

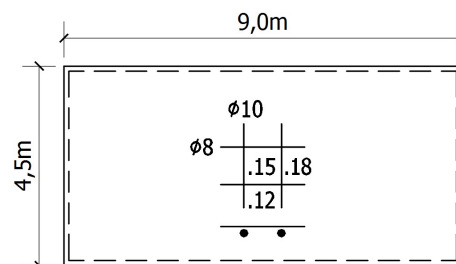
Ejercicio 1

a)

$$M_{d,y}^+ = 31,80 \text{ kNm/m} \rightarrow A_{s,nec} = 6,26 \text{ cm}^2/\text{m} \rightarrow \phi 10/12$$

$$M_{d,x}^+ = 7,95 \text{ kNm/m} \rightarrow A_{s,nec} = 1,62 \text{ cm}^2/\text{m}$$

$$A_{s,nec} = 2,70 \text{ cm}^2/\text{m} \text{ (cuantía geométrica)} \rightarrow \phi 8/18$$

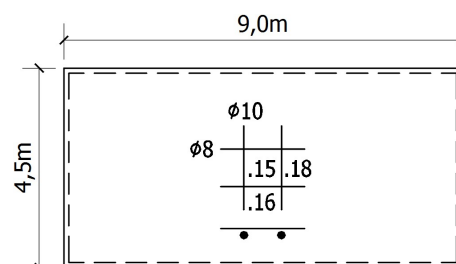


b)

$$M_{d,y}^+ = 25,18 \text{ kNm/m} \rightarrow A_{s,nec} = 4,88 \text{ cm}^2/\text{m} \rightarrow \phi 10/16$$

$$M_{d,x}^+ = 8,14 \text{ kNm/m} \rightarrow A_{s,nec} = 1,66 \text{ cm}^2/\text{m}$$

$$A_{s,nec} = 2,70 \text{ cm}^2/\text{m} \text{ (cuantía geométrica)} \rightarrow \phi 8/18$$



Ejercicio 2

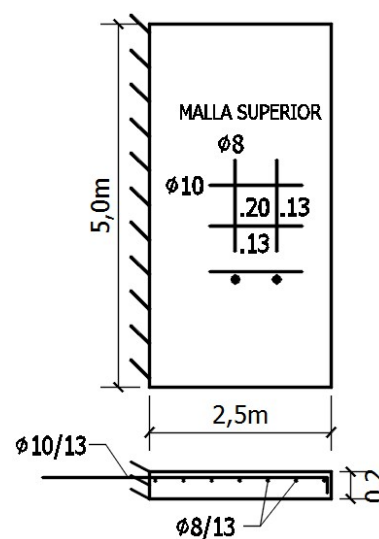
i.

$$M_{d,y}^- = 39,84 \text{ kNm/m} \rightarrow A_{s,nec} = 5,77 \text{ cm}^2/\text{m} \rightarrow \phi 10/13$$

$$M_{d,x}^- = 9,96 \text{ kNm/m} \rightarrow A_{s,nec} = 1,49 \text{ cm}^2/\text{m}$$

$$A_{s,nec} = 3,60 \text{ cm}^2/\text{m} \text{ (cuantía geométrica)} \rightarrow \phi 8/13$$

$$V_d = 31,9 \text{ kN/m} < V_{Rd,c} = 89,47 \text{ kN/m} \text{ (verifica)}$$



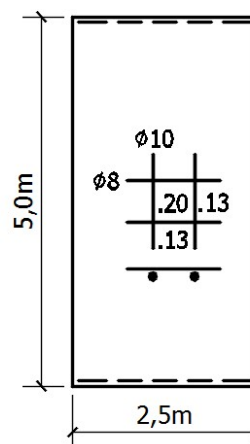
ii.

$$M_{d,x}^+ = 39,84 \text{ kNm/m} \rightarrow A_{s,nec} = 5,77 \text{ cm}^2/\text{m} \rightarrow \phi 10/13$$

$$M_{d,y}^+ = 9,96 \text{ kNm/m} \rightarrow A_{s,nec} = 1,49 \text{ cm}^2/\text{m}$$

$$A_{s,nec} = 3,60 \text{ cm}^2/\text{m} \text{ (cuantía geométrica)} \rightarrow \phi 8/13$$

$$V_d = 31,9 \text{ kN/m} < V_{Rd,c} = 89,47 \text{ kN/m} \text{ (verifica)}$$



Ejercicio 3

i.

$$M_{d,y}^- = 15,69 \text{ kNm/m} \rightarrow A_{s,nec} = 3,22 \text{ cm}^2/\text{m} \rightarrow \phi 8/15$$

