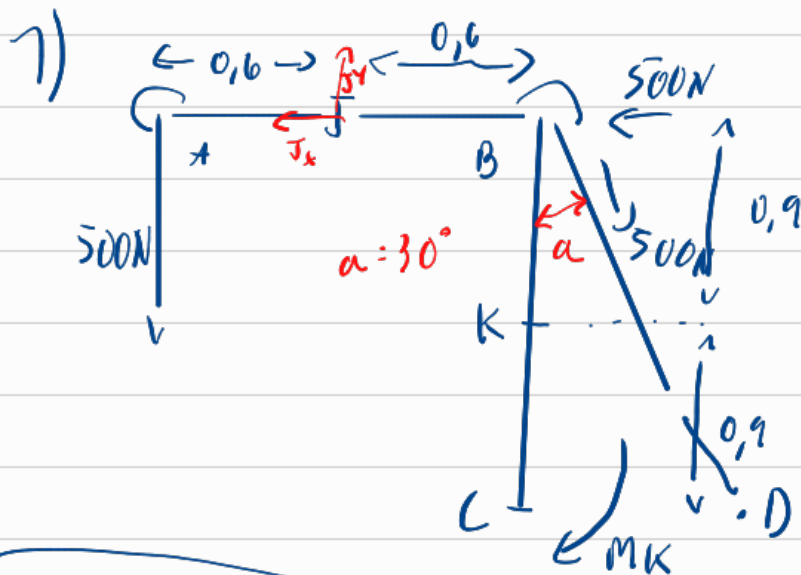


Fernando Almeida Negrini Lista 4 Mecânica 1



$$\rightarrow \sum F_x = 0$$

$$500 - J_x = 0$$

$$J_x = 500 \text{ N}$$

$$\uparrow \sum F_y = 0$$

$$J_y - 500 = 0$$

$$J_y = 500 \text{ N}$$

$$\sum F_x = 0$$

$$500 - 500 + 500 \cdot \sin 30^\circ - K_x = 0$$

$$K_x = 250 \text{ N}$$

$$\sum F_y = 0$$

$$-500 - 500 \cdot \cos 30^\circ + K_y = 0$$

$$K_y = 933 \text{ N}$$

$$\uparrow \sum M = 0$$

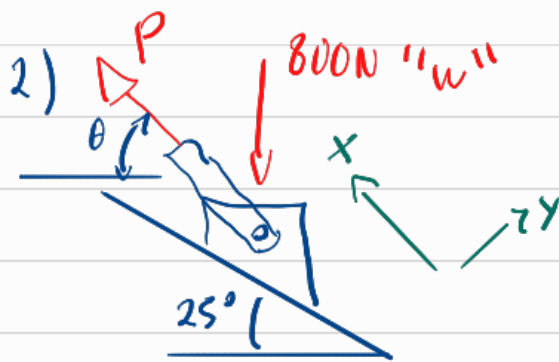
$$500 \cdot 1,2 - 500 \sin 30^\circ \cdot 0,9 - M_K = 0$$

$$M_K = 375 \text{ N} \cdot \text{m}$$

$$\sum M_J = 0$$

$$500 \cdot 0,6 - M = 0$$

$$M_J = 300 \text{ N} \cdot \text{m}$$



$$\mu_s = 0,20$$

$$\theta = 40$$

$$\mu_k = 0,15$$

$$P = 400$$

$$40 - 25 = 15$$

$$\sum F_x = 0$$

$$W_x = 800 \text{ N} \cdot \sin 25 = 338,09 \text{ N} \searrow$$

$$W_y = 800 \text{ N} \cdot \cos 25 = 725,05 \text{ N} \downarrow$$

força $P = 400 \text{ N}$ $\theta = 40 \leadsto 40 - 25 = 15^\circ$

$$P_x = 400 \cdot \cos 15 = 386,37 \text{ N} \nwarrow$$

$$P_y = 400 \cdot \sin 15 = 103,53 \text{ N} \uparrow$$

$$\sum F_y = 0$$

$$N + P_y - W_y = 0$$

$$N + 103,53 - 725,05 = 0$$

$$N = 621,5 \text{ N}$$

$$\sum F_x = 0$$

$$P_x - W_x - F_{at} = 0$$

P/verificar onde o bloco tende a se mover:

