

## T.P.Integrador: Edificio N°3

A partir de la planta estructural y los datos entregados, proceder al dimensionado de los siguientes componentes un edificio de hormigón armado según las indicaciones entregadas en el Programa de Clases Prácticas.

### **Grupo 3**

El destino del edificio es el de una asociación de jubilados en la ciudad de Trelew.

Condición de exposición según CIRSOC 201-05: A2

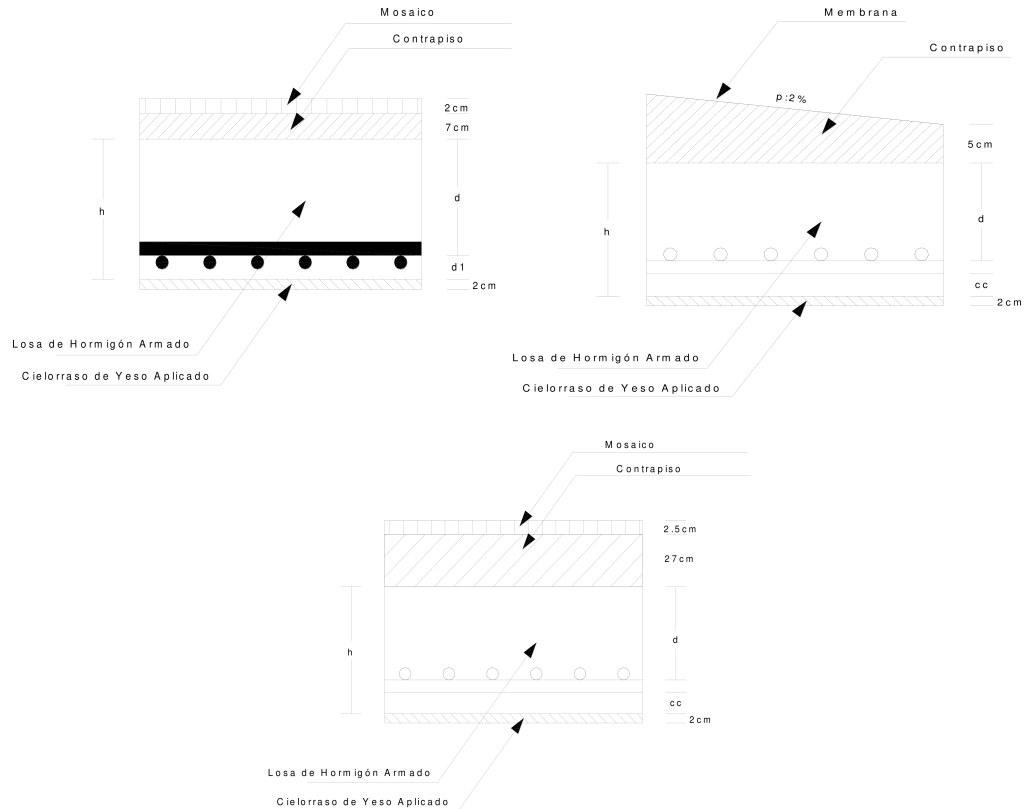
Hormigón H-25 (s/ CIRSOC 201-05) - Hormigón H-21 (s/ CIRSOC 201-82) - Acero ADN 42/50.

Características de la estructura:

1. A continuación se anexa la tabla de usos de cada una de las losas de la estructura.

<b>Losa</b>	<b>Destino</b>
101 – 102	Sala de reuniones
108	Aula
109 – 110	Salón de usos múltiples
103	Balcón
104	Sala de recepción
105 – 107	Pasillo – corredor
106	Aula
111	Baños
201 – 202 – 208 – 209	Aulas
210	Sala de computación
203	Balcón
204	Cocina - Comedor
205 – 207	Pasillo – corredor
206	Secretaría
211	Baños
301 a 311	Azotea accesible privadamente
301	Dos tanques de agua de 1100 litros cada uno

2. Los apeos de mampostería en losas se han indicado en la planta con líneas de trazo. Todas las vigas interiores y exteriores soportan muros de mampostería de 0,20 m de espesor de ladrillo común con excepción de las vigas 126, 127, 226 y 227. La azotea posee un murete perimetral de 1 m de altura de 0,20 m de espesor de ladrillo común.
3. Considerar para las losas de azotea, la carga generada por el respectivo contrapiso con pendientes equivalentes al 2% para desagües pluviales. Las azoteas son accesibles.
4. Las alturas de los niveles resultan de 3,50 m para la planta baja, y de 3 m para los restantes niveles.
5. Los paquetes estructurales de las losas corresponden a los siguientes esquemas:



6. Los suelos sobre los que se funda la estructura poseen una tensión admisible del suelo de  $2,5 \text{ kg/cm}^2$ , y no resultan agresivos. El nivel de fundación es de  $-1,5 \text{ m}$ .

Cálculo de Losas

Datos:

$$\text{Hormigón H-25} \Rightarrow f'c = 250 \frac{Kg}{cm^2} = 25 MPa$$

$$\text{Acero ADN 42/50} \Rightarrow fy = 4200 \frac{Kg}{cm^2} = 420 MPa$$

$$\text{Recubrimiento Cc} = 2cm$$

1. Predimensionado de losas en dos direcciones. L208

Losa L208.

$$l_x = 3,90m$$

$$l_y = 5,20m$$

$$h_{losa} = 14cm$$

Vigas.

$$b_w = 20cm \quad b_w = 20cm$$

$$h = 40cm \quad h = 40cm$$

Momento de inercia de la viga.

$$I_B = \frac{b \cdot h^3}{12} = \frac{20cm \cdot (40cm)^3}{12} = \boxed{106667cm^4}$$

Momento de inercia de la losa.

$$I_{sy} = \frac{b \cdot h^3}{12} = \frac{520cm \cdot (14cm)^3}{12} = \boxed{118907cm^4}$$

$$I_{sx} = \frac{b \cdot h^3}{12} = \frac{390cm \cdot (14cm)^3}{12} = \boxed{89180cm^4}$$

$$\alpha_y = \frac{I_B}{I_{sy}} = \frac{106667cm^4}{118907cm^4} = \boxed{0,90}$$

$$\alpha_x = \frac{I_B}{I_{sx}} = \frac{106667cm^4}{89180cm^4} = \boxed{1,20}$$

$$\alpha_m = \frac{\alpha_x + \alpha_y}{2} = \frac{(0,90 + 1,20)}{2} = \boxed{1,05}$$

Dado que  $\alpha_m < 2$  entonces:

$$\begin{aligned}\alpha_m &= 1,05 < 2 \\ h &\geq = \frac{l_w \cdot (0,80 + \frac{fy}{1400})}{36 + 5 \cdot \beta \cdot (\alpha_m - 0,2)} \\ h &\geq = \frac{520cm \cdot (0,80 + \frac{420MPa}{1400})}{36 + 5 \cdot \frac{520cm}{390cm} \cdot (1,05 - 0,2)} \\ h &\geq \boxed{13,73cm} \\ h_{min} &\geq 12cm\end{aligned}$$

Adopto  $\boxed{h = 14cm}$   
 $h_{adoptado} = 14cm \geq 13,73cm$  Verifica

## 2. Predimensionado de losas en una dirección

### ■ Losa L102

$$h_{minlosa} = \frac{ln}{24} = \frac{250cm}{24} = \boxed{10,41cm} \quad \text{De tabla 9.5.a}$$

$$h_{adoptado} = \boxed{14cm} \geq 10,41cm \text{ Verifica}$$

### ■ Losa L103

$$h_{minlosa} = \frac{ln}{10} = \frac{130cm}{10} = \boxed{13cm} \quad \text{De tabla 9.5.a}$$

$$h_{adoptado} = \boxed{14cm} \geq 13cm \text{ Verifica}$$

## 3. Análisis de cargas

### ■ Losa L101 y L102: Sala de Reuniones

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,07m \cdot 1600 \frac{Kg}{m^3} = 112 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,02m \cdot 2000 \frac{Kg}{m^3} = 40 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 528 \frac{Kg}{m^2}$$

$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1433,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,43 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

■ Losa L103 y L203: Balcón

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,07m \cdot 1600 \frac{Kg}{m^3} = 112 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,02m \cdot 2000 \frac{Kg}{m^3} = 40 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 528 \frac{Kg}{m^2}$$

$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1433,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,43 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

■ Losa L111 : Baños

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,27m \cdot 1600 \frac{Kg}{m^3} = 432 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,025m \cdot 2000 \frac{Kg}{m^3} = 50 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 858 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 858 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1509,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,50 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 858 \frac{Kg}{m^2} = 1201,2 \frac{Kg}{m^2} \Rightarrow 1,20 \frac{t}{m^2}$$

■ Losa L211: Ba os

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,27m \cdot 1600 \frac{Kg}{m^3} = 432 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,025m \cdot 2000 \frac{Kg}{m^3} = 50 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 858 \frac{Kg}{m^2}$$

$$D_{pared} = \frac{(0,10m \cdot (1m + 1m + 2,28) \cdot 2,7m \cdot 1700 \frac{Kg}{m^3}) \cdot 1,60}{3,60m \cdot 3,60m}$$

$$+ \frac{(0,10m \cdot 1,81m \cdot 2,7m \cdot 1700 \frac{Kg}{m^3}) \cdot 1,60}{3,60m \cdot 3,60m}$$

$$D_{pared} = 345 \frac{Kg}{m^2}$$

$$D_{total} = 858 \frac{Kg}{m^2} + 345 \frac{Kg}{m^2} = 1203 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D_{total} + 1,6 \cdot L = 1,2 \cdot 1203 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1923,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,92 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D_{total} = 1,4 \cdot 1203 \frac{Kg}{m^2} = 1684,2 \frac{Kg}{m^2} \Rightarrow 1,68 \frac{t}{m^2}$$

■ Losa L104: Recepci n

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,07m \cdot 1600 \frac{Kg}{m^3} = 112 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,02m \cdot 2000 \frac{Kg}{m^3} = 40 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 528 \frac{Kg}{m^2}$$

$$L = 250 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 250 \frac{Kg}{m^2} = 1033,3 \frac{Kg}{m^2} \Rightarrow \boxed{1,03 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

■ Losa L105, L107, L205 y L207: Pasillo - Corredor

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,07m \cdot 1600 \frac{Kg}{m^3} = 112 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,02m \cdot 2000 \frac{Kg}{m^3} = 40 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 528 \frac{Kg}{m^2}$$

$$L = 400 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 400 \frac{Kg}{m^2} = 1273 \frac{Kg}{m^2} \Rightarrow \boxed{1,27 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

■ Losa L106, L201, L208 y L209: Aulas

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,07m \cdot 1600 \frac{Kg}{m^3} = 112 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,02m \cdot 2000 \frac{Kg}{m^3} = 40 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 528 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1113,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,11 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

■ Losa L108: Aulas

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,07m \cdot 1600 \frac{Kg}{m^3} = 112 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,02m \cdot 2000 \frac{Kg}{m^3} = 40 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 528 \frac{Kg}{m^2}$$

$$\frac{l_1}{l_2} = \frac{3,9m}{5,2m} = 0,75 \Rightarrow 0,8 \Rightarrow \text{De tabla tenemos los coeficientes}$$

$$\text{Muro paralelo al lado corto} = 1,50$$

$$\text{Muro paralelo al lado largo} = 1,70$$

$$D_{pared} = \frac{2,6m \cdot 2,7m \cdot 0,1m \cdot 1700 \frac{Kg}{m^3}}{3,9m \cdot 5,2m} \cdot 1,50 + \frac{2,6m \cdot 2,7m \cdot 0,1m \cdot 1700 \frac{Kg}{m^3}}{3,9m \cdot 5,2m} \cdot 1,70$$

$$D_{pared} = 130,6 \frac{Kg}{m^2}$$

$$D_{total} = 528 \frac{Kg}{m^2} + 130,6 \frac{Kg}{m^2} = 658,6 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D_{total} + 1,6 \cdot L = 1,2 \cdot 658,6 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1270,32 \frac{Kg}{m^2} \Rightarrow \boxed{1,27 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D_{total} = 1,4 \cdot 658,6 \frac{Kg}{m^2} = 922,04 \frac{Kg}{m^2} \Rightarrow 0,92 \frac{t}{m^2}$$



■ Losa L202: Aulas

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,07m \cdot 1600 \frac{Kg}{m^3} = 112 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,02m \cdot 2000 \frac{Kg}{m^3} = 40 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 528 \frac{Kg}{m^2}$$

$$D_{pared} = 1m \cdot 2,7m \cdot 0,1m \cdot 1700 \frac{Kg}{m^3}$$

$$D_{pared} = 459Kg$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1113,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,11 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$q_u = 1,2 \cdot D_{pared} = 1,2 \cdot 459Kg = 550,8Kg \Rightarrow 0,55t$$

