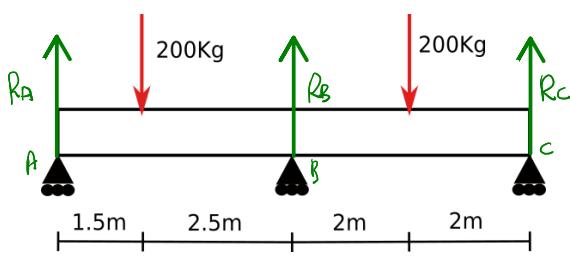


Problema 1 Calcular las reacciones, el diagrama de esfuerzos y de momentos flectores en la liga



Solo en la parte a la izda de B ya que no rota, cada parte esté en equilibrio.

$$\begin{aligned} \sum M_A = 0 & \Rightarrow R_A \cdot 4m = 200 \text{ kp} \cdot 1.5m \\ & \Rightarrow R_A = 125 \text{ kp} \\ & \Rightarrow R_C \cdot 6m = 200 \text{ kp} \cdot 2m \end{aligned}$$

A) Reacciones

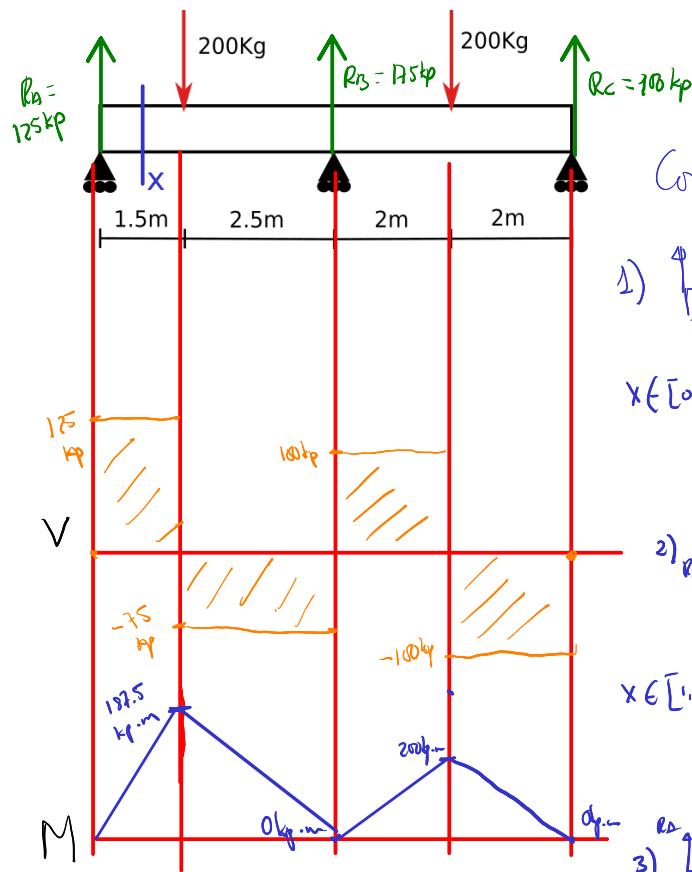
$$\sum F_x = 0 \quad \sum F_y = 0 \quad \sum M = 0$$

$$\begin{aligned} & \Rightarrow R_A + R_B + R_C = 400 \text{ kp} \quad \sum F_y = 0 \\ & \sum M_A = 0 \end{aligned}$$

$$R_B \cdot 4m + R_C \cdot 8m = 200 \text{ kp} \cdot (1.5m + 6m)$$

$$R_B + 2R_C = 375 \text{ kp}$$

$$\left. \begin{array}{l} R_A = 125 \text{ kp} \\ R_C = 100 \text{ kp} \end{array} \right\} \rightarrow \overline{R_B = 375 \text{ kp} - 200 \text{ kp}} = \boxed{175 \text{ kp}}$$



Converso de signos

$\curvearrowleft M > 0$ $\curvearrowright M < 0$

$$\begin{aligned} 1) & \quad \text{Diagrama de } M_1 \quad \sum M_i = 0 \quad -M_1 + R_A \cdot x = 0 \\ & \quad M_1(x) = 125 \text{ kp} \cdot x \quad M_1(x=1.5m) = 187.5 \text{ kp.m} \\ & \quad V_1 = \frac{dM_1}{dx} = 125 \text{ kp} \quad M_1(x=0m) = 0 \text{ kp.m} \end{aligned}$$

$$\begin{aligned} 2) & \quad \text{Diagrama de } M_2 \quad \sum M_i = 0 \quad -M_2 - 200 \text{ kp} \cdot (x-1.5m) + R_A \cdot x = 0 \\ & \quad M_2(x) = 125 \text{ kp} \cdot x - 200 \text{ kp} \cdot (x-1.5m) \quad M_2(x=1.5m) = 187.5 \text{ kp.m} \quad M_2(x=4m) = 0 \text{ kp.m} \\ & \quad V_2 = \frac{dM_2}{dx} = 125 \text{ kp} - 200 \text{ kp} = -75 \text{ kp} \end{aligned}$$

$$\begin{aligned} 3) & \quad \text{Diagrama de } M_3 \quad M_3 = 125 \text{ kp} \cdot x - 200 \text{ kp} \cdot (x-1.5m) - 175 \text{ kp} \cdot (x-4m) \\ & \quad M_3(x=6m) = 250 \text{ kp.m} \\ & \quad V_3 = \frac{dM_3}{dx} = 125 \text{ kp} - 200 \text{ kp} + 175 \text{ kp} = 100 \text{ kp.} \end{aligned}$$

$$\begin{aligned} 4) & \quad \text{Diagrama de } M_4 \quad M_4 = 125 \text{ kp} \cdot x - 200 \text{ kp} \cdot (x-1.5m) + 175 \text{ kp} \cdot (x-4m) - 200 \text{ kp} \cdot (x-6m) \\ & \quad M_4(x=6m) = 0 \text{ kp.m} \quad M_4(x=6m) = 200 \text{ kp} \end{aligned}$$

$$V_{u4} = \frac{dM_4}{dx} = 125 \text{ kp} - 200 \text{ kp} + 175 \text{ kp} - 200 \text{ kp} = -150 \text{ kp}$$

Problema 2

Calcular los esfuerzos cortantes y el momento flector en la viga de la figura.

