

# Beam Design - Shmidt Garage Addition

2. Design Loads

4. Design Assumptions and Notes

## 1. Beam Data

Uniform Dist. Load Live Load: 100 plf Load Type: Support: Simple Beam Dead Load: 75 plf Sawn Lumber Beam Type: Selfweight: 46.5 lbs Southern Pine Dist. Selfweight: 5.64 plf Species: SP No.2 Grade: Total Weight: 47.9 lbs

 Size:
 2 x 8

 Design Span (L):
 8.25 ft.

 Clear Span:
 8.00 ft.

 Total Span:
 8.50 ft.

 Bearing (lb):
 3 in.

 Quantity (N):
 2

# 3. Design Options

Lateral Support: braced Code Standard: IBC 2015, NDS 2015

Defl. Limits: 360|240 Bending Stress: Parallel to Grain

Load Duration: 1.15 Notes:

Load Duration:1.15Exposure:dryTemperature: $T \le 100^{\circ}F$ Orientation:VerticalIncised Lumber:NoRep. Members:No

# 5. Adjustment Factors

Factor	Description	Fb	Ft	$F_{\mathbf{v}}$	Fc	Fc⊥	E/E <sub>min</sub>
CD	Load Duration Factor	1.15	1.15	1.15	1.15	-	-
CM	Wet Service Factor	1 <sup>b</sup>	1	1	1 <sup>c</sup>	1	1
Ct	Temperature Factor	1	1	1	1	1	1
CL	Beam Stability Factor	1	-	-	-	-	-
CF	Size Factor	1	1	-	1	-	-
Cfu	Flat Use Factor	1.15 <sup>d</sup>	_	-	_	-	-
Ci	Incising Factor	1	1	1	1	1	1
Cr	Repetitive Member Factor	1	-	-	-	-	-

- a) Adjustment factors per AWC NDS 2015 and NDS 2015 Supplement.
- b) When  $(F_b)(C_F) \le 1,150$  psi,  $C_M = 1.0$ .
- c) When  $(F_c)(C_F) \le 750 \text{ psi}$ ,  $C_M = 1.0$ .
- d) Only applies when sawn lumber or glulam beams are loaded in bending about the y-y axis.

Beam Design	KEVIN SCHMIDT	1145 Pamela	Road	2023.5
N. Wilkerson	MEDEEK ENGINE		This report may not be copied, reproduced or distributed without the written consent of Medeek Engineering Inc.	Rev.
2/1/2023	3050 State Route 109 Copa ph. (425) 741-5555 www.r	lis Beach, WA 98535 nedeek.com	Copyright © 2014	Page 1

## 6. Beam Calculations

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

$$A = b \times d$$

$$S_x = \frac{bd^2}{6}, \ S_y = \frac{b^2d}{6}$$

$$I_x = \frac{bd^3}{12}, \ I_y = \frac{b^3d}{12}$$

where:

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

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

A = Cross sectional area of beam (in.<sup>2</sup>)

 $S_X$  = Section modulus about the X-X axis (in.<sup>3</sup>)

 $S_y$  = Section modulus about the Y-Y axis (in.<sup>3</sup>)

 $I_X$  = Moment of inertia about the X-X axis (in.<sup>4</sup>)

 $I_y = Moment of inertia about the Y-Y axis (in.<sup>4</sup>)$ 

b = 1.500 in.

d = 7.250 in.

$$A = 1.500 \text{ x } 7.250 = 10.88 \text{ in.}^2$$

$$S_x = (1.500)(7.250)^2/6 = 13.14 \text{ in.}^3$$

$$S_v = (1.500)^2 (7.250)/6 = 2.72 \text{ in.}^3$$

$$I_x = (1.500)(7.250)^3/12 = 47.63 \text{ in.}^4$$

$$I_v = (1.500)^3 (7.250)/12 = 2.04 \text{ in.}^4$$

Reference Design Values from Table 4B NDS Supplement (Reference Design Values for Visually Graded Southern Pine Dimension Lumber, 2" - 4" thick). Values per March 2013 Addendum

Species & Grade	Fb	Ft	$F_{\mathbf{v}}$	Fc⊥	Fc	Е	Emin	G
SP No.2	925	550	175	565	1350	1400000	510000	0.55

