

Beam Design - Roof Beam Sizing

1. Beam Data

2. Design Loads

Load Type: Uniform Dist. Load Live Load: 723 plf Support: Simple Beam Dead Load: 494 plf Glulam Selfweight: Beam Type: 598.0 lbs Species: Southern Pine Dist. Selfweight: 31.00 plf 24F-V8 1.8E SP/SP Grade: Total Weight: 612.2 lbs

 Size:
 5.5 x 22

 Design Span (L):
 19.29 ft.

 Clear Span:
 18.83 ft.

 Total Span:
 19.75 ft.

 Bearing (lb):
 5.5 in.

 Quantity (N):
 1

4. Design Assumptions and Notes

Lateral Support: braced Code

Defl. Limite: 180120 Standard:

BC 2015, NDS 2015

Defl. Limits: 180|120 Standard:

Lead Duration: 1.15 Bending

Load Duration: 1.15

Exposure: dry

Bending
Stress:

Parallel to Grain

Exposure: dry

Temperature: $T \le 100^{\circ}F$ Orientation: Vertical

Notes: Sizing for the main roof beam, which bears the dead and live loads from both the south and north roofs, including solar PV and extensive green roof

including solar PV and extensive green roof installations.

5. Adjustment Factors

3. Design Options

Factor	Description	Fb	Ft	$F_{\mathbf{v}}$	Fc	$F_{c\perp}$	E/E _{min}
C_{D}	Load Duration Factor	1.15	1.15	1.15	1.15	-	-
C _M	Wet Service Factor	1	1	1	1	1	1
Ct	Temperature Factor	1	1	1	1	1	1
CL	Beam Stability Factor	1	-	-	-	-	-
Cv	Volume Factor	0.971 ^b	-	-	_	_	-
C _{fu}	Flat Use Factor	N/A ^c	-	-	-	-	-

- a) Adjustment factors per AWC NDS 2015 and NDS 2015 Supplement.
- b) The volume factor, C_V , shall not apply simultaneously with the beam stability factor, C_L . The lesser factor shall apply.
- c) Only applies when glulam beam is loaded in bending about the y-y axis.

Subject	Customer	Location	Job No.				
Beam Design	Steven Rhodes 1302 Tarragon Drive, Marysville OH 43040						
N. Wilkerson	MEDEEK ENGINEERING INC. This report may not be copled, reproduced or distributed without the written consent of Medeek Engineering Inc.						
5/29/2021	3050 State Route 109 Copa ph. (425) 741-5555 www.r	alis Beach, WA 98535 medeek.com	Page 1				

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 = 5.500 in.

d = 22.000 in.

 $A = 5.500 \times 22.000 = 121.00 \text{ in.}^2$

 $S_x = (5.500)(22.000)^2/6 = 443.67 \text{ in.}^3$

 $S_V = (5.500)^2 (22.000)/6 = 110.92 \text{ in.}^3$

 $I_x = (5.500)(22.000)^3/12 = 4880.33 \text{ in.}^4$

 $I_y = (5.500)^3 (22.000)/12 = 305.02 \text{ in.}^4$

Reference Design Values from Table 5A NDS Supplement (Reference Design Values for Structural Glue Laminated Softwood Timber Combinations).

Species & Grade	F _{bx} +	F _{bx} -	$F_{c\perp x}$	Fvx	Ex	Eminx	Fby	$F_{c\perp y}$	Fvy	Ey	Eminy	Ft	Fc	G
24F-V8 1.8E SP/SP	2400	2400	740	300	1800000	950000	1700	650	260	1600000	850000	1150	1650	0.55

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

where:

 $\rho_{\rm W}$ = Density of wood (lbs/ft³

G = Specific gravity of wood (dimensionless)

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

G = 0.55

m.c. = 16 % (Max. moisture content at dry service conditions)

Subject Beam Design	Steven Rhodes Location 1302 Tarragon Drive, Marysville OH 43040					
Engr.	Steven Italiaas	This report may not be	CPH1			
N. Wilkerson	MEDEEK ENGINE	ERING INC.	-			
5/29/2021	3050 State Route 109 Copa ph. (425) 741-5555 www.r	lis Beach, WA 98535 nedeek.com	Page 2			

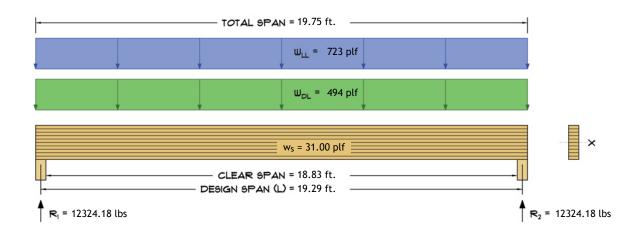
$$= 36.89 \text{ lbs/ft}^3$$

$$\begin{aligned} & Volume_{total} = N[A \ x \ (L + l_b)] = 1 \ x \ [121.00 \ x \ (231.50 + 5.5)] \ x \ (12 \ in./ft.)^3 = 16.60 \ ft^3 \\ & Volume_{span} = N[A \ x \ L] = 1 \ x \ [121.00 \ x \ 231.50] \ x \ (12 \ in./ft.)^3 = 16.21 \ ft^3 \end{aligned}$$

Total Weight (W_T) = ρ_W x Volume_{total} = 36.89 x 16.60 = 612.2 lbs Self Weight (W_S) = ρ_W x Volume_{span} = 36.89 x 16.21 = 598.0 lbs

