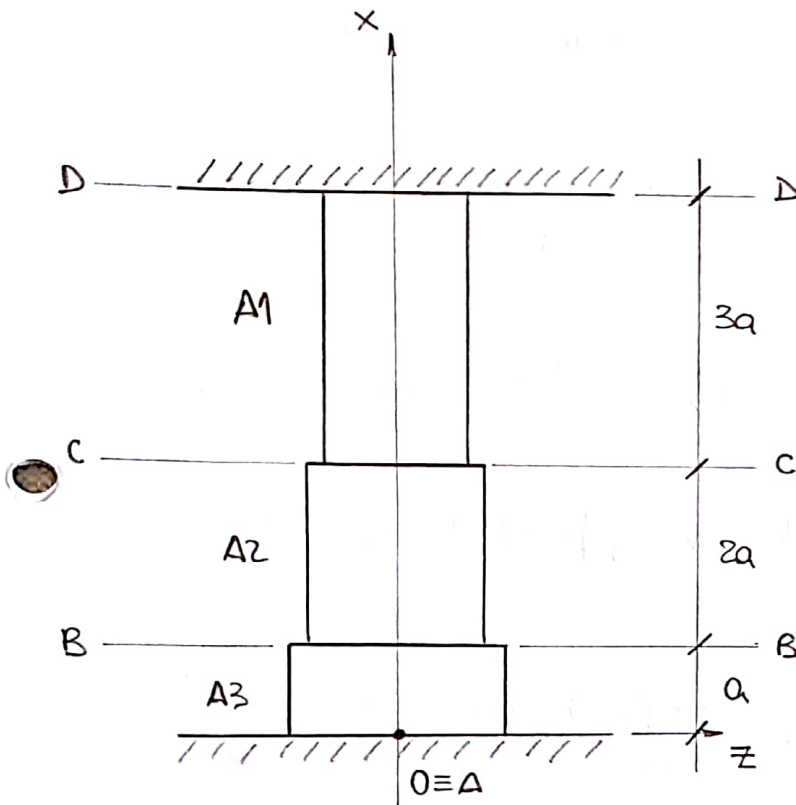




$$Q = 1,25 \text{ m}$$

$$A_1 = 20 \text{ cm} \times 20 \text{ cm} = 400 \text{ cm}^2$$

$$A_2 = 25 \text{ cm} \times 25 \text{ cm} = 625 \text{ cm}^2$$

$$A_3 = 30 \text{ cm} \times 30 \text{ cm} = 900 \text{ cm}^2$$

Horizontal:

$$E = 204 \text{ MPa} = 2000 \text{ kN/cm}^2$$

$$\gamma_H = 24 \text{ kN/m}^3$$

$$\alpha_H = 1.10^{-5} \frac{1}{^\circ\text{C}}$$

$$\sigma_{\text{adm},H} = 200 \text{ MPa}$$

01 - Resciantes de niveles:

$$R_A + R_D - 0,04 \cdot 3,75 \cdot 24 - 0,0625 \cdot 2,50 \cdot 24 - 0,09 \cdot 1,25 \cdot 24 = 0$$

$$R_A + R_D - 3^{\underline{60}} - 3^{\underline{75}} - 2^{\underline{20}} = 0$$

$$R_A + R_D - 10,05 = 0 \quad (1) \quad \text{EC. de equilibrio}$$

EC. de compatibilidad:

$$\Delta L_1 + \Delta L_2 + \Delta L_3 = 0 \quad (2)$$

$$\cancel{N_3} + R_A - \rho_3 \cdot x = 0$$

$$N_3 = -R_A + \rho_3 x$$

$$\begin{cases} q_1 = \gamma_H \cdot A_1 = \frac{24 \text{ kN}}{\text{m}^3} \cdot 0,06 \text{ m}^2 = 0,96 \text{ kN/m} \\ q_2 = \gamma_H \cdot A_2 = \frac{24 \text{ kN}}{\text{m}^3} \cdot 0,0625 \text{ m}^2 = 1,50 \text{ kN/m} \\ q_3 = \gamma_H \cdot A_3 = \frac{24 \text{ kN}}{\text{m}^3} \cdot 0,09 \text{ m}^2 = 2,16 \text{ kN/m} \end{cases}$$

