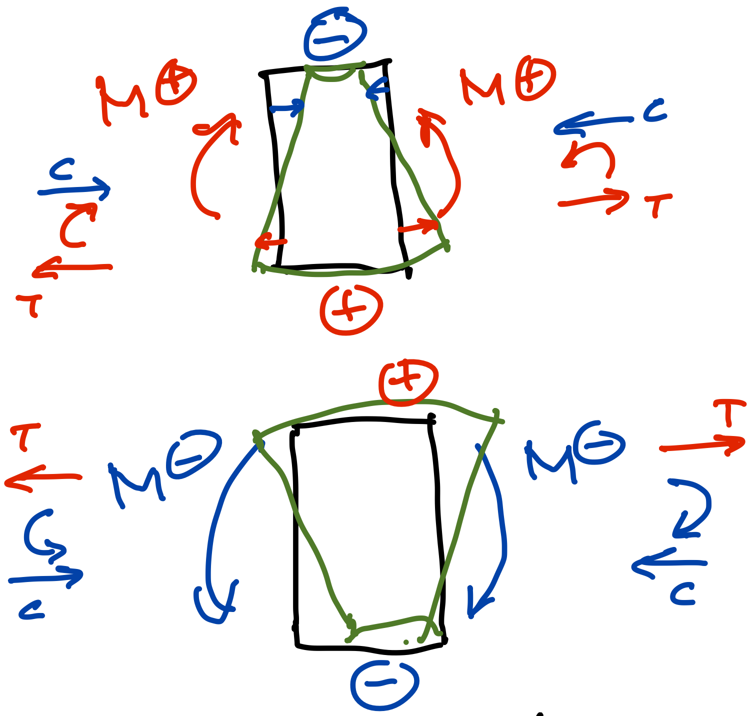
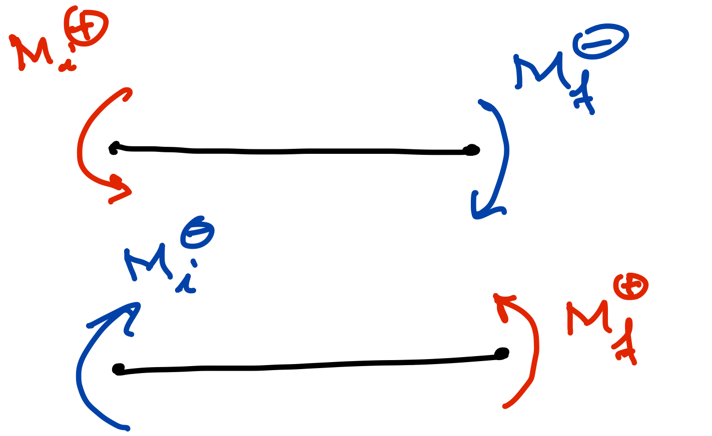
Convenção de sinais para momentos flectores

De traçado



O diagrama de momentos flectores é traçado do lado da fibra traccionada

Processo de Cross (Mét. dos Desloc.)



