

Log do Programa

Questão 1

Propriedades da viga

- Tipo: hollow
- Largura: 1
- Raio externo: 0.08
- Raio interno: 0.06
- Área: 0.00879646
- Volume: 0.00879646
- E : 207000000000
- G : 79300000000
- Limite de escoamento: 290000000000
- I_z : 2.19911e-05
- I_y : 2.19911e-05
- I_p : 4.39823e-05

Valores

- Forças Verticais:
 - Valor: 9328.53, Posição: 1
 - Valor: -14000, Posição: 0.6
- Forças Horizontais:
 - Valor: 5829.11, Posição: 1
- Momentos:
- Torques:
 - Valor: 5600, Posição: 0.6
- Carregamentos:
 - Função: $3100x^1 + 0x^0$, Posição: $[0.04 - 0.4]$

Funções de Singularidade

- Carregamentos, Forças Verticais e Momentos:

$$\begin{aligned} & -9328.53 \langle x-1 \rangle^{-1} \\ & -14000 \langle x-0.6 \rangle^{-1} \\ & -3100 \langle x-0.04 \rangle^1 \\ & -3100 \langle x-0.4 \rangle^1 \\ & -1116 \langle x-0.4 \rangle^0 \end{aligned}$$

- Forças Horizontais:

$$-5829.11 \langle x-1 \rangle^{-1}$$

- Torques:

$$-5600 \langle x-0.6 \rangle^{-1}$$

Equações

Equação das forças verticais e momentos externos

$$q(x) = M \langle x-0 \rangle^{-2} + Fy \langle x-0 \rangle^{-1} + 9328.53 \langle x-1 \rangle^{-1} - 14000 \langle x-0.6 \rangle^{-1} + 3100 \langle x-0.04 \rangle^1 - 3100 \langle x-0.4 \rangle^1 - 1116 \langle x-0.4 \rangle^0$$

Equação das forças cortantes

$$V(x) = \int q(x) dx$$

$$V(x) = M \langle x-0 \rangle^{-1} + Fy \langle x-0 \rangle^0 + 9328.53 \langle x-1 \rangle^0 - 14000 \langle x-0.6 \rangle^0 + 1550 \langle x-0.04 \rangle^2 - 1550 \langle x-0.4 \rangle^2 - 1116 \langle x-0.4 \rangle^1$$

Equação dos momentos internos

$$M(x) = \int V(x) dx$$

$$M(x) = M \langle x-0 \rangle^0 + Fy \langle x-0 \rangle^1 + 9328.53 \langle x-1 \rangle^1 - 14000 \langle x-0.6 \rangle^1 + 516.667 \langle x-0.04 \rangle^3 - 516.667 \langle x-0.4 \rangle^3 - 558 \langle x-0.4 \rangle^2$$

Reações de apoio

$$V(1^+) = M \langle 1^+ - 0 \rangle^{-1} + Fy \langle 1^+ - 0 \rangle^0 + 9328.53 \langle 1^+ - 1 \rangle^0 - 14000 \langle 1^+ - 0.6 \rangle^0 + 1550 \langle 1^+ - 0.04 \rangle^2 - 1550 \langle 1^+ - 0.4 \rangle^2 - 1116 \langle 1^+ - 0.4 \rangle^1 = 0$$

$$V(1^+) = M \cdot 0 + Fy \cdot 1 - 4470.59 = 0$$

$$M(1^+) = M \langle 1^+ - 0 \rangle^0 + Fy \langle 1^+ - 0 \rangle^1 + 9328.53 \langle 1^+ - 1 \rangle^1 - 14000 \langle 1^+ - 0.6 \rangle^1 + 516.667 \langle 1^+ - 0.04 \rangle^3 - 516.667 \langle 1^+ - 0.4 \rangle^3 - 558 \langle 1^+ - 0.4 \rangle^2 = 0$$

