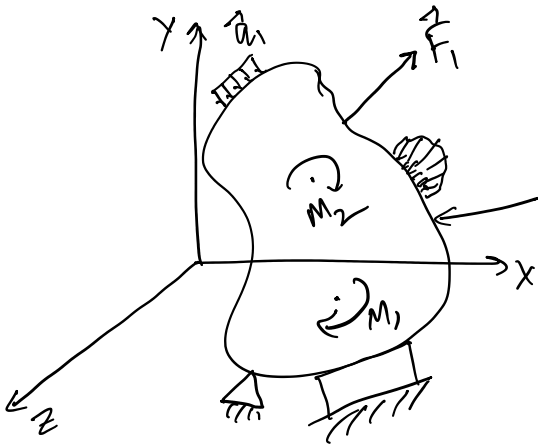


Rigid Body Equilibrium

Wednesday, January 15, 2025 9:39 AM



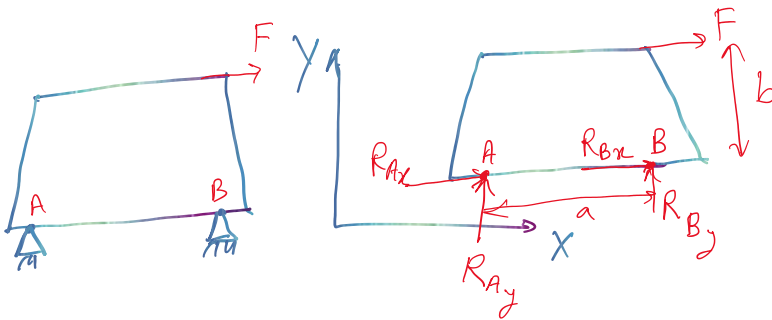
$$\sum \vec{F} = 0$$

$$\sum \vec{M} = 0$$

$$\sum F_x \hat{i} + \sum F_y \hat{j} + \sum F_z \hat{k} = 0$$

$$\sum M_x \hat{i} + \sum M_y \hat{j} + \sum M_z \hat{k} = 0$$

$$\left. \begin{array}{l} \sum F_x = 0 \\ \sum F_y = 0 \\ \sum F_z = 0 \end{array} \right\} \begin{array}{l} \sum M_x = 0 \\ \sum M_y = 0 \\ \sum M_z = 0 \end{array}$$



$$\sum F_x = 0 \quad \sum M_A = 0$$

$$\sum F_y = 0$$

$$\sum F_x = 0 \Rightarrow F + R_{Ax} + R_{Bx} = 0$$

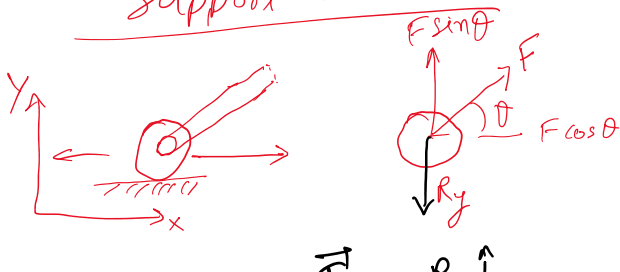
$$\sum F_y = 0 \Rightarrow R_{Ay} + R_{By} = 0$$

$$\sum M_A = 0 \Rightarrow R_{By} a - Fb = 0$$

$$R_{By} = \frac{Fb}{a}$$

$$R_{Ay} = -\frac{Fb}{a}$$

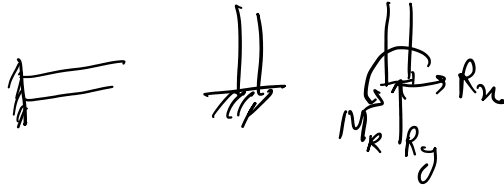
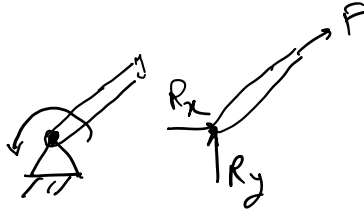
Support Reaction



