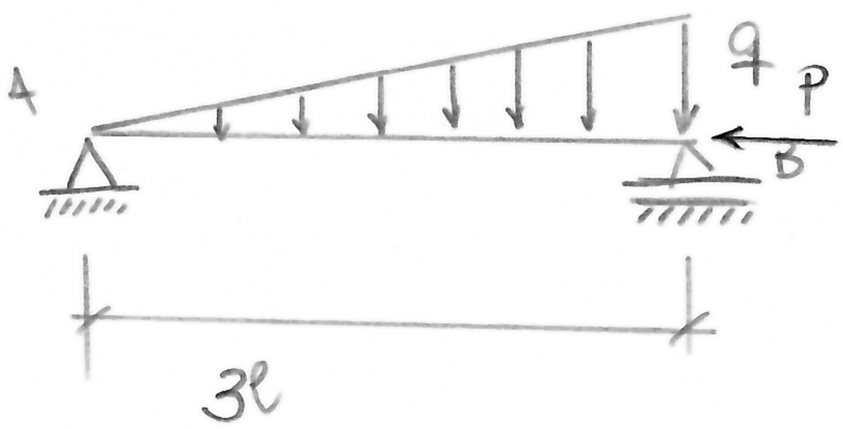
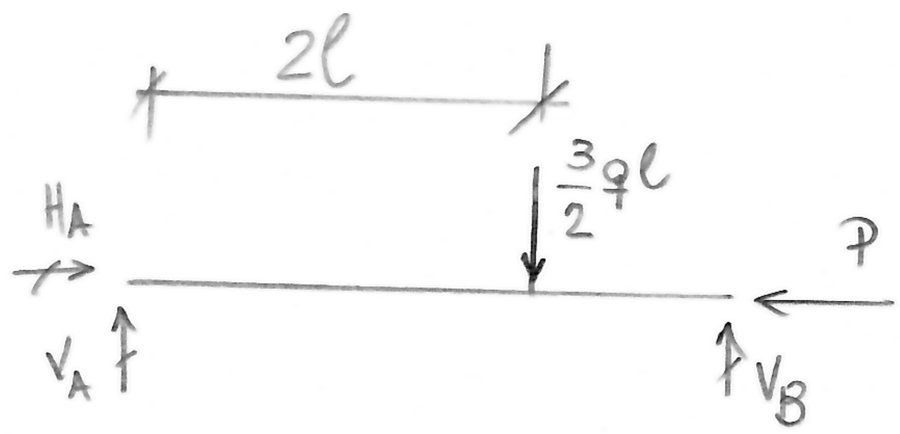




$$\sum F_H = 0: \quad \boxed{H_A = +P}$$

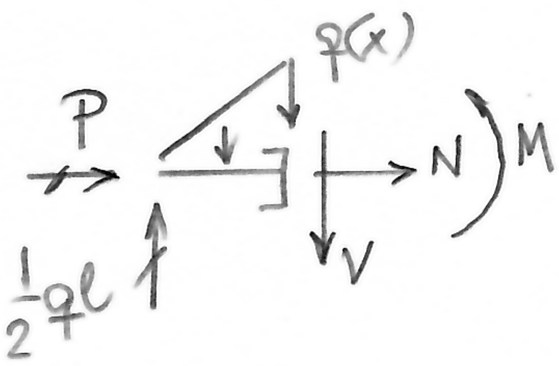
$$\sum F_V = 0: \quad V_A + V_B = \frac{3}{2} q\ell$$

$$\sum M_A = 0: \quad \frac{3}{2} q\ell \cdot 2\ell = 3\ell V_B \Rightarrow 3\ell \cdot V_B = 3q\ell^2 \Rightarrow \boxed{V_B = q\ell}$$