■ Losa L206: Secretaria

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,07m \cdot 1600 \frac{Kg}{m^3} = 112 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,02m \cdot 2000 \frac{Kg}{m^3} = 40 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 528 \frac{Kg}{m^2}$$

$$L = 250 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 250 \frac{Kg}{m^2} = 1033,3 \frac{Kg}{m^2} \Rightarrow \boxed{1,03 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

■ Losa L204: Cocina - Comedor

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,27m \cdot 1600 \frac{Kg}{m^3} = 432 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,025m \cdot 2000 \frac{Kg}{m^3} = 50 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 858 \frac{Kg}{m^2}$$

$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 858 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1829,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,82 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 858 \frac{Kg}{m^2} = 1201,2 \frac{Kg}{m^2} \Rightarrow 1,20 \frac{t}{m^2}$$

■ Losa L210: Sala de Computaci n

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,07m \cdot 1600 \frac{Kg}{m^3} = 112 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,02m \cdot 2000 \frac{Kg}{m^3} = 40 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 528 \frac{Kg}{m^2}$$

$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1433,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,43 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

■ Losa L109: Sala de Usos Múltiples

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,07m \cdot 1600 \frac{Kg}{m^3} = 112 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,02m \cdot 2000 \frac{Kg}{m^3} = 40 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 528 \frac{Kg}{m^2}$$

$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1433,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,43 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

■ Losa L110: Sala de Usos Múltiples

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,07m \cdot 1600 \frac{Kg}{m^3} = 112 \frac{Kg}{m^2}$$

$$\text{Piso} + \text{Carpeta} \rightarrow 0,02m \cdot 2000 \frac{Kg}{m^3} = 40 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 528 \frac{Kg}{m^2}$$

$$D_{pared} = 2,7m \cdot 0,1m \cdot 1700 \frac{Kg}{m^3} = 459 \frac{Kg}{m^2}$$

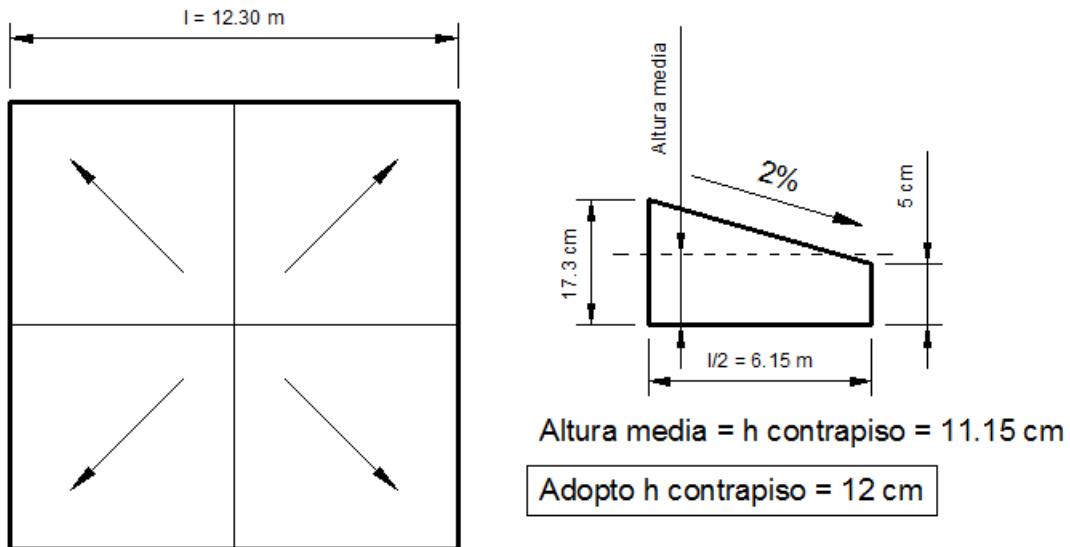
$$D_{total} = 528 \frac{Kg}{m^2} + 459 \frac{Kg}{m^2} = 987 \frac{Kg}{m^2}$$

$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D_{total} + 1,6 \cdot L = 1,2 \cdot 987 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1984,4 \frac{Kg}{m^2} \Rightarrow \boxed{1,98 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D_{total} = 1,4 \cdot 987 \frac{Kg}{m^2} = 1381,8 \frac{Kg}{m^2} \Rightarrow 1,38 \frac{t}{m^2}$$

- Losa L302 a L311: Azotea accesible privadamente



$$\text{Peso propio} \rightarrow 0.14 \text{ m} \cdot 2500 \frac{\text{Kg}}{\text{m}^3} = 350 \frac{\text{Kg}}{\text{m}^2}$$

$$\text{Contrapiso} \rightarrow 0.12 \text{ m} \cdot 1600 \frac{\text{Kg}}{\text{m}^3} = 192 \frac{\text{Kg}}{\text{m}^2}$$

$$\text{Membrana} + \text{Aislación} \rightarrow 20 \frac{\text{Kg}}{\text{m}^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0.02 \text{ m} \cdot 1300 \frac{\text{Kg}}{\text{m}^3} = 26 \frac{\text{Kg}}{\text{m}^2}$$

$$D = 588 \frac{\text{Kg}}{\text{m}^2}$$

$$L = 300 \frac{\text{Kg}}{\text{m}^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1.2 \cdot D + 1.6 \cdot L = 1.2 \cdot 588 \frac{\text{Kg}}{\text{m}^2} + 1.6 \cdot 300 \frac{\text{Kg}}{\text{m}^2} = 1185.6 \frac{\text{Kg}}{\text{m}^2} \Rightarrow 1.18 \frac{\text{t}}{\text{m}^2}$$

$$q_u = 1.4 \cdot D = 1.4 \cdot 588 \frac{\text{Kg}}{\text{m}^2} = 823.2 \frac{\text{Kg}}{\text{m}^2} \Rightarrow 0.82 \frac{\text{t}}{\text{m}^2}$$

- Losa L301: Azotea accesible privadamente

$$\text{Peso propio} \rightarrow 0,14m \cdot 2500 \frac{Kg}{m^3} = 350 \frac{Kg}{m^2}$$

$$\text{Contrapiso} \rightarrow 0,12m \cdot 1600 \frac{Kg}{m^3} = 192 \frac{Kg}{m^2}$$

$$\text{Membrana} + \text{Aislaci n} \rightarrow = 20 \frac{Kg}{m^2}$$

$$\text{Cielorraso aplicado} \rightarrow 0,02m \cdot 1300 \frac{Kg}{m^3} = 26 \frac{Kg}{m^2}$$

$$D = 588 \frac{Kg}{m^2}$$

$$D_{tanques} = \frac{2 \cdot 1100Kg + 2 \cdot 40Kg}{2 \cdot \left(\frac{\pi \cdot D^2}{4}\right)}$$

$$D_{tanques} = \frac{2 \cdot 1100Kg + 2 \cdot 40Kg}{2 \cdot \left(\frac{\pi \cdot (1,10m)^2}{4}\right)}$$

$$D_{tanques} = 1200 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 588 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1185,6 \frac{Kg}{m^2} \Rightarrow 1,18 \frac{t}{m^2}$$

$$q_u = 1,4 \cdot (D + D_{tanques}) = 1,4 \cdot \left(588 \frac{Kg}{m^2} + 1200 \frac{Kg}{m^2}\right) = 2503,2 \frac{Kg}{m^2} \Rightarrow \boxed{2,50 \frac{t}{m^2}}$$

- Dpared Losa L108

$$D_{pared} = \frac{(0,10m \cdot 2,6m \cdot 2,7m \cdot 1700 \frac{Kg}{m^3}) \cdot 1,50}{3,90m \cdot 5,20m} + \frac{(0,10m \cdot 1,10m \cdot 2,7m \cdot 1700 \frac{Kg}{m^3}) \cdot 1,70}{3,90m \cdot 5,20m}$$

$$D_{pared} = 130,6 \frac{Kg}{m^2}$$

- Dpared Losa L110

$$D_{pared} = (0,10m \cdot 2,7m \cdot 1700 \frac{Kg}{m^3})$$

$$D_{pared} = 459 \frac{Kg}{m}$$

Consideramos la pared ocupando todo el ancho de la losa en una direcci n.

- Dpared Losa L202

$$D_{pared} = (0,10m \cdot 1m \cdot 2,7m \cdot 1700 \frac{Kg}{m^3})$$

$$D_{pared} = 459Kg$$

■ Dpared Losa L211

$$D_{pared} = \frac{(0,10m \cdot (1m + 1m + 2,28) \cdot 2,7m \cdot 1700 \frac{Kg}{m^3}) \cdot 1,60}{3,60m \cdot 3,60m}$$

$$+ \frac{(0,10m \cdot 1,81m \cdot 2,7m \cdot 1700 \frac{Kg}{m^3}) \cdot 1,60}{3,60m \cdot 3,60m}$$

$$D_{pared} = 345 \frac{Kg}{m^2}$$

■ Dtanques Losa L301

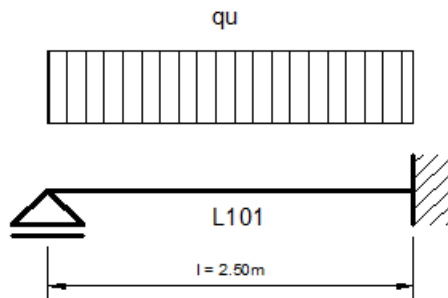
$$D_{tanque} = \frac{2 \cdot 1100Kg + 2 \cdot 40Kg}{2 \cdot (\frac{\pi \cdot D^2}{4})}$$

$$D_{tanque} = \frac{2 \cdot 1100Kg + 2 \cdot 40Kg}{2 \cdot (\frac{\pi \cdot (1,10m)^2}{4})}$$

$$D_{tanque} = 1200 \frac{Kg}{m^2}$$

4. Momentos flectores - Nivel 1

■ Losa L101: Sala de Reuniones



$$D = 528 \frac{Kg}{m^2}$$

$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

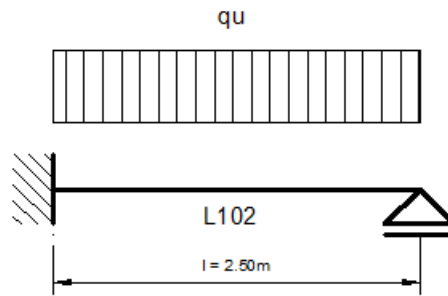
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1433,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,43 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$Mu_{empotrado} = \frac{q_u \cdot l^2}{8} = \frac{1,43 \frac{t}{m^2} \cdot (2,50m)^2}{8} = \boxed{1,11 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = \frac{9}{128} \cdot q \cdot l^2 = \frac{9}{128} \cdot 1,43 \frac{t}{m^2} \cdot (2,50m)^2 = \boxed{0,62 \frac{t \cdot m}{m}}$$

■ Losa L102: Sala de Reuniones



$$D = 528 \frac{Kg}{m^2}$$

$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

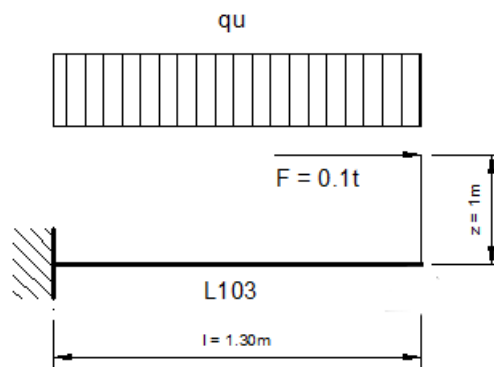
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1433,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,43 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$Mu_{empotrado} = \frac{q_u \cdot l^2}{8} = \frac{1,43 \frac{t}{m^2} \cdot (2,50m)^2}{8} = \boxed{1,11 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = \frac{9}{128} \cdot q \cdot l^2 = \frac{9}{128} \cdot 1,43 \frac{t}{m^2} \cdot (2,50m)^2 = \boxed{0,62 \frac{t \cdot m}{m}}$$

■ Losa L103: Balcón



$$D = 528 \frac{Kg}{m^2}$$

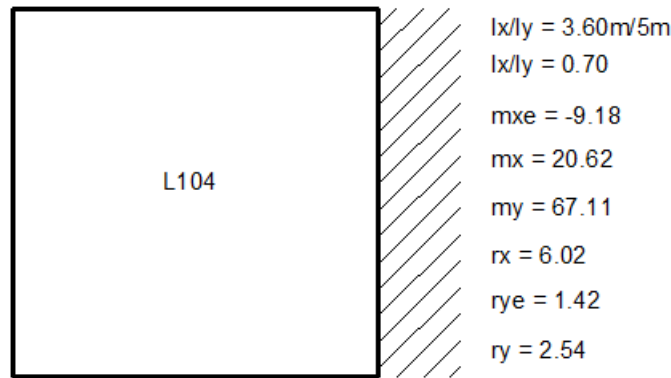
$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1433,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,43 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$Mu_{empotrado} = \frac{q_u \cdot l^2}{2} + F \cdot z = \frac{1,43 \frac{t}{m^2} \cdot (1,30m)^2}{2} + 0,1t \cdot 1m = \boxed{1,30 \frac{t \cdot m}{m}}$$

