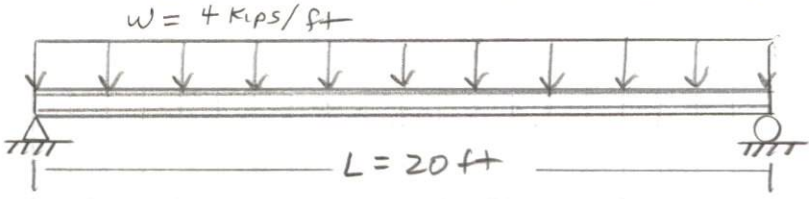
15-1

Select the lightest wide-flange steel section for a simple beam of 20-ft span that will carry a uniform load of 4 kips/ft. Use A36 steel and assume that the beam is supported laterally for its entire length.

Solution



Step 1. Knowns

$w = 4$ kips/ft

$L = 20$ ft

A36 STEEL

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

Step 2. Table 13-1, case 4

$$V_{MAX} = \frac{wL}{2} = \frac{4 \text{ kips/ft}\,(20 \text{ ft})}{2} = 40 \text{ kips}$$

$$M_{max} = \frac{wL^2}{8} = \frac{4 \text{ kips/ft}\,(20 \text{ ft})^2}{8} = 200 \text{ kip}\cdot\text{ft}\left(\frac{12 \text{ in}}{\text{ft}}\right) = 2400 \text{ kip}\cdot\text{in}$$

Step 3.

$$S_{req} = \frac{M_{MAX}}{\sigma_{allow}} = \frac{2400 \text{ kip}\cdot\text{in}}{24 \text{ kip/in}^2} = 100 \text{ in.}^3$$

Step 4. Table A-11a)

W 18 × 60	$S = 108$ in.^{3}	(lightest)
W 16 × 89	$S = 155$ in.^{3}	
W 14 × 68	$S = 103$ in.^{3}	

Select W 18 × 60

$$\frac{\text{Beam weight}}{\text{Load}} = \frac{60 \text{ lb/ft}}{4000 \text{ lb/ft}} = 0.015$$

$$\frac{\text{Extra } S}{S_{req}} = \frac{108 \text{ in.}^3 - 100 \text{ in.}^3}{108 \text{ in.}^3} = 0.08 > 0.015$$

$\therefore$ Section is satisfactory for bending

Step 5. W 18 × 60

$d = 18.24$ in

$t_w = 0.415$ in

$$\tau_{avg} = \frac{V_{max}}{d\,t_w} = \frac{40 \text{ kips}}{(18.24 \text{ in})(0.415 \text{ in})} = 5.3 \text{ ksi}$$

Since $5.3 \text{ ksi} < \tau_{allow} = 14.5$ ksi

the section is satisfactory for shear

USE, W 18 × 60