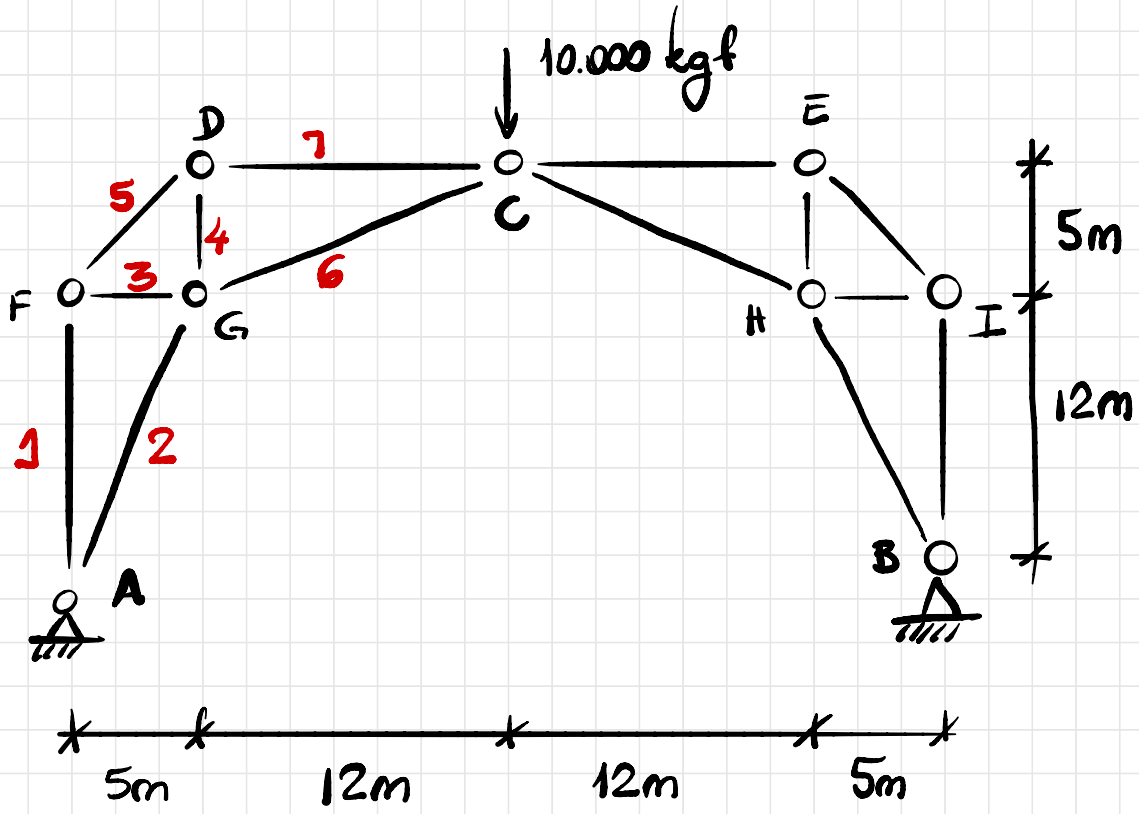
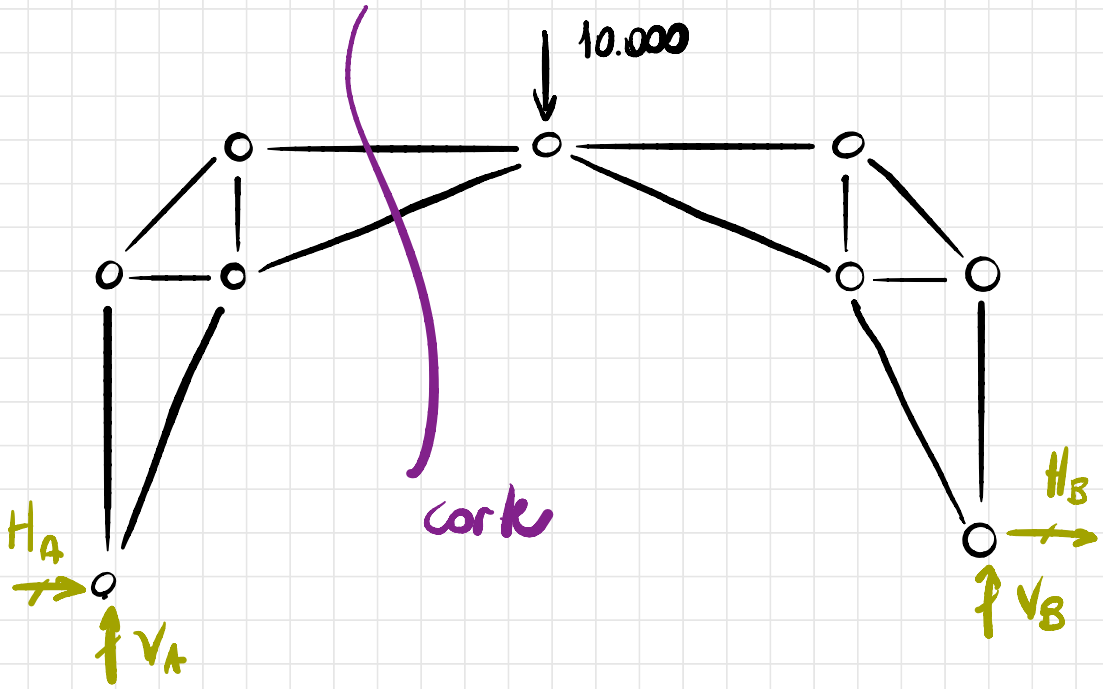