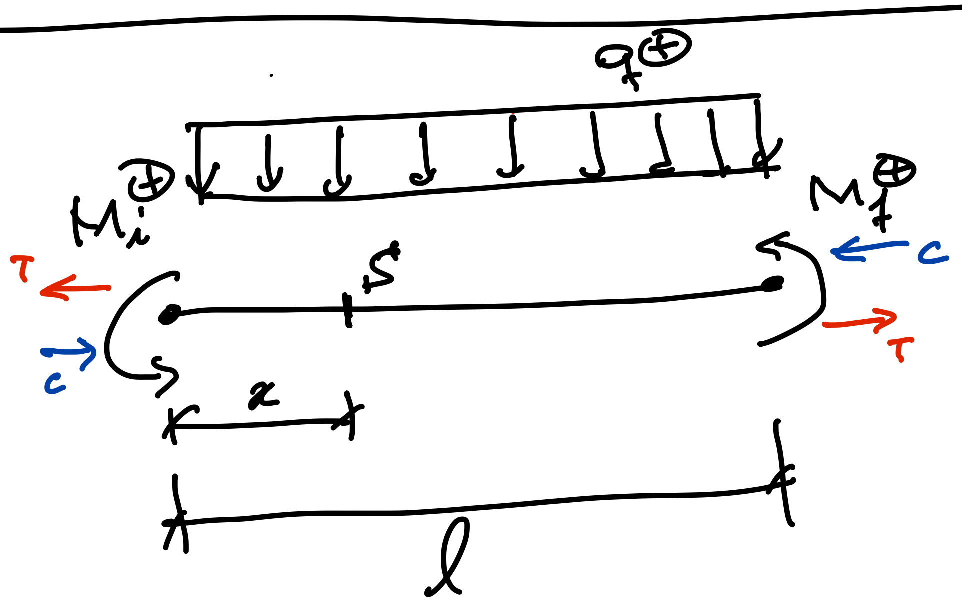
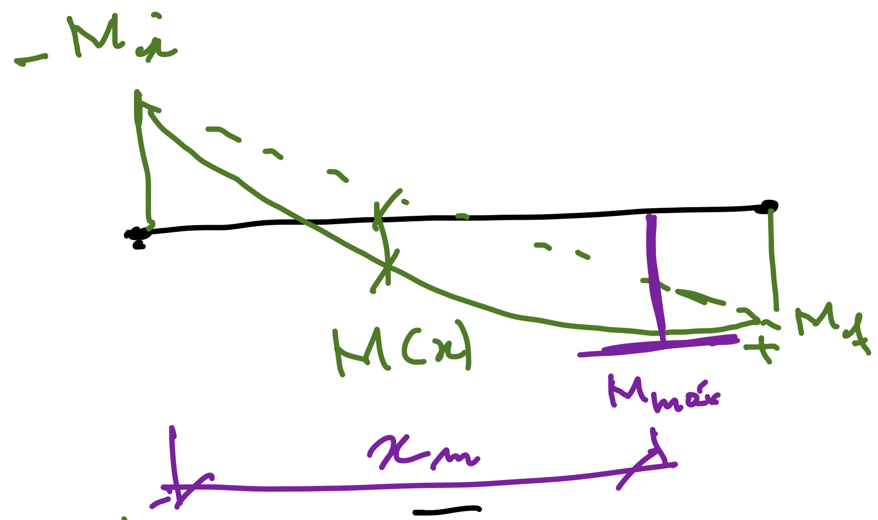


Diagrama de momentos flectores

$M(x)$



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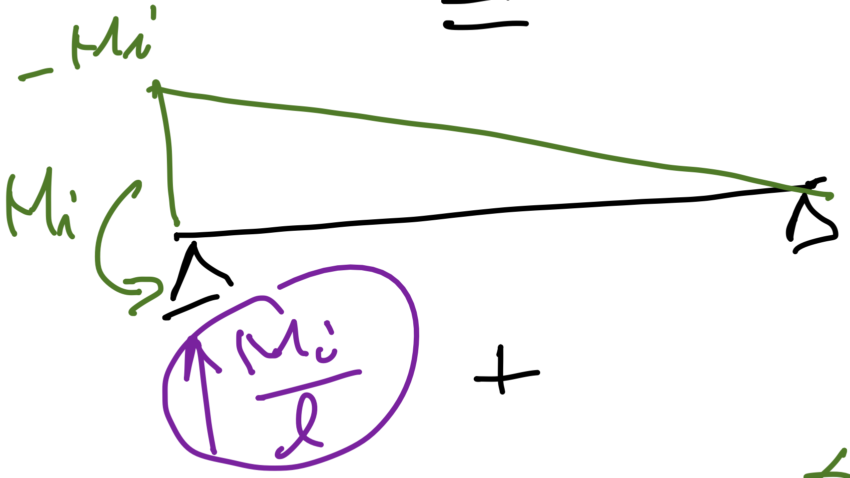
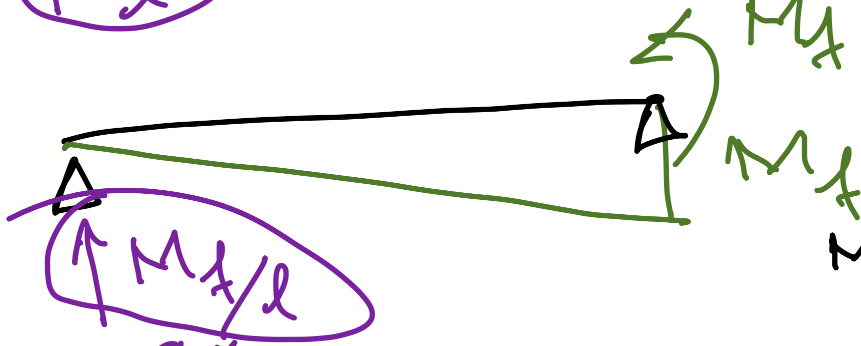
(a)



