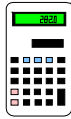


**EXAMPLE 5.4****Built-Up Floor Girder Design****Given**Loads

Floor live load	= 40 psf
Floor dead load	= 10 psf
Required girder span (support column spacing)	= 14 ft
Joist span (both sides of girder)	= 12 ft
Species	= Southern Pine, No. 1
Maximum girder depth	= 12

Find Minimum number of 2x10s or 2x12s required for the built-up girder.

Solution

1. Calculate the design load

$$W = (\text{Trib. floor joist span})(D + L) = (12 \text{ ft})(40 \text{ psf} + 10 \text{ psf}) = 600 \text{ plf}$$

2. Determine tabulated design values (NDS-S Table 4B)

$$\begin{array}{ll} F_b = 1250 \text{ psi} & F_{c\perp} = 565 \text{ psi} \\ F_v = 90 \text{ psi} & E = 1.7 \times 10^6 \text{ psi} \end{array}$$

3. Lumber property adjustments (Section 5.2.4):

$$\begin{array}{ll} C_r = 1.2 \text{ (Table 5.4)} & C_D = 1.0 \\ C_F = 1.0 & C_b = 1.0 \\ C_H = 2.0 & C_L = 1.0 \end{array}$$

(compression flange laterally braced by connection of floor joists to top or side of girder)

$$\begin{array}{ll} F_b' = F_b C_D C_r C_F C_L = 1,250 \text{ psi} (1.0)(1.2)(1)(1) = 1,500 \text{ psi} \\ F_v' = F_v C_D C_H = 90 \text{ psi} (1.25)(2.0) = 225 \text{ psi} \\ F_{c\perp}' = F_{c\perp} C_b = 565 \text{ psi} (1) = 565 \text{ psi} \\ E' = E = 1.7 \times 10^6 \text{ psi} \end{array}$$

4. Determine number of members required due to bending

$$\begin{aligned} M_{\max} &= \frac{w\ell^2}{8} = \frac{(600 \text{ plf})(14 \text{ ft})^2}{8} = 14,700 \text{ ft-lb} \\ f_b &= \frac{M}{S} = \frac{(14,700 \text{ ft-lb})(12 \text{ in/ft})}{S} = \frac{176,400}{S} \\ f_b &\leq F_b' \\ \frac{176,400}{S} &\leq 1,500 \text{ psi} \\ S_x &= 118 \text{ in}^3 \end{aligned}$$

Using Table 1B in NDS-S

$$\begin{array}{ll} 5 \text{ 2x10s} & S = 5(21.39) = 107 < 118 \text{ (marginal, but 5 too thick)} \\ 4 \text{ 2x12s} & S = 4(31.64) = 127 > 118 \text{ (OK)} \end{array}$$



5. Determine number of members required due to horizontal shear

$$V_{\max} = \frac{w\ell}{2} = \frac{600 \text{ plf} (14 \text{ ft})}{2} = 4,200 \text{ lb}$$

$$f_v = \frac{3V}{2A} = \frac{3 \left(\frac{4200}{A} \right)}{2} = 6,300 \text{ lb}/A$$

$$f_v \leq F_v'$$

$$\frac{6,300 \text{ lb}}{A} \leq 225 \text{ psi}$$

$$A = 28 \text{ in}^2 \quad \begin{array}{l} 2 \text{ 2x12s} \\ 2 \text{ 2x10s} \end{array} \quad \begin{array}{l} A = 33.8 > 28 \text{ OK} \\ A = 27.8 \approx 28 \text{ OK} \end{array}$$

6. Determine required bearing length using 4 2x12s

$$R_1 = R_2 = V_{\max} = 4,200 \text{ lb}$$

$$f_{c\perp} = \frac{R}{A_b} = \frac{4,200 \text{ lb}}{(6 \text{ in})(\ell_b)} = \frac{700}{\ell_b}$$

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

$$\frac{700}{\ell_b} \leq 565 \text{ psi}$$

$$\ell_b = 1.24 \text{ in (OK)}$$

7. Determine member size due to deflection

$$\rho_{\max} = \frac{5w\ell^4}{384EI} = \frac{5(480 \text{ plf}) * (14 \text{ ft})^4 (1,728 \text{ in}^3 / \text{ft}^3)}{384EI} = \frac{4.15 \times 10^8}{EI}$$

*includes 40 psf live load only

$$\rho_{\text{all}} \leq \frac{\ell}{360} = \frac{14 \text{ ft} (12 \text{ in/ft})}{360} = 0.47 \text{ in}$$

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

$$\frac{4.15 \times 10^8}{EI} = 0.47 \text{ in}$$

$$EI = 8.8 \times 10^8$$

$$(1.7 \times 10^6)(I) = 8.8 \times 10^8$$

$$I = 519 \text{ in}^4$$

$$3 \text{ 2x12s} \quad I = 534 > 519 \text{ okay}$$