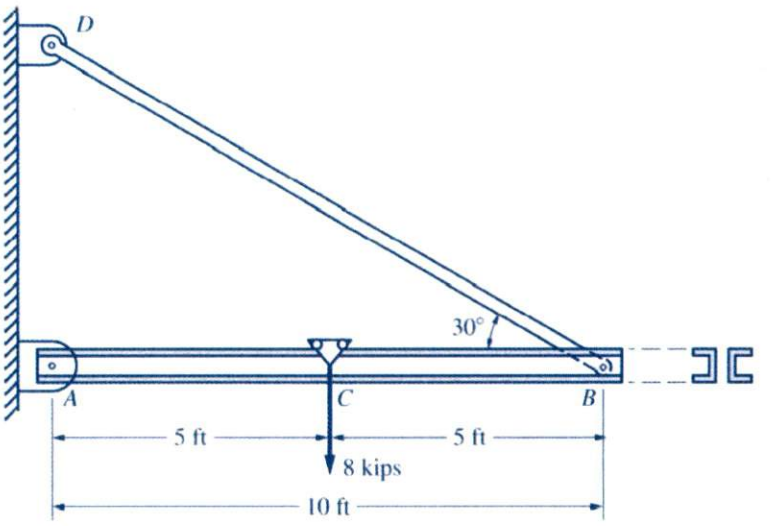
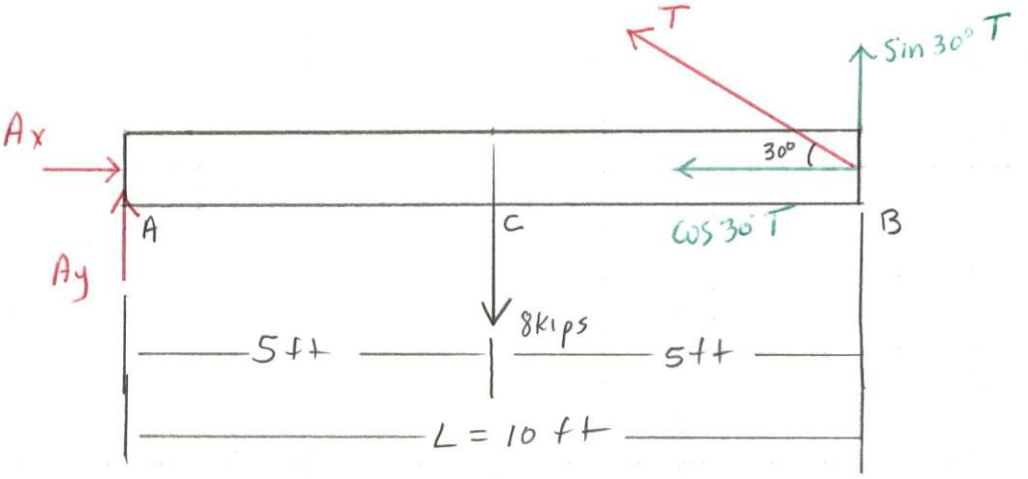
18-5

The horizontal beam of the jib crane is made of two standard steel channels. The maximum load, including the weight of the moving cart that the crane is designed to carry, is 8 kips. If the allowable compressive stress is 15 ksi, select a proper size for the pair of channels.

Solution.

$\sigma_{allow} = 15\ ksi$





FBD- Beam ACB

Equilibrium Equations

$+\circlearrowleft [\Sigma M_B = 0] \quad -A_y(10\,ft) + 8\,kips(5\,ft) = 0$

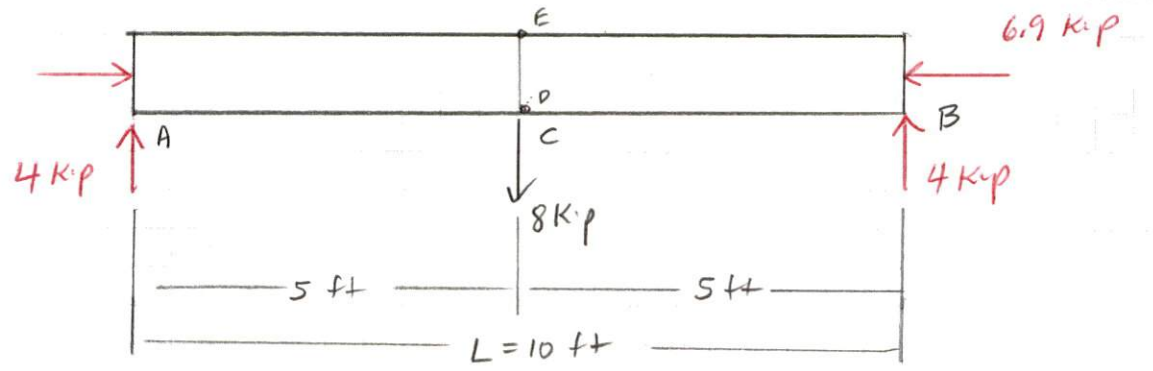
$A_y = \frac{40\ kip\cdot ft}{10\ ft} = 4\ kip \uparrow$

$[\Sigma F_y = 0] \quad A_y - 8\ kips + \sin 30°\, T = 0$

$T = \frac{8\ kips - 4\ kips}{\sin 30°} = 8\ kips \quad (T)$

$[\Sigma F_x = 0] \quad A_x - \cos 30°\, T = 0$

$A_x = \cos 30°\,(8\ kip) = 6.9\ kip \rightarrow$



Axial load

$$\sigma = \frac{P}{A} = \frac{-6.9\ \text{kip}}{A}$$

Maximum Bending at C Table 13-1, case 1

$$M_{MAX} = \frac{PL}{4} = \frac{8\ \text{kip}\,(10\ \text{ft})}{4} = 20\ \text{kip-ft}\left(\frac{12\ \text{in}}{\text{ft}}\right) = 240\ \text{kip-in}$$

$$S_{req} = \frac{M_{MAX}}{\sigma_{allow}} = \frac{240\ \text{kip-in}}{15\ \text{ksi}} = 16\ \text{in}^3$$

Two channels

$$S_{req} = \frac{16\ \text{in}^3}{2} = \underline{8\ \text{in}^3}$$

Table A-3(a) (C shapes)

Try C 8 x 11.5 $A = 3.38\ \text{in}^2$ $S = 8.14\ \text{in}^3$

Combined stresses

$$|\sigma^{(c)}| = \frac{\frac{P}{2}}{A} + \frac{\frac{M}{2}}{S} = \frac{\frac{-6.9\ \text{kip}}{2}}{3.38\ \text{in}^2} - \frac{\frac{240\ \text{kip-in}}{2}}{8.14\ \text{in}^3} = 15.8\ \text{ksi} > \sigma_{allow} = 13\ \text{k}$$

Try C 9 x 13.4 $A = 3.94\ \text{in}^2$ $S = 10.6\ \text{in}^3$

Combined stresses

$$|\sigma^{(c)}| = \frac{\frac{6.9\ \text{kip}}{2}}{3.94\ \text{in}^2} + \frac{\frac{240\ \text{kip-in}}{2}}{10.6\ \text{in}^3} = 12.2\ \text{ksi} < \sigma_{allow} = 13\ \text{ksi}\ \checkmark$$

Use, Two C 9 x 13.4