The following formula shall be used to determine the density of wood (lbs/ft<sup>3</sup>. (NDS Supplement Sec. 3.1.3)

$$\rho_w = 62.4 \left[ \frac{G}{1 + G(0.009)(m.c)} \right] \left[ 1 + \frac{m.c.}{100} \right]$$

where:

 $\rho_W$  = Density of wood (lbs/ft<sup>3</sup>

G = Specific gravity of wood (dimensionless)

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

G = 0.55

m.c. = 19 % (Max. moisture content at dry service conditions)

Beam Design	Customer KEVIN SCHMIDT	1145 Pamela Road	Job No. 2023.5
N. Wilkerson	MEDEEK ENGINE	ERING INC.  This report may not be copied, reproduced or distributed without the wirth consent of	Rev
Date 2/1/2023	3050 State Route 109 Copa ph. (425) 741-5555 www.r	lis Beach, WA 98535 nedeek.com	Page 2

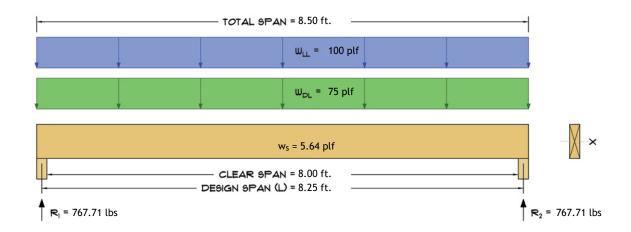
$$\rho_w = 62.4 \left[ \frac{0.55}{1 + 0.55(0.009)(19)} \right] \left[ 1 + \frac{19}{100} \right] = 37.33 \text{ lbs/ft}^3$$

Volume<sub>total</sub> = N[A x (L + l<sub>b</sub>)] = 2 x [10.88 x (99.00 + 3)] x (12 in./ft.)<sup>3</sup> = 1.28 ft<sup>3</sup> Volume<sub>span</sub> = N[A x L] = 2 x [10.88 x 99.00] x (12 in./ft.)<sup>3</sup> = 1.25 ft<sup>3</sup>

Total Weight (W<sub>T</sub>) =  $\rho_W$  x Volume<sub>total</sub> = 37.33 x 1.28 = 47.9 lbs Self Weight (W<sub>S</sub>) =  $\rho_W$  x Volume<sub>span</sub> = 37.33 x 1.25 = 46.5 lbs

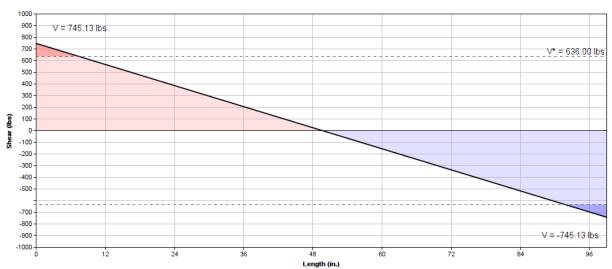
Distributed Self Weight (w<sub>s</sub>) = 
$$\frac{W_S}{L} = \frac{46.5}{8.25}$$
 = 5.64 plf

### Load, Shear and Moment Diagrams:



Beam - Shear Diagram

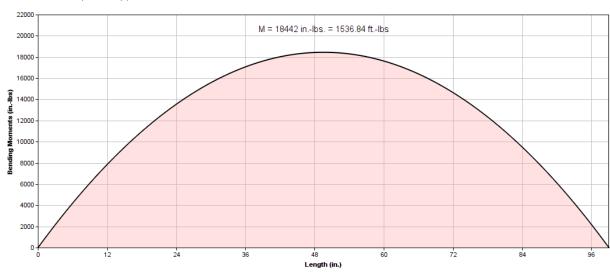
Shear Equation: V(x) = -15.05x + 745.1



Subject Beam Design	Customer KEVIN SCHMIDT	Location 1145 Pamela Road	Job No. 2023.5
N. Wilkerson	MEDEEK ENGINE	written con:	ed or t the nt of
Date 2/1/2023	3050 State Route 109 Copa ph. (425) 741-5555 www.r	lis Beach, WA 98535	Page 3