→ x

↓ Ry

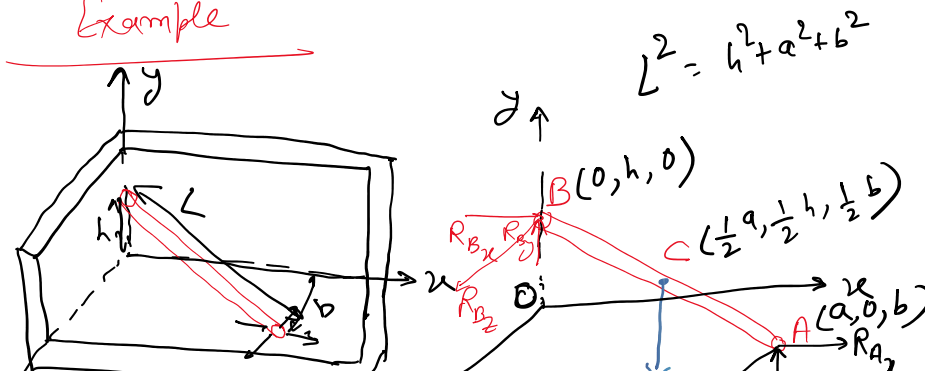
$$\begin{aligned} \vec{F}_R &= R_y \hat{j} \\ &= -5 \hat{j} \text{ N} \\ &= 5 \text{ N} (-\hat{j}) \end{aligned}$$

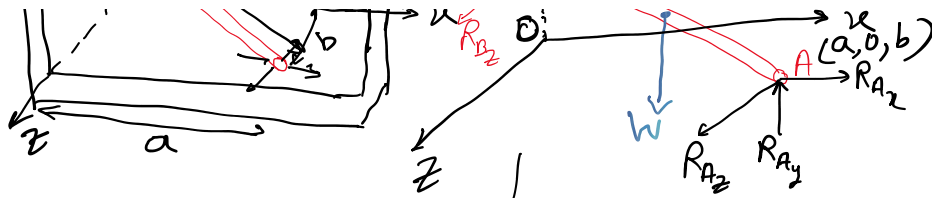


Steps for Drawing FBD

1. Decide your system (sub-system) whose equilibrium is to be studied.
2. Isolate the system from its surrounding using a bounding curve (surface).
3. Sketch the system.
4. Apply externally applied forces & Moments.
5. Apply Reaction forces & Moments because of the supports.
6. Write equations of static equilibrium.
7. Evaluate the unknown reactions.

Example





$$\sum \vec{F} = 0$$

$$(R_{Ax} + R_{Bx})\hat{i} + (R_{Ay} + R_{By} - W)\hat{j} + (R_{Az} + R_{Bz})\hat{k} = 0$$

