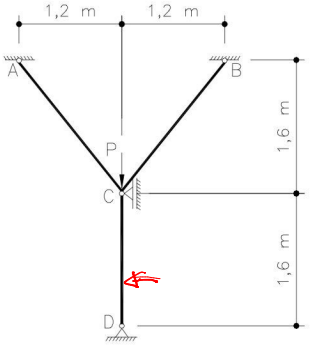
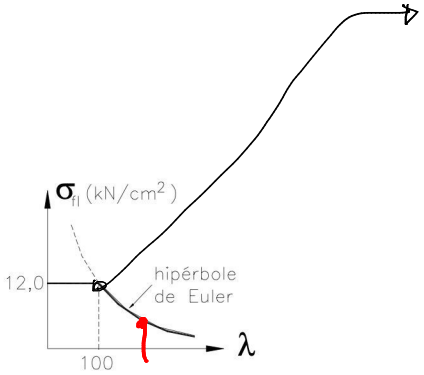
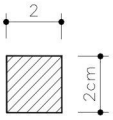
**3)** Determinar a carga máxima para a estrutura abaixo.
Dado

$\sigma_{tmáx} = 12\ kN/cm^2$.




Seção transversal das barras




Módulo de Elasticidade

$\sigma_{cr} = \frac{\pi^2 E}{\lambda^2}$

$\frac{12\ kN}{cm^2} = \frac{\pi^2 \cdot E}{100^2}$

$E = \frac{12 \cdot 100^2}{\pi^2} = 12158{,}54\ \frac{kN}{cm^2}$

Barra comprimida = CD

1- Verificar tensão máxima para CD:

momento de Inércia:

$I = \frac{2 \cdot 2^3}{12} = 1{,}333\ cm^4$

Área:

$A = (2\ cm)^2 = 4\ cm^2$

Raio de Giração:

$r = \sqrt{\frac{I}{A}} = \sqrt{\frac{1{,}333}{4}} = 0{,}5774\ cm$

Índice de Esbeltez:

$\lambda = \frac{L_e}{r} = \frac{K \cdot L}{r} = \frac{1 \cdot 160\ cm}{0{,}5774} = 277{,}13$ → Fórmula de Euler!

Carga crítica para CD:

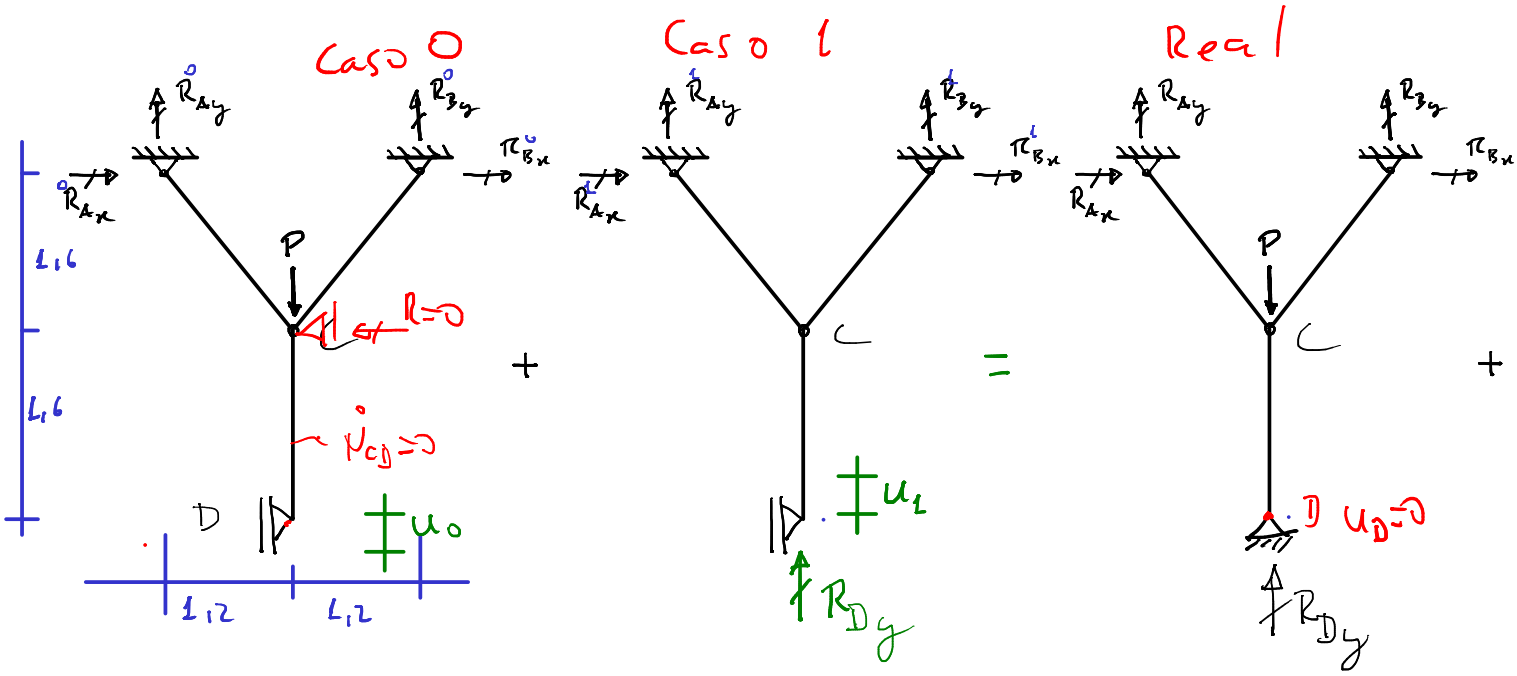
$P_{cr} = \frac{\pi^2 \cdot EI}{L_e^2} = \frac{\pi^2 \cdot 12158{,}54 \cdot 1{,}333}{160^2} = 6{,}25\ kN$

