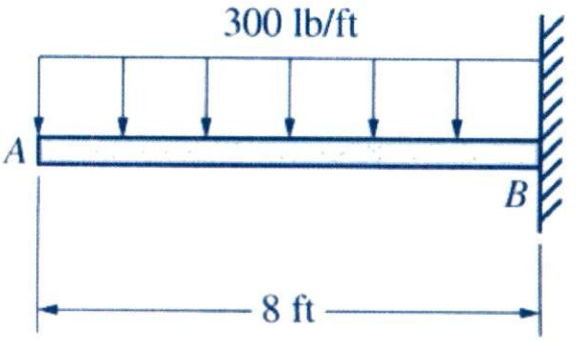
15-15

Select the lightest, rectangular Douglas fir section for the cantilever beam subjected to the loading shown in Fig. P15-15.



Solution.

Step 1.

$w = 300$ lb/ft

$L = 8$ ft

Douglas Fir

$\sigma_{allow} = 1450$ psi

$\tau_{allow} = 95$ psi

Step 2. Table 13-1, case 6

$$V_{MAX} = wL = 300 \text{ lb/ft} \,(8 \text{ ft}) = 2400 \text{ lb}$$

$$M_{MAX} = \frac{WL^2}{2} = \frac{300 \text{ lb/ft}\,(8 \text{ ft})^2}{2} = 9600 \text{ lb}\cdot\text{ft}\left(\frac{12 \text{ in}}{\text{ft}}\right) = 115{,}200 \text{ lb}\cdot\text{in}$$

Step 3.

$$S_{req} = \frac{M_{MAX}}{\sigma_{allow}} = \frac{115{,}200 \text{ lb}\cdot\text{in}}{1450 \text{ psi}} = 79.5 \text{ in.}^3$$

Step 4.

$$A_{req} = \frac{1.5\, V_{MAX}}{\tau_{allow}} = \frac{1.5\,(2400 \text{ lb})}{95 \text{ psi}} = 37.9 \text{ in.}^2$$

Step 5. Table A-6(a)

Nominal size	A (in.^{2})	S (in.^{3})	wt (lb/ft)
4 x 14	46.4	102	12.9
6 x 10	52.3	82.7	14.5
6 x 12	63.3	121	17.6
8 x 10	71.3	113	19.8

Select 4×14 (lightest)

$$\frac{\text{Wt of beam}}{\text{Load}} = \frac{12.9 \text{ lb/ft}}{300 \text{ lb/ft}} = 0.043 = 4.3\%$$

$$\frac{\text{Extra } S}{S_{req}} = \frac{102 \text{ in.}^3 - 79.5 \text{ in.}^3}{79.5 \text{ in.}^3} = 0.283 = 28\% > 4.3\%$$

Bending ✓

$$\frac{\text{Extra } A}{A_{req}} = \frac{46.4 \text{ in}^2 - 37.9 \text{ in}^2}{37.9 \text{ in}^2} = 0.224 = 22\% > 4.3\%$$

Shear ✓

use, 4×14 Rectangular Section