■ Losa L104: Recepción



$$D = 528 \frac{Kg}{m^2}$$

$$L = 250 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 250 \frac{Kg}{m^2} = 1033,3 \frac{Kg}{m^2} \Rightarrow \boxed{1,03 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

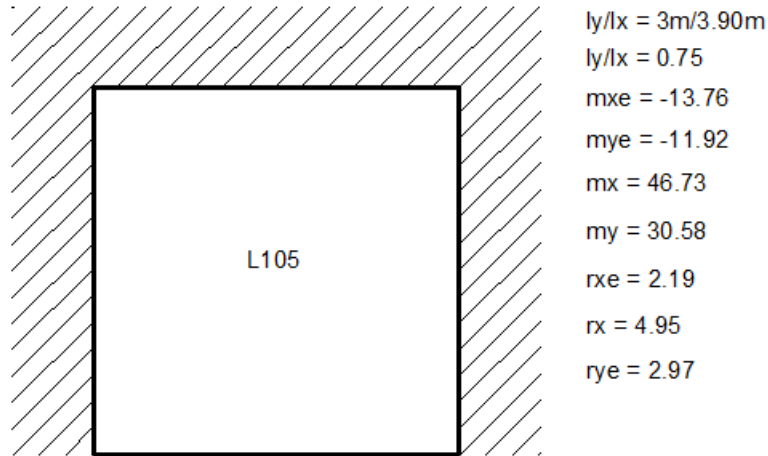
$$Mu_{xe} = \frac{q_u \cdot (l_{menor})^2}{m_{xe}} = \frac{1,03 \frac{t}{m^2} \cdot (3,60m)^2}{9,18} \boxed{1,45 \frac{t \cdot m}{m}}$$

$$Mu_x = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,03 \frac{t}{m^2} \cdot (3,60m)^2}{20,62} \boxed{0,64 \frac{t \cdot m}{m}}$$

$$Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,03 \frac{t}{m^2} \cdot (3,60m)^2}{67,11} \boxed{0,19 \frac{t \cdot m}{m}}$$



■ Losa L105: Pasillo - Corredor



$$D = 528 \frac{Kg}{m^2}$$

$$L = 400 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 400 \frac{Kg}{m^2} = 1273 \frac{Kg}{m^2} \Rightarrow \boxed{1,27 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

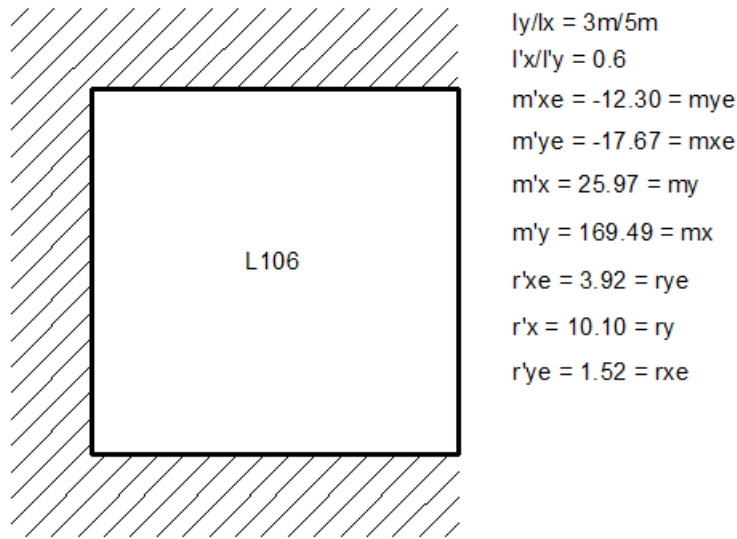
$$Mu_{xe} = \frac{q_u \cdot (l_{menor})^2}{m_{xe}} = \frac{1,27 \frac{t}{m^2} \cdot (3m)^2}{13,76} \boxed{0,83 \frac{t \cdot m}{m}}$$

$$Mu_{ye} = \frac{q_u \cdot (l_{menor})^2}{m_{ye}} = \frac{1,27 \frac{t}{m^2} \cdot (3m)^2}{11,92} \boxed{0,96 \frac{t \cdot m}{m}}$$

$$Mu_x = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,27 \frac{t}{m^2} \cdot (3m)^2}{46,73} \boxed{0,83 \frac{t \cdot m}{m}}$$

$$Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,27 \frac{t}{m^2} \cdot (3m)^2}{30,58} \boxed{0,37 \frac{t \cdot m}{m}}$$

■ Losa L106: Aula



$$D = 528 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1113,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,11 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

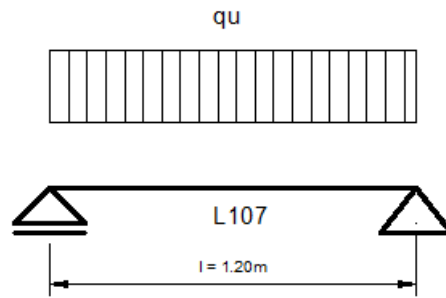
$$Mu_{xe} = \frac{q_u \cdot (l_{menor})^2}{m_{xe}} = \frac{1,11 \frac{t}{m^2} \cdot (3m)^2}{17,67} \boxed{0,56 \frac{t \cdot m}{m}}$$

$$Mu_{ye} = \frac{q_u \cdot (l_{menor})^2}{m_{ye}} = \frac{1,11 \frac{t}{m^2} \cdot (3m)^2}{12,30} \boxed{0,81 \frac{t \cdot m}{m}}$$

$$Mu_x = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,11 \frac{t}{m^2} \cdot (3m)^2}{169,49} \boxed{0,058 \frac{t \cdot m}{m}}$$

$$Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,11 \frac{t}{m^2} \cdot (3m)^2}{25,97} \boxed{0,38 \frac{t \cdot m}{m}}$$

■ Losa L107: Pasillo - Corredor



$$D = 528 \frac{Kg}{m^2}$$

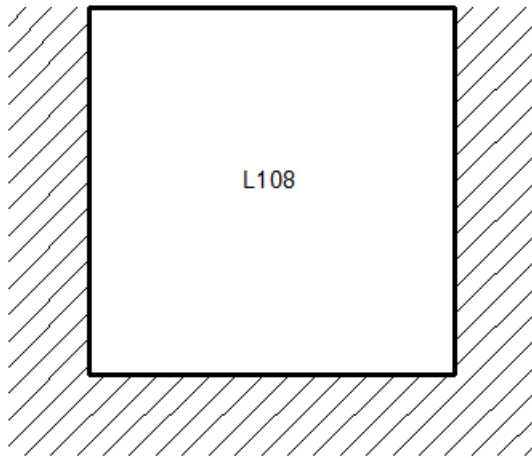
$$L = 400 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 400 \frac{Kg}{m^2} = 1273 \frac{Kg}{m^2} \Rightarrow \boxed{1,27 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$Mu_{tramo} = \frac{q_u \cdot l^2}{8} = \frac{1,27 \frac{t}{m^2} \cdot (1,20m)^2}{8} = \boxed{0,23 \frac{t \cdot m}{m}}$$

■ Losa L108: Aula



$l_x/l_y = 3.90\text{m}/5.20\text{m}$   
 $l_x/l_y = 0.75$   
 $m_{xe} = -13.37$   
 $m_{ye} = -17.51$   
 $m_x = 30.03$   
 $m_y = 93.46$   
 $r_{xe} = 3.85$   
 $r_x = 10.00$   
 $r_{ye} = 2.05$

$$D = 528 \frac{\text{Kg}}{\text{m}^2}$$

$$D_{pared} = 130,6 \frac{\text{Kg}}{\text{m}^2}$$

$$D_{total} = 528 \frac{\text{Kg}}{\text{m}^2} + 130,6 \frac{\text{Kg}}{\text{m}^2} = 658,6 \frac{\text{Kg}}{\text{m}^2}$$

$$L = 300 \frac{\text{Kg}}{\text{m}^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D_{total} + 1,6 \cdot L = 1,2 \cdot 658,6 \frac{\text{Kg}}{\text{m}^2} + 1,6 \cdot 300 \frac{\text{Kg}}{\text{m}^2} = 1270,32 \frac{\text{Kg}}{\text{m}^2} \Rightarrow \boxed{1,27 \frac{\text{t}}{\text{m}^2}}$$

$$q_u = 1,4 \cdot D_{total} = 1,4 \cdot 658,6 \frac{\text{Kg}}{\text{m}^2} = 922,04 \frac{\text{Kg}}{\text{m}^2} \Rightarrow 0,92 \frac{\text{t}}{\text{m}^2}$$

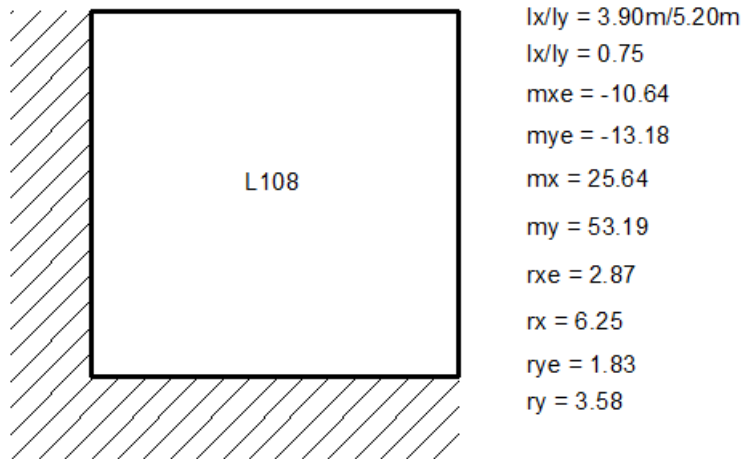
$$M_{u_{xe}} = \frac{q_u \cdot (l_{menor})^2}{m_{xe}} = \frac{1,27 \frac{\text{t}}{\text{m}^2} \cdot (3,90\text{m})^2}{13,37} \boxed{1,44 \frac{\text{t} \cdot \text{m}}{\text{m}}}$$

$$M_{u_{ye}} = \frac{q_u \cdot (l_{menor})^2}{m_{ye}} = \frac{1,27 \frac{\text{t}}{\text{m}^2} \cdot (3,90\text{m})^2}{17,51} \boxed{1,10 \frac{\text{t} \cdot \text{m}}{\text{m}}}$$

$$M_{u_x} = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,27 \frac{\text{t}}{\text{m}^2} \cdot (3,90\text{m})^2}{30,03} \boxed{0,64 \frac{\text{t} \cdot \text{m}}{\text{m}}}$$

$$M_{u_y} = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,27 \frac{\text{t}}{\text{m}^2} \cdot (3,90\text{m})^2}{93,46} \boxed{0,20 \frac{\text{t} \cdot \text{m}}{\text{m}}}$$

Cambio de sustentaci n



$$D = 528 \frac{Kg}{m^2}$$

$$D_{pared} = 130,6 \frac{Kg}{m^2}$$

$$D_{total} = 528 \frac{Kg}{m^2} + 130,6 \frac{Kg}{m^2} = 658,6 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D_{total} + 1,6 \cdot L = 1,2 \cdot 658,6 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1270,32 \frac{Kg}{m^2} \Rightarrow \boxed{1,27 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D_{total} = 1,4 \cdot 658,6 \frac{Kg}{m^2} = 922,04 \frac{Kg}{m^2} \Rightarrow 0,92 \frac{t}{m^2}$$

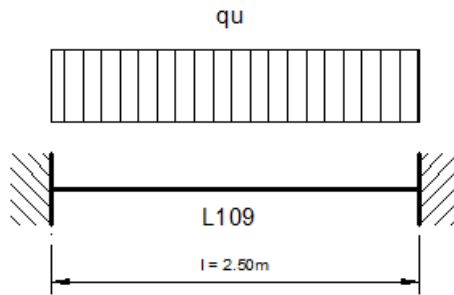
$$M_{u_{xe}} = \frac{q_u \cdot (l_{menor})^2}{m_{xe}} = \frac{1,27 \frac{t}{m^2} \cdot (3,90m)^2}{10,64} \boxed{1,81 \frac{t \cdot m}{m}}$$

$$M_{u_{ye}} = \frac{q_u \cdot (l_{menor})^2}{m_{ye}} = \frac{1,27 \frac{t}{m^2} \cdot (3,90m)^2}{13,18} \boxed{1,46 \frac{t \cdot m}{m}}$$

$$M_{u_x} = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,27 \frac{t}{m^2} \cdot (3,90m)^2}{25,64} \boxed{0,75 \frac{t \cdot m}{m}}$$

$$M_{u_y} = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,27 \frac{t}{m^2} \cdot (3,90m)^2}{53,19} \boxed{0,36 \frac{t \cdot m}{m}}$$

