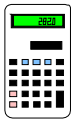
EXAMPLE 5.1 *Typical Simple Span Floor Joist Design*



Given

Live load (L)	=	30 psf (bedroom area)
Dead load (D)	=	10 psf
Trial joist spacing	=	16 on center
Trial joist size	=	2x8
Trial joist species and grade	=	Hem-Fir, No. 1 (S-dry, 19% MC)

Find Maximum span for specified joist member.

Solution

1. Determine tabulated design values by using NDS-S (Tables 4A and 1B)

F_b	=	975 psi	I_{xx}	=	47.63 in^4
F_v	=	75 psi	S_{xx}	=	13.14 in^3
$F_{c\perp}$	=	405 psi	b	=	1.5 in
E	=	1,500,000 psi	d	=	7.25 in

2. Lumber property adjustments and adjusted design values (Section 5.2.4 and NDS•2.3)

C_D = 1.0 (Section 5.2.4.1)
C_r = 1.15 (Table 5.4)
C_F = 1.2 (NDS-S Table 4A adjustment factors)
C_H = 2.0 (Section 5.2.4.3)
C_L = 1.0 (NDS•3.3.3, continuous lateral support)
C_b = 1.0 (NDS•2.3.10)

$F_b' = F_bC_rC_FC_DC_L = 975\ (1.15)(1.2)(1.0)(1.0) = 1{,}345$ psi
$F_v' = F_vC_HC_D = 75\ (2)(1.0) = 150$ psi
$F_{c\perp}' = F_{c\perp}C_b = 405\ (1.0) = 405$ psi
$E' = E = 1{,}500{,}000$ psi

3. Calculate the applied load

W = (joist spacing)(D+L) = (16 in)(1 ft/12 in)(40 psf) = 53.3 plf

4. Determine maximum clear span based on bending capacity

$$M_{max} = \frac{w\ell^2}{8} = \frac{(53.3\ \text{plf})(\ell^2)}{8} = 6.66\,\ell^2$$

$$f_b = \frac{M}{S} = \frac{(6.66\ell^2)(12\ \text{in/ft})}{13.14\ \text{in}^3} = 6.08\,\ell^2$$

$f_b \le F_b'$
$6.08\ \ell^2 \le 1{,}345$ psi
$\ell^2 = 221$
$\ell = 14.9$ ft = 14 ft-11 in (maximum clear span due to bending stress)

5. Determine maximum clear span based on horizontal shear capacity

$$V_{max} = \frac{w\ell}{2} = \frac{(53.3\ \text{plf})(\ell)}{2} = 26.7\ \ell$$

$$f_v = \frac{3V}{2A} = \frac{3}{2}\left(\frac{26.7\ell}{(1.5\ \text{in})(7.25\ \text{in})}\right) = 3.7\ \ell$$

$f_v \leq F_v'$

$3.7\ell \leq 150$ psi

ℓ = 40.5 ft = 40 ft-6 in (maximum clear span due to horizontal shear stress)

6. Determine maximum clear span based on bearing capacity

Bearing length = (3.5-in top plate width) - (1.5-in rim joist width) = 2 in

$$f_{c\perp} = \frac{\frac{1}{2}w\ell}{A_b} = \frac{\frac{1}{2}(53.3\ \text{plf})(\ell)}{(2\ \text{in})(1.5\ \text{in})} = 8.9\ \ell$$

$f_{c\perp} < F_{c\perp}'$

$8.9\ell \leq 405$ psi

ℓ = 45.5 ft = 45 ft-6 in (maximum clear span due to bearing stress)

7. Consider maximum clear span based on deflection criteria (Section 5.3.2)

$$\rho_{max} = \frac{5w\ell^4}{384EI} = \frac{5(40\ \text{plf})^*(\ell)^4\ (1{,}728\ \text{in}^3/\text{ft}^3)}{384(1{,}500{,}000\ \text{psi})(47.63\ \text{in}^4)} = 1.26 \times 10^{-5}\ell^4$$

*applied live load of 30 psf only

$$\rho_{all} = \frac{\ell}{360}(12\ \text{in/ft}) = 0.033\ \ell$$

$\rho_{max} \leq \rho_{all}$

$1.26 \times 10^{-5}\ \ell^4 \leq 0.033\ \ell$

$\ell^3 = 2{,}619$

ℓ = 13.8 ft = 13 ft-10 in (recommended clear span limit due to deflection criteria)

8. Consider floor vibration (Section 5.3.2)

The serviceability deflection check was based on the design floor live load for bedroom areas of 30 psf. The vibration control recommended in Section 5.3.2 recommends using a 40 psf design floor live load with the ℓ/360 deflection limit. Given that the span will not be greater than 15 feet, it is not necessary to use the absolute deflection limit of 0.5 inch.

w = (16 in)(1 ft/12 in)(40 psf) = 53.3 plf

$$\rho_{all} = (\ell/360)(12\ \text{in/ft}) = 0.033\ \ell$$

$$\rho_{max} = \frac{5w\ell^4}{384EI} = \frac{5(53.3\ \text{plf})^*(\ell^4)\ (1{,}728\ \text{in}^3/\text{ft}^3)}{384(1.5 \times 10^6\ \text{psi})(47.63\ \text{in}^4)} = 1.7 \times 10^{-5}\ell^4$$

*applied live load of 40 psf only

$\rho_{max} \leq \rho_{all}$

$1.7 \times 10^{-5}\ \ell^4 \leq 0.033\ \ell$

$\ell^3 = 1{,}941$

ℓ = 12.5 ft = 12 ft-6 in (recommended clear span limit due to vibration)