



Beam Design

1. Beam Data

Load Type: Uniform Dist. Load
 Support: Simple Beam
 Beam Type: Sawn Lumber
 Species: Hem-Fir
 Grade: HF No.2
 Size: 2 x 12
 Design Span (L): 11.00 ft.
 Clear Span: 10.50 ft.
 Total Span: 11.50 ft.
 Bearing (lb): 6 in.
 Quantity (N): 4

2. Design Loads

Live Load: 330 plf
 Dead Load: 220 plf
 Selfweight: 153.4 lbs
 Dist. Selfweight: 13.94 plf
 Total Weight: 160.3 lbs

3. Design Options

Lateral Support: unbraced
 Defl. Limits: 360|240
 Load Duration: 1.00
 Exposure: dry
 Temperature: $T \leq 100^{\circ}\text{F}$
 Orientation: Vertical
 Incised Lumber: No
 Rep. Members: No

4. Design Assumptions and Notes

Code Standard: IBC 2015, NDS 2015
 Bending Stress: Parallel to Grain
 Notes:

5. Adjustment Factors

| Factor | Description | F_b | F_t | F_v | F_c | $F_{c \perp}$ | E/E_{min} |
|----------|--------------------------|---------|-------|-------|-------|---------------|-------------|
| C_D | Load Duration Factor | 1.00 | 1.00 | 1.00 | 1.00 | - | - |
| C_M | Wet Service Factor | 1^b | 1 | 1 | 1^c | 1 | 1 |
| C_t | Temperature Factor | 1 | 1 | 1 | 1 | 1 | 1 |
| C_L | Beam Stability Factor | 0.993 | - | - | - | - | - |
| C_F | Size Factor | 1 | 1 | - | 1 | - | - |
| C_{fu} | Flat Use Factor | 1.2^d | - | - | - | - | - |
| C_i | Incising Factor | 1 | 1 | 1 | 1 | 1 | 1 |
| C_r | Repetitive Member Factor | 1 | - | - | - | - | - |

a) Adjustment factors per AWC NDS 2015 and NDS 2015 Supplement.

b) When $(F_b)(C_F) \leq 1,150$ psi, $C_M = 1.0$.

c) When $(F_c)(C_F) \leq 750$ psi, $C_M = 1.0$.

d) Only applies when sawn lumber or glulam beams are loaded in bending about the y-y axis.

| | | | |
|------------------------|---|---|--|
| Subject Beam Design | Customer | Location 61 Elm Street, Somerville, MA | Job No. 2021A562 |
| Engr. N. Wilkerson | MEDEEK ENGINEERING INC. 3050 State Route 109 Copalis Beach, WA 98535 ph. (425) 741-5555 www.medeek.com | | Rev. - |
| Date 9/30/2021 | | |  <p>This report may not be copied, reproduced or distributed without the written consent of Medeek Engineering Inc.</p> <p>Page 1</p> <p>Copyright © 2014</p> |

6. Beam Calculations

Determine reference design values, sectional properties and self weight of beam:

$$A = b \times d$$

,

,

where:

b = Breadth of rectangular beam in bending (in.)

d = Depth of rectangular beam in bending (in.)

A = Cross sectional area of beam (in.²)

S_x = Section modulus about the X-X axis (in.³)

S_y = Section modulus about the Y-Y axis (in.³)

I_x = Moment of inertia about the X-X axis (in.⁴)

I_y = Moment of inertia about the Y-Y axis (in.⁴)

$$b = 1.500 \text{ in.}$$

$$d = 11.250 \text{ in.}$$

$$A = 1.500 \times 11.250 = 16.88 \text{ in.}^2$$

$$S_x = (1.500)(11.250)^2/6 = 31.64 \text{ in.}^3$$

$$S_y = (1.500)^2(11.250)/6 = 4.22 \text{ in.}^3$$

$$I_x = (1.500)(11.250)^3/12 = 177.98 \text{ in.}^4$$

$$I_y = (1.500)^3(11.250)/12 = 3.16 \text{ in.}^4$$

Reference Design Values from Table 4A NDS Supplement (Reference Design Values for Visually Graded Dimension Lumber, 2" - 4" thick).