$$N_3 = -R_A + q_3 x \quad (3a)$$

$$N_2 = -R_A + q_3 L_3 + q_2 (x - L_3) \quad (3b)$$

$$N_1 = -R_A + q_3 L_3 + q_2 L_2 + q_1 [x - (L_1 + L_2)] \quad (3c)$$

$$\Delta L_3 = \int_0^{L_3} \frac{N_3(x)}{EA_3} dx = \int_0^{L_3} \frac{(-R_A + q_3 x)}{EA_3} dx$$

$$\Delta L_3 = \frac{1}{EA_3} \left[-R_A L_3 + \frac{q_3 L_3^2}{2} \right]$$

$$\Delta L_2 = \frac{1}{EA_2} \left[-R_A L_2 + \frac{q_3 L_3 L_2}{675} + \frac{q_2 L_2^2}{468,75} \right]$$

$$\Delta L_1 = \frac{1}{EA_1} \left[-R_A L_1 + \frac{q_3 L_3 L_1}{102,5} + \frac{q_2 L_2 L_1}{1406,25} + \frac{q_1 L_1^2}{675} \right]$$

$$\Delta L_3 = - \frac{6,944}{15675} 10^{-8} R_A + 9,375 \cdot 10^{-4}$$

$$\Delta L_2 = - 2 \cdot 10^{-4} R_A + 9,15 \cdot 10^{-4}$$

$$\Delta L_1 = - 4,6875 \cdot 10^{-4} R_A + 3,867 \cdot 10^{-3}$$

$$- 6,844 \cdot 10^{-4} R_A - 2 \cdot 10^{-4} R_A - 4,6645 \cdot 10^{-4} R_A +$$

$$+ 9,325 \cdot 10^{-4} + 9,15 \cdot 10^{-4} + 3,867 \cdot 10^{-3} = 0$$

$$7,3819 \cdot 10^{-4} R_A = 4,87575 \cdot 10^{-3}$$

$$\underline{R_A = 6,605 \text{ kN}}$$

$$R_D = 10,05 - 6,605 \rightarrow \underline{R_D = 3,445 \text{ kN}}$$

02 -

I) Esfuerzos normales:

Tramo (3): $N_3(x) = -R_A + f_3 x = -6,605 + 2,16 \cdot x$

$$0 \leq x \leq L_3 \quad \left\{ \begin{array}{l} N_3(0) = -6,605 \text{ kN} \\ N_3(1,25) = -3,905 \text{ kN} \end{array} \right.$$

Tramo (2): $N_2(x) = -R_A + f_3 L_3 + f_2 (x - L_3)$

$L_3 \leq x \leq L_2 + L_3$ ~~$N_2(x=1,25)$~~

$$\left\{ \begin{array}{l} N_2(x) = -6,605 + 2,16 \cdot 1,25 + 1,50 (x - 1,25) \\ N_2(x) = -3,905 + 1,50 (x - 1,25) \\ N_2(3,75) = -0,155 \text{ kN} \end{array} \right.$$

PROBLEMA (4):

$$N_1(x) = -P_1 + f_3 \cdot L_3 + f_2 \cdot L_2 + f_1 [x - (L_1 + L_2)] \quad 4)9$$

$$L_2 + L_3 \leq x \leq L_1 + L_2 + L_3 \quad N_1(x) = -6.605 + 2.16 \cdot 1.25 + 1.50 \cdot 2.50 + 0.96 [x - (1.25 + 2.50)]$$

$$\begin{cases} N_1(x) = -0.115 + 0.96 [x - 3.75] \\ N_1(x=7.50) = +3.445 \text{ KN} \end{cases}$$