$$M(1^+) = M \cdot 1 + Fy \cdot 1 - 5455.37 = 0$$

$$M = 984.775$$

$$Fy = 4470.59$$

Equação das forças horizontais

$$f(x) = Fx \langle x-0 \rangle^{-1} + 5829.11 \langle x-1 \rangle^{-1}$$

Equação das forças normais

$$N(x) = \int f(x) dx$$

$$N(x) = Fx \langle x-0 \rangle^0 + 5829.11 \langle x-1 \rangle^0$$

Reações de apoio

$$N(1^+) = Fx \langle 1^+ - 0 \rangle^0 + 5829.11 \langle 1^+ - 1 \rangle^0 = 0$$

$$N(1^+) = Fx \cdot 1 + 5829.11 = 0$$

$$Fx = -5829.11$$

Equação dos torques

$$t(x) = T \langle x - 0 \rangle^{-1} + -5600 \langle x - 0.6 \rangle^{-1}$$

Equação dos torques internos

$$T(x) = \int t(x) dx$$

$$T(x) = T \langle x - 0 \rangle^0 + -5600 \langle x - 0.6 \rangle^0$$

Reações de apoio

$$T(1^+) = T \langle 1^+ - 0 \rangle^0 + -5600 \langle 1^+ - 0.6 \rangle^0 = 0$$

$$T(1^+) = T \cdot 1 + -5600 = 0$$

$$T = 5600$$

0.1 Inclinação

$$\theta(x) = \frac{1}{EI} \int M(x) dx$$

$$\theta(0) = 0.00102462 \langle 0 - 1 \rangle^2 - 0.00153773 \langle 0 - 0.6 \rangle^2 + 2.83748e-05 \langle 0 - 0.04 \rangle^4 - 2.83748e-05 \langle 0 - 0.4 \rangle^4 - 4.08597e-05 \langle 0 - 0.4 \rangle^3 + 0.000216331 \langle 0 - 0 \rangle^1 + 0.00049104 \langle 0 - 0 \rangle^2 + C1 = 0$$

$$\theta(x) = 0.00102462 \langle x - 1 \rangle^2 - 0.00153773 \langle x - 0.6 \rangle^2 + 2.83748e-05 \langle x - 0.04 \rangle^4 - 2.83748e-05 \langle x - 0.4 \rangle^4 - 4.08597e-05 \langle x - 0.4 \rangle^3 + 0.000216331 \langle x - 0 \rangle^1 + 0.00049104 \langle x - 0 \rangle^2$$

0.2 Deflexão

$$v(x) = \int \theta(x) dx$$

$$v(0) = 0.000341542 \langle 0 - 1 \rangle^3 - 0.000512576 \langle 0 - 0.6 \rangle^3 + 5.67495e-06 \langle 0 - 0.04 \rangle^5 - 5.67495e-06 \langle 0 - 0.4 \rangle^5 - 1.02149e-05 \langle 0 - 0.4 \rangle^4 + 0.000108166 \langle 0 - 0 \rangle^2 + 0.00016368 \langle 0 - 0 \rangle^3 + C1 = 0$$

$$v(x) = 0.000341542 \langle x - 1 \rangle^3 - 0.000512576 \langle x - 0.6 \rangle^3 + 5.67495e-06 \langle x - 0.04 \rangle^5 - 5.67495e-06 \langle x - 0.4 \rangle^5 - 1.02149e-05 \langle x - 0.4 \rangle^4 + 0.000108166 \langle x - 0 \rangle^2 + 0.00016368 \langle x - 0 \rangle^3$$

0.3 Alongamento

$$\Delta L(x) = \frac{1}{EA} \int N(x) dx$$

$$\Delta L(0) = 3.20128e-06 \langle 0 - 1 \rangle^1 - 3.20128e-06 \langle 0 - 0 \rangle^1 + C1 = 0$$

$$\Delta L(x) = 3.20128e-06 \langle x - 1 \rangle^1 - 3.20128e-06 \langle x - 0 \rangle^1$$

