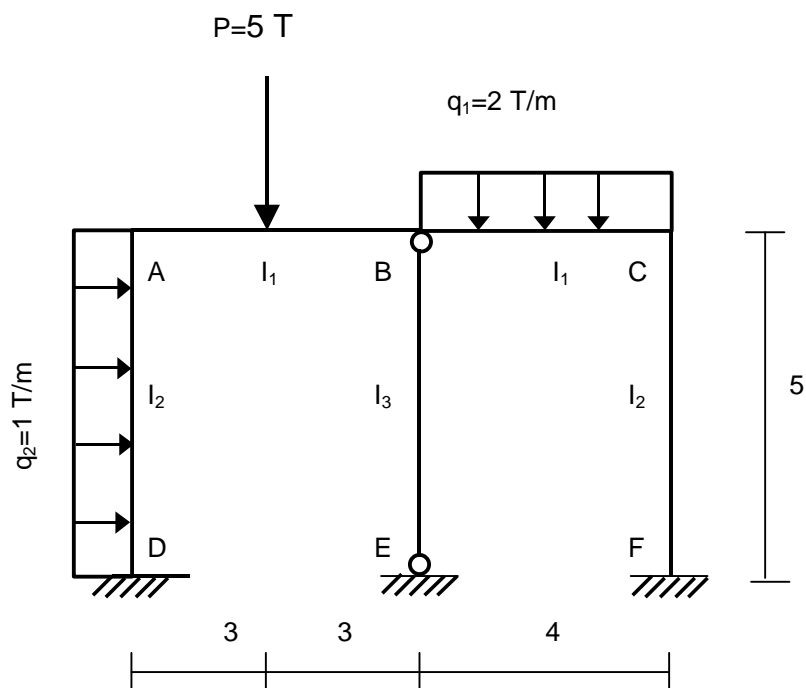


Hallar por el método de Cross los diagramas de momentos flectores y esfuerzos cortantes, así como las reacciones de todas las barras del pórtico de la figura.

La relación entre los momentos de inercia de las barras es:

$$I_1 = 2 \cdot I_2 = 3 \cdot I_3$$



1º . Determinamos los coeficientes elásticos (β_i , K_i y r_i).

Nudo A

$$K_{AD} = \frac{4 \cdot E \cdot I_2}{5} = 0.8 \cdot E \cdot I_2$$

$$K_{AB} = \frac{4 \cdot E \cdot I_1}{6} = 1.33 \cdot E \cdot I_2$$

$$\beta_{AB} = \frac{1}{2}$$

$$\beta_{AD} = \frac{1}{2}$$

$$r_{AD} = \frac{K_{AD}}{K_{AD} + K_{AB}} = \frac{0.8}{0.8 + 1.33} = 0.38$$

$$r_{AB} = \frac{K_{AB}}{K_{AD} + K_{AB}} = \frac{1.33}{0.8 + 1.33} = 0.62$$

Nudo B

$$K_{BA} = \frac{4 \cdot E \cdot I_1}{6} = 0.67 \cdot E \cdot I_1$$

$$K_{BC} = \frac{4 \cdot E \cdot I_1}{4} = E \cdot I_1$$

$$K_{BE} = 0$$

$$\beta_{BA} = \frac{1}{2}$$

$$\beta_{BC} = \frac{1}{2}$$

$$\beta_{BE} = 0$$

$$r_{BA} = \frac{K_{BA}}{K_{BA} + K_{BC} + K_{BE}} = \frac{0.67}{0.67 + 1 + 0} = 0.40$$

$$r_{BC} = \frac{K_{BC}}{K_{BA} + K_{BC} + K_{BE}} = \frac{1}{0.67 + 1 + 0} = 0.60$$

