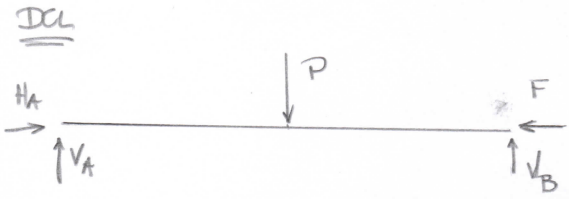
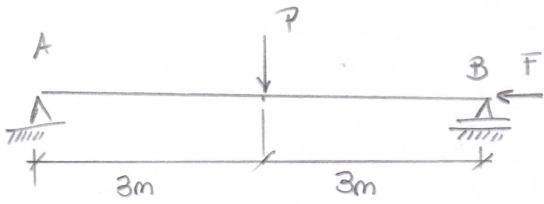


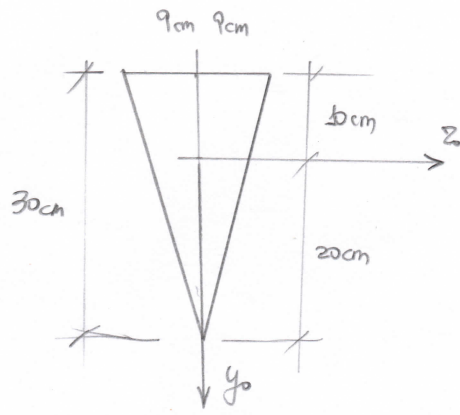
Apostila (cap. 5.4, ex 17)



$$|H_A = F|$$

$$V_A + V_B = P$$

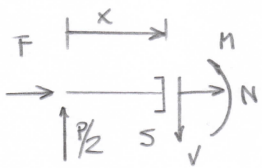
$$-P \cdot 3 + V_B \cdot 6 = 0 \Rightarrow V_B = V_A = P/2$$



$$I_{\omega} = \frac{1}{362} \cdot 18 \cdot 30^3 = 13500 \text{ cm}^4$$

$$A = \frac{9}{2} \cdot 18 \cdot 30 = 270 \text{ cm}^2$$

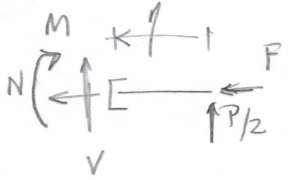
Diagramas:



$$|N = -F|$$

$$|V = P/2|$$

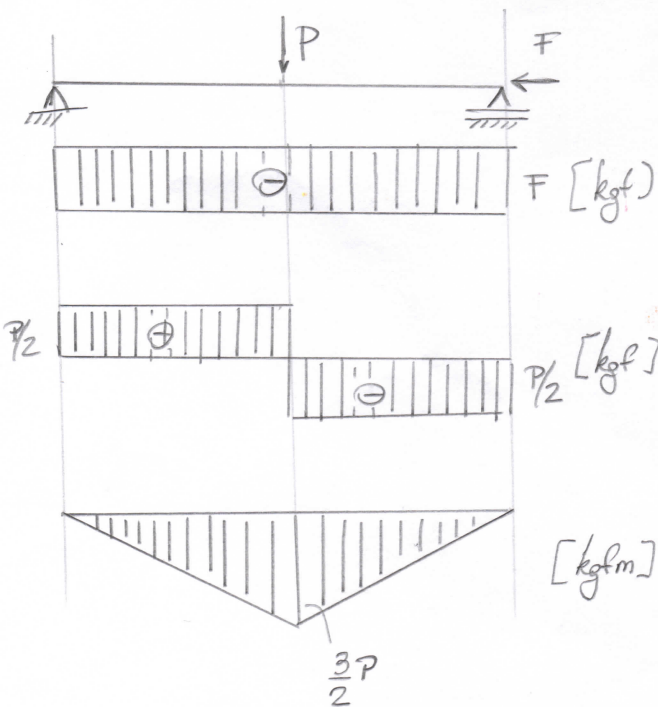
$$+M + P/2 x = 0 \Rightarrow |M = -P/2 x|$$



