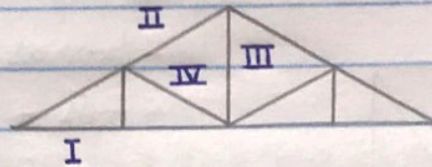


Barra submetida a força nominal

- elementos estruturais lineares que possuem comprimento bem maior que a seção transversal.

Tusara



- I - barra inferior
- II - barra superior
- III - montante
- IV - diagonal

Treliça →

B = barras

N = nós

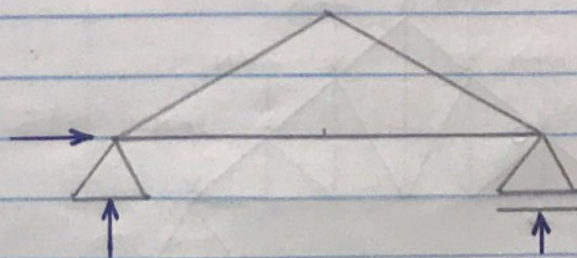
• isostática $B = 2N$

• hipostática $B < 2N$

• hiperestática $B > 2N$

Apóios

Apóio fixo

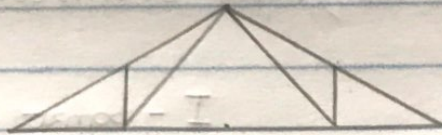


Apóio móvel

Banzo superior - compressão
 Banzo inferior - tração

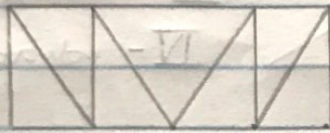
Ex. 1 - Classifique as estruturas

a)



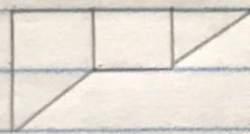
- barras = 11
 - nós = 7 ($7 \times 2 = 14$)
 $11 < 14$ (hipostática)

b)



- barras = 15
 - nós = 9 ($9 \times 2 = 18$)
 $15 < 18$ (hipostática)

c)

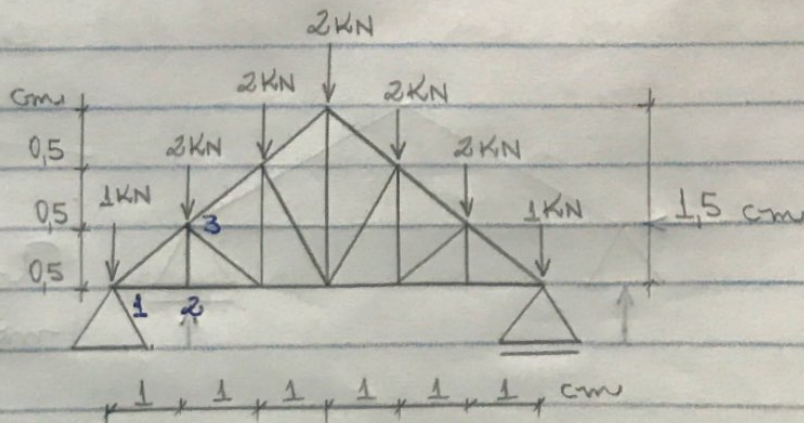


- barras = 9
 - nós = 7 ($7 \times 2 = 14$)
 $9 < 14$ (hipostática)

Métodos para cálculo de esforços em barras

- 1 - método dos nós
- 2 - método das peças

Ex. 2 - Calcule os esforços nas barras ~~da~~ ^{12 e 13 da trilha} trilha pelo método dos nós.



• cálculo das reações de apoio

$$\sum F_x = 0$$

$$\sum F_y = F_{Ay} + F_{By} = 12 \text{ kN.}$$

$$\sum M_A = 0$$

$$(-2 \cdot 1) + (-2 \cdot 2) + (-2 \cdot 3) + (-2 \cdot 4) + (-2 \cdot 5) + (-1 \cdot 6) + (F_{By} \cdot 6)$$

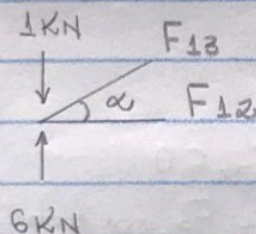
$$-2 - 4 - 6 - 8 - 10 - 6 = -F_{By} \cdot 6$$

