PROBLEMAS RESUELTOS ESTATICA

DECIMA EDICION

R. C. HIBBELER

CAPITULO 6
ANALISIS ESTRUCTURAL

6.1 Armaduras simples
6.2 El método de los nudos
6.3 Miembros de fuerza cero

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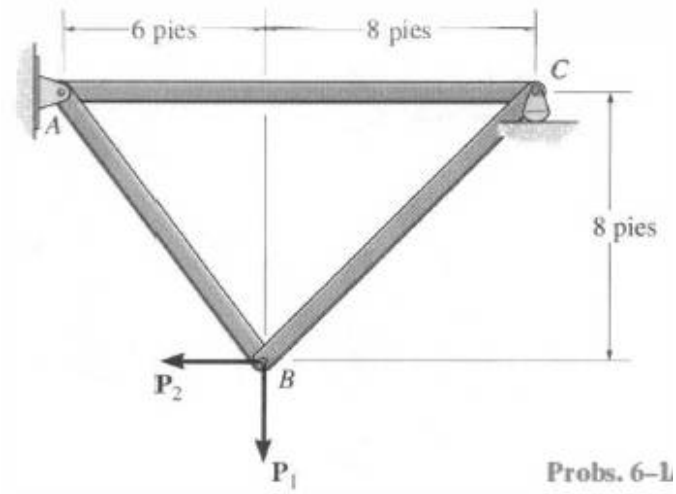
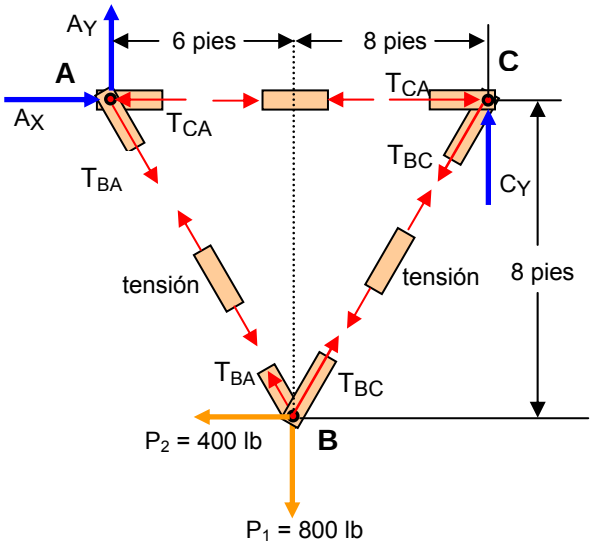
Problema 6.1 Estática Hibbeler edic 10

Determine la fuerza en cada miembro de la armadura y establezca si los miembros están en tensión o en compresión. Considere P_1 = 800 lb. y P_2 = 400 lb.





$\Sigma M_A = 0$

$\curvearrowright +$ $\quad - 400\,(8) - 800\,(6) + C_Y\,(6 + 8) = 0$

$- 400\,(8) - 800\,(6) + C_Y\,(14) = 0$

$- 3200 - 4800 + C_Y\,(14) = 0$

$- 8000 + C_Y\,(14) = 0$

$C_Y\,(14) = 8000$

$$C_Y = \frac{8000}{14} = 571{,}42 \text{ lb}$$

C_Y = 571,42 lb

$\sum F_X = 0$

$A_X - 400 = 0$

A_X = 400 lb.

$\Sigma M_C = 0$

$\curvearrowright +$ $\quad - A_Y\,(6 + 8) - 400\,(8) + 800\,(8) = 0$

$- A_Y\,(14) - 400\,(8) + 800\,(8) = 0$

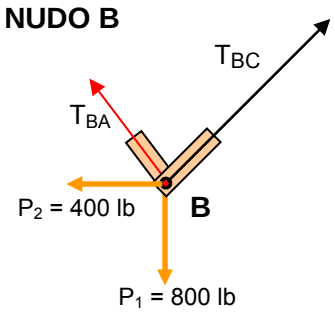
$- 14\,A_Y - 3200 = 0$

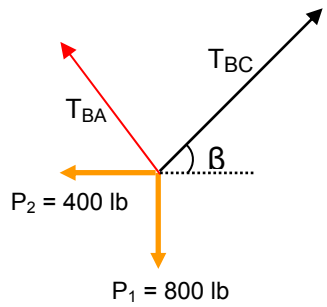
$14\,A_Y = 3200$

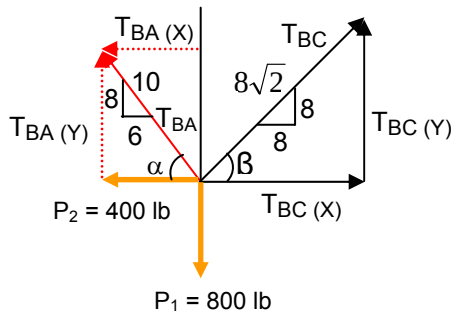
$$A_Y = \frac{3200}{14} = 228{,}57 \text{ lb}$$

A_Y = 228,57 lb

NUDO B







$$\text{sen}\,\alpha = \frac{8}{10} = \frac{4}{5}$$

$$\cos\alpha = \frac{6}{10} = \frac{3}{5}$$

$$\text{sen}\,\beta = \frac{8}{8\sqrt{2}} = \frac{\sqrt{2}}{2}$$

$$\cos\beta = \frac{8}{8\sqrt{2}} = \frac{\sqrt{2}}{2}$$

$$\text{sen}\,\alpha = \frac{T_{BA(Y)}}{T_{BA}} \Rightarrow T_{BA(Y)} = \text{sen}\alpha\,(T_{BA})$$

$$T_{BA(Y)} = \left(\frac{4}{5}\right)(T_{BA})$$

$$\cos\alpha = \frac{T_{BA(X)}}{T_{BA}} \Rightarrow T_{BA(X)} = \cos\alpha\,(T_{BA})$$

$$T_{BA(X)} = \left(\frac{3}{5}\right)(T_{BA})$$

$$\text{sen}\,\beta = \frac{T_{BC(Y)}}{T_{BC}} \Rightarrow T_{BC(Y)} = \text{sen}\beta\,(T_{BC})$$

$$T_{BC(Y)} = \left(\frac{\sqrt{2}}{2}\right)(T_{BC})$$

$$\cos\beta = \frac{T_{BC(X)}}{T_{BC}} \Rightarrow T_{BC(X)} = \cos\beta\,(T_{BC})$$

$$T_{BC(X)} = \left(\frac{\sqrt{2}}{2}\right)(T_{BC})$$

$\sum F_X = 0$

$- 400 + T_{BC\,(X)} - T_{BA\,(X)} = 0$

$T_{BC\,(X)} - T_{BA\,(X)} = 400$

$$\frac{\sqrt{2}}{2}(T_{BC}) - \frac{3}{5}T_{BA} = 400$$ **(Ecuación 1)**

$\sum F_Y = 0$

$- 800 + T_{BC\,(Y)} + T_{BA\,(Y)} = 0$

$T_{BC\,(Y)} + T_{BA\,(Y)} = 800$

$$\frac{\sqrt{2}}{2}(T_{BC}) + \frac{4}{5}T_{BA} = 800$$ **(Ecuación 2)**

resolver ecuación 1 y ecuación 2

$$\frac{\sqrt{2}}{2}(T_{BC}) - \frac{3}{5}T_{BA} = 400 \quad \textbf{(-1)}$$

$$\frac{\sqrt{2}}{2}(T_{BC}) + \frac{4}{5}T_{BA} = 800$$

$$\cancel{-\frac{\sqrt{2}}{2}(T_{BC})} + \frac{3}{5}T_{BA} = -400$$

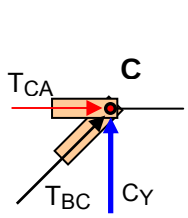
$$\cancel{\frac{\sqrt{2}}{2}(T_{BC})} + \frac{4}{5}T_{BA} = 800$$

