HORMIGÓN ARMADO I

Edificio

Integrantes:

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Memoria de Cálculo de la Estructura

Descripción de la Estructura

La presente memoria tiene por objeto la descripción y justificación de los distintos elementos que configuran la estructura del proyecto para la construcción de un edificio compuesto por planta baja, planta alta y azotea accesible, destinado a departamentos habitacionales.

Estructura

La estructura del edificio es una construcción de hormigón armado a base de bases aisladas, columnas, vigas y losas.

Medios usados en el cálculo de la estructura

Para el cálculo de las solicitaciones de las losas cruzadas se utilizaron las tablas Ertürk.

Para la determinación de las solicitaciones de las losas derechas y vigas se utilizó el software Ftool.

Hipótesis de cálculo

Las hipótesis de cálculo consideradas se ajustan a los criterios del reglamento CIRSOC 201.

Para las cargas permanentes y variables se han seguido los pesos específicos y sobrecargas del CIRSOC 101.

No se han considerado las acciones sísmicas o de viento.

Materiales a emplear

El hormigón adoptado para todos los elementos es un H-25.

El acero utilizado será ADN 420 para las barras y mallas Acindar T-500 para las esquinas de las losas cruzadas.

Losas

Para la determinación de las solicitaciones de losas cruzadas se utilizaron las tablas de Ertürk.

Predimensionado

$l_n = 5{,}20\ m = 5200\ mm$

$\beta = \frac{5{,}20\ m}{3{,}17\ m} = 1{,}64$

$h \geq \frac{l_n\left(0{,}8 + \frac{fy}{1400}\right)}{36 + 9\beta} = \frac{5200\ mm\left(0{,}8 + \frac{420\ MPa}{1400}\right)}{36 + 9 * 1{,}64} = 112{,}69\ mm$

Adopto h = 12 cm

Losas L01-L02 IDEM L06-07 ‖ L11-L12 ‖ L16-L17

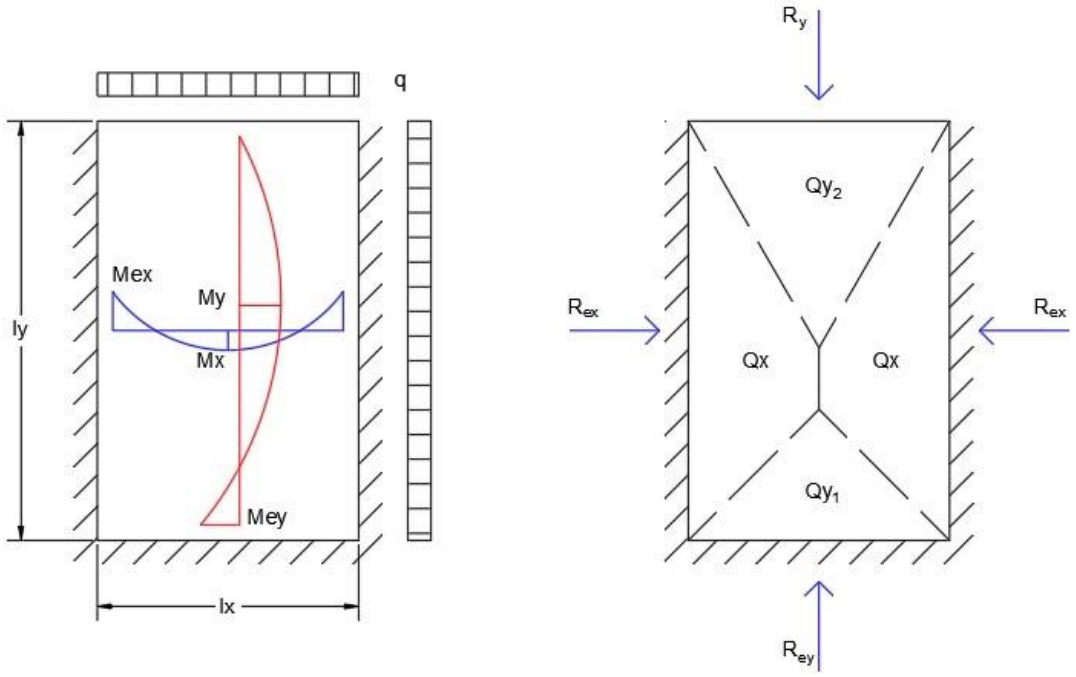
- Análisis de Carga

	Espesor (m)	Peso Específico (kN/m^3)	Peso (kN/m^2)
Piso	0,012	23	0,28
Carpeta	0,025	19	0,48
Contrapiso	0,07	18	1,26
Losa	0,12	25	3
Cielorraso	0,02	-	0,2

D=	5,22
L =	2

- Solicitaciones

De tabla 19:



$$\frac{l_y}{l_x} = \frac{5{,}40\ m}{3{,}37\ m} = 1{,}6$$

$$M_i = \eta_i * Q$$

$$Q_i = \gamma_i * Q$$

Carga Permanente

q= 5,22 kN/m²

$$Q = q * l_x * l_y = 5{,}22\frac{kN}{m^2} * 3{,}37\ m * 5{,}40\ m = 95kN$$

η_{ex}	-0,051
η_{ey}	-0,0355
η_x	0,0238
η_y	0,0042
γ_x	0,377

M_{ex}	-4,84
M_{ey}	-3,37
M_x	2,26
M_y	0,40
Q_x	35,81

	ɣy1	0,156		Qy1	14,82
	ɣy2	0,09		Qy2	8,55

$$R_{ex} = \frac{Q_x}{l_y} = \frac{35{,}81\ kN}{5{,}40\ m} = 6{,}63\ kN/m$$

$$R_{ey} = \frac{Q_{ɣ1}}{l_x} = \frac{14{,}82\ kN}{3{,}37\ m} = 4{,}39\ kN/m$$

$$R_y = \frac{Q_{ɣ2}}{l_x} = \frac{8{,}55\ kN}{3{,}37\ m} = 2{,}53\ kN/m$$

Sobrecarga

q= 2 kN/m²

$$Q = q * l_x * l_y = 2\frac{kN}{m^2} * 3{,}37\ m * 5{,}40\ m = 37\ kN$$

	ηex	-0,051		Mex	-1,89
	ηey	-0,0355		Mey	-1,31
	ηx	0,0238		Mx	0,88
	ηy	0,0042		My	0,16
	ɣx	0,377		Qx	13,95
	ɣy1	0,156		Qy1	5,77
	ɣy2	0,09		Qy2	3,33

$$R_{ex} = \frac{Q_x}{l_y} = \frac{13{,}95\ kN}{5{,}40\ m} = 2{,}58\ kN/m$$

$$R_{ey} = \frac{Q_{ɣ1}}{l_x} = \frac{5{,}77\ kN}{3{,}37\ m} = 1{,}71\ kN/m$$

$$R_y = \frac{Q_{ɣ2}}{l_x} = \frac{3{,}33\ kN}{3{,}37\ m} = 0{,}99\ kN/m$$

Cargas Últimas

$U = 1{,}2 * D + 1{,}6 * L$

Mu_{ex}	-8,83	kNm/m
Mu_{ey}	-6,15	kNm/m
Mu_{x}	4,12	kNm/m
Mu_{y}	0,73	kNm/m
Ru_{ex}	12,09	kN/m
Ru_{ey}	8,02	kN/m
Ru_{y}	4,63	kN/m

Losas L03-L04 IDEM L08-09 ‖ L13-L14 ‖ L18-L19

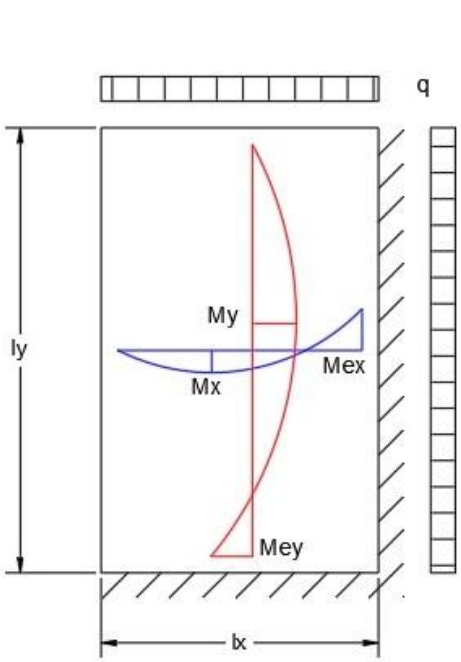
- Análisis de Carga

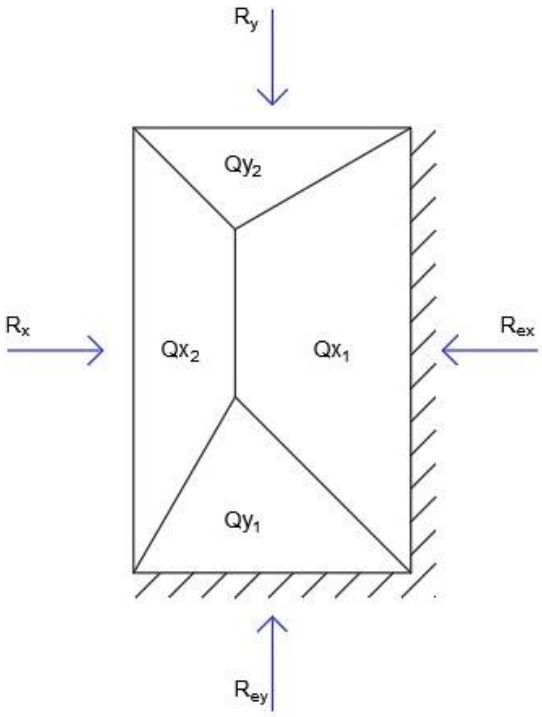
	Espesor (m)	Peso Específico (kN/m^3)	Peso (kN/m^2)
Piso	0,012	23	0,28
Carpeta	0,025	19	0,48
Contrapiso	0,07	18	1,26
Losa	0,12	25	3
Cielorraso	0,02	-	0,2

D=	5,22
L =	2

- Solicitaciones

De tabla 15





$$\frac{l_y}{l_x} = \frac{5{,}40\ m}{3{,}37\ m} = 1{,}6$$

$$M_i = \eta_i * Q$$

$$Q_i = \gamma_i * Q$$

Carga Permanente

q= 5,22 kN/m²

$$Q = q * l_x * l_y = 5{,}22\frac{kN}{m^2} * 3{,}37\ m * 5{,}40\ m = 95kN$$

η_{ex}	-0,0685
η_{ey}	-0,0503
η_x	0,03
η_y	0,0088
γ_{x1}	0,436
γ_{x2}	0,252

M_{ex}	-6,51
M_{ey}	-4,78
M_x	2,85
M_y	0,84
Q_{x1}	41,42
Q_{x2}	23,94

γ_{y1}	0,198
γ_{y2}	0,114

Q_{y1}	18,81
Q_{y2}	10,83

$$R_{ex} = \frac{Q_{x1}}{l_y} = \frac{41{,}42\ kN}{5{,}40\ m} = 7{,}67\ kN/m$$

$$R_x = \frac{Q_{x2}}{l_y} = \frac{23{,}94\ kN}{5{,}40\ m} = 4{,}43\ kN/m$$

$$R_{ey} = \frac{Q_{\gamma 1}}{l_x} = \frac{18{,}81\ kN}{3{,}37\ m} = 5{,}58\ kN/m$$

$$R_y = \frac{Q_{\gamma 2}}{l_x} = \frac{10{,}83\ kN}{3{,}37\ m} = 3{,}21\ kN/m$$

Sobrecarga

q= 2 kN/m²

$$Q = q * l_x * l_y = 2\frac{kN}{m^2} * 3{,}37\ m * 5{,}40\ m = 37\ kN$$

η_{ex}	-0,0685
η_{ey}	-0,0503
η_x	0,03
η_y	0,0088
γ_{x1}	0,436
γ_{x2}	0,252
γ_{y1}	0,198
γ_{y2}	0,114

M_{ex}	-2,49
M_{ey}	-1,83
M_x	1,09
M_y	0,32
Q_{x1}	15,87
Q_{x2}	9,17
Q_{y1}	7,21
Q_{y2}	4,15

$$R_{ex} = \frac{Q_{x1}}{l_y} = \frac{15{,}87\ kN}{5{,}40\ m} = 2{,}94\ kN/m$$

$$R_x = \frac{Q_{x2}}{l_y} = \frac{9{,}17\ kN}{5{,}40\ m} = 1{,}70\ kN/m$$

$$R_{ey} = \frac{Q_{\gamma 1}}{l_x} = \frac{7{,}21\ kN}{3{,}37\ m} = 2{,}14\ kN/m$$

$$R_y = \frac{Q_{Y2}}{l_x} = \frac{4{,}15\ kN}{3{,}37\ m} = 1{,}23\ kN/m$$

Cargas Últimas

$U = 1{,}2 * D + 1{,}6 * L$

Mu_{ex}	-11,80	kNm/m
Mu_{ey}	-8,66	kNm/m
Mu_x	5,17	kNm/m
Mu_y	1,52	kNm/m
Ru_{ex}	13,90	kN/m
Ru_x	8,04	kN/m
Ru_{ey}	10,12	kN/m
Ru_y	5,83	kN/m

Losa L05 IDEM L010 ‖ L15 ‖ L110

- Predimensionado

  Para losas macizas armadas en una dirección en voladizo:

  $h \geq \frac{l}{10} = \frac{130\ cm}{10} = 13\ cm$

  Para mantener el mismo espesor de losa adopto h = 12 cm.

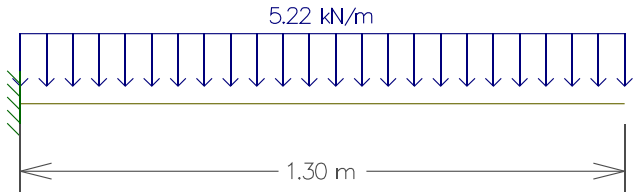
- Análisis de Cargas

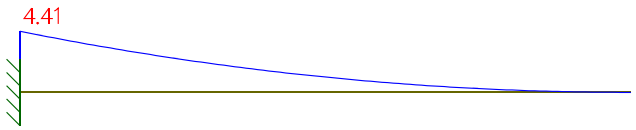
	Espesor (m)	Peso Específico (kN/m^3)	Peso (kN/m^2)
Piso	0,012	23	0,28
Carpeta	0,025	19	0,48
Contrapiso	0,07	18	1,26
Losa	0,12	25	3
Cielorraso	0,02	-	0,2

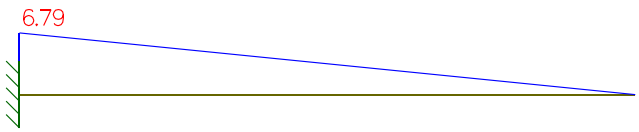
D=	5,22
L =	5

- Solicitaciones

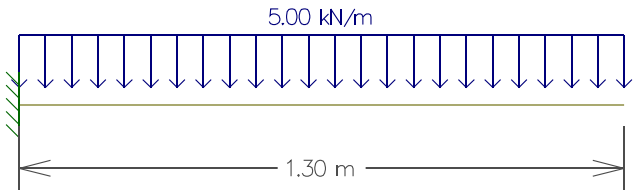
Cargas Permanentes

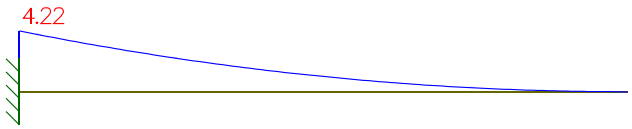


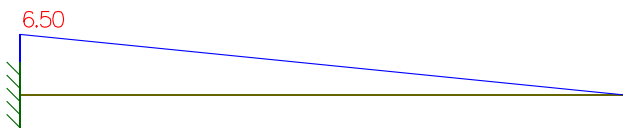




Sobrecargas







Cargas Últimas

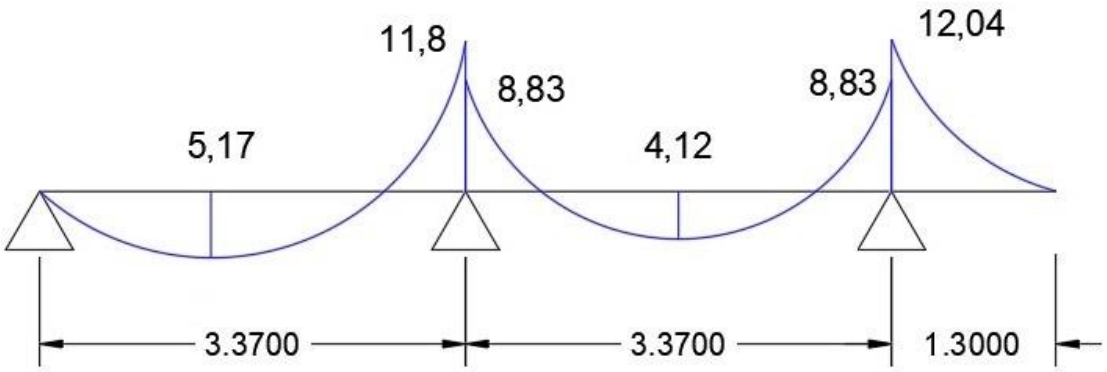
$U = 1{,}2 * D + 1{,}6 * L$

$M_u = 1{,}2 * 4{,}41 + 1{,}6 * 4{,}22 = 12{,}04\ kNm/m$

$R_u = 1{,}2 * 6{,}79 + 1{,}6 * 6{,}5 = 18{,}55\ kN/m$

- Dimensionamiento a Flexión

  En dirección “x”



Consideraciones

Encuentro L01-L03

$$\frac{M_{máx} - M_{mín}}{M_{máx} + M_{mín}} = \frac{11{,}8 - 8{,}83}{11{,}8 + 8{,}83} = 0{,}14 < 0{,}2$$

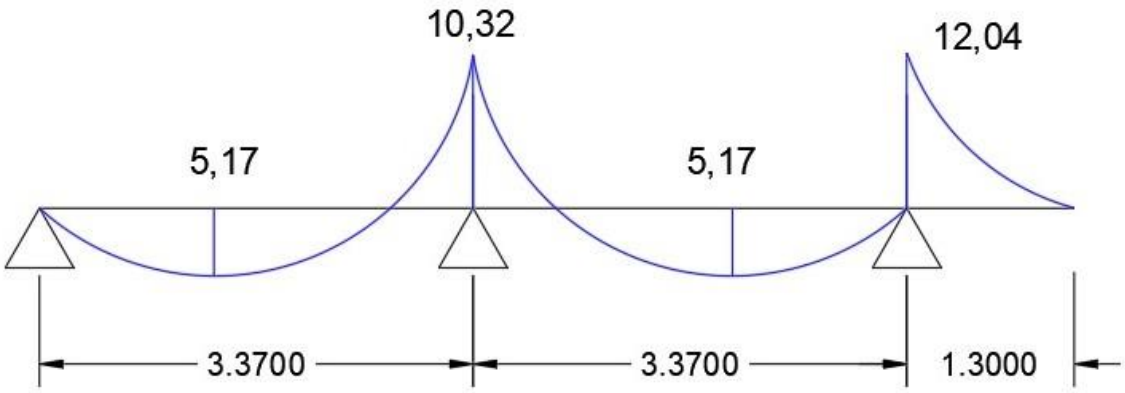
$$\therefore\ M_{prom} = \frac{M_{máx} + M_{mín}}{2} = \frac{(11{,}8 + 8{,}83)kNm/m}{2} = 10{,}32\ kNm/m$$

Encuentro L01-L05

Se diseña con el momento del voladizo ya que no es posible la redistribución de esfuerzos.

Tramos

Se diseña el tramo de la losa L01 con el mayor momento de tramo ya que no siempre estará actuado la carga total del voladizo.



