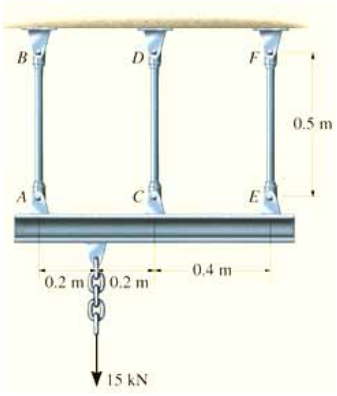
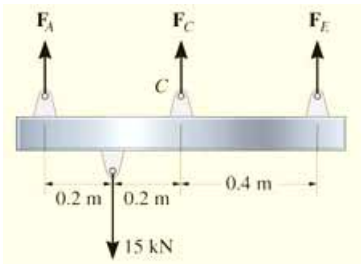
Example: Statically Indeterminate

The three A-36 steel bars are pin connected to a RIGID member. If the applied load on the member is 15 kN, determine the force developed in each bar. Bars *AB* and *EF* each have a cross-sectional area of 25 mm^2, and bar *CD* has a cross-sectional area of 15 mm^2.



Solution:

Free-Body Diagram of the Rigid Bar

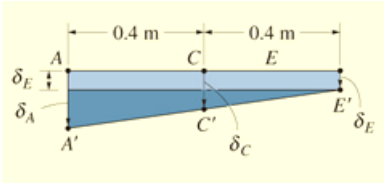


Equilibrium Conditions

$$\sum F_y = 0 = F_A + F_C + F_E - 15 \qquad \text{(i)}$$

$$\sum M_A = 0 = F_C(0.4) + F_E(0.8) - 15(0.2) \qquad \text{(ii)}$$

Compatibility Condition



$$\frac{\delta_C - \delta_E}{0.4} = \frac{\delta_A - \delta_E}{0.8}$$

$$2\delta_C = \delta_A + \delta_E$$

$$\Rightarrow \qquad 2\frac{F_C L}{EA_{CD}} = \frac{F_A L}{EA_{AB}} + \frac{F_E L}{EA_{EF}}$$

$$\Rightarrow \qquad 2\frac{F_C L}{E(15)} = \frac{F_A L}{E(25)} + \frac{F_E L}{E(25)}$$

$$\Rightarrow \qquad 10F_C = 3F_A + 3F_E \qquad \text{(iii)}$$

Rewrite (i)-(iii)

$$F_A + F_C + F_E = 15$$

$$0.4F_C + 0.8F_E = 3$$

$$3F_A - 10F_C + 3F_E = 0$$

$$\Rightarrow \qquad \boxed{F_A = 9.52\,\text{kN}; \qquad F_C = 3.46\,\text{kN}; \qquad F_E = 2.02\,\text{kN};}$$