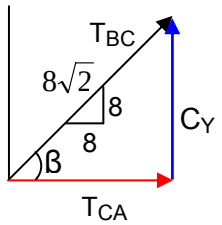
$$\frac{7}{5}T_{BA} = 400$$

$$T_{BA} = \frac{(400)5}{7}$$

T_{BA} = 285,71 lb. (Tensión)

NUDO C





Reemplazando en la ecuación 1

$$\frac{\sqrt{2}}{2}(T_{BC}) - \frac{3}{5}T_{BA} = 400 \quad \textbf{(Ecuación 1)}$$

$$\frac{\sqrt{2}}{2}(T_{BC}) - \frac{3}{5}(285{,}71) = 400$$

$$\frac{\sqrt{2}}{2}(T_{BC}) - 171{,}42 = 400$$

$$\frac{\sqrt{2}}{2}(T_{BC}) = 571{,}42$$

$$T_{BC} = \left(\frac{2}{\sqrt{2}}\right)571{,}42$$

T_{BC} = 808,12 lb. (Tensión)

Las ecuaciones de equilibrio para el nudo C son:

$$\frac{T_{CA}}{8} = \frac{T_{BC}}{8\sqrt{2}} = \frac{C_Y}{8}$$

Hallar T_{CA}

$$\frac{T_{CA}}{8} = \frac{T_{BC}}{8\sqrt{2}}$$

Pero:

T_{BC} = 808,12 lb.

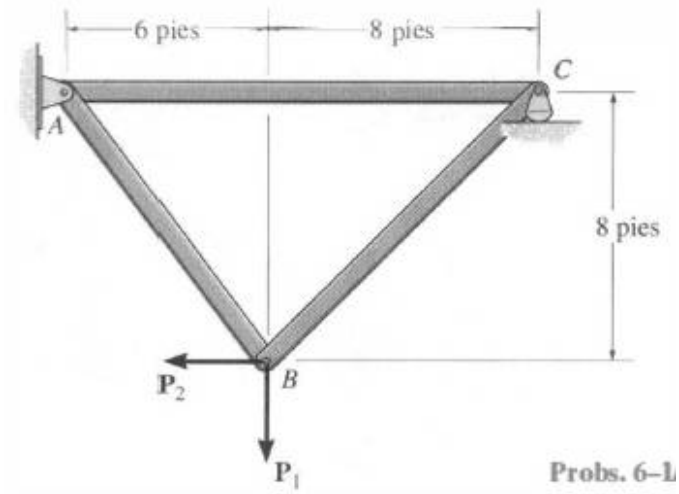
$$\frac{T_{CA}}{\cancel{8}} = \frac{808{,}12}{\cancel{8}\sqrt{2}}$$

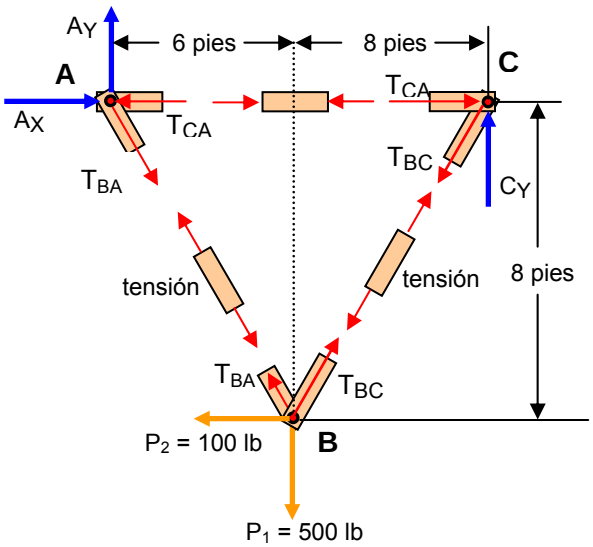
$$T_{CA} = \frac{808{,}12}{\sqrt{2}} = 571{,}42 \text{ lb}$$

T_{CA} = 571,42 lb (Compresión)

Problema 6.2 Estática Hibbeler edic 10

Determine la fuerza en cada miembro de la armadura y establezca si los miembros están en tensión o en compresión. Considere P_1 = 500 lb. y P_2 = 100 lb.





$\Sigma M_A = 0$

$+$ $\quad -100\,(8) - 500\,(6) + C_Y\,(6 + 8) = 0$

$-100\,(8) - 500\,(6) + C_Y\,(14) = 0$

$-800 - 3000 + C_Y\,(14) = 0$

$-3800 + C_Y\,(14) = 0$

$C_Y\,(14) = 3800$

$$C_Y = \frac{3800}{14} = 271{,}42 \text{ lb}$$

C_Y = 271,42 lb

$\sum F_X = 0$

$A_X - 400 = 0$

A_X = 400 lb.

$\Sigma M_C = 0$

$+$ $\quad -A_Y\,(6 + 8) - 100\,(8) + 500\,(8) = 0$

$-A_Y\,(14) - 100\,(8) + 500\,(8) = 0$

$-A_Y\,(14) - 800 + 4000 = 0$

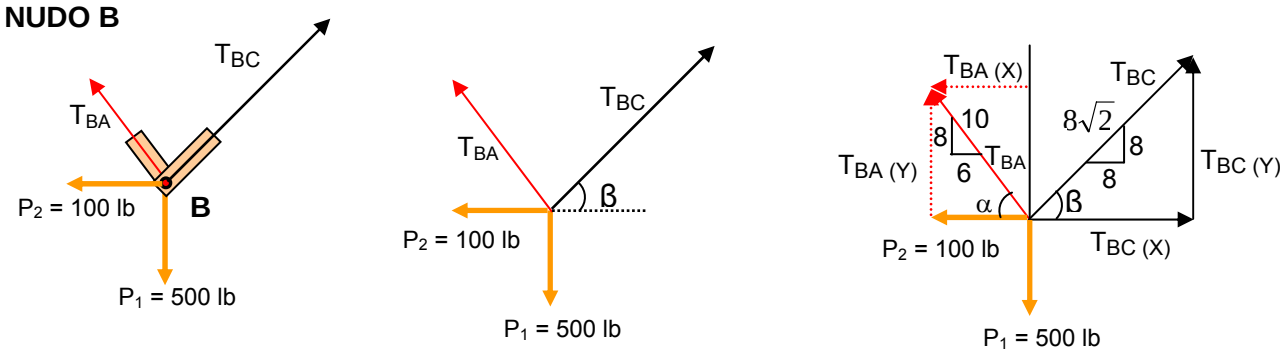
$-14\,A_Y + 3200 = 0$

$14\,A_Y = 3200$

$$A_Y = \frac{3200}{14} = 228{,}57 \text{ lb}$$

A_Y = 228,57 lb

NUDO B



$$\text{sen}\,\alpha = \frac{8}{10} = \frac{4}{5}$$

$$\cos\alpha = \frac{6}{10} = \frac{3}{5}$$

$$\text{sen}\,\beta = \frac{8}{8\sqrt{2}} = \frac{\sqrt{2}}{2}$$

$$\cos\beta = \frac{8}{8\sqrt{2}} = \frac{\sqrt{2}}{2}$$

$$\text{sen}\,\alpha = \frac{T_{BA(Y)}}{T_{BA}} \Rightarrow T_{BA(Y)} = \text{sen}\alpha\,(T_{BA})$$

$$T_{BA(Y)} = \left(\frac{4}{5}\right)(T_{BA})$$

$$\cos\alpha = \frac{T_{BA(X)}}{T_{BA}} \Rightarrow T_{BA(X)} = \cos\alpha\,(T_{BA})$$

