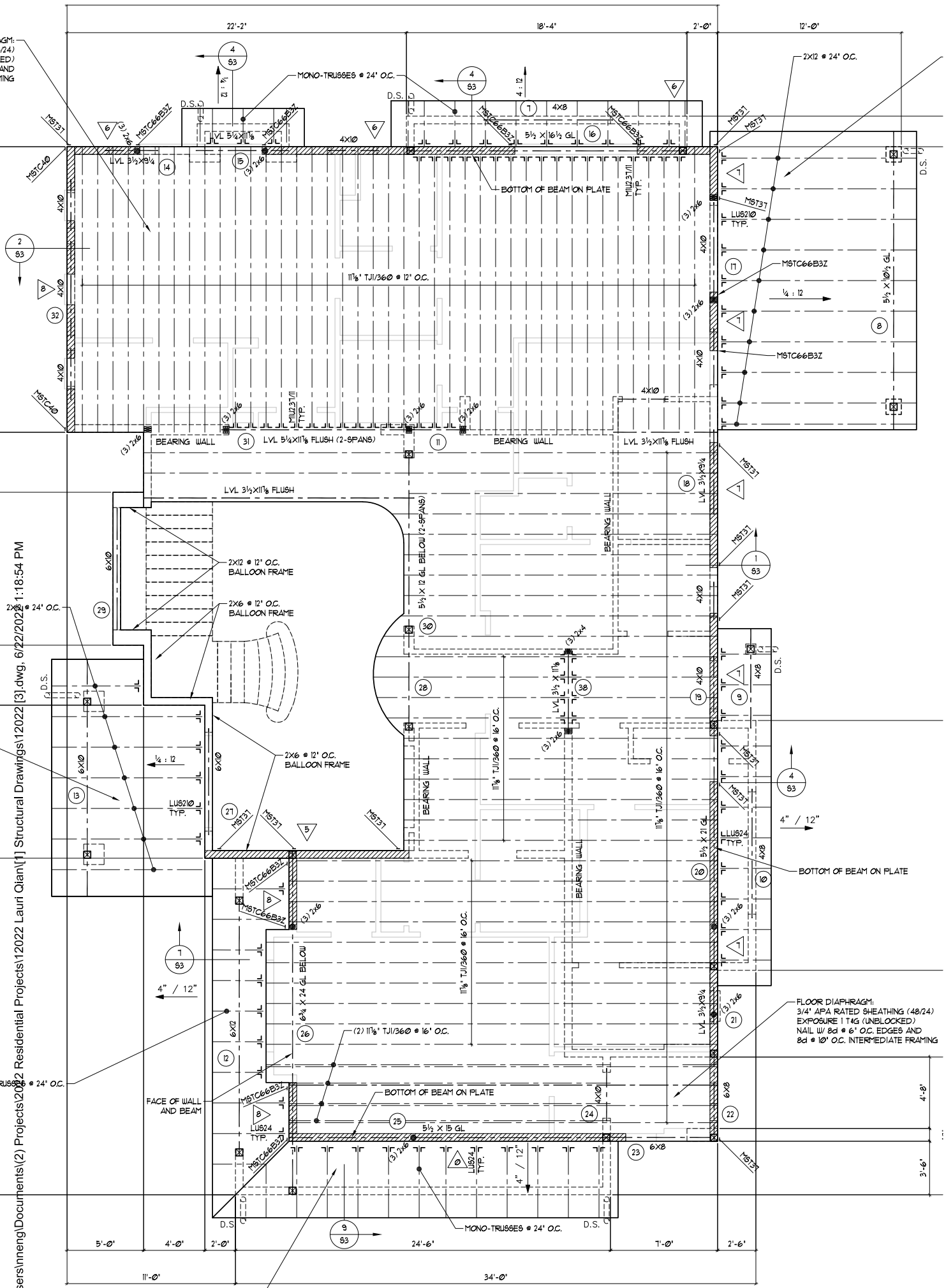
$I_{req} := \frac{5 \cdot w \cdot L^4}{384 \cdot E' \cdot \Delta_{TL}}$ $I_{req} = 16.28 \cdot in^4$ $\leq$ $I = 250 \cdot in^4$ **OK** $\frac{I_{req}}{I} = 6.51 \cdot \%$



