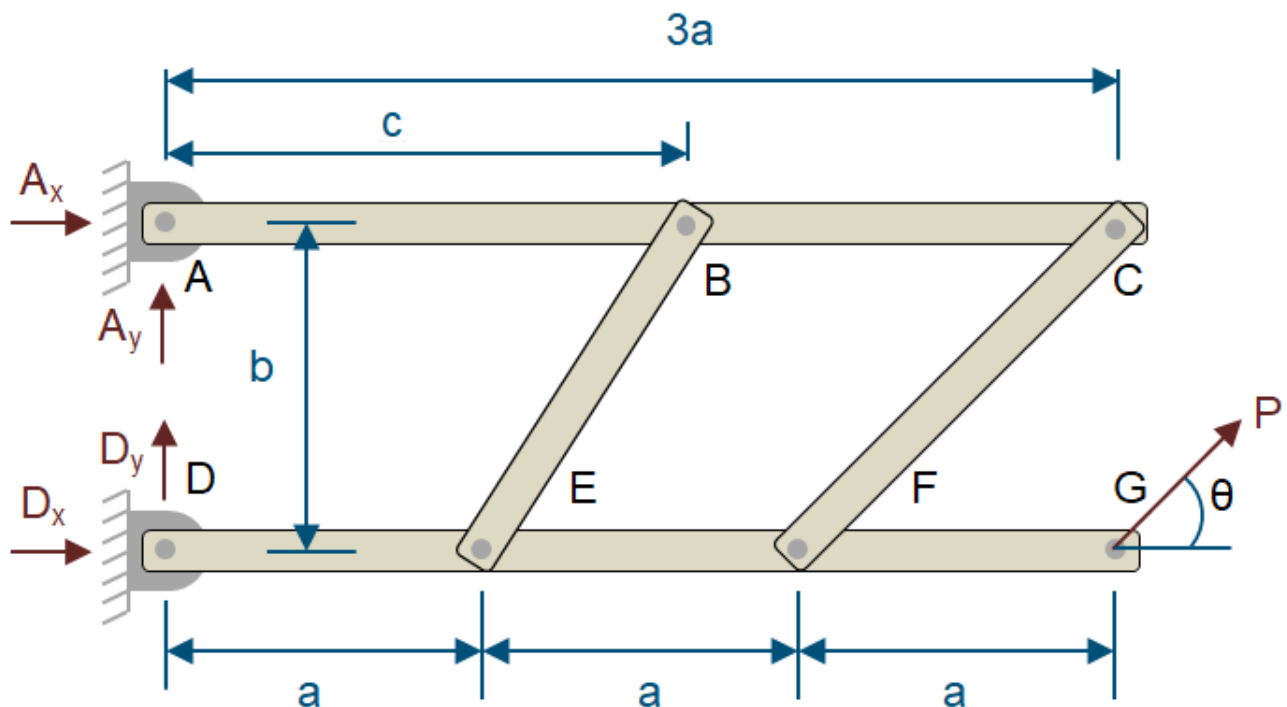


Forces in a 4 Member Frame

▼ Introduction

This frame is subject to a load P at point G . This application will determine the forces at the supports and in members BE and CF .



Since the frame is in equilibrium, the sum of horizontal forces, sum of vertical forces, and sum of momentum about a point is zero. This allows us to identify the unknown forces in a system.

> restart:
with(Units[Simple]) :

▼ Parameters

Load and load angle

- > $P := -800 \text{ N} :$
- $\theta := 30.0 \text{ deg} :$

Lengths

- > $a := 0.3 \text{ m} :$
- $b := 0.4 \text{ m} :$
- $c := 0.5 \text{ m} :$

▼ Analysis

Sum of the moments about A

- > $sum_moments_A := b D_x + b P \cos(\theta) + 3 a P \sin(\theta) = 0$
 $sum_moments_A := 0.4 D_x \text{ m} - 637.1281293 \text{ J} = 0$ (3.1)