■ Losa L109: Sala de Usos Múltiples



$$D = 528 \frac{Kg}{m^2}$$

$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

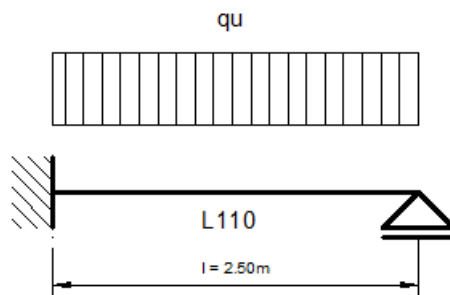
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1433,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,43 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$Mu_{empotrado} = \frac{q_u \cdot l^2}{12} = \frac{1,43 \frac{t}{m^2} \cdot (2,50m)^2}{12} = \boxed{0,74 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = \frac{q_u \cdot l^2}{24} = \frac{1,43 \frac{t}{m^2} \cdot (2,50m)^2}{24} = \boxed{0,37 \frac{t \cdot m}{m}}$$

■ Losa L110: Sala de Usos Múltiples



$$D = 528 \frac{Kg}{m^2}$$

$$D_{pared} = 459 \frac{Kg}{m}$$

$$D_{total} = 987 \frac{Kg}{m}$$

$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

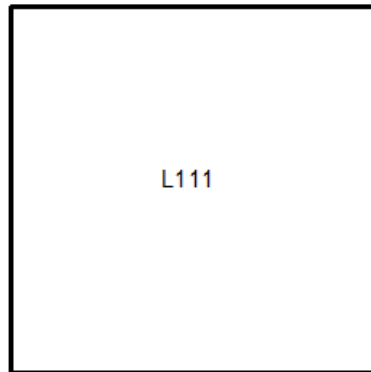
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 987 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1984,4 \frac{Kg}{m^2} \Rightarrow \boxed{1,98 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 987 \frac{Kg}{m^2} = 1381,8 \frac{Kg}{m^2} \Rightarrow 1,38 \frac{t}{m^2}$$

$$Mu_{empotrado} = \frac{q_u \cdot l^2}{8} = \frac{1,98 \frac{t}{m^2} \cdot (2,50m)^2}{8} = \boxed{1,54 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = \frac{9}{128} \cdot q \cdot l^2 = \frac{9}{128} \cdot 1,98 \frac{t}{m^2} \cdot (2,50m)^2 = \boxed{0,87 \frac{t \cdot m}{m}}$$

- Losa L111: Ba os



$$l_x/l_y = 3.60m/3.60m$$

$$l_x/l_y = 1$$

$$m_x = 27.17$$

$$m_y = 27.17$$

$$r_x = 4$$

$$r_y = 4$$

$$D = 858 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 858 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1509,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,50 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 858 \frac{Kg}{m^2} = 1201,2 \frac{Kg}{m^2} \Rightarrow 1,20 \frac{t}{m^2}$$

$$Mu_x = Mu_y = \frac{q_u \cdot l^2}{m_x} = \frac{1,50 \frac{t}{m^2} \cdot (3,60m)^2}{27,17} \boxed{0,71 \frac{t \cdot m}{m}}$$

5. Compatibilización de Momentos - Nivel 1

- Losas L104 y L108

$$(1,81 - 1,45) < 0,40 \cdot \frac{(1,81 + 1,45)}{2}$$

$$0,36 < 0,65 \Rightarrow \text{Verifica}$$

$$\text{Adopto } \boxed{1.62} \text{ en el apoyo}$$

$$0,75 + (1,81 - 1,62) = 0,93$$

$$\text{Adopto } \boxed{0.93} \text{ en el tramo}$$

- Losas L105 y L108

$$(1,46 - 0,96) < 0,40 \cdot \frac{(1,46 + 0,96)}{2}$$

$$0,5 < 0,48 \Rightarrow \text{No Verifica}$$

$$\text{Adopto de todas formas } \boxed{1.21} \text{ en el apoyo}$$

$$0,36 + (1,46 - 1,21) = 0,61$$

$$\text{Adopto } \boxed{0.61} \text{ en el tramo}$$

- Losas L105 y L106

$$(0,83 - 0,56) < 0,40 \cdot \frac{(0,83 + 0,56)}{2}$$

$$0,27 < 0,278 \Rightarrow \text{Verifica}$$

$$\text{Adopto } \boxed{0.69} \text{ en el apoyo}$$

$$0,24 + (0,83 - 0,69) = 0,38$$

$$\text{Adopto } \boxed{0.38} \text{ en el tramo}$$

- Losas L109 y L110

$$\frac{(0,74 + 1,54)}{2} = 1,14$$

$$\text{Adopto } \boxed{1.14} \text{ en el apoyo}$$

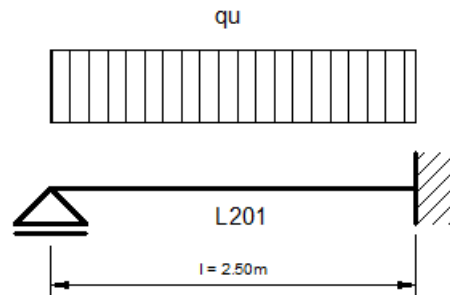
$$0,87 + (1,54 - 1,14) = 1,27$$

$$\text{Adopto } \boxed{1.27} \text{ en el tramo}$$



6. Momentos flectores - Nivel 2

- Losa L201: Aulas



$$D = 528 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

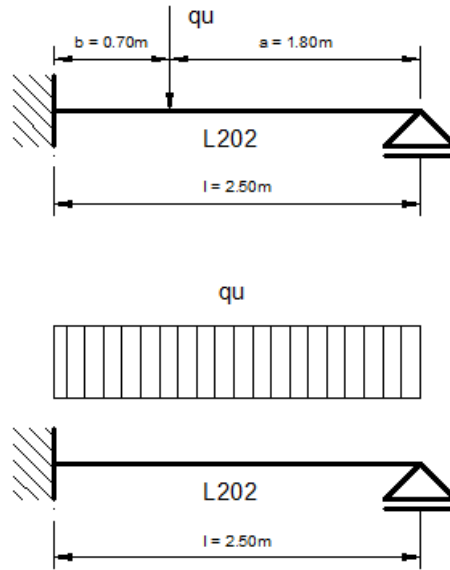
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1113,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,11 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$Mu_{apoyo} = \frac{q_u \cdot l^2}{8} = \frac{1,11 \frac{t}{m^2} \cdot (2,50m)^2}{8} = \boxed{0,86 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = \frac{9}{128} \cdot q \cdot l^2 = \frac{9}{128} \cdot 1,11 \frac{t}{m^2} \cdot (2,50m)^2 = \boxed{0,48 \frac{t \cdot m}{m}}$$

■ Losa L202: Aulas



$$D = 528 \frac{Kg}{m^2}$$

$$D_{pared} = 459 Kg$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1113,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,11 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$q_u = 1,2 \cdot D_{pared} = 1,2 \cdot 459 Kg = 550,8 Kg \Rightarrow 0,55 t$$

Carga uniformemente distribuida:

$$Mu_{empotrado} = \frac{q_u \cdot l^2}{8} = \frac{1,11 \frac{t}{m^2} \cdot (2,50m)^2}{8} = \boxed{0,86 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = \frac{9}{128} \cdot q \cdot l^2 = \frac{9}{128} \cdot 1,11 \frac{t}{m^2} \cdot (2,50m)^2 = \boxed{0,48 \frac{t \cdot m}{m}}$$

Carga concentrada:

$$Mu_{empotrado} = \frac{q_u \cdot a}{2 \cdot l^2} \cdot (l^2 - a^2) = \frac{0,55t \cdot 1,80m}{2 \cdot (2,50m)^2} \cdot ((2,50m)^2 - (1,80m)^2) = \boxed{0,23 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = \frac{q_u \cdot a}{2 \cdot l^3} \cdot b^2 \cdot (3 \cdot a + 2 \cdot b)$$

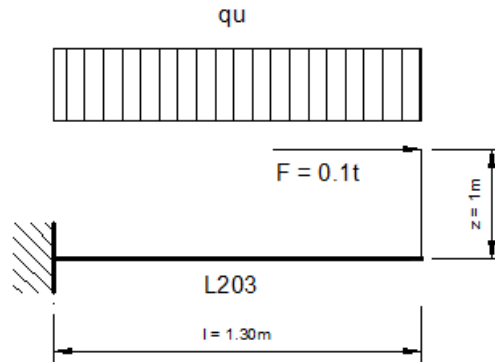
$$Mu_{tramo} = \frac{0,55t \cdot 1,80m}{2 \cdot (2,50m)^3} \cdot (0,70m)^2 \cdot (3 \cdot 1,80m + 2 \cdot 0,70m) = \boxed{0,10 \frac{t \cdot m}{m}}$$

Superposición de efectos:

$$Mu_{empotrado} = \boxed{0,86 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = 0,48 \frac{t \cdot m}{m} + 0,10 \frac{t \cdot m}{m} = \boxed{0,58 \frac{t \cdot m}{m}}$$

■ Losa L203: Balcón



$$D = 528 \frac{Kg}{m^2}$$

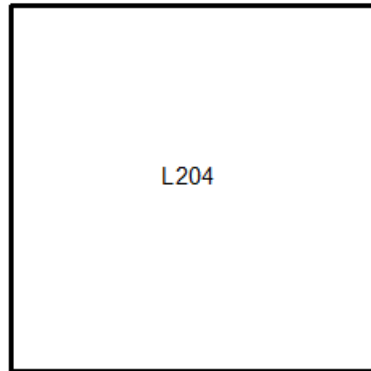
$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1433,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,43 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$Mu_{empotrado} = \frac{q_u \cdot l^2}{2} + F \cdot z = \frac{1,43 \frac{t}{m^2} \cdot (1,30\text{m})^2}{2} + 0,1t \cdot 1\text{m} = \boxed{1,30 \frac{t \cdot m}{m}}$$

■ Losa L204: Cocina - Comedor



$$l_x/l_y = 3.60\text{m}/5\text{m}$$

$$l_x/l_y = 0.70$$

$$m_x = 14.64$$

$$m_y = 33.56$$

$$r_x = 3.77$$

$$r_y = 2.22$$

$$D = 858 \frac{Kg}{m^2}$$

$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

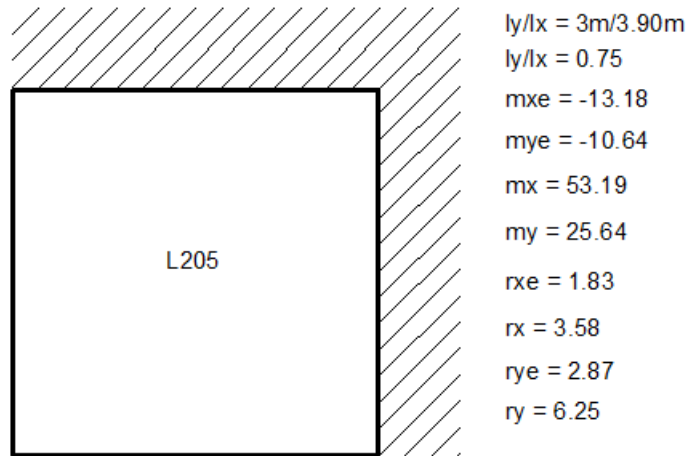
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 858 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1829,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,82 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 858 \frac{Kg}{m^2} = 1201,2 \frac{Kg}{m^2} \Rightarrow 1,20 \frac{t}{m^2}$$

$$Mu_x = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,82 \frac{t}{m^2} \cdot (3,60\text{m})^2}{14,64} \boxed{1,61 \frac{t \cdot m}{m}}$$

$$Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,82 \frac{t}{m^2} \cdot (3,60\text{m})^2}{33,56} \boxed{0,70 \frac{t \cdot m}{m}}$$

■ Losa L205: Pasillo - Corredor



$$D = 528 \frac{Kg}{m^2}$$

$$L = 400 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 400 \frac{Kg}{m^2} = 1273 \frac{Kg}{m^2} \Rightarrow \boxed{1,27 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