$$r_{BE} = \frac{K_{BA}}{K_{BA} + K_{BC} + K_{BE}} = 0$$

Nudo C

$$K_{CB} = \frac{4 \cdot E \cdot I_1}{4} = 2 \cdot E \cdot I_2$$

$$K_{CF} = \frac{4 \cdot E \cdot I_2}{5} = 0.8 \cdot E \cdot I_2$$

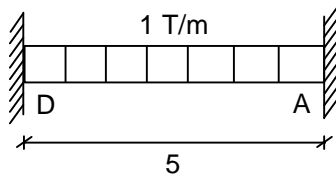
$$\beta_{CB} = \frac{1}{2}$$

$$\beta_{CF} = \frac{1}{2}$$

$$r_{CB} = \frac{K_{CB}}{K_{CB} + K_{CF}} = \frac{2}{2 + 0.8} = 0.71$$

$$r_{CF} = \frac{K_{CF}}{K_{CB} + K_{CF}} = \frac{0.8}{2 + 0.8} = 0.29$$

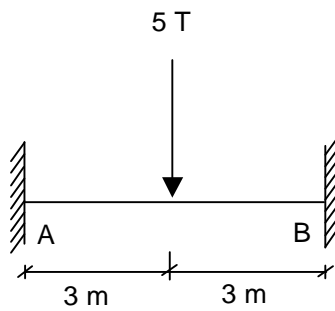
2º . Calculamos los momentos y pares de empotramiento.



$$M_D = M_A = -\frac{q \cdot l^2}{12} = -\frac{1 \cdot 5^2}{12} = -2.08 \text{ T} \cdot \text{m}$$

$$m_D = +2.08 \text{ T} \cdot \text{m}$$

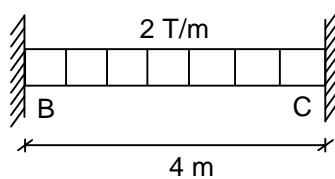
$$m_A = -2.08 \text{ T} \cdot \text{m}$$



$$M_A = M_B = -\frac{P \cdot l}{8} = -\frac{5 \cdot 6}{8} = -3.75 \text{ T} \cdot \text{m}$$