Determinar as normais nas treliças numeradas.

- treliça isostática
  - 4 reações vinculares
  - 14 barras
  - 9 nós $\Rightarrow$ 18 equações l.i. de equilíbrio.



$$\sum F_H = 0 : H_A + H_B = 0$$

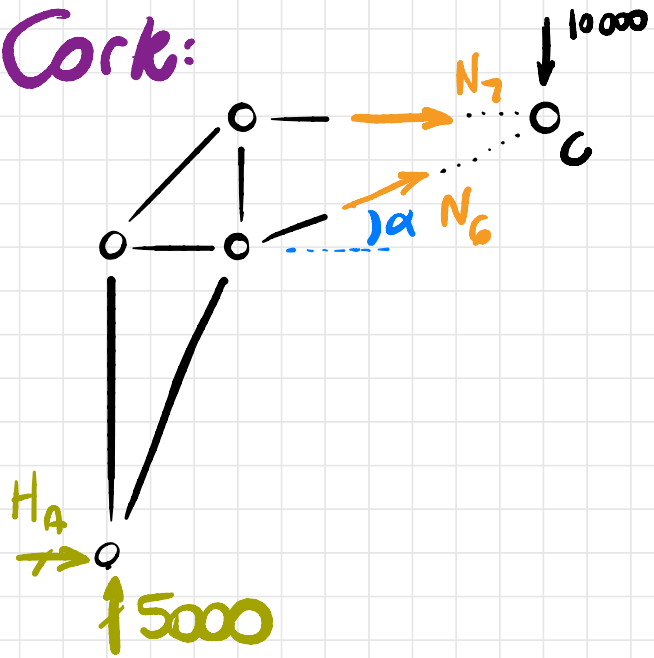
$$\sum F_V = 0 : V_A + V_B = 10.000$$

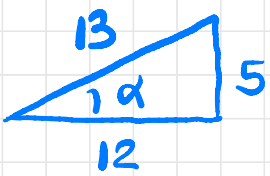
$$(+) \sum M_A = 0 : -10.000 \cdot 17 + V_B \cdot 34 = 0$$

$$\boxed{V_B = 5000 \text{ kgf}}$$

$$\boxed{V_A = 5000 \text{ kgf}}$$

Cork:





