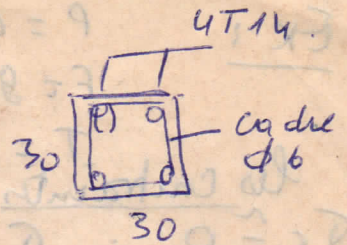


Ex1: $N_u = 0,15 \text{ MN}$, section $B = 30 \times 30 \text{ cm}$

$f_{t28} = 25 \text{ MPa}$, $f_e \in 400$

fixation peu nuisible.

$$A_u = \frac{N_u}{\sigma_{st}} = \frac{N_u}{f_{t28}} = \frac{0,15 \times 1,1}{400} = 0,00043 \text{ m}^2 = 4,3 \text{ cm}^2$$



$$f_{t28} = 2,1 \text{ MPa} \quad (f_{t28} = 25 \text{ MPa})$$

$$A_{\min} = \frac{B f_{t28}}{400} = 4,73 \text{ cm}^2 \rightarrow A = \max(A_u, A_{\min}) = 4,73 \text{ cm}^2$$

$$\text{soit } 4 \text{ HA } 14 = 6,16 \text{ cm}^2$$

Ex2: $B = 15 \times 20$, $l = 30 \text{ m}$. $N_G = 0,2 \text{ MN}$ et $N_Q = 0,15 \text{ MN}$

Caractéristiques des matériaux avec fissuration préjudiciable.

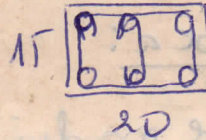
1) section d'acier:

$$\text{ELU: } N_u = 1,35 N_G + 1,5 N_Q = 0,495 \text{ MN} \rightarrow A_u = \frac{0,495}{348} = 14,22 \text{ cm}^2$$

$$\text{ELS: } N_{ser} = N_G + N_Q = 0,35 \text{ MN}, \quad \sigma_{st} = \min\left(\frac{2}{3} f_e, 150\right) = 240 \text{ MPa}$$

$$A_{su} = \frac{0,35}{240} = 14,58 \text{ cm}^2$$

$$A_{\min} = \frac{B f_{t28}}{f_e} = 1,58 \text{ cm}^2, \quad A_s = A_{ser} = 14,58 \text{ cm}^2 \text{ soit } 4 \text{ T } 20 + 2 \text{ T } 12 = 14,83 \text{ cm}^2$$



$$2) \quad \epsilon = \frac{\sigma}{E} = \frac{240}{2105} = 1,2\%, \quad \text{et } \epsilon = \frac{\Delta L}{L} \Rightarrow \Delta L = \epsilon L = 0,036 \text{ m} = 3,6 \text{ cm}$$

Ex3: section (20×20) , $l = 19,60 \text{ m}$

a) aire des armatures: $N_{ser} = 1,35 \times 0,2 \times 0,2 \times 19,6 (25) = 19,6 \text{ kN} = 1960 \text{ daN}$

$$A_{ser} = \frac{19,6}{\sigma_{st}} \quad \text{et} \quad \sigma_{st} = \min\left(\frac{1}{2} f_e, 110\right) = 176 \text{ MPa}$$

$$A_{su} = \frac{19,6 \cdot 10^{-3}}{176} = 1,14 \text{ cm}^2$$

$$A_{st} \geq 2,1 \text{ cm}^2 \text{ soit } 4 \text{ HA } 10 = 3,14 \text{ cm}^2$$

$$A_{\min} = \frac{B f_{t28}}{f_e} = 2,1 \text{ cm}^2$$

$$\epsilon = \frac{\sigma}{E} = \frac{176}{2105} = 0,88\%, \quad \rightarrow \Delta l = \epsilon l = 1,7 \text{ cm}$$