$$T_{BA(X)} = \left(\frac{3}{5}\right)(T_{BA})$$

$$\text{sen}\,\beta = \frac{T_{BC(Y)}}{T_{BC}} \Rightarrow T_{BC(Y)} = \text{sen}\beta\,(T_{BC})$$

$$T_{BC(Y)} = \left(\frac{\sqrt{2}}{2}\right)(T_{BC})$$

$$\cos\beta = \frac{T_{BC(X)}}{T_{BC}} \Rightarrow T_{BC(X)} = \cos\beta\,(T_{BC})$$

$$T_{BC(X)} = \left(\frac{\sqrt{2}}{2}\right)(T_{BC})$$

$\sum F_X = 0$

$- 100 + T_{BC\,(X)} - T_{BA\,(X)} = 0$

$T_{BC\,(X)} - T_{BA\,(X)} = 100$

$$\frac{\sqrt{2}}{2}(T_{BC}) - \frac{3}{5}T_{BA} = 100$$ **(Ecuación 1)**

$\sum F_Y = 0$

$- 500 + T_{BC\,(Y)} + T_{BA\,(Y)} = 0$

$T_{BC\,(Y)} + T_{BA\,(Y)} = 500$

$$\frac{\sqrt{2}}{2}(T_{BC}) + \frac{4}{5}T_{BA} = 500$$ **(Ecuación 2)**

resolver ecuación 1 y ecuación 2

$$\frac{\sqrt{2}}{2}(T_{BC})-\frac{3}{5}T_{BA}=100 \quad \textbf{(-1)}$$

$$\frac{\sqrt{2}}{2}(T_{BC})+\frac{4}{5}T_{BA}=500$$

$$\cancel{-\frac{\sqrt{2}}{2}(T_{BC})}+\frac{3}{5}T_{BA}=-100$$

$$\cancel{\frac{\sqrt{2}}{2}(T_{BC})}+\frac{4}{5}T_{BA}=500$$

$$\frac{7}{5}T_{BA}=400$$

$$T_{BA}=\frac{(400)5}{7}$$

T_{BA} = 285,71 lb. (Tensión)

Reemplazando en la ecuación 1

$$\frac{\sqrt{2}}{2}(T_{BC})-\frac{3}{5}T_{BA}=100 \quad \textbf{(Ecuación 1)}$$

$$\frac{\sqrt{2}}{2}(T_{BC})-\frac{3}{5}(285{,}71)=100$$

$$\frac{\sqrt{2}}{2}(T_{BC})-171{,}42=100$$

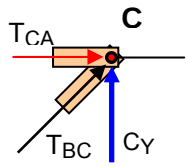
$$\frac{\sqrt{2}}{2}(T_{BC})=271{,}42$$

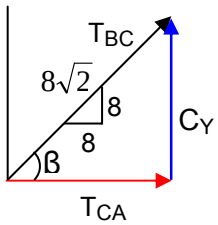
$$T_{BC}=\left(\frac{2}{\sqrt{2}}\right)271{,}42$$

T_{BC} = 383,84 lb. (Tensión)

NUDO C

Las ecuaciones de equilibrio para el nudo C son:





$$\frac{T_{CA}}{8}=\frac{T_{BC}}{8\sqrt{2}}=\frac{C_Y}{8}$$

Hallar T_{CA}

$$\frac{T_{CA}}{8}=\frac{T_{BC}}{8\sqrt{2}}$$

Pero:
T_{BC} = 383,84 lb.

$$\frac{T_{CA}}{\cancel{8}}=\frac{383{,}84}{\cancel{8}\sqrt{2}}$$

$$T_{CA}=\frac{383{,}84}{\sqrt{2}}=271{,}42\text{ lb}$$

T_{CA} = 271,42 lb (Compresión)

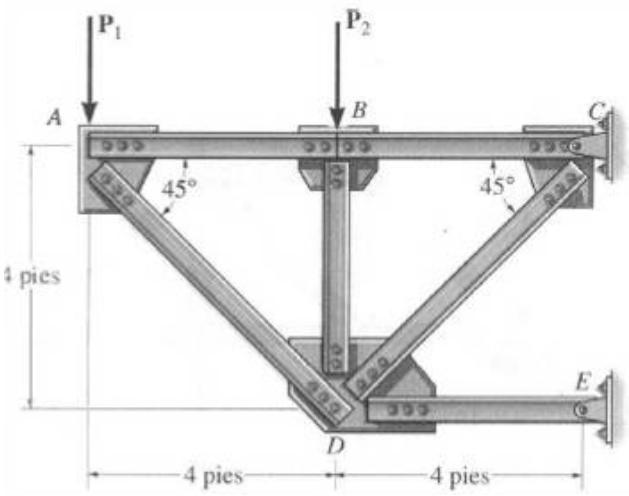
T_{BA} = 285,71 lb. (Tensión)

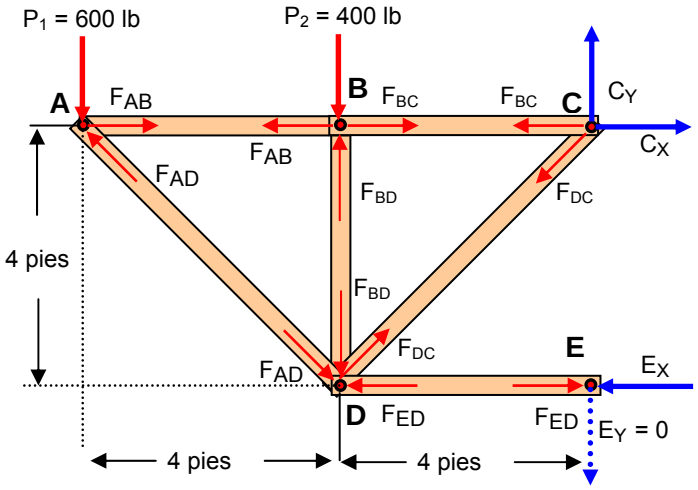
T_{BC} = 383,84 lb. (Tensión)

T_{CA} = 271,42 lb (Compresión)

Problema 6.3 Estática Hibbeler edic 10

La armadura, usada para soportar un balcón, esta sometida a la carga mostrada. Aproxime cada nudo como un pasador y determine la fuerza en cada miembro. Establezca si los miembros están en tensión o en compresión. Considere P_1 = 600 lb P_2 = 400 lb.





$\Sigma M_C = 0$

$+$ $\quad P_1 (4 + 4) + P_2 (4) - E_X (4) = 0$

$600 (4 + 4) + 400 (4) - E_X (4) = 0$

$600 (8) + 400 (4) - 4 E_X = 0$

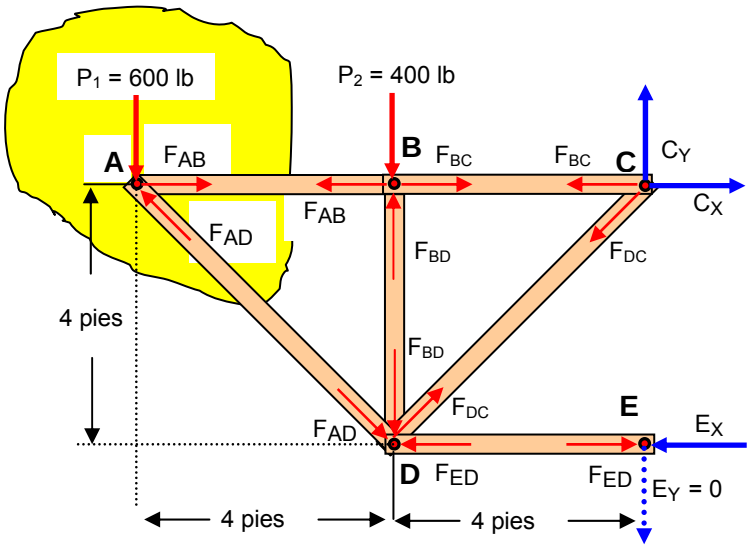
$4800 + 1600 - 4 E_X = 0$

$6400 - 4 E_X = 0$

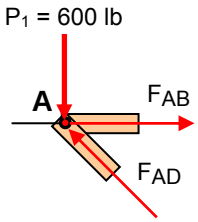
$4 E_X = 6400$

$$E_X = \frac{6400}{4} = 1600 \text{ lb}$$

E_X = 1600 lb



NUDO A



Las ecuaciones de equilibrio para el nudo A son:

$$\frac{F_{AB}}{\cancel{4}} = \frac{F_{AD}}{\cancel{4}\sqrt{2}} = \frac{600}{\cancel{4}}$$

