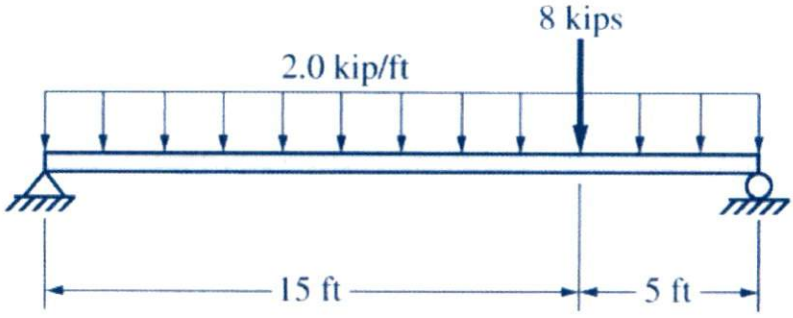
15-5

A simply supported beam of 20-ft span is subjected to a uniformly distributed load and a concentrated load, as shown in Fig. P15-5. Select the lightest W shape using A36 steel and assume that the beam is supported laterally for its entire length.



Solution.

Step 1.

$w = 2.0$ kip/ft
$P = 8$ kips
$L = 20$ ft
$a = 15$ ft
$b = 5$ ft

A36 steel

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

Step 2.

Table 13-1, case 2 and Case 4

By Superposition,

$$V_{MAX} = \frac{Pa}{L} + \frac{wL}{2} = \frac{8\text{ kips}(15\text{ ft})}{20\text{ ft}} + \frac{2.0\text{ kip/ft}(20\text{ ft})}{2} = 26\text{ kips}$$

$$M_{MAX} = \frac{Pab}{L} + \frac{wL^2}{8} = \frac{8\text{ kips}(15\text{ ft})(5\text{ ft})}{20\text{ ft}} + \frac{2.0\text{ kip/ft}(20\text{ ft})^2}{8} = 130\text{ kip.ft} = 1560\text{ kip.in}$$

Step 3.

$$S_{req} = \frac{M_{MAX}}{\sigma_{allow}} = \frac{1560\text{ kip.in}}{24\text{ ksi}} = 65\text{ in.}^3$$

Step 4. Table A-11a)

W 18 x 46	$S = 78.8$ in.^{3}	(lightest)
W 16 x 50	$S = 81.0$ in.^{3}	
W 14 x 53	$S = 77.8$ in.^{3}	

W 18 x 46

$d = 18.06$ in.

$t_w = 0.360$ in.

Moment Due to Beam Weight

$$M_{WT} = \frac{wL^2}{8} = \frac{46\text{ lb/ft}(20\text{ ft})^2}{8} = 2300\text{ lb.ft}$$

$$\frac{M_{WT}}{M} = \frac{2300\text{ lb.ft}}{130{,}000\text{ lb.ft}} = 0.018$$

$$\frac{\text{Extra } S}{S_{req}} = \frac{78.8 - 65}{65} = 0.212 > 0.018 \quad \checkmark \text{ ok for Bending}$$

Step 5. $\tau_{avg} = \frac{V_{MAX}}{d t_w} = \frac{26\text{ kips}}{(18.06\text{ in})(0.360\text{ in.})} = 4\text{ ksi} < \tau_{allow} = 14.5\text{ ksi}$ ✓

Use, W 18 x 46