Tramo

$$M_n = \frac{M_u}{\varphi} = \frac{5{,}17\ kNm/m}{0{,}9} = 5{,}74 kNm = 0{,}00574\ MNm/m$$

$$d = h - c_c - \frac{1}{2} d_b = 12\ cm - 2{,}5\ cm - 0{,}5\ cm = 9\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}09\ m}{\sqrt{\frac{0{,}00574\ MNm/m}{1\ m}}} = 1{,}19$$

De tabla de Flexión 3: $k_e = 24{,}301\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}301\ {cm^2}/{MN} * \frac{0{,}00574 {MNm}/{m}}{0{,}09\ m} = 1{,}55\ cm^2/m$$

$$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 12\ cm = 2{,}16\ cm^2/m$$

Adopto 1 Ø6 c/ 13 cm ($A_s = 2{,}17\ cm^2/m$)

Verificación de la separación de la armadura

S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 120\ mm = 240\ mm \\ \leq 25 d_b = 25 * 6\ mm = 150\ mm \\ \leq 300\ mm \end{cases}$$

Verifica

Apoyo L01-L03

$$M_n = \frac{M_u}{\varphi} = \frac{10{,}32\ kNm/m}{0{,}9} = 11{,}47 kNm = 0{,}01147\ MNm/m$$

$$d = h - c_c - \frac{1}{2} d_b = 12\ cm - 2{,}5\ cm - 0{,}5\ cm = 9\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}09\ m}{\sqrt{\frac{0{,}01147\ MNm/m}{1\ m}}} = 0{,}84$$

De tabla de Flexión 3: $k_e = 24{,}766\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}766\ {}^{cm^2}/_{MN} * \frac{0{,}01147 {}^{MNm}/_{m}}{0{,}09\ m} = 3{,}16\ cm^2/m$$

$$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 12\ cm = 2{,}16\ cm^2/m$$

Adopto 1 Ø8 c/ 15 cm ($A_s = 3{,}35\ cm^2/m$)

Verificación de la separación de la armadura

S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 120\ mm = 240\ mm \\ \leq 25 d_b = 25 * 8\ mm = 200\ mm \\ \leq 300\ mm \end{cases}$$

Verifica

Apoyo L01-L05

$$M_n = \frac{M_u}{\varphi} = \frac{12{,}04\ kNm/m}{0{,}9} = 13{,}38 kNm = 0{,}01338\ MNm/m$$

$$d = h - c_c - \frac{1}{2} d_b = 12\ cm - 2{,}5\ cm - 0{,}5\ cm = 9\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}09\ m}{\sqrt{\frac{0{,}01338\ MNm/m}{1\ m}}} = 0{,}78$$

De tabla de Flexión 3: $k_e = 25{,}207\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 25{,}207\ {cm^2}/{MN} * \frac{0{,}01338 MNm/m}{0{,}09\ m} = 3{,}75\ cm^2/m$$

$$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 12\ cm = 2{,}16\ cm^2/m$$

Adopto 1 Ø8 c/ 13 cm ($A_s = 3{,}87\ cm^2/m$)

En el voladizo se colocará armadura de repartición igual a 1 Ø6 c/ 13 cm ($A_s = 2{,}17\ cm^2/m$)

Verificación de la separación de la armadura

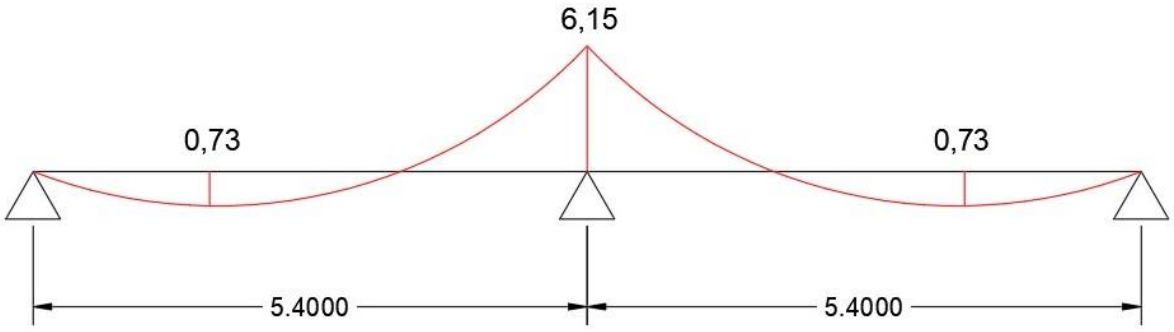
S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 120\ mm = 240\ mm \\ \leq 25 d_b = 25 * 8\ mm = 200\ mm \\ \leq 300\ mm \end{cases}$$

Verifica

En dirección "y"

Losas L01-L02



Tramo

Por ser muy bajo el momento se adopta armadura mínima por contracción y temperatura.

$$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 12\ cm = 2{,}16\ cm^2/m$$

Adopto 1 Ø6 c/ 13 cm ($A_s = 2{,}17\ cm^2/m$)

Verificación de la separación de la armadura

S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 120\ mm = 240\ mm \\ \leq 25d_b = 25 * 6\ mm = 150\ mm \\ \leq 300\ mm \end{cases}$$ **Verifica**

Apoyo L01-L02

$$M_n = \frac{M_u}{\varphi} = \frac{6{,}15\ kNm/m}{0{,}9} = 6.83\ kNm = 0{,}00683\ MNm/m$$

$$d = h - c_c - 1{,}5d_b = 12\ cm - 2{,}5\ cm - 1{,}5 * 1\ cm = 8\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}08\ m}{\sqrt{\frac{0{,}00683\ MNm/m}{1\ m}}} = 0{,}97$$

De tabla de Flexión 3: $k_e = 24{,}766\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}766\ {}^{cm^2}/_{MN} * \frac{0{,}00683 {}^{MNm}/_{m}}{0{,}08\ m} = 2{,}11\ cm^2/m$$

$$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 12\ cm = 2{,}16\ cm^2/m$$

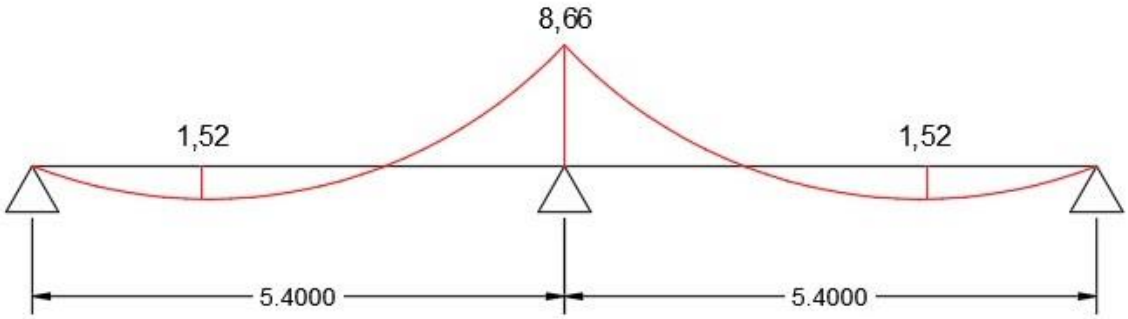
Adopto 1 Ø6 c/ 13 cm ($A_s = 2{,}17\ cm^2/m$)

Verificación de la separación de la armadura

S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 120\ mm = 240\ mm \\ \leq 25d_b = 25 * 6\ mm = 150\ mm \\ \leq 300\ mm \end{cases}$$ **Verifica**

Losas L03-L04



Tramo

Por ser muy bajo el momento se adopta armadura mínima por contracción y temperatura.

$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 12\ cm = 2{,}16\ cm^2/m$

Adopto 1 Ø6 c/ 13 cm ($A_s = 2{,}17\ cm^2/m$)

Verificación de la separación de la armadura

S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 120\ mm = 240\ mm \\ \leq 25d_b = 25 * 6\ mm = 150\ mm \\ \leq 300\ mm \end{cases}$$

Verifica

Apoyo L03-L04

$M_n = \frac{M_u}{\varphi} = \frac{8{,}66\ kNm/m}{0{,}9} = 9{,}62\ kNm = 0{,}00962\ MNm/m$

$d = h - c_c - 1{,}5d_b = 12\ cm - 2{,}5\ cm - 1{,}5 * 1\ cm = 8\ cm$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}08\ m}{\sqrt{\frac{0{,}00962\ MNm/m}{1\ m}}} = 0{,}81$$

De tabla de Flexión 3: $k_e = 24{,}766\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}766\ {}^{cm^2}/_{MN} * \frac{0{,}00962 {}^{MNm}/_{m}}{0{,}08\ m} = 2{,}98\ cm^2/m$$

$$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 12\ cm = 2{,}16\ cm^2/m$$

Adopto 1 Ø8 c/ 16,5 cm ($A_s = 3{,}05\ cm^2/m$)

Verificación de la separación de la armadura

S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 120\ mm = 240\ mm \\ \leq 25d_b = 25 * 8\ mm = 200\ mm \\ \leq 300\ mm \end{cases}$$

Verifica

- Dimensionamiento al Corte

  El máximo corte último es:

  $V_u = 13{,}90\ {}^{kN}/_{m}$

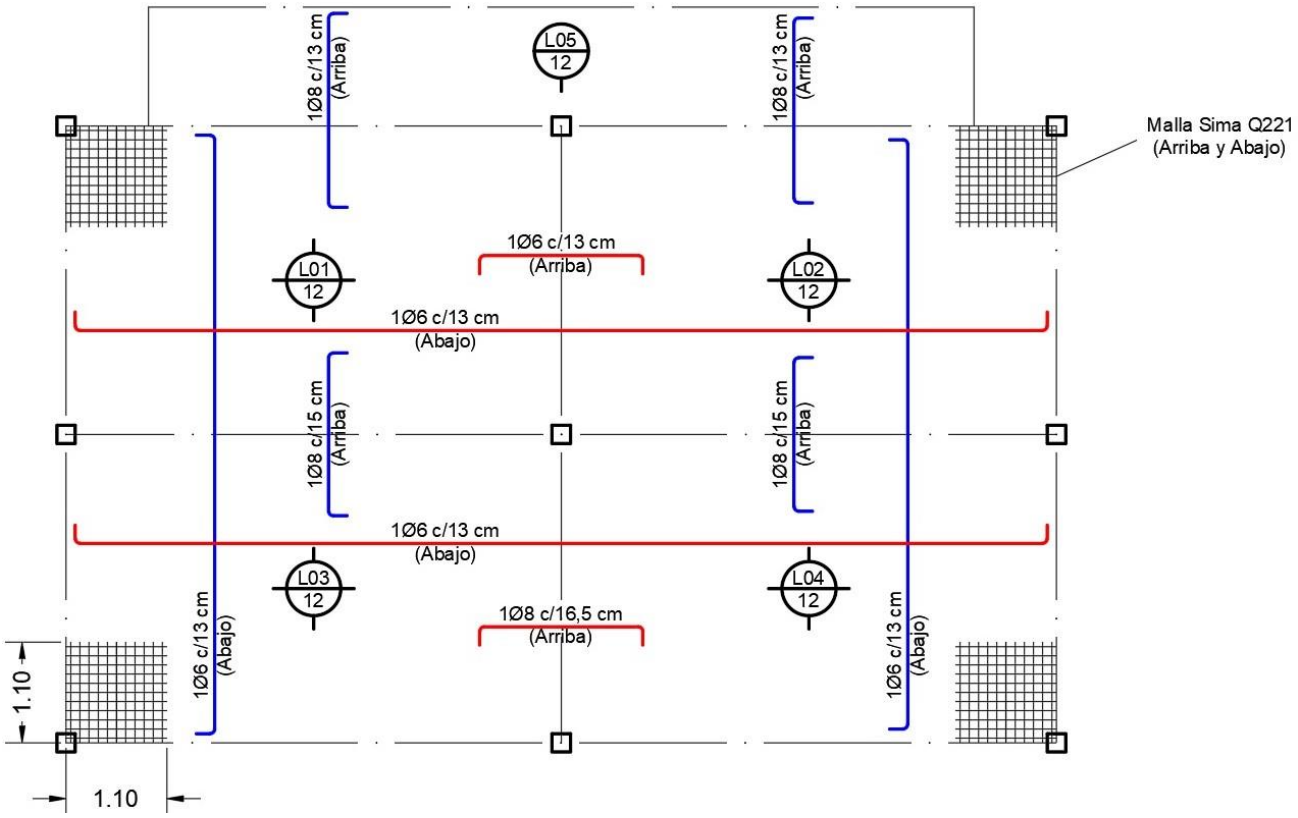
  $V_n = \frac{V_u}{\varphi} = \frac{13{,}90\ kN/m}{0{,}75} = 18{,}53\ {}^{kN}/_{m} = 0{,}01853\ MN/m$

  $V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 1\ m * 0{,}12\ m = 0{,}10\ MN\ >\ V_n$

  No es necesaria armadura de corte.

- Detalle de Armado

  Se coloca como armadura adicional en las esquinas una malla Sima Q221 ($A_s = 2{,}21\ cm^2/m$) a una distancia, en cada dirección, igual a 1,10 m.



Losa L011 IDEM L111

- Predimensionado

  Para losas macizas armadas en una dirección en voladizo:

  $$h \geq \frac{l}{20} = \frac{178\ cm}{20} = 8{,}9\ cm$$

  Adopto h = 10 cm

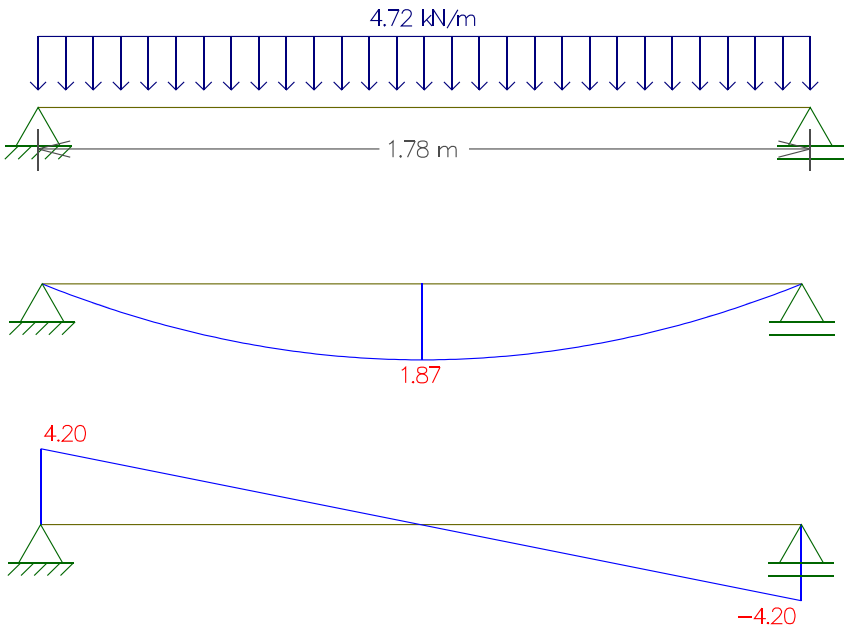
- Análisis de Cargas

	Espesor (m)	Peso Específico (kN/m^3)	Peso (kN/m^2)
Piso	0,012	23	0,28
Carpeta	0,025	19	0,48
Contrapiso	0,07	18	1,26
Losa	0,10	25	2,5
Cielorraso	0,02	-	0,2

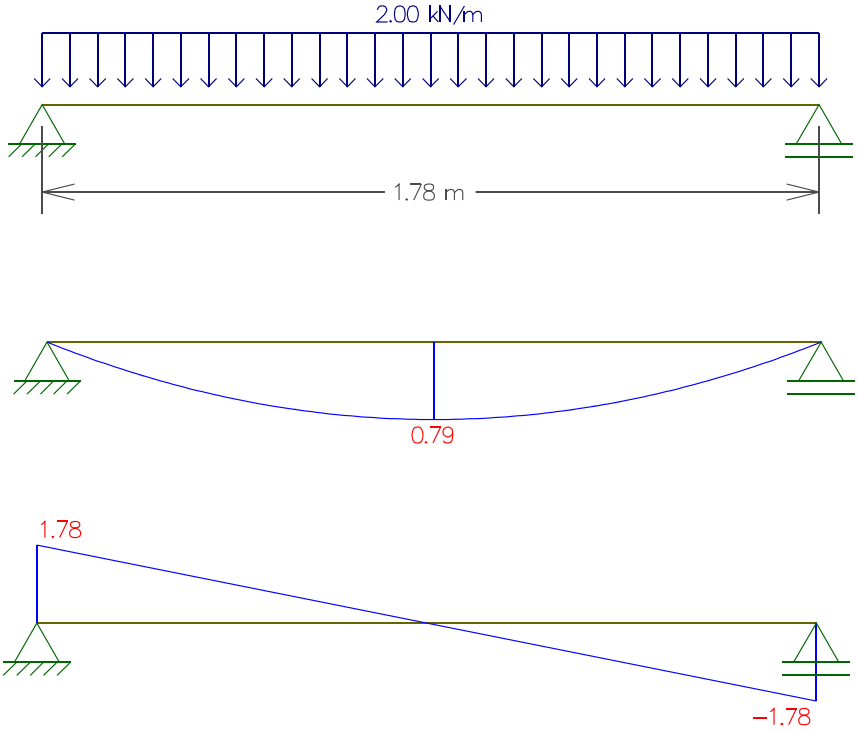
D=	4,72
L =	2

- Solicitaciones

Cargas Permanentes



Sobrecargas



Cargas Últimas

$U = 1{,}2 * D + 1{,}6 * L$

$M_u = 1{,}2 * 1{,}87 + 1{,}6 * 0{,}79 = 3{,}51\ kNm/m$

$V_u = 1{,}2 * 4{,}20 + 1{,}6 * 1{,}78 = 7{,}89\ kN/m$

- Dimensionamiento a Flexión

Tramo

Por ser muy bajo el momento se adopta armadura mínima por contracción y temperatura.

$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 10\ cm = 1{,}8\ cm^2/m$

Adopto 1 Ø6 c/ 15 cm ($A_s = 1{,}89\ cm^2/m$)

Armadura de repartición

Adopto 1 Ø6 c/ 15 cm ($A_s = 1{,}89\ cm^2/m$)

Verificación de la separación de la armadura

S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 100\ mm = 200\ mm \\ \leq 25d_b = 25 * 6\ mm = 150\ mm \\ \leq 300\ mm \end{cases}$$

Verifica

- Dimensionamiento al Corte

El máximo corte último es:

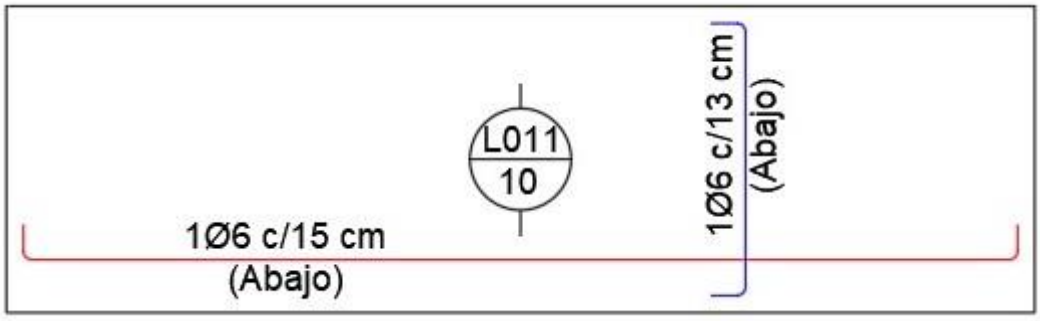
$V_u = 7{,}89\ {}^{kN}/_{m}$

$V_n = \frac{V_u}{\varphi} = \frac{7{,}89\ kN/m}{0{,}75} = 10{,}52\ {}^{kN}/_{m} = 0{,}01052\ MN/m$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 1\ m * 0{,}10\ m = 0{,}083\ MN\ >\ V_n$

No es necesaria armadura de corte.

- Detalle de Armado



Losas L012 IDEM L013 ‖ L112 ‖ L113

- Predimensionado

Para losas macizas armadas en una dirección en voladizo:

$$h \geq \frac{l}{20} = \frac{143\ cm}{20} = 7{,}15\ cm$$

Adopto h = 10 cm

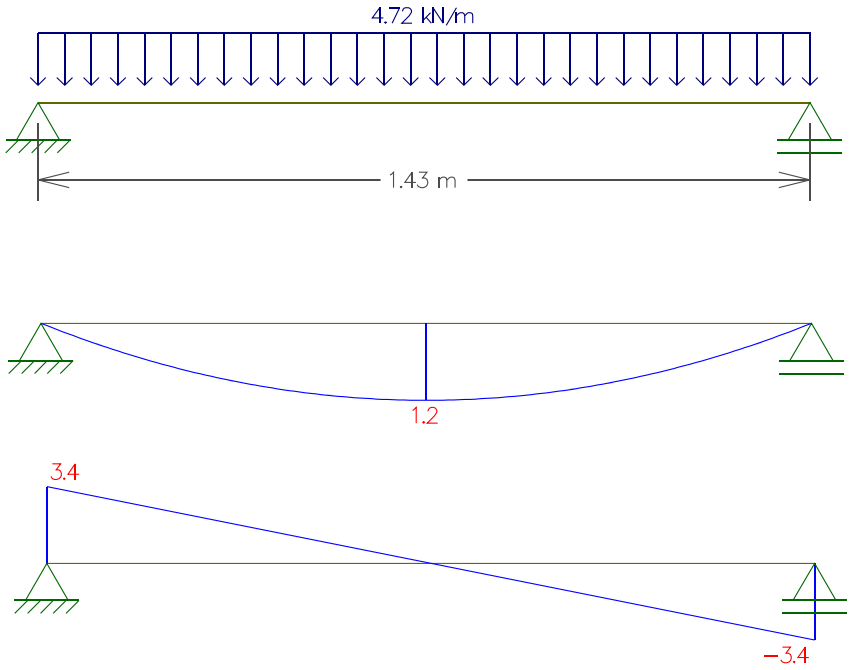
- Análisis de Cargas

	Espesor (m)	Peso Específico (kN/m^3)	Peso (kN/m^2)
Piso	0,012	23	0,28
Carpeta	0,025	19	0,48
Contrapiso	0,07	18	1,26
Losa	0,10	25	2,5
Cielorraso	0,02	-	0,2

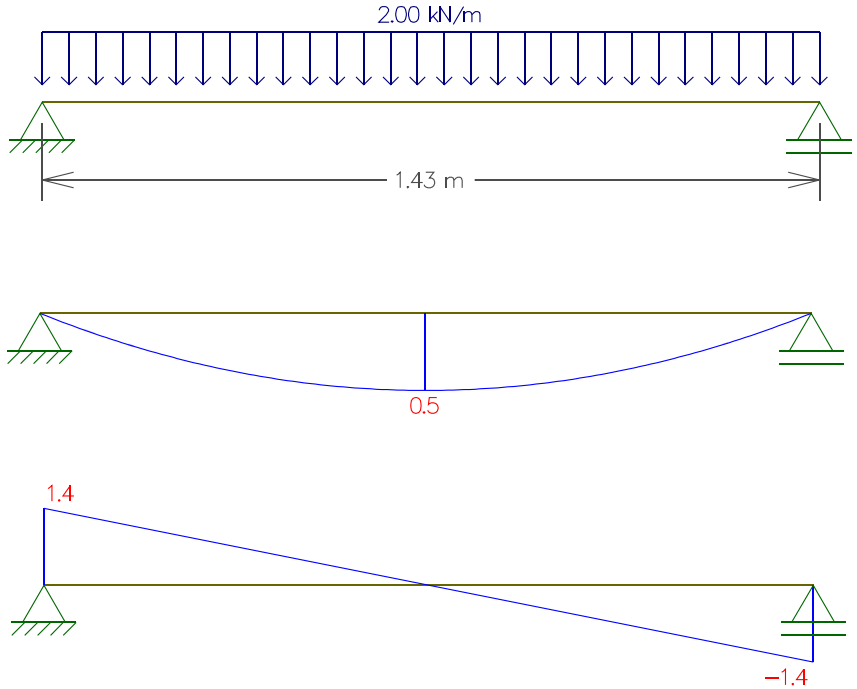
D=	4,72
L =	2

- Solicitaciones

Cargas Permanentes



Sobrecargas



Cargas Últimas

$U = 1{,}2 * D + 1{,}6 * L$

$M_u = 1{,}2 * 1{,}2 + 1{,}6 * 0{,}5 = 2{,}24\ kNm/m$

$V_u = 1{,}2 * 3{,}40 + 1{,}6 * 1{,}4 = 6{,}32\ kN/m$

- Dimensionamiento a Flexión

Tramo

Por ser muy bajo el momento se adopta armadura mínima por contracción y temperatura.

$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 10\ cm = 1{,}8\ cm^2/m$

Adopto 1 Ø6 c/ 15 cm ($A_s = 1{,}89\ cm^2/m$)

Armadura de repartición

Adopto 1 Ø6 c/ 15 cm ($A_s = 1{,}89\ cm^2/m$)

Verificación de la separación de la armadura

S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 100\ mm = 200\ mm \\ \leq 25d_b = 25 * 6\ mm = 150\ mm \\ \leq 300\ mm \end{cases}$$

Verifica

- Dimensionamiento al Corte

El máximo corte último es:

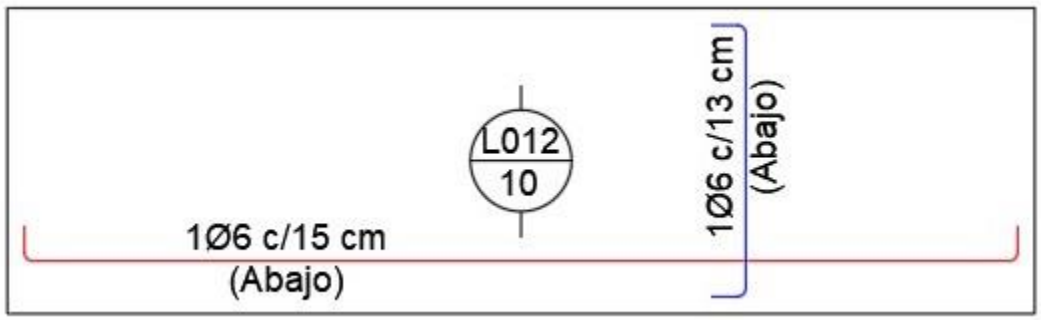
$V_u = 6{,}32\ {}^{kN}/_{m}$

$V_n = \frac{V_u}{\varphi} = \frac{6{,}32\ kN/m}{0{,}75} = 8{,}43\ {}^{kN}/_{m} = 0{,}00843\ MN/m$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 1\ m * 0{,}10\ m = 0{,}083\ MN\ >\ V_n$

No es necesaria armadura de corte.