$$\therefore V_A = \frac{1}{2} q\ell$$

Diagramas

$$\boxed{N = -P}, \quad q(x) = \frac{q}{3\ell} x$$



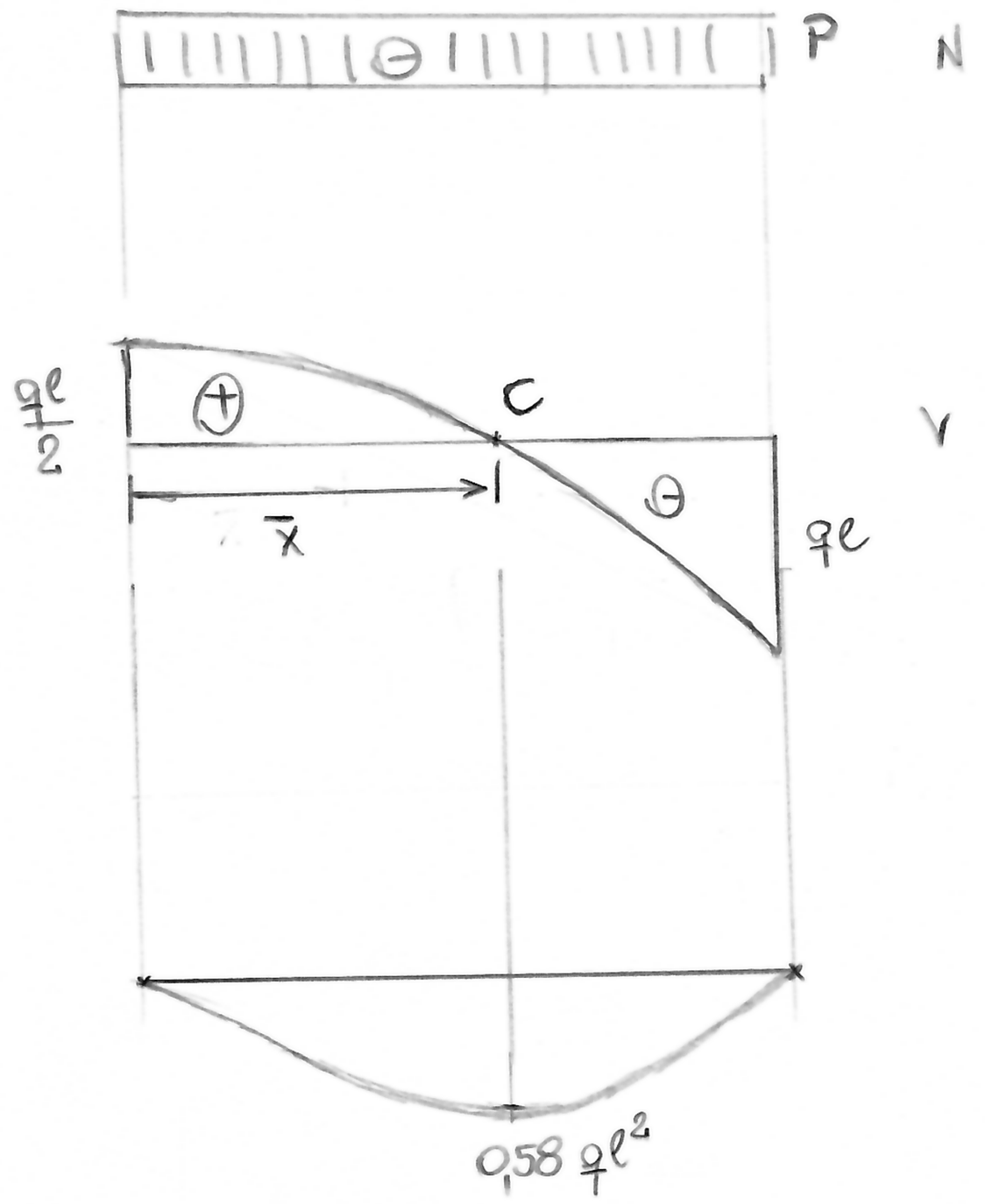
$$\frac{dV}{dx} = -q \Rightarrow V(x) = \int -q(x)\,dx \Rightarrow V(x) = \int -\frac{q}{3\ell} x\,dx$$

$$V(x) = -\frac{q}{3\ell}\left(\frac{x^2}{2}\right) + C_1 \qquad V(0) = \frac{1}{2} q\ell = C_1$$

$$\therefore \boxed{V(x) = \frac{q\ell}{2} - \frac{qx^2}{6\ell}}$$

$$\frac{dM}{dx} = V(x) \Rightarrow M(x) = \int \left[\frac{q\ell}{2} - \frac{qx^2}{6\ell}\right] dx \Rightarrow M(x) = \frac{q\ell x}{2} - \frac{qx^3}{18\ell} + C_2$$

