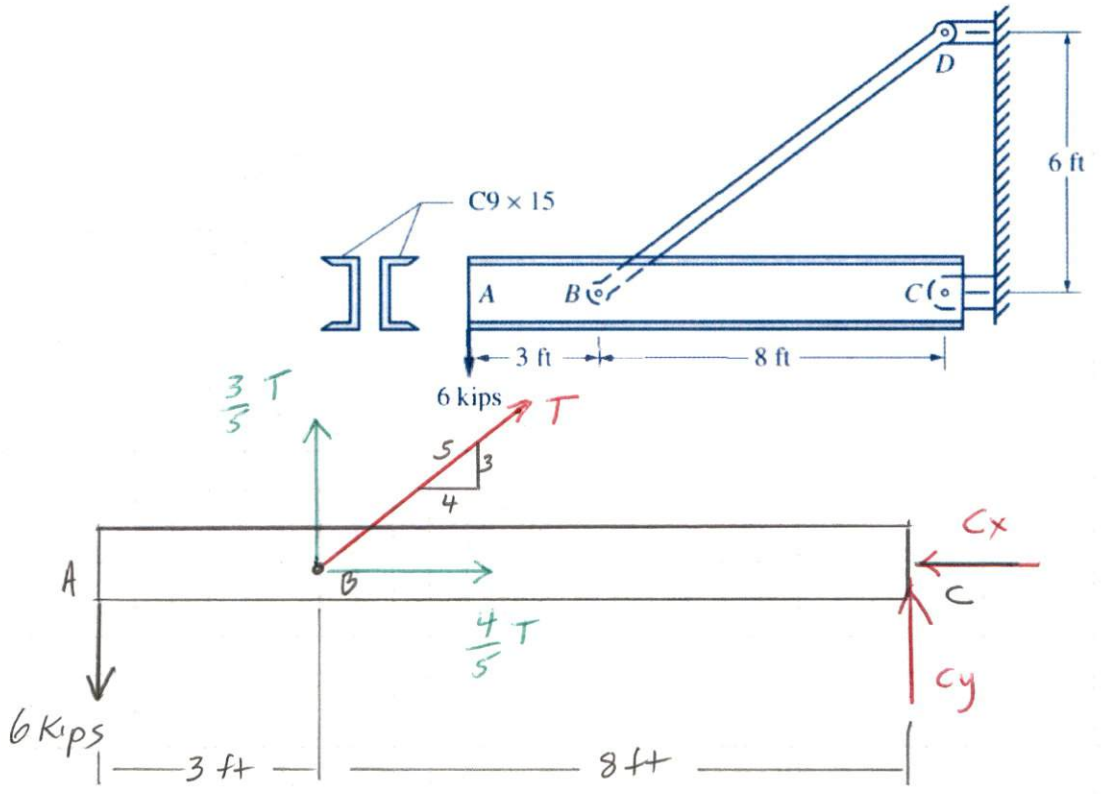
18-4

A beam consisting of two standard C9 x 15 steel channels, arranged back to back as shown in Fig. P18-4, is subjected to a load of 6 kips. Determine the maximum tensile and compressive stresses along the beam.

Solution.




FBD- Beam ABC

Equilibrium Equations

$+\circlearrowleft [\Sigma M_C = 0]$ $\quad 6\ \text{Kips}(11\ \text{ft}) - \frac{3}{5}T(8\ \text{ft}) = 0$

$$T = \frac{5(66\ \text{Kip.ft})}{3(8\ \text{ft})} = 13.75\ \text{Kips}\ (T)$$

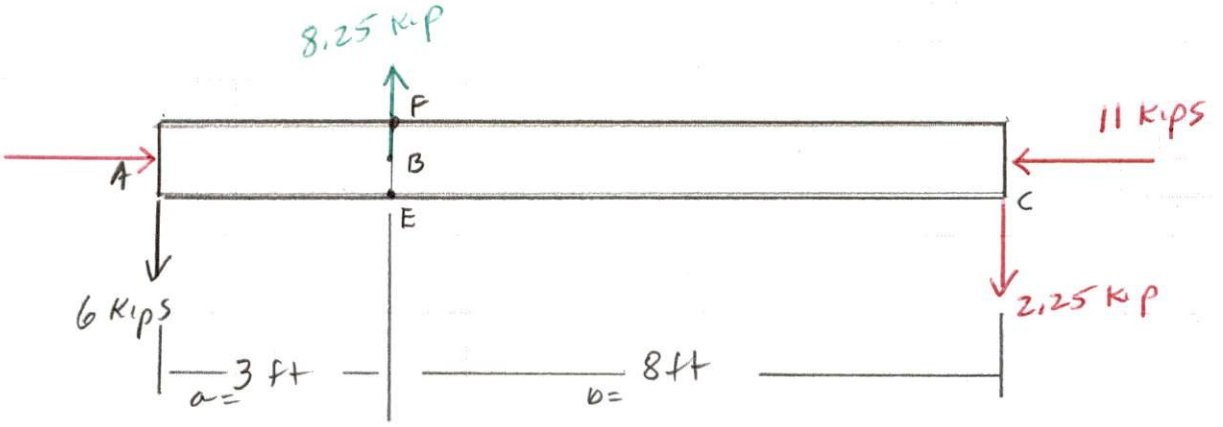
$[\Sigma F_x = 0]$ $\quad \frac{4}{5}T - C_x = 0$

$$C_x = \frac{4}{5}(13.75\ \text{Kips}) = 11\ \text{Kips} \leftarrow$$

$[\Sigma F_y = 0]$ $\quad -6\ \text{Kips} + \frac{3}{5}T + C_y = 0$

$$C_y = 6\ \text{Kips} - \frac{3}{5}(13.75\ \text{Kip}) = -2.25\ \text{Kip} \uparrow$$

and $\boxed{C_y = 2.25\ \text{Kip} \downarrow}$



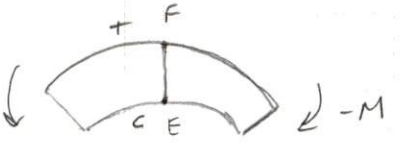

## Axial Load

$P = -11$ Kips (constant Compression throughout the Beam)

$$\sigma = \frac{P}{A} = \frac{-11 \text{ Kips}}{A}$$

## Beam Bending Load

$$M_{MAX} = -\frac{Pab}{L} = -\frac{8.25 \text{ K·p}\,(3\text{ft})(8\text{ft})}{11 \text{ ft}} = -18 \text{ K·p·ft}\left(\frac{12\text{in}}{1\text{ft}}\right) = -216 \text{ K·p·in}$$




## Two C9X15 Table A-3(a)

$A = 4.41 \text{ in}^2$ $\quad A = 2 \times 4.41 = 8.82 \text{ in}^2$

$S = 11.3 \text{ in}^2$ $\quad S = 2 \times 11.3 = 22.6 \text{ in}^3$

## Combined Stresses

$$\sigma_{MAX}^{(c)} = \sigma_E = -\frac{P}{A} - \frac{M}{S} = \frac{-11 \text{ Kips}}{8.82 \text{in}^2} - \frac{216 \text{ K·p·in}}{22.6 \text{in}^3} = -10.8 \text{ ksi}$$

$$\sigma_{MAX}^{(T)} = \sigma_F = -\frac{P}{A} + \frac{M}{S} = \frac{-11 \text{ Kips}}{8.82 \text{in}^2} + \frac{216 \text{ K·p in}}{22.6 \text{ in}^3} = 8.31 \text{ ksi}$$