II) - Tensiones normales:

$$\sigma_{3A} = -\frac{6.605}{900} = -7.339 \cdot 10^{-3} \text{ KN/cm}^2$$

$$\sigma_{3B} = -\frac{3.905}{900} = -4.339 \cdot 10^{-3} \text{ "}$$

$$\sigma_{2B} = -\frac{3.905}{625} = -6.248 \cdot 10^{-3} \text{ "}$$

$$\sigma_{2C} = -\frac{0.155}{625} = -2.48 \cdot 10^{-4} \text{ "}$$

$$\sigma_{1C} = -\frac{0.115}{400} = -3.875 \cdot 10^{-4} \text{ "}$$

$$\sigma_{1D} = +\frac{3.445}{400} = +8.6125 \cdot 10^{-3}$$

Tramo (3):

$$\delta_3(x) = \frac{1}{EA_3} \int_0^{x^*} N_3(x) dx = \frac{1}{EA_3} \int_0^{x^*} (-6,605 + 2,16x) dx$$

$$\delta_3(x) = \frac{1}{EA_3} \left(\underbrace{-6,605x}_{[kN]} + \underbrace{\frac{2,16}{2} \frac{x^2}{2}}_{\left[\frac{kN}{m}\right]} \right) \Big|_0^{x^*}$$

$$\delta_3(x) = \frac{1}{2000 \cdot 900} \left[-6,605 \cdot x + \frac{2,16}{100} \frac{x^2}{2} \right]$$

$$\delta_3(x) = -3,67 \cdot 10^{-6} x + 6 \cdot 10^{-9} x^2$$

$$\delta_3(x=0) = \delta_A = 0.$$

$$\delta_3(x=1,25m) = \delta_B = -3,65 \cdot 10^{-4} cm.$$

Tramo (2):

$$\delta_2(x) = \delta_B + \frac{1}{EA_2} \int_{1,25}^{x^*} N_2(x) dx$$

$$\delta_2(x) = -3,65 \cdot 10^{-4} + \frac{1}{2000 \cdot 625} \int_{1,25}^{x^*} \left(\underbrace{-5,78}_{[kN]} + \underbrace{0,015x}_{\left[\frac{kN}{cm}\right]} \right) dx$$

$$\delta_2(x) = -3,65 \cdot 10^{-4} + \frac{1}{2000 \cdot 625} \left[-5,78 \cdot x + 0,015 \frac{x^2}{2} \right] \Big|_{1,25}^{x^*}$$

$$\delta_2(x) = -3,65 \cdot 10^{-4} + \frac{1}{2000 \cdot 64} \left[-5,78(x^* - 125) + \frac{0,015}{2}(x^{*2} - 125^2) \right] \quad 6/9$$

$$\delta_2(x) = -3,65 \cdot 10^{-4} - 4,624 \cdot 10^{-6} x + 5,78 \cdot 10^{-7} + 6 \cdot 10^{-9} x^2 - 9,371 \cdot 10^{-4}$$

$$\delta_2(x) = 1,1925 \cdot 10^{-4} - 4,624 \cdot 10^{-6} x + 6 \cdot 10^{-9} x^2$$

$$\delta_2(x=125) = -3,65 \cdot 10^{-4} \text{ cm} = \delta_B \quad \checkmark$$

$$\delta_2(x=375) = \delta_C = -7,71 \cdot 10^{-4} \text{ cm} \quad \checkmark$$

Then (7):

$$\delta_1(x) = \delta_C + \frac{1}{EA_1} \int_{375}^{x^*} N_1(x) dx$$

$$\delta_1(x) = -7,71 \cdot 10^{-4} + \frac{1}{2000 \cdot 400} \int_{375}^{x^*} (-3,755 + 9,6 \cdot 10^{-3} x) dx$$

$$\delta_1(x) = -7,71 \cdot 10^{-4} + \frac{1}{2000 \cdot 400} \left[-3,755 x + 9,6 \cdot 10^{-3} \frac{x^2}{2} \right]_{375}^{x^*}$$