| Species & Grade | F _b | F _t | F _v | F _{c⊥} | F _c | E | E _{min} | G |
|-----------------|----------------|----------------|----------------|-----------------|----------------|---------|------------------|------|
| HF No.2 | 850 | 525 | 150 | 405 | 1300 | 1300000 | 470000 | 0.43 |

The following formula shall be used to determine the density of wood (lbs/ft³). (NDS Supplement Sec. 3.1.3)

where:

ρ_w = Density of wood (lbs/ft³)

G = Specific gravity of wood (dimensionless)

m.c. = Moisture content of wood (percentile)

$$G = 0.43$$

$$\text{m.c.} = 19 \% \text{ (Max. moisture content at dry service conditions)}$$

| | | | |
|------------------------|---|---|---------------------|
| Subject Beam Design | Customer | Location 61 Elm Street, Somerville, MA | Job No. 2021A562 |
| Engr. N. Wilkerson | MEDEEK ENGINEERING INC. 3050 State Route 109 Copalis Beach, WA 98535 ph. (425) 741-5555 www.medeek.com | | Rev. - |
| Date 9/30/2021 | | | Page 2 |



This report may not be copied, reproduced or distributed without the written consent of Medeek Engineering Inc.

Copyright © 2014

$$= 29.74 \text{ lbs/ft}^3$$

$$\text{Volume}_{\text{total}} = N[A \times (L + l_b)] = 4 \times [16.88 \times (132.00 + 6)] \times (12 \text{ in./ft.})^3 = 5.39 \text{ ft}^3$$

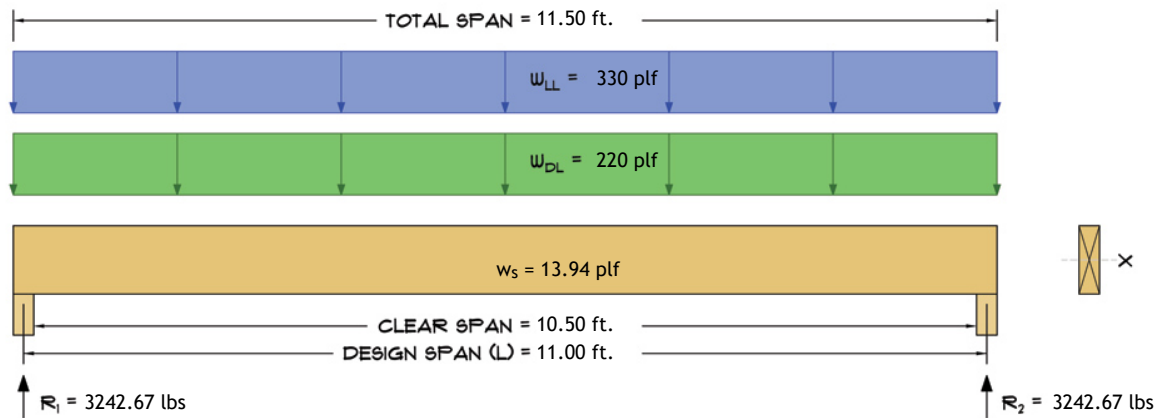
$$\text{Volume}_{\text{span}} = N[A \times L] = 4 \times [16.88 \times 132.00] \times (12 \text{ in./ft.})^3 = 5.16 \text{ ft}^3$$

$$\text{Total Weight (} W_T) = \rho_w \times \text{Volume}_{\text{total}} = 29.74 \times 5.39 = 160.3 \text{ lbs}$$