A) Reacciones

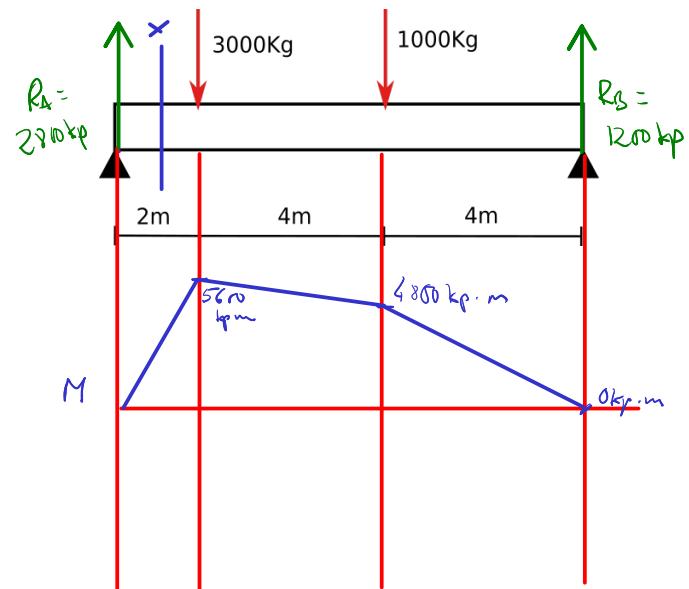
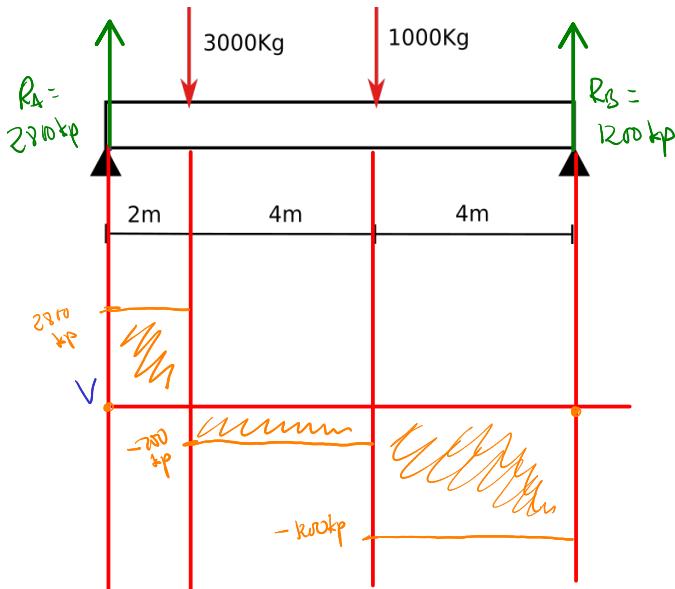
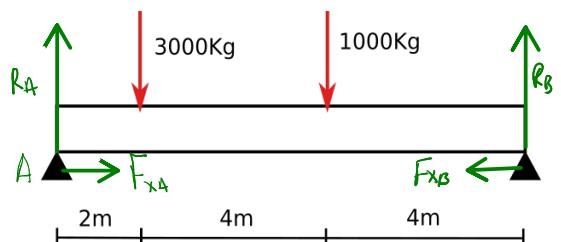
$$1) \text{ Como } \sum F_x = 0 \rightarrow F_{x_A} = -F_{x_B}$$

$$2) \sum F_y = 0 \quad R_A + R_B = 4000 \text{ kp}$$

$$3) \sum M_B = 0 \quad -R_A \cdot 10 \text{ m} + 3000 \text{ kp} \cdot 8 \text{ m} + 1000 \text{ kp} \cdot 4 \text{ m} = 0$$

$$\boxed{R_A = \frac{3000 \text{ kp} \cdot 8 \text{ m} + 1000 \text{ kp} \cdot 4 \text{ m}}{10 \text{ m}} = 2800 \text{ kp}}$$

$$\Rightarrow \boxed{\begin{aligned} R_B &= 4000 \text{ kp} - 2800 \text{ kp} = \\ &= 1200 \text{ kp} \end{aligned}}$$



Momento flector

$$X \in [0, 2m] \quad M_x = R_A \cdot x = 2800 \text{ kp} \cdot x \quad M_{2m} = 5600 \text{ kp.m} \quad V = \frac{dM}{dx} = 2800 \text{ kp}$$

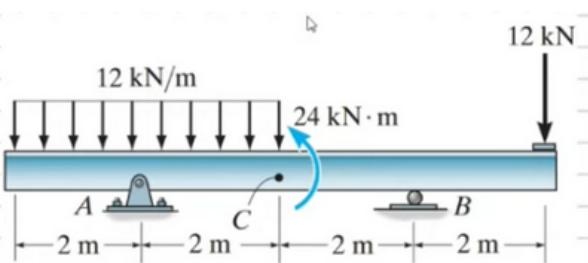
$$X \in [2m, 6m] \quad M_x = R_A \cdot x - 3000 \text{ kp} \cdot (x - 2m) = \\ = -200 \text{ kp} \cdot x + 6000 \text{ kp.m} \Rightarrow M_{6m} = 4800 \text{ kp.m}$$

$$V_x = \frac{dM}{dx} = -200 \text{ kp}$$

$$V_x = \frac{dM}{dx} = -1200 \text{ kp}$$

$$X \in [6m, 10m] \quad M_x = R_A \cdot x - 3000 \text{ kp} \cdot (x - 2m) - 1000 \text{ kp} \cdot (x - 6m) = \\ = -1200 \text{ kp} \cdot x + 12000 \text{ kp.m} \quad M_{10m} = 0 \text{ kp.m}$$

Problema 3



Calcular los esfuerzos cortantes y momentos flectores en esta viga. Representarlos.

a) Reacciones

$$\sum F_x = 0 \rightarrow F_{x_A} = 0$$

$$\sum F_y = 0 \quad P_1 = 12 \text{ kN/m} \cdot 4 \text{ m} = 48 \text{ kN}$$

aplicada en un centro de masas
a 2m del extremo sobre el apoyo 1

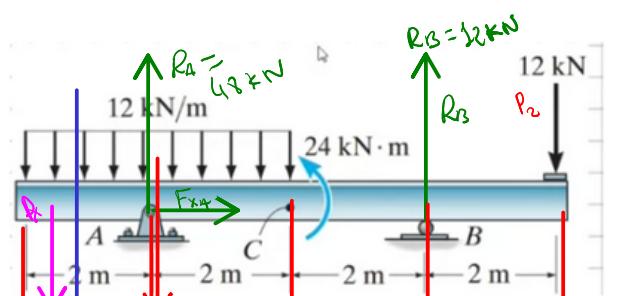
$$R_A + R_B = P_1 + P_2 = 60 \text{ kN}$$

$$\sum M_B = 0 \quad -R_A \cdot 4\text{m} = 2\text{m} \cdot P_2 + P_1 \cdot 4\text{m} + 24 \text{ kN} \cdot \text{m} = 0$$

+ gira igual que P_1

$R_A = \frac{24 \text{ kN} \cdot \text{m} + 48 \text{ kN} \cdot \text{m} \cdot 4\text{m} - 2\text{m} \cdot 12 \text{ kN}}{4\text{m}} = 48 \text{ kN}$ Giro cte

$$R_B = 60 \text{ kN} - R_A = 60 \text{ kN} - 48 \text{ kN} = 12 \text{ kN}$$



Esfuerzos cortantes.