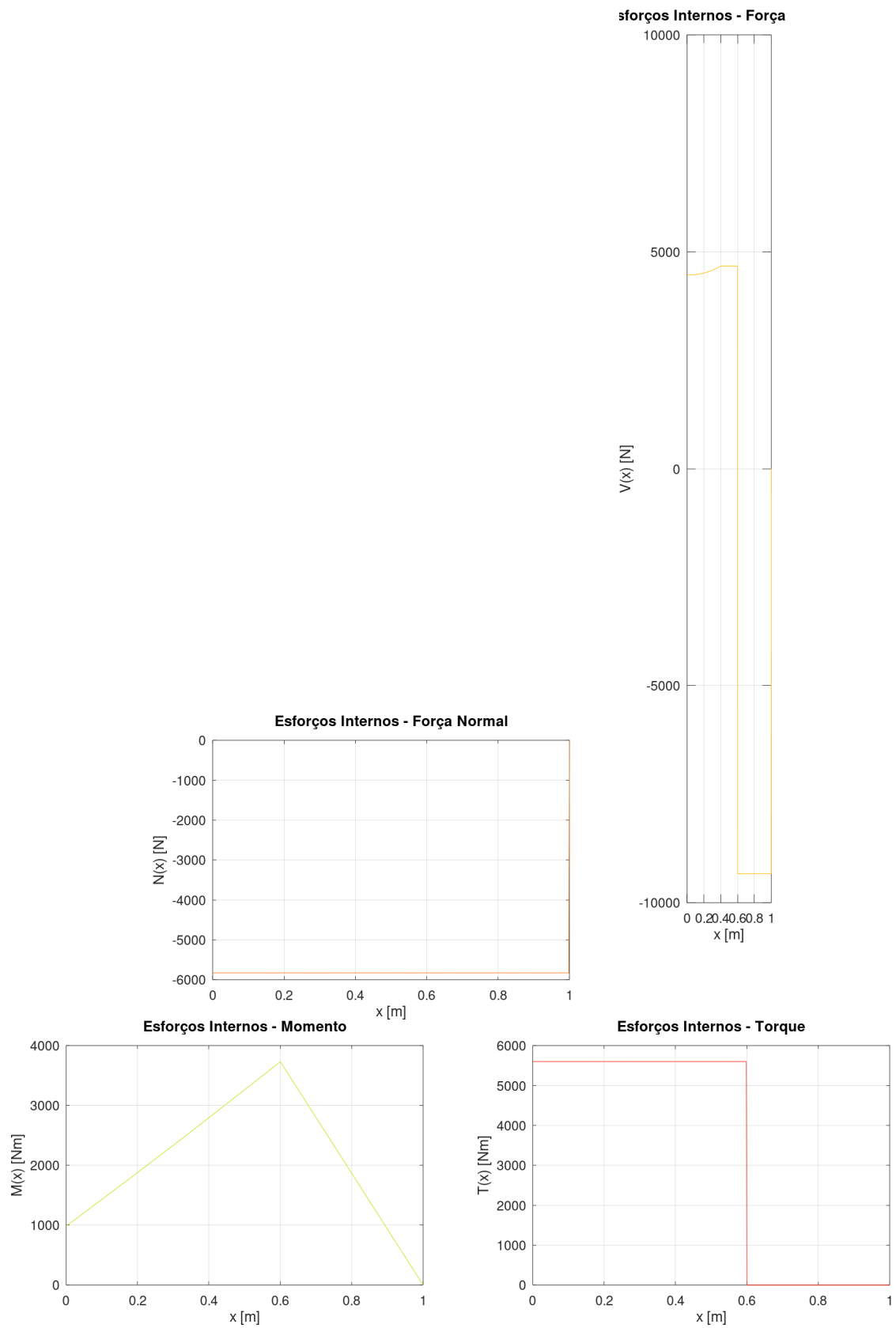
0.4 Torção

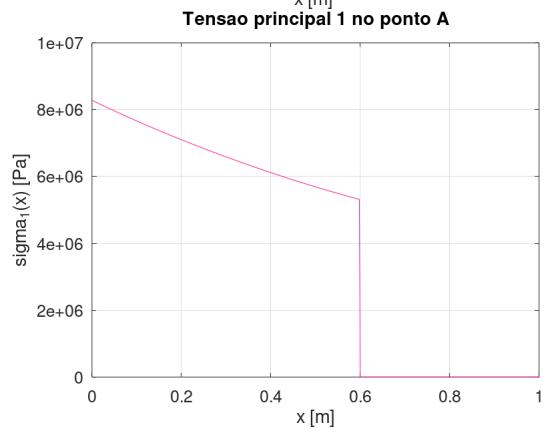
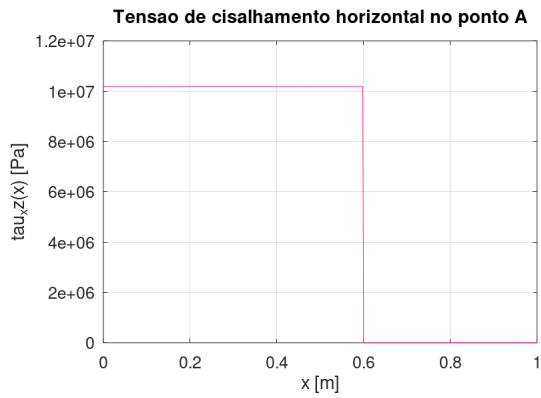
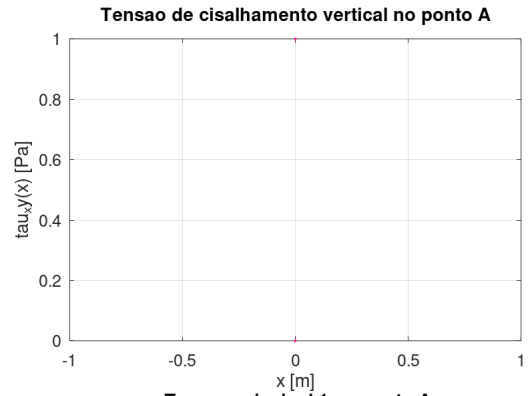
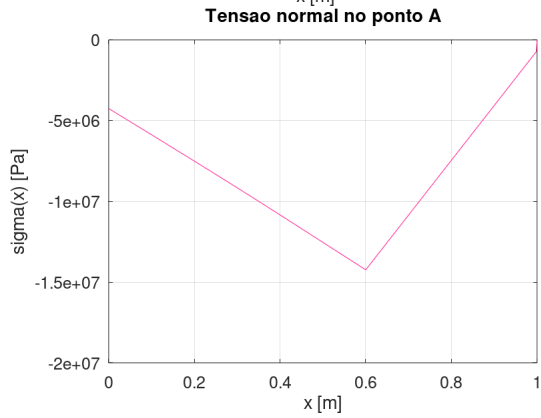