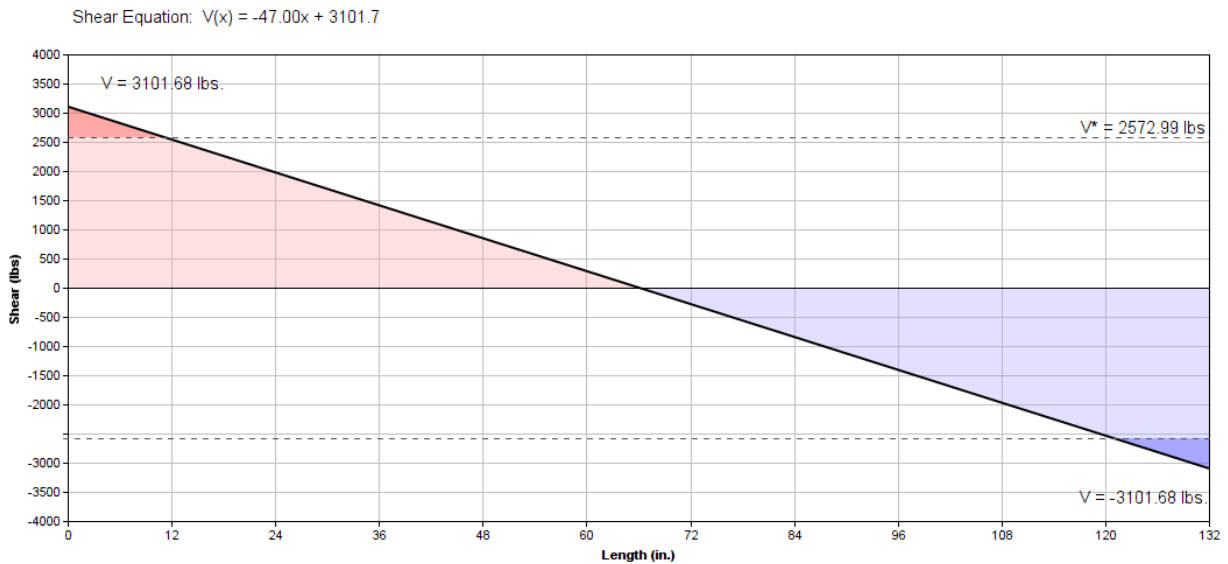
$$\text{Self Weight (} W_S) = \rho_w \times \text{Volume}_{\text{span}} = 29.74 \times 5.16 = 153.4 \text{ lbs}$$

$$\text{Distributed Self Weight (} w_s) = = 13.94 \text{ plf}$$

Load, Shear and Moment Diagrams:



Beam - Shear Diagram

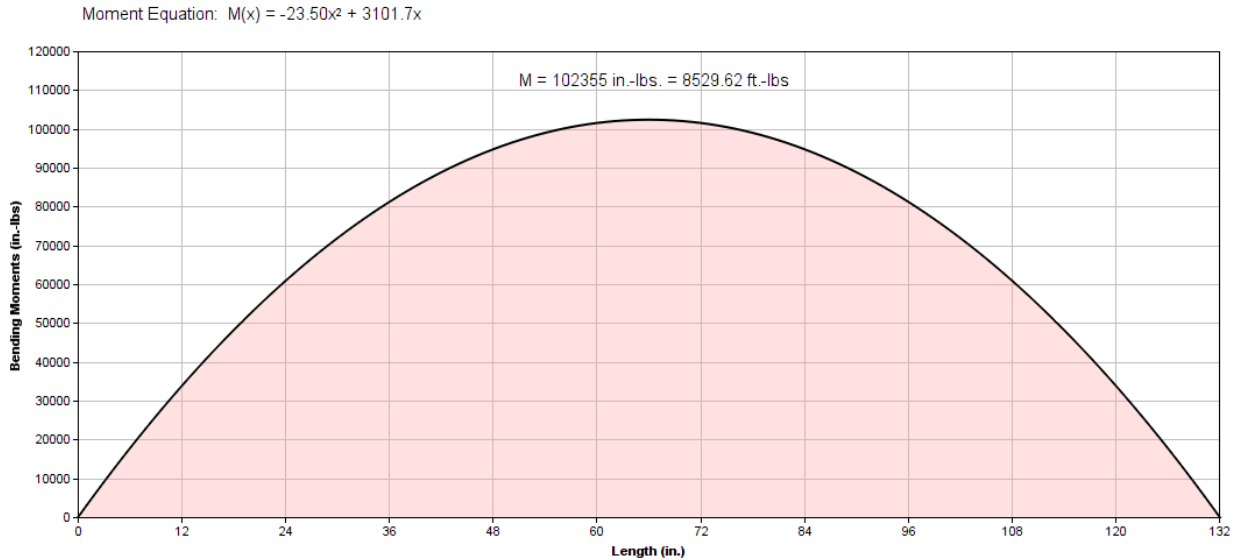


| | | | |
|-------------------------------|---|--|----------------------------|
| Subject Beam Design | Customer | Location 61 Elm Street, Somerville, MA | Job No. 2021A562 |
| Engr. N. Wilkerson | MEDEEK ENGINEERING INC. 3050 State Route 109 Copalis Beach, WA 98535 ph. (425) 741-5555 www.medeek.com | | Rev. - |
| Date 9/30/2021 | | | Page 3 |



This report may not be copied, reproduced or distributed without the written consent of Medeek Engineering Inc.

Beam - Moment Diagram



1.) Bending:

Members subject to bending stresses shall be proportioned so that the actual bending stress or moment shall not exceed the adjusted bending design value:

$$f_b \leq F_b' \quad (\text{NDS Sec. 3.3.1})$$

where:

$$f_b = M / S$$

$$F_b' = F_b(C_D)(C_M)(C_t)(C_L)(C_F)(C_i)(C_r)$$

Beam is unbraced along its compression edge, lateral stability is considered below:

Slenderness Ratio for bending member RB:

$$l_u = \text{Unbraced Length} = 11.000 \text{ ft.}$$

$$l_u/d = 11.73$$

$$l_e = 1.63l_u + 3d = 1.63(132.0) + 3(11.25) = 248.91 \text{ in.} = 20.74 \text{ ft.} \quad (\text{NDS Table 3.3.3})$$

$$R_b = 8.82$$

$$R_b = 8.82 < 50 \quad ? \quad \text{OK}$$

| | | | |
|-------------------------------|---|--|---|
| Subject Beam Design | Customer | Location 61 Elm Street, Somerville, MA | Job No. 2021A562 |
| Engr. N. Wilkerson | MEDEEK ENGINEERING INC. 3050 State Route 109 Copalis Beach, WA 98535 ph. (425) 741-5555 www.medeek.com | | Rev. - |
| Date 9/30/2021 | | |  This report may not be copied, reproduced or distributed without the written consent of Medeek Engineering Inc. Copyright © 2014 |

Euler-based ASD critical buckling value for bending members:

$$E_{\min y}' = E_{\min y}(C_M)(C_t)(C_i) = 470000(1)(1)(1) = 470000 \text{ psi}$$

$$F_{bE} = = 7250.81 \text{ psi}$$

$$F_{bx}^* = F_{bx}(C_D)(C_M)(C_t)(C_F)(C_i)(C_r) = (850)(1.00)(1)(1)(1)(1)(1) = 850.00 \text{ psi}$$

Beam stability factor:

$$C_L = = 0.993$$

$$F_{bx}' = (850)(1.00)(1)(1)(0.993)(1)(1)(1) = 844.4 \text{ psi}$$

$$f_b = = 808.7 \text{ psi}$$

$$f_b = 808.7 \text{ psi} < F_{bx}' = 844.4 \text{ psi} \text{ (CSI} = 0.96) \text{ ? OK}$$

2.) Shear:

Members subject to shear stresses shall be proportioned so that the actual shear stress parallel to grain or shear force at any cross section of the bending member shall not exceed the adjusted shear design value:

$$f_v \leq F_v' \text{ (NDS Sec. 3.4.1)}$$

where:

$$f_v =$$

$$F_v' = F_v(C_D)(C_M)(C_t)(C_i)$$

$$F_{vx}' = (150)(1.00)(1)(1)(1) = 150.00 \text{ psi}$$

Shear Reduction: Uniformly distributed loads within a distance, d , from supports equal to the depth of the bending member shall be permitted to be ignored. Concentrated loads within a distance equal to the depth of the bending member from supports shall be permitted to be multiplied by x/d where x is the distance from the beam support face to the load. See NDS 2015, Figure 3C.

