

## Tema 2 - Ejercicio 1:

$$P := 8 \text{ kN}$$

$$L := 4 \text{ m}$$

$$CS := 1.6$$

$$\sigma_{fl} := 240 \text{ MPa}$$

$$E := 210 \text{ GPa}$$

$$e := 1.27 \text{ cm}$$

Perfil IPN 160

$$J_{yIPN} := 935 \text{ cm}^4$$

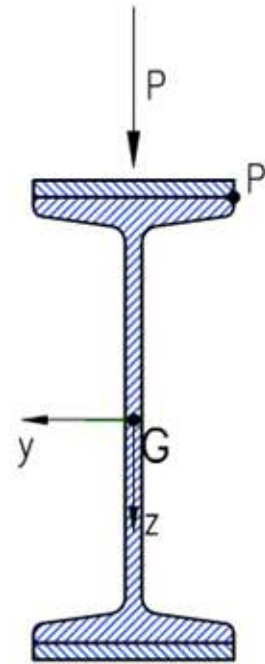
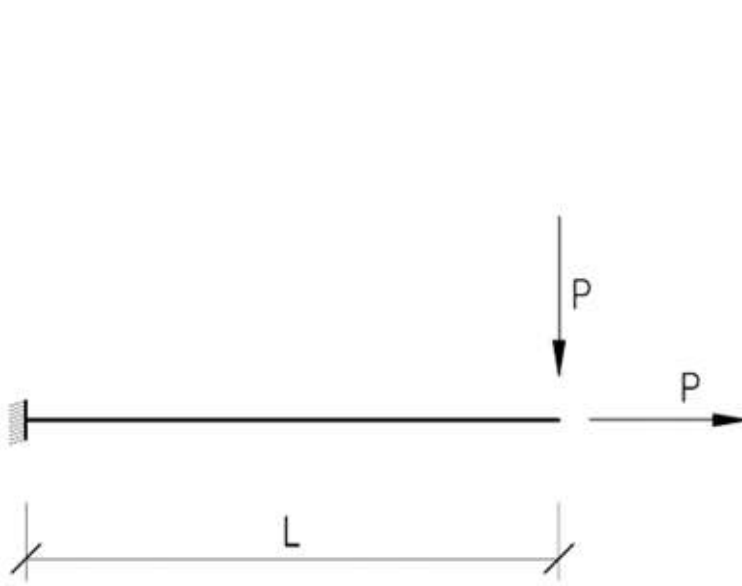
$$h_{IPN} := 16 \text{ cm}$$

$$b_{IPN} := 7.4 \text{ cm}$$

$$J_{zIPN} := 54.7 \text{ cm}^4$$

$$A_{IPN} := 22.8 \text{ cm}^2$$

$$\sigma_{adm} := \frac{240 \text{ MPa}}{CS} = 150 \text{ MPa}$$



$$M_y := -P \cdot L - P \cdot \frac{h_{IPN}}{2} = -32.64 \text{ kN m}$$

$$M_z := P \cdot b_{IPN} = 0.592 \text{ kN m} \quad N := P = 8 \text{ kN}$$

$$J_y := J_{yIPN} + 2 \cdot \left( \frac{b_{IPN} \cdot e^3}{12} + b_{IPN} \cdot e \cdot \left( \frac{h_{IPN} + e}{2} \right)^2 \right) = 2339.0167 \text{ cm}^4$$

$$J_z := J_{zIPN} + 2 \cdot \frac{e \cdot b_{IPN}^3}{12} = 140.4724 \text{ cm}^4 \quad A_T := A_{IPN} + 2 \cdot b_{IPN} \cdot e = 41.596 \text{ cm}^2$$

Las tensiones en cualquier punto:

$$\sigma(yz) = \frac{N}{A} + \frac{M_y \cdot z}{J_y} - \frac{M_z \cdot y}{J_z}$$

Punto más solicitado.