(a la izq. de X)

$$X < 2\text{m} \quad P_x = 12 \text{ kN/m} \cdot X$$

$$V = -12 \text{ kN/m} \cdot X$$

$$V_{2\text{m}} = -24 \text{ kN}$$

$$X \in [2\text{m}, 4\text{m}] \quad P_x = 12 \text{ kN/m} \cdot X$$

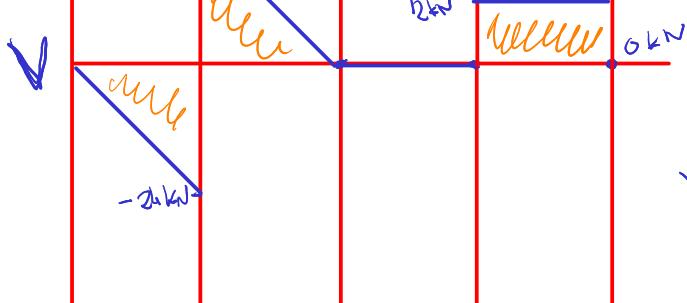
$$V = R_A - P_x = 48 \text{ kN} - 12 \frac{\text{kN}}{\text{m}} \cdot X$$

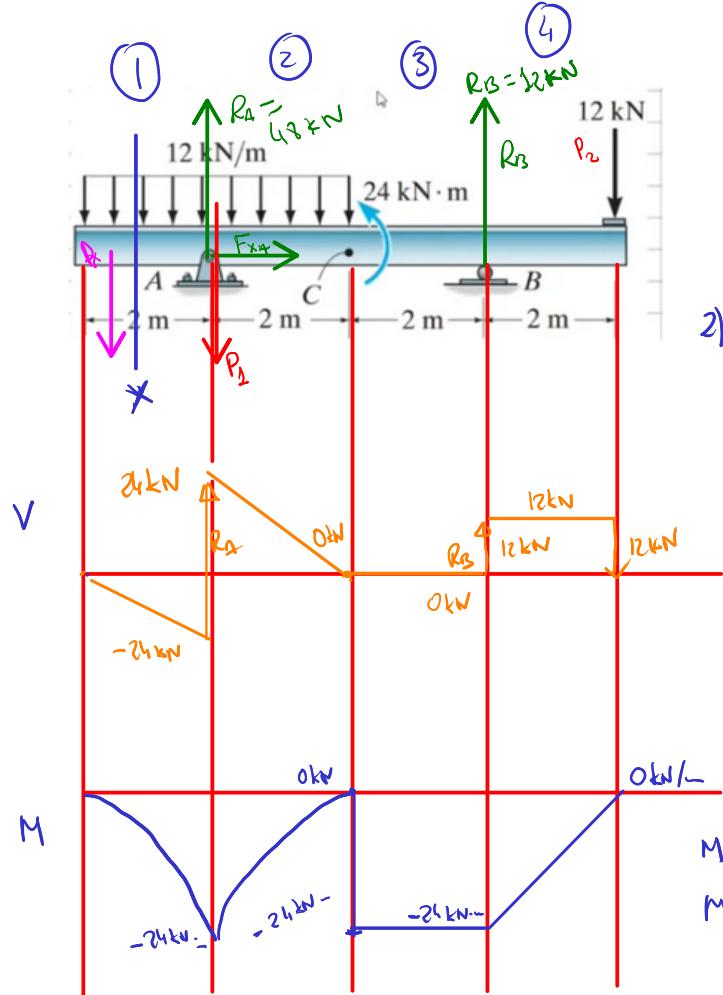
$$V_{4\text{m}} = 48 \text{ kN} - 12 \frac{\text{kN}}{\text{m}} \cdot 4\text{m} = 0 \text{ kN}$$

$$X \in [4\text{m}, 6\text{m}] \quad V = 0 \quad V_{6\text{m}} = 0 \text{ kN}$$

$$X \in [6\text{m}, 8\text{m}] \quad V = 48 \text{ kN} - 12 \frac{\text{kN}}{\text{m}} \cdot 6\text{m} + 12 \text{ kN} = 12 \text{ kN}$$

$$V_{8\text{m}} = 12 \text{ kN} \parallel V_{8\text{m}}^+ = 12 \text{ kN} - 12 \text{ kN} = 0 \text{ kN} \quad V_{8\text{m}}^+ = 12 \text{ kN}$$





1) $x \in [0, 2]$

$$\sum M = 0 \quad \rightarrow M_1 = 12 \text{ kN/m} \cdot x \cdot \frac{x}{2} = 0$$

$$M_1(x) = -6 \text{ kN/m} \cdot x^2$$

$$M_1(x=0) = 0 \text{ kN.m} \quad || \quad M_1(x=2) = -24 \text{ kN.m}$$

$$M_1(x=4) = -6 \text{ kN.m}$$

$$V_1 = \frac{dM_1}{dx} = 12 \text{ kN/m} \cdot x \rightarrow V_1(2) = -24 \text{ kN}$$

2) $x \in [2, 4]$ $\sum M = 0$

$$M_2 = -12 \text{ kN/m} \cdot x \cdot \frac{x}{2} + 48 \text{ kN} \cdot (x-2)$$

$$M_2 = -6 \text{ kN/m} \cdot x^2 + 48 \text{ kN} \cdot (x-2)$$

$$M_2(x=2) = -24 \text{ kN.m} \quad || \quad M_2(x=4) = 0 \text{ kN.m}$$

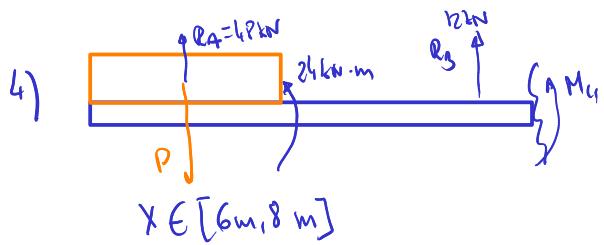
$$V_2 = \frac{dM_2}{dx} = -12 \text{ kN/m} \cdot x + 48 \text{ kN} \quad V_2(2) = -24 \text{ kN}$$

$$V_2(4) = 0 \text{ kN}$$

3) $x \in [4, 6]$

$$M_3 = 48 \text{ kN} \cdot (x-2) - 12 \text{ kN/m} \cdot 4 \cdot (x-2) - 24 \text{ kN.m}$$

$$M_3 = -24 \text{ kN.m} \quad V_3 = \frac{dM_3}{dx} = 0 \text{ kN}$$



$$M_4 = 48 \text{ kN} \cdot (x-2) - 12 \text{ kN/m} \cdot 4 \cdot (x-2) - 24 \text{ kN.m} + 12 \text{ kN} \cdot (x-6) = 12 \text{ kN} \cdot (x-6) - 24 \text{ kN.m}$$