$\sin\alpha = 5/13$

$\cos\alpha = 12/13$

$$\sum F_H = 0: \quad H_A + N_7 + N_6\cos\alpha = 0$$

$$\sum F_V = 0: \quad 5000 + N_6\sin\alpha = 0$$

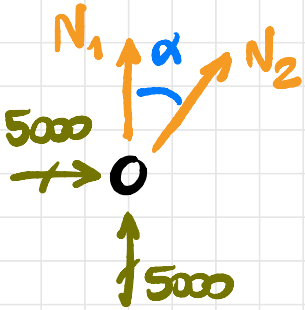
$$N_6 = -\frac{5000}{\sin\alpha} \Rightarrow \boxed{N_6 = -13000\ kgf}$$

$$\circlearrowleft + \sum M_C = 0: \quad H_A \cdot 17 - 5000 \cdot 17 = 0$$

$$\boxed{H_A = 5000\ kgf}$$

$$N_7 = -H_A - N_6\cos\alpha = -5000 + 12000 \Rightarrow \boxed{N_7 = 7000\ kgf}$$

Nó A:



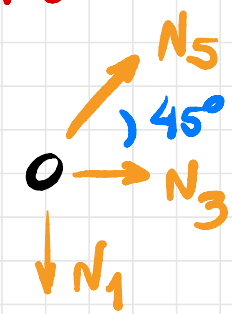
$$\sum F_H = 0: \; 5000 + N_2 \sin\alpha = 0$$

$$\boxed{N_2 = -13000\ kgf}$$

$$\sum F_V = 0: \; 5000 + N_1 + N_2 \cos\alpha = 0$$

$$N_1 = -5000 - N_2 \cos\alpha \Rightarrow \boxed{N_1 = 7000\ kgf}$$

Nó F:



$$\sum F_H = 0: \; N_5 \cos 45° + N_3 = 0$$

$$\sum F_V = 0: \; -N_1 + N_5 \sin 45° = 0$$

$$\boxed{N_5 = 7000\sqrt{2}\ kgf}$$

$$N_3 = -N_5 \cos 45° \Rightarrow \boxed{N_3 = -7000\ kgf}$$

Nó D:

$$\sum F_H = 0 : -N_5 \operatorname{sen} 45° + N_7 = 0$$

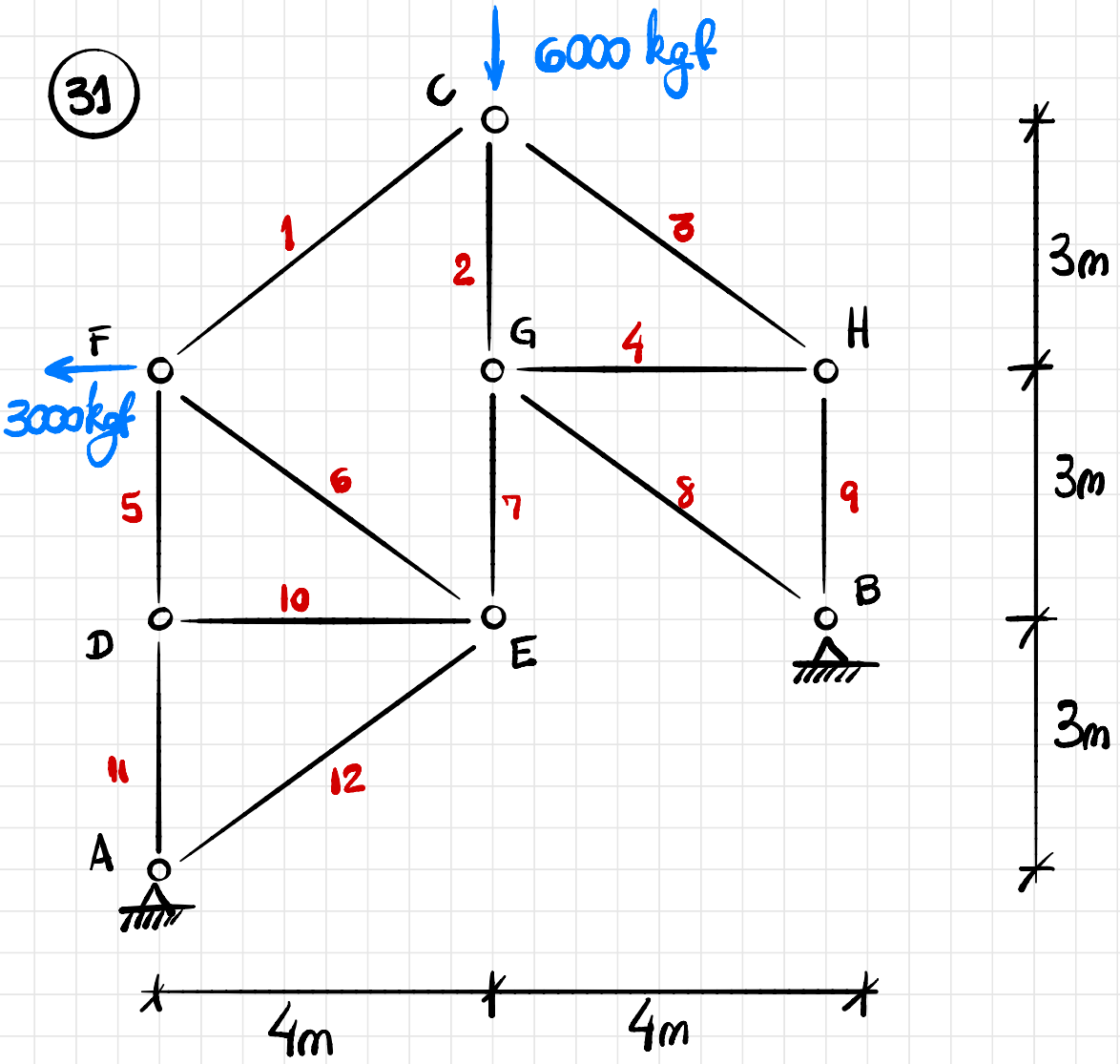
$$-7000\sqrt{2} \cdot \frac{1}{\sqrt{2}} + 7000 = 0$$

$$\sum F_V = 0 : -N_5 \cos 45° - N_4 = 0$$

$$N_4 = -N_5 \cos 45° \Rightarrow \boxed{N_4 = -7000\ kgf}$$

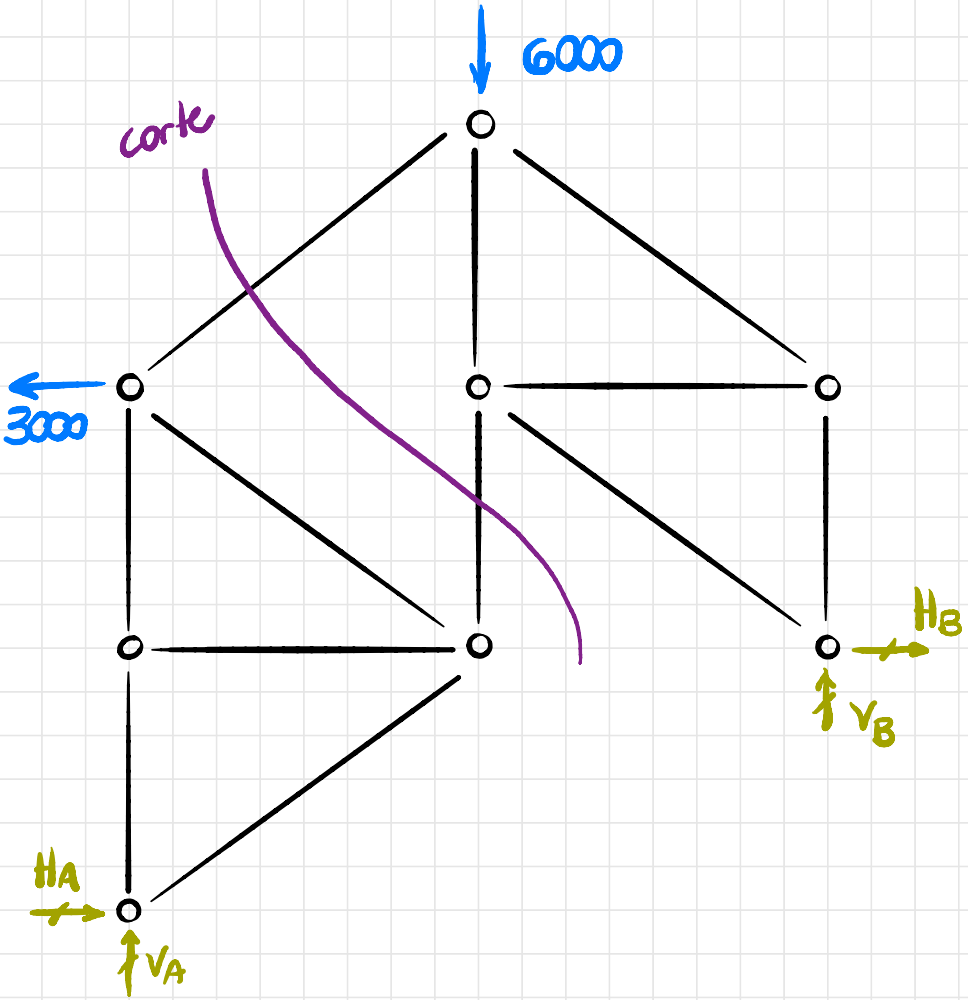
barra	N [kgf]
1	7000
2	-13000
3	-7000
4	-7000
5	$7000\sqrt{2}$
6	-13000
7	7000