Cancelar términos semejantes

$$F_{AB} = \frac{F_{AD}}{\sqrt{2}} = 600$$

Hallar F_{AB}

$$F_{AB} = 600\,\text{lb}$$

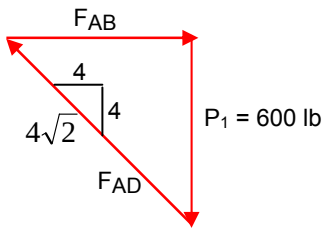
F_{AB} = 600 lb (Tension)

Hallar F_{AD}

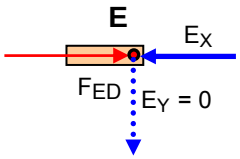
$$\frac{F_{AD}}{\sqrt{2}} = 600$$

$$F_{AD} = \left(\sqrt{2}\right)600 = 848{,}52\,\text{lb}$$

F_{AD} = 848,52 lb (compresión)



NUDO E



$\Sigma F_X = 0$

$F_{ED} - E_X = 0$

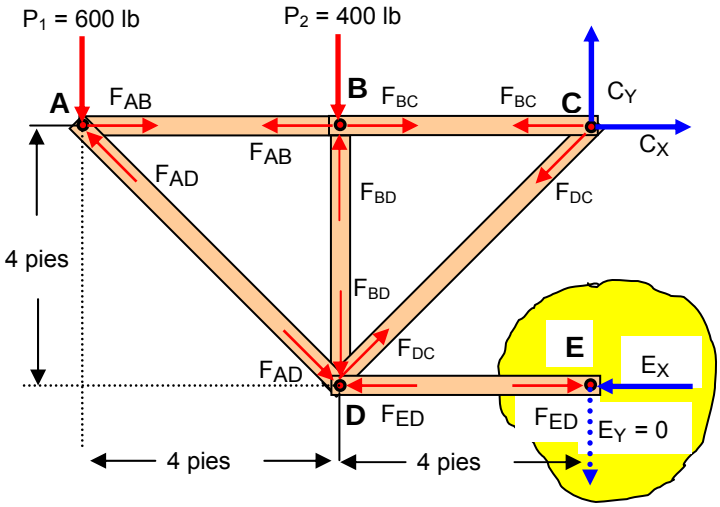
$F_{ED} = E_X$

PERO: **E_X = 1600 lb**

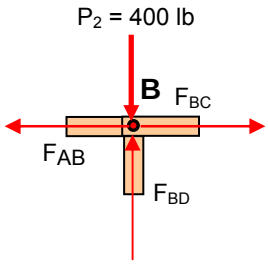
F_{ED} = 1600 lb (compresión)

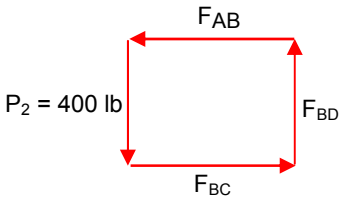
$\Sigma F_Y = 0$

E_Y = 0



NUDO B





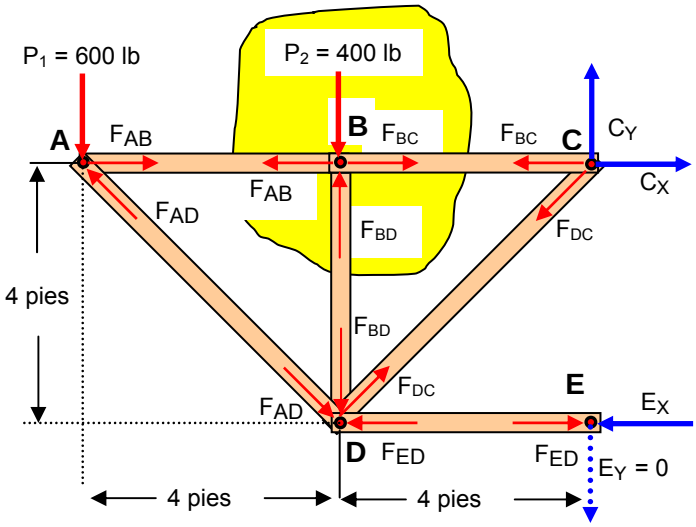
$\Sigma F_X = 0$

$F_{BC} - F_{AB} = 0$

$F_{BC} = F_{AB}$

PERO: **F_{AB} = 600 lb (Tensión)**

F_{BC} = 600 lb (Tensión)



$\Sigma F_Y = 0$

$F_{BD} - 400 = 0$

F_{BD} = 400 lb (compresión)

$\Sigma F_Y = 0$

$C_Y - 600 - 400 = 0$

$C_Y - 1000 = 0$

C_Y = 1000 lb.

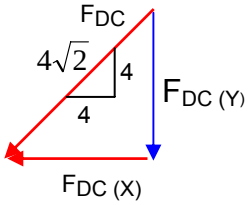
$\Sigma F_X = 0$

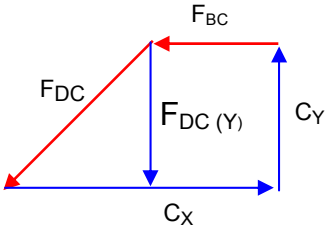
$C_X - E_X = 0$

$C_X = E_X$

PERO: **E_X = 1600 lb**

C_X = 1600 lb





NUDO C

$\Sigma F_Y = 0$

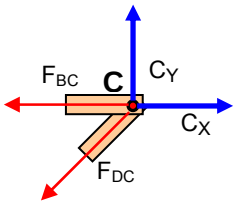
$C_Y - F_{DC(Y)} = 0$

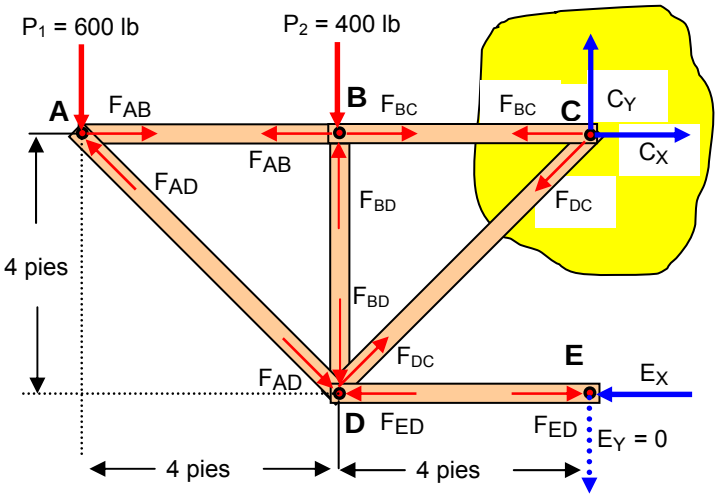
$C_Y = F_{DC(Y)}$

PERO: **C_Y = 1000 lb.**

$F_{DC(Y)}$ = 1000 lb

$$\text{sen}\,\alpha = \frac{4}{4\sqrt{2}} = \frac{1}{\sqrt{2}} = 0{,}7071$$





$$\text{sen}\,\alpha = \frac{F_{DC(Y)}}{F_{DC}}$$

$$F_{DC} = \frac{F_{DC(Y)}}{\text{sen}\,\alpha}$$

$$F_{DC} = \frac{1000}{0{,}7071} = 1414{,}22\ \text{lb}$$

F_{DC} = 1414,22 lb (tensión)

E_X = 1600 lb

E_Y = 0

C_X = 1600 lb

C_Y = 1000 lb.