- Detalle de Armado



Losa L214

- Predimensionado

Para losas macizas armadas en una dirección en voladizo:

$$h \geq \frac{l}{20} = \frac{178\ cm}{20} = 8{,}90\ cm$$

Adopto h = 10 cm

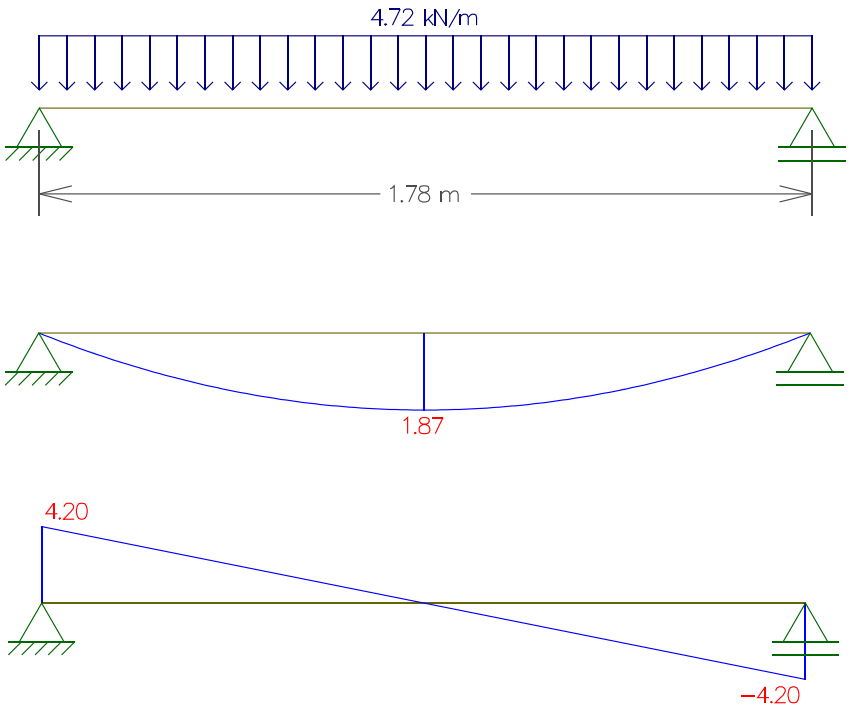
- Análisis de Cargas

	Espesor (m)	Peso Específico (kN/m^3)	Peso (kN/m^2)
Piso	0,012	23	0,28
Carpeta	0,025	19	0,48
Contrapiso	0,07	18	1,26
Losa	0,10	25	2,5
Cielorraso	0,02	-	0,2

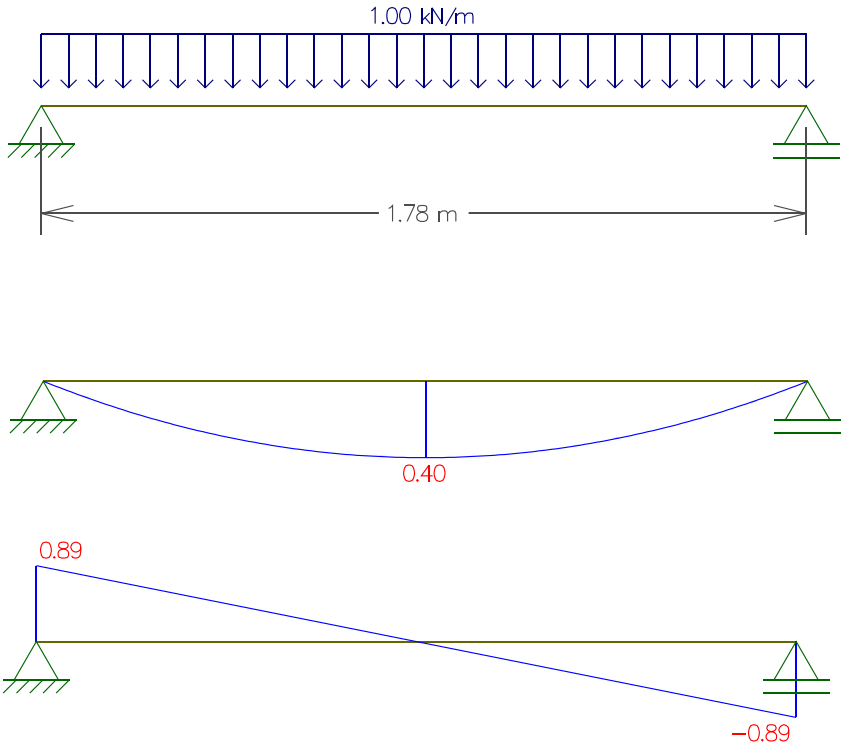
D=	4,72
L =	1

- Solicitaciones

Cargas Permanentes



Sobrecargas



Cargas Últimas

$U = 1{,}2 * D + 1{,}6 * L$

$M_u = 1{,}2 * 1{,}87 + 1{,}6 * 0{,}4 = 2{,}88\ kNm/m$

$V_u = 1{,}2 * 4{,}20 + 1{,}6 * 0{,}89 = 6{,}46\ kN/m$

- Dimensionamiento a Flexión

Tramo

Por ser muy bajo el momento se adopta armadura mínima por contracción y temperatura.

$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 10\ cm = 1{,}8\ cm^2/m$

Adopto 1 Ø6 c/ 15 cm ($A_s = 1{,}89\ cm^2/m$)

Armadura de repartición

Adopto 1 Ø6 c/ 15 cm ($A_s = 1{,}89\ cm^2/m$)

Verificación de la separación de la armadura

S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 100\ mm = 200\ mm \\ \leq 25d_b = 25 * 6\ mm = 150\ mm \\ \leq 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

El máximo corte último es:

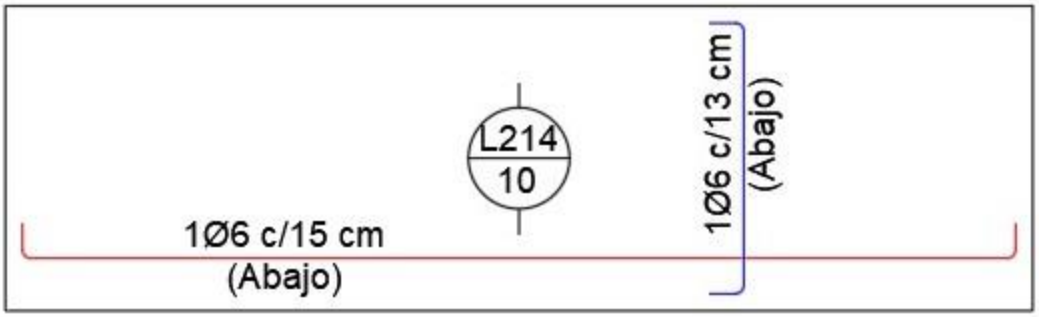
$V_u = 6{,}46\ {}^{kN}/_{m}$

$V_n = \frac{V_u}{\varphi} = \frac{6{,}46\ kN/m}{0{,}75} = 8{,}61\ {}^{kN}/_{m} = 0{,}00861\ MN/m$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 1\ m * 0{,}10\ m = 0{,}083\ MN\ >\ V_n$

No es necesaria armadura de corte.

- Detalle de Armado



Losa L215

- Predimensionado

  Para losas macizas armadas en una dirección en voladizo:

  $$h \geq \frac{l}{20} = \frac{190\ cm}{20} = 9{,}5\ cm$$

  Adopto h = 10 cm

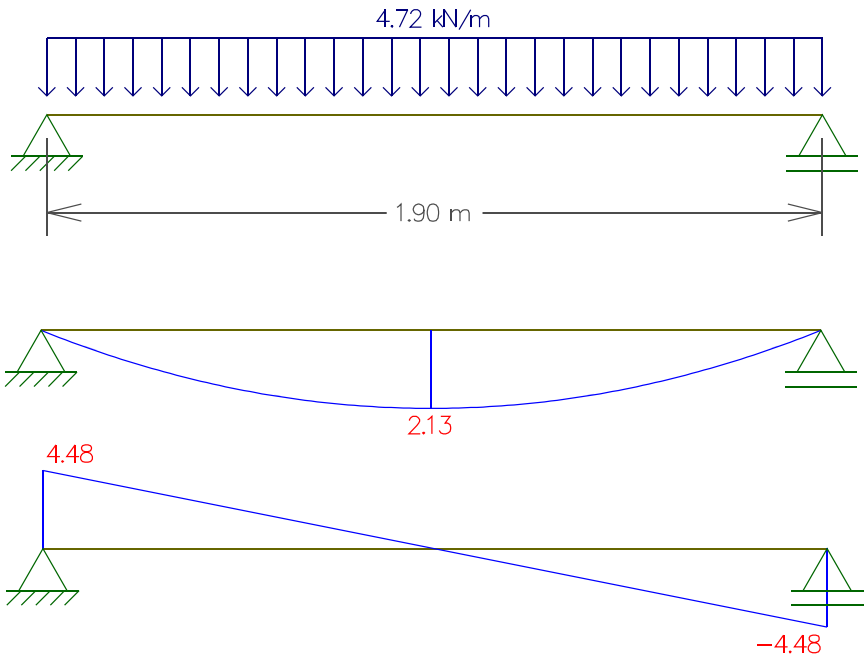
- Análisis de Cargas

	Espesor (m)	Peso Específico (kN/m^3)	Peso (kN/m^2)
Piso	0,012	23	0,28
Carpeta	0,025	19	0,48
Contrapiso	0,07	18	1,26
Losa	0,10	25	2,5
Cielorraso	0,02	-	0,2

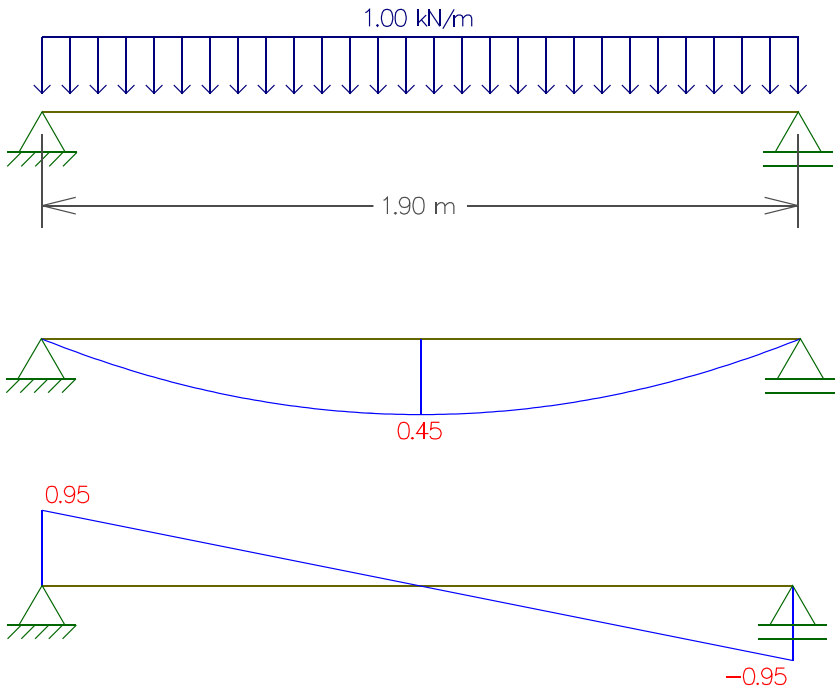
D=	4,72
L =	1

- Solicitaciones

Cargas Permanentes



Sobrecargas



Cargas Últimas

$U = 1{,}2 * D + 1{,}6 * L$

$M_u = 1{,}2 * 2{,}13 + 1{,}6 * 0{,}45 = 3{,}28\ kNm/m$

$V_u = 1{,}2 * 4{,}48 + 1{,}6 * 0{,}95 = 6{,}90\ kN/m$

- Dimensionamiento a Flexión

Tramo

Por ser muy bajo el momento se adopta armadura mínima por contracción y temperatura.

$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 10\ cm = 1{,}8\ cm^2/m$

Adopto 1 Ø6 c/ 15 cm ($A_s = 1{,}89\ cm^2/m$)

Armadura de repartición

Adopto 1 Ø6 c/ 15 cm ($A_s = 1{,}89\ cm^2/m$)

Verificación de la separación de la armadura

S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 100\ mm = 200\ mm \\ \leq 25d_b = 25 * 6\ mm = 150\ mm \\ \leq 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

El máximo corte último es:

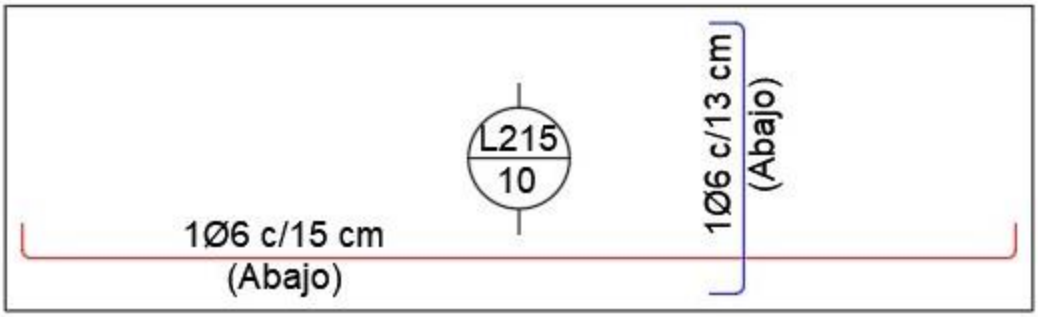
$V_u = 6{,}90\ {}^{kN}/_{m}$

$V_n = \frac{V_u}{\varphi} = \frac{6{,}90\ kN/m}{0{,}75} = 9{,}20\ {}^{kN}/_{m} = 0{,}00920\ MN/m$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 1\ m * 0{,}10\ m = 0{,}083\ MN\ >\ V_n$

No es necesaria armadura de corte.

- Detalle de Armado



Losa L216

- Predimensionado

Para losas macizas armadas en una dirección en voladizo:

$$h \geq \frac{l}{20} = \frac{150\ cm}{20} = 7{,}5\ cm$$

Adopto h = 10 cm

- Análisis de Cargas

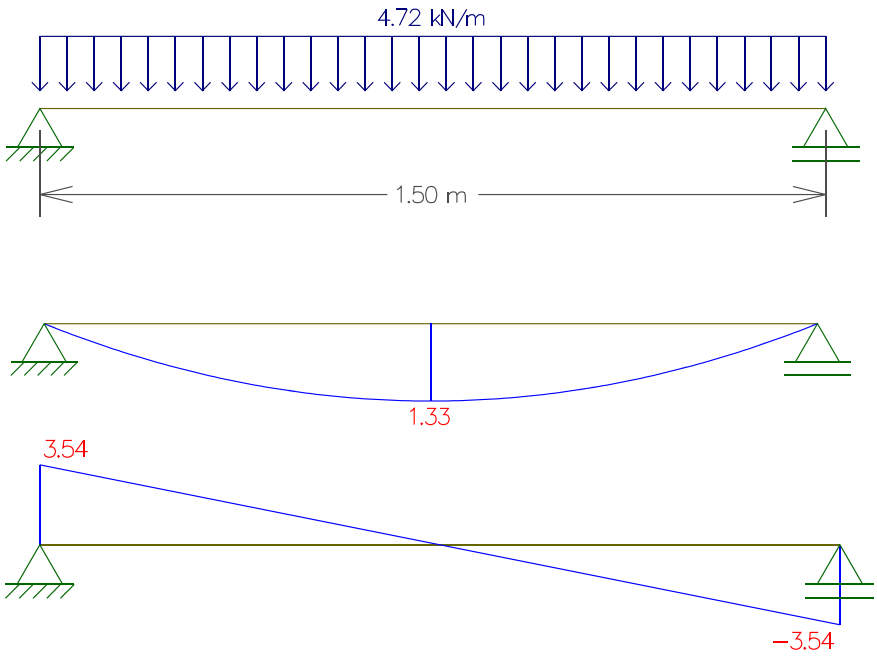
	Espesor (m)	Peso Específico (kN/m^3)	Peso (kN/m^2)
Piso	0,012	23	0,28
Carpeta	0,025	19	0,48
Contrapiso	0,07	18	1,26
Losa	0,10	25	2,5
Cielorraso	0,02	-	0,2

D=	4,72
L =	5

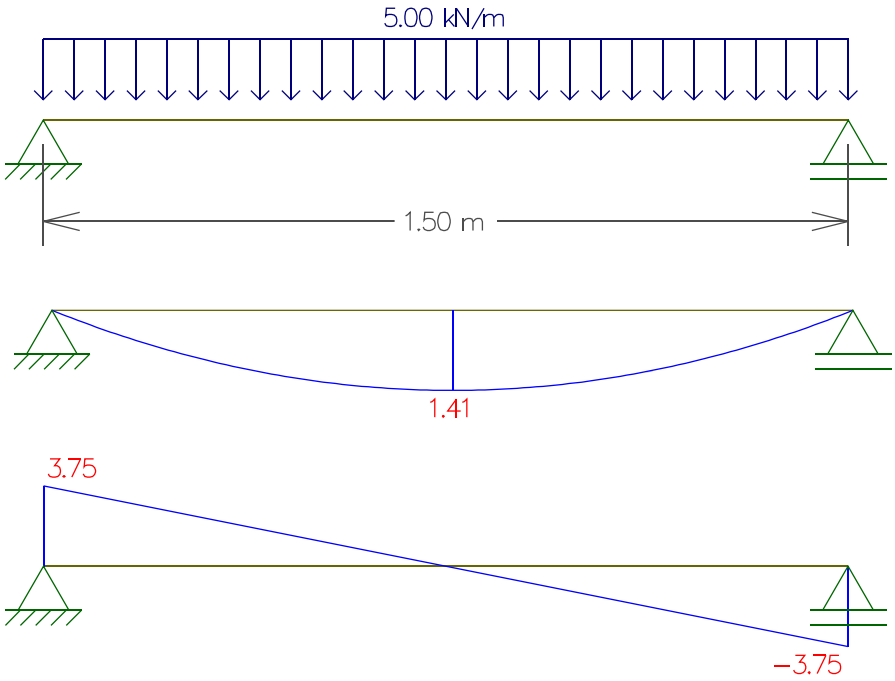
Consideramos la carga del tanque como una sobrecarga uniformemente repartida de 5 kN/m².

- Solicitaciones

Cargas Permanentes



Sobrecargas



Cargas Últimas

$U = 1{,}2 * D + 1{,}6 * L$

$M_u = 1{,}2 * 1{,}33 + 1{,}6 * 1{,}41 = 3{,}85\ kNm/m$

$V_u = 1{,}2 * 3{,}54 + 1{,}6 * 3{,}75 = 10{,}25\ kN/m$

- Dimensionamiento a Flexión

Tramo

Por ser muy bajo el momento se adopta armadura mínima por contracción y temperatura.

$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 10\ cm = 1{,}8\ cm^2/m$

Adopto 1 Ø6 c/ 15 cm ($A_s = 1{,}89\ cm^2/m$)

Armadura de repartición

Adopto 1 Ø6 c/ 15 cm ($A_s = 1{,}89\ cm^2/m$)

Verificación de la separación de la armadura

S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 100\ mm = 200\ mm \\ \leq 25d_b = 25 * 6\ mm = 150\ mm \\ \leq 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

El máximo corte último es:

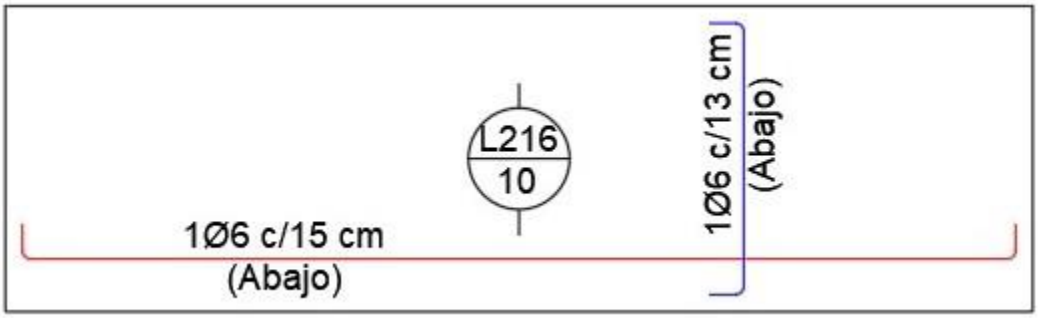
$V_u = 10{,}25\ {}^{kN}/_{m}$

$V_n = \frac{V_u}{\varphi} = \frac{10{,}25\ kN/m}{0{,}75} = 13{,}67\ {}^{kN}/_{m} = 0{,}01367\ MN/m$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 1\ m * 0{,}10\ m = 0{,}083\ MN\ >\ V_n$

No es necesaria armadura de corte.