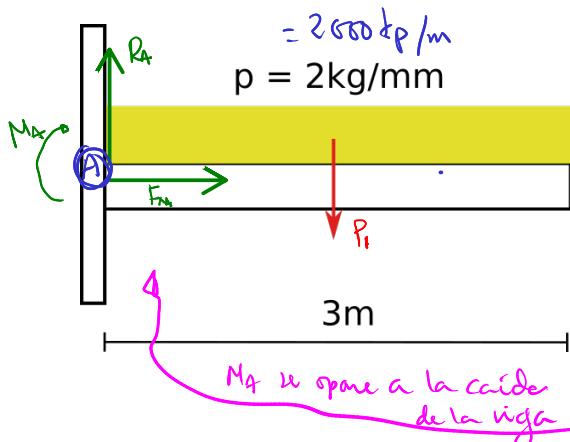
$$M_4|_{x=6} = -24 \text{ kN.m} \quad M_4|_{x=8} = 0 \text{ kN.m}$$

$$V_4 = \frac{dM_4}{dx} = 12 \text{ kN} \cdot \rightarrow V_4(x=6) = 12 \text{ kN}$$

$$V_4(x=8) = 12 \text{ kN}$$

Reacciones

$$F > 0 \quad \downarrow \quad M > 0$$



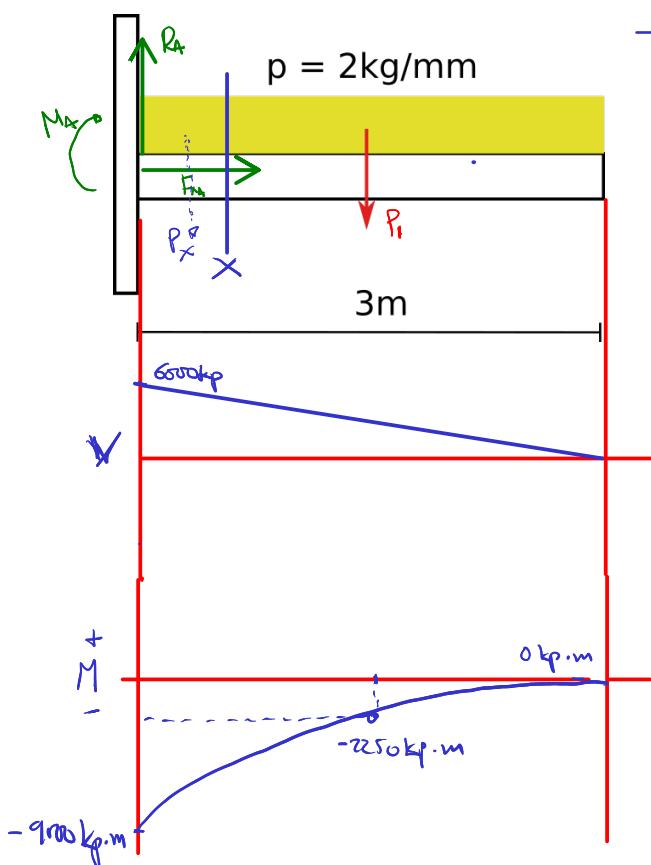
$$1) \sum F_x = 0 \rightarrow F_H = 0 \approx$$

$$2) \sum F_y = 0 = R_A + p \cdot L = 0$$

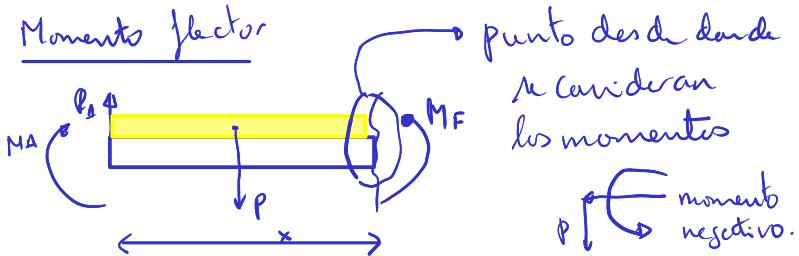
$$R_A = p \cdot L = 2000 \text{ kp/m} \cdot 3 \text{ m} = \underline{\underline{6000 \text{ kp}}}$$

$$3) \sum M = 0 \quad M_A + p \cdot L \cdot \frac{L}{2} = 0$$

$$M_A = -p \frac{L^2}{2} = -2000 \text{ kp/m} \cdot \frac{9 \text{ m}^2}{2} = -\underline{\underline{9000 \text{ kp} \cdot \text{m}}}$$



Momentos flectores



$$-M_F + M_A + R_A \cdot x - p \cdot x \cdot \frac{x}{2} = 0$$

$$M_F = -9000 \text{ kp} \cdot \text{m} + 6000 \text{ kp} \cdot x - 2000 \text{ kp/m} \cdot \frac{x^2}{2}$$

$$M_F(x=0 \text{ m}) = -9000 \text{ kp} \cdot \text{m}$$

$$M_F(x=1.5 \text{ m}) = -2250 \text{ kp} \cdot \text{m}$$

$$M_F(x=3 \text{ m}) = 0 \text{ kp} \cdot \text{m}$$

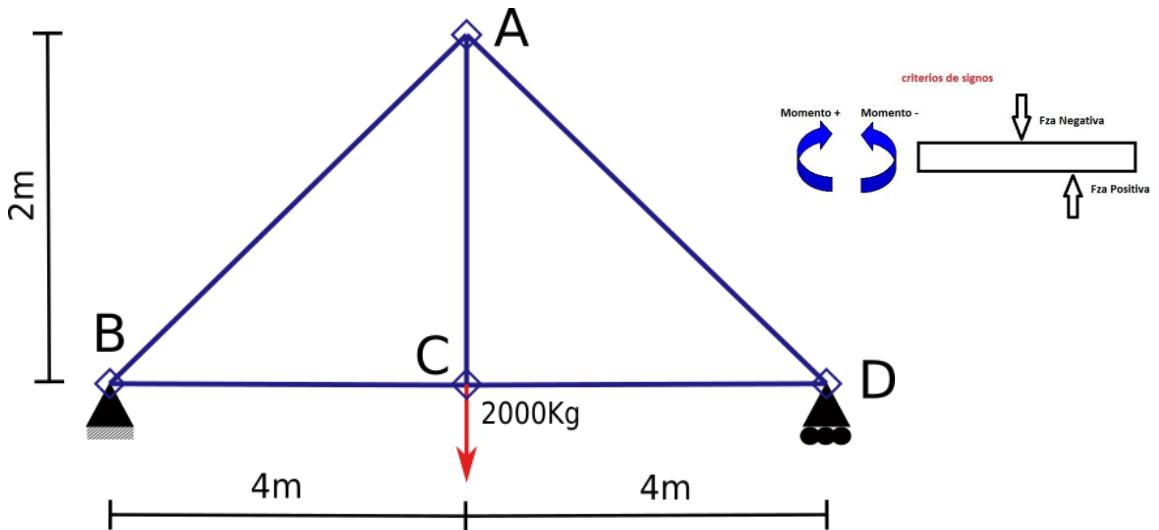
Esfuerzo cortante

$$V = \frac{dM_F}{dx} = 6000 \text{ kp} - 2000 \text{ kp/m} \cdot x$$

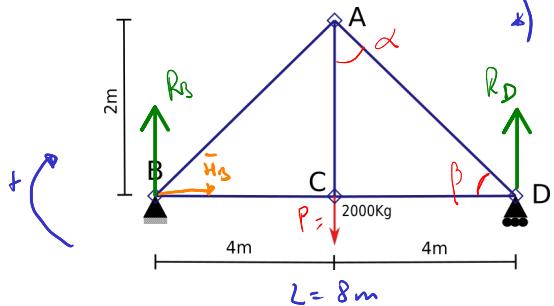
$$V(0) = 6000 \text{ kp} \quad V(3 \text{ m}) = 0 \text{ kp}$$

Problema 5

Calcular los esfuerzos en cada barra.



