Example

Consider the structure below. All members can be considered massless. Set up the equations necessary to find the reactions at \( A \) and \( D \).

\[
\sum F_y = 0 \\
A_y + D = 0 \\
A_y = -D \quad (2)
\]

\[
\sum M_A = 0 \\
-HP + LD = 0 \\
D = \frac{HP}{L} \quad (3)
\]

\[
\Sigma F_x = 0 \\
P + A_x = 0 \\
A_x = -P \quad (1)
\]

Now reactions @ \( A \) & \( D \) are known.
Example

Find the reactions at pins B and C in the last example. Is there anything special about those reactions?

4 unknowns
but only 3 equations

Look @ FBD of BC

Try this

\[ \sum M_B = 0 \]
\[ -L_2 \cdot C_y = 0 \]
\[ C_y = 0 \]

\[ \sum F_y = 0 \]
\[ -C_y + B_y = 0 \]
\[ B_y = 0 \]

\[ \sum F_x = 0 \]
\[ -B_x - C_x = 0 \]
\[ B_x = -C_x \]

Result

Two force member

- Reactions are collinear
- " " oppositely directed
- Makes life easier!
Example

Find the reactions at B and C. Assume that the weight of the structure is negligible.

All dimensions in mm.

NEW FBD of ABC:

\[ \tan^{-1}\left(\frac{400}{100}\right) = \theta \]

\( \sum M_B = 0 \)

\( \frac{1}{2} c \sin \theta + (l_4 - l_5) c \cos \theta + l_1 A = 0 \)  \( (1) \)

\( \\ c = -\frac{l_1 A}{\sin \theta} \)

\( \sum F_x = 0 \)

\( B_x - c \cos \theta = 0 \)  \( (2) \)

\( \sum F_y = 0 \)

\( -A + B_y + c \sin \theta = 0 \)  \( (3) \)
Example

Find the components of all forces $ABD$. Assume that the weight of the structure is negligible.

All dimensions in mm.

$\Sigma M_A = 0$

$F \cdot (l_3 + l_4) - F_1 \cdot (l_1 + l_5) - F_2 \cdot (l_1 + l_5 + l_6 + l_7) = 0$

$F = 10.8 \text{ kN}$

$\Rightarrow$ FROM (1) $A_x = -10.8 \text{ kN}$

$\Sigma F_x = 0$

$A_x + F_2 = 0$

$A_x = -F_2$

$\Sigma F_y = 0$

$A_y - F_1 - F_2 = 0$

$A_y = F_1 + F_2$

$= 7 \text{ kN}$

$\sum = 4$ UNKNOWNS

$\sum = 3$ EQUATIONS

$\Sigma F_x = 0$

$A_x + B_x + D_x = 0$ (4)

$\Sigma F_y = 0$

$A_y + B_y + D_y = 0$ (5)

$\sum M_D = 0$

$-l_5 A_x - l_3 A_y - (l_1 + l_2) A_y - (l_2) B_y = 0$ (6)

NEED ANOTHER FBD:

$\Sigma H_c = 0$

$-l_5 F_1 - (l_5 + l_6) D_y - (l_5 + l_6 + l_7) F_2 = 0$

$D_y = -6.5 \text{ kN}$

NOTE DIRECTION
FROM (5)
\[ B_y = -A_y \quad D_y = -7 \text{ kN} \quad (-6.5 \text{ kN}) = -0.5 \text{ kN} \]

FROM (6)
\[-(250 \text{ mm})(-10.8 \text{ kN}) = -(250 \text{ mm})B_x - (1000)(7) - (300)(-0.5) = 0 \]
\[ \therefore B_x = 16.2 \text{ kN} \]

FROM (4)
\[-B_x = -A_x = D_x \quad P_x = -B_x - A_x \]
\[ = -(10.8 \text{ kN}) \quad = -(16.2) - (-10.8) \text{ kN} \]
\[ = 27 \text{ kN} \]