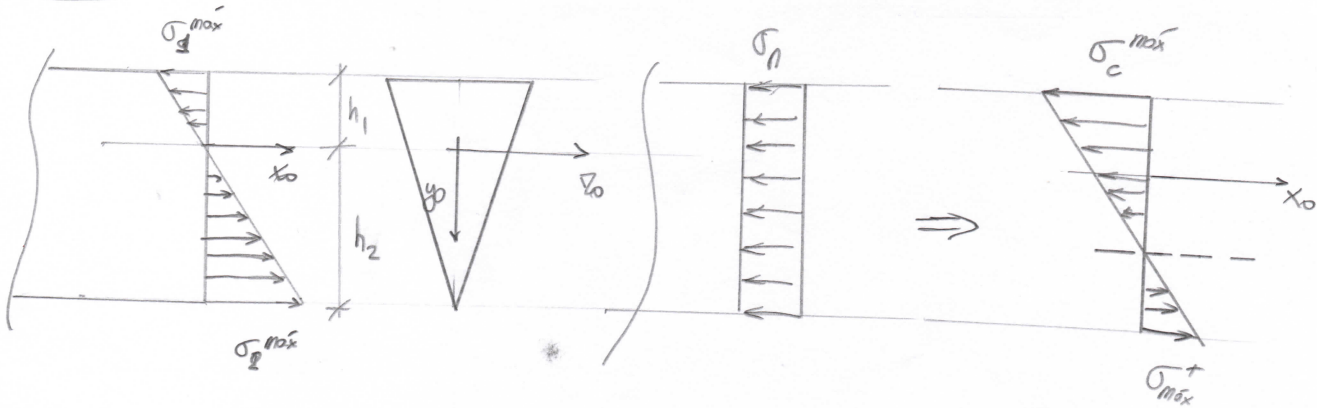
$$|N = -F|$$

$$|V = -P/2|$$

$$-M + P/2 y = 0 \Rightarrow M = -P/2 y$$



Tenses



$$\sigma_c^{\max} = \sigma_t + \sigma_n = -\frac{F}{A} - \frac{Mh_1}{I_{z_0}}$$

$$h_1 = 10 \text{ cm}$$

$$h_2 = 20 \text{ cm}$$

$$\sigma_t^{\max} = \frac{-F}{A} + \frac{Mh_2}{I_{z_0}}$$

$$M = \frac{3}{2} P [\text{kgf}\cdot\text{m}] = 150P [\text{kgf}\cdot\text{cm}]$$

$$|\sigma_c^{\max}| = \frac{F}{A} + \frac{Mh_1}{I_{z_0}} \leq \bar{\sigma}_c = 1100 \text{ kgf/cm}^2$$

$$\sigma_t^{\max} = \frac{-F}{A} + \frac{Mh_2}{I_{z_0}} \leq \bar{\sigma}_t = 800 \text{ kgf/cm}^2$$

$$\frac{F}{270} + \frac{150P \cdot 10}{13500} \leq 1100$$

$$\frac{-F}{270} + \frac{150P \cdot 20}{13500} \leq 800$$

$$\frac{F}{270} + \frac{P}{9} \leq 1100$$

$$\frac{-F}{270} + \frac{2P}{9} \leq 800$$

$$\frac{F + 30P}{270} \leq 1100$$

$$\frac{-F + 60P}{270} \leq 800$$

$$F + 30P \leq 297000$$

$$-F + 60P \leq 216000$$

no limite:

$$\begin{cases} 1F + 30P = 297000 \\ -F + 60P = 216000 \end{cases}$$

$$\begin{cases} 1F + 30P = 297000 \\ -F + 60P = 216000 \end{cases}$$

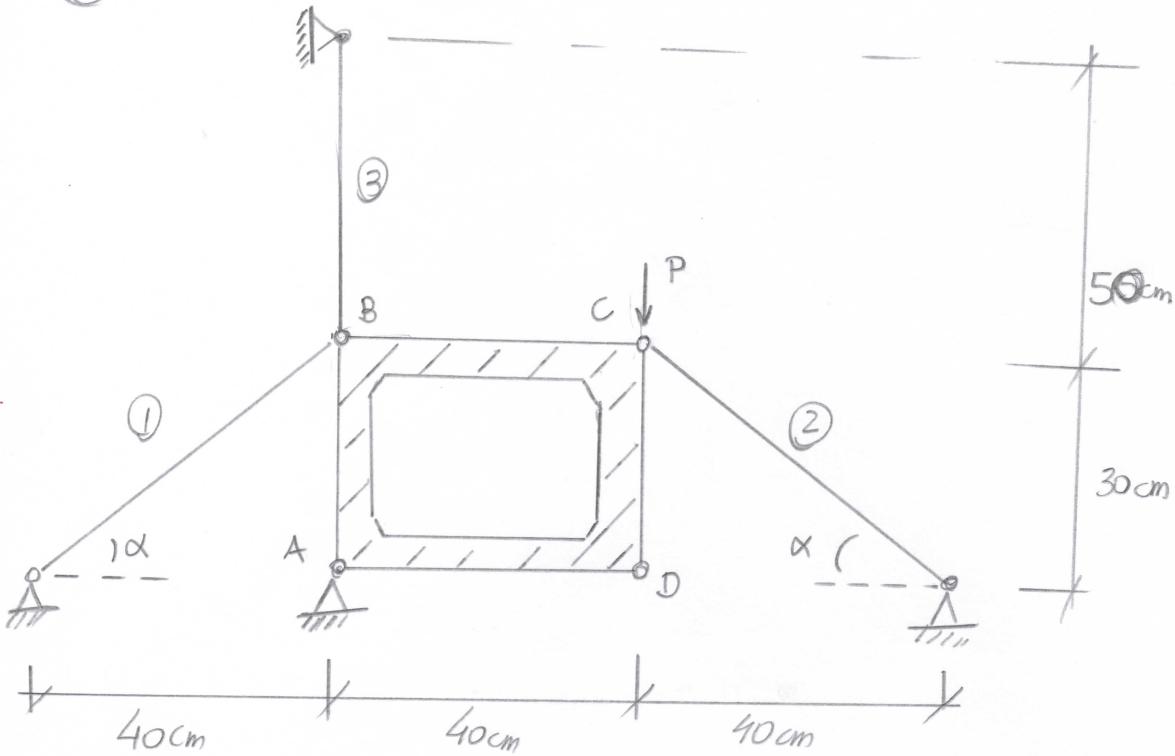
$$90P = 513000$$

$$P_{\max} = 5700 \text{ kgf} \Rightarrow F = 126000 \text{ kgf}$$

$$\text{Para } F=0 \Rightarrow \begin{cases} \frac{P}{9} \leq 1100 \Rightarrow P \leq 9900 \text{ kgf} \\ \frac{2P}{9} \leq 800 \Rightarrow P \leq 3600 \text{ kgf} \end{cases}$$

$$\text{Logo } P = 3600 \text{ kgf}$$

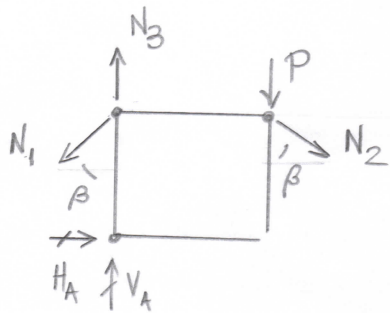
(14)



$P = 900 \text{ kgf}$
 $\bar{\sigma} = 480 \text{ kgf/cm}^2$
 $\bar{\varphi} = 0,0025 \text{ rad}$
 $l = 50 \text{ cm}$
 $E = 10^5 \text{ kgf/cm}^2$

$\text{sen } \alpha = \text{cos } \beta = \frac{3}{5}$
 $\text{cos } \alpha = \text{sen } \beta = \frac{4}{5}$

Equilibrio:



$\sum F_H = 0: -N_1 \text{sen } \beta + H_A + N_2 \text{sen } \beta = 0$

$\sum F_V = 0: V_A + N_3 - N_1 \text{cos } \beta - P - N_2 \text{cos } \beta = 0$

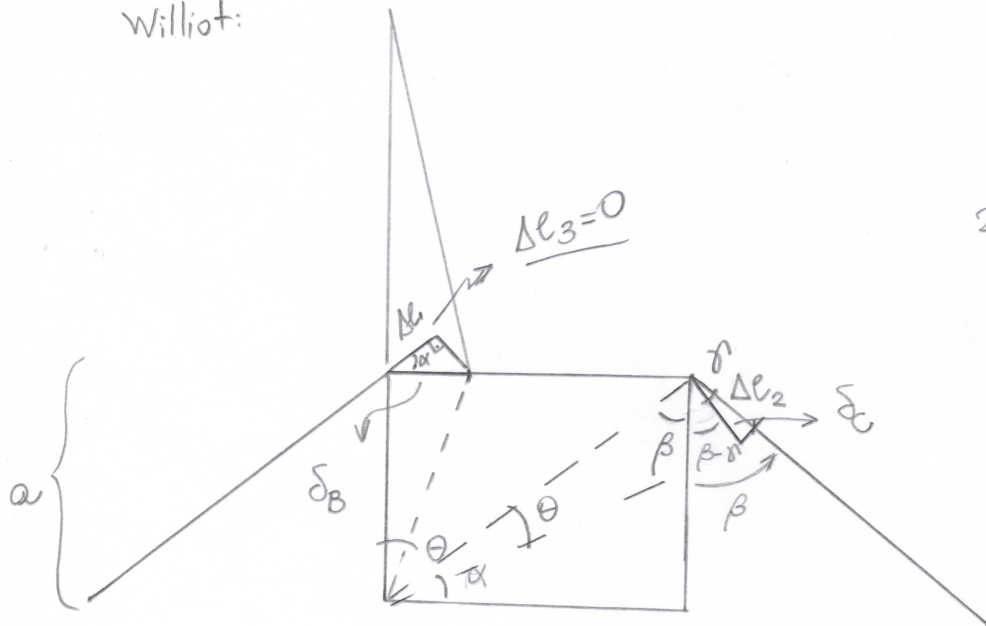
$\sum M_A = 0: N_1 \text{sen } \beta \cdot 30 - P \cdot 40 - N_2 \text{cos } \beta \cdot 40 - N_2 \text{sen } \beta \cdot 30 = 0$