$$M_a(x) = -M_i \frac{l-x}{l}$$

+

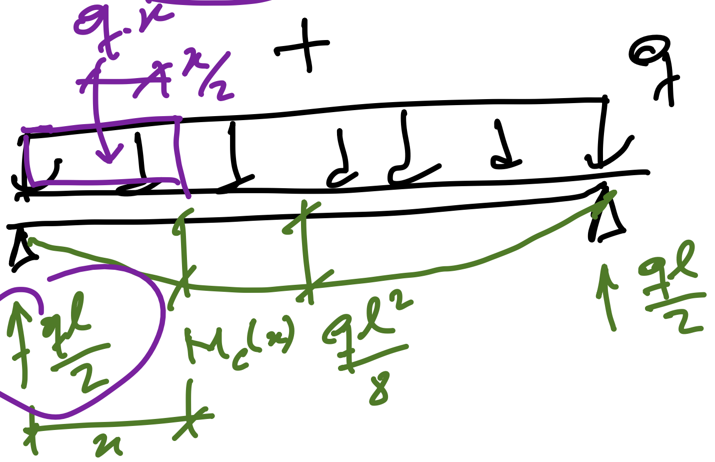
(b)



$$M_b = +M_f \frac{x}{l}$$

+

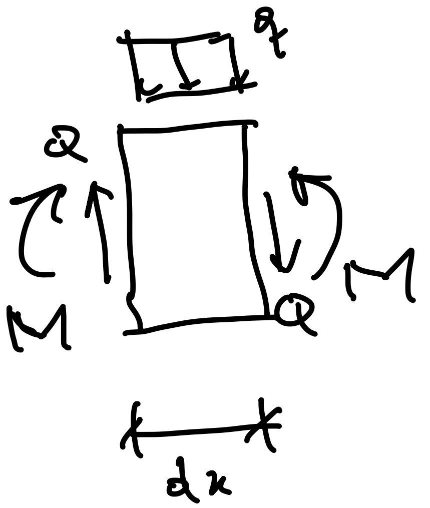
(c)



$$M_c(x) = \frac{ql}{2} \cdot x - qx \cdot \frac{x}{2} \rightarrow M_c(x) = \frac{ql}{2} \cdot x - \frac{qx^2}{2}$$

$$\boxed{M(x) = -M_i \frac{l-x}{l} + M_f \frac{x}{l} + \frac{ql}{2} \cdot x - \frac{qx^2}{2}}$$