#### Beam - Moment Diagram

Moment Equation:  $M(x) = -7.53x^2 + 745.1x$ 



## 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:

$$f_b = M / S$$

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

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

 $C_L$  = Beam Stability Factor = 1.0

$$F_{bx}' = (925)(1.15)(1)(1)(1)(1)(1)(1) = 1063.8 \text{ psi}$$

$$\mathbf{f_b} = \frac{M}{N \times S_x} = \frac{18442}{2 \times 13.14} = 701.7 \text{ psi}$$

$$f_b = 701.7 \text{ psi} < F_{bx'} = 1063.8 \text{ psi} \text{ (CSI} = 0.66) ? OK$$

Subject	Customer	Location	Job No.
Beam Design	KEVIN SCHMIDT	1145 Pamela Road	2023.5
N. Wilkerson	MEDEEK ENGINE	written consent of	Rev. –
Date 2/1/2023	3050 State Route 109 Copa ph. (425) 741-5555 www.r		Page 4

## 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:

$$\mathbf{f_v} = \frac{3V}{2A}$$

$$F_{v'} = F_{v}(C_{D})(C_{M})(C_{t})(C_{i})$$

$$F_{vx'} = (175)(1.15)(1)(1)(1) = 201.25 \text{ psi}$$

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.

$$\mathbf{f_{v}}^* = \frac{3V^*}{2(N \times A)} = \frac{3(636.00)}{2(2 \times 10.88)} = 43.86 \text{ psi}$$

$$f_v^* = 43.86 \text{ psi} < F_{vx'} = 201.25 \text{ psi} \text{ (CSI} = 0.22)$$
 ? **OK**

No Reduction in Shear (conservative):

$$f_{V} = \frac{3V}{2(N \times A)} = \frac{3(745.13)}{2(2 \times 10.88)} = 51.39 \text{ psi}$$

$$f_v = 51.39 \text{ psi} < F_{vx'} = 201.25 \text{ psi} \text{ (CSI} = 0.26)$$
 ? **OK**

### 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

$$E_{x'} = E_{x}(C_{M})(C_{t})(C_{i}) = 1400000(1)(1)(1) = 1400000 \text{ psi}$$

Subject	Customer	Location	Job No.
Beam Design	KEVIN SCHMIDT	1145 Pamela Road	2023.5
N. Wilkerson	MEDEEK ENGINE	written consent of	-
2/1/2023	3050 State Route 109 Copa ph. (425) 741-5555 www.r	llis Beach, WA 98535	Page 5

$$\Delta_{\rm LL} = \frac{5w_{LL}L^4}{384E_x'(N\times I_x)} = \frac{5(100)(8.250)^4}{384(1400000)(2\times47.63)}\times \left(12\frac{in.}{ft.}\right)^3 = \textbf{0.08 in.}$$

$$(L/d)_{LL} = 99.00 / 0.08 = 1267$$

$$\Delta_{LL} = 0.08 \text{ in} = L/1267 < L/360$$
 ? **OK**

$$\Delta_{\rm TL} = \frac{5(w_{TL} + w_s)L^4}{384 E_x'(N \times I_x)} = \frac{5(175 + 5.64)(8.250)^4}{384(1400000)(2 \times 47.63)} \times \left(12 \frac{in.}{ft.}\right)^3 = \textbf{0.14 in.}$$

$$(L/d)_{TL} = 99.00 / 0.14 = 701$$

$$\Delta_{TL} = 0.14 \text{ in} = L/701 < L/240$$
 ? **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:

$$f_{c\perp} = \frac{R}{A_b}$$

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

$$F_{c+x}' = (565)(1)(1)(1) = 565.00 \text{ psi}$$

$$A_b = b \times l_b = 1.5 \times 3 = 4.50 \text{ in}^2$$

$$\mathbf{f_{c}}_{\perp} = \frac{R}{N \times A_b} = \frac{767.71}{2 \times 4.50} = 85.3 \text{ psi}$$

$$f_{c\perp} = 85.3 \text{ psi} < F_{c\perp x'} = 565.00 \text{ psi} \text{ (CSI} = 0.15)$$
 ? **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	Customer	Location 1145 D. 1 D. 1	Job No.
Beam Design	KEVIN SCHMIDT	1145 Pamela Road	2023.5
N. Wilkerson	MEDEEK ENGINE	written consent of	Rev.
Date 2/1/2023	3050 State Route 109 Copa ph. (425) 741-5555 www.r	ilis Beach, WA 98535	Page 6