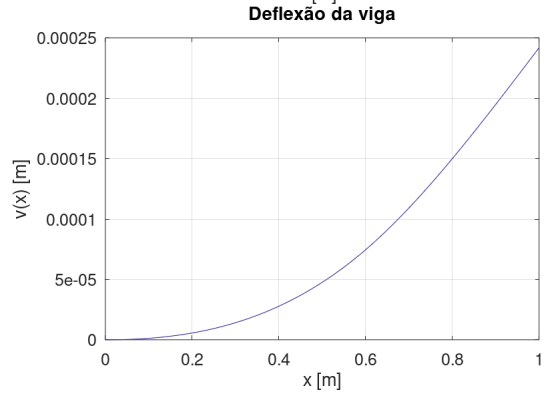
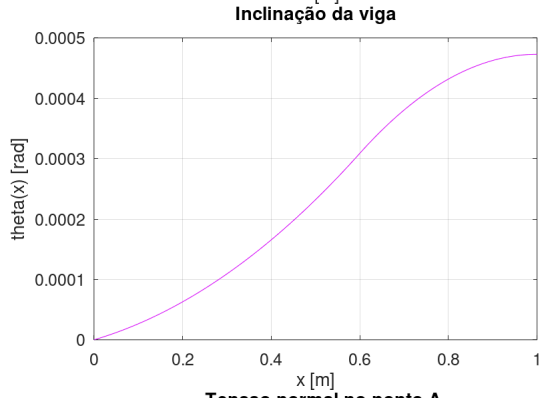
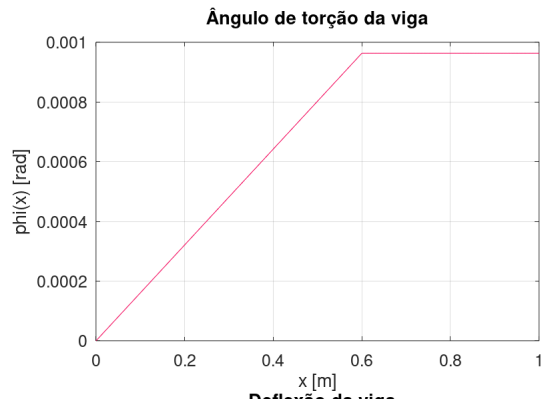
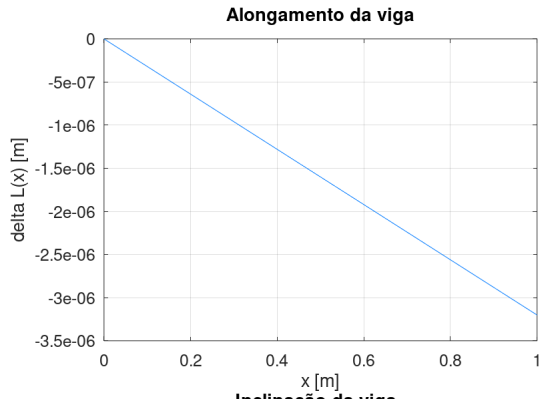
$$\phi(x) = \frac{1}{GI_p} \int M_x(x) dx$$