$$m_A = +3.75 \text{ T} \cdot \text{m}$$

$$m_B = -3.75 \text{ T} \cdot \text{m}$$

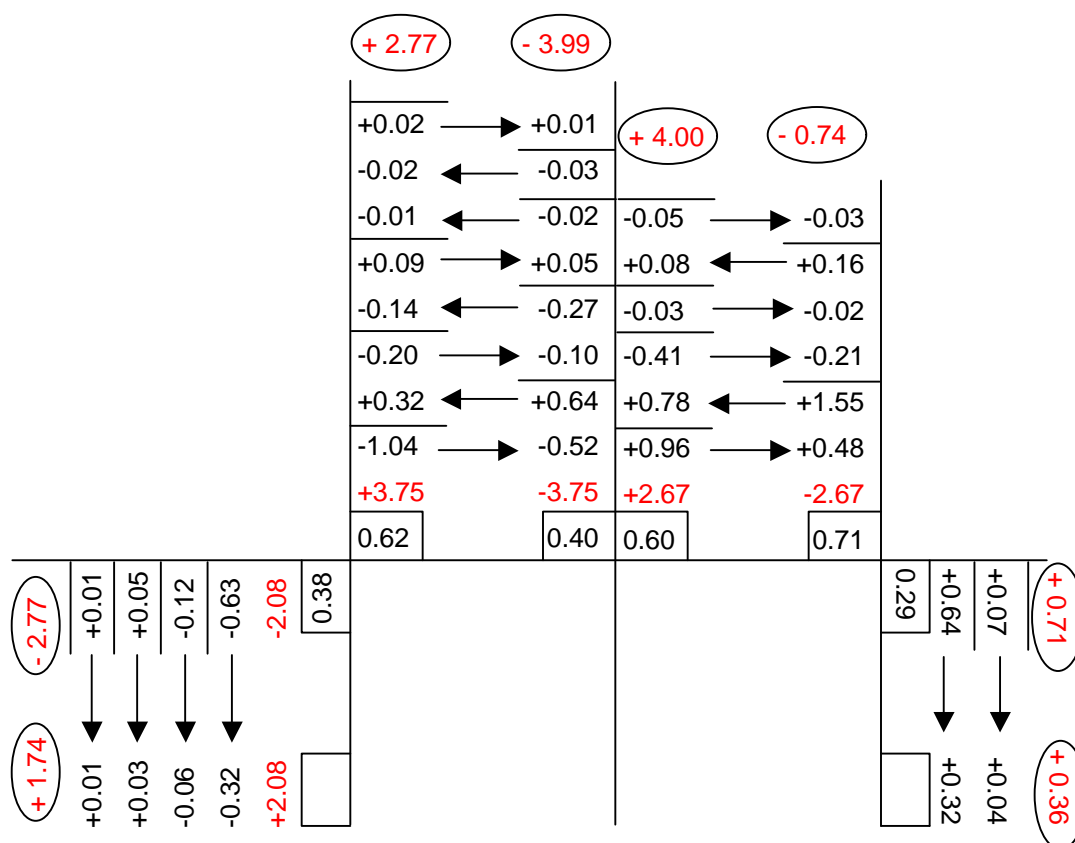


$$M_B = M_C = -\frac{q \cdot l^2}{12} = -\frac{2 \cdot 4^2}{12} = -2.67 \text{ T} \cdot \text{m}$$

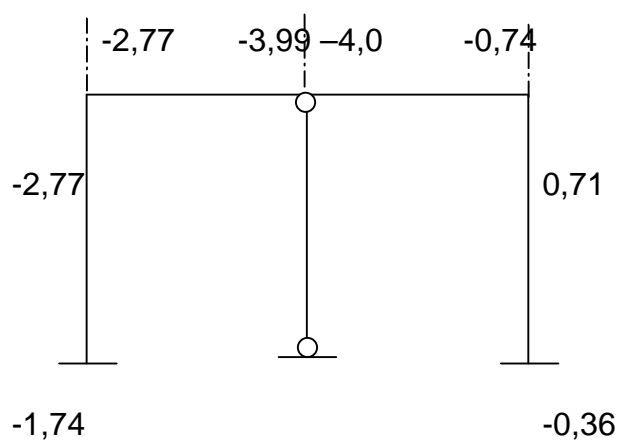
$$m_B = +2.67 \text{ T} \cdot \text{m}$$

$$m_C = -2.67 \text{ T} \cdot \text{m}$$

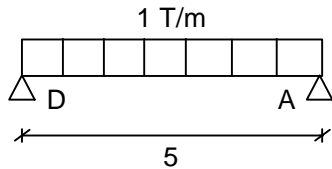
3º . Cross: Transmisiones.



► Momentos flectores en los nudos:

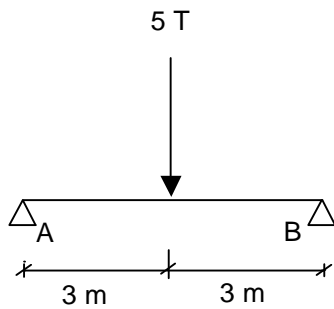


► Momentos isostáticos



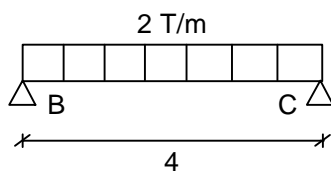
$$M_{\text{máx}_i} = \frac{q \cdot l^2}{8} = \frac{1 \cdot 5^2}{8} = 3.13 \text{ T} \cdot \text{m}$$

$$M_{\text{máx}} = \frac{M_D + M_A}{2} + M_{\text{máx}_i} = \frac{-1.74 - 2.77}{2} + 3.13 = 0.87 \text{ T} \cdot \text{m}$$



$$M_{\text{máx}_i} = \frac{P \cdot l}{4} = \frac{5 \cdot 6}{4} = 7.5 \text{ T} \cdot \text{m}$$