F_{BD} = 400 lb (compresión)

F_{BC} = 600 lb (Tensión)

F_{AB} = 600 lb (Tensión)

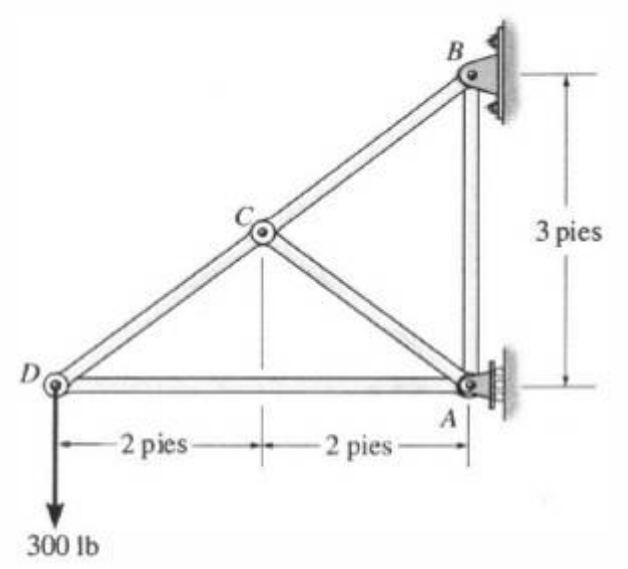
F_{ED} = 1600 lb (compresión)

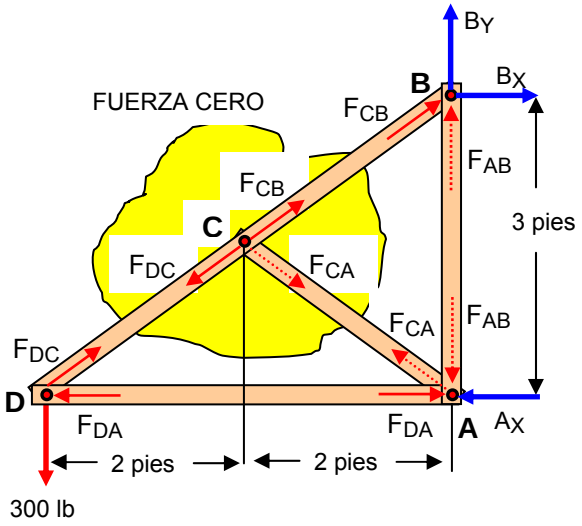
F_{AD} = 848,52 lb (compresión)

F_{DC} = 1414,22 lb (tensión)

Problema C-34 estática Hibbeler edic 10

Determine la fuerza en cada miembro de la armadura. Establezca si los miembros están en tensión o en compresión.

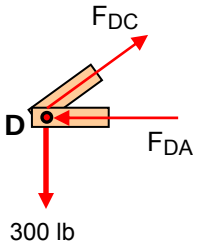


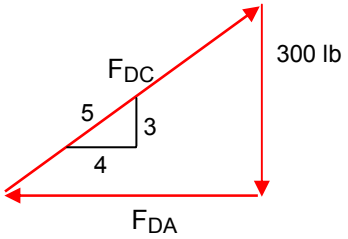


NUDO D

$$\frac{F_{DC}}{5} = \frac{300}{3} = \frac{F_{DA}}{4}$$

$$\frac{F_{DC}}{5} = 100 = \frac{F_{DA}}{4}$$





Hallar F_{DA}

$$\frac{F_{DA}}{4} = 100$$

F_{DA} = (4) 100 = 400 lb (compresión)

Hallar F_{CD}

$$\frac{F_{DC}}{5} = 100$$

F_{DC} = (5) 100 = 500 lb (Tensión)

FUERZA CERO

Si tres miembros forman un nudo de armadura en el cual dos de los miembros son colineales, el tercer miembro es un miembro de fuerza cero siempre que ninguna fuerza exterior o reacción de soporte este aplicada al nudo.

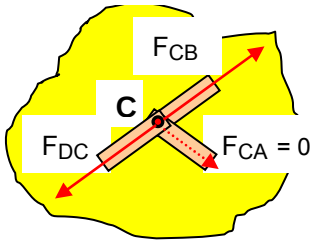
F_{CA} = 0

F_{DC} = F_{CB}

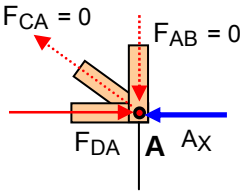
Pero: F_{DC} = 500 lb

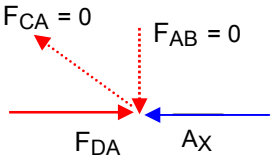
F_{CB} = 500 lb (Tensión)

FUERZA CERO



NUDO A





$\sum F_X = 0$

$F_{DA} - A_X = 0$

$\sum F_Y = 0$

F_{AB} = 0

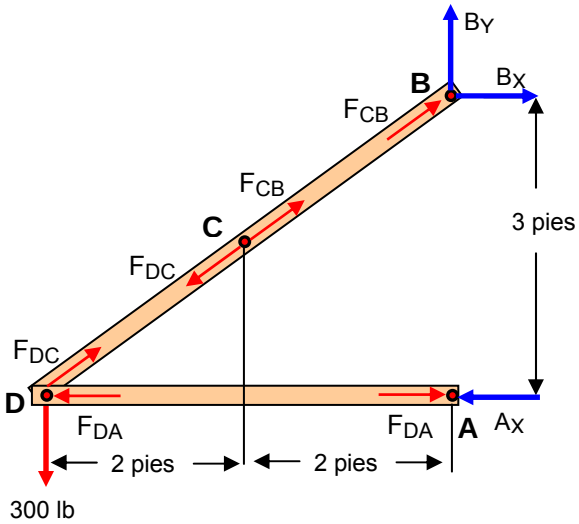
F_{CA} = 0

F_{AB} = 0

F_{CB} = 500 lb (Tensión)

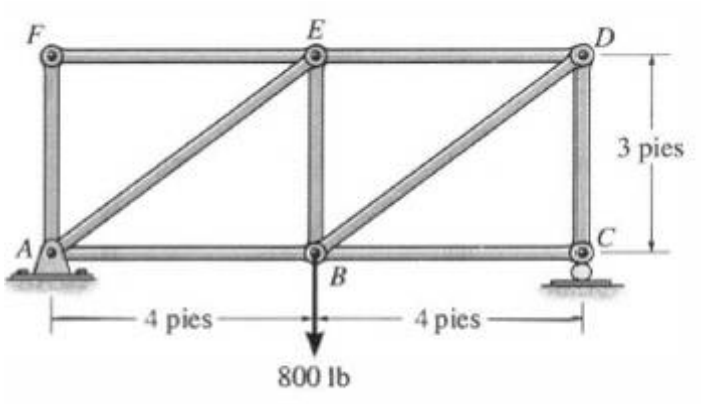
F_{DA} = (4) 100 = 400 lb (compresión)