31



Treliça isostática (8 nós, 4 reações, 12 barras)

Reações de apoio:



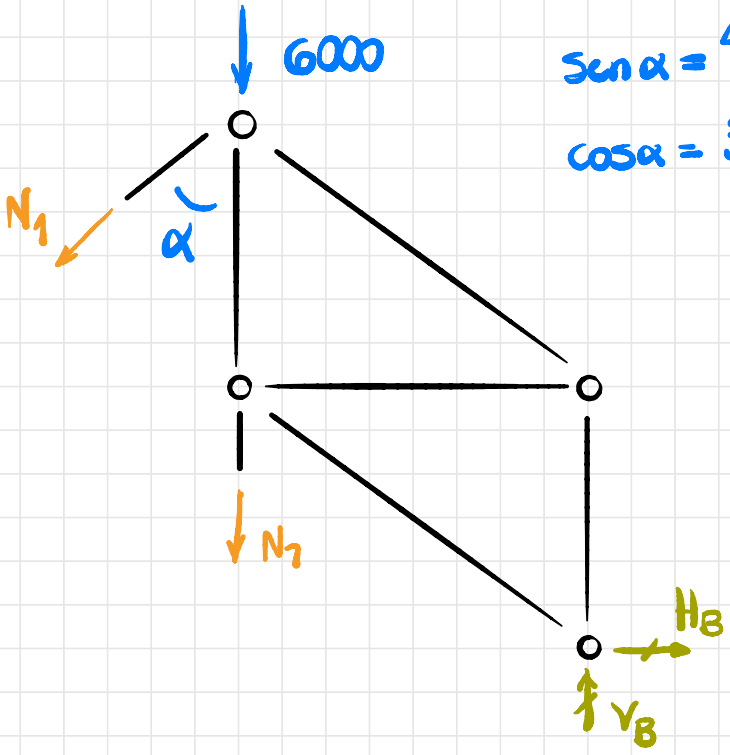
$$\sum F_H = 0: \quad H_A + H_B = 3000$$

$$\sum F_V = 0: \quad V_A + V_B = 6000$$

$$\circlearrowleft \sum M_A = 0: \quad 3000.6 - 6000.4 - H_B.3 + V_B.8 = 0$$

$$8V_B - 3H_B = 6000$$

Apenas com o equilíbrio, não é possível encontrar as reações de apoio. Fazendo o corte:



$\operatorname{sen}\alpha = 4/5$

$\cos\alpha = 3/5$

$$\sum F_H = 0: \quad -N_1 \operatorname{sen}\alpha + H_B = 0$$

$$\sum F_V = 0: \quad -6000 - N_1 \cos\alpha - N_7 + V_B = 0$$

$$\circlearrowleft \sum M_C = 0: \quad V_B \cdot 4 + 6H_B = 0$$

$$H_B = -\frac{2}{3} V_B$$

$$8V_B - 3\left(-\tfrac{2}{3}V_B\right) = 6000$$

$$10V_B = 6000 \rightarrow \boxed{V_B = 600\ kgf}$$

$$H_B = -\tfrac{2}{3}.600 \rightarrow \boxed{H_B = -400\ kgf}$$

$$H_A = 3000 - (-400) \rightarrow \boxed{H_A = 3400\ kgf}$$

$$V_A = 6000 - 600 \rightarrow \boxed{V_A = 5400\ kgf}$$

$$N_1 = H_B / \operatorname{sen}\alpha = -400 . \frac{5}{4}$$

$$\boxed{N_1 = -500\ kgf}$$

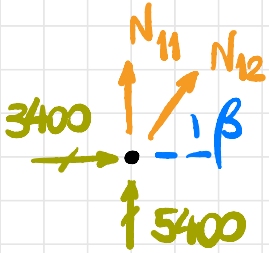
$$N_1 = -6000 - N_1 \cos\alpha + V_B$$

$$N_1 = -6000 - (-500) . 3/5 + 600$$

$$\boxed{N_1 = -5100\ kgf}$$

$\sin\beta = 3/5$; $\cos\beta = 4/5$

Nó A:



$\Sigma F_H = 0$: $3400 + N_{12}\cos\beta = 0$

$$N_{12} = -4250\ kgf$$

$\Sigma F_V = 0$: $5400 + N_{11} + N_{12}\sin\alpha = 0$

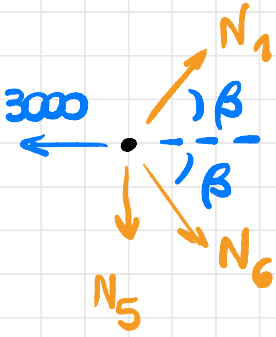
$$N_{11} = -2850\ kgf$$

Nó D:

$\Sigma F_H = 0$: $N_{10} = 0$

$\Sigma F_V = 0$: $N_5 = N_{11} \rightarrow N_5 = -2850\ kgf$

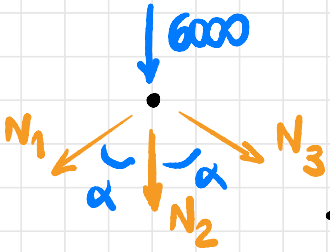
Nó F:



$\Sigma F_H = 0$: $N_1\cos\beta + N_6\cos\beta = 3000$

$$N_6 = 4250\ kgf$$

Nó C:



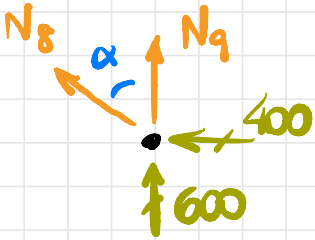
$$\sum F_H = 0: \; N_1 \sin\alpha - N_3 \sin\alpha = 0$$

$$\boxed{N_3 = -500 \text{ kgf}}$$

$$\sum F_V = 0: \; -6000 - N_2 - N_1 \cos\alpha - N_3 \cos\alpha = 0$$

$$\boxed{N_2 = -5400 \text{ kgf}}$$

Nó B:



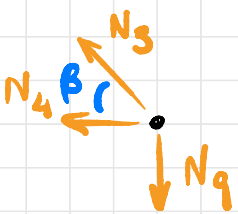
$$\sum F_H = 0: \; -N_8 \sin\alpha - 400 = 0$$

$$\boxed{N_8 = -500 \text{ kgf}}$$

$$\sum F_V = 0: \; 600 + N_8 \cos\alpha + N_9 = 0$$

$$\boxed{N_9 = -300 \text{ kgf}}$$

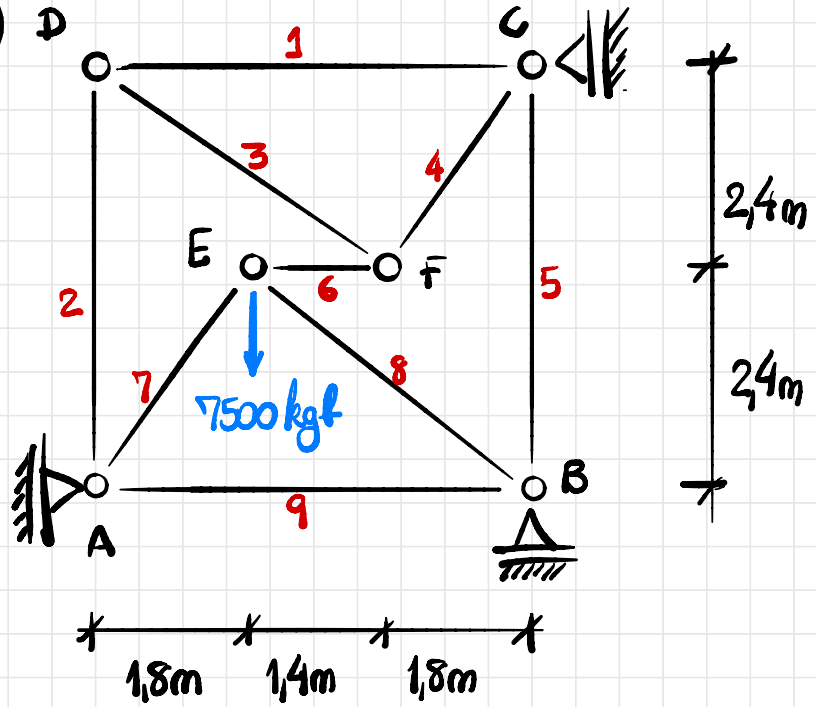
Nó H:



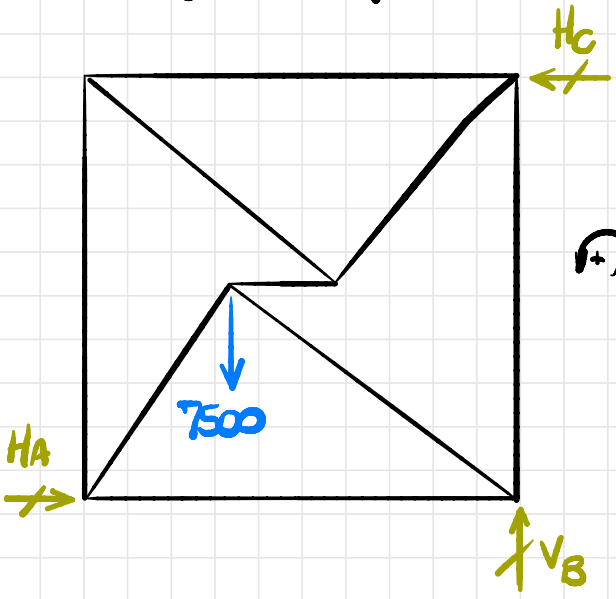
$$\sum F_H = 0: \; -N_4 - N_3 \cos\beta = 0$$