$N_{CD}(comp)_{máx} = -P_{cr}$

$N_{CD}(comp)_{máx} = -6{,}25\ kN$

# $N_{CD}$ em função de P:

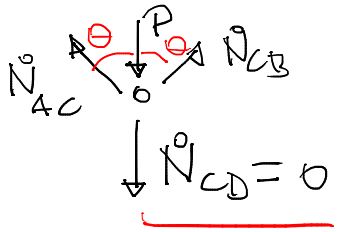
→ Superposição de Efeitos:




CASO 0:

Equilíbrio do nó C:

$\theta = ?$ $\quad arctg(\theta) = \frac{1,2}{1,6} \quad \theta = 36,87°$




$$\sum F_x = 0$$

$$-N_{AC} \cdot Sen(\theta) + N_{CB} \cdot Sen(\theta) = 0$$

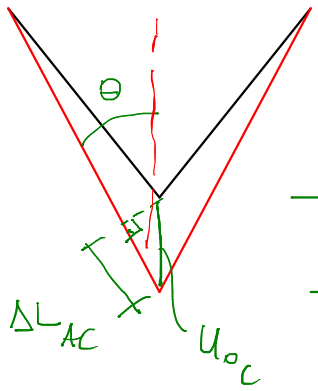
$$N_{AC} = N_{CB}$$

$$\sum F_y = 0: \quad N_{AC} \cdot Cos(\theta) + N_{CB} \cdot Cos(\theta) - P = 0$$

$$N_{CB} = N_{AC} = \frac{P}{2\,Cos(\theta)} = 0,625P$$

$$u_{0_D} = u_{0_C} + \Delta L_{CD} = u_{0_C}$$

$$u_{0_D} = u_{0_C} = \frac{N_{AC}^{0} \cdot L_{AC}}{EA \cdot \cos(\theta)}$$




$$u_{0_C} = \frac{\Delta L_{AC}}{\cos(\theta)} = \frac{\Delta L_{CB}}{\cos(\theta)}$$

$$L_{AC} = \sqrt{1{,}6^2 + 1{,}2^2} = 2\ m = 200\ cm$$

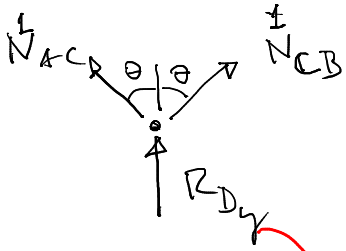
$$A = 4\ cm^2$$

$$u_{0D} = \frac{0{,}625\ P \cdot 200}{12158{,}54 \cdot \cos(36{,}87)} = 0{,}00321\ P$$

CASO 1:

$$N_{CD} = -R_{D_y}$$

Nó C:




$$\Sigma F_x = 0:$$

$$N_{AC}^{1} = N_{CB}^{1}$$

$$\Sigma F_y = 0:$$

$$N_{AC}^{1} \cdot \cos(\theta) + N_{BC}^{1} \cdot \cos(\theta) + R_{D_y} = 0$$

$$N_{AC}^{1} = N_{CB}^{1} = -\frac{R_{D_y}}{2\cos(\theta)} = -0{,}625\ R_{D_y}$$

$$u_D = u_C + \Delta L_{CD} = \frac{\Delta L_{AC}}{\cos\theta} + \Delta L_{CD} = \frac{N_{CD}^{1} \cdot L_{CD}}{EA} + \frac{N_{AC}^{1} \cdot L_{AC}}{EA \cdot \cos(\theta)}$$

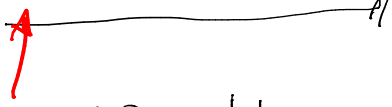
$$u_D^{1} = -0{,}00065\ R_{D_y}$$

$$u_D = 0 = u_D^{0} + u_D^{1}$$

$$0 = 0{,}00321P - 0{,}0065 R_{Dy}$$

$$\boxed{R_{Dy} = 0{,}494\,P}$$

Logo: $N_{CD} = -0{,}494P$



Como $N_{CD\,máx} = -6{,}25\,kN$:

$$-6{,}25\,kN = -0{,}494\,P$$

$$P = \frac{-6{,}25}{-0{,}494} = 12{,}65$$