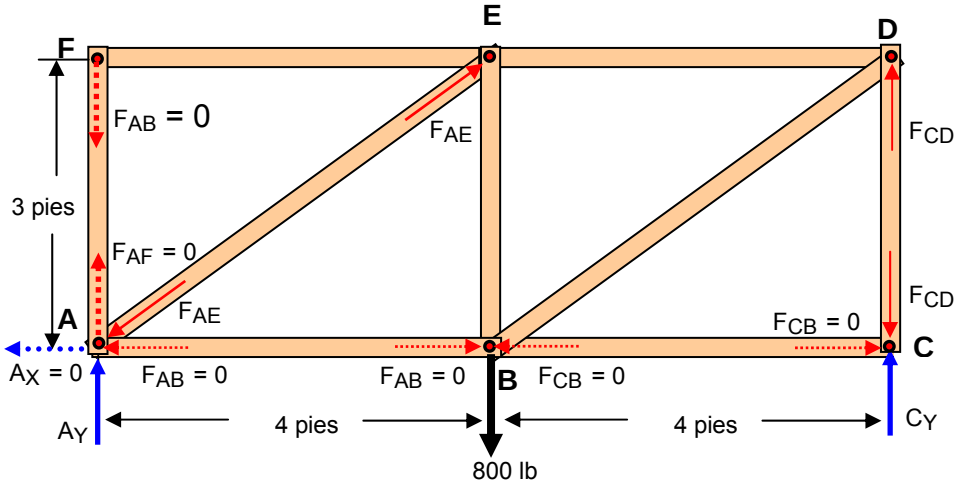
F_{DC} = (5) 100 = 500 lb (Tensión)



Problema C-35 estática Hibbeler edic 10

Determine la fuerza en los miembros AE y DC. Establezca si los miembros están en tensión o en compresión.





$\Sigma M_A = 0$

$+ \quad -800\,(4) + C_Y\,(4 + 4) = 0$

$-3200 + C_Y\,(8) = 0$

$C_Y\,(8) = 3200$

$$C_Y = \frac{3200}{8} = 400 \text{ lb}$$

$C_Y = 400$ lb

$\sum F_Y = 0$

$A_Y - 800 + C_Y = 0$

Pero: $C_Y = 400$ lb

$A_Y - 800 + 400 = 0$

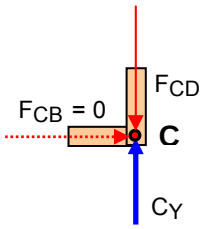
$A_Y - 400 = 0$

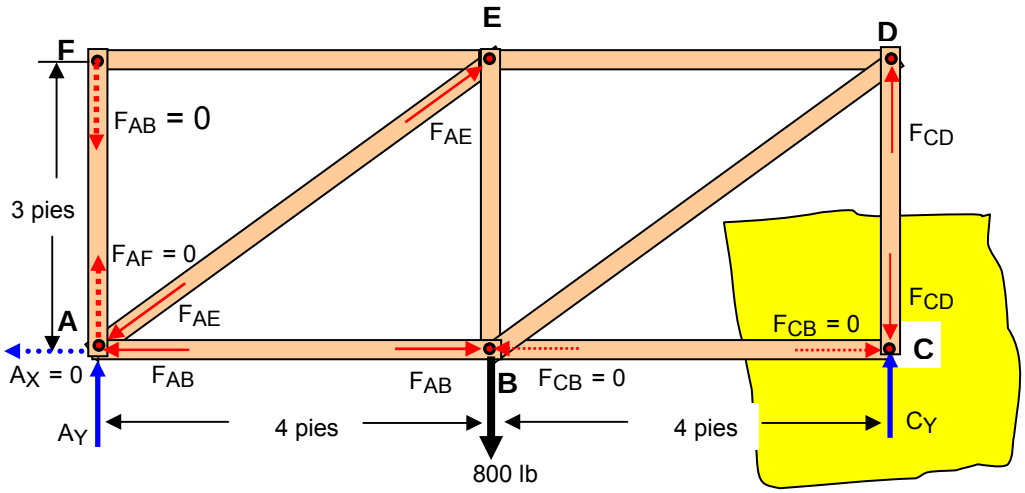
$A_Y = 400$ lb

$\sum F_X = 0$

$A_X = 0$

NUDO C





$\sum F_Y = 0$

$C_Y - F_{CD} = 0$

Pero: $C_Y = 400$ lb

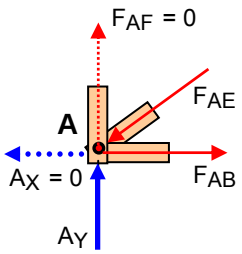
$C_Y = F_{CD}$

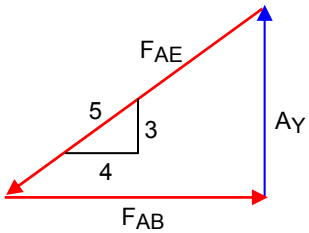
F_{CD} = 400 lb (compresión)

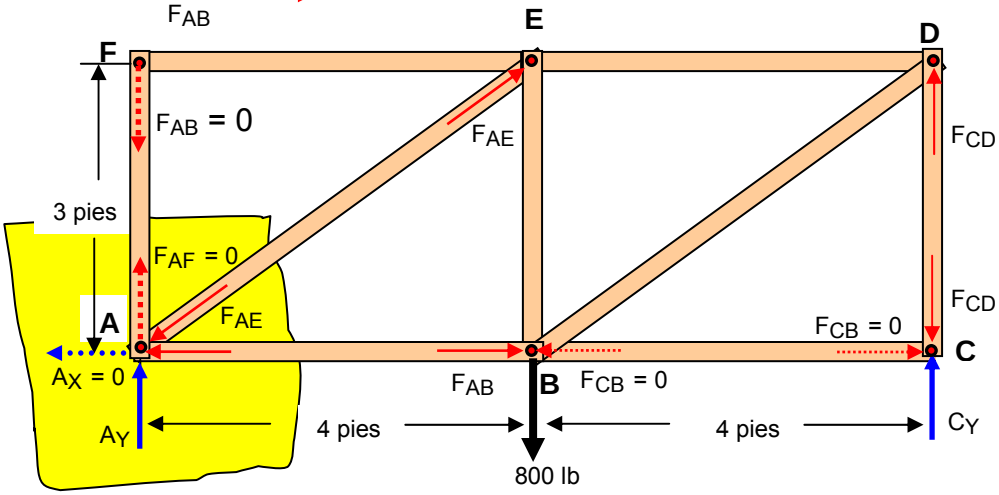
$\sum F_X = 0$

F_{CB} = 0

NUDO A







$$\frac{F_{AE}}{5} = \frac{A_Y}{3} = \frac{F_{AB}}{4}$$

Pero: **A_Y = 400 lb**

$$\frac{F_{AE}}{5} = \frac{400}{3} = \frac{F_{AB}}{4}$$

Hallar F_{AE}

$$\frac{F_{AE}}{5} = \frac{400}{3}$$

$$F_{AE} = \frac{400(5)}{3}$$

F_{AE} = 666,66 lb (compresión)