$3N_1 \frac{4}{5} - N_2 \left[4 \cdot \frac{3}{5} + 3 \cdot \frac{4}{5} \right] = 4P$

$12N_1 - 24N_2 = 20P$

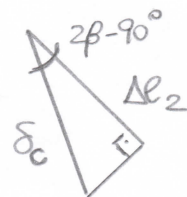
$3N_1 - 6N_2 = 5P$

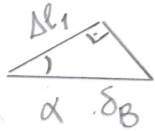
Williot:



$2\beta - \delta = 90^\circ$

$\delta = 2\beta - 90^\circ$

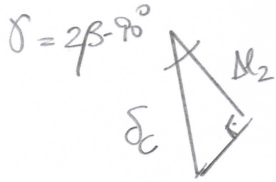




$$\cos \alpha = \frac{\Delta l_1}{\delta_B}$$

$$\therefore \delta_B = \frac{\Delta l_1}{\cos \alpha}$$

$$\underline{\Delta l_2 = 0}$$



$$\cos \delta = \frac{|\Delta l_2|}{\delta_c}$$

$$\delta_c = \frac{|\Delta l_2|}{\cos \delta}$$

$$\cos(2\beta - 90^\circ) = \cos 2\beta \cos 90^\circ + \sin 2\beta \sin 90^\circ$$

$$\cos(2\beta - 90^\circ) = \sin 2\beta = 2 \sin \beta \cos \beta$$

$$\cos \delta = 2 \cdot \frac{3}{5} \cdot \frac{4}{5} = \frac{24}{25}$$

Mas:

$$\lg \theta = \frac{\delta_B}{30} = \frac{\delta_c}{50} \Rightarrow \frac{\delta_B}{3} = \frac{\delta_c}{5}$$

$$\frac{1}{3} \cdot \frac{\Delta l_1}{\cos \alpha} = \frac{1}{5} \cdot \frac{|\Delta l_2|}{\cos \delta}$$

$$\Delta l_1 = \frac{3}{5} \cdot \frac{\cos \alpha}{\cos \delta} |\Delta l_2| = \frac{3}{5} \cdot \frac{4}{5} \cdot \frac{25}{24} |\Delta l_2|$$

$$\underline{\underline{\left| \frac{\Delta l_1 = |\Delta l_2|}{2} \right|}} \Rightarrow \Delta l_1 = -\frac{\Delta l_2}{2}$$

$$\frac{N_1 l_1}{E_1 A_1} = -\frac{1}{2} \frac{N_2 l_2}{E_2 A_2} \Rightarrow \underline{\underline{N_1 = -\frac{N_2}{2}}} \quad \underline{\underline{N_3 = 0}}$$

Substituindo no equilíbrio:

$$3 \cdot N_1 - 6 \cdot (-2N_1) = 5P$$

$$15N_1 = 5P$$

$$N_1 = \frac{P}{3} \Rightarrow N_1 = 300 \text{ kgf} ; N_2 = -600 \text{ kgf}$$

Dimensionamento:

1ª tensão

$$\sigma \leq \bar{\sigma} \Rightarrow \frac{|N_2|}{A} \leq \bar{\sigma} \Rightarrow A \geq \frac{|N_2|}{\bar{\sigma}} \Rightarrow A \geq \frac{600}{480}$$

$$\underline{A \geq 1,25 \text{ cm}^2}$$

2ª rotação:

$$\theta \leq \bar{\varphi} \Rightarrow \text{tg} \theta \leq \text{tg} \bar{\varphi} \Rightarrow \frac{\delta_B}{a} \leq \text{tg} \bar{\varphi} \Rightarrow \frac{\Delta l_1}{a \cos \alpha} \leq \text{tg} \bar{\varphi}$$

$$\frac{N_1 \cdot l}{E A \cos \alpha} \leq \text{tg} \bar{\varphi} \Rightarrow A \geq \frac{N_1 \cdot l}{E a \cos \alpha \text{ tg} \bar{\varphi}} \quad A \geq \frac{300 \cdot 50}{10^5 \cdot 30 \cdot 4/5 \cdot 0,0025}$$

$$\underline{A \geq 2,5 \text{ cm}^2}$$

$$\text{Logo } A = 2,5 \text{ cm}^2.$$