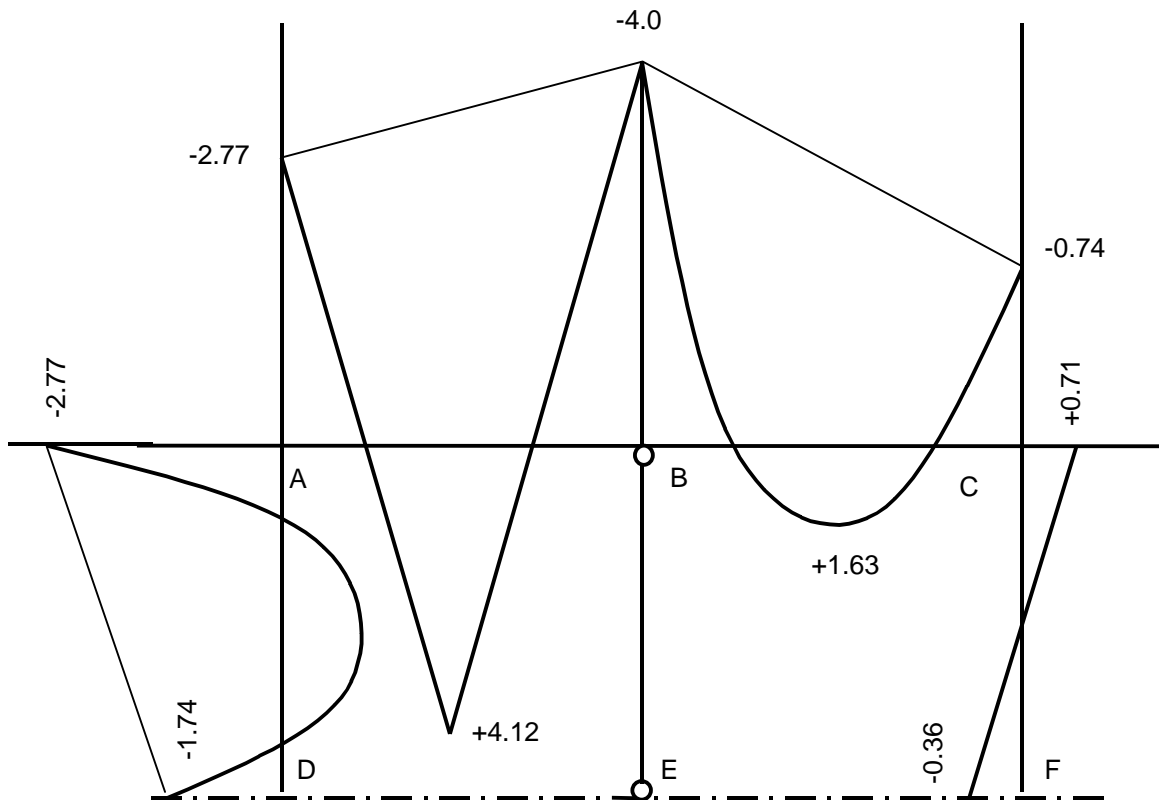
$$M_{\text{máx}} = \frac{-2.77 - 3.99}{2} + 7.5 = 4.12 \text{ T} \cdot \text{m}$$



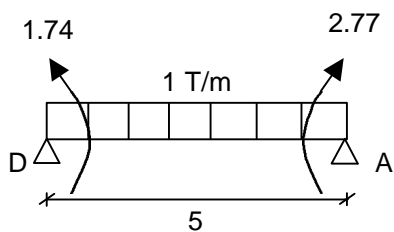
$$M_{\text{máx}_i} = \frac{q \cdot l^2}{8} = \frac{2 \cdot 4^2}{8} = 4 \text{ T} \cdot \text{m}$$

$$M_{\text{máx}} = \frac{M_B + M_C}{2} + M_{\text{máx}_i} = \frac{-4.0 - 0.74}{2} + 4 = 1.63 \text{ T} \cdot \text{m}$$

4º . Diagrama de momentos flectores.



5º . Cálculo de reacciones.