A) Reacciones



$$\sum \vec{F}_x = 0 \rightarrow \bar{R}_B = 0 \text{ kN}$$

$$\begin{aligned} \sum \vec{F}_y = 0 & \rightarrow \bar{R}_B + \bar{R}_D + \bar{P} = 0 \\ R_B \bar{i} + R_D \bar{j} - P \bar{j} &= 0 \Rightarrow \boxed{R_B + R_D = P} \end{aligned}$$

$$\sum M_D = 0$$

$$R_B \cdot L - P \cdot \frac{L}{2} = 0$$

$$R_B = P/2 \quad R_D = P/2$$

$$R_B = 1000 \text{ kN}$$

$$R_D = 1000 \text{ kN}$$

$$\tan \alpha = \frac{4 \text{ m}}{2 \text{ m}} \Rightarrow \alpha = 63,43^\circ$$

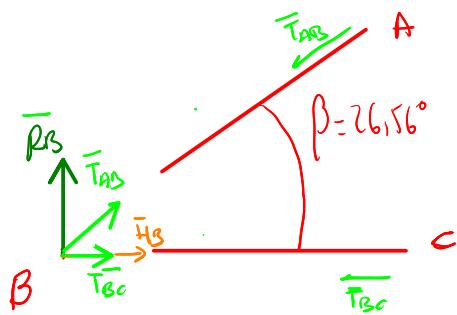
$$\tan \beta = \frac{2 \text{ m}}{4 \text{ m}} \Rightarrow \beta = 26,56^\circ$$

- B) "Rumbo" la estructura. En cada nodo dibujo las tensiones a las que esté sometido. Como no permito momentos flectores, no tengo ecuaciones de momento. Así lo en fuerzas en ambos ejes.
- * Considera que todas las barras están sometidas a tracción. Si estuvieran a compresión, saldría negativo.



Las tensiones N (σ_T) son las reacciones de la barra a las fuerzas. Si esté sometida a tracción, las reacciones van "hacia dentro".

Nodo B (Sólo dos barras)



$$\sum \bar{F}_y = 0$$

$$R_B + \bar{T}_{AB} \sin \beta = 0$$

$$R_B \vec{j} + \bar{T}_{AB} \sin \beta \vec{j} = 0$$

$$\bar{T}_{AB} = -\frac{R_B}{\sin \beta} = -\frac{1000 \text{ kp}}{\sin 26,56^\circ} = -2236,46 \text{ kp}$$

↓) Como supuse que la barra BA trabaja a tracción, y al calcular, \bar{T}_{AB} vale negativo, la barra AB en realidad trabaja a compresión

$$\sum \bar{F}_x = 0 \quad \bar{T}_{BC} + \bar{H}_B + \bar{T}_{AB} \cos \beta = 0 \Rightarrow$$

$$\bar{T}_{BC} \vec{i} + \bar{T}_{AB} \cos \beta \vec{i} = 0 \quad \bar{T}_{BC} = -\bar{T}_{AB} \cdot \cos \beta$$

$$\bar{T}_{BC} = -(-2236,46 \text{ kp}) \cdot \cos(26,56^\circ) = 2000 \text{ kp}$$

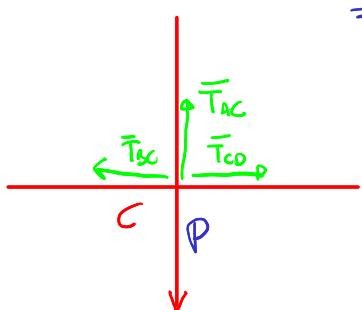
↓) Al ver $\bar{T}_{BC} > 0$, se confirma que la barra BC trabaja a tracción

Nodo C

$$\sum \bar{F}_y = 0 \quad \bar{P} + \bar{T}_{AC} = 0 \quad -\bar{P} \vec{j} + \bar{T}_{AC} \vec{j} = 0$$

#

$$\bar{T}_{AC} = \bar{P} = 2000 \text{ kp} \quad (\text{a tracción})$$

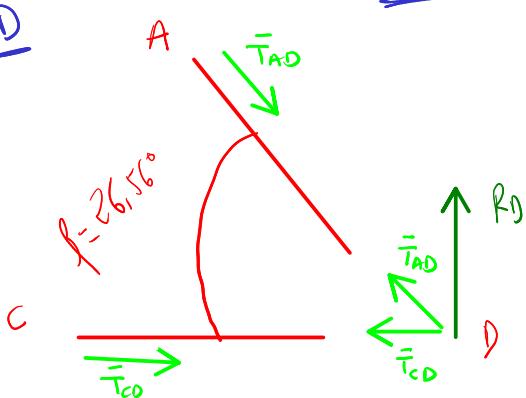


$$\sum \bar{F}_x = 0 \quad \bar{T}_{BC} + \bar{T}_{CD} = 0 \quad -\bar{T}_{BC} \vec{i} + \bar{T}_{CD} \vec{i} = 0$$

#

$$\bar{T}_{CD} = \bar{T}_{BC} = 2000 \text{ kp} \quad (\text{a tracción})$$

Nodo D



$$\sum \bar{F}_x = 0 \quad \bar{T}_{AD} + \bar{T}_{CD} \cos \beta = 0 \Rightarrow -\bar{T}_{AD} \vec{i} - \bar{T}_{CD} \cos \beta \vec{i} = 0$$

$$\bar{T}_{CD} = -\bar{T}_{AD} \cdot \cos \beta$$

$$\sum \bar{F}_y = 0 \quad \bar{R}_D + \bar{T}_{AD} \sin \beta = 0$$

$$\bar{R}_D \vec{j} + \bar{T}_{AD} \sin \beta \vec{j} = 0$$

$$\bar{T}_{AD} = -\frac{\bar{R}_D}{\sin \beta} = -\frac{2000 \text{ kp}}{\sin 26,56^\circ} = -2236,46 \text{ kp}$$

a compresión

$$\bar{T}_{CD} = -(-2236,46 \text{ kp}) \cdot \cos(26,56^\circ) = 2000 \text{ kp}$$

a tracción

Conclusión:

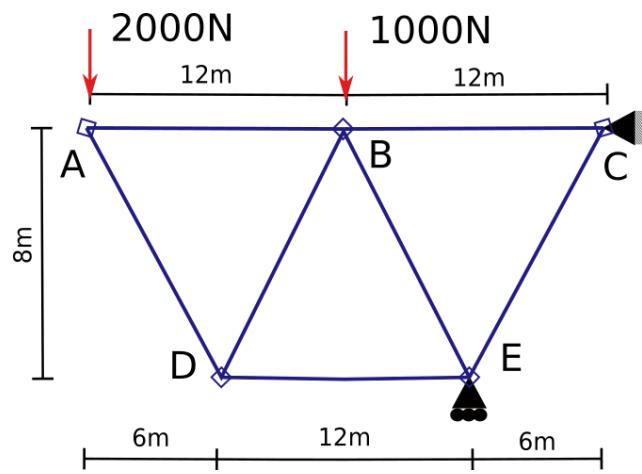
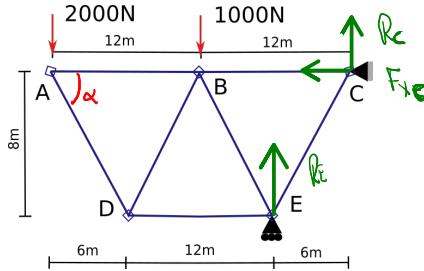
$$\begin{aligned} T_{AB} &= -2236,46 \text{ kp} \\ T_{AD} &= -2236,46 \text{ kp} \end{aligned} \quad \left. \begin{array}{l} \text{A compresión} \\ \text{A tracción} \end{array} \right\}$$

#

$$\begin{aligned} T_{CD} &= 2000 \text{ kp} \\ T_{BC} &= 2000 \text{ kp} \\ T_{CA} &= 2000 \text{ kp} \end{aligned} \quad \left. \begin{array}{l} \text{A compresión} \\ \text{A tracción} \end{array} \right\}$$

Se puede utilizar el nodo A para comprobar que se cumple el criterio

Problema 6



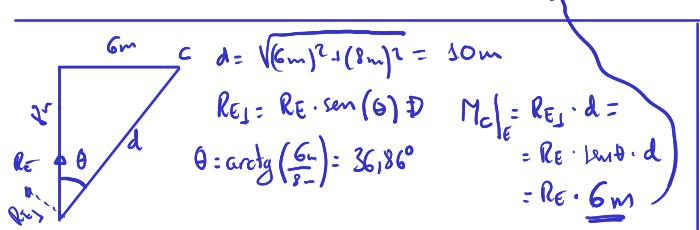
A) Reacciones

$$\sum \bar{F}_x = 0 \rightarrow F_{x_C} = 0 \text{ N}$$

$$\begin{aligned} \sum \bar{F}_y = 0 \quad R_E + R_C + P_A - P_B &= 0 \quad // \quad R_E - R_C - P_A + P_B = 0 \\ R_E + R_C &= 3000 \text{ N} \end{aligned}$$

$$\sum M_C = 0 \quad -P_A \cdot 24 \text{ m} - P_B \cdot 12 \text{ m} + R_E \cdot 6 \text{ m} = 0 \Rightarrow$$

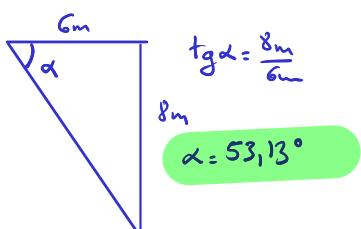
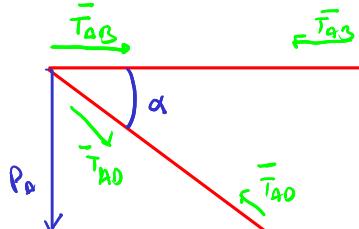
$$R_E = \frac{P_A \cdot 24 \text{ m} + P_B \cdot 12 \text{ m}}{6 \text{ m}} = \frac{2000 \text{ N} \cdot 24 \text{ m} + 1000 \text{ N} \cdot 12 \text{ m}}{6 \text{ m}} =$$



$$R_E = 10000 \text{ N} = 10 \text{ kN}$$

$$R_C = -7000 \text{ N}$$

(A)



$$\sum \bar{F}_y = 0 \quad -P_A - T_{AD} \sin \alpha = 0$$

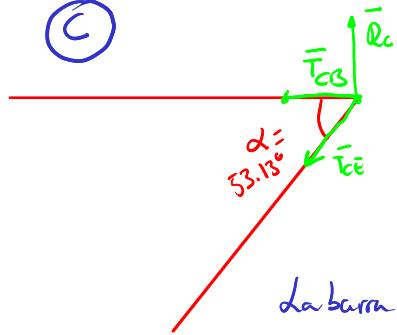
$$T_{AD} = \frac{-P_A}{\sin \alpha} = \frac{-2000 \text{ N}}{\sin(53.13^\circ)} = -2500 \text{ N}$$

La barra AD trabaja a compresión

$$\sum \bar{F}_x = 0 \quad T_{AB} + T_{AD} \cos \alpha = 0$$

$$T_{AB} = -T_{AD} \cos \alpha = -(-2500 \text{ N}) \cdot \cos(53.13^\circ) = 1500 \text{ N}$$

C

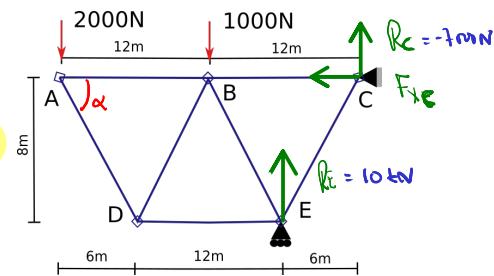


$$\sum F_y = 0$$

$$R_{Cj} - T_{CE} \sin \alpha \hat{j} = 0$$

$$T_{CE} = \frac{R_C}{\sin \alpha} : \frac{-7000N}{\sin(53.13^\circ)} = -8750N$$

La barra CE trabaja a compresión

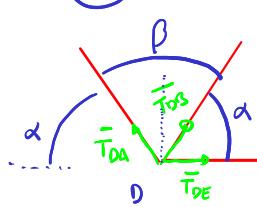


$$\sum F_x = 0 \quad -T_{CB} \hat{i} - T_{CE} \cos \alpha \hat{i} = 0$$

$$T_{CB} = -T_{CE} \cos \alpha = -(-8750N) \cdot \cos(53.13^\circ) = 5250N$$

La barra BC trabaja a tracción

D



Ya sé que T_{AD} = -2500N del nodo A. y que T_{CB} = 5250N

$$\beta = \pi - 2\alpha = 180^\circ - 2 \cdot (53.13^\circ) = 73.76^\circ$$

$$*) \sum F_y = 0 \Rightarrow T_{DA} \sin \alpha \hat{j} + T_{DB} \sin \alpha \hat{j} = 0 \Rightarrow T_{DB} = -T_{DA} = 2500N$$

la barra DB trabaja a tracción

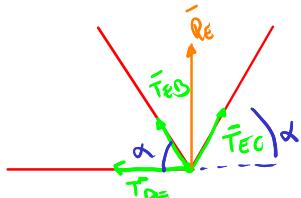
$$*) \sum F_x = 0 \Rightarrow T_{DE} \hat{i} + T_{DB} \cos \alpha \hat{i} - T_{DA} \cos \alpha \hat{i} = 0$$

