

Tema 2 - Ejercicio 1:

$$P := 16 \text{ kN}$$

$$L := 5 \text{ m}$$

$$CS := 1,6$$

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

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

$$e := 2,54 \text{ cm}$$

Perfil IPN 200

$$J_{yIPN} := 2140 \text{ cm}^4$$

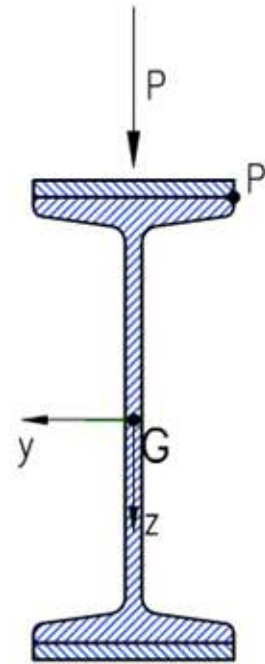
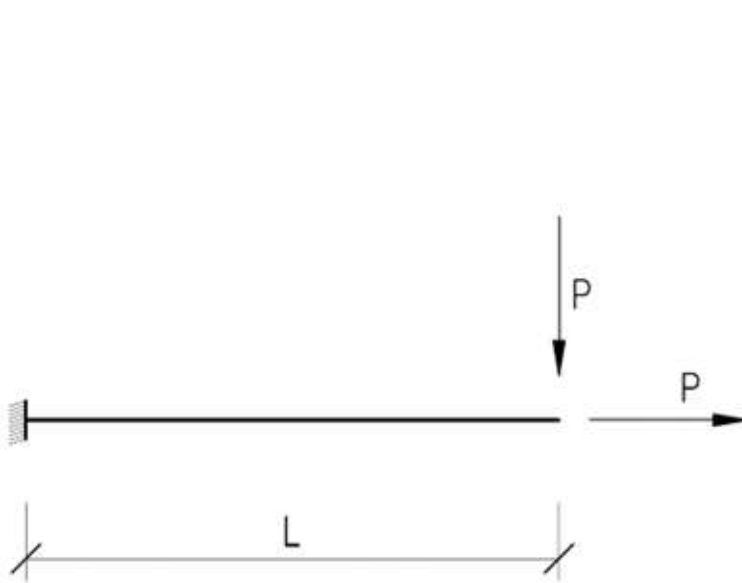
$$h_{IPN} := 20 \text{ cm}$$

$$b_{IPN} := 9 \text{ cm}$$

$$J_{zIPN} := 117 \text{ cm}^4$$

$$A_{IPN} := 33,4 \text{ cm}^2$$

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



$$M_y := -P \cdot L - P \cdot \frac{h_{IPN}}{2} = -81,6 \text{ kN m}$$

$$M_z := P \cdot \frac{b_{IPN}}{2} = 0,72 \text{ kN m}$$

$$N := P = 16 \text{ kN}$$

$$J_y := J_{yIPN} + 2 \cdot \left(\frac{b_{IPN} \cdot e^3}{12} + b_{IPN} \cdot e \cdot \left(\frac{h_{IPN} + e}{2} \right)^2 \right) = 7971,6104 \text{ cm}^4$$

$$J_z := J_{zIPN} + 2 \cdot \frac{e \cdot b_{IPN}^3}{12} = 425,61 \text{ cm}^4$$

$$A_T := A_{IPN} + 2 \cdot b_{IPN} \cdot e = 79,12 \text{ cm}^2$$

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.

$$z_A := -\frac{h_{IPN}}{2} - e = -12,54 \text{ cm} \quad y_A := -\frac{b_{IPN}}{2} = -4,5 \text{ cm}$$

$$\sigma_A := \frac{N}{A_T} + \frac{M_Y \cdot z_A}{J_Y} - \frac{M_Z \cdot y_A}{J_Z} = 137,9984 \text{ MPa}$$

Linea Neutra:

$$0 = \frac{N}{A} + \frac{M_Y \cdot z}{J_Y} - \frac{M_Z \cdot y}{J_Z}$$

Si $y := 0$ $y_{LN} := -\frac{N \cdot J_Y}{A_T \cdot M_Y} = 0,1976 \text{ cm}$

Si $z := 0$ $y_{LN} := \frac{N \cdot J_Z}{A_T \cdot M_Z} = 1,1954 \text{ cm}$

$$z_{CP} := \frac{M_Y}{N} = -510 \text{ cm} \quad y_{CP} := -\frac{M_Z}{N} = -4,5 \text{ cm}$$

$$\sigma_{max} := \sigma_A = 137,9984 \text{ MPa}$$

$$z_B := \frac{h_{IPN}}{2} + e = 12,54 \text{ cm} \quad y_B := \frac{b_{IPN}}{2} = 4,5 \text{ cm}$$

$$\sigma_B := \frac{N}{A_T} + \frac{M_Y \cdot z_B}{J_Y} - \frac{M_Z \cdot y_B}{J_Z} = -133,9539 \text{ MPa}$$

Si solo tengo el perfil:

$$\sigma_A := \frac{N}{A_{IPN}} + \frac{M_Y \cdot \frac{-h_{IPN}}{2}}{J_{YIPN}} - \frac{M_Z \cdot \frac{-b_{IPN}}{2}}{J_{ZIPN}} = 413,7911 \text{ MPa}$$

Para calcular la longitud de las platabandas

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

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

$$l_{min} := \left[\left(\sigma_{adm} - \frac{N}{A_{IPN}} + \frac{P \cdot b_{IPN} \cdot \frac{-b_{IPN}}{2}}{J_{ZIPN}} \right) \cdot \frac{J_{YIPN}}{\left(-\frac{h_{IPN}}{2} \right)} + P \cdot \frac{h_{IPN}}{2} \right] \cdot \frac{1}{P} + L = 3,8986 \text{ m}$$

Comprobación: $M_1 := -P \cdot \left(L - l_{min} \right) - P \cdot \frac{h_{IPN}}{2} = -19,2225 \text{ kN m}$

$$\sigma_A := \frac{N}{A_{IPN}} + \frac{M_1 \cdot \frac{-h_{IPN}}{2}}{J_{yIPN}} - \frac{M_z \cdot \frac{-b_{IPN}}{2}}{J_{zIPN}} = 122,3077 \text{ MPa}$$

$$\sigma_B := \frac{N}{A_{IPN}} + \frac{M_1 \cdot \frac{h_{IPN}}{2}}{J_{yIPN}} - \frac{M_z \cdot \frac{b_{IPN}}{2}}{J_{zIPN}} = -112,7269 \text{ MPa}$$