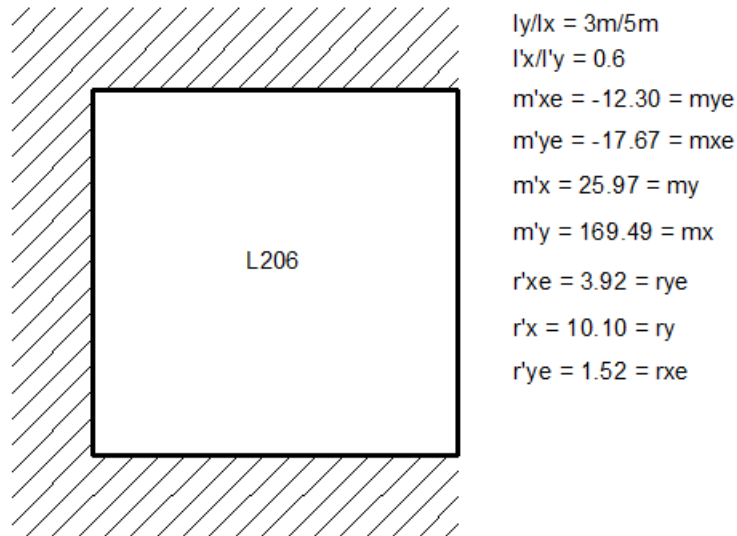
$$Mu_{xe} = \frac{q_u \cdot (l_{menor})^2}{m_{xe}} = \frac{1,27 \frac{t}{m^2} \cdot (3\text{m})^2}{13,18} \boxed{0,86 \frac{t \cdot m}{m}}$$

$$Mu_{ye} = \frac{q_u \cdot (l_{menor})^2}{m_{ye}} = \frac{1,27 \frac{t}{m^2} \cdot (3\text{m})^2}{10,64} \boxed{1,07 \frac{t \cdot m}{m}}$$

$$Mu_x = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,27 \frac{t}{m^2} \cdot (3\text{m})^2}{53,19} \boxed{0,21 \frac{t \cdot m}{m}}$$

$$Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,27 \frac{t}{m^2} \cdot (3\text{m})^2}{25,64} \boxed{0,44 \frac{t \cdot m}{m}}$$

■ Losa L206: Secretaria



$$D = 528 \frac{Kg}{m^2}$$

$$L = 250 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 250 \frac{Kg}{m^2} = 1033,3 \frac{Kg}{m^2} \Rightarrow \boxed{1,03 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

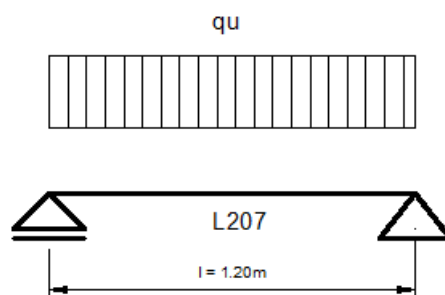
$$Mu_{xe} = \frac{q_u \cdot (l_{menor})^2}{m_{xe}} = \frac{1,03 \frac{t}{m^2} \cdot (3m)^2}{17,67} \boxed{0,52 \frac{t \cdot m}{m}}$$

$$Mu_{ye} = \frac{q_u \cdot (l_{menor})^2}{m_{ye}} = \frac{1,03 \frac{t}{m^2} \cdot (3m)^2}{12,30} \boxed{0,75 \frac{t \cdot m}{m}}$$

$$Mu_x = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,03 \frac{t}{m^2} \cdot (3m)^2}{169,49} \boxed{0,054 \frac{t \cdot m}{m}}$$

$$Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,03 \frac{t}{m^2} \cdot (3m)^2}{25,97} \boxed{0,35 \frac{t \cdot m}{m}}$$

■ Losa L207: Pasillo - Corredor



$$D = 528 \frac{Kg}{m^2}$$

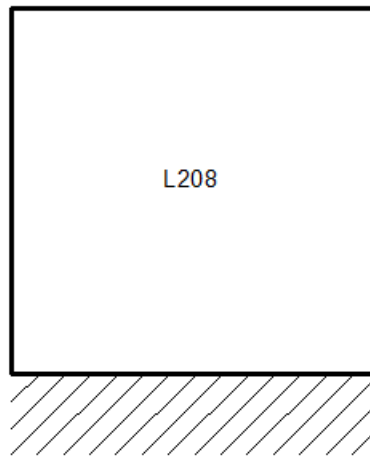
$$L = 400 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 400 \frac{Kg}{m^2} = 1273 \frac{Kg}{m^2} \Rightarrow \boxed{1,27 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$Mu_{tramo} = \frac{q_u \cdot l^2}{8} = \frac{1,27 \frac{t}{m^2} \cdot (1,20m)^2}{8} = \boxed{0,23 \frac{t \cdot m}{m}}$$

- Losa L208: Aulas



$$l_x/l_y = 3.90m/5.20m$$

$$l_y/l_x = 0.75$$

$$m'_{xe} = -9.48 = m_{ye}$$

$$m'_x = 31.35 = m_y$$

$$m'_y = 20.62 = m_x$$

$$r'_x = 3.36 = r_y$$

$$r'_{ye} = 2.07 = r_{xe}$$

$$r'_y = 3.89 = r_x$$

$$D = 528 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1113,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,11 \frac{t}{m^2}}$$

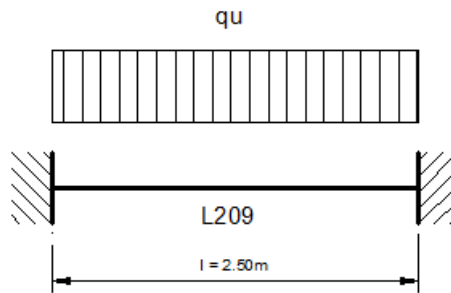
$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$Mu_{ye} = \frac{q_u \cdot (l_{menor})^2}{m_{ye}} = \frac{1,11 \frac{t}{m^2} \cdot (3,90m)^2}{9,48} \boxed{1,78 \frac{t \cdot m}{m}}$$

$$Mu_x = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,11 \frac{t}{m^2} \cdot (3,90m)^2}{20,62} \boxed{0,81 \frac{t \cdot m}{m}}$$

$$Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,11 \frac{t}{m^2} \cdot (3,90m)^2}{31,35} \boxed{0,53 \frac{t \cdot m}{m}}$$

■ Losa L209: Aulas



$$D = 528 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

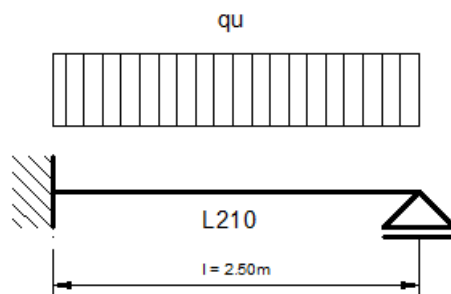
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1113,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,11 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$Mu_{empotrado} = \frac{q_u \cdot l^2}{12} = \frac{1,11 \frac{t}{m^2} \cdot (2,50m)^2}{12} = \boxed{0,57 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = \frac{q_u \cdot l^2}{24} = \frac{1,11 \frac{t}{m^2} \cdot (2,50m)^2}{24} = \boxed{0,28 \frac{t \cdot m}{m}}$$

■ Losa L210: Sala de Computación





$$D = 528 \frac{Kg}{m^2}$$

$$L = 500 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

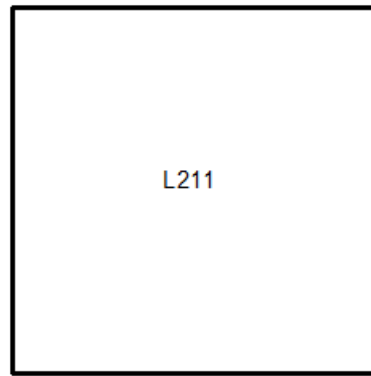
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 528 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = 1433,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,43 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 528 \frac{Kg}{m^2} = 739,2 \frac{Kg}{m^2} \Rightarrow 0,739 \frac{t}{m^2}$$

$$Mu_{empotrado} = \frac{q_u \cdot l^2}{8} = \frac{1,43 \frac{t}{m^2} \cdot (2,50m)^2}{8} = \boxed{1,11 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = \frac{9}{128} \cdot q \cdot l^2 = \frac{9}{128} \cdot 1,43 \frac{t}{m^2} \cdot (2,50m)^2 = \boxed{0,62 \frac{t \cdot m}{m}}$$

- Losa L211: Ba os



$$lx/ly = 3.60m/3.60m$$

$$lx/ly = 1$$

$$mx = 27.17$$

$$my = 27.17$$

$$rx = 4$$

$$ry = 4$$

$$D = 858 \frac{Kg}{m^2}$$

$$D_{pared} = 345 \frac{Kg}{m^2}$$

$$D_{total} = 1203 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Seg n CIRSOC 101-05 - Cap tulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 1203 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1923,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,92 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 1203 \frac{Kg}{m^2} = 1684,2 \frac{Kg}{m^2} \Rightarrow 1,68 \frac{t}{m^2}$$

$$Mu_x = Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,92 \frac{t}{m^2} \cdot (3,60m)^2}{27,17} = \boxed{0,91 \frac{t \cdot m}{m}}$$

7. Compatibilización de Momentos - Nivel 2

■ Losas L205 y L208

$$(1,78 - 1,07) < 0,40 \cdot \frac{(1,78 + 1,07)}{2}$$

$$0,71 < 0,57 \Rightarrow \text{No Verifica}$$

$$\text{Adopto } \boxed{1.42} \text{ en el apoyo}$$

$$0,53 + (1,78 - 1,42) = 0,89$$

$$\text{Adopto } \boxed{0.89} \text{ en el tramo}$$

■ Losas L205 y L206

$$(0,86 - 0,52) < 0,40 \cdot \frac{(0,86 + 0,52)}{2}$$

$$0,34 < 0,28 \Rightarrow \text{No Verifica}$$

$$\text{Adopto } \boxed{0.69} \text{ en el apoyo}$$

$$0,21 + (0,86 - 0,69) = 0,38$$

$$\text{Adopto } \boxed{0.38} \text{ en el tramo}$$

■ Losas L209 y L210

$$(1,11 - 0,57) < 0,40 \cdot \frac{(1,11 + 0,57)}{2}$$

$$0,54 < 0,33 \Rightarrow \text{No Verifica}$$

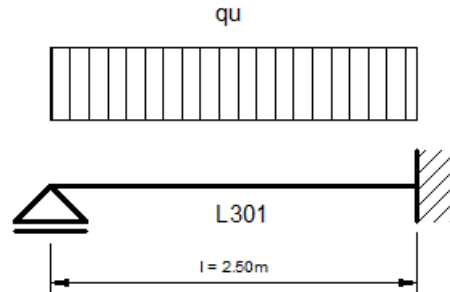
$$\text{Adopto } \boxed{0.84} \text{ en el apoyo}$$

$$0,62 + (1,11 - 0,84) = 0,89$$

$$\text{Adopto } \boxed{0.89} \text{ en el tramo}$$

8. Momentos flectores - Nivel 3

- Losa L301: Azotea accesible privadamente



$$D = 588 \frac{\text{Kg}}{\text{m}^2}$$

$$D_{\text{tanques}} = 1200 \frac{\text{Kg}}{\text{m}^2}$$

$$L = 300 \frac{\text{Kg}}{\text{m}^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

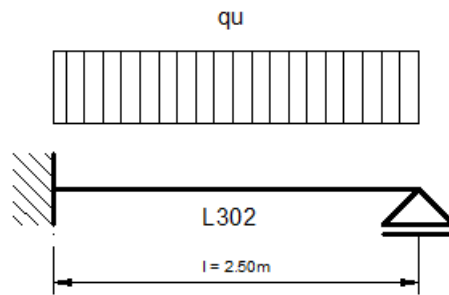
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 588 \frac{\text{Kg}}{\text{m}^2} + 1,6 \cdot 300 \frac{\text{Kg}}{\text{m}^2} = 1185,6 \frac{\text{Kg}}{\text{m}^2} \Rightarrow 1,18 \frac{\text{t}}{\text{m}^2}$$

$$q_u = 1,4 \cdot (D + D_{\text{tanques}}) = 1,4 \cdot \left( 588 \frac{\text{Kg}}{\text{m}^2} + 1200 \frac{\text{Kg}}{\text{m}^2} \right) = 2503,2 \frac{\text{Kg}}{\text{m}^2} \Rightarrow \boxed{2,50 \frac{\text{t}}{\text{m}^2}}$$

$$M_{u_{\text{empotrado}}} = \frac{q_u \cdot l^2}{8} = \frac{2,50 \frac{\text{t}}{\text{m}^2} \cdot (2,50\text{m})^2}{8} = \boxed{1,95 \frac{\text{t}\cdot\text{m}}{\text{m}}}$$

$$M_{u_{\text{tramo}}} = \frac{9}{128} \cdot q \cdot l^2 = \frac{9}{128} \cdot 2,50 \frac{\text{t}}{\text{m}^2} \cdot (2,50\text{m})^2 = \boxed{1,09 \frac{\text{t}\cdot\text{m}}{\text{m}}}$$

- Losa L302: Azotea accesible privadamente



$$D = 588 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

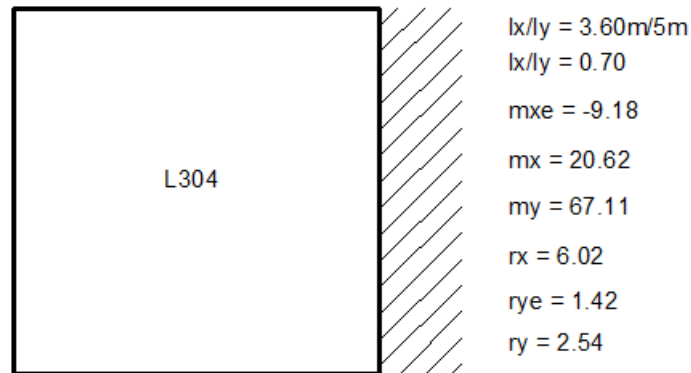
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 588 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1185,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,18 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 588 \frac{Kg}{m^2} = 823,2 \frac{Kg}{m^2} \Rightarrow 0,82 \frac{t}{m^2}$$

$$Mu_{empotrado} = \frac{q_u \cdot l^2}{8} = \frac{1,18 \frac{t}{m^2} \cdot (2,50m)^2}{8} = \boxed{0,92 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = \frac{9}{128} \cdot q \cdot l^2 = \frac{9}{128} \cdot 1,18 \frac{t}{m^2} \cdot (2,50m)^2 = \boxed{0,51 \frac{t \cdot m}{m}}$$