- Detalle de Armado



Losa Escalera

- Predimensionado

Para losas macizas armadas en una dirección en voladizo:

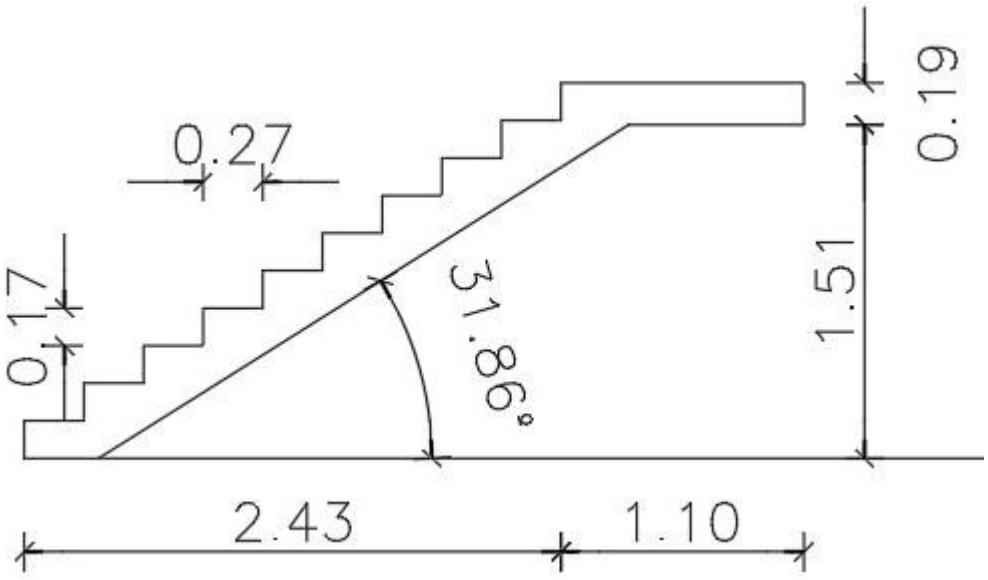
$$h \geq \frac{l}{20} = \frac{353\ cm}{20} = 17{,}65\ cm$$

Adopto h = 18 cm

- Análisis de Cargas

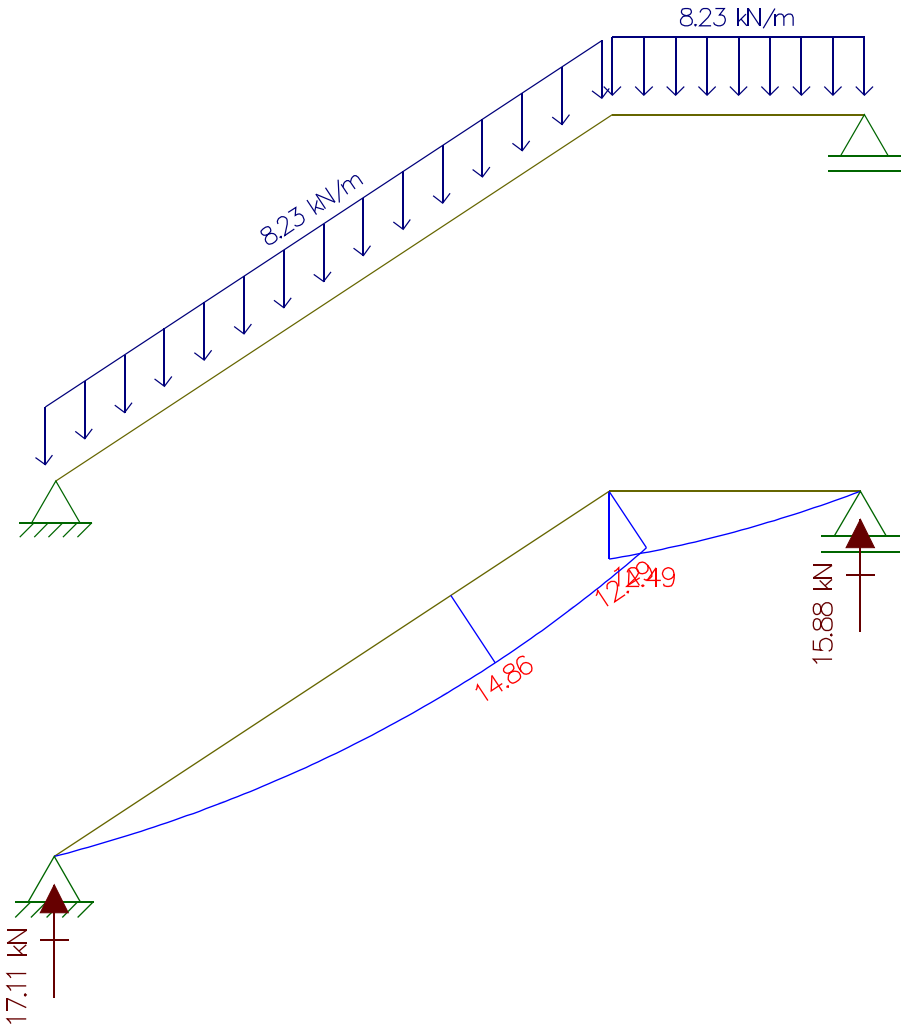
	Espesor (m)	Peso Específico (kN/m^3)	Peso (kN/m^2)
Piso	(0,27+0,17)*0,012/0,27	23	0,45
Carpeta	(0,27+0,17)*0,015/0,27	19	0,46
Escalones	0,17/2	18	1,53
Losa	0,19/cos 31,86º	25	5,59
Cielorraso	0,02/cos 31,86º	-	0,2

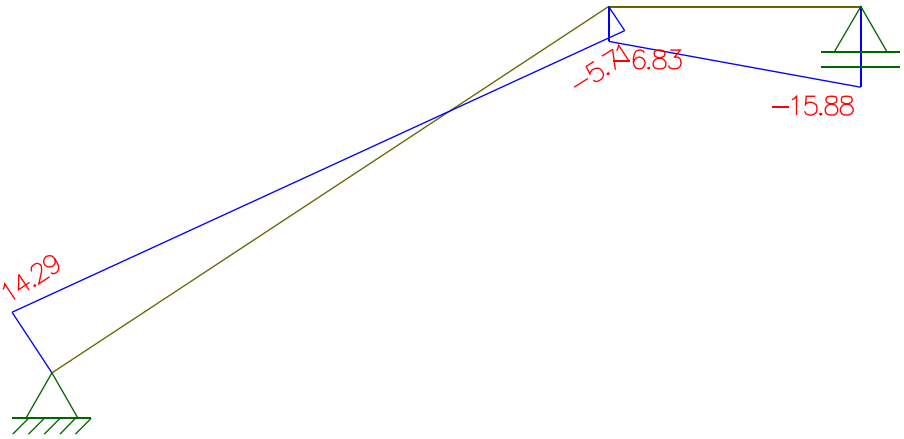
D=	8,23
L =	2



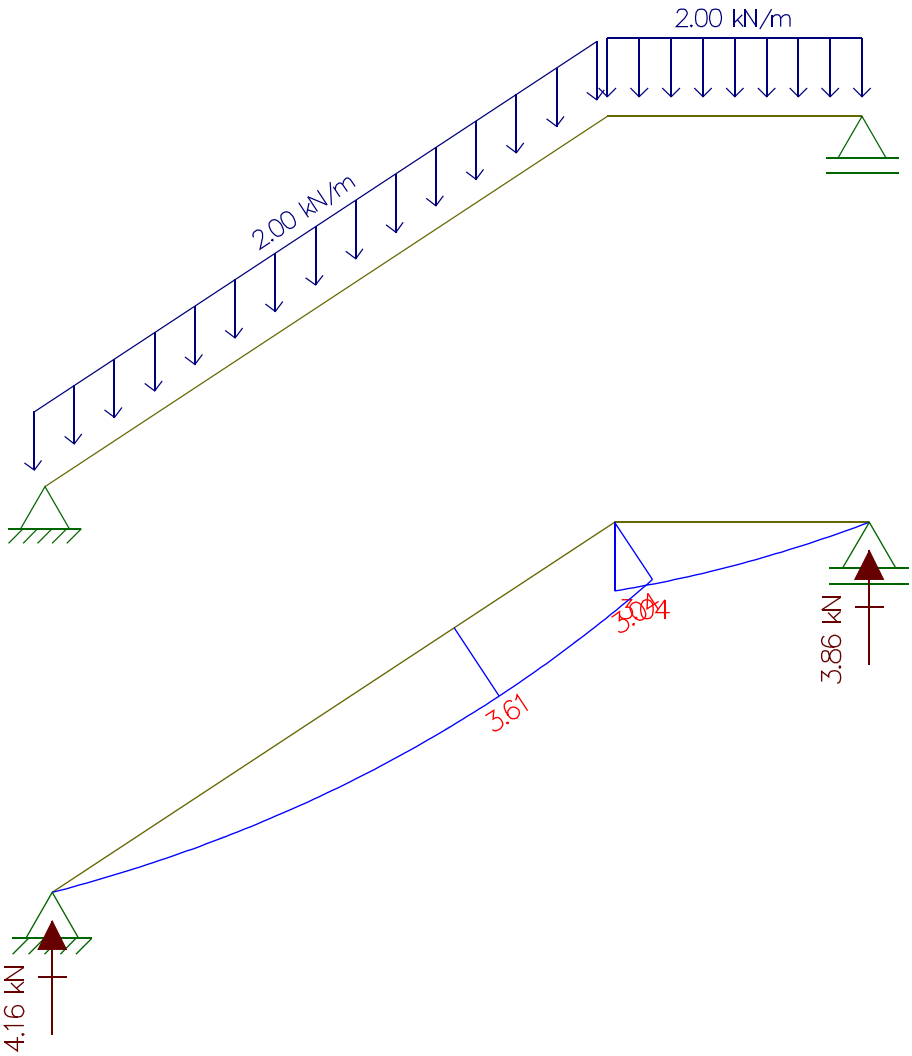
- Solicitaciones

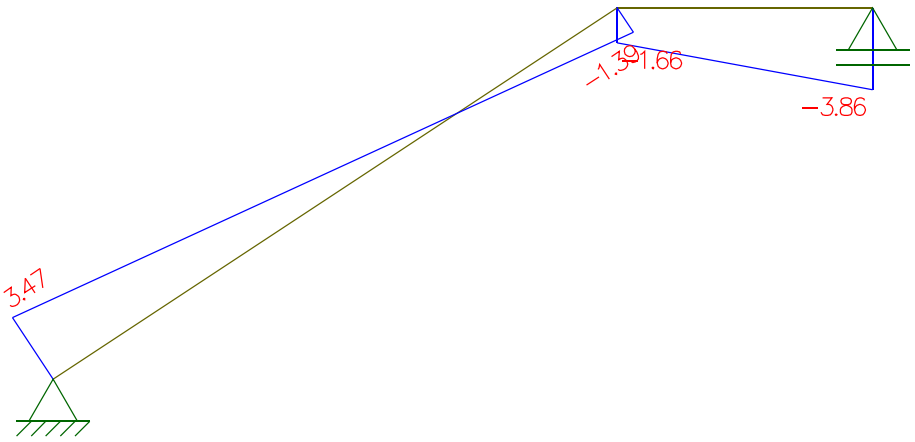
  Cargas Permanentes





Sobrecargas





Cargas Últimas

$U = 1{,}2 * D + 1{,}6 * L$

$M_u = 1{,}2 * 14{,}86 + 1{,}6 * 3{,}61 = 23{,}61\ kNm/m$

$V_u = 1{,}2 * 15{,}88 + 1{,}6 * 3{,}86 = 25{,}23\ kN/m$

- Dimensionamiento a Flexión

Tramo

$$M_n = \frac{M_u}{\varphi} = \frac{23{,}61\ kNm/m}{0{,}9} = 26{,}23\ kNm = 0{,}02623\ MNm/m$$

$$d = h - c_c - \frac{1}{2}d_b = 19\ cm - 2{,}5\ cm - 0{,}5\ cm = 16\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}16\ m}{\sqrt{\frac{0{,}02623\ MNm/m}{1\ m}}} = 0{,}99$$

De tabla de Flexión 3: $k_e = 24{,}301\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}301\ {cm^2}/{MN} * \frac{0{,}02623\ {MNm}/{m}}{0{,}16\ m} = 3{,}98\ cm^2/m$$

$A_{s,mín} = 0{,}0018 * b_w * h = 0{,}0018 * 100\ cm * 19\ cm = 3{,}42\ cm^2/m$

Adopto 1 Ø8 c/ 12,5 cm ($A_s = 4{,}02\ cm^2/m$)

Armadura de repartición

Adopto 1 Ø8 c/ 14 cm ($A_s = 3{,}59\ cm^2/m$)

Verificación de la separación de la armadura

S/ CIRSOC 201-7.6.5

$$s_l \begin{cases} \leq 2h = 2 * 190\ mm = 380\ mm \\ \leq 25d_b = 25 * 8\ mm = 2000\ mm \\ \leq 300\ mm \end{cases}$$

Verifica

- Dimensionamiento al Corte

  El máximo corte último es:

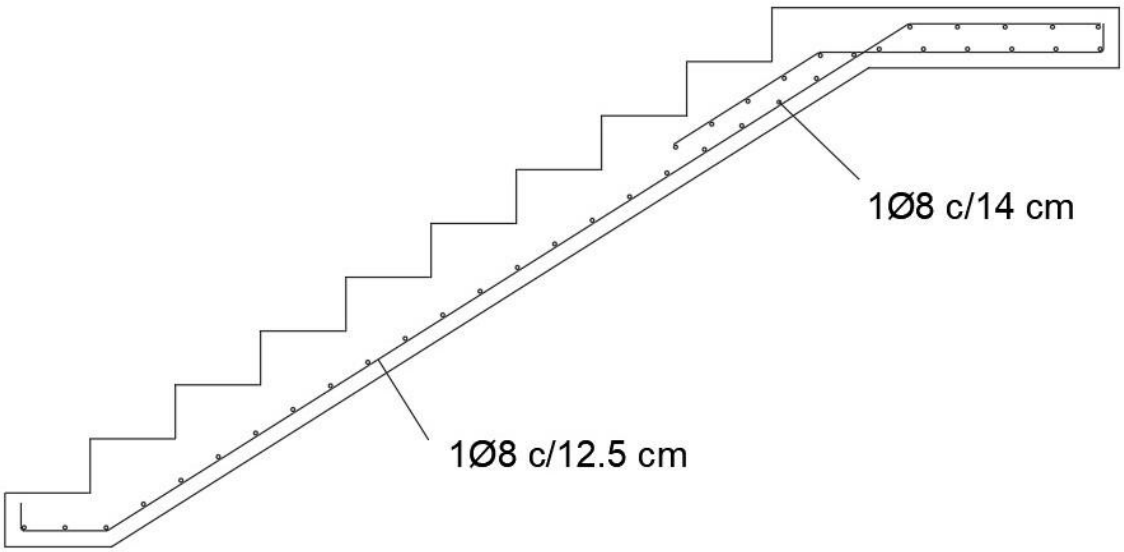
  $V_u = 25{,}23\ {kN}/{m}$

  $V_n = \frac{V_u}{\varphi} = \frac{25{,}23\ kN/m}{0{,}75} = 33{,}64\ {kN}/{m} = 0{,}03364\ MN/m$

  $V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 1\ m * 0{,}16\ m = 0{,}13\ MN\ >\ V_n$

  No es necesaria armadura de corte.

- Detalle de Armado



Vigas

Vigas V01-V02 IDEM V011-V012

- Predimensionado

$$h = \frac{l}{12} = \frac{540\ cm}{12} = 0{,}45\ m$$

Adopto h = 50 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}50\ m = 2{,}5\ kN/m$$

Peso de pared:

$$p_{par} = \gamma * e * h = 10{,}5\ {}^{kN}/_{m^3} * 0{,}20\ m * 3\ m = 6{,}3\ kN/m$$

$$D = R_{L01D} + R_{L05D} + p_p + p_{par} = {}^{(6{,}63 + 6{,}79 + 2{,}5 + 6{,}3)kN}/_{m} =$$

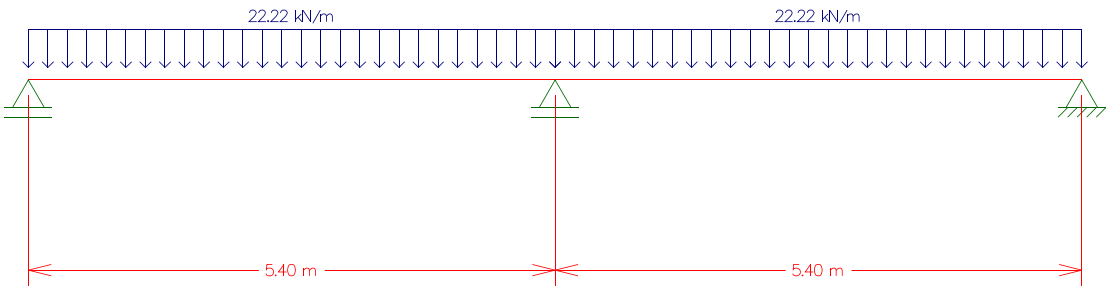
$$D = 22{,}22\ kN/m$$

$$L = R_{L01L} + R_{L05L} = {}^{(2{,}58 + 6{,}5)kN}/_{m} = 9{,}08\ kN/m$$

- Solicitaciones

Carga Permanente

DCL



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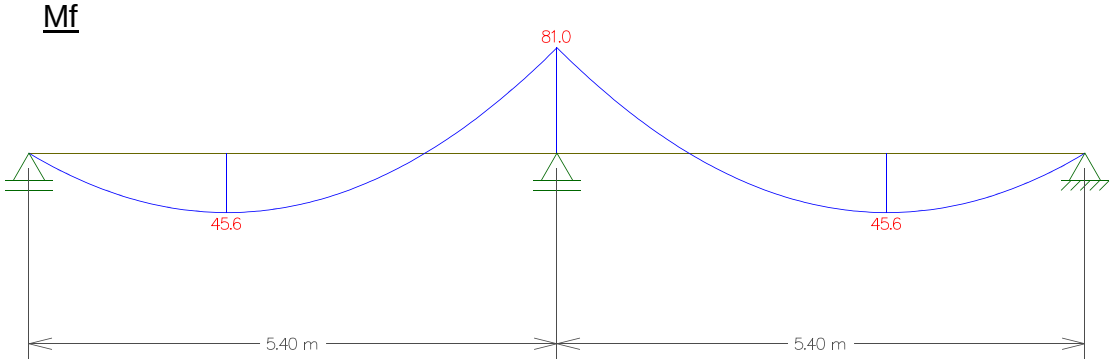

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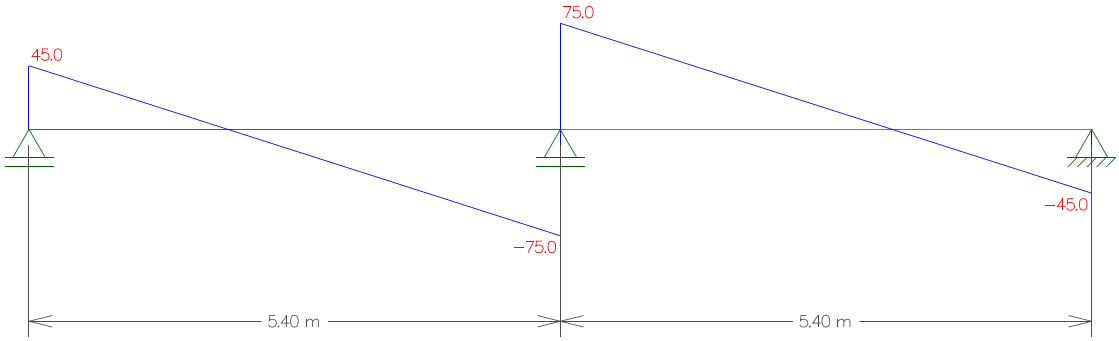
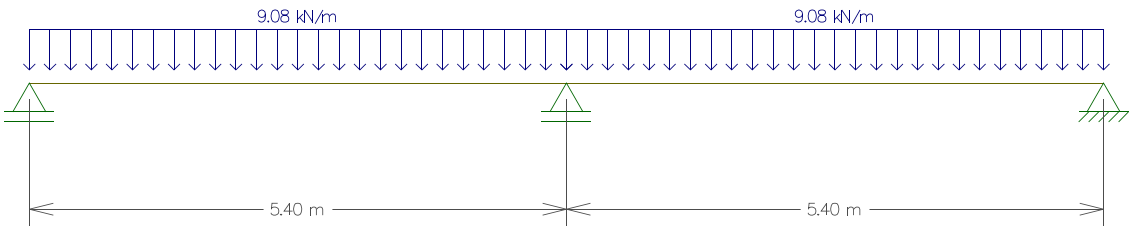
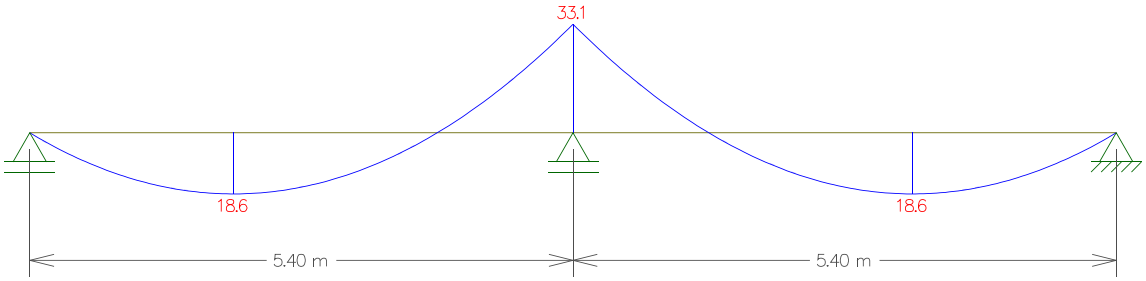


Sobrecarga

DCL



Mf



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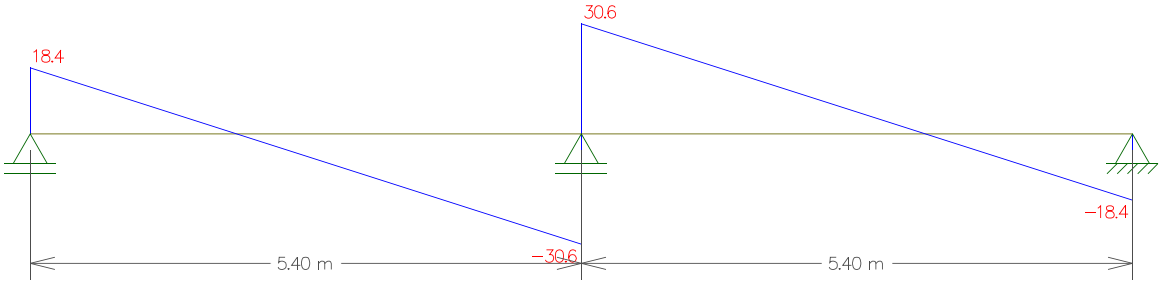


- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 45{,}6 + 1{,}6 * 18{,}6)kNm = 84{,}48\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{84{,}48\ kNm}{0{,}9} = 93{,}87kNm = 0{,}09387\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}09387\ MNm}{0{,}20\ m}}} = 0{,}66$$

De tabla de Flexión 3: $k_e = 25{,}625\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 25{,}625\ {cm^2}/{MN} * \frac{0{,}09387 MNm}{0{,}456\ m} = 5{,}27\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 5Ø12 abajo en dos capas. ($A_s = 5{,}65\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 12 - 2 * 30 - 2 * 6)}{2} = 46\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

Apoyo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 81 + 1{,}6 * 33{,}1)kNm = 150{,}16\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{150{,}16\ kNm}{0{,}9} = 166{,}84kNm = 0{,}16684\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}16684\ MNm}{0{,}20\ m}}} = 0{,}50$$

De tabla de Flexión 3: $k_e = 26{,}758\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 26{,}758\ {cm^2}/{MN} * \frac{0{,}16684 MNm}{0{,}456\ m} = 9{,}79\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 5Ø16 arriba ($A_s = 10{,}5\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 16 - 2 * 30 - 2 * 6)}{2} = 40\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 16\ mm \\ \geq 25 mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 45 + 1{,}6 * 18{,}4) kN = 83{,}44\ kN$$

Tomamos el corte a una distancia “d” del filo del apoyo.

$$q_u = 1{,}2 q_D + 1{,}6 q_L = {(1{,}2 * 22{,}22 + 1{,}6 * 9{,}08) kN}/{m} = 41{,}19\ kN/m$$

$$V_u = 83{,}44\ kN - 0{,}556\ m * 41{,}19\ {kN}/{m} = 60{,}54\ kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{60{,}54\ kN}{0{,}75} = 80{,}72\ kN = 0{,}08072\ MN$$

$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}456\ m = 0{,}076\ MN$$

$$V_s = V_n - V_c = 0{,}08072\ MN - 0{,}076\ MN = 0{,}00472\ MN$$

Adoptando estribos Ø6 de 2 ramas.

$$s_{máx} = \frac{d}{2} = \frac{0{,}456\ m}{2} = 0{,}228\ m$$

$$\frac{A_v}{s} = \frac{V_s * 10^4}{f_y * d} = \frac{0{,}00472\ MN * 10^4}{420\ MPa * 0{,}456\ m} = 0{,}49\ cm^2/m$$

$s = \frac{A_v}{0{,}49\ cm^2/m} = \frac{2*0{,}28\ cm^2}{0{,}49\ cm^2/m} = 1{,}14\ m$; Adopto smax

Adopto estribos Ø6 de 2 ramas c/ 22 cm.