$$R_{Ax} + R_{Bx} = 0$$

$$R_{Ay} + R_{By} = W$$

$$R_{Az} + R_{Bz} = 0$$

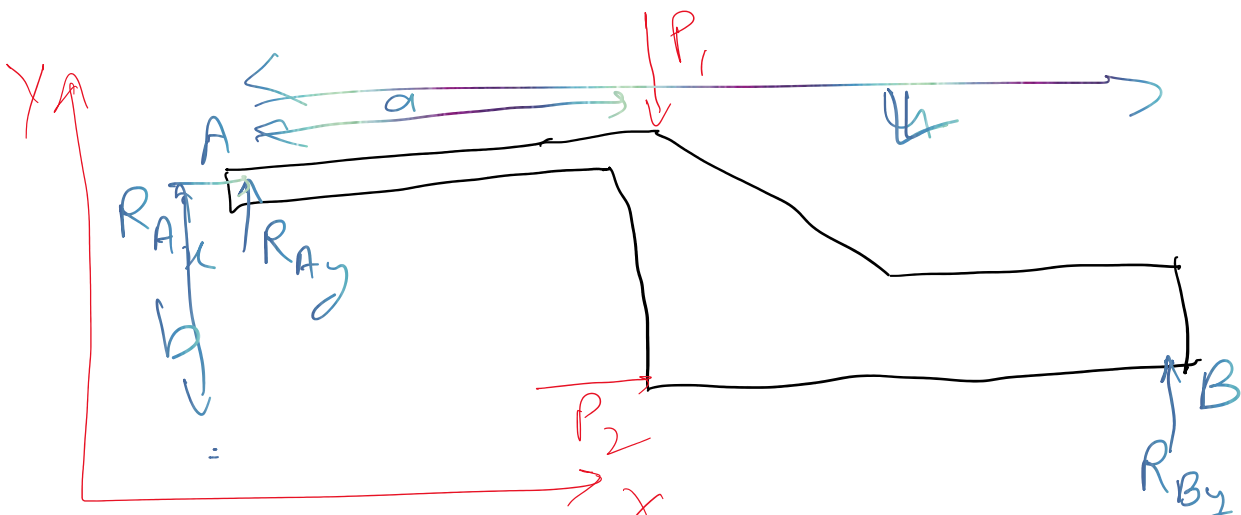
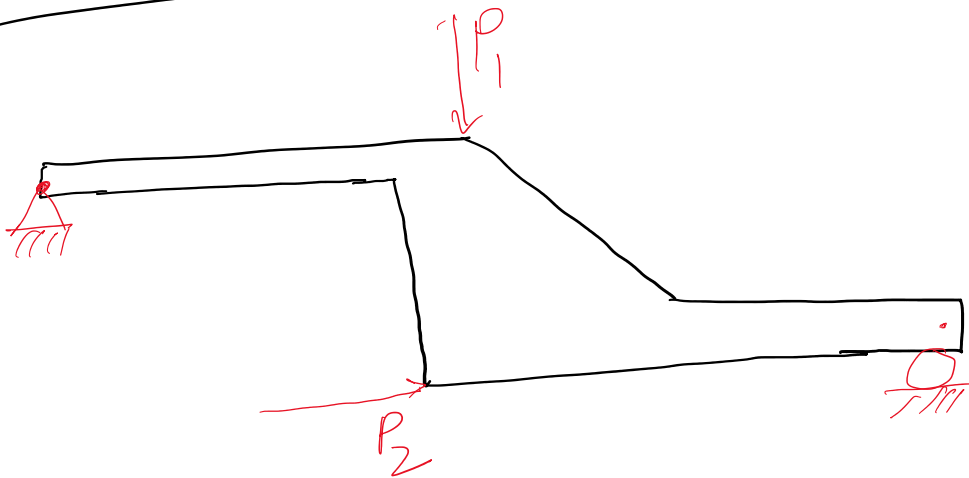
$$\sum \vec{M}_A = 0$$

$$\vec{r}_{B/A} \times \vec{R}_B + \vec{r}_{C/A} \times W(-\hat{j}) + \vec{r}_{A/A} \times \vec{R}_A = 0$$

$$(-a\hat{i} + b\hat{j} - b\hat{k}) \times (R_{Bx}\hat{i} + R_{By}\hat{j} + R_{Bz}\hat{k}) + \left(\frac{1}{2}a\hat{i} + \frac{1}{2}b\hat{j} - \frac{1}{2}b\hat{k}\right) \times W(-\hat{j}) = 0$$

$$\Rightarrow \left(\frac{1}{2}aw\hat{k} - \frac{1}{2}bw\hat{i}\right) + \vec{r}_{B/A} \times \vec{R}_B = 0$$

Example - 2





$$\sum \vec{F} = 0$$

$$\sum \vec{M}_A = 0$$

$$\sum M_A = 0$$

$$R_{By} \times 2 - P_1 \times a + P_2 \times b = 0$$

$$R_{By} =$$

R'_{By}