Cálculo da seção onde ocorre $M_{máx}$ e do seu valor



$M \rightarrow$ momento fletor

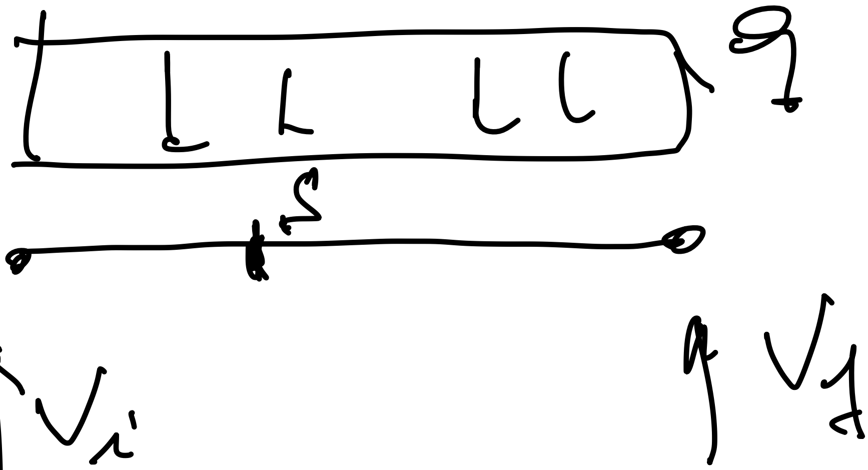
$Q \rightarrow$ esforço cortante

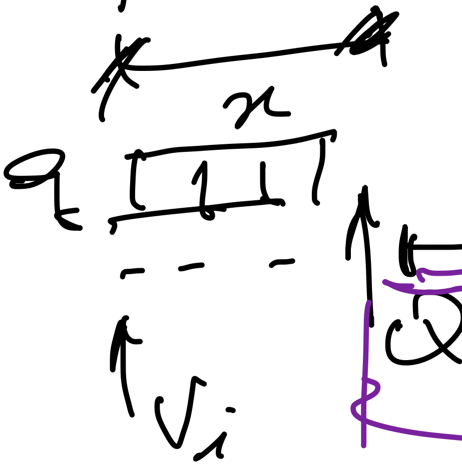
Equilíbrio do elemento infinitesimal

$$\boxed{\frac{dQ}{dx} = q_t} \qquad \boxed{\frac{dM}{dx} = Q}$$

$$\boxed{\frac{d^2M}{dx^2} = q_t}$$

$$M_{máx} \rightarrow \frac{dM}{dx} = 0 \rightarrow Q = 0$$





$$\boxed{Q(x) = V_i - q_t \cdot x}$$

$$Q(x) = 0 \longrightarrow V_i - q \cdot x_m = 0$$

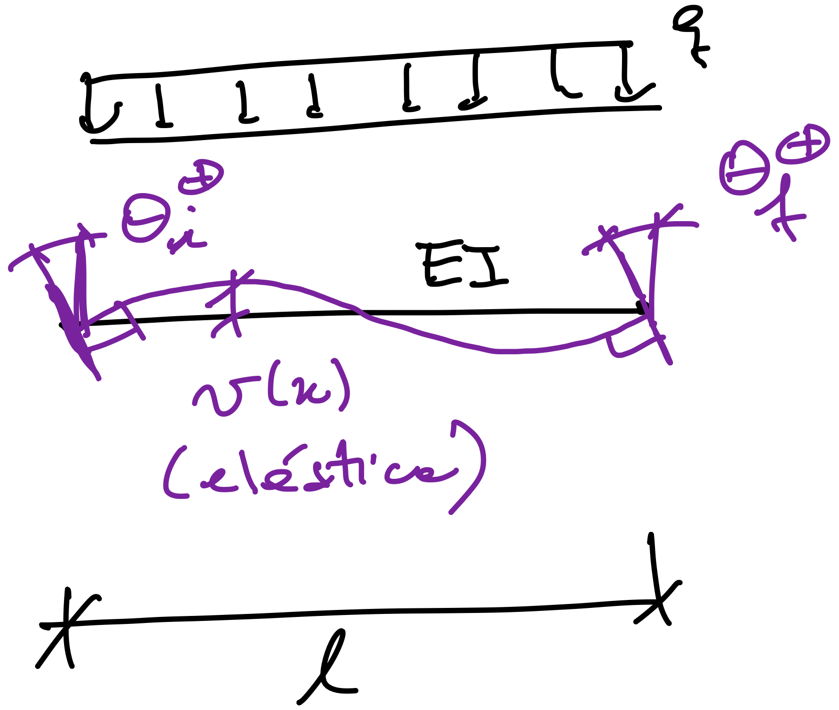
$$\boxed{x_m = \frac{V_i}{q}}$$

$$\boxed{V_i = \frac{M_i}{l} + \frac{M_j}{l} + \frac{q\,l}{2}}$$

$$M_{max} = M(x_m)$$

Dedução da equação da elástica
(configuração deformada)