$$\delta_1(x) = -7,71 \cdot 10^{-4} + \frac{1}{2000 \cdot 400} \left[-3,755(x^* - 375) + \frac{9,6 \cdot 10^{-3}}{2}(x^{*2} - 375^2) \right]$$

$$\delta_1(x) = -7,71 \cdot 10^{-4} - 4,694 \cdot 10^{-6} x + 1,76 \cdot 10^{-3} + 6 \cdot 10^{-9} x^2 - 8,4375 \cdot 10^{-4}$$

$$f_1(x) = 1,4525 \cdot 10^{-4} - 4,694 \cdot 10^{-6} x + 6 \cdot 10^{-9} x^2$$

$$f_1(x=375) = f_0 = -7,71 \cdot 10^{-4} \text{ cm.} \quad \checkmark$$

$$f_1(x=750) = f_3 = -2,5 \cdot 10^{-7} \text{ cm} \approx 0. \quad \checkmark$$

IV) - DORONNACIONES ESPECIFICAS:

Grupo (3):

$$E_3(x) = \frac{df_3(x)}{dx} = -3,67 \cdot 10^{-6} + 1,2 \cdot 10^{-8} x.$$

$$E_3(x=0) = -3,67 \cdot 10^{-6}$$

$$E_3(x=125) = -2,17 \cdot 10^{-6}.$$

Grupo (2):