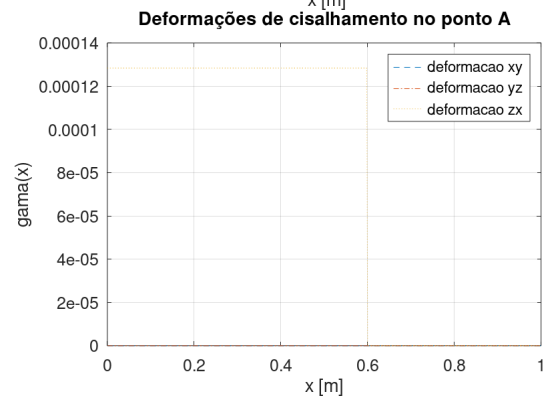
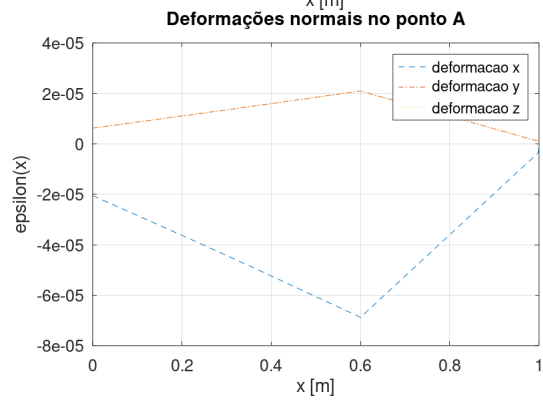
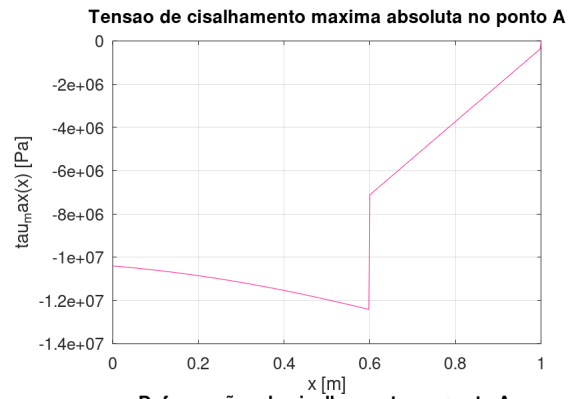
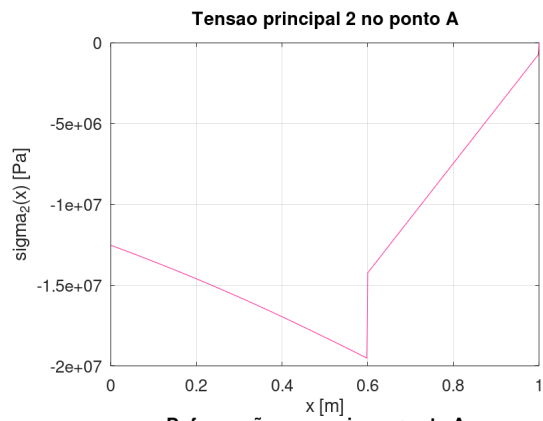
$$\phi(0) = -0.0016056 \langle 0 - 0.6 \rangle^1 + 0.0016056 \langle 0 - 0 \rangle^1 + C1 = 0$$