$$F_T = P_x - W_x$$

$$F_T = 386,37 - 338,09 = 48,28 \text{ N}$$

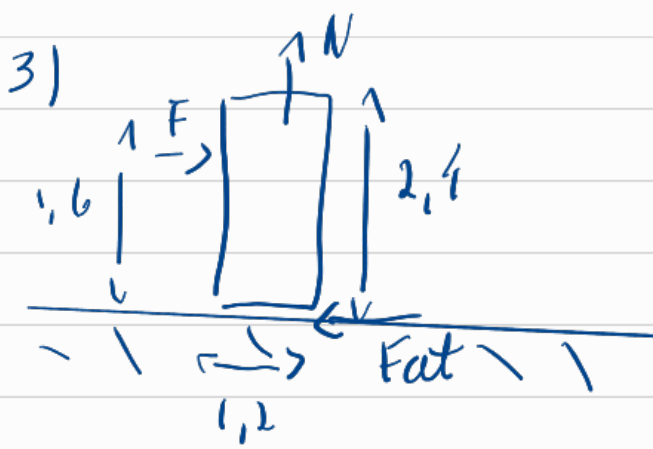
$$P > W$$

aponta p/ $\searrow (-)$

a tendência é $\nwarrow$ subir (+) logo $F_{at} = (-) \searrow$

$$F_{at \text{ max}} = \mu_s \cdot N = 0,20 \times 621,5 = 124,3 \text{ N}$$

Está em equilíbrio! $F_T < F_{at \text{ max}}$



$$P_{caixote} = m \cdot g = 150 \cdot 9,81$$

$$\Rightarrow 1471,5 \text{ N}$$

$$F_{atc} = \mu_s \cdot N_c = 0,2 \cdot 1471,5$$

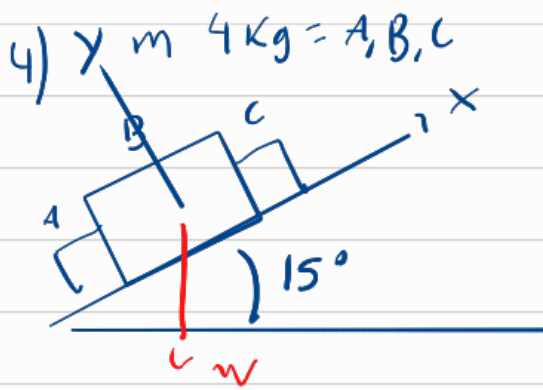
$$\Rightarrow 294,3 \text{ N}$$

Precisa de $F >$ que $294,3 \text{ N}$
para deslizar.

$$P_{homem} = 85 \cdot 9,81 = 833,85 \text{ N}$$

$$F_{at h} = \mu_s \cdot N = 0,4 \cdot 833,85 = \boxed{333,54 \text{ N}}$$

Ou seja, o homem consegue mover o caixote!



$$\begin{array}{l|l} A \text{ e } C & \mu_s = 0,3 \quad \mu_{sB} = 0,1 \\ \text{"} & \mu_k = 0,2 \quad \mu_{kB} = 0,08 \end{array}$$

$$F = \mu \cdot N$$

$$(4\text{kg} \cdot 9,81 = 39,24\text{N})$$

$$F_{a3} \rightarrow 0,3 \cdot 37,9 = \boxed{11,4\text{N}}$$

$$N = 39,24 \cdot \cos 15 = 37,9\text{N}$$

$$\rightarrow \sum F_x = 0$$

$$F_c - W \sin 15 = 0$$

$$F_c - 39,24 \cdot \sin 15 = 0$$

$$F_c = 10,16\text{N}$$

$$F_c < F_a \quad \text{o Pacote C não se move}$$

$$B: F_B = 10,16$$

$$\uparrow \sum F_y = 0$$

$$N_c - W \cos 15 = 0$$

$$N_c - 39,24 \cdot \cos 15 = 0$$

$$N_c = 37,9\text{N}$$

$$\mu_s \cdot N_B =$$

$$0,1 \cdot 37,9 \rightarrow \boxed{3,74\text{N}}$$

$$F_{atC} = 10,16\text{N}$$

Pacote B sozinho se move!