$$T_{DE} = T_{DA} \cdot \cos \alpha - T_{DB} \cdot \cos \alpha = (T_{DA} - T_{DB}) \cdot \cos \alpha$$

$$T_{DE} = (-2500N - 2500N) \cdot \cos(53.13^\circ) = -3000N$$

luego la barra DE trabaja a compresión

E



Y sé T_{DE} = -3000N y T_{CE} = -8750N

Nos quedan T_{EB}

$$\sum F_x = 0 \quad -T_{DE} \hat{i} - T_{EB} \cos \alpha \hat{i} + T_{EC} \cos \alpha \hat{i} = 0$$

$$T_{EB} = -\frac{T_{DE}}{\cos \alpha} + T_{EC} = -\frac{-3000N}{\cos(53.13^\circ)} - 8750N = -3750N$$

la barra DE trabaja a compresión

*) Puedo usar $\sum F_y = 0$ para comprobar.

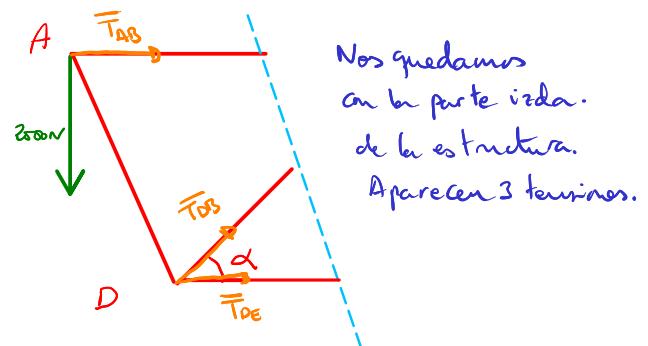
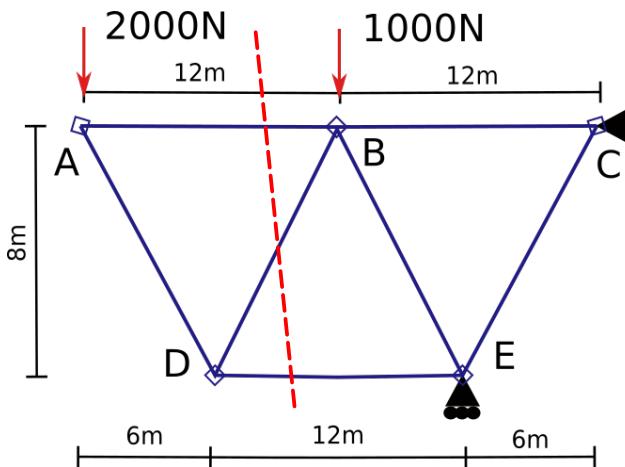
$$T_{EB} \cdot \sin \alpha \hat{j} + T_{EC} \sin \alpha \hat{j} + R_E \hat{j} = 0 \rightarrow (-3750N - 8750N) \cdot \sin(53.13^\circ) + 10000N = 0N$$

*) También puedo usar los resultados en B para comprobar.

Resumen: Tracción: $T_{AB} = 1500N$, $T_{CB} = 5250N$, $T_{DB} = 2500N$

Compresión: $T_{AD} = -2500N$, $T_{CE} = -8750N$, $T_{DE} = -3000N$, $T_{EB} = -3750N$

Problema 7: usalo cuando no necesito saber las tensiones en todas las barras



* De antes he calculado $P_C = -7000N$ y $R_E = 10000N$

Puedo aplicar cualquier ecuación de equilibrio. En x, y fuerzas, y momentos.

$$\sum \bar{F}_y = 0 \quad -P_A \bar{j} + T_{AB} \sin \alpha \bar{j} = 0 \rightarrow T_{AB} = \frac{P_A}{\sin \alpha} = \frac{2000 N}{\sin(53.13^\circ)} = 2500 N$$

$\sum M_B = 0$ las fuerzas que producen momento son \bar{T}_{AB} y \bar{P}_A

vectorialmente $\bar{P}_A = (-6\bar{i} + 8\bar{j}) m$

$$\bar{M}_{PA} + \bar{M}_{T_{AB}} = 0 \quad (-6\bar{i} + 8\bar{j}) m \wedge (-P_A \bar{j}) + (-6\bar{i} + 8\bar{j}) m \wedge (T_{AB} \bar{i}) = 0 \quad \bar{i} \wedge \bar{j} = 0$$

$$(-6m) \cdot (-P_A) (\bar{i} \wedge \bar{j}) + (8m \cdot T_{AB}) \cdot (\bar{i} \wedge \bar{i}) = 0$$

$$(-6m) P_A \bar{k} - 8m \cdot T_{AB} \bar{k} = 0 \rightarrow T_{AB} = \frac{6m \cdot P_A}{8m} = 1500 N$$

O implemente

$$\frac{T_{AB} \cdot 8m - P_A \cdot 6m}{6m} = 0 \quad \text{momento negativo.}$$

Lo momento positivo

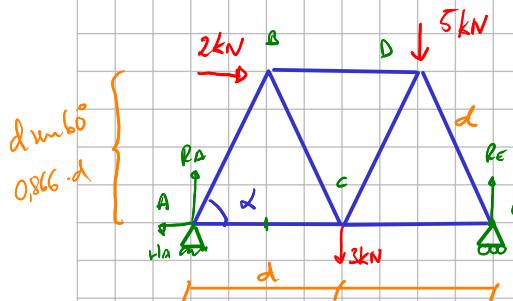
$$\sum \bar{F}_x = 0 \rightarrow$$

$$T_{AB} \bar{i} + T_{DE} \bar{i} + T_{DB} \cdot \cos \alpha \bar{i} = 0$$

$$T_{DE} = -T_{AB} - T_{DB} \cdot \cos \alpha = -1500 N - 2500 N \cdot \cos(53.13^\circ) = \\ = -3500 N$$