- Losa L304: Azotea accesible privadamente



$$D = 588 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 588 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1185,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,18 \frac{t}{m^2}}$$

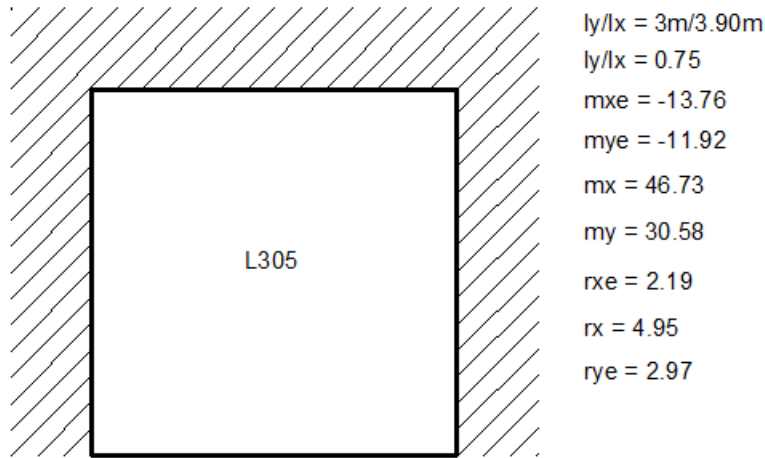
$$q_u = 1,4 \cdot D = 1,4 \cdot 588 \frac{Kg}{m^2} = 823,2 \frac{Kg}{m^2} \Rightarrow 0,82 \frac{t}{m^2}$$

$$Mu_{xe} = \frac{q_u \cdot (l_{menor})^2}{m_{xe}} = \frac{1,18 \frac{t}{m^2} \cdot (3,60m)^2}{9,18} \boxed{1,66 \frac{t \cdot m}{m}}$$

$$Mu_x = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,18 \frac{t}{m^2} \cdot (3,60m)^2}{20,62} \boxed{0,74 \frac{t \cdot m}{m}}$$

$$Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,18 \frac{t}{m^2} \cdot (3,60m)^2}{67,11} \boxed{0,22 \frac{t \cdot m}{m}}$$

■ Losa L305: Azotea accesible privadamente



$$D = 588 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 588 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1185,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,18 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 588 \frac{Kg}{m^2} = 823,2 \frac{Kg}{m^2} \Rightarrow 0,82 \frac{t}{m^2}$$

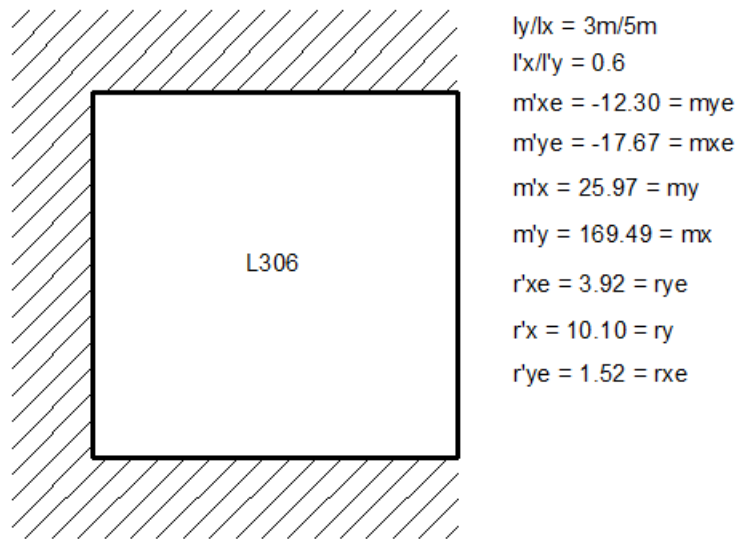
$$Mu_{xe} = \frac{q_u \cdot (l_{menor})^2}{m_{xe}} = \frac{1,18 \frac{t}{m^2} \cdot (3m)^2}{13,76} \boxed{0,77 \frac{t \cdot m}{m}}$$

$$Mu_{ye} = \frac{q_u \cdot (l_{menor})^2}{m_{ye}} = \frac{1,18 \frac{t}{m^2} \cdot (3m)^2}{11,92} \boxed{0,89 \frac{t \cdot m}{m}}$$

$$Mu_x = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,18 \frac{t}{m^2} \cdot (3m)^2}{46,73} \boxed{0,22 \frac{t \cdot m}{m}}$$

$$Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,18 \frac{t}{m^2} \cdot (3m)^2}{30,58} \boxed{0,34 \frac{t \cdot m}{m}}$$

■ Losa L306: Azotea accesible privadamente



$$D = 588 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 588 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1185,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,18 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 588 \frac{Kg}{m^2} = 823,2 \frac{Kg}{m^2} \Rightarrow 0,82 \frac{t}{m^2}$$

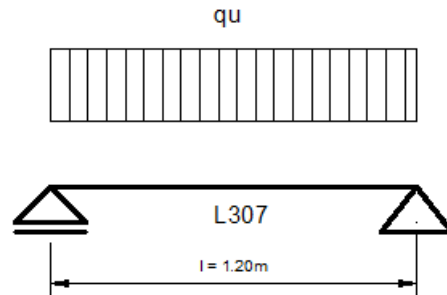
$$Mu_{xe} = \frac{q_u \cdot (l_{menor})^2}{m_{xe}} = \frac{1,18 \frac{t}{m^2} \cdot (3m)^2}{17,67} \boxed{0,60 \frac{t \cdot m}{m}}$$

$$Mu_{ye} = \frac{q_u \cdot (l_{menor})^2}{m_{ye}} = \frac{1,18 \frac{t}{m^2} \cdot (3m)^2}{12,30} \boxed{0,86 \frac{t \cdot m}{m}}$$

$$Mu_x = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,18 \frac{t}{m^2} \cdot (3m)^2}{169,49} \boxed{0,062 \frac{t \cdot m}{m}}$$

$$Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,18 \frac{t}{m^2} \cdot (3m)^2}{25,97} \boxed{0,40 \frac{t \cdot m}{m}}$$

- Losa L307: Azotea accesible privadamente



$$D = 588 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

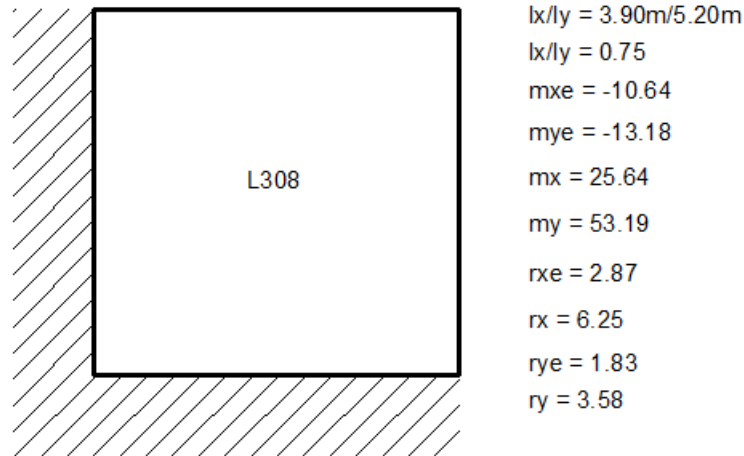
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 588 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1185,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,18 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 588 \frac{Kg}{m^2} = 823,2 \frac{Kg}{m^2} \Rightarrow 0,82 \frac{t}{m^2}$$

$$Mu_{tramo} = \frac{q_u \cdot l^2}{8} = \frac{1,18 \frac{t}{m^2} \cdot (1,20m)^2}{8} = \boxed{0,21 \frac{t \cdot m}{m}}$$



■ Losa L308: Azotea accesible privadamente



$$D = 588 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 588 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1185,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,18 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 588 \frac{Kg}{m^2} = 823,2 \frac{Kg}{m^2} \Rightarrow 0,82 \frac{t}{m^2}$$

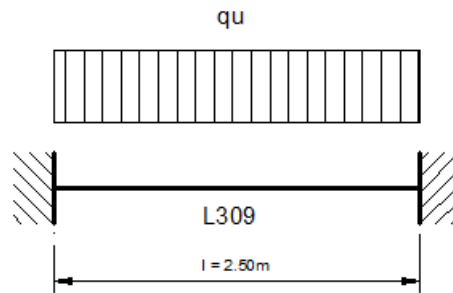
$$Mu_{xe} = \frac{q_u \cdot (l_{menor})^2}{m_{xe}} = \frac{1,18 \frac{t}{m^2} \cdot (3,90m)^2}{10,64} \boxed{1,68 \frac{t \cdot m}{m}}$$

$$Mu_{ye} = \frac{q_u \cdot (l_{menor})^2}{m_{ye}} = \frac{1,18 \frac{t}{m^2} \cdot (3,90m)^2}{13,18} \boxed{1,36 \frac{t \cdot m}{m}}$$

$$Mu_x = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,18 \frac{t}{m^2} \cdot (3,90m)^2}{25,64} \boxed{0,69 \frac{t \cdot m}{m}}$$

$$Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_y} = \frac{1,18 \frac{t}{m^2} \cdot (3,90m)^2}{53,19} \boxed{0,33 \frac{t \cdot m}{m}}$$

- Losa L309: Azotea accesible privadamente



$$D = 588 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

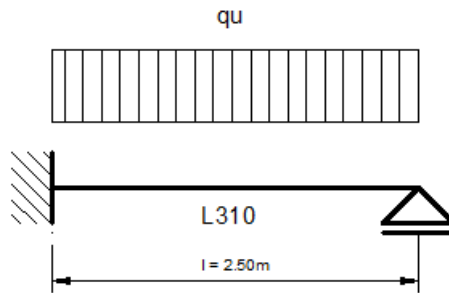
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 588 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1185,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,18 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 588 \frac{Kg}{m^2} = 823,2 \frac{Kg}{m^2} \Rightarrow 0,82 \frac{t}{m^2}$$

$$Mu_{empotrado} = \frac{q_u \cdot l^2}{12} = \frac{1,18 \frac{t}{m^2} \cdot (2,50m)^2}{12} = \boxed{0,61 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = \frac{q_u \cdot l^2}{24} = \frac{1,18 \frac{t}{m^2} \cdot (2,50m)^2}{24} = \boxed{0,30 \frac{t \cdot m}{m}}$$

- Losa L310: Azotea accesible privadamente



$$D = 588 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

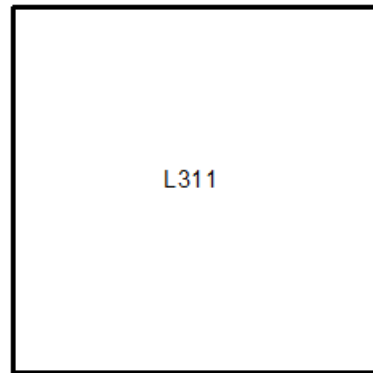
$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 588 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1185,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,18 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 588 \frac{Kg}{m^2} = 823,2 \frac{Kg}{m^2} \Rightarrow 0,82 \frac{t}{m^2}$$

$$Mu_{empotrado} = \frac{q_u \cdot l^2}{8} = \frac{1,18 \frac{t}{m^2} \cdot (2,50m)^2}{8} = \boxed{0,92 \frac{t \cdot m}{m}}$$

$$Mu_{tramo} = \frac{9}{128} \cdot q \cdot l^2 = \frac{9}{128} \cdot 1,18 \frac{t}{m^2} \cdot (2,50m)^2 = \boxed{0,51 \frac{t \cdot m}{m}}$$

- Losa L311: Azotea accesible privadamente



$$l_x/l_y = 3.60\text{m}/3.60\text{m}$$

$$l_x/l_y = 1$$

$$m_x = 27.17$$

$$m_y = 27.17$$

$$r_x = 4$$

$$r_y = 4$$

$$D = 588 \frac{Kg}{m^2}$$

$$L = 300 \frac{Kg}{m^2} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 588 \frac{Kg}{m^2} + 1,6 \cdot 300 \frac{Kg}{m^2} = 1185,6 \frac{Kg}{m^2} \Rightarrow \boxed{1,18 \frac{t}{m^2}}$$

$$q_u = 1,4 \cdot D = 1,4 \cdot 588 \frac{Kg}{m^2} = 823,2 \frac{Kg}{m^2} \Rightarrow 0,82 \frac{t}{m^2}$$

$$Mu_x = Mu_y = \frac{q_u \cdot (l_{menor})^2}{m_x} = \frac{1,18 \frac{t}{m^2} \cdot (3,60\text{m})^2}{27,17} \boxed{0,56 \frac{t \cdot m}{m}}$$