A + B Juntos (já que C não se move)

$$F_A + F_B = \boxed{20,4\text{N}}$$

em movimento $\mu_k = 0,2$ A
 $0,08$ B

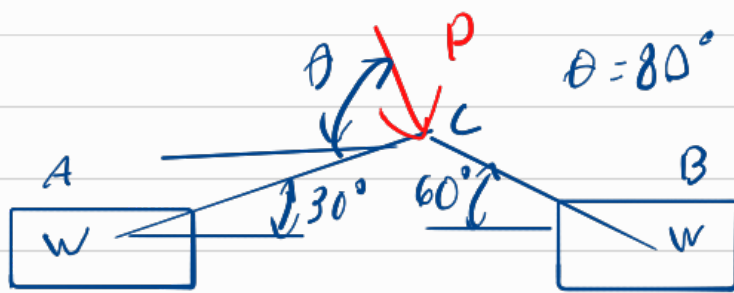
$$F_{atA} = 0,2 \cdot 37,9 = 7,58\text{N}$$

$$F_{atB} = 0,08 \cdot 37,9 = 3,03\text{N}$$

$$\begin{array}{l} \text{atrito A} = 11,37 \\ \text{atrito B} = 3,79 \end{array} > \boxed{15,16\text{N}}$$

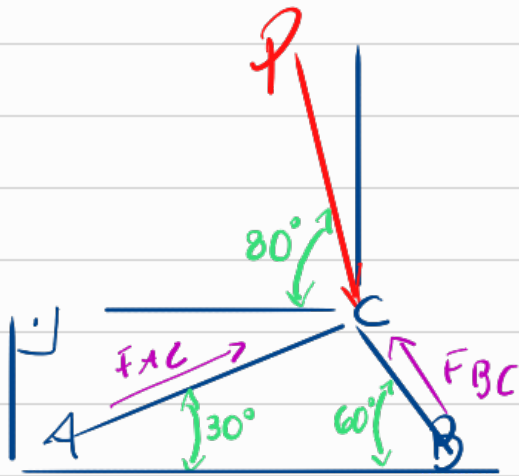
A e B se movem!

5)



