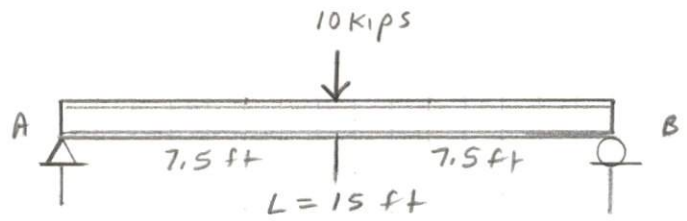
15-3

Select the lightest wide-flange steel girder for a simple span of 15 ft subjected to a concentrated load of 10 kips at the midspan. Use A36 steel and assume that the beam is supported laterally for its entire length.

Solution.



Step 1.

$P = 10$ kips

$L = 15$ ft

A36 Steel

$\sigma_{allow} = 24$ ksi $\quad \tau_{allow} = 14.5$ ksi

Step 2. Table 13-1, case 1

$$V_{MAX} = \frac{P}{2} = \frac{10 \text{ kips}}{2} = 5 \text{ kips}$$

$$M_{MAX} = \frac{PL}{4} = \frac{10 \text{ kips}\,(15 \text{ ft})}{4} = 37.5 \text{ kip·ft}\left(\frac{12 \text{ in}}{\text{ft}}\right) = 450 \text{ kip·in}$$

Step 3.

$$S_{req} = \frac{M_{MAX}}{\sigma_{allow}} = \frac{450 \text{ kip·in}}{24 \text{ kip/in.}^2} = 18.75 \text{ in.}^3$$

Step 4.

Table A-1(a)

W 8 × 24	$S = 20.9$ in.^{3}
W 10 × 22	$S = 23.2$ in.^{3}
W 12 × 22	$S = 25.4$ in.^{3}

Select W 12 × 22

$d = 12.31$ in

$t_w = 0.260$ in.

$S = 25.4$ in.^{3}

moment due to the Beam Weight

$$M_{WT} = \frac{wL^2}{8} = \frac{22 \text{ lb/ft}\,(15 \text{ ft})^2}{8}\left(\frac{12 \text{ in}}{\text{ft}}\right) = 7.43 \text{ kip·in}$$

$$\frac{M_{WT}}{M_p} = \frac{7.43 \text{ kip·in}}{450 \text{ kip·in}} = 0.017$$

$$\frac{\text{Extra } S}{S_{req}} = \frac{25.4 \text{ in.}^3 - 18.75 \text{ in}^3}{18.75 \text{ in}^3} = 0.35 > 0.017$$

Section satisfactory for Bending

Step 5.

$$\tau_{AVG} = \frac{V_{MAX}}{d\,t_w} = \frac{5 \text{ kips}}{(12.31 \text{ in})(0.260 \text{ in})} = 1.6 \text{ ksi}$$

$1.5 \text{ ksi} < \tau_{allow} = 14.5$ ksi

Use, W 12 × 22