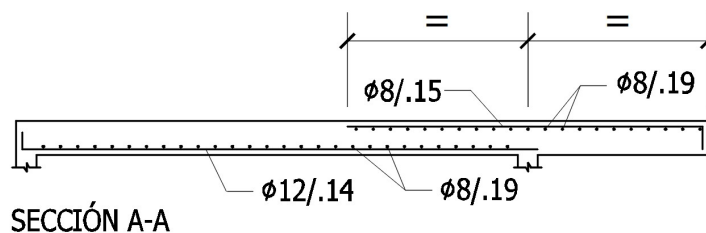
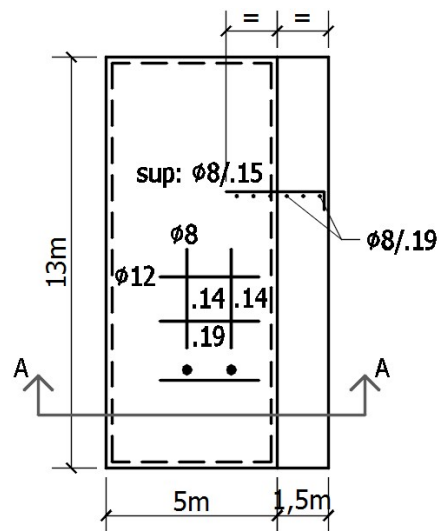
$$M_{d,x}^- = 3,92 \text{ kNm/m} \rightarrow A_{s,nec} = 0,87 \text{ cm}^2/\text{m}$$

$$A_{s,nec} = 2,52 \text{ cm}^2/\text{m} \text{ (cuantía geométrica)} \rightarrow \phi 8/19$$

$$M_{d,y}^+ = 36,10 \text{ kNm/m} \rightarrow A_{s,nec} = 7,78 \text{ cm}^2/\text{m} \rightarrow \phi 12/14$$

$$M_{d,x}^+ = 9,02 \text{ kNm/m} \rightarrow A_{s,nec} = 2,03 \text{ cm}^2/\text{m}$$

$$A_{s,nec} = 2,52 \text{ cm}^2/\text{m} \text{ (cuantía geométrica)} \rightarrow \phi 8/19$$



ii.

$$M_{d,y}^- = 15,69 \text{ kNm/m} \rightarrow A_{s,nec} = 3,22 \text{ cm}^2/\text{m} \rightarrow \phi 8/15$$

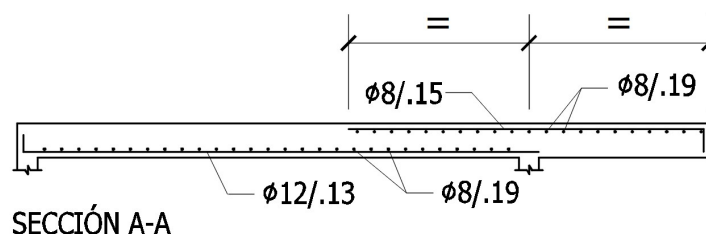
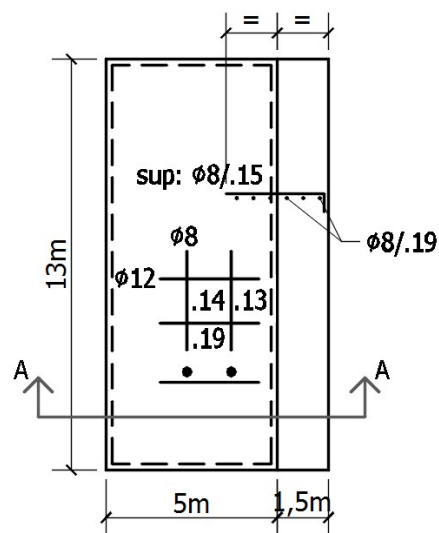
$$M_{d,x}^- = 3,92 \text{ kNm/m} \rightarrow A_{s,nec} = 0,87 \text{ cm}^2/\text{m}$$

$$A_{s,nec} = 2,52 \text{ cm}^2/\text{m} \text{ (cuantía geométrica)} \rightarrow \phi 8/19$$

$$M_{d,y}^+ = 38,44 \text{ kNm/m} \rightarrow A_{s,nec} = 8,32 \text{ cm}^2/\text{m} \rightarrow \phi 12/13$$

$$M_{d,x}^+ = 9,61 \text{ kNm/m} \rightarrow A_{s,nec} = 2,17 \text{ cm}^2/\text{m}$$

$$A_{s,nec} = 2,52 \text{ cm}^2/\text{m} \text{ (cuantía geométrica)} \rightarrow \phi 8/19$$



