LETTER KEY

w = uniform load per length in inches
ℓ = length of member between supporting members in inches
L = length of member between supporting members in feet
b = width of rectangular member (actual not nominal) in inches
d = depth of rectangular member (actual not nominal) in inches
S = section modulus of lumber
M = bending moment in inch-pounds
E = modulus of elasticity of lumber
I = moment of inertia in $(\text{inches})^4$

LETTER KEY

F_b = allowable unit stress for extreme fiber in psi
F_v = allowable unit horizontal shear in psi
R_v = vertical reaction in pounds
PSF = pounds per square foot
PLF = pounds per lineal foot
psi = pounds per square inch
TL = total load
LL = live load
D = actual deflection

FORMULAS

Load on Joist - PSF x Spacing/12” = PLF

Maximum Bending Moment - $M = TL \times L/8$

Section Modulus - $S = b \times d^2/6$

Maximum Fiber Stress - $F_{b\ max} = M/S$

Moment of Inertia - $I = b \times d^3/12$

FORMULAS

Actual Deflection - $D = \dfrac{5 \times TL \times L^3}{384 \times E \times I}$

Allowable Deflection - $\ell/360$

Horizontal Shear - $R_v = PLF \times L/2$

$$F_v = \frac{3 \times R_v}{2 \times b \times d}$$

CALCULATIONS

1. Case Scenario: Use 3” X 10” (full) #3 SPF as a floor joist 24” o.c.

2. Design Data: Deflection = ℓ/360; Live Load = 40 psf; Dead Load = 10 psf; Joist Span (out to out) = 12’

Design Values from Table 4a of the NDS.

F_b = 500 F_t = 250 F_v = 135 $F_{c\perp}$ = 425 F_c = 650 E = 1,200,000

ADJUSTMENT FACTORS

NDS Table 4a

Repetitive Member Factor, C_r

Wet Service Factor, C_M

Flat Use Factor, C_{fu}

Size Factor, C_F

ADJUSTMENT FACTORS

NDS Table 4a

Repetitive Member Factor, C_r

Wet Service Factor, C_M

Flat Use Factor, C_{fu}

Size Factor, C_F

ADJUSTMENT FACTORS

Repetitive Member Factor, C_r

Bending design values, F_b, for dimension lumber 2” to 4" thick shall be multiplied by the repetitive member factor, C_r = 1.15, when such members are used as joists, truss chords, rafters, studs, planks, decking, or similar members which are in contact or spaced not more than 24” on center, are not less than 3 in number and are joined by floor, roof, or other load distributing elements adequate to support the design load.

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ADJUSTMENT FACTORS

Size Factor, C_f

Tabulated bending, tension, and compression parallel to grain design values for dimension lumber 2" to 4" thick shall be multiplied by the following size factors:

ADJUSTMENT FACTORS

Size Factors, C_F

Grades	Width (depth)	F_b Thickness (breadth) 2" & 3"	F_b Thickness (breadth) 4"	F_t	F_c
Select Structural, No.1 & Btr, No.1, No.2, No.3	2", 3", & 4"	1.5	1.5	1.5	1.15
	5"	1.4	1.4	1.4	1.1
	6"	1.3	1.3	1.3	1.1
	8"	1.2	1.3	1.2	1.05
	10"	1.1	1.2	1.1	1.0
	12"	1.0	1.1	1.0	1.0
	14" & wider	0.9	1.0	0.9	0.9
Stud	2", 3", & 4"	1.1	1.1	1.1	1.05
	5" & 6"	1.0	1.0	1.0	1.0
	8" & wider	Use No.3 Grade tabulated design values and size factors			
Construction, Standard	2", 3", & 4"	1.0	1.0	1.0	1.0
Utility	4"	1.0	1.0	1.0	1.0
	2" & 3"	0.4	—	0.4	0.6

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Design Values from Table 4a of the NDS.

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Adjustment factors: F_b x C_r x C_f

F_b = 500 x 1.15 x 1.1 = 632.5 psi

CALCULATIONS

3. Load on Joist

50 psf x 24”/12” = 100 plf - 100 plf x 12’ = 1,200 lbs TL

4. Maximum Bending Moment

1,200 lbs x (12’ x 12”)/8 = 21,500 in lbs.