Apoyo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 75 + 1{,}6 * 30{,}6)kN = 138{,}96\ kN$$

Tomamos el corte a una distancia “d” del apoyo.

$$q_u = 1{,}2q_D + 1{,}6q_L = {(1{,}2 * 22{,}22 + 1{,}6 * 9{,}08)kN}/{m} = 41{,}19\ kN/m$$

$$V_u = 138{,}96\ kN - 0{,}556\ m * 41{,}19\ {kN}/{m} = 116{,}06\ kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{116{,}06\ kN}{0{,}75} = 154{,}75\ kN = 0{,}15475\ MN$$

$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}456\ m = 0{,}076\ MN$$

$$V_s = V_n - V_c = 0{,}15475\ MN - 0{,}076\ MN = 0{,}079\ MN$$

Adoptando estribos Ø6 de 2 ramas.

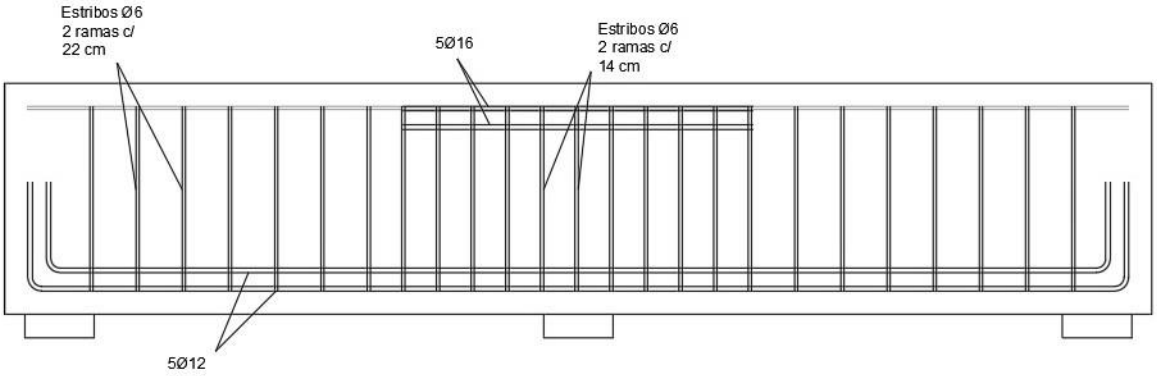
$$s_{máx} = \frac{d}{2} = \frac{0{,}456\ m}{2} = 0{,}228\ m$$

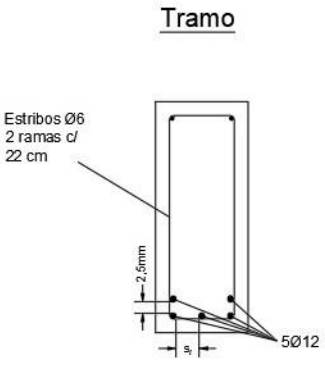
$$\frac{A_v}{s} = \frac{V_s * 10^4}{f_y * d} = \frac{0{,}079\ MN * 10^4}{420\ MPa * 0{,}456\ m} = 4{,}12\ cm^2/m$$

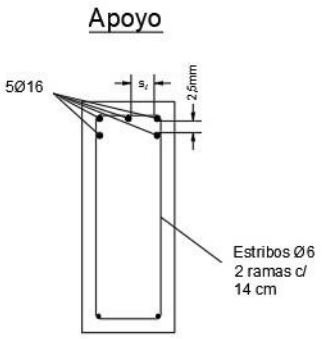
$$s = \frac{A_v}{4{,}12\ cm^2/m} = \frac{2 * 0{,}28\ cm^2}{4{,}12\ cm^2/m} = 0{,}14\ m$$

Adopto estribos Ø6 de 2 ramas c/ 14 cm.

- Detalle de Armado







Vigas V03-V04 IDEM V09-V010

- Predimensionado

$$h = \frac{l}{12} = \frac{540\ cm}{12} = 0{,}45\ m$$

Adopto h= 50 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}50\ m = 2{,}5\ kN/m$$

Peso de pared:

$$p_{par} = \gamma * e * h = 10{,}5\ {}^{kN}/_{m^3} * 0{,}20\ m * 3\ m = 6{,}3\ kN/m$$

$$D = R_{L01D} + R_{L03D} + p_p + p_{par} = {}^{(6{,}63 + 7.66 + 2{,}5 + 6{,}3)kN}/_{m} =$$

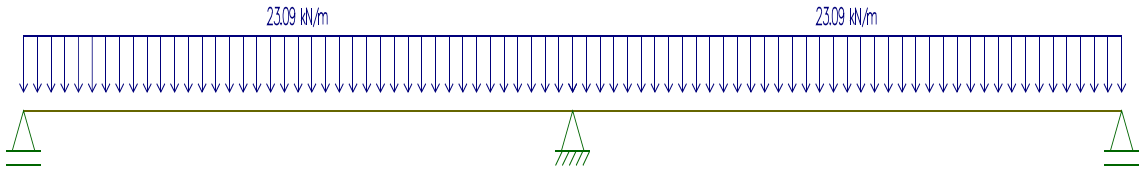
$$D = 23{,}09\ kN/m$$

$$L = R_{L01L} + R_{L03L} = {}^{(2{,}58 + 2{,}94)kN}/_{m} = 5{,}52kN/m$$

- Solicitaciones

Carga Permanente

DCL



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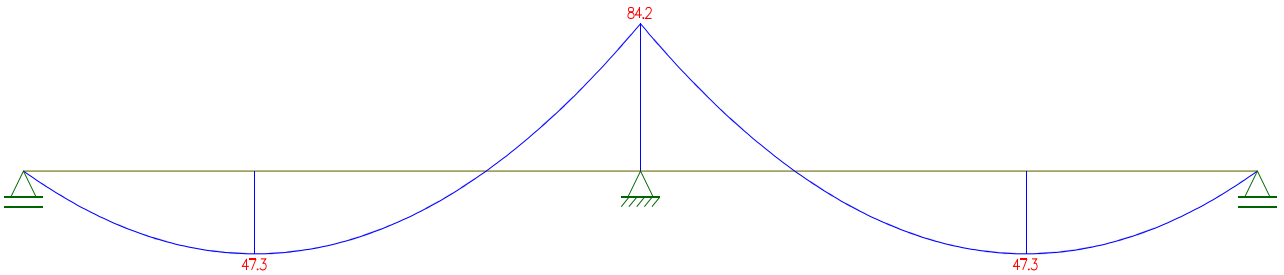

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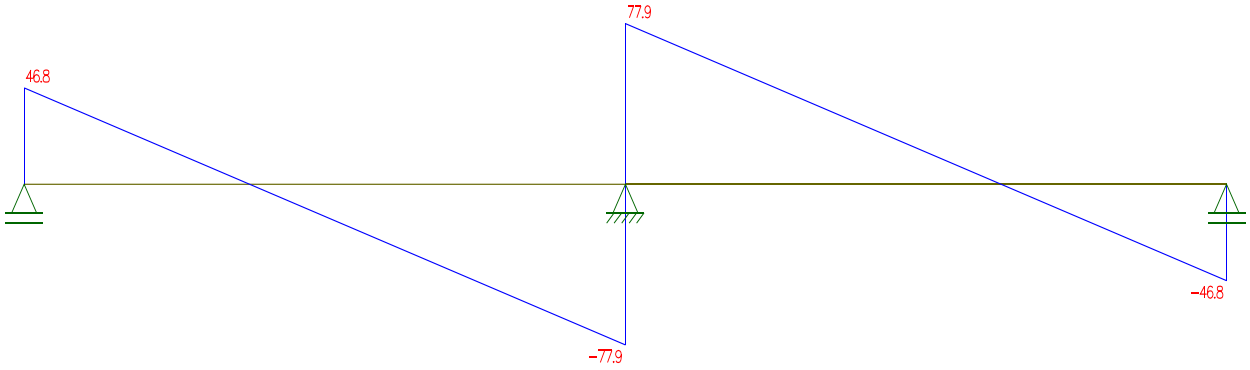
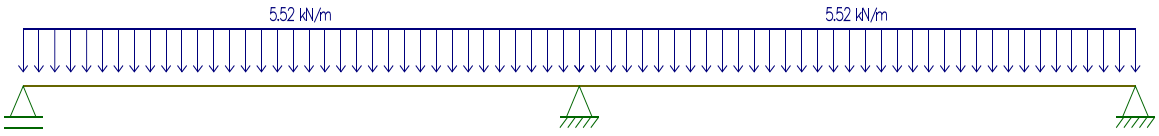


Sobrecarga

DCL



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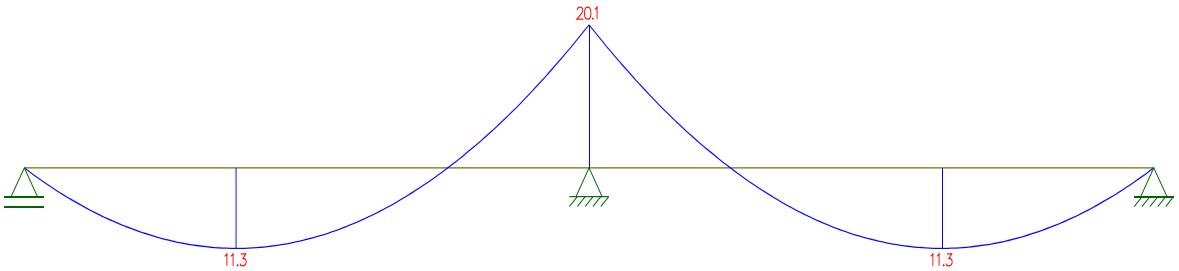

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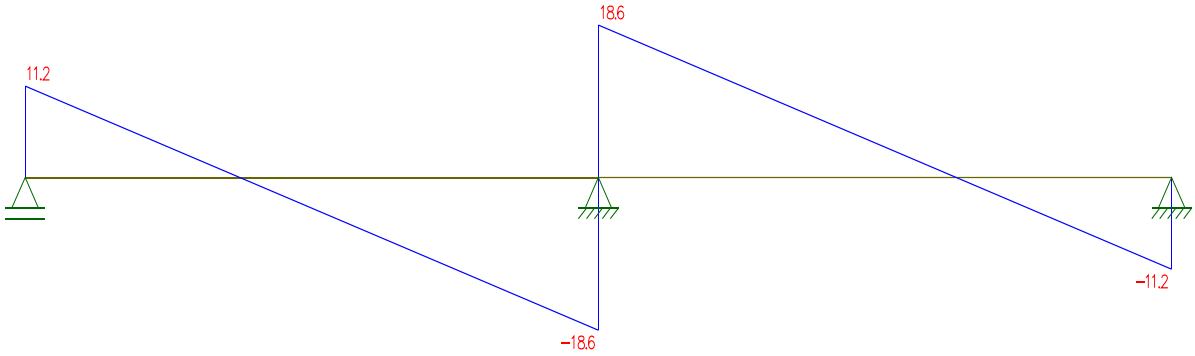


- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 47{,}35 + 1{,}6 * 11{,}32)kNm = 74{,}93\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{74{,}93\ kNm}{0{,}9} = 83{,}25kNm = 0{,}08325\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}08325\ MNm}{0{,}20\ m}}} = 0{,}706$$

De tabla de Flexión 3: $k_e = 25{,}207\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 25{,}207\ {}^{cm^2}/_{MN} * \frac{0{,}08325 MNm}{0{,}456\ m} = 4{,}6\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 3Ø16 abajo ($A_s = 6{,}03\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}{}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}{}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 16 - 2 * 30 - 2 * 6)}{2} = 40\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 16\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

Apoyo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 84{,}16 + 1{,}6 * 20{,}12) kNm = 133{,}184\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{133{,}184\ kNm}{0{,}9} = 147{,}98\ kNm = 0{,}14798\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}14798\ MNm}{0{,}20\ m}}} = 0{,}53$$

De tabla de Flexión 3: $k_e = 26{,}399\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 26{,}399\ {}^{cm^2}/_{MN} * \frac{0{,}14798 MNm}{0{,}456\ m} = 8{,}56\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 5Ø16 en dos capas arriba ($A_s = 10{,}5\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}{}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}{}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 16 - 2 * 30 - 2 * 6)}{2} = 40\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 16\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 46{,}75 + 1{,}6 * 11{,}17)kN = 73{,}97\ kN$

Tomamos el corte a una distancia “d” del filo del apoyo.

$q_u = 1{,}2q_D + 1{,}6q_L = {}^{(1{,}2 * 23{,}09 + 1{,}6 * 5{,}52)kN}/_{m} = 36{,}05\ kN/m$

$V_u = 73{,}97\ kN - 0{,}556\ m * 36{,}05\ {}^{kN}/_{m} = 53{,}67\ kN$

$V_n = \frac{V_u}{\varphi} = \frac{53{,}67\ kN}{0{,}75} = 71{,}56\ kN = 0{,}07156\ MN$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}456\ m = 0{,}076\ MN$

Vc>Vn; Del Reglamento CIROSC 201-05: $Avmin = \frac{\sqrt{f`_c} * bw * s}{16fy} = 0{,}33\ cm^2$

$s_{máx} = \frac{d}{2} = \frac{0{,}456\ m}{2} = 0{,}228\ m$; Adopto smax, Adoptando estribos Ø6 de 2 ramas.

Adopto estribos Ø6 de 2 ramas c/ 22 cm.

Apoyo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 77{,}92 + 1{,}6 * 18{,}63)kN = 123{,}31\ kN$

Tomamos el corte a una distancia “d” del apoyo.

$V_u = 123{,}31\ kN - 0{,}556\ m * 36{,}05\ {}^{kN}/_{m} = 103{,}01\ kN$

$V_n = \frac{V_u}{\varphi} = \frac{103{,}01\ kN}{0{,}75} = 137{,}35\ kN = 0{,}13735\ MN$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}456\ m = 0{,}076\ MN$

$V_s = V_n - V_c = 0{,}13735\ MN - 0{,}076\ MN = 0{,}06135\ MN$

Adoptando estribos Ø6 de 2 ramas.

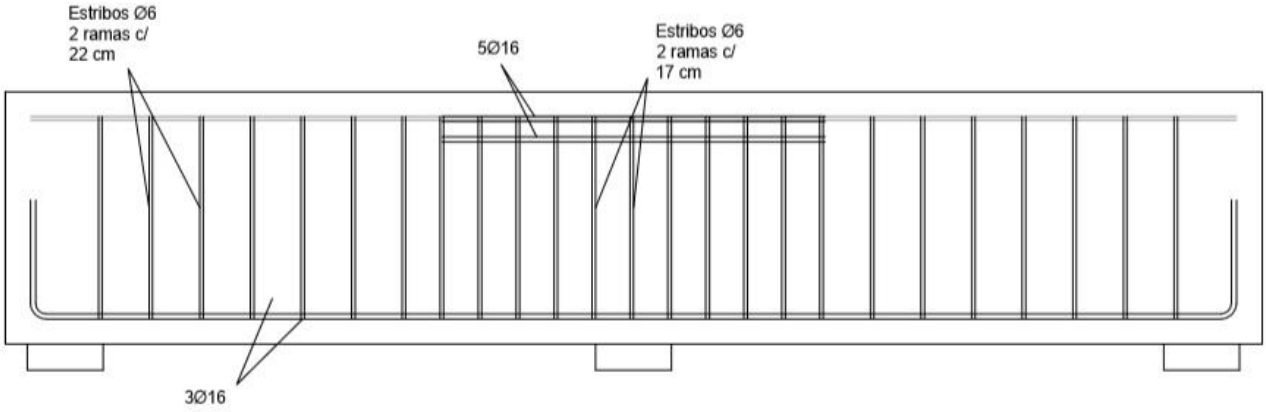
$s_{máx} = \frac{d}{2} = \frac{0{,}456\ m}{2} = 0{,}228\ m$

$\frac{A_v}{s} = \frac{V_s * 10^4}{f_y * d} = \frac{0{,}06135\ MN * 10^4}{420\ MPa * 0{,}456\ m} = 3{,}2\ cm^2/m$

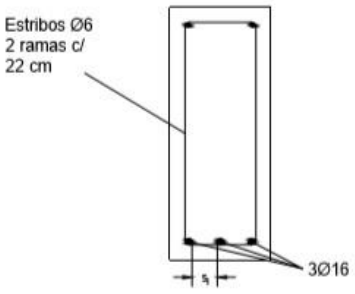
$$s = \frac{A_v}{3{,}2\ cm^2/m} = \frac{2 * 0{,}28\ cm^2}{3{,}2\ cm^2/m} = 0{,}17\ m$$

Adopto estribos Ø6 de 2 ramas c/ 17 cm.

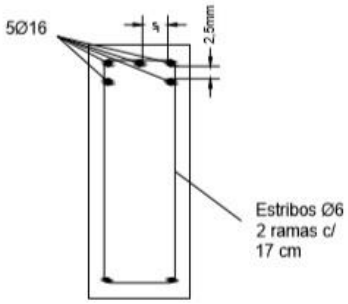
- Detalle de Armado



Tramo



Apoyo



Vigas V05-V06 IDEM V07-V08

- Predimensionado

$$h = \frac{l}{12} = \frac{540\ cm}{12} = 0{,}45\ m$$

Adopto h= 50 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}50\ m = 2{,}5\ kN/m$$

Peso de pared:

$$p_{par} = \gamma * e * h = 10{,}5\ {}^{kN}/_{m^3} * 0{,}20\ m * 3\ m = 6{,}3\ kN/m$$

$$qD = R_{L03D} + p_p + p_{par} = {}^{(4{,}43 + 2{,}5 + 6{,}3)kN}/_{m} =$$

$qD = 13{,}23\ kN/m$; $R_{V025D} = 18{,}12\ KN$; $R_{V026D} = 8{,}8\ KN$;

$R_{V029D} = 4{,}9\ KN$

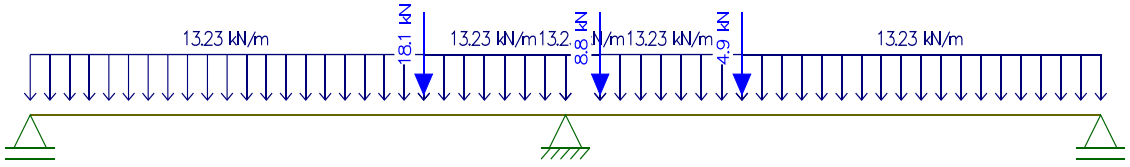
$L = R_{L03L} = {}^{(1{,}7)kN}/_{m} = 1{,}7kN/m$; $R_{V025L} = 5{,}3\ KN$

$R_{V026L} = 3{,}1\ KN$; $R_{V029L} = 1{,}4\ KN$

- Solicitaciones

Carga Permanente

DCL



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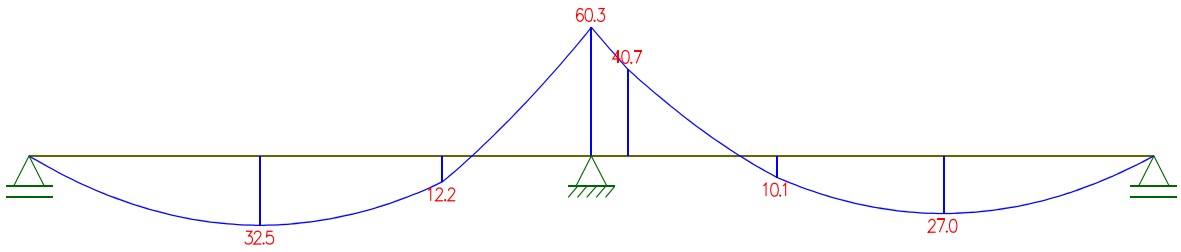
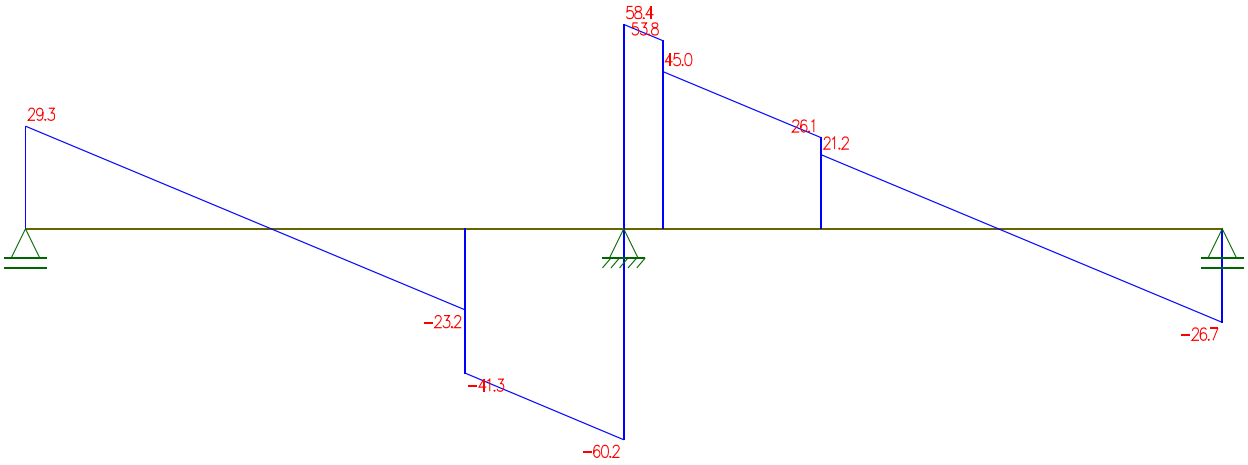
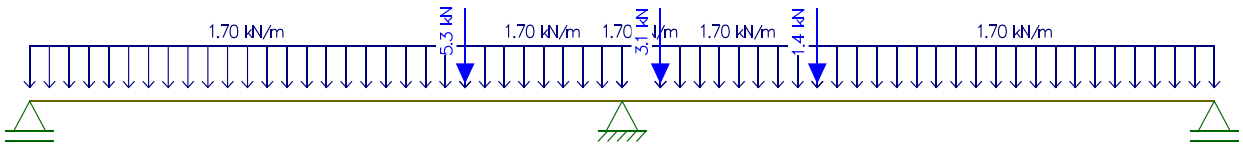