$$\mu_s = 0,3$$

$$W = 100\text{ N}$$



$$F_{AC} = P \sin 20 = 0,342 P$$

$$F_{BC} = P \cos 20 = 0,940 P$$

$$\rightarrow \Sigma F_x = 0$$

$$P \cos 80 + F_{AC} \cos 30 - F_{BC} \cos 60 = 0$$

$$\uparrow \Sigma F_y = 0$$

$$- P \sin 80 + F_{AC} \sin 30 + F_{BC} \sin 60 = 0$$

$$A: \Sigma F_y = 0$$

$$N_A - 100 - F_{AC} \sin 30 = 0$$

$$N_A = 100 + (0,342 P \cdot 0,5)$$

$$N_A = 100 + 0,17 P$$

$$\Sigma F_x = 0$$

$$F_{at A} - F_{AC} \cos 30 = 0$$

$$F_{at A} = 0,342 P \cdot 0,866$$

$$F_{at A} = 0,296 P$$

Na iminência $F_{at} = \mu_s \cdot N$

$$0,296 P = 0,3 \cdot (100 + 0,17 P)$$

$$P = 122,6 \text{ N}$$

Para A não deslizar,

$$P \leq 122,6 \text{ N}$$

Para B não deslizar,

$$P \leq 132,8 \text{ N}$$

$$B: \Sigma F_y = 0$$

$$N_B - 100 - F_{BC} \sin 60 = 0$$

$$N_B = 100 + (0,940 P \cdot 0,866)$$

$$N_B = 100 + 0,814 P$$

$$\Sigma F_x = 0$$

$$F_{BC} \cos 60 - F_{at B} = 0$$

$$F_{at B} = 0,470 P$$

$$F_{at B} = \mu_s \cdot N_B$$

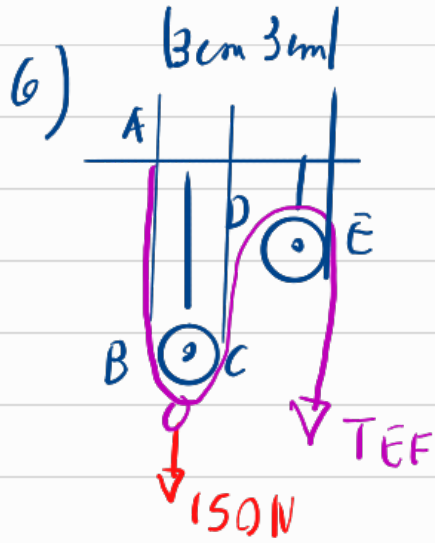
$$0,470 P = 0,3 \cdot (100 + 0,814 P)$$

Na iminência

$$F_{at B} = \mu_s \cdot N_B$$

$$0,470 P = 0,3 \cdot (100 + 0,814 P)$$

$$P = 132,8 \text{ N}$$



3 cm ϕ
 3 cm
 K $\rightarrow$
 3 cm
 eixos
 0,5 cm

$$\mu_s = 0,2$$

carga!

$$T_{AB}, T_{CD}, T_{EF} \text{ e } \downarrow 150 \text{ N}$$

Atrito só ocorre
no eixo

$$R_{\text{polia}} = r \text{ 1,5 cm}$$

$$R_{\text{eixo}} = r \text{ 0,25 cm}$$

$$R_{\text{raio de atrito}} = 0,2 \times 0,25$$

$$r_{\text{a}} \hookrightarrow 0,05 \text{ cm}$$

Momento de atrito 1 $\Sigma M = 0$

$$0,05 \cdot 150 = 7,5 \text{ N} \cdot \text{cm}$$

DIFÍCIL

$$T_{AB} + T_{CD} = 150$$

$$T_{CD} \cdot 1,5 - T_{AB} \cdot 1,5 = 7,5$$

$$T_{CD} - T_{AB} = 5$$

$$2 T_{CD} = 155$$

$$T_{CD} = 77,5 \text{ N}$$

$$T_{AB} + 77,5 = 150$$

$$T_{AB} = 72,5$$

Momento atrito 2

$$\Sigma M = 0$$

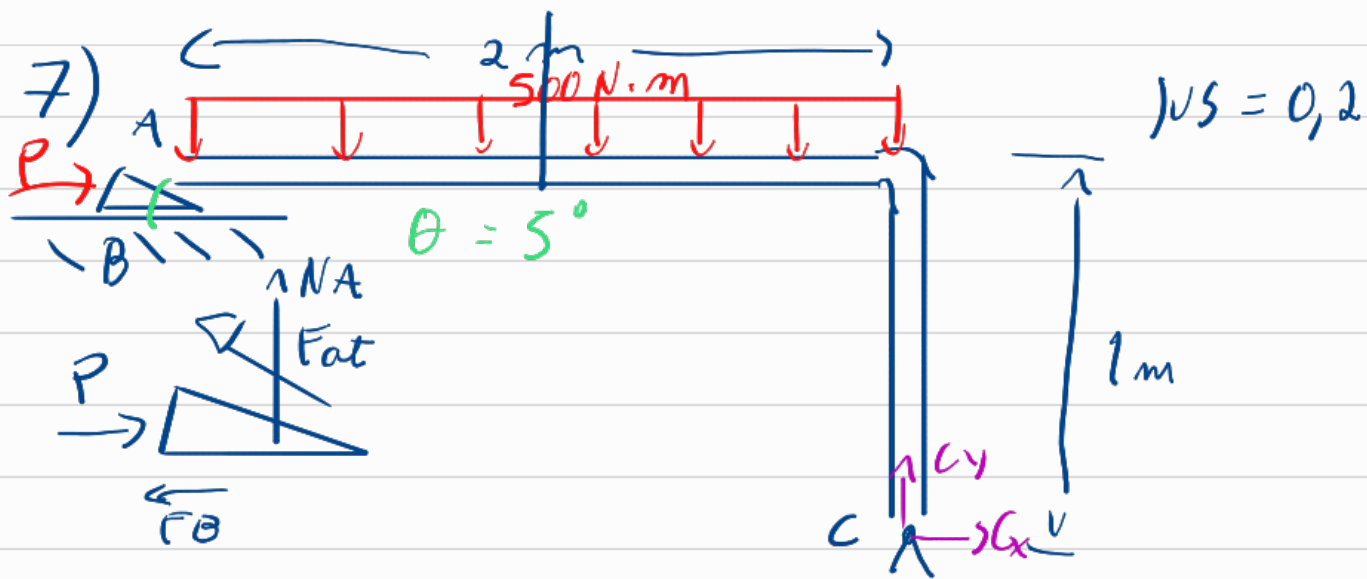
$$T_{EF} \cdot 1,5 - T_{CD} \cdot 1,5 -$$