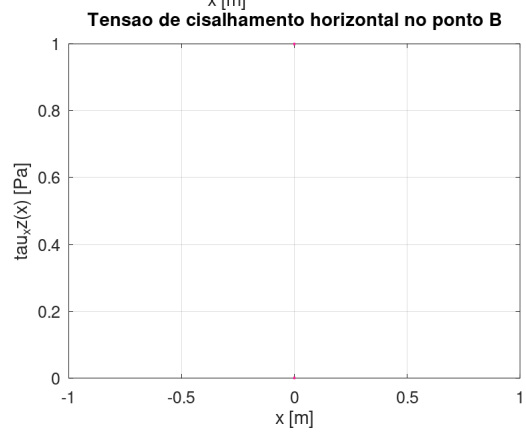
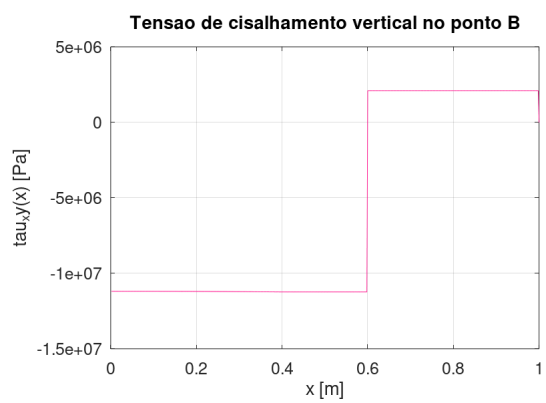
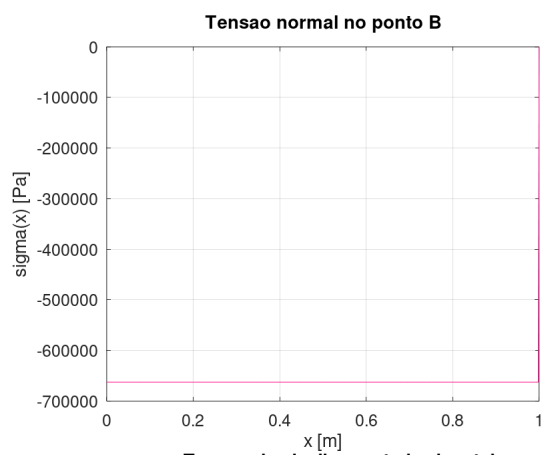
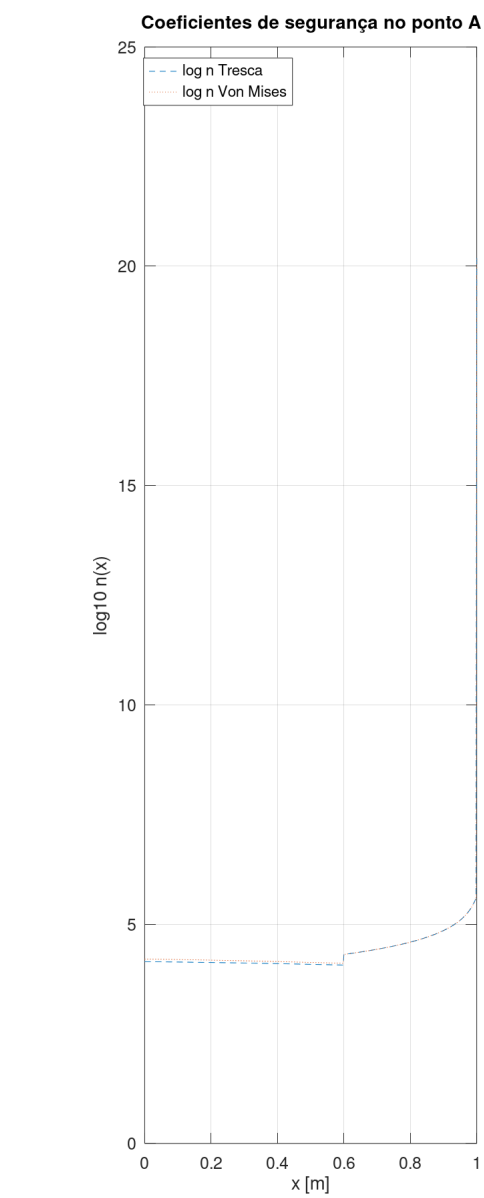
$$\phi(x) = -0.0016056 \langle x - 0.6 \rangle^1 + 0.0016056 \langle x - 0 \rangle^1$$