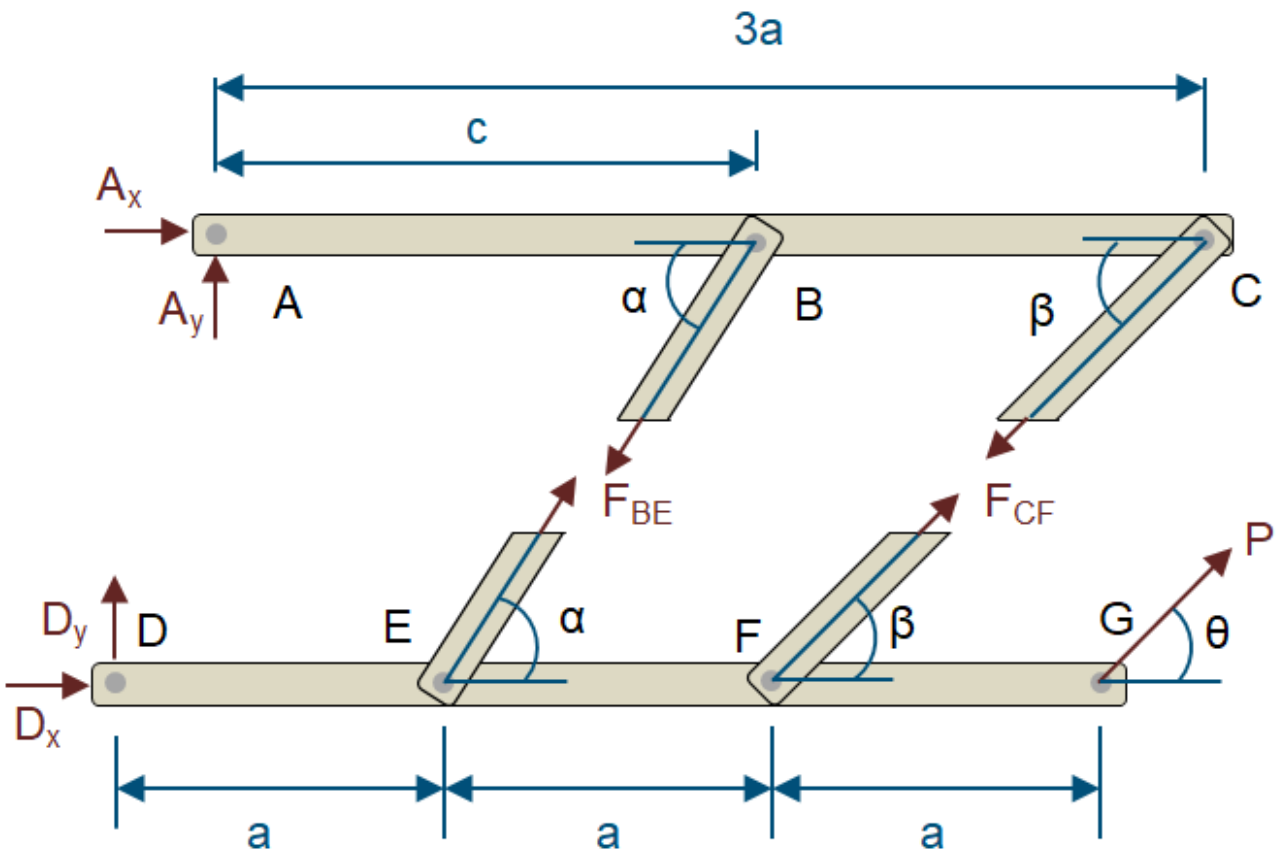
- > $D_x := fsolve(sum_moments_A, D_x)$
 $1.593 \times 10^3 \text{ N}$ (3.2)

Sum of the forces about A

- > $sum_forces_A := A_x + D_x + P \cos(\theta) = 0$
 $sum_forces_A := A_x + 900.0000000 \text{ N} = 0$ (3.3)

- > $A_x := fsolve(sum_forces_A, A_x)$
 -900.00 N (3.4)

The forces on BE and CF must be equal (but opposite in sign) for the members to be at rest. Split BE and CF like so



$$> \alpha := \arctan\left(\frac{b}{c-a}\right)$$

$$\alpha := 1.107148718 \quad (3.5)$$

$$> \beta := \arctan\left(\frac{b}{a}\right)$$

$$\beta := 0.9272952179 \quad (3.6)$$

Four unknown forces remain: A_y , D_y , F_{BE} and F_{CF}

$$> \text{sum_moments_ABC} := c F_{BE} \sin(\alpha) + 3 a F_{CF} \sin(\beta) = 0;$$

$$\text{sum_moments_DEFG} := a F_{BE} \sin(\alpha) + 2 a F_{CF} \sin(\beta) + 3 a P \sin(\theta) = 0;$$

$$447.21 \times 10^{-3} F_{BE} + 720.00 \times 10^{-3} F_{CF} = 0.00$$

$$(268.33 \times 10^{-3} F_{BE} + 480.00 \times 10^{-3} F_{CF}) \text{ m} - 360.00 \text{ J} = 0.00 \quad (3.7)$$

These two equations are solved for F_{BE} and F_{CF}

$$> \text{fsolve}(\{\text{sum_moments_ABC}, \text{sum_moments_DEFG}\}, \{F_{BE}, F_{CF}\})$$

$$\{F_{BE} = -12.07 \times 10^3 \text{ N}, F_{CF} = 7.50 \times 10^3 \text{ N}\} \quad (3.8)$$

$$> \text{assign}(\%)$$

Member ABC

$$\begin{aligned}
 > \text{sum_forces_ABC} := A_y - F_{BE} \sin(\alpha) - F_{CF} \sin(\beta) = 0 \\
 & \text{sum_forces_ABC} := A_y + 4799.999998 \text{ N} = 0 \qquad (3.9)
 \end{aligned}$$

$$\begin{aligned}
 > \text{solve}(\text{sum_forces_ABC}, A_y) \\
 & -4.80 \times 10^3 \text{ N} \qquad (3.10)
 \end{aligned}$$

Member DEFG

$$\begin{aligned}
 > \text{sum_forces_DEFG} := D_y + F_{BE} \sin(\alpha) + F_{CF} \sin(\beta) + P \sin(\theta) = 0 \\
 & \text{sum_forces_DEFG} := D_y - 5199.999998 \text{ N} = 0 \qquad (3.11)
 \end{aligned}$$

$$\begin{aligned}
 > \text{solve}(\text{sum_forces_DEFG}, D_y) \\
 & 5.20 \times 10^3 \text{ N} \qquad (3.12)
 \end{aligned}$$