Caso sem articulação



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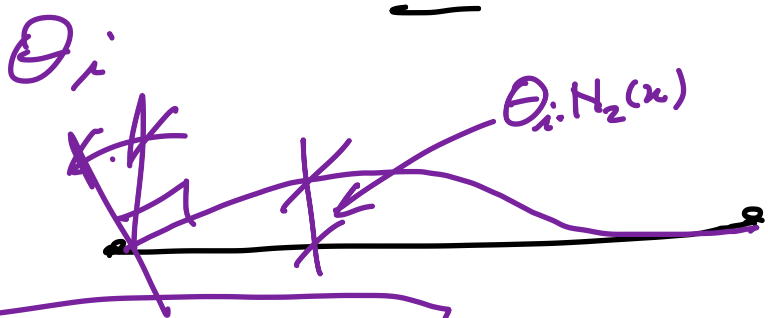
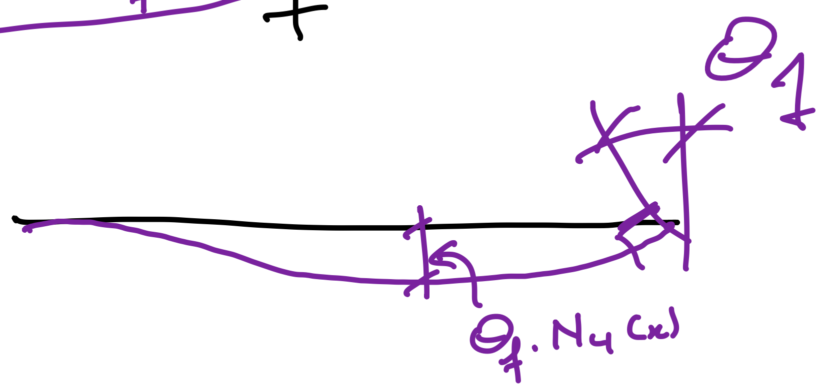


$$\boxed{v_{II}(x) = \theta_i \cdot N_2(x) + \theta_f \cdot N_4(x)}$$

+



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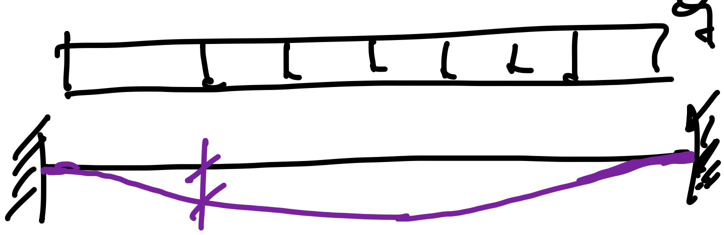

$v_I(x)$

$$\boxed{v(x) = v_I(x) + v_{II}(x)}$$

Equações diferenciais de compatibilidade

$$\boxed{\frac{dv}{dx} = \theta(x)} \qquad \boxed{\frac{d^2v}{dx^2} = \frac{M(x)}{EI}}$$

$EI = \text{const.} \Longrightarrow$

$$\boxed{\frac{d^2M}{dx^2} = q} \qquad \boxed{\frac{d^4v}{dx^4} = \frac{q}{EI}}$$

$q = \text{const.} \Longrightarrow$

$v(x) = ax^4 + bx^3 + cx^2 + dx + e$

$v_I(x)$ é um polinômio do 4º grau

$q = 0 \rightarrow v_{II}(x)$ é um polinômio do 3º grau

$v_I(x)$ e $v_{II}(x)$ são deduzidas utilizando condições de contorno em $v(0)$, $\theta(0) = dv/dx(0)$, $v(\ell)$, $\theta(\ell) = \frac{dv}{dx}(\ell)$