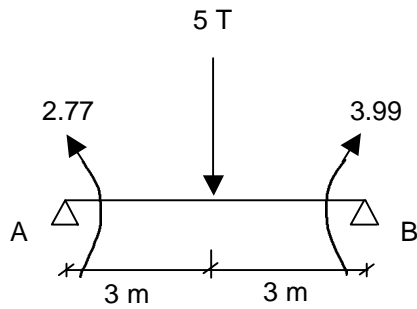


$$\sum M_A = 0$$

$$R_D \cdot 5 - 1.74 + 2.77 - 1 \cdot 5 \cdot \frac{5}{2} = 0$$

$$R_D = 2.29 \text{ T}$$

$$\sum M_D = 0$$



$$R_A \cdot 5 + 1.74 - 2.77 - 1 \cdot 5 \cdot \frac{5}{2} = 0$$

$$R_A = 2.71 \text{ T}$$

$$\sum M_B = 0$$

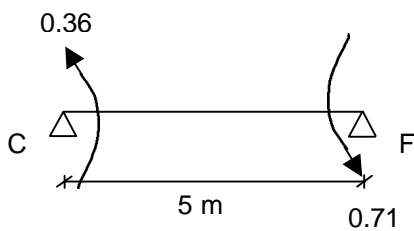
$$R_A \cdot 6 - 2.77 - 5 \cdot 3 + 3.99 = 0$$

$$R_A = 2.30 \text{ T}$$

$$\sum M_A = 0$$

$$R_B \cdot 6 - 3.99 + 2.77 - 5 \cdot 3 = 0$$

$$R_B = 2.70 \text{ T}$$



$$\sum M_C = 0$$

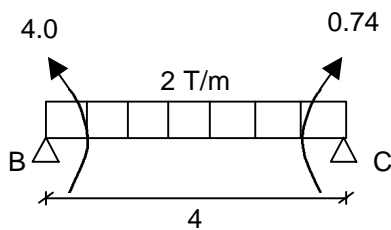
$$R_F \cdot 5 + 0.36 + 0.71 = 0$$

$$R_F = 0.21 \text{ T}$$

$$\sum M_F = 0$$

$$R_C \cdot 5 - 0.36 - 0.71 = 0$$

$$R_C = -0.21 \text{ T}$$



$$\sum M_B = 0$$

$$R_C \cdot 4 - 0.74 + 4.0 - 2 \cdot 4 \cdot \frac{4}{2} = 0$$

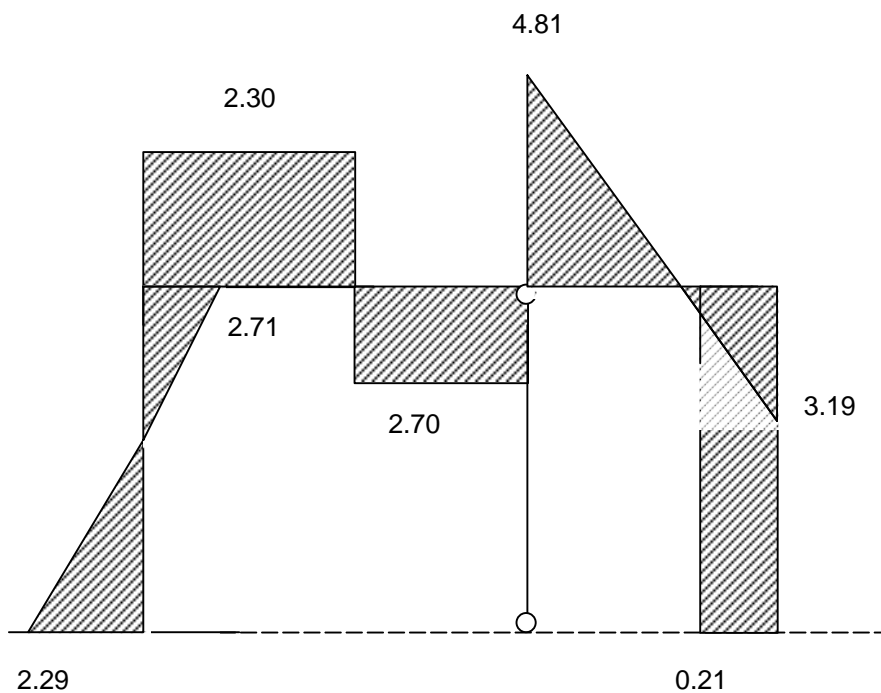
$$R_C = 3.19 \text{ T}$$

$$\sum M_C = 0$$

$$R_B \cdot 4 + 0.74 - 4.0 - 2 \cdot 4 \cdot \frac{4}{2} = 0$$

$$R_B = 4.81 \text{ T}$$

6º . Diagrama de esfuerzo cortante.



7º . Deformada.