$$\boxed{N_4 = 400 \text{ kgf}}$$

30



Reações de apoio



$\Sigma F_H = 0: \; H_A = H_C$

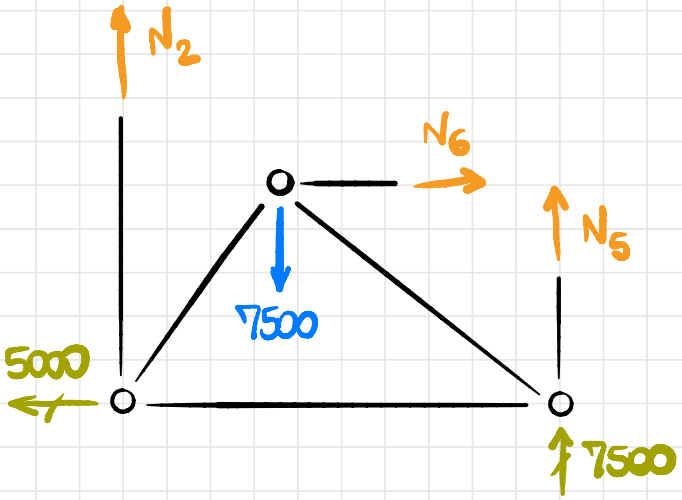
$\Sigma F_V = 0: \; V_B = 7500 kgf$

$\circlearrowleft \Sigma M_A = 0: \; -7500 \cdot 1,8 + 5V_B + 4,8H_C = 0$

$H_C = -5000 kgf$

$H_A = -5000 kgf$

Fazendo um corte:



$$\sum F_H = 0: \; -5000 + N_6 = 0 \rightarrow \boxed{N_6 = 5000\,kgf}$$

$$\sum F_V = 0: \; N_2 + N_5 = 0$$

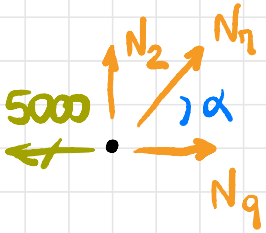
$$\curvearrowleft \sum M_A = 0: \; -7500 \cdot 1{,}8 - N_6 \cdot 2{,}4 + 7500 \cdot 5 + N_5 \cdot 5 = 0$$

$$5N_5 = -12000 \rightarrow \boxed{N_5 = -2400\,kgf}$$

$$\boxed{N_2 = 2400\,kgf}$$

Nó A:

$\sin\alpha = 0{,}8$; $\cos\alpha = 0{,}6$



$$\sum F_H = 0 : -5000 + N_1 \cos\alpha + N_9 = 0$$

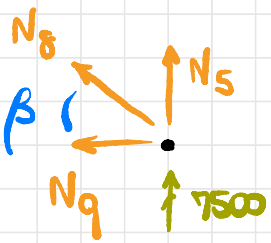
$$\sum F_V = 0 : N_2 + N_1 \sin\alpha = 0$$

$$N_1 = -N_2 / \sin\alpha \rightarrow \boxed{N_1 = -3000\ kgf}$$

$$N_9 = 5000 - N_8 \cos\alpha \rightarrow \boxed{N_9 = 6800\ kgf}$$

Nó B:

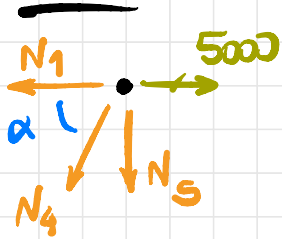
$\sin\beta = 0{,}6$; $\cos\beta = 0{,}8$



$$\sum F_H = 0 : -N_9 - N_8 \cos\beta = 0$$

$$N_8 = -N_9 / \cos\beta \rightarrow \boxed{N_8 = -8500\ kgf}$$

Nó C:



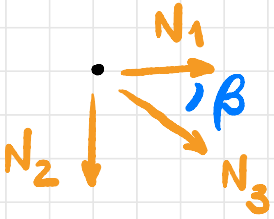
$$\sum F_H = 0 : -N_1 - N_4 \cos\alpha + 5000 = 0$$

$$\sum F_V = 0 : -N_5 - N_4 \sin\alpha = 0$$

$$N_4 = -N_5 / \sin\alpha \rightarrow \boxed{N_4 = 3000\ kgf}$$

$$N_1 = 5000 - N_4 \cos\alpha \rightarrow \boxed{N_1 = 3200\ kgf}$$

Nó D:



$$\Sigma F_H = 0: \quad N_1 + N_3 \cos\beta = 0$$

$$N_3 = -N_1/\cos\beta \rightarrow \boxed{N_3 = -4000\ kgf}$$

barra	N[kgf]
1	3200
2	2400
3	-4000
4	3000
5	-2400
6	5000
7	-3000
8	-8500
9	6800