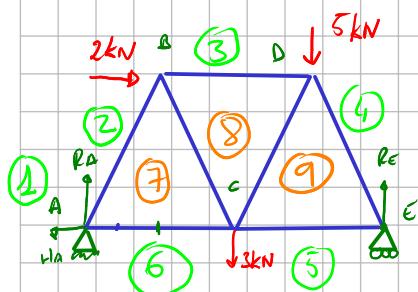
MÉTODO CREMONA

Problema 8



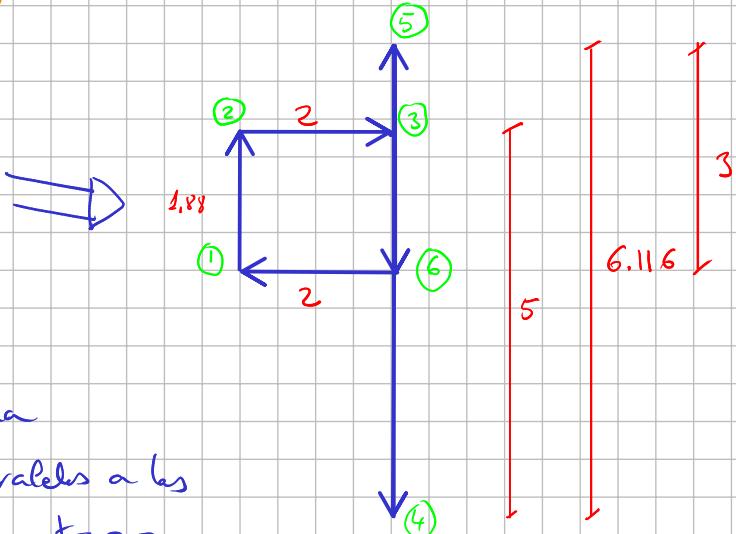
$$\sum M_A = 0 \quad 2kN \cdot 0,866 \cdot d + 3kN \cdot d - R_E \cdot 2d + 5kN \cdot 3d/2 = 0$$

$$R_E = \frac{2kN \cdot 0,866 \cdot d + 3kN \cdot d + 5kN \cdot 3d/2}{2d} = 6,116 \text{ kN} \rightarrow R_B = 1,884 \text{ kN}$$

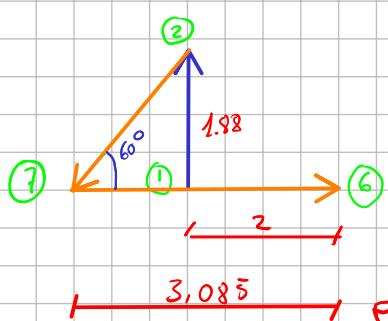


- *) Se divide en zonas, delimitadas por las fuerzas, y se numeran siguiendo el sentido de las agujas del reloj. 1, 2, 3, 4, 5, y 6
- *) Siguiendo el orden se numeran las zonas interiores 7, 8 y 9

- *) Se recorren las zonas exteriores y se dibujan las fuerzas proporcionalmente a su valor. Siempre en el sentido de las agujas del reloj



- *) Se hace lo mismo con la zona 1, 2, 7, 6. Dibujar trazos paralelos a las barras. Las longitudes de esos trazos darán el valor de las tensiones en las barras.



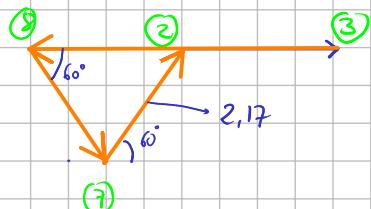
$$d(2,7) = \frac{1.88}{\sin 60^\circ} = 2.17 \quad T_{AB} = 2.17 \text{ kN} \quad \text{COMPRESIÓN (hacia el nudo)}$$

$$d(7,6) = 2 + 2.17 \cdot \cos 60^\circ = 3,085$$

$$T_{AC} = 3,085 \text{ kN} \quad \text{Tracción (hacia fuera del nudo)}$$

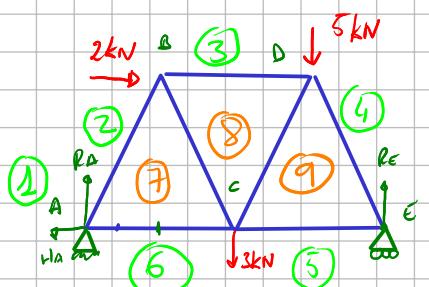
3-8-7-2

Girando en torno al punto B



$$d(3,8) = 2 + (2.17 \cos 60^\circ) \cdot 2 = 4.17 \Rightarrow T_{BD} = 4.17 \text{ kN} \text{ hacia el nudo COMPRESIÓN}$$

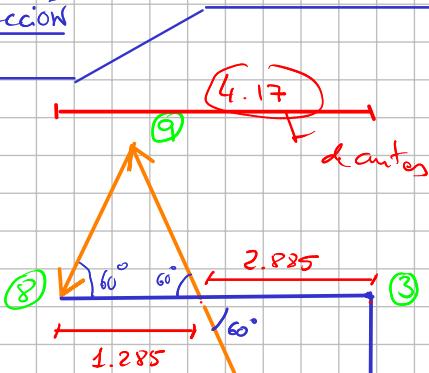
$$d(8,7) = 2.17 \Rightarrow T_{BC} = 2.17 \text{ kN fuera del nudo TRACCIÓN}$$



3-4-9-8 Girando en torno a D

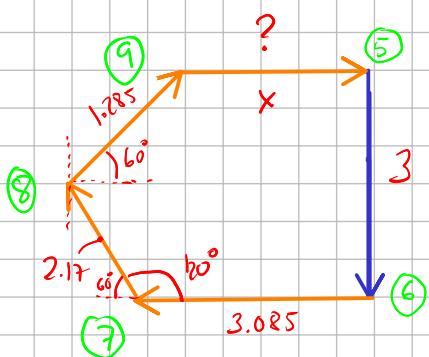
$$d(9,8) = 1.285 \Rightarrow T_{DC} = 1.285 \text{ kN a tracción}$$

$$d(4,9) = \frac{5}{\cos 30^\circ} + 1.285 \Rightarrow T_{DE} = 7.055 \text{ kN a compresión}$$



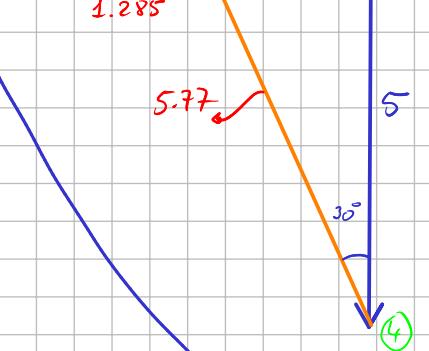
5-6-7-8-9

Giro entorno a C

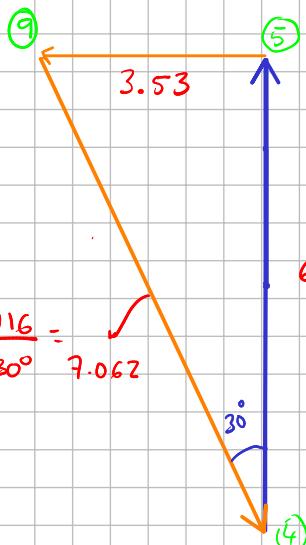


$$\begin{aligned} x + 1.285 \cdot \cos 60^\circ &= \\ 2.17 \cdot \cos 60^\circ + 3.085 & \\ x &= 3.52 \end{aligned}$$

$$d(5,9) = 3.52$$



$$T_{CE} = 3.52 \text{ kN fuera del nudo, a tracción}$$



$$d(5,9) = 3.53 \quad T_{CE} = 3.53 \text{ kN}$$

fuerza del nudo E, a tracción.

O bien giro en torno a E

4-5-9

$$\frac{6.116}{\cos 30^\circ} = 7.062$$

Problema 8