$$z_A := -\frac{h_{IPN}}{2} - e = -9.27 \text{ cm} \quad y_A := -\frac{b_{IPN}}{2} = -3.7 \text{ cm}$$

$$\sigma_A := \frac{N}{A_T} + \frac{M_y \cdot z_A}{J_y} - \frac{M_z \cdot y_A}{J_z} = 146.8753 \text{ MPa}$$

Linea Neutra:

$$0 = \frac{N}{A} + \frac{M_y \cdot z}{J_y} - \frac{M_z \cdot y}{J_z}$$

$$\text{Si } y := 0 \quad y_{LN} := -\frac{N \cdot J_y}{A_T \cdot M_y} = 0.1378 \text{ cm}$$

$$\text{Si } z := 0 \quad y_{LN} := \frac{N \cdot J_z}{A_T \cdot M_z} = 0.4564 \text{ cm}$$

$$z_{CP} := \frac{M_y}{N} = -408 \text{ cm} \quad y_{CP} := -\frac{M_z}{N} = -7.4 \text{ cm}$$

$$\sigma_{max} := \sigma_A = 146.8753 \text{ MPa}$$

$$z_B := \frac{h_{IPN}}{2} + e = 9.27 \text{ cm} \quad y_B := \frac{b_{IPN}}{2} = 3.7 \text{ cm}$$

$$\sigma_B := \frac{N}{A_T} + \frac{M_y \cdot z_B}{J_y} - \frac{M_z \cdot y_B}{J_z} = -143.0288 \text{ MPa}$$

Si solo tengo el perfil:

$$\sigma_A := \frac{N}{A_{IPN}} + \frac{M_y \cdot \frac{-h_{IPN}}{2}}{J_{yIPN}} - \frac{M_z \cdot \frac{-b_{IPN}}{2}}{J_{zIPN}} = 322.8254 \text{ MPa}$$

Para calcular la longitud de las platabandas

$$\sigma_{adm} = \frac{N}{A_{IPN}} + \frac{\left( -P \cdot \left( L - l_{min} \right) - P \cdot \frac{h_{IPN}}{2} \right) \cdot \frac{-h_{IPN}}{2}}{J_{yIPN}} - \frac{P \cdot b_{IPN} \cdot \frac{-b_{IPN}}{2}}{J_{zIPN}}$$

$$-P \cdot \left( L - l_{min} \right) - P \cdot \frac{h_{IPN}}{2} = \left( \sigma_{adm} - \frac{N}{A_{IPN}} + \frac{P \cdot b_{IPN} \cdot \frac{-b_{IPN}}{2}}{J_{zIPN}} \right) \cdot \frac{J_{yIPN}}{\left( -\frac{h_{IPN}}{2} \right)}$$

$$l_{min} := \left[ \left( \sigma_{adm} - \frac{N}{A_{IPN}} + \frac{P \cdot b_{IPN} \cdot \frac{-b_{IPN}}{2}}{J_{zIPN}} \right) \cdot \frac{J_{yIPN}}{\left( -\frac{h_{IPN}}{2} \right)} + P \cdot \frac{h_{IPN}}{2} \right] \cdot \frac{1}{P} + L = 2.5249 \text{ m}$$

$$\text{Comprobación:} \quad M_1 := -P \cdot \left( L - l_{min} \right) - P \cdot \frac{h_{IPN}}{2} = -12.441 \text{ kN m}$$

$$\sigma_A := \frac{N}{A_{IPN}} + \frac{M_1 \cdot \frac{-h_{IPN}}{2}}{J_{yIPN}} - \frac{M_z \cdot \frac{-b_{IPN}}{2}}{J_{zIPN}} = 150 \text{ MPa}$$

$$\sigma_B := \frac{N}{A_{IPN}} + \frac{M_1 \cdot \frac{h_{IPN}}{2}}{J_{yIPN}} - \frac{M_z \cdot \frac{b_{IPN}}{2}}{J_{zIPN}} = -142.9825 \text{ MPa}$$