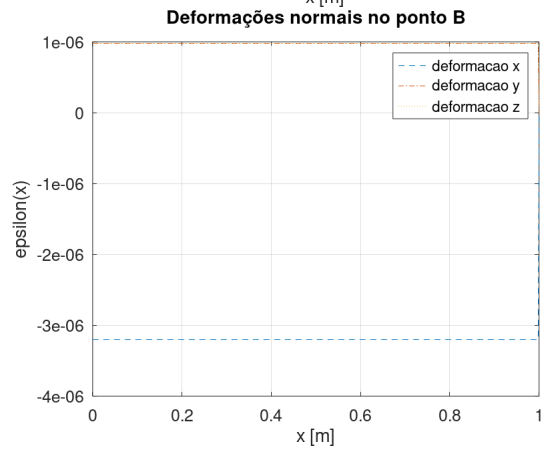
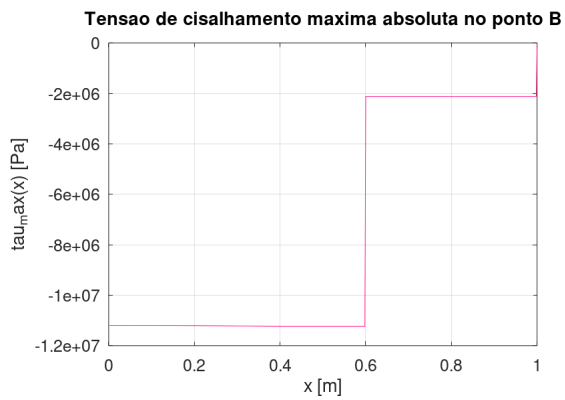
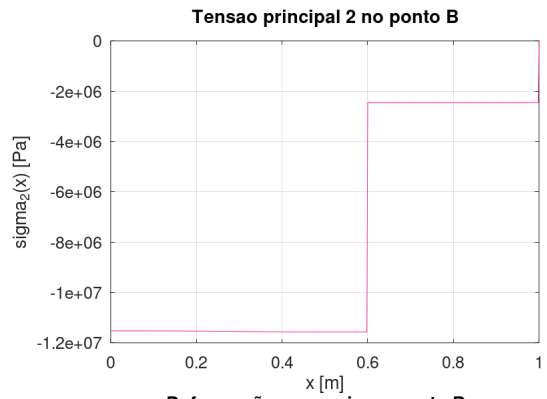
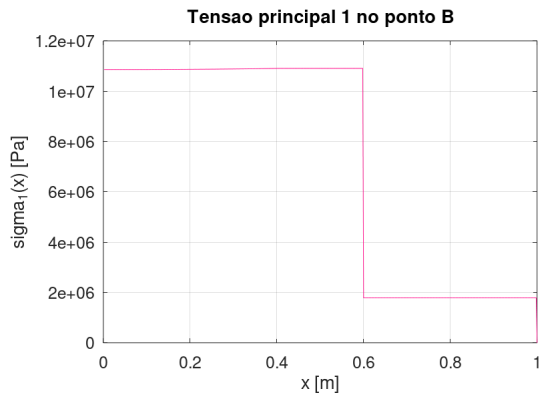
Gráficos











Deformações de cisalhamento no ponto B Coeficientes de segurança no ponto