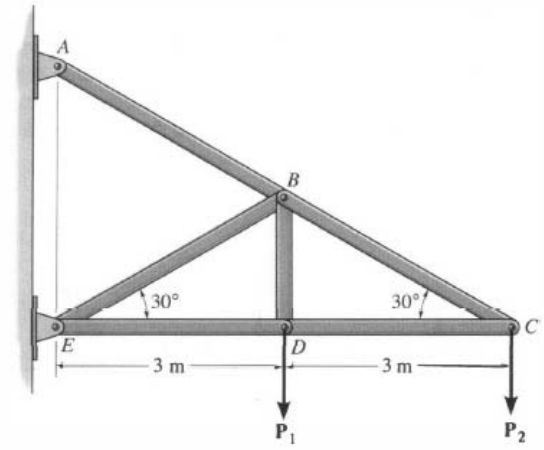
Hallar F_{CD}

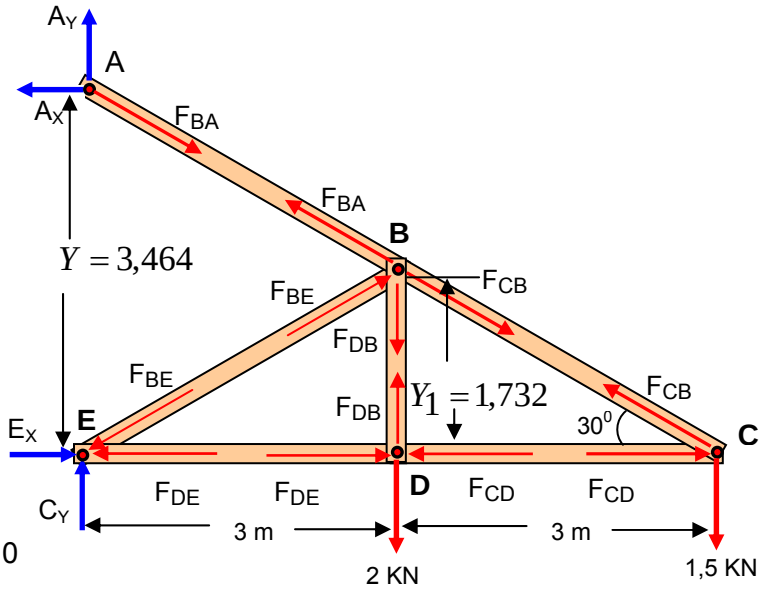
$$\frac{F_{AB}}{4} = \frac{400}{3}$$

F_{AB} = 533,33 lb (Tensión)

Problema 6.8 estática Hibbeler edic 10

Determine la fuerza en cada miembro de la armadura y establezca si los miembros están a tensión o en compresión. Considere P_1 = 2 KN y P_2 = 1,5 kN.





$\Sigma M_E = 0$

$$- 2\,(3) - 1{,}5\,(3 + 3) + A_X\,(3{,}464) = 0$$

$$- 6 - 1{,}5\,(6) + 3{,}464\,A_X = 0$$

$$- 6 - 9 + 3{,}464\,A_X = 0$$

$$- 15 + 3{,}464\,A_X = 0$$

$$3{,}464\,A_X = 15$$

$$A_X = \frac{15}{3{,}464} = 4{,}33\,\text{kN}$$

A_X = 500 N

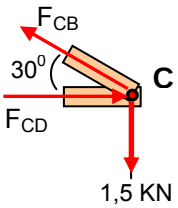
$$\text{tg}\,30 = \frac{Y}{6}$$

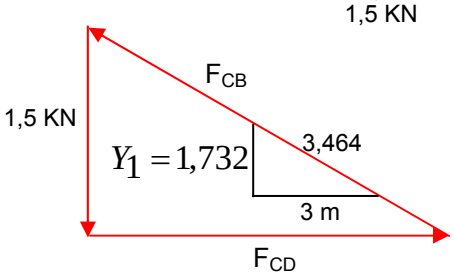
Y = 6 tg 30 = 6 (0,5773) = 3,464 m

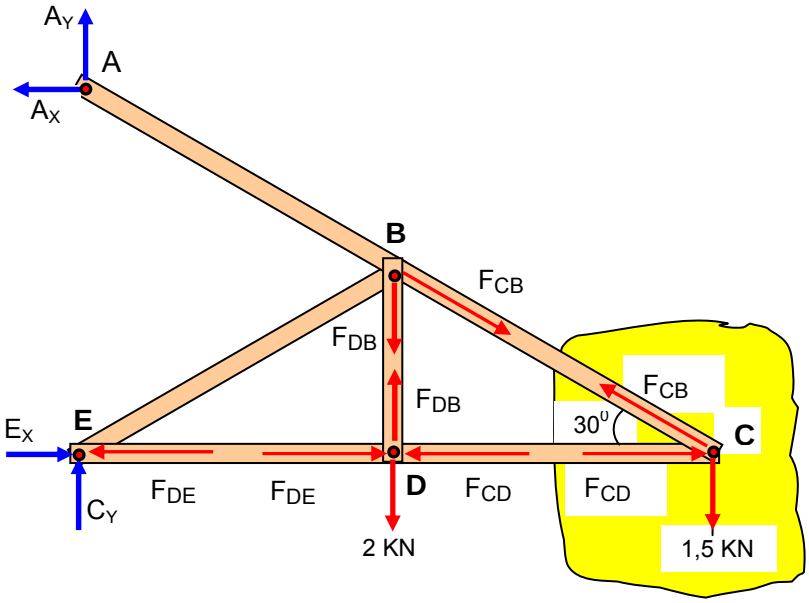
$$\text{tg}\,30 = \frac{Y_1}{3}$$

Y_1 = 3 tg 30 = 3 (0,5773) = 1,732 m

NUDO C







Las ecuaciones de equilibrio para la junta C son:

$$\frac{F_{CB}}{3{,}464} = \frac{1{,}5}{1{,}732} = \frac{F_{CD}}{3}$$

Hallar F_{CB}

$$\frac{F_{CB}}{3{,}464} = \frac{1{,}5}{1{,}732}$$

$$F_{CB} = \frac{1{,}5\,(3{,}464)}{1{,}732} = 3\,\text{kN}$$

F_{CB} = 3 kN (tensión)

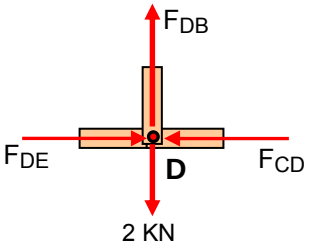
Hallar F_{CD}

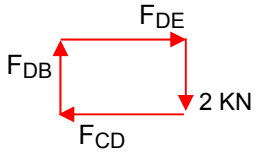
$$\frac{1{,}5}{1{,}732} = \frac{F_{CD}}{3}$$

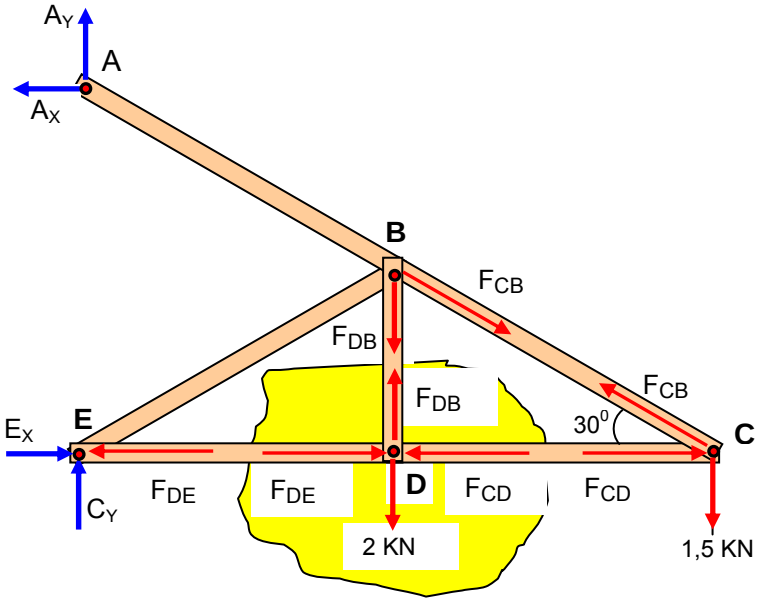
$$F_{CD} = \frac{1{,}5\,(3)}{1{,}732} = 2{,}598\,\text{kN}$$