Q

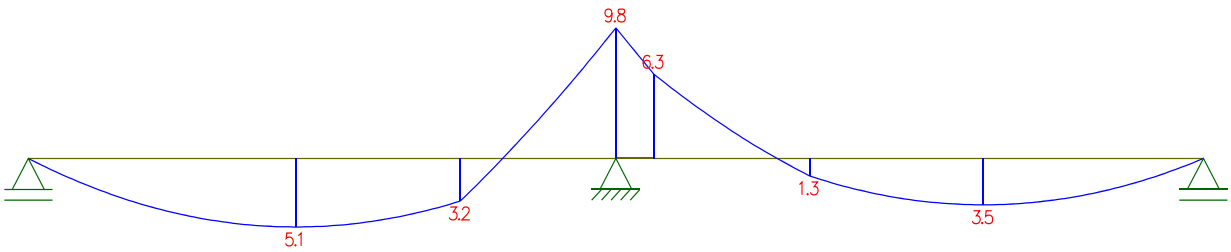


Sobrecarga

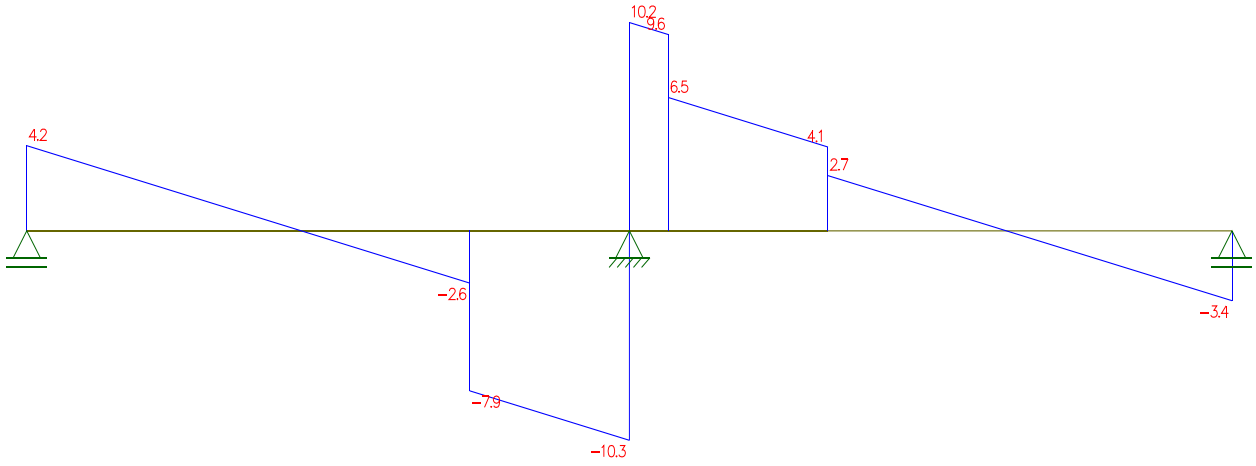
DCL



Mf



Q



- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 32{,}5 + 1{,}6 * 5{,}1) kNm = 47{,}16\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{47{,}16\ kNm}{0{,}9} = 52{,}4 kNm = 0{,}0524\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}0524\ MNm}{0{,}20\ m}}} = 0{,}89$$

De tabla de Flexión 3: $k_e = 24{,}766\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}766\ {cm^2}/{MN} * \frac{0{,}0524 MNm}{0{,}456\ m} = 2{,}84\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 3Ø12 abajo ($A_s = 3{,}39\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 12 - 2 * 30 - 2 * 6)}{2} = 46\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

Apoyo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 60{,}3 + 1{,}6 * 9{,}8) kNm = 88{,}04\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{88{,}04\ kNm}{0{,}9} = 97{,}82\ kNm = 0{,}09782\ MNm$$

$$d = h - c_c - \frac{1}{2} d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}09782\ MNm}{0{,}20\ m}}} = 0{,}65$$

De tabla de Flexión 3: $k_e = 25{,}625\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 25{,}625\ {}^{cm^2}/_{MN} * \frac{0{,}09782 MNm}{0{,}456\ m} = 5{,}49\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 3Ø16 arriba ($A_s = 6{,}03\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}{}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}{}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 16 - 2 * 30 - 2 * 6)}{2} = 40\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 16\ mm \\ \geq 25 mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5 c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 29{,}3 + 1{,}6 * 4{,}2) kN = 41{,}88\ kN$

$V_n = \frac{V_u}{\varphi} = \frac{41{,}88\ kN}{0{,}75} = 55{,}84\ kN = 0{,}05584\ MN$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}456\ m = 0{,}076\ MN$

Vc>Vn; Del Reglamento CIROSC 201-05: $Avmin = \frac{\sqrt{f`_c} * bw * s}{16 fy} = 0{,}33\ cm^2$

$s_{máx} = \frac{d}{2} = \frac{0{,}456\ m}{2} = 0{,}228\ m$; Adopto smax, Adoptando estribos Ø6 de 2 ramas.

Adopto estribos Ø6 de 2 ramas c/ 22 cm.

Apoyo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 60{,}2 + 1{,}6 * 10{,}3) kN = 88{,}72\ kN$

$V_n = \frac{V_u}{\varphi} = \frac{88{,}72\ kN}{0{,}75} = 118{,}29\ kN = 0{,}11829\ MN$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}456\ m = 0{,}076\ MN$

$V_s = V_n - V_c = 0{,}11829\ MN - 0{,}076\ MN = 0{,}0423\ MN$

Adoptando estribos Ø6 de 2 ramas.

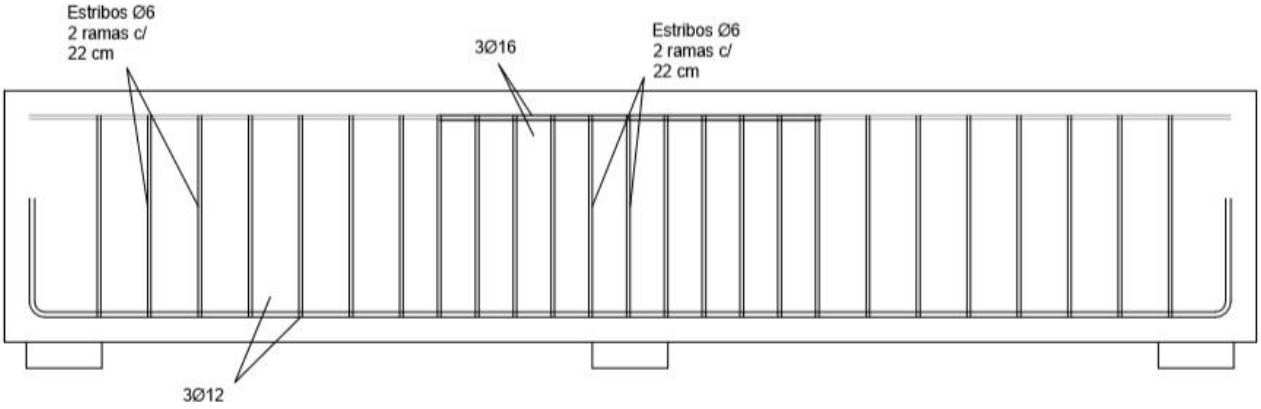
$s_{máx} = \frac{d}{2} = \frac{0{,}456\ m}{2} = 0{,}228\ m$

$\frac{A_v}{s} = \frac{V_s * 10^4}{f_y * d} = \frac{0{,}0423\ MN * 10^4}{420\ MPa * 0{,}456\ m} = 2{,}2\ cm^2/m$

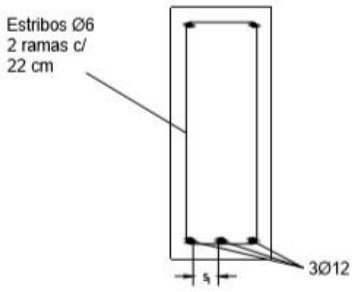
$s = \frac{A_v}{2{,}2\ cm^2/m} = \frac{2 * 0{,}28\ cm^2}{2{,}2\ cm^2/m} = 0{,}25\ m$; Adopto smax

Adopto estribos Ø6 de 2 ramas c/ 22 cm.

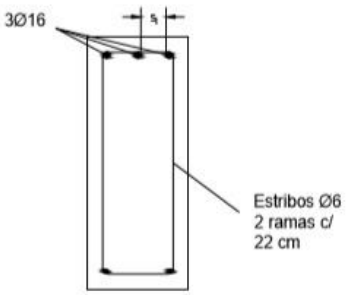
- Detalle de Armado



Tramo



Apoyo



Vigas V013-V014 IDEM V015-V016 ‖ V021-V022 ‖ V023-V024

- Predimensionado

$$h = \frac{l}{12} = \frac{338\ cm}{12} = 0{,}28\ m$$

Adopto h= 30 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}30\ m = 1{,}5\ kN/m$$

Peso de pared:

$$p_{par} = \gamma * e * h = 10{,}5\ {}^{kN}/_{m^3} * 0{,}20\ m * 3\ m = 6{,}3\ kN/m$$

$$D014 = R_{L03D} + p_p + p_{par} = {}^{(3{,}21 + 1{,}5 + 6{,}3)kN}/_{m} = 11{,}01\ kN/m$$

$$D013 = R_{L01D} + p_p + p_{par} = {}^{(2{,}53 + 1{,}5 + 6{,}3)kN}/_{m} = 10{,}33\ kN/m$$

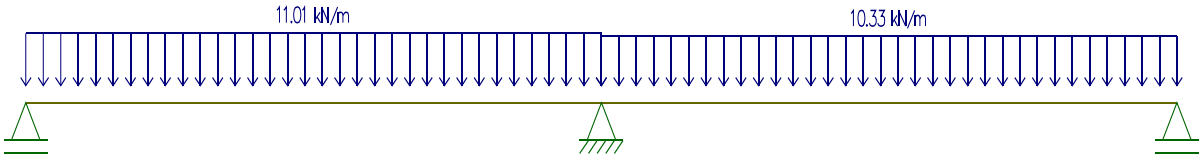
$$L014 = R_{L03L} = {}^{(1{,}23)kN}/_{m} = 1{,}23\ kN/m$$

$$L013 = R_{L01L} = {}^{(0{,}98)kN}/_{m} = 0{,}98\ kN/m$$

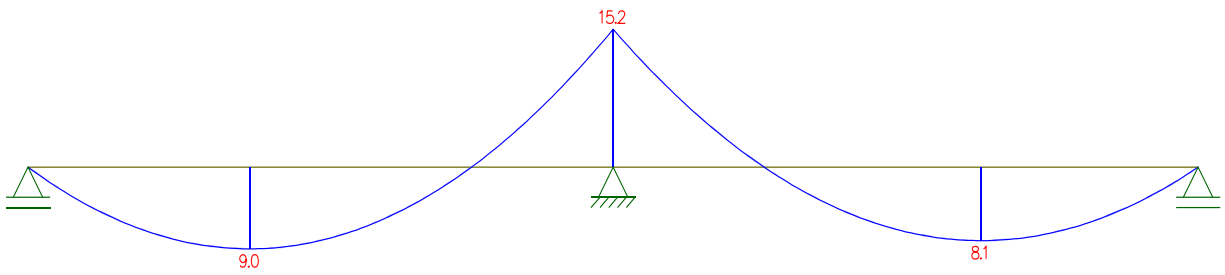
- Solicitaciones

Carga Permanente

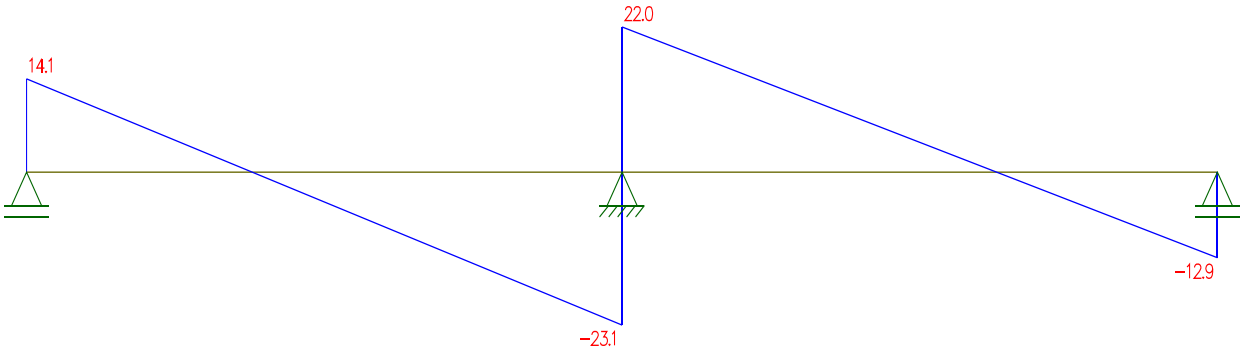
DCL



Mf

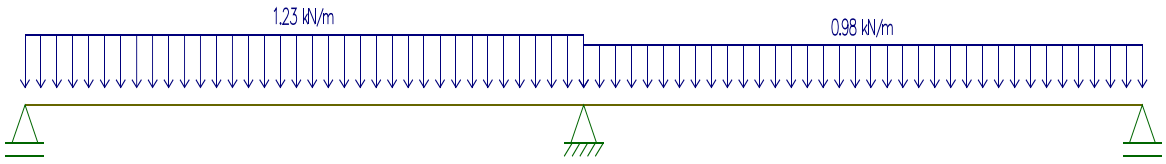


Q



Sobrecarga

DCL



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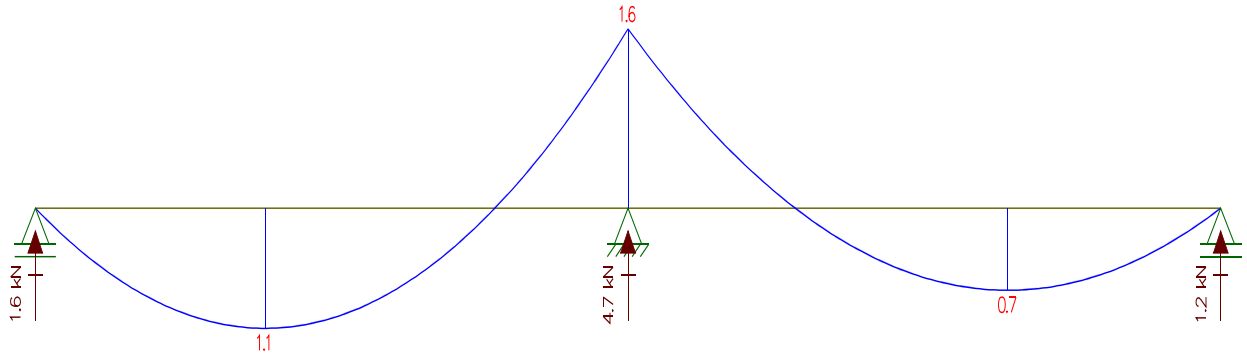
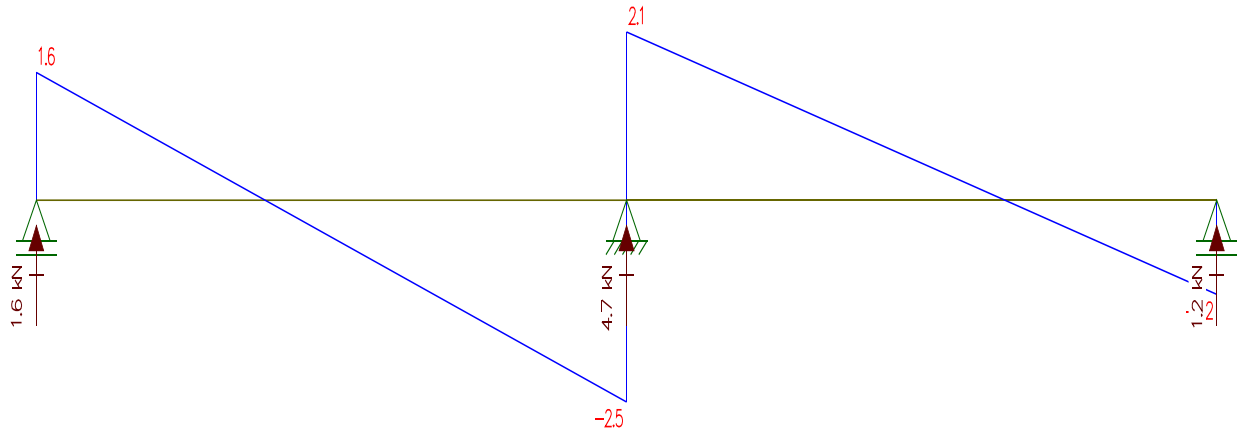


Q



- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 9 + 1{,}6 * 1{,}1)kNm = 12{,}56\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{12{,}56\ kNm}{0{,}9} = 13{,}95kNm = 0{,}01395\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 30\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 25{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}256\ m}{\sqrt{\frac{0{,}01395\ MNm}{0{,}20\ m}}} = 0{,}97$$

De tabla de Flexión 3: $k_e = 24{,}766\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}766\ {cm^2}/{MN} * \frac{0{,}01395 MNm}{0{,}256\ m} = 1{,}35\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 3Ø12 abajo. ($A_s = 3{,}39\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}{}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}{}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 12 - 2 * 30 - 2 * 6)}{2} = 46\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

Apoyo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 15{,}2 + 1{,}6 * 1{,}6) kNm = 20{,}8\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{20{,}8\ kNm}{0{,}9} = 23{,}11 kNm = 0{,}02311\ MNm$$

$$d = h - c_c - \frac{1}{2} d_b - d_{est} = 30\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 25{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}256\ m}{\sqrt{\frac{0{,}02311\ MNm}{0{,}20\ m}}} = 0{,}75$$

De tabla de Flexión 3: $k_e = 25{,}207 cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 25{,}207\ {cm^2}/{MN} * \frac{0{,}02311 MNm}{0{,}256\ m} = 2{,}27\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 3Ø12 arriba ($A_s = 3{,}39\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^o{}_{d_b} * d_b - 2c_c - 2d_{est}}{n^o{}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 12 - 2 * 30 - 2 * 6)}{2} = 46\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25 mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5 c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 14{,}1 + 1{,}6 * 1{,}6) kN = 19{,}48\ kN$

$V_n = \frac{V_u}{\varphi} = \frac{19{,}48\ kN}{0{,}75} = 25{,}97\ kN = 0{,}02597\ MN$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}256\ m = 0{,}0426\ MN$

Vc>Vn; Del Reglamento CIROSC 201-05: $Avmin = \frac{\sqrt{f`_c} * bw * s}{16 fy} = 0{,}18\ cm^2$

$s_{máx} = \frac{d}{2} = \frac{0{,}256\ m}{2} = 0{,}128\ m$; Adopto smax, Adopto estribos Ø6 de 2 ramas c/ 12 cm.

Apoyo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 23{,}1 + 1{,}6 * 2{,}5) kN = 31{,}72\ kN$

$V_n = \frac{V_u}{\varphi} = \frac{31{,}72\ kN}{0{,}75} = 42{,}29\ kN = 0{,}0423\ MN$

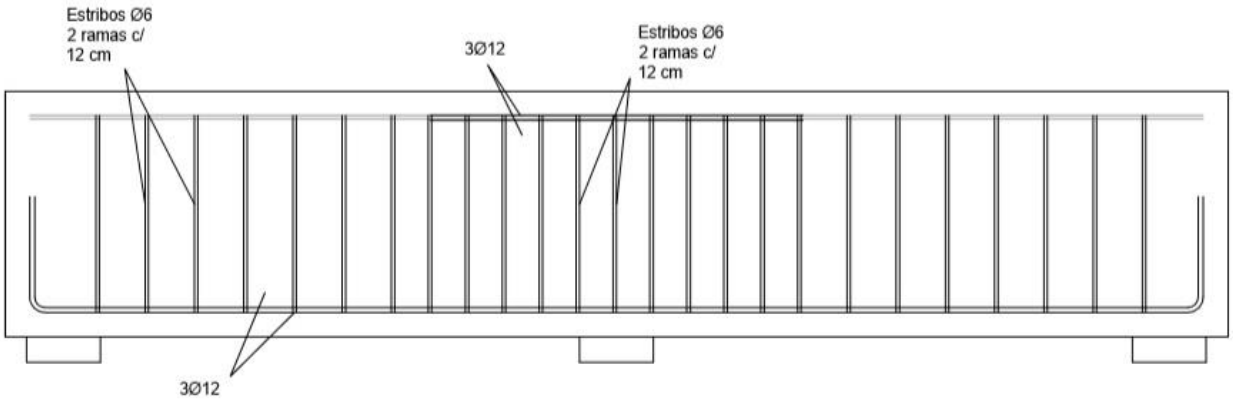
$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}256\ m = 0{,}0426\ MN$

Vc>Vn; Del Reglamento CIROSC 201-05: $Avmin = \frac{\sqrt{f`_c} * bw * s}{16 fy} = 0{,}18\ cm^2$

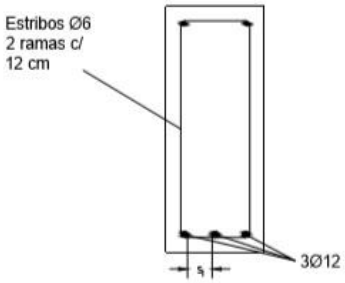
$s_{máx} = \frac{d}{2} = \frac{0{,}256\ m}{2} = 0{,}128\ m$; Adopto smax.

Adopto estribos Ø6 de 2 ramas c/ 12 cm.