$$(0,05 \cdot 77,5 + T_{EF}) = 0$$

$$1,5 T_{EF} - 116,25 - 3,875$$

$$- 0,05 T_{EF} = 0$$

$$T_{EF} = 82,84 \text{ N}$$



$$F_R = 500 \text{ N.m} \cdot 2 = 1000 \text{ N no ponto } 1 \text{ m}$$

Fat A empurra barra p/ esquerda

A Normal em A empurra barra p/ cima

$$\sum M_C = 0$$

$$+N_A \cdot 2 - F_R \cdot 1 - F_{atA} \cdot 1\text{ m} = 0$$

$$2N_A - 0,2N_A = 1000$$

$$N_A = 555,55 \text{ N}$$

$$F_{atA} = 0,2 \cdot 555,55 = 111,11 \text{ N}$$

$$\sum F_y = 0$$

$$+N_B \cdot \cos 5 - F_{atB} \cdot \sin 5 - N_A = 0$$

$$N_B \cdot 0,996 - N_B \cdot (0,2 \cdot 0,087) = 555,55 \Rightarrow N_B = 567,7 \text{ N}$$

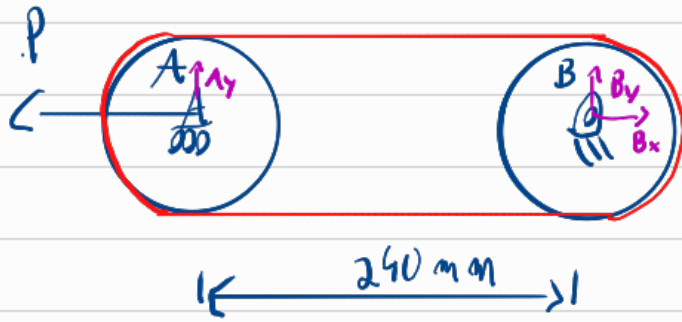
$$\sum F_x = 0$$

$$+P + F_{atA} - N_B \cdot \sin 5 - F_{atB} \cdot \cos 5 = 0$$

$$P + 111,11 - (567,7 \cdot 0,087) - (113,54 \cdot 0,996) = 0$$

$$P = 51,36 \text{ N}$$

8) $\mu_s = 0,35$ Maior binário e Tensão máx



$$P = 900 \text{ N} \quad r = 60 \text{ mm}$$

$$F = \mu_s \cdot N$$

$$\beta = 180^\circ (\beta = \pi \text{ rad})$$

$$T_2 = T_1 \cdot e^{\mu_s \cdot \beta}$$

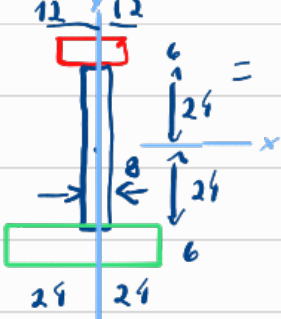
$$T_2 = 3,0028 \cdot T_1 \quad (\text{non usar 3})$$

$$\begin{array}{l} \rightarrow \Sigma F_x = 0 \\ T_1 + T_2 = 900 \end{array} \quad \left| \quad \begin{array}{l} (T_1) \quad (T_2) \\ -3,0028X + 1Y = 0 \\ 1X + 1Y = 900 \\ X = 224,84 \text{ N} \quad Y = 675,16 \text{ N} \\ \text{lado} \quad T_1 \nearrow \quad T_2 \nearrow \text{lado Tenso} \\ \text{frouxo} \end{array} \right.$$