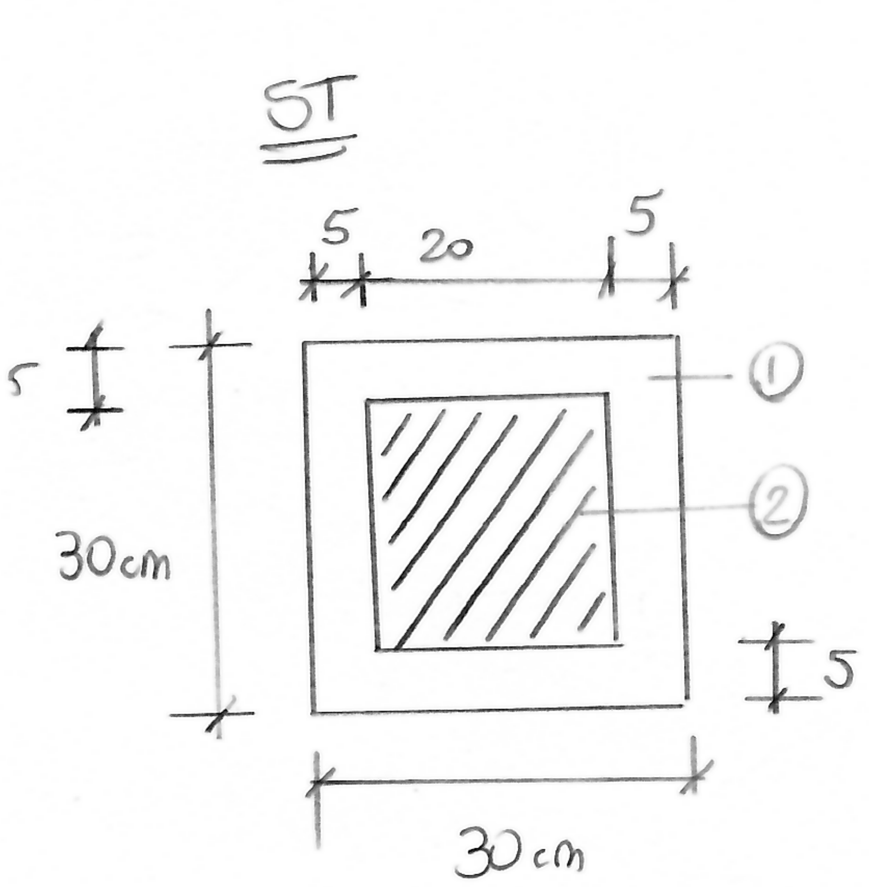
$$M(0) = 0 \Rightarrow C_2 = 0 \qquad \therefore \boxed{M(x) = \frac{q\ell x}{2} - \frac{qx^3}{18\ell}}$$



$$\bar{x}: \quad \frac{\cancel{A}\,\bar{x}^2}{6\ell} = \frac{\cancel{A}\,\ell}{2}$$

$$\bar{x} = 3\ell^2$$

$$x \cong 1{,}73\ell$$

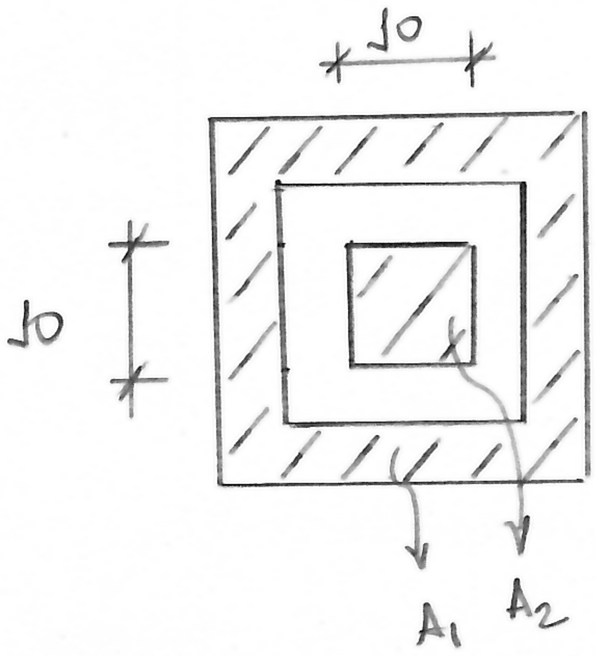


$$E_1 = 2E_2$$

Usando ① como base:

$$b_{eq} = \frac{E_2}{E_1} \cdot b = \frac{b}{2}$$

Logo:

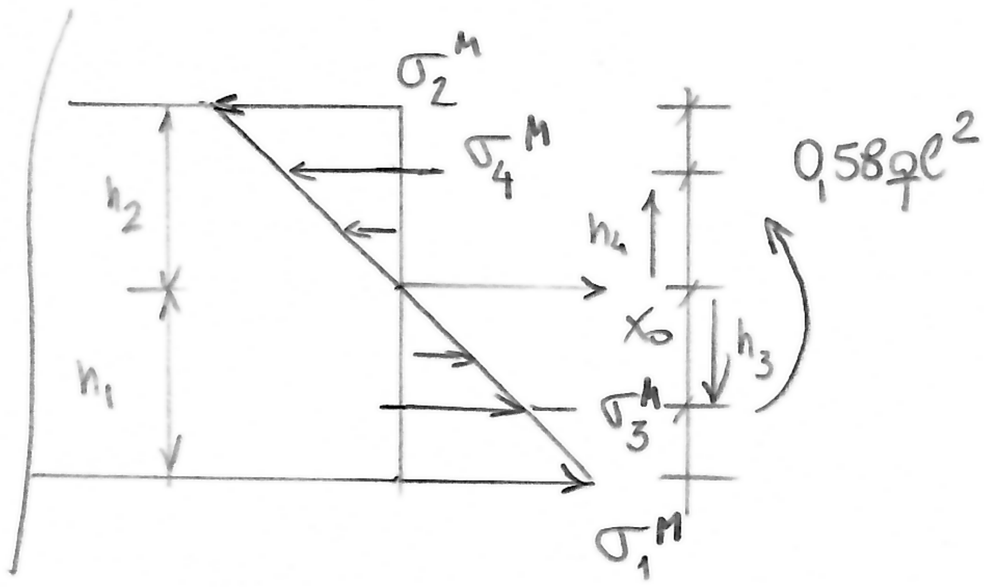


$$A_T = \underbrace{(30.30 - 20.20)}_{A_1} + \underbrace{(10.10)}_{A_2} = 600\,cm^2 = 0{,}06\,m^2$$

$$I_{zo} = \underbrace{\left(\frac{30^4}{12} - \frac{20^4}{12}\right)}_{I_0'} + \underbrace{\left(\frac{10^4}{12}\right)}_{I_{zc}} = 55000\,cm^4 = 5{,}5.10^{-4}\,m^4$$

* não há transporte: todos os eixos são coincidentes

Tensões máximas em O:



$h_1 = h_2 = 15cm = 0,15m$

$h_3 = h_4 = 10cm = 0,1m$

$\sigma_2^M = -\sigma_1^M$; $\sigma_4^M = -\sigma_3^M$

$$\sigma_1 = \sigma_N + \sigma_1^M = -\frac{P}{A} + \frac{0,58ql^2}{I_{x0}} \cdot 0,15$$

$$\sigma_2 = \sigma_N + \sigma_2^M = -\frac{P}{A} + \frac{0,58ql^2}{I_{x0}} \cdot 0,15$$

$$\sigma_3 = \sigma_N + \sigma_3^M = -\frac{P}{A} + \frac{0,58ql^2}{I_{x0}} \cdot 0,1$$

$$\sigma_4 = \sigma_N + \sigma_4^M - \frac{P}{A} - \frac{0,58ql^2}{I_{x0}} \cdot 0,1$$

Para $P = 6kN$ e $q = 2kN/m$, $l = 2m$:

$$\sigma_1 = -\frac{6.10^3}{0,06} + \frac{0,087}{5,5.10^{-4}} \cdot 2.2^2 = -10^5 - 1265 = -101,265kPa$$

$$\sigma_2 = -10^5 + 1265 = -98,735kPa$$

$$\sigma_3 = -10^5 + \frac{0,058}{55.10^{-4}} \cdot 2.2^2 = -10^5 + 844 = -99,156kPa$$

$$\sigma_4 = -10^5 - 844 = 100,844kPa$$

Convertendo as do material ②:

$$\sigma_2^2 = \sigma_2 \cdot \frac{E_2}{E_1} = -49,3675kPa$$

$$\sigma_3^2 = \sigma_3 \cdot \frac{E_2}{E_1} = -49,578kPa$$