

**Ejercicio 1**

1)  $x/d = 0,47 \rightarrow$  dominio 3

2)

a)  $x/d = -0,67 \rightarrow$  dominio 1

b)  $x/d = 0,16 \rightarrow$  dominio 2

c)  $x/d = 0,65 \rightarrow$  dominio 4

d)  $x/d = 1,51 \rightarrow$  dominio 5

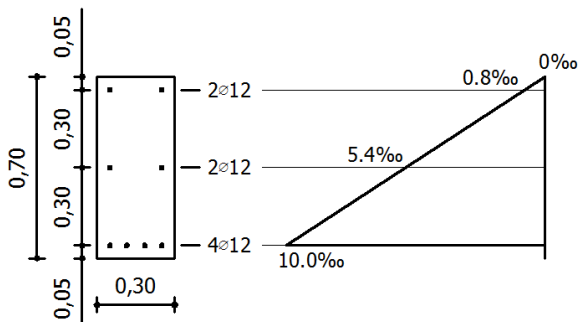
3)

a)  $x/d = 0,259 \rightarrow$  límite entre dominio 2 y dominio 3

b)  $x/d = 0,41 \rightarrow$  dominio 3

4)  $x/d = 0,30 \rightarrow$  dominio 3

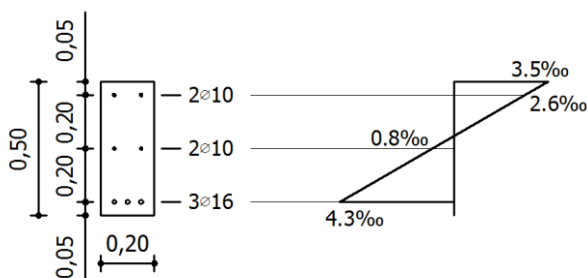
**Ejercicio 2**



Curvatura:  $1/r = 15,38 \text{ km}^{-1}$

$N_u = 329,8 \text{ kN}$   
 $e = -0,147 \text{ m}$  ( $M_u = 48,6 \text{ kNm}$ ).

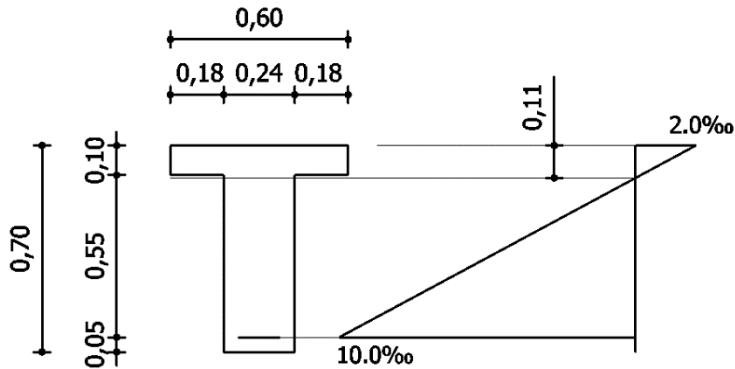
**Ejercicio 3**



Curvatura:  $1/r = 17,28 \text{ km}^{-1}$

$N_u = -351,3 \text{ kN}$   
 $e = 0,418 \text{ m}$  ( $M_u = 146,8 \text{ kNm}$ ).

**Ejercicio 4**

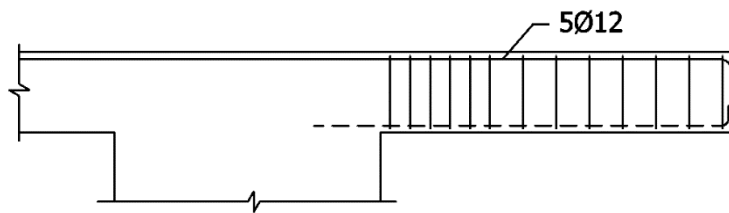


$$N_u = -26,3 \text{ kN},$$

$$e = 19,92 \text{ m} (M_u = 524,0 \text{ kNm}).$$

**Ejercicio 5**

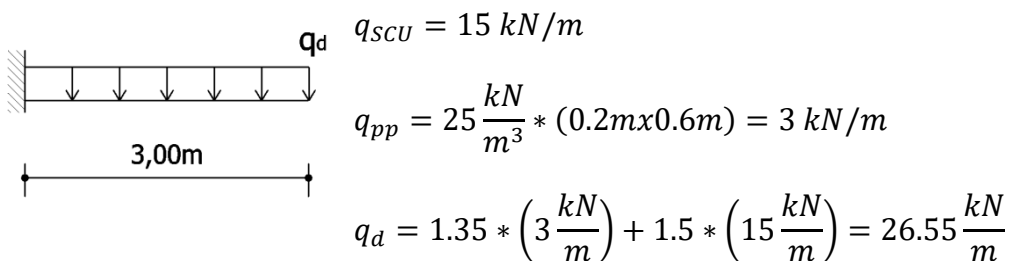
Armadura de la pieza:



Obtengo luz de cálculo de ménsula :

$$L_{cal} = 2.70m + \min\left(\frac{2.0}{2}; \frac{0.6}{2}\right) = 3.0 \text{ m}$$

Obtengo carga de diseño :



Cálculo :