Binário MÁx

$$M = (T_2 - T_1) \cdot r^{0,06} = (224,84 - 675,16) \times 0,06 \\ \Rightarrow \underline{\underline{27,02 \text{ N} \cdot \text{m}}}$$

9)



b_1	$12 + 12 = 24 \text{ mm}$	b_2	8 mm
h_1	6 mm	h_2	$24 + 24 = 48 \text{ mm}$
A_1	$24 \cdot 6 = 144 \text{ mm}^2$	A_2	$8 \cdot 48 = 384 \text{ mm}^2$
d_1	$24 + 3 = 27 \text{ mm}$	d_2	0

$b_3 = 24 + 24 = 48 \text{ mm}$
 $h_3 = 6 \text{ mm}$
 $A_3 = 48 \cdot 6 = 288 \text{ mm}^2$
 $d_3 = -27$

$A_{TOT} = 816 \text{ mm}^2$

$I_{x_1} = \frac{24 \cdot 6^3}{12} + 144 \cdot 27^2 \Rightarrow 105408 \text{ mm}^4$

$I_{x_2} = \frac{48 \cdot 6^3}{12} + 384 \cdot 0^2 \Rightarrow 73728 \text{ mm}^4$

$I_{x_3} = \frac{48 \cdot 6^3}{12} + 288 \cdot (-27)^2 \Rightarrow 210916 \text{ mm}^4$

$I_x = 389952 \text{ mm}^4$

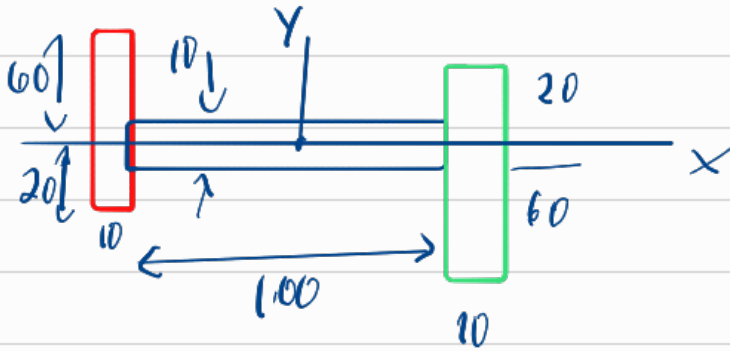
$K_x = \sqrt{\frac{I_x}{A_{TOT}}}$

$K_x = 21,86 \text{ mm}$

mom. de inércia $\hat{}$

Raio de giro $\hat{}$

$$10) I_{xy} = \sum (\bar{I}_{xy} + A \cdot \bar{x} \cdot \bar{y})$$



$$10 \cdot 80 = 800 \text{ mm}^2$$

$$\bar{x}_1 = -55 \text{ mm}$$

$$\bar{y}_1 = 20$$

$$100 \cdot 20 = 2000 \text{ mm}^2$$

$$\bar{x}_1 = 0 \quad \bar{y}_1 = 0$$

$$I_{xy2} = 2000 \cdot 0 \cdot 0 = 0$$

$$I_{xy1} = 800 \cdot -55 \cdot 20$$

$$\Rightarrow -880000 \text{ mm}^4$$

$$10 \cdot 80 = 800 \text{ mm}^2 \quad \bar{x}_3 = 55$$

$$I_{xy3} = 800 \cdot 55 \cdot -20 \quad \bar{y}_3 = -20$$

$$\Rightarrow -880000 \text{ mm}^4$$

$$I_{xy} = (-880000) + 0 + (-880000) =$$

$$\Rightarrow -1760000 \text{ mm}^4$$

$$\text{Prod inércia } xy \text{ é } -1,76 \cdot 10^6 \text{ mm}^4$$