$$E_2(x) = \frac{df_2(x)}{dx} = -4,624 \cdot 10^{-6} + 1,2 \cdot 10^{-8} x.$$

$$E_2(x=125) = -3,124 \cdot 10^{-6}$$

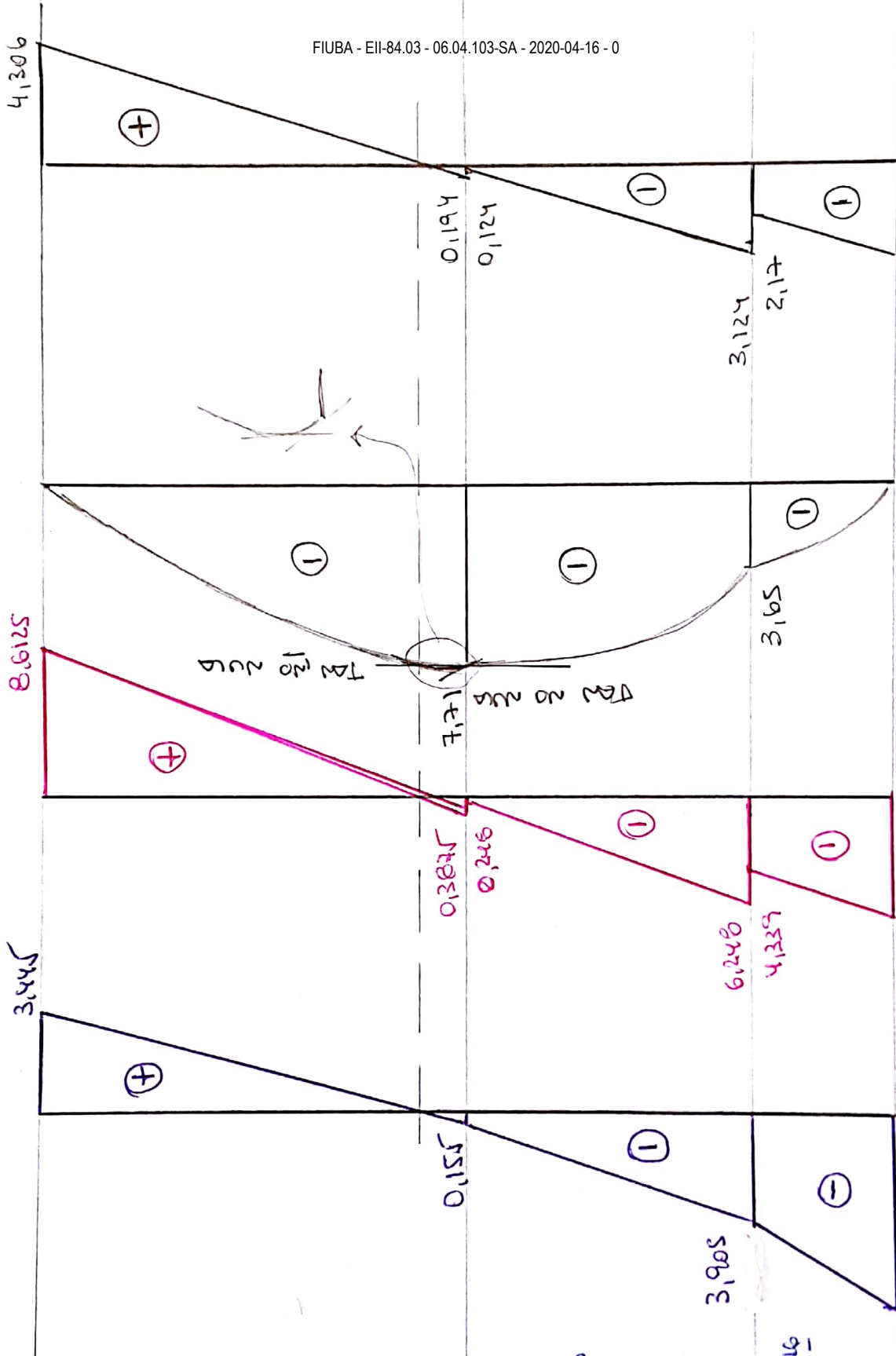
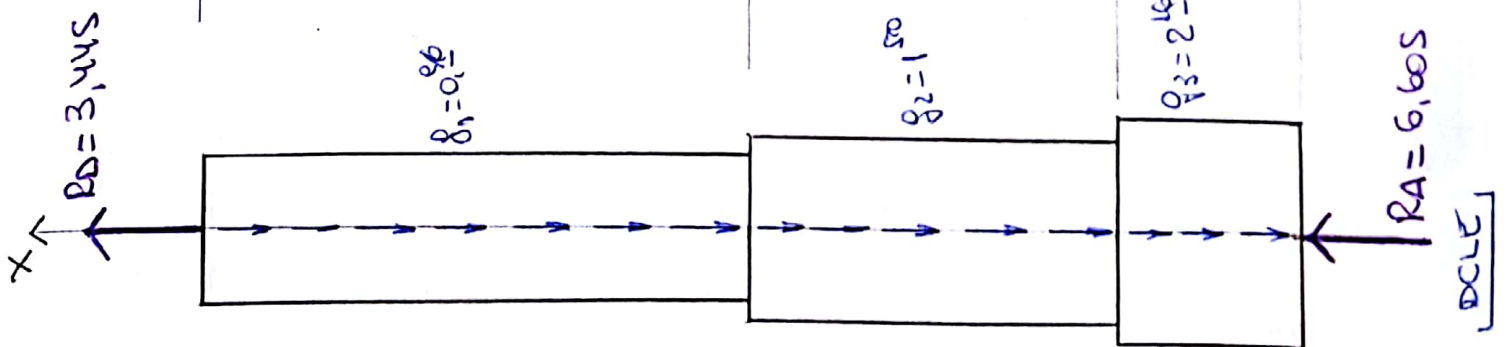
$$E_2(x=375) = -1,24 \cdot 10^{-7}$$

Tramo ①:

$$\underline{E_1(x) = \frac{df_1(x)}{dx} = -4,694 \cdot 10^{-6} + 1,2 \cdot 10^{-8} x.}$$

$$E_1(x=375) = -1,94 \cdot 10^{-7}$$

$$E_1(x=750) = +4,306 \cdot 10^{-6}.$$



$$\frac{V(x)}{[kN]} \cdot 10^{-3} \quad [kN/m^2]$$

$$\frac{M(x)}{[cm]} \cdot 10^{-4} \quad [cm]$$