F_{CD} = 2,598 kN (compresión)

NUDO D







$\sum F_X = 0$

$F_{DE} - F_{CD} = 0$

$F_{DE} = F_{CD}$

Pero: F_{CD} = 2,598 kN (compresión)

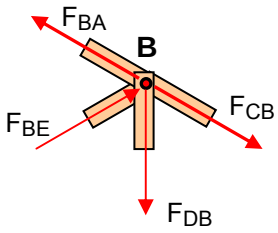
F_{DE} = 2,598 kN (compresión)

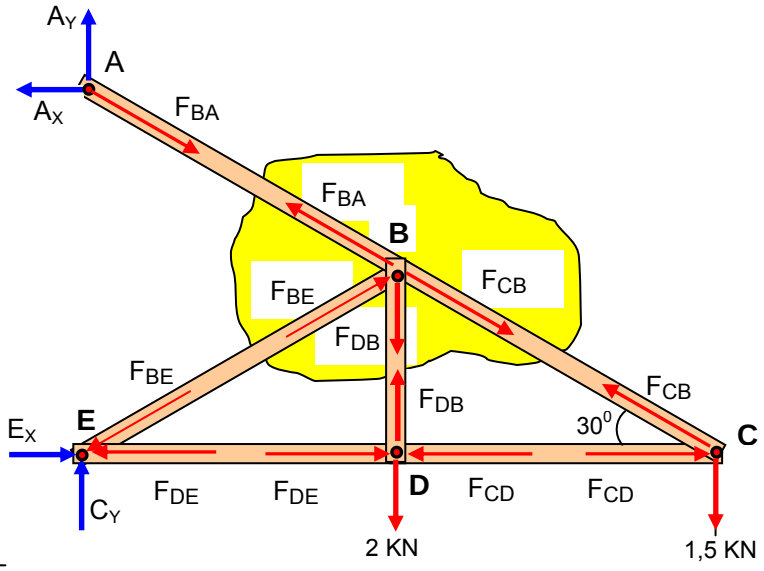
$\sum F_Y = 0$

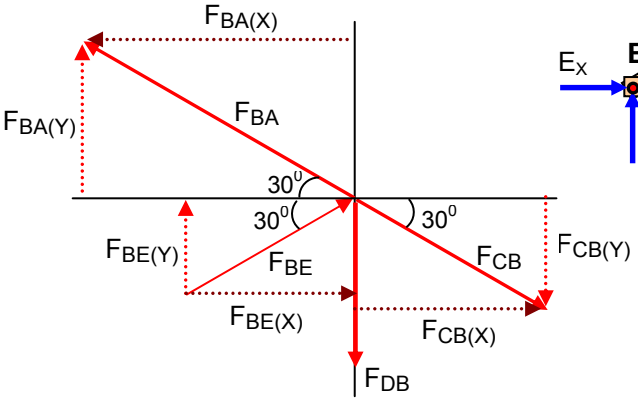
$F_{DB} - 2 = 0$

F_{DB} = 2 kN (tensión)

NUDO B







Para abreviar los cálculos

$$\text{sen } 30 = \frac{\sqrt{3}}{2} \qquad \text{sen } 60 = \frac{1}{2}$$

$$\text{sen } 30 = \frac{F_{BA(Y)}}{F_{BA}}$$

$F_{BA\,(Y)}$ = F_{BA} sen 30

$$F_{BA(Y)} = F_{BA}\left(\frac{1}{2}\right)$$

$$\text{sen } 30 = \frac{F_{BE(Y)}}{F_{BE}}$$

$F_{BE\,(Y)}$ = F_{BE} sen 30

$$F_{BE(Y)} = F_{BE}\left(\frac{1}{2}\right)$$

$$\text{sen } 30 = \frac{F_{CB(Y)}}{F_{CB}}$$

$F_{CB\,(Y)}$ = F_{CB} sen 30

$$F_{CB(Y)} = F_{CB}\left(\frac{1}{2}\right)$$

$$\cos 30 = \frac{F_{BA(X)}}{F_{BA}}$$

$F_{BA\,(X)}$ = F_{BA} cos 30

$$F_{BA(X)} = F_{BA}\left(\frac{\sqrt{3}}{2}\right)$$

$$\cos 30 = \frac{F_{BE(X)}}{F_{BE}}$$

$F_{BE\,(X)}$ = F_{BE} cos 30

$$F_{BE(X)} = F_{BE}\left(\frac{\sqrt{3}}{2}\right)$$

$$\cos 30 = \frac{F_{CB(X)}}{F_{CB}}$$

$F_{CB\,(X)}$ = F_{CB} cos 30

$$F_{CB(X)} = F_{CB}\left(\frac{\sqrt{3}}{2}\right)$$

$\sum F_Y = 0$

$F_{BA\,(Y)} + F_{BE\,(Y)} - F_{CB\,(Y)} - F_{DB} = 0$

$$\left(\frac{1}{2}\right)F_{BA} + \left(\frac{1}{2}\right)F_{BE} - \left(\frac{1}{2}\right)F_{CB} - F_{DB} = 0$$

Pero:
F_{DB} = 2 kN (tensión)

F_{CB} = 3 kN (tensión)

$$\left(\frac{1}{2}\right)F_{BA} + \left(\frac{1}{2}\right)F_{BE} - \left(\frac{1}{2}\right)(3) - 2 = 0$$

$$\left(\frac{1}{2}\right)F_{BA} + \left(\frac{1}{2}\right)F_{BE} = \left(\frac{1}{2}\right)(3) + 2$$

$$\left(\frac{1}{2}\right)F_{BA} + \left(\frac{1}{2}\right)F_{BE} = 1{,}5 + 2 = 3{,}5$$

$0{,}5\ F_{BA} + 0{,}5\ F_{BE} = 3{,}5$ dividiendo por 0,5 (para simplificar)

$F_{BA} + F_{BE} = 7$ (Ecuación 1)

$\sum F_X = 0$

$- F_{BA\,(X)} + F_{BE\,(X)} + F_{CB\,(X)} = 0$

$$-\cancel{\left(\frac{\sqrt{3}}{2}\right)}F_{BA} + \cancel{\left(\frac{\sqrt{3}}{2}\right)}F_{BE} + \cancel{\left(\frac{\sqrt{3}}{2}\right)}F_{CB} = 0$$

$- F_{BA} + F_{BE} + F_{CB} = 0$

Pero:
F_{CB} = 3 kN (tensión)

$- F_{BA} + F_{BE} + 3 = 0$

$- F_{BA} + F_{BE} = - 3 \quad (- 1)$

$F_{BA} - F_{BE} = 3$ (Ecuación 2)

Resolver la ecuación 1 y 2

$F_{BA} + \cancel{F_{BE}} = 7$ (Ecuación 1)

$F_{BA} - \cancel{F_{BE}} = 3$ (Ecuación 2)

$2\ F_{BA} = 10$

$$F_{BA} = \frac{10}{2} = 5\ kN$$

F_{BA} = 5 kN (tensión)

Reemplazando en la ecuación 1

$F_{BA} + F_{BE} = 7$ (Ecuación 1)

Pero: F_{BA} = 5 kN (tensión)

$5 + F_{BE} = 7$

$F_{BE} = 7 - 5$

F_{BE} = 2 kN (compresión)

A_X = 500 N

F_{CB} = 3 kN (tensión)

F_{CD} = 2,598 kN (compresión)

F_{DE} = 2,598 kN (compresión)

F_{DB} = 2 kN (tensión)

F_{BA} = 5 kN (tensión)

F_{BE} = 2 kN (compresión)