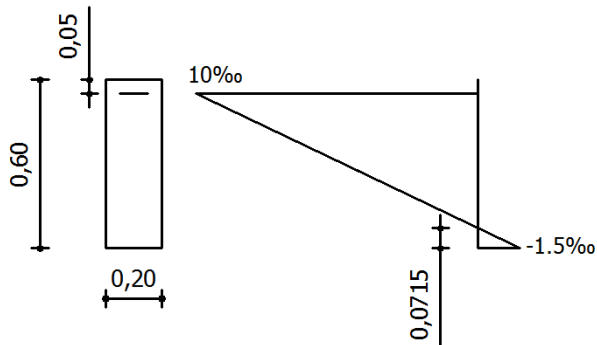
$$M_d = q_d * \frac{L_{calc}^2}{2} = 119.5 \text{ kNm}$$

$$\mu = \frac{M_u}{bd^2 f_{cd}} = \frac{119.5 \text{ kNm}}{0.2 \text{ m} * (0.6 - 0.05) \text{ m}^2 * (30 \text{ MPa} / 1.5)} = 0.0988$$

$$\omega = 1 - \sqrt{1 - 2\mu} = 0.1042$$

$$A_{s1} = \omega b d f_{cd} / f_{yd} = 0.1042 * 0.2 \text{ m} * 0.55 \text{ m} * \frac{30 \text{ MPa}}{1.5} / \left( \frac{500}{1.15} \text{ MPa} \right) = 5.27 \text{ cm}^2 \rightarrow 5\phi 12$$

Diagrama de deformaciones límite :



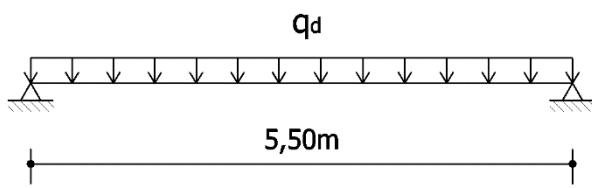
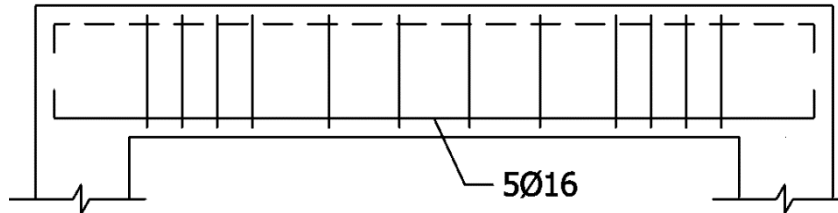
$$\xi = \frac{\omega}{0.8} = 0.13 = \frac{x}{d} \rightarrow x = 0.0715 \rightarrow \text{Dominio 2}$$

$$\varepsilon_{s1} = 10\text{‰}$$

Equivalencia de triángulos:

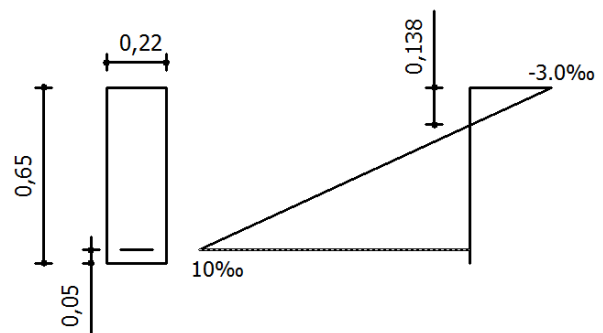
$$\frac{\varepsilon_{s1}}{d-x} = \frac{\varepsilon_c}{x} \rightarrow \varepsilon_c = 1.5\text{‰}$$

**Ejercicio 6**

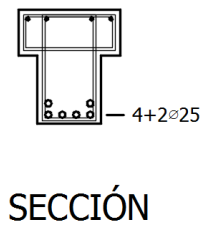
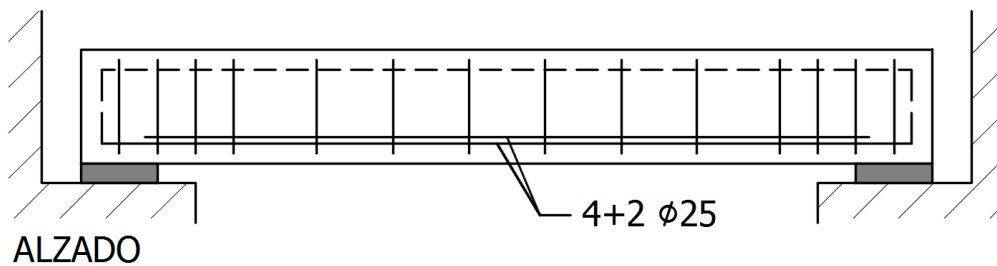


$$q_d = 58,5 \text{ kN/m} \rightarrow M_d = 221,2 \text{ kNm}$$

$$A_{s,nec} = 9,34 \text{ cm}^2 \rightarrow 3\text{Ø}20$$



**Ejercicio 7**



$$h_1 = x = 18,0 \text{ cm}$$

$$A_{s,nec} = 26,5 \text{ cm}^2 \rightarrow (4 + 2)\text{Ø}25$$

$$\text{Curvatura: } 1/r = 19,44 \text{ km}^{-1}$$