FOUNDATION / MAIN FLOOR FRAMING PLAN

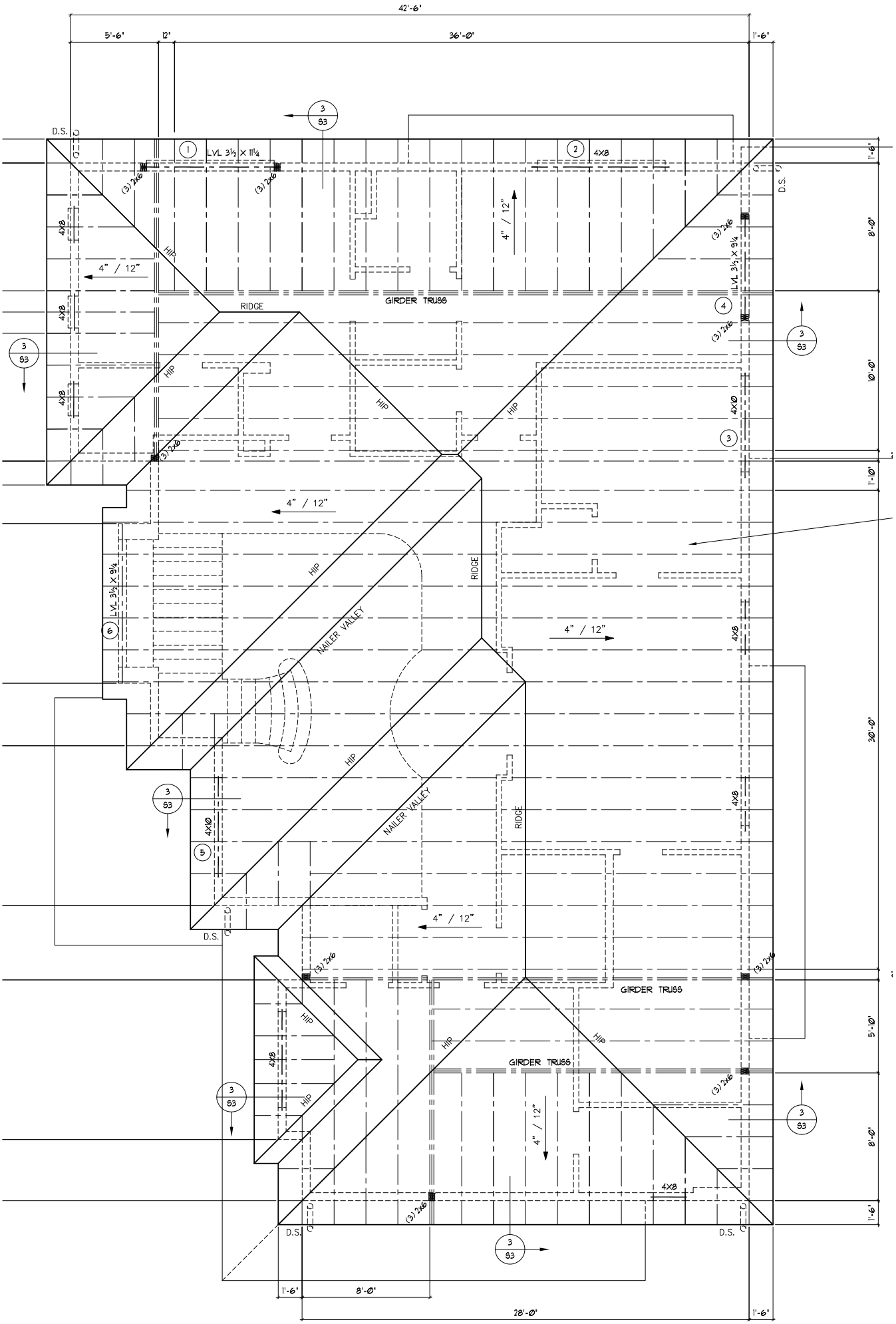
FOUNDATION VENTILATION:

PROVIDE CRAWL SPACE VENTILATION AS PER IBC SEC. 1
'CRAWLSPACE AREA' x 1/150 = TOTAL VENT AREA REQUIR



UPPER FLOOR FRAMING PLAN

C:\Users\nneng\Documents\(2) Projects\2022 Residential Projects\12022 Lauri Qian\[1] Structural Drawings\12022 [3].dwg, 6/22/2022 1:18:54 PM



ROOF FRAMING PLAN