9. Compatibilización de Momentos - Nivel 3

■ Losas L301 y L302

$$(1,95 - 0,92) < 0,40 \cdot \frac{(1,95 + 0,92)}{2}$$

$$1,03 < 0,57 \Rightarrow \text{No Verifica}$$

$$\text{Adopto } \boxed{1.43} \text{ en el apoyo}$$

$$1,09 + (1,95 - 1,43) = 1,61$$

$$\text{Adopto } \boxed{1.61} \text{ en el tramo}$$

■ Losas L304 y L308

$$(1,68 - 1,66) < 0,40 \cdot \frac{(1,68 + 1,66)}{2}$$

$$0,02 < 0,66 \Rightarrow \text{Verifica}$$

$$\text{Adopto } \boxed{1.67} \text{ en el apoyo}$$

$$0,69 + (1,68 - 1,67) = 0,70$$

$$\text{Adopto } \boxed{0.70} \text{ en el tramo}$$

■ Losas L305 y L308

$$(1,36 - 0,89) < 0,40 \cdot \frac{(1,36 + 0,89)}{2}$$

$$0,47 < 0,45 \Rightarrow \text{No Verifica}$$

$$\text{Adopto } \boxed{1.12} \text{ en el apoyo}$$

$$0,33 + (1,36 - 1,12) = 0,57$$

$$\text{Adopto } \boxed{0.57} \text{ en el tramo}$$

■ Losas L305 y L306

$$(0,77 - 0,60) < 0,40 \cdot \frac{(0,77 + 0,60)}{2}$$

$$0,17 < 0,27 \Rightarrow \text{Verifica}$$

$$\text{Adopto } \boxed{0.68} \text{ en el apoyo}$$

$$0,22 + (0,77 - 0,68) = 0,31$$

$$\text{Adopto } \boxed{0.31} \text{ en el tramo}$$

■ Losas L309 y L310

$$(0,92 - 0,61) < 0,40 \cdot \frac{(0,92 + 0,61)}{2}$$

$$0,31 < 0,30 \Rightarrow \text{No Verifica}$$

Adopto 0.76 en el apoyo

$$0,51 + (0,92 - 0,76) = 0,67$$

Adopto 0.67 en el tramo

## 10. Cálculo de Armaduras

### ■ Armadura Superior

$$\begin{aligned}
 M_u &= 1,67 \frac{t \cdot m}{m} \\
 M_n &= \frac{M_u}{\phi} = \frac{1,67 \frac{t \cdot m}{m}}{0,9} = 1,85 \frac{t \cdot m}{m} \Rightarrow 0,0185 \frac{MN \cdot m}{m} \\
 d &= h - db - Cc - \frac{db}{2} = 14cm - 1cm - 2cm - \frac{1cm}{2} = 10,5cm \\
 Kd &= \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0,105m}{\sqrt{\frac{0,0185 \frac{MN \cdot m}{m}}{1m}}} = 0,771 \Rightarrow Ke = 24,856 \\
 A_s &= Ke \cdot \frac{M_n}{d} = 24,856 \cdot \frac{0,0185 \frac{MN \cdot m}{m}}{0,105m} = 4,38 \frac{cm^2}{m} \\
 A_{smin} &= 0,0018 \cdot b \cdot h = 0,0018 \cdot 100cm \cdot 14cm = 2,52 \frac{cm^2}{m}
 \end{aligned}$$

Se adopta A° superior  $\phi$  10 cada 17cm  $\rightarrow \boxed{4,62 \frac{cm^2}{m}}$

### Verificación de separaciones

$$\begin{aligned}
 s = 17cm &\leq \begin{cases} 2,5 \cdot h = 2,5 \cdot 14cm = 35cm & \checkmark \\ 25 \cdot db = 25 \cdot 1cm = 25cm & \checkmark \\ 30cm & \checkmark \end{cases} \\
 s = 17cm &\geq \begin{cases} db = 1cm & \checkmark \\ \geq 2,5cm & \checkmark \\ \geq \frac{4}{3} \cdot \text{Tamaño máximo del agregado} \end{cases}
 \end{aligned}$$

### ■ Armadura Inferior

$$\begin{aligned}
 M_u &= 1,61 \frac{t \cdot m}{m} \\
 M_n &= \frac{M_u}{\phi} = \frac{1,61 \frac{t \cdot m}{m}}{0,9} = 1,78 \frac{t \cdot m}{m} \Rightarrow 0,0178 \frac{MN \cdot m}{m} \\
 d &= h - db - Cc - \frac{db}{2} = 14cm - 1cm - 2cm - \frac{1cm}{2} = 10,5cm \\
 Kd &= \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0,105m}{\sqrt{\frac{0,0178 \frac{MN \cdot m}{m}}{1m}}} = 0,785 \Rightarrow Ke = 24,856 \\
 A_s &= Ke \cdot \frac{M_n}{d} = 24,856 \cdot \frac{0,0178 \frac{MN \cdot m}{m}}{0,105m} = 4,21 \frac{cm^2}{m} \\
 A_{smin} &= 0,0018 \cdot b \cdot h = 0,0018 \cdot 100cm \cdot 14cm = 2,52 \frac{cm^2}{m}
 \end{aligned}$$

Se adopta A° inferior  $\phi$  10 cada 17cm  $\rightarrow$   $\boxed{4,62 \frac{cm^2}{m}}$

Verificación de separaciones

$$s = 17cm \leq \begin{cases} 2,5 \cdot h = 2,5 \cdot 14cm = 35cm & \checkmark \\ 25 \cdot db = 25 \cdot 1cm = 25cm & \checkmark \\ 30cm & \checkmark \end{cases}$$

$$s = 17cm \geq \begin{cases} db = 1cm & \checkmark \\ \geq 2,5cm & \checkmark \\ \geq \frac{4}{3} \cdot \text{Tamaño máximo del agregado} \end{cases}$$



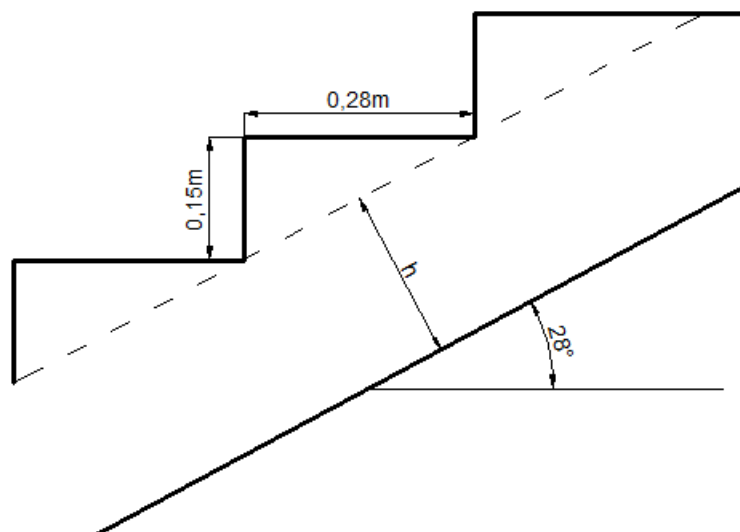
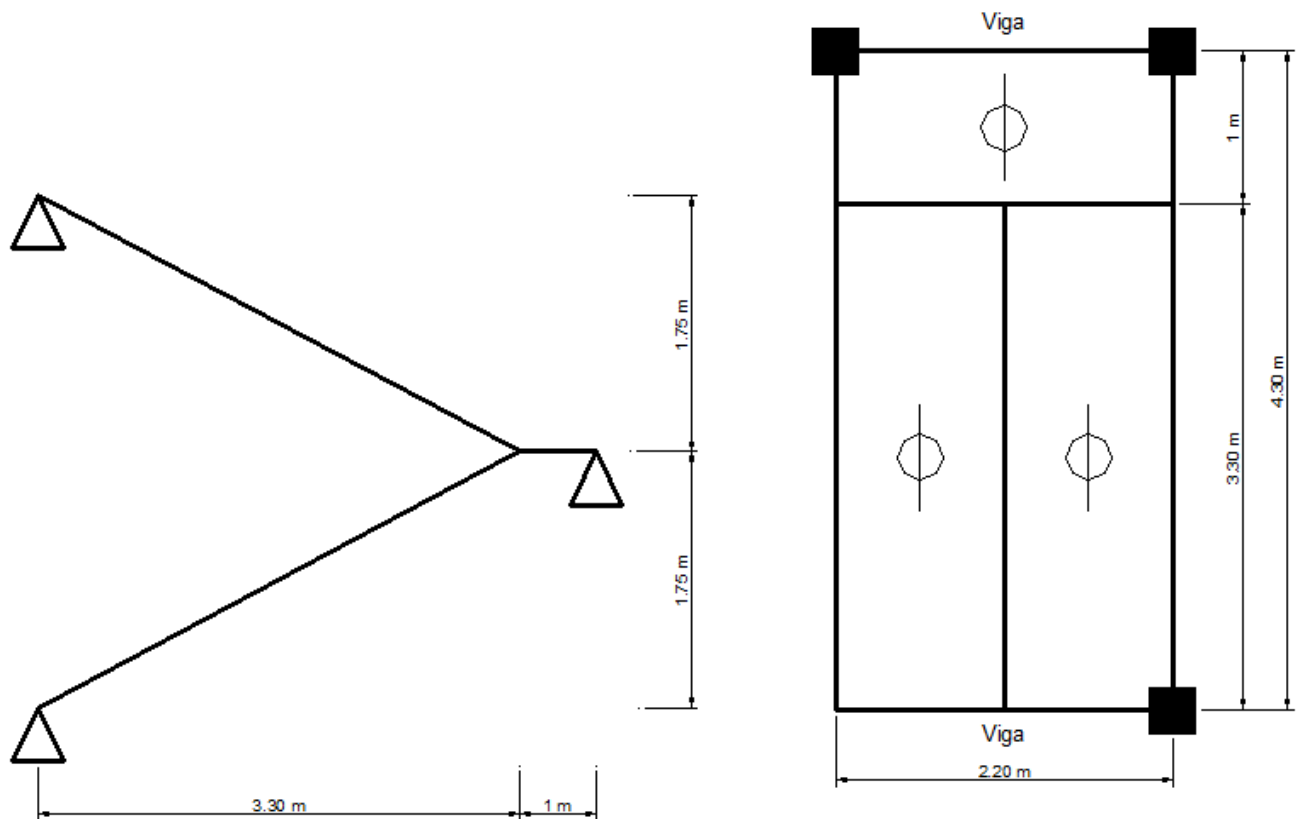
## Losas de Escalera

Datos:

Hormigón H-25  $\Rightarrow f'c = 250 \frac{Kg}{cm^2} = 25 MPa$

Acero ADN 42/50  $\Rightarrow fy = 4200 \frac{Kg}{cm^2} = 420 MPa$

Recubrimiento  $Cc = 2cm$



1. Predimensionado

$$h \geq \frac{l}{20} = \frac{430cm}{20cm} = 21,3cm \quad \text{Adopto} \Rightarrow \boxed{21cm}$$

2. Análisis de cargas

$$\text{Peso propio} \rightarrow 0,21m \cdot \frac{2500 \frac{Kg}{m^3}}{\cos(28^\circ)} = \boxed{595 \frac{Kg}{m^2}}$$

$$\text{Peso propio escalones} \rightarrow \frac{0,15m}{2} \cdot 2200 \frac{Kg}{m^3} = \boxed{165 \frac{Kg}{m^2}}$$

$$\text{Peso propio de carpeta} \rightarrow \frac{(0,282m + 0,15m)}{0,282m} \cdot 0,015m \cdot 2100 \frac{Kg}{m^3} = \boxed{48 \frac{Kg}{m^2}}$$

$$\text{Peso propio de piso} \rightarrow \frac{(0,282m + 0,15m)}{0,282m} \cdot 0,012m \cdot 2800 \frac{Kg}{m^3} = \boxed{51 \frac{Kg}{m^2}}$$

$$\text{Peso propio de cielorraso} \rightarrow 0,02m \cdot \frac{1200 \frac{Kg}{m^3}}{\cos(28^\circ)} = \boxed{27 \frac{Kg}{m^2}}$$

$$D = \boxed{886 \frac{Kg}{m^2}}$$

$$L = \boxed{500 \frac{Kg}{m^2}} \rightarrow \text{Según CIRSOC 101-05 - Capítulo 4}$$

$$q_u = 1,2 \cdot D + 1,6 \cdot L = 1,2 \cdot 886 \frac{Kg}{m^2} + 1,6 \cdot 500 \frac{Kg}{m^2} = \boxed{1863,2 \frac{Kg}{m^2}}$$