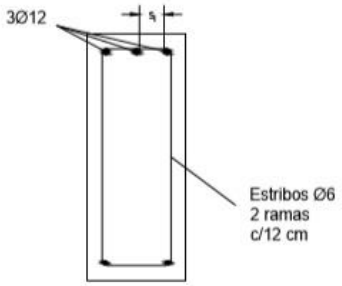
- Detalle de Armado



Tramo



Apoyo



Vigas V017-V018 IDEM V019-V020

- Predimensionado

$$h = \frac{l}{12} = \frac{338\ cm}{12} = 0{,}28\ m$$

Adopto h= 30 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}30\ m = 1{,}5\ kN/m$$

Peso de pared:

$$p_{par} = \gamma * e * h = 10{,}5\ {}^{kN}/_{m^3} * 0{,}20\ m * 3\ m = 6{,}3\ kN/m$$

$$D017 = R_{L01D} + R_{L02D} + p_p + p_{par} = {}^{(4{,}39 + +4{,}39 + 1{,}5 + 6{,}3)kN}/_{m} =$$

$D017 = 16{,}58\ kN/m$

$D018 = R_{L03D} + R_{L04D} + p_p + p_{par} = {(5{,}58 + 5{,}58 + 1{,}5 + 6{,}3)kN}/{m} =$

$D018 = 18{,}96\ kN/m$

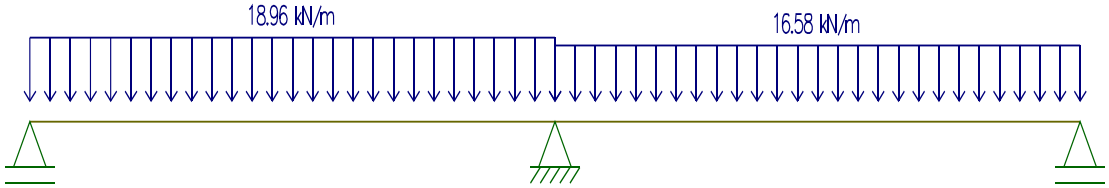
$L017 = R_{L01L} + R_{L02L} = {(1{,}71 + 1{,}71)kN}/{m} = 3{,}42kN/m$

$L018 = R_{L03L} + R_{L04L} = {(2{,}14 + 2{,}14)kN}/{m} = 4{,}28kN/m$

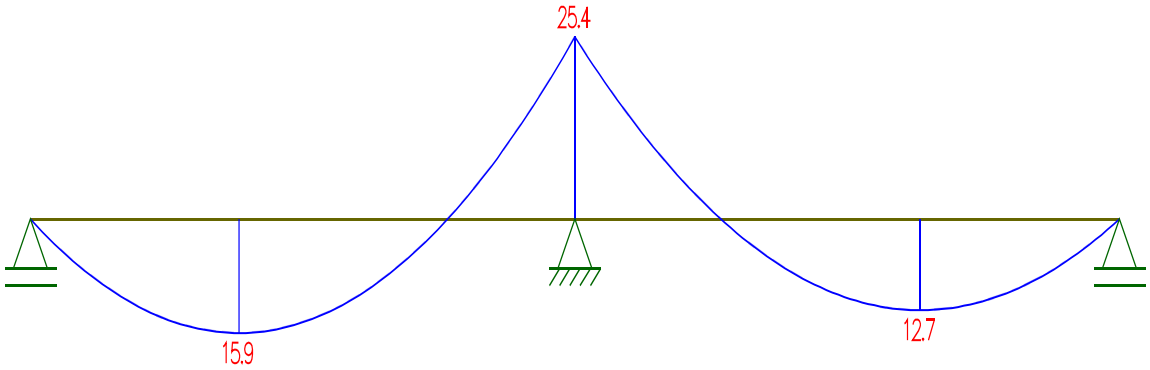
- Solicitaciones

Carga Permanente

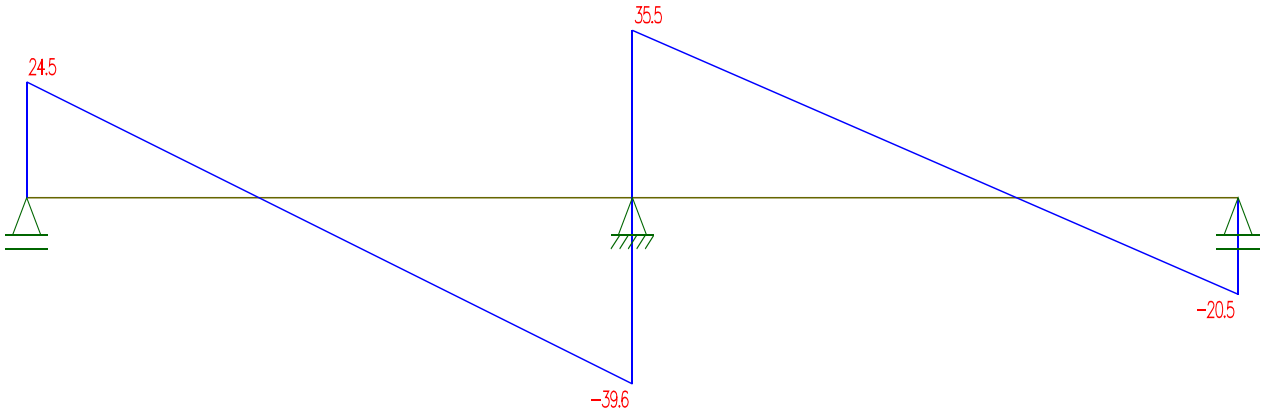
DCL



Mf

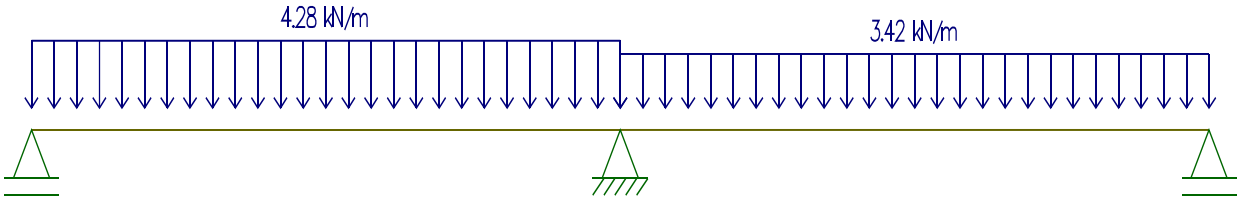


Q



Sobrecarga

DCL



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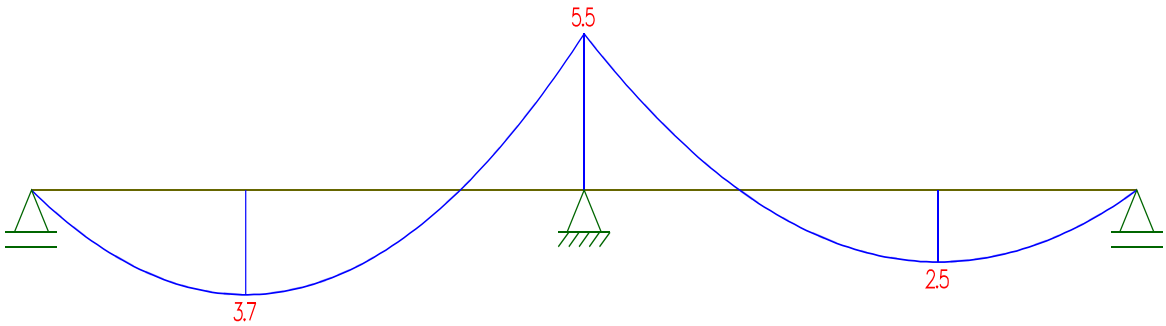

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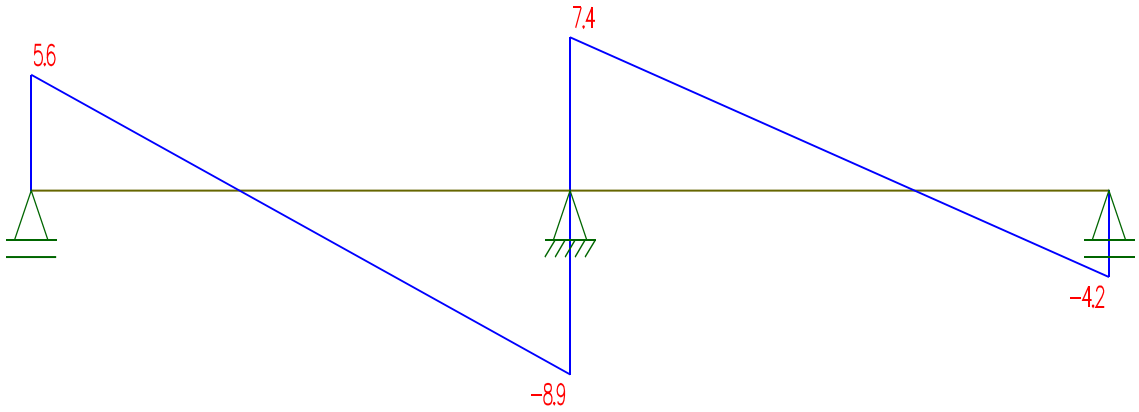


- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 15{,}9 + 1{,}6 * 3{,}7)kNm = 25\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{25\ kNm}{0{,}9} = 27{,}8kNm = 0{,}0278\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 30\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 25{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}256\ m}{\sqrt{\frac{0{,}0278\ MNm}{0{,}20\ m}}} = 0{,}68$$

De tabla de Flexión 3: $k_e = 25{,}207 cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 25{,}207\ {cm^2}/{MN} * \frac{0{,}0278 MNm}{0{,}256\ m} = 2{,}73\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 25{,}6\ cm}{420\ MPa} = 1{,}70\ cm^2$$

Adopto 3Ø12 abajo. ($A_s = 3{,}39\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 12 - 2 * 30 - 2 * 6)}{2} = 46\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

Apoyo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 25{,}4 + 1{,}6 * 5{,}5)kNm = 39{,}28\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{39{,}28\ kNm}{0{,}9} = 43{,}65kNm = 0{,}04365\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 30\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 25{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}256\ m}{\sqrt{\frac{0{,}04365\ MNm}{0{,}20\ m}}} = 0{,}548$$

De tabla de Flexión 3: $k_e = 26{,}399\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 26{,}399\ {cm^2}/{MN} * \frac{0{,}04365 MNm}{0{,}256\ m} = 4{,}5\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 25{,}6\ cm}{420\ MPa} = 1{,}7\ cm^2$$

Adopto 4Ø12 arriba ($A_s = 4{,}52\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}{}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}{}_{espacios}}$$

$$s_l = \frac{(200 - 4 * 12 - 2 * 30 - 2 * 6)}{3} = 26{,}6\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 24{,}5 + 1{,}6 * 5{,}6)kN = 38{,}36\ kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{38{,}36\ kN}{0{,}75} = 51{,}14\ kN = 0{,}05114\ MN$$

$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}256\ m = 0{,}0426\ MN$$

$$V_s = V_n - V_c = 0{,}05114\ MN - 0{,}0426\ MN = 0{,}00854\ MN$$

Adoptando estribos Ø6 de 2 ramas.

$$s_{máx} = \frac{d}{2} = \frac{0{,}256\ m}{2} = 0{,}128\ m$$

$$\frac{A_v}{s} = \frac{V_s * 10^4}{f_y * d} = \frac{0{,}00854\ MN * 10^4}{420\ MPa * 0{,}256\ m} = 0{,}794\ cm^2/m$$

$s = \frac{A_v}{0{,}794\ cm^2/m} = \frac{2 * 0{,}28\ cm^2}{0{,}794\ cm^2/m} = 0{,}7\ m$; Adopto smax

Adopto estribos Ø6 de 2 ramas c/ 12 cm.

Apoyo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 39{,}6 + 1{,}6 * 8{,}9) kN = 61{,}76\ kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{61{,}76\ kN}{0{,}75} = 82{,}34\ kN = 0{,}08234\ MN$$

$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}256\ m = 0{,}0426\ MN$$

$$V_s = V_n - V_c = 0{,}08234\ MN - 0{,}0426\ MN = 0{,}03974\ MN$$

Adoptando estribos Ø6 de 2 ramas.

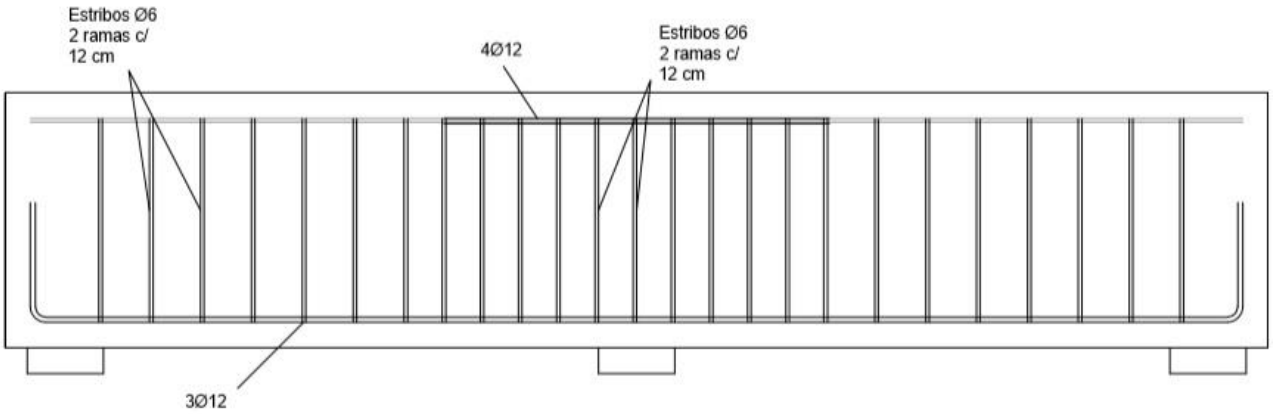
$$s_{máx} = \frac{d}{2} = \frac{0{,}256\ m}{2} = 0{,}128\ m$$

$$\frac{A_v}{s} = \frac{V_s * 10^4}{f_y * d} = \frac{0{,}03974\ MN * 10^4}{420\ MPa * 0{,}256\ m} = 3{,}69\ cm^2/m$$

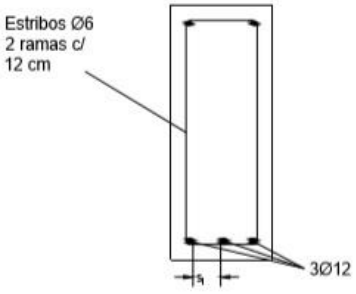
$s = \frac{A_v}{3{,}69\ cm^2/m} = \frac{2 * 0{,}28\ cm^2}{3{,}69\ cm^2/m} = 0{,}15\ m$; Adopto smax

Adopto estribos Ø6 de 2 ramas c/ 12 cm.

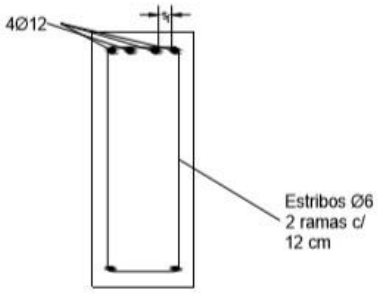
- Detalle de Armado



Tramo



Apoyo



Viga V025 IDEM V125

- Predimensionado

$$h = \frac{l}{12} = \frac{600\ cm}{12} = 0{,}50\ m$$

Adopto h= 50 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}50\ m = 2{,}5\ kN/m$$

$$D = R_{L011D} + p_p = {}^{(4{,}2 + 2{,}5)kN}/_{m} =$$

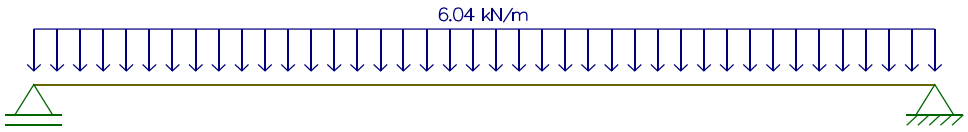
$$D = 6{,}04\ kN/m$$

$$L = R_{L011L} = {}^{(1{,}78)kN}/_{m} = 1{,}78 kN/m$$

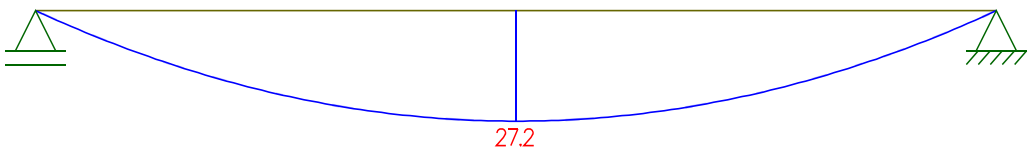
- Solicitaciones

Carga Permanente

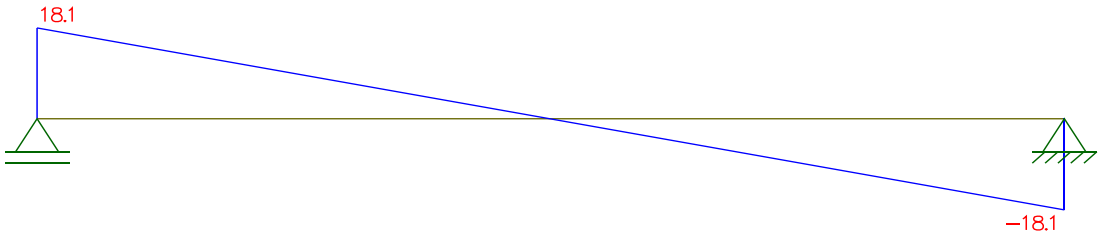
DCL



Mf

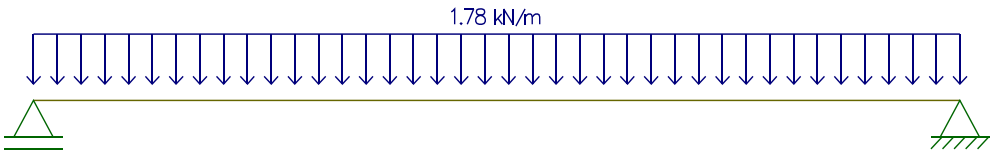


Q

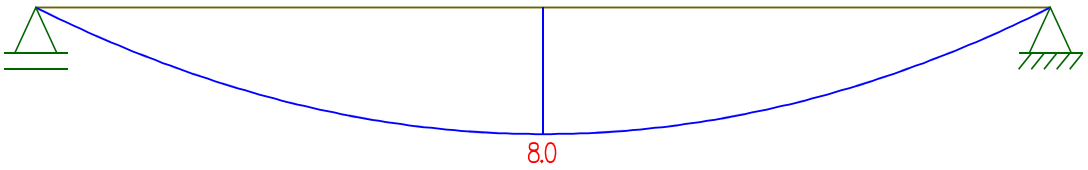


Sobrecarga

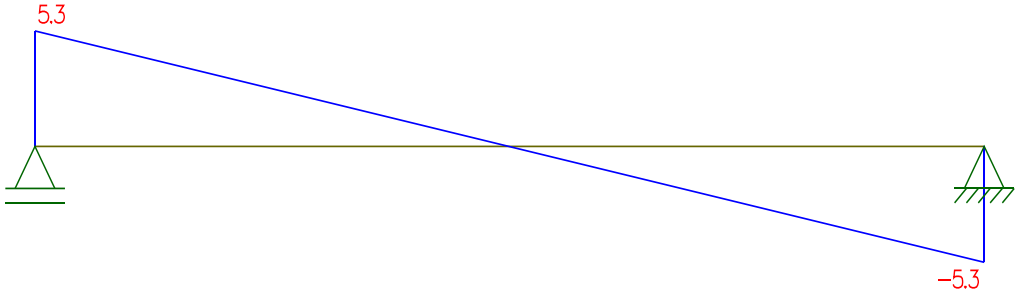
DCL



Mf



Q



- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 27{,}18 + 1{,}6 * 6{,}75)kNm = 43{,}41\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{43{,}41\ kNm}{0{,}9} = 48{,}24kNm = 0{,}04824\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}04824\ MNm}{0{,}20\ m}}} = 0{,}93$$

De tabla de Flexión 3: $k_e = 24{,}766cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}766\, cm^2/_{MN} * \frac{0{,}04824 MNm}{0{,}456\, m} = 2{,}62\, cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\, cm * 25{,}6\, cm}{420\, MPa} = 1{,}7\, cm^2$$

Adopto 3Ø12 abajo ($A_s = 3{,}39\, cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 12 - 2 * 30 - 2 * 6)}{2} = 46\, mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\, mm \\ \geq 25 mm \\ \geq 1{,}33\, T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\, mm = 305\, mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\, mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 18{,}12 + 1{,}6 * 4{,}5) kN = 28{,}94\, kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{28{,}94\, kN}{0{,}75} = 38{,}58\, kN = 0{,}03858\, MN$$

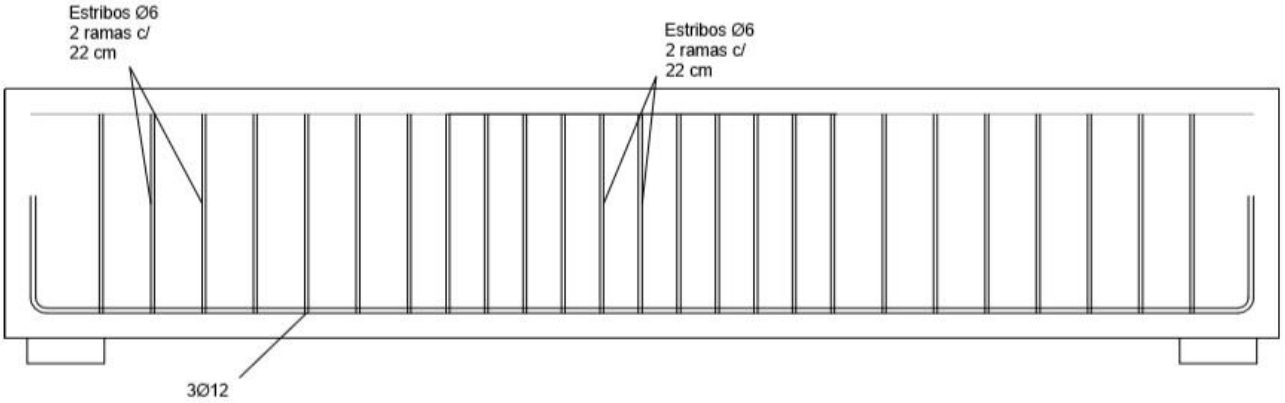
$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\, MPa} * 0{,}2\, m * 0{,}456\, m = 0{,}076\, MN$$

Vc>Vn; Del Reglamento CIROSC 201-05: $Avmin = \frac{\sqrt{f`_c} * bw * s}{16 fy} = 0{,}33\, cm^2$

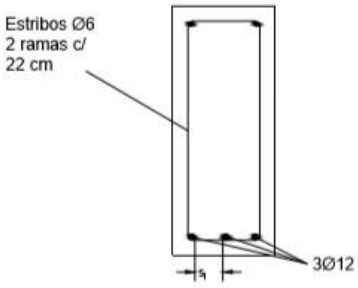
$s_{máx} = \frac{d}{2} = \frac{0{,}456\ m}{2} = 0{,}228\ m$; Adopto smax, Adoptando estribos Ø6 de 2 ramas.

Adopto estribos Ø6 de 2 ramas c/ 22 cm.