$$f_v^* = = 57.18 \text{ psi}$$

$$f_v^* = 57.18 \text{ psi} < F_{vx}' = 150.00 \text{ psi} \text{ (CSI} = 0.38) \text{ ? OK}$$

No Reduction in Shear (conservative):

$$f_v = = 68.93 \text{ psi}$$

$$f_v = 68.93 \text{ psi} < F_{vx}' = 150.00 \text{ psi} \text{ (CSI} = 0.46) \text{ ? OK}$$

| | | | |
|------------------------|--|---|---------------------|
| Subject Beam Design | Customer | Location 61 Elm Street, Somerville, MA | Job No. 2021A562 |
| Engr. N. Wilkerson | MEDEEK ENGINEERING INC. 3050 State Route 109 Copalis Beach, WA 98535 ph. (425) 741-5555 www.medeek.com | | Rev. - |
| Date 9/30/2021 | | | Page 5 |

This report may not be copied, reproduced or distributed without the written consent of Medeek Engineering Inc.



Copyright © 2014

3.) Deflection:

Bending deflections calculated per standard method of engineering mechanics for live load and total load:

LL Allowable: $L/360$

TL Allowable: $L/240$

$$E_x' = E_x(C_M)(C_t)(C_i) = 1300000(1)(1)(1) = 1300000 \text{ psi}$$

$$\Delta_{LL} = = 0.12 \text{ in.}$$

$$(L/d)_{LL} = 132.00 / 0.12 = 1124$$

$$\Delta_{LL} = 0.12 \text{ in} = L/1124 < L/360 \quad ? \text{ OK}$$

$$\Delta_{TL} = = 0.20 \text{ in.}$$

$$(L/d)_{TL} = 132.00 / 0.20 = 658$$

$$\Delta_{TL} = 0.20 \text{ in} = L/658 < L/240 \quad ? \text{ OK}$$

4.) Bearing:

Members subject to bearing stresses perpendicular to the grain shall be proportioned so that the actual compressive stress perpendicular to grain shall be based on the net bearing area and shall not exceed the adjusted compression design value perpendicular to grain:

$$f_{c \perp} \leq F_{c \perp}' \quad (\text{NDS Sec. 3.10.2})$$

where:

$$f_{c \perp} =$$

$$F_{c \perp}' = F_{c \perp}(C_M)(C_t)(C_i)$$

$$F_{c \perp x}' = (405)(1)(1)(1) = 405.00 \text{ psi}$$

$$A_b = b \times l_b = 1.5 \times 6 = 9.00 \text{ in}^2$$

$$f_{c \perp} = = 90.1 \text{ psi}$$

$$f_{c \perp} = 90.1 \text{ psi} < F_{c \perp x}' = 405.00 \text{ psi} \quad (\text{CSI} = 0.22) \quad ? \text{ OK}$$

*Disclaimer: The calculations produced herein are for initial design and estimating purposes only. The calculations and drawings presented do not constitute a fully engineered design. All of the potential load cases required to fully design an actual structure may not be provided by this calculator. For the design of an actual structure, a registered and licensed professional should be consulted as per IRC 2012 Sec. R802.10.2 and designed according to the minimum requirements of ASCE 7-10. The beam calculations provided by this online tool are for educational and illustrative purposes only. Medeek Design assumes no liability or loss for any designs presented and does not guarantee fitness for use.

| | | | |
|------------------------|---|---|---------------------|
| Subject Beam Design | Customer | Location 61 Elm Street, Somerville, MA | Job No. 2021A562 |
| Engr. N. Wilkerson | MEDEEK ENGINEERING INC. 3050 State Route 109 Copalis Beach, WA 98535 ph. (425) 741-5555 www.medeek.com | | Rev. - |
| Date 9/30/2021 | | | Page 6 |

This report may not be copied, reproduced or distributed without the written consent of Medeek Engineering Inc.

Copyright © 2014