$$-36 = -F_{By} \cdot 6$$

$$F_{By} = 6 \text{ kN.}$$

$$F_{Ay} = 6 \text{ kN.}$$

• nó 1



$$\tan \alpha = \frac{CO}{CA} = \frac{0,5}{1} = 0,5$$

$$\alpha = 26,5^\circ$$

$$\sum F_x = F_{12} + F_{13} \cdot \cos 26,5^\circ$$

$$F_{12} + 0,89 \cdot F_{13} = 0$$

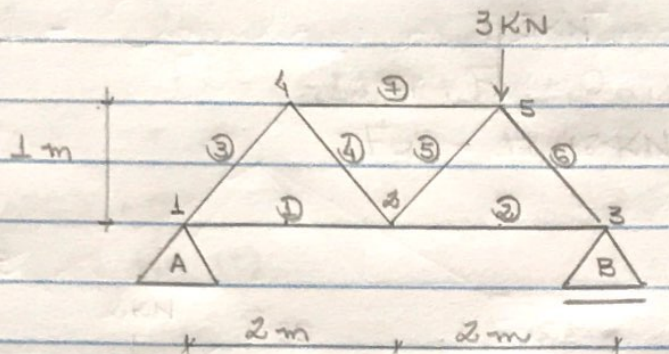
$$\sum F_y = 6 - 1 + F_{13} \cdot \sin 26,5^\circ = 0$$

$$5 + F_{13} \cdot 0,45 = 0$$

$$F_{13} = \frac{-5}{0,45} = -11,11 \text{ kN (C)}$$

$$F_{12} = 12,48 \text{ kN (T)}$$

Ex. 3 - Calcule as forças nas barras da tríplice pelo método dos nós.



$$\sum F_x = 0$$

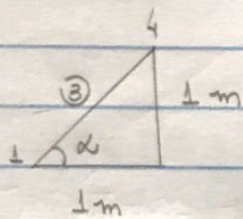
$$F_{Ax} = 0$$

$$\sum F_y = 0$$

$$(-3 \cdot 3) + (F_{By} \cdot 4) = 0$$

$$F_{By} = 2,25 \text{ kN}$$

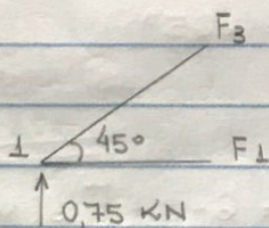
$$F_{Ay} = 3 - 2,25 = 0,75 \text{ kN}$$



$$\text{tg } \alpha = \frac{CO}{CA} = \frac{1}{1} = 1$$

$$\alpha = 45^\circ$$

• nó 1



$$\sum F_x = 0$$

$$F_1 + F_3 \cdot \cos 45^\circ = 0$$

$$F_1 + F_3 \cdot 0,7 = 0$$

$$\sum F_y = 0$$

$$0,75 + F_3 \cdot \sin 45^\circ = 0$$

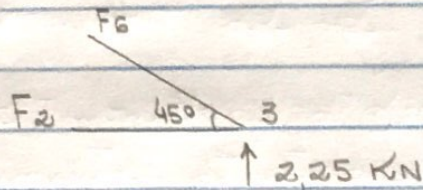
$$0,75 + F_3 \cdot 0,7 = 0$$

$$F_1 + F_3 \cdot 0,7 = 0$$

$$F_1 = 0,75 \text{ kN (T)}$$

$$F_3 = -1,07 \text{ kN (C)}$$

• nº 3



$$-F_2 - F_6 \cdot 0,7 = 0$$

$$F_2 = 2,25 \text{ kN (T)}$$

$$\Sigma F_x = 0$$

$$-F_2 - F_6 \cdot \cos 45^\circ = 0$$

$$-F_2 - F_6 \cdot 0,7 = 0$$

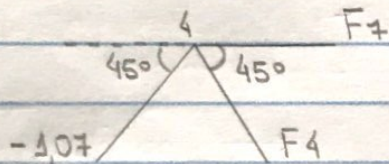
$$\Sigma F_y = 0$$

$$2,25 + F_6 \cdot \sin 45^\circ = 0$$

$$2,25 + F_6 \cdot 0,7 = 0$$

$$F_6 = -3,21 \text{ kN (C)}$$

• nº 4



$$F_7 + F_4 \cdot 0,7 + 0,75 = 0$$

$$F_7 = -1,82 \text{ kN (C)}$$

$$\Sigma F_x = 0$$

$$F_7 + F_4 \cdot \cos 45^\circ - (-1,07 \cdot \cos 45^\circ) = 0$$

$$F_7 + F_4 \cdot 0,7 + 0,75 = 0$$

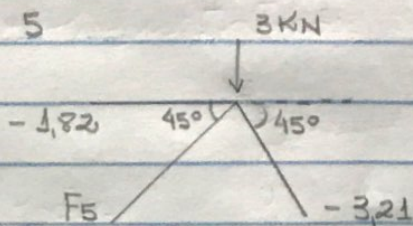
$$\Sigma F_y = 0$$

$$-F_4 \cdot \sin 45^\circ - (-1,07 \cdot \sin 45^\circ) = 0$$

$$-F_4 \cdot 0,7 + 0,75 = 0$$

$$F_4 = 1,07 \text{ kN (T)}$$

• nº 5



$$\Sigma F_y = 0$$

$$-3 - (-3,21 \cdot \sin 45^\circ) - F_5 \cdot \sin 45^\circ = 0$$

$$-3 + 2,25 - F_5 \cdot 0,7 = 0$$

$$F_5 = -1,07 \text{ kN (C)}$$