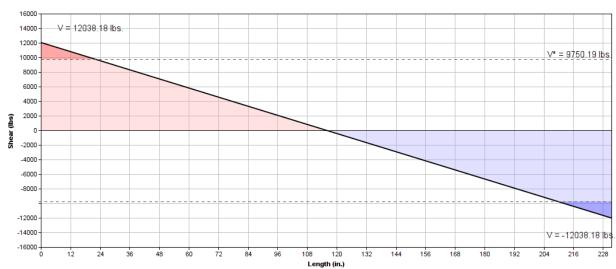
Distributed Self Weight (w_s) = = 31.00 plf

Load, Shear and Moment Diagrams:



Beam - Shear Diagram

Shear Equation: V(x) = -104.00x + 12038.2



Subject	Customer	Location	Job No.		
Beam Design	Steven Rhodes	1302 Tarragon Drive, Marysville OH 43040	CPH1		
N. Wilkerson	MEDEEK ENGINEERING INC. This report may not be copied, reproduced or distributed without the written consent of Medeek Engineering Inc.				
5/29/2021	3050 State Route 109 Copa ph. (425) 741-5555 www.r	ilis Beach, WA 98535	Page 3		

Beam - Moment Diagram

Moment Equation: $M(x) = -52.00x^2 + 12038.2x$



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:

$$f_b \leq F_{b} \text{'} \ \textit{(NDS Sec. 3.3.1)}$$

where:

$$f_b = M / S$$

$$F_{bx}{'} = F_{bx}(C_D)(C_M)(C_t)(C_V) \quad \text{or} \quad F_{bx}{'} = F_{bx}(C_D)(C_M)(C_t)(C_L)$$

Beam is braced laterally along its compression edge. Laterial stability is not a consideration:

 C_L = Beam Stability Factor = 1.0

$$C_V = -0.971$$

Volume effect governs over lateral stability:

$$C_V = 0.971 < C_L = 1$$

$$F_{bx}' = (2400)(1.15)(1)(1)(0.971) = 2679.5 \text{ psi}$$

$$f_b = 1570.4 \text{ psi}$$

$$f_b = 1570.4 \text{ psi} < F_{bx'} = 2679.5 \text{ psi } (CSI = 0.59)$$
 ? **OK**

Subject	Customer	Location	Job No.				
Beam Design	Steven Rhodes 1302 Tarragon Drive, Marysville OH 43040						
Engr.			Rev.				
N. Wilkerson	MEDEEK ENGINEERING INC. This report may not be copied, reproduced or distributed without the written consent of warning to the control of th						
5/29/2021	3050 State Route 109 Copa ph. (425) 741-5555 www.n	lis Beach, WA 98535	Page 4				
	Copyright © 201						

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:

$$f_v \le F_{v'}$$
 (NDS Sec. 3.4.1)

where:

$$f_v =$$

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

$$F_{vx'} = (300)(1.15)(1)(1) = 345.00 \text{ psi}$$

Shear Reduction: For beams supported by full bearing on one surface and loads applied to the opposite surface, uniformly distributed loads within a distance, d, from supports equal to the depth of the bending member shall be pemitted to be ignored. For beams supported by full bearing on one surface and loads applied to the opposite surface, 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.

$$f_v* = 120.87 \text{ psi}$$

$$f_v^* = 120.87 \text{ psi} < F_{vx'} = 345.00 \text{ psi} \text{ (CSI} = 0.35) ? OK$$

No Reduction in Shear (conservative):

$$f_v = 149.23 \text{ psi}$$

$$f_v = 149.23 \ psi < F_{vx}{}' = 345.00 \ psi \ (CSI = 0.43) \ ? \ \textbf{OK}$$

3.) Deflection:

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

LL Allowable: L/180 TL Allowable: L/120

$$E_{x'} = E_{x}(C_{M})(C_{t}) = 1800000(1)(1) = 18000000 \text{ psi}$$

Subject	Customer Location J						
Beam Design	Steven Rhodes 1302 Tarragon Drive, Marysville OH 43040						
N. Wilkerson	MEDEEK ENGINEERING INC. This report may not be copied, reproduced or distributed without the written consent of Medeek Engineering Jin.						
5/29/2021	3050 State Route 109 Copa ph. (425) 741-5555 www.r		Page 5				

$$\Delta_{LL} = = 0.26$$
 in.

$$(L/d)_{LL} = 231.50 / 0.26 = 903$$

$$\Delta_{LL} = 0.26 \text{ in} = L/903 < L/180$$
 ? **OK**

$$\Delta_{TL} = 0.44 \text{ in.}$$

$$(L/d)_{TL} = 231.50 / 0.44 = 523$$

$$\Delta_{TL} = 0.44 \text{ in} = L/523 < L/120$$
 ? **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:

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

where:

$$f_{c\perp} =$$

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

$$F_{c \perp x'} = (740)(1)(1) = 740.00 \text{ psi}$$

$$A_b = b \times l_b = 5.5 \times 5.5 = 30.25 \text{ in}^2$$

$$f_{c\perp}$$
 = = 407.4 psi

$$f_{c\perp} = 407.4 \text{ psi} < F_{c\perp x}' = 740.00 \text{ psi} \text{ (CSI} = 0.55)$$
 ? **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.

Beam Design	Steven Rhodes 1302 Tarragon Drive, Marysville OH 43040				СРН1
N. Wilkerson	MEDEEK ENGINE			This report may not be copied, reproduced or distributed without the written consent of Medeek Engineering Inc.	Rev.
5/29/2021	3050 State Route 109 Copa ph. (425) 741-5555 www.r	llis Beach, WA 98535 medeek.com			Page 6