Ejercicio 4

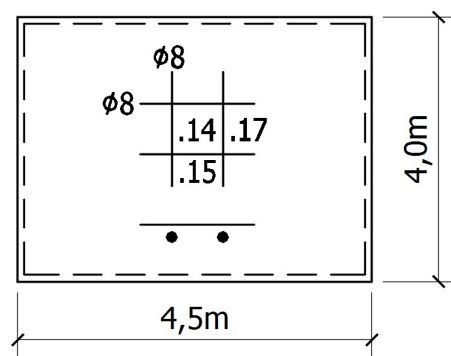
$$M_{d,y}^+ = 13,32 \text{ kNm/m} \rightarrow A_{s,nec} = 3,27 \text{ cm}^2/\text{m} \rightarrow \phi 8/15$$

$$M_{d,x}^+ = 10,96 \text{ kNm/m} \rightarrow A_{s,nec} = 2,95 \text{ cm}^2/\text{m} \rightarrow \phi 8/17$$

Descargas a los apoyos:

- Apoyos cortos: $CM = 3,5 \text{ kN/m}$, $SCU = 7,5 \text{ kN/m}$
- Apoyos largos: $CM = 3,9 \text{ kN/m}$, $SCU = 8,3 \text{ kN/m}$

$$V_d = 17,7 \text{ kN/m} < V_{Rd,c} = 57,42 \text{ kN/m} \text{ (verifica)}$$



Ejercicio 5

$$M_{d,y}^+ = 10,84 \text{ kNm/m} \rightarrow A_{s,nec} = 3,78 \text{ cm}^2/\text{m} \rightarrow \phi 10/20$$

$$M_{d,x}^+ = 3,90 \text{ kNm/m} \rightarrow A_{s,nec} = 1,54 \text{ cm}^2/\text{m}$$

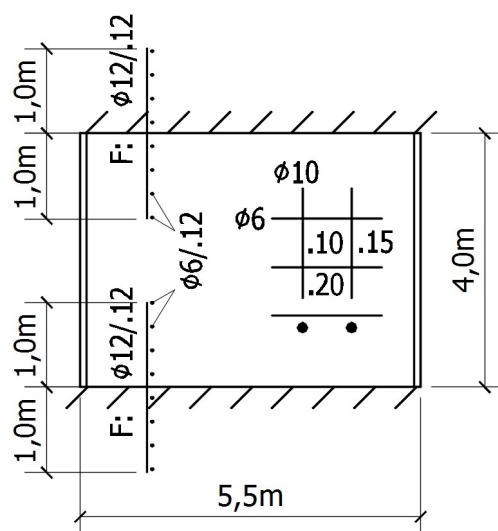
$$A_{s,nec} = 1,84 \text{ cm}^2/\text{m} \text{ (cuantía mecánica)} \rightarrow \phi 6/15$$

$$M_{d,y}^- = 22,82 \text{ kNm/m} \rightarrow A_{s,nec} = 8,84 \text{ cm}^2/\text{m} \rightarrow \phi 12/12$$

$$M_{d,x}^- = 5,71 \text{ kNm/m} \rightarrow A_{s,nec} = 2,28 \text{ cm}^2/\text{m} \rightarrow \phi 6/12$$

Descargas a los apoyos:

- Ap. empotrados: $CM = 3,95 \text{ kN/m}$, $SCU = 15,0 \text{ kN/m}$
- Ap. articulados: $CM = 1,4 \text{ kN/m}$, $SCU = 5,5 \text{ kN/m}$



Ejercicio 6

$$M_{y,u} = 22,61 \text{ kNm/m}, M_{x,u} = 10,19 \text{ kNm/m} \rightarrow SCU_u = 11,94 \text{ kN/m}^2$$

Ejercicio 7

$$M_{d,y}^+ = 14,13 \text{ kNm/m} \rightarrow A_{s,nec} = 2,92 \text{ cm}^2/\text{m} \rightarrow \phi 8/17$$

$$M_{d,x}^+ = 7,99 \text{ kNm/m} \rightarrow A_{s,nec} = 1,79 \text{ cm}^2/\text{m}$$

$$A_{s,nec} = 2,52 \text{ cm}^2/\text{m} \text{ (cuantía geométrica)} \rightarrow \phi 8/19$$

$$M_{d,y}^- = 31,03 \text{ kNm/m} \rightarrow A_{s,nec} = 6,79 \text{ cm}^2/\text{m} \rightarrow \phi 12/16$$

$$M_{d,x}^- = 7,76 \text{ kNm/m} \rightarrow A_{s,nec} = 1,74 \text{ cm}^2/\text{m} \rightarrow \phi 6/16$$

Descargas a los apoyos:

- Apoyo intermedios: $CM = 12,6 \text{ kN/m}$, $SCU = 34,7 \text{ kN/m}$

$$V_d = 34,5 \text{ kN/m} < V_{Rd,c} = 67,31 \text{ kN/m} \text{ (verifica)}$$