5. Section Modulus of a 3 x 10 (full)

3” x 10^2”/6 = 50 in^3

CALCULATIONS

6. Maximum Fiber Stress

21,600 in lbs./50 in^3 = 432 psi

432 psi < 632 psi

Maximum Fiber Stress is OK

CALCULATIONS

7. Check the Deflection for Total Load

A. Determine the moment of inertia for a 3 x 10

$3x10^3/12 = 250 \text{ in}^4$

CALCULATIONS

7. Calculate the Actual (B.) and Allowable (C.) Deflection

B. $$\frac{5 \times 1{,}200 \times 144^3}{384 \times 1{,}200{,}000 \times 250} = .155"$$

C. $$\frac{\ell}{360} = \frac{144}{360} = .40"$$

CALCULATIONS

7. Calculate the Actual (B.) and Allowable (C.) Deflection

B.

$$\frac{5 \times 1{,}200 \times 144^3}{384 \times 1{,}200{,}000 \times 250} = .155''$$

C.

$$\frac{\ell}{360} = \frac{144}{360} = .40''$$

$$.155'' < .40''$$

Deflection is OK

CALCULATIONS

8. Calculate Allowable Horizontal Shear

$$100 \text{ PLF} \times \frac{12}{2} = 600 \text{ lbs.}$$

CALCULATIONS

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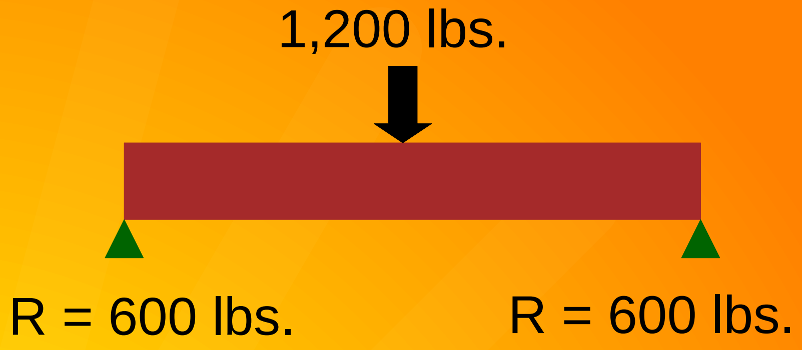
$$100 \text{ PLF} \times \frac{12}{2} = 600 \text{ lbs.}$$



$$\frac{3 \times 600}{2 \times 3 \times 10} = 30 \text{ psi}$$

$30 \text{ psi} < 135 \text{ psi}$

Shear is OK

CALCULATIONS

9. Required Bearing Area

$$\frac{600 \text{ lbs.}}{425 \text{ psi}} = 1.41 \text{ sq. in. req. brg. area}$$

10. Minimum Required Bearing Length

$$\frac{1.41 \text{ sq. in.}}{3''} = .47''$$

SHOULDER STUD CALCS.

26’ wide roof w/2’ overhang; 40 psf., LL 10 psf., DL 50 PSF TL

Installed 2-ply 2 x ?? x 7’ header w/1 shoulder stud on each end

SOLVE FOR R

(26/2 + 2) x (40 + 10) x 7/2 = 2,625 lbs.

R= 2,625 lbs.

R= 2,625 lbs.

SHOULDER STUD CALCS.

R= 2,625 lbs. R= 2,625 lbs.

F_c for 2 x 6 SPF South Stud grade = 625 psi

Calculate Req. Brg. Length

$$\frac{R}{F_c \times b} = \frac{2,625}{625 \times 3} = 1.4''$$

SHOULDER STUD CALCS.

(26/2 + 2) x (40 + 10) x 7/2 = 2,625 lbs.

15’ x 50 psf = 750 plf
750 plf x 7’ = 5,250 lbs.
5,250 lbs / 2 = 2,625 lbs.

R= 2,625 lbs. R= 2,625 lbs.