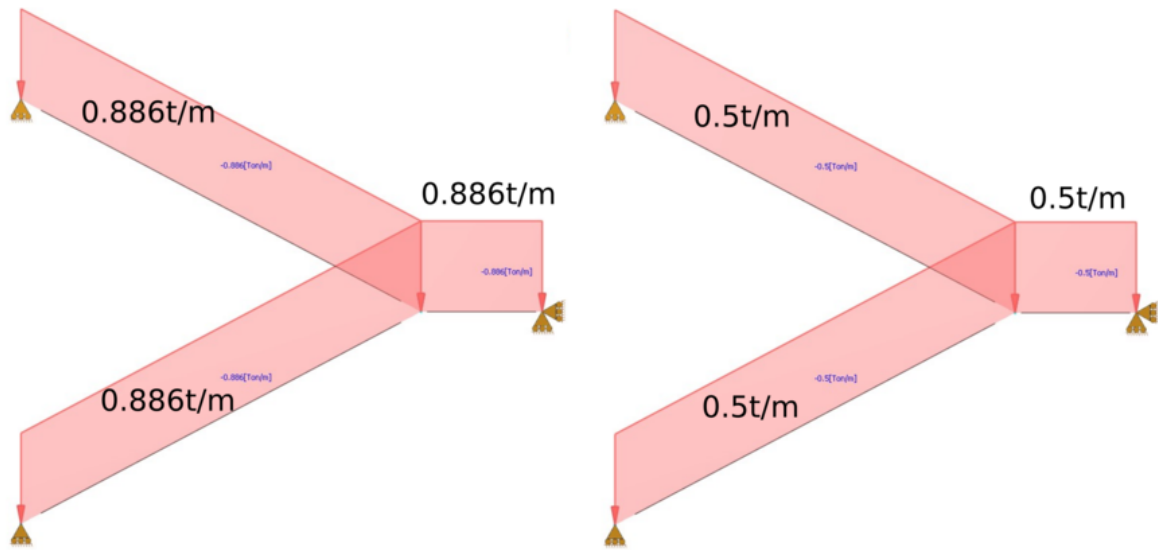
$$q_u = 1,4 \cdot D = 1,4 \cdot 886 \frac{Kg}{m^2} = \boxed{1240,4 \frac{Kg}{m^2}}$$

3. Modelado en RAM

Mediante software se modelo la estructura de escalera con dos sistemas de apoyo, cargando los valores de D y L para luego realizar las combinaciones de carga  $1,2 \cdot D + 1,6 \cdot L$  y  $1,4 \cdot D$

De la modelación por software se obtuvieron los momentos máximos positivos y negativos que se utilizarán para dimensionar las armaduras superior e inferior de las losas de escalera.

### Modelo 1



D = Peso Propio

L = Sobrecarga

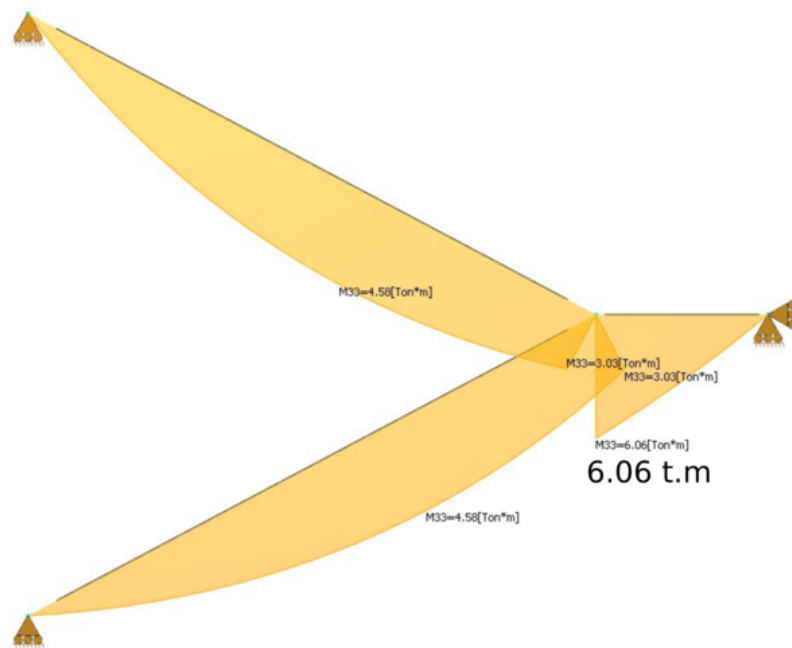
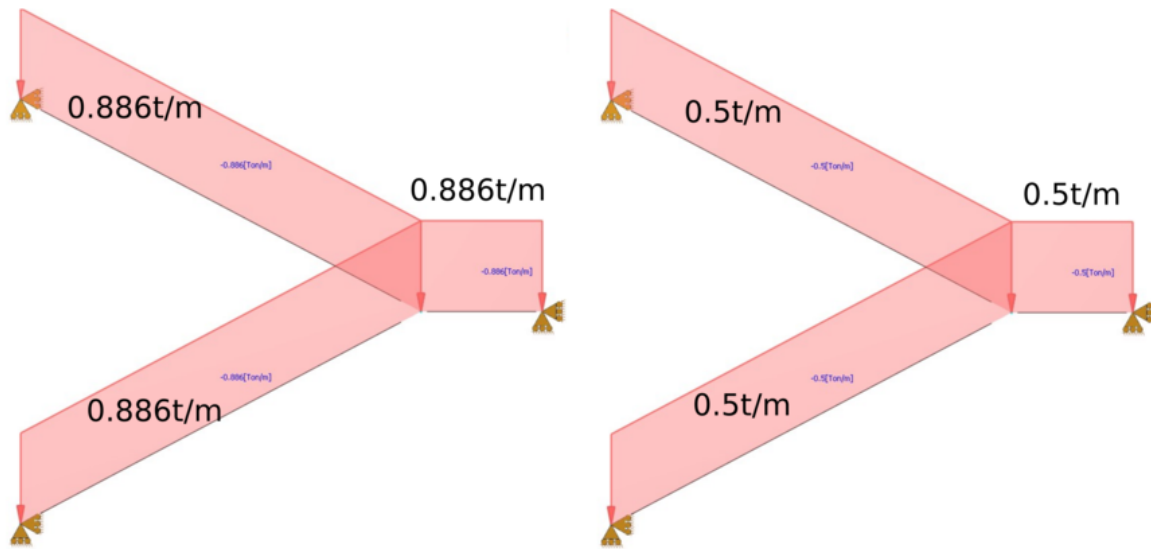


Diagrama de Momentos

## Modelo 2



D = Peso Propio

L = Sobrecarga

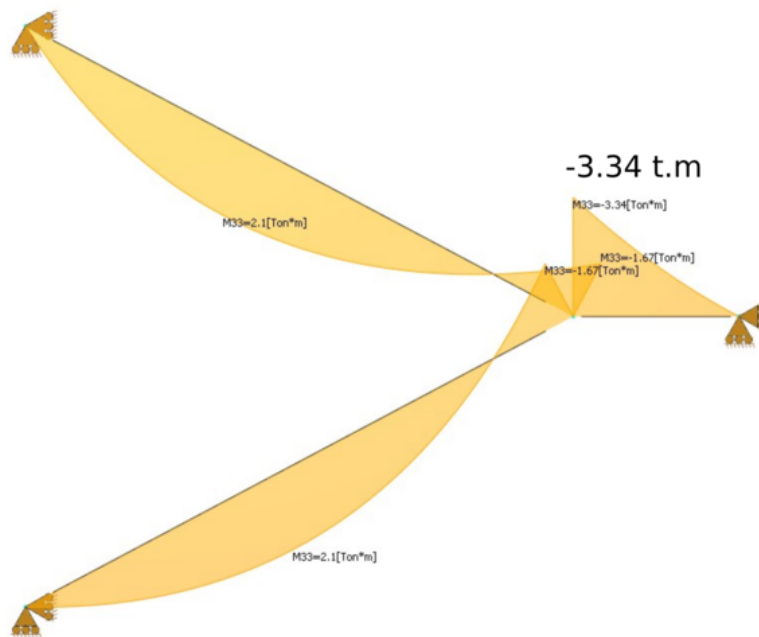


Diagrama de Momentos

### 4. Esfuerzos  ltimos

$$M_u = 6,06 \frac{t \cdot m}{m}$$

$$M_u = -3,34 \frac{t \cdot m}{m}$$

### 5. Armadura Inferior

$$\begin{aligned}
 M_u &= 6,06 \frac{t \cdot m}{m} \\
 M_n &= \frac{M_u}{\phi} = \frac{6,06 \frac{t \cdot m}{m}}{0,9} = 6,73 \frac{t \cdot m}{m} \Rightarrow 0,067 \frac{MN \cdot m}{m} \\
 d &= h - db - Cc - \frac{db}{2} = 21cm - 1,2cm - 2cm - \frac{1cm}{2} = 17,8cm \\
 Kd &= \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0,178m}{\sqrt{\frac{0,067 \frac{MN \cdot m}{m}}{1m}}} = 0,688 \Rightarrow Ke = 25,121 \\
 A_s &= Ke \cdot \frac{M_n}{d} = 25,121 \cdot \frac{0,067 \frac{MN \cdot m}{m}}{0,178m} = 9,46 \frac{cm^2}{m} \\
 A_{s_{min}} &= 0,0018 \cdot b \cdot h = 0,0018 \cdot 100cm \cdot 21cm = 3,78 \frac{cm^2}{m}
 \end{aligned}$$

Se adopta A° inferior  $\phi$  12 cada 12cm  $\rightarrow \boxed{9,48 \frac{cm^2}{m}}$

### Verificación de separaciones

$$\begin{aligned}
 s = 12cm &\leq \begin{cases} 2,5 \cdot h = 2,5 \cdot 21cm = 52,5cm & \checkmark \\ 25 \cdot db = 25 \cdot 1,2cm = 30cm & \checkmark \\ 30cm & \checkmark \end{cases} \\
 s = 12cm &\geq \begin{cases} db = 1,2cm & \checkmark \\ \geq 2,5cm & \checkmark \\ \geq \frac{4}{3} \cdot \text{Tamaño máximo del agregado} \end{cases}
 \end{aligned}$$

### 6. Armadura Superior

$$\begin{aligned}
 M_u &= 3,34 \frac{t \cdot m}{m} \\
 M_n &= \frac{M_u}{\phi} = \frac{3,34 \frac{t \cdot m}{m}}{0,9} = 3,71 \frac{t \cdot m}{m} \Rightarrow 0,037 \frac{MN \cdot m}{m} \\
 d &= h - db - Cc - \frac{db}{2} = 21cm - 1,2cm - 2cm - \frac{1cm}{2} = 17,8cm \\
 Kd &= \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0,178m}{\sqrt{\frac{0,037 \frac{MN \cdot m}{m}}{1m}}} = 0,925 \Rightarrow Ke = 24,583 \\
 A_s &= Ke \cdot \frac{M_n}{d} = 24,583 \cdot \frac{0,037 \frac{MN \cdot m}{m}}{0,178m} = 5,11 \frac{cm^2}{m} \\
 A_{s_{min}} &= 0,0018 \cdot b \cdot h = 0,0018 \cdot 100cm \cdot 21cm = 3,78 \frac{cm^2}{m}
 \end{aligned}$$

Se adopta A° superior  $\phi$  10 cada 15cm  $\rightarrow$   $\boxed{5,24 \frac{cm^2}{m}}$

Verificación de separaciones

$$s = 15cm \leq \begin{cases} 2,5 \cdot h = 2,5 \cdot 21cm = 52,5cm & \checkmark \\ 25 \cdot db = 25 \cdot 1cm = 25cm & \checkmark \\ 30cm & \checkmark \end{cases}$$

$$s = 15cm \geq \begin{cases} db = 1cm & \checkmark \\ \geq 2,5cm & \checkmark \\ \geq \frac{4}{3} \cdot \text{Tamaño máximo del agregado} \end{cases}$$

7. Armadura Transversal de repartición

$$As_{min} = 0,0018 \cdot b \cdot h = 0,0018 \cdot 100cm \cdot 21cm = 3,78 \frac{cm^2}{m}$$

Se adopta A° transversal de repartición  $\phi$  8 cada 12cm  $\rightarrow$   $\boxed{4,19 \frac{cm^2}{m}}$  inferiores

Verificación de separaciones

$$s = 12cm \leq \begin{cases} 2,5 \cdot h = 2,5 \cdot 21cm = 52,5cm & \checkmark \\ 25 \cdot db = 25 \cdot 0,8cm = 20cm & \checkmark \\ 30cm & \checkmark \end{cases}$$

$$s = 12cm \geq \begin{cases} db = 0,8cm & \checkmark \\ \geq 2,5cm & \checkmark \\ \geq \frac{4}{3} \cdot \text{Tamaño máximo del agregado} \end{cases}$$