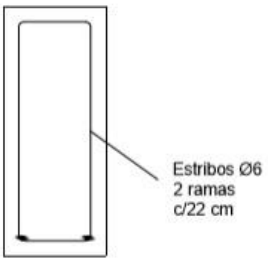
- Detalle de Armado



Tramo



Apoyo



Viga V026 IDEM V126 ‖ V028 ‖ V128

- Predimensionado

$$h = \frac{l}{12} = \frac{193\ cm}{12} = 0{,}16\ m$$

Adopto h= 30 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}30\ m = 1{,}5\ kN/m$$

$$D = R_{L011D} + R_{L012D} + p_p = {}^{(4{,}2 + 3{,}4 + 1{,}5)kN}/_{m} =$$

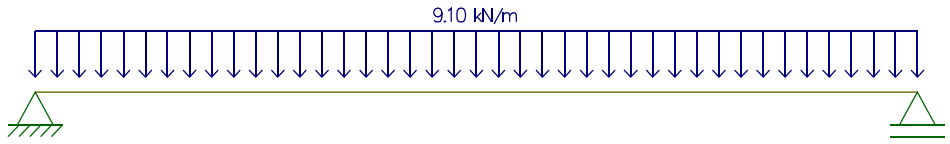
$$D = 9{,}1\ kN/m$$

$$L = R_{L011L} + R_{L012L} = {}^{(1{,}78 + 1{,}4)kN}/_{m} = 3{,}18 kN/m$$

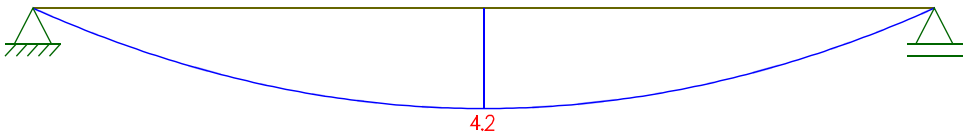
- Solicitaciones

Carga Permanente

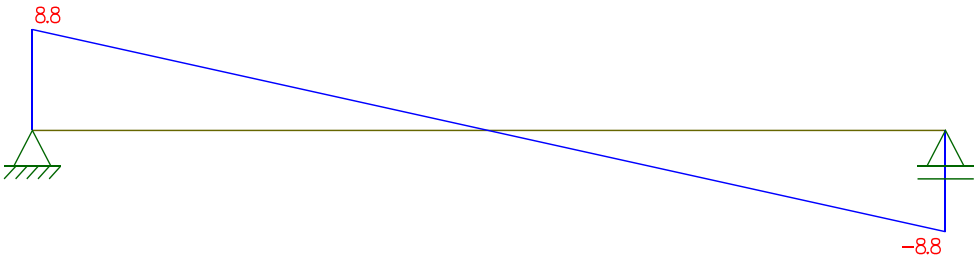
DCL



Mf

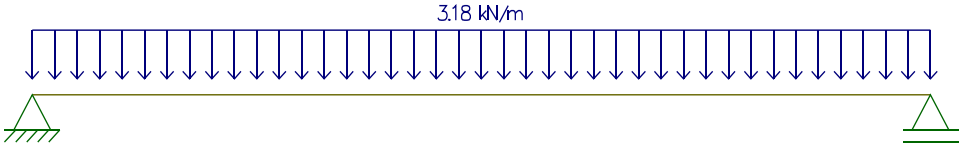


Q

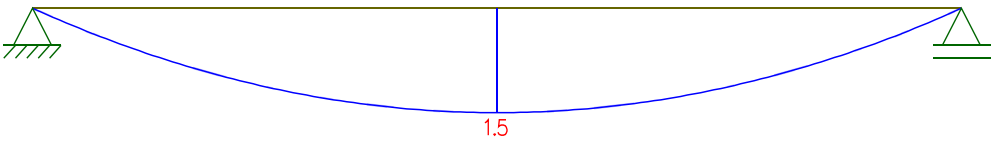


Sobrecarga

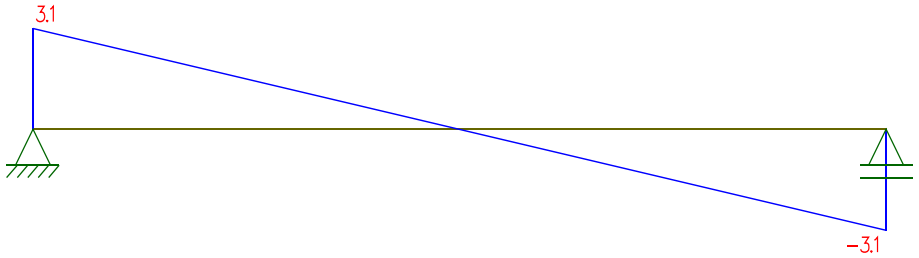
DCL



Mf



Q



- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 4{,}2 + 1{,}6 * 1{,}5)kNm = 7{,}44\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{7{,}44\ kNm}{0{,}9} = 8{,}26kNm = 0{,}00826\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 30\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 25{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}256\ m}{\sqrt{\frac{0{,}00826\ MNm}{0{,}20\ m}}} = 1{,}26$$

De tabla de Flexión 3: $k_e = 24{,}301 cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}301\ {cm^2}/{MN} * \frac{0{,}00826 MNm}{0{,}256\ m} = 0{,}78\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 25{,}6\ cm}{420\ MPa} = 1{,}7\ cm^2$$

Adopto 2Ø12 abajo ($A_s = 2{,}26\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^o{}_{d_b} * d_b - 2c_c - 2d_{est}}{n^o{}_{espacios}}$$

$$s_l = \frac{(200 - 2 * 12 - 2 * 30 - 2 * 6)}{1} = 104\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 8{,}8 + 1{,}6 * 3{,}1)kN = 15{,}52\ kN$

$V_n = \frac{V_u}{\varphi} = \frac{15{,}52\ kN}{0{,}75} = 20{,}69\ kN = 0{,}02069MN$

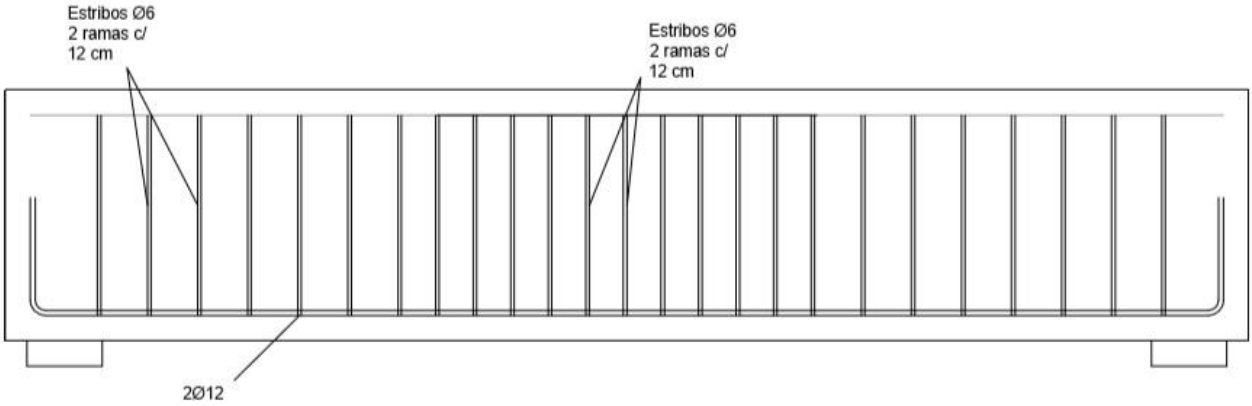
$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}256\ m = 0{,}0426\ MN$

Vc>Vn; Del Reglamento CIROSC 201-05: $Avmin = \frac{\sqrt{f`_c} * bw * s}{16fy} = 0{,}18\ cm^2\ cm^2$

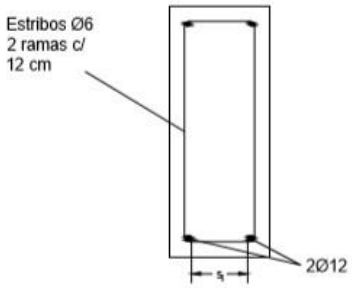
$s_{máx} = \frac{d}{2} = \frac{0{,}256\ m}{2} = 0{,}128\ m$; Adopto smax, Adoptando estribos Ø6 de 2 ramas.

Adopto estribos Ø6 de 2 ramas c/ 12 cm.

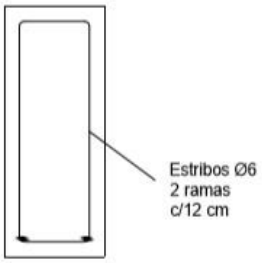
- Detalle de Armado



Tramo



Apoyo



Viga V027 IDEM V127

- Predimensionado

$$h = \frac{l}{12} = \frac{215\ cm}{12} = 0{,}18\ m$$

Adopto h= 30 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}30\ m = 1{,}5\ kN/m$$

$$D = R_{L011D} + R_{LescD} + p_p = {}^{(4{,}2 + 17{,}11 + 1{,}5)kN}/_{m} =$$

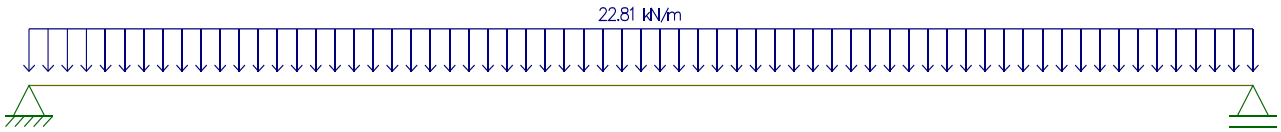
$$D = 22{,}81\ kN/m$$

$$L = R_{L011L} + R_{LescL} = {}^{(1{,}78 + 4{,}16)kN}/_{m} = 5{,}94 kN/m$$

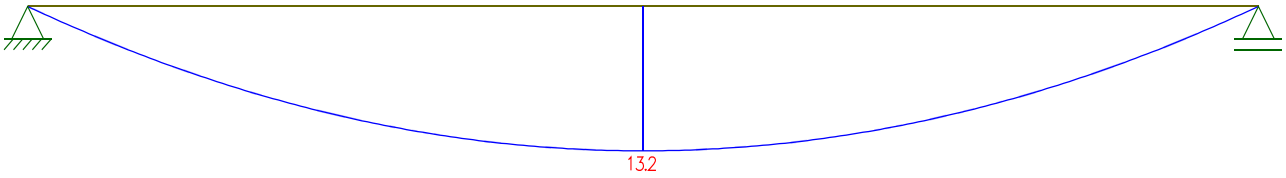
- Solicitaciones

Carga Permanente

DCL



Mf



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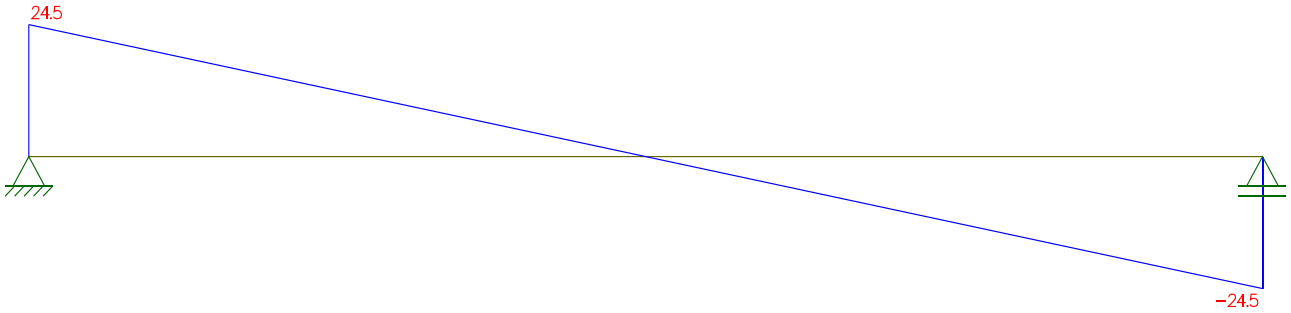
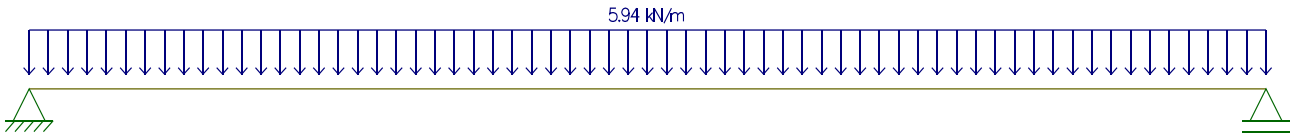
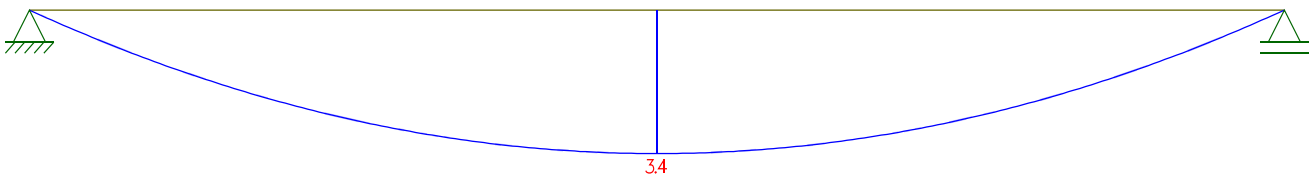


Sobrecarga

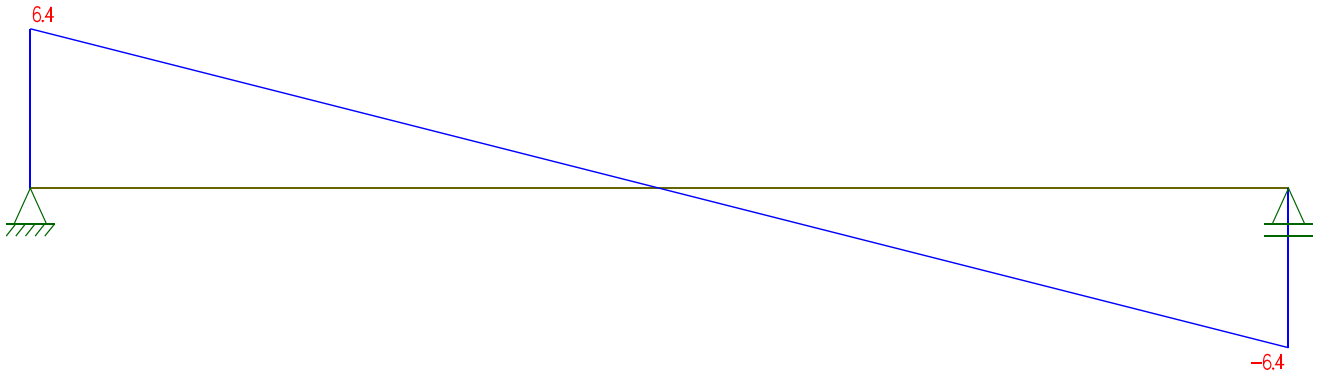
DCL



Mf



Q



- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 13{,}2 + 1{,}6 * 3{,}43) kNm = 21{,}33\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{21{,}33\ kNm}{0{,}9} = 23{,}7 kNm = 0{,}0237\ MNm$$

$$d = h - c_c - \frac{1}{2} d_b - d_{est} = 30\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 25{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}256\ m}{\sqrt{\frac{0{,}0237\ MNm}{0{,}20\ m}}} = 0{,}74$$

De tabla de Flexión 3: $k_e = 25{,}207\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 25{,}207\ {cm^2}/{MN} * \frac{0{,}0237 MNm}{0{,}256\ m} = 2{,}33\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 3Ø12 abajo ($A_s = 3{,}39\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^o{}_{d_b} * d_b - 2c_c - 2d_{est}}{n^o{}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 12 - 2 * 30 - 2 * 6)}{2} = 46\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 24{,}5 + 1{,}6 * 6{,}4)kN = 39{,}64kN$

$V_n = \frac{V_u}{\varphi} = \frac{39{,}64\ kN}{0{,}75} = 52{,}85\ kN = 0{,}05285\ MN$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}256\ m = 0{,}0426\ MN$

$V_s = V_n - V_c = 0{,}05285\ MN - 0{,}0426\ MN = 0{,}01025\ MN$

Adoptando estribos Ø6 de 2 ramas.

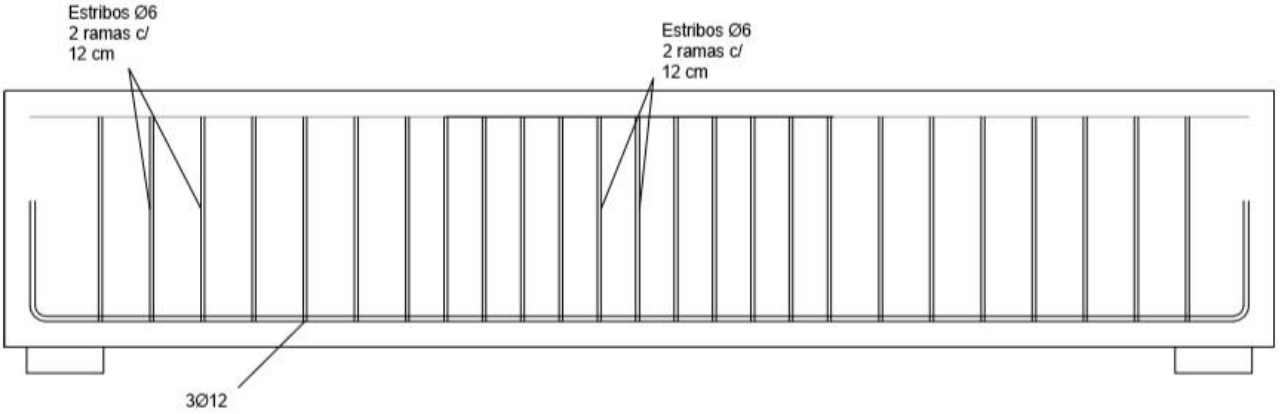
$s_{máx} = \frac{d}{2} = \frac{0{,}256\ m}{2} = 0{,}128\ m$

$\frac{A_v}{s} = \frac{V_s * 10^4}{f_y * d} = \frac{0{,}01025\ MN * 10^4}{420\ MPa * 0{,}256\ m} = 0{,}95\ cm^2/m$

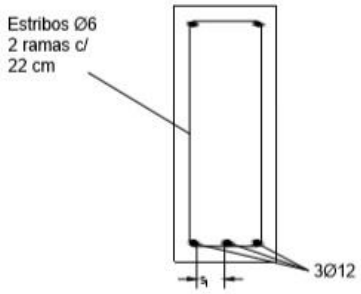
$s = \frac{A_v}{0{,}95\ cm^2/m} = \frac{2 * 0{,}28\ cm^2}{0{,}95\ cm^2/m} = 0{,}58\ m$; Adopto smax

Adopto estribos Ø6 de 2 ramas c/ 12 cm.

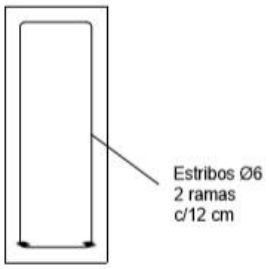
- Detalle de Armado



Tramo



Apoyo



Viga V029 IDEM V030 ‖ V129 ‖ V130

- Predimensionado

$$h = \frac{l}{12} = \frac{193\ cm}{12} = 0{,}16\ m$$

Adopto h= 30 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}30\ m = 1{,}5\ kN/m$$

$$D = R_{L012D} + p_p = {}^{(3{,}4 + 1{,}5)kN}/_{m} =$$

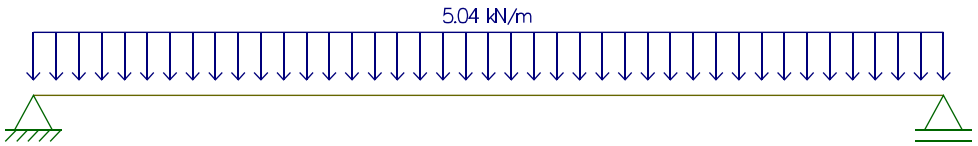
$$D = 5{,}04\ kN/m$$

$$L = R_{L012L} = {}^{(1{,}4)kN}/_{m} = 1{,}4kN/m$$

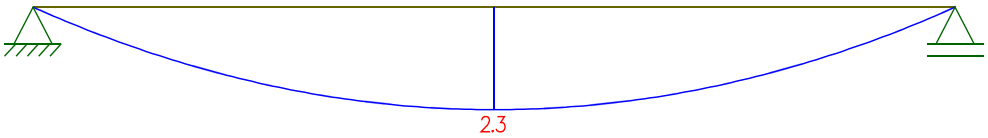
- Solicitaciones

Carga Permanente

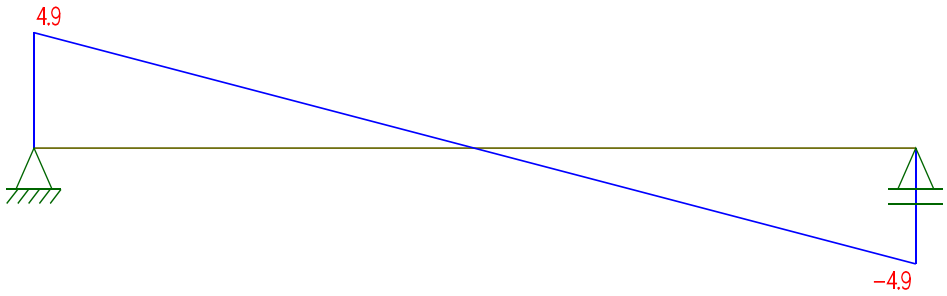
DCL



Mf

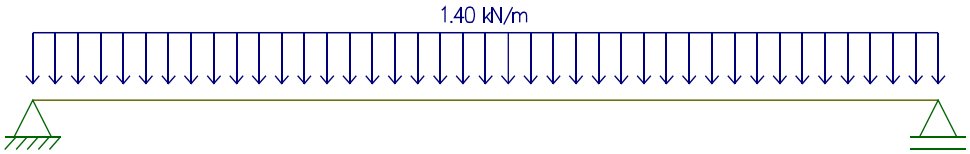


Q

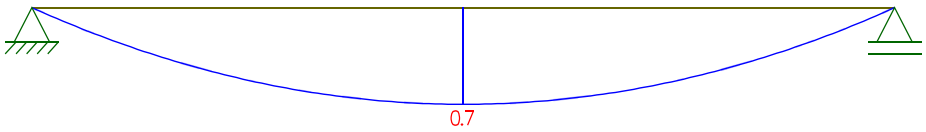


Sobrecarga

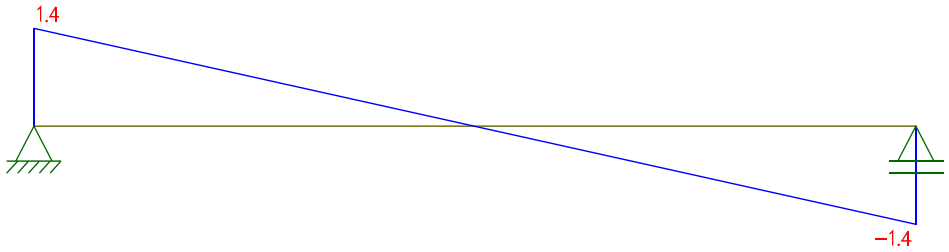
DCL



Mf



Q



- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 2{,}3 + 1{,}6 * 0{,}7) kNm = 3{,}88\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{3{,}88\ kNm}{0{,}9} = 4{,}31 kNm = 0{,}00431\ MNm$$

$$d = h - c_c - \frac{1}{2} d_b - d_{est} = 30\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 25{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}256\ m}{\sqrt{\frac{0{,}00431\ MNm}{0{,}20\ m}}} = 1{,}74$$

De tabla de Flexión 3: $k_e = 24{,}301 cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}301\ {}^{cm^2}/_{MN} * \frac{0{,}00431 MNm}{0{,}256\ m} = 0{,}409\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 25{,}6\ cm}{420\ MPa} = 1{,}7\ cm^2$$

Adopto 2Ø12 abajo ($A_s = 2{,}26\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}{}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}{}_{espacios}}$$

$$s_l = \frac{(200 - 2 * 12 - 2 * 30 - 2 * 6)}{1} = 104\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 4{,}9 + 1{,}6 * 1{,}4)kN = 8{,}12\ kN$

$V_n = \frac{V_u}{\varphi} = \frac{8{,}12\ kN}{0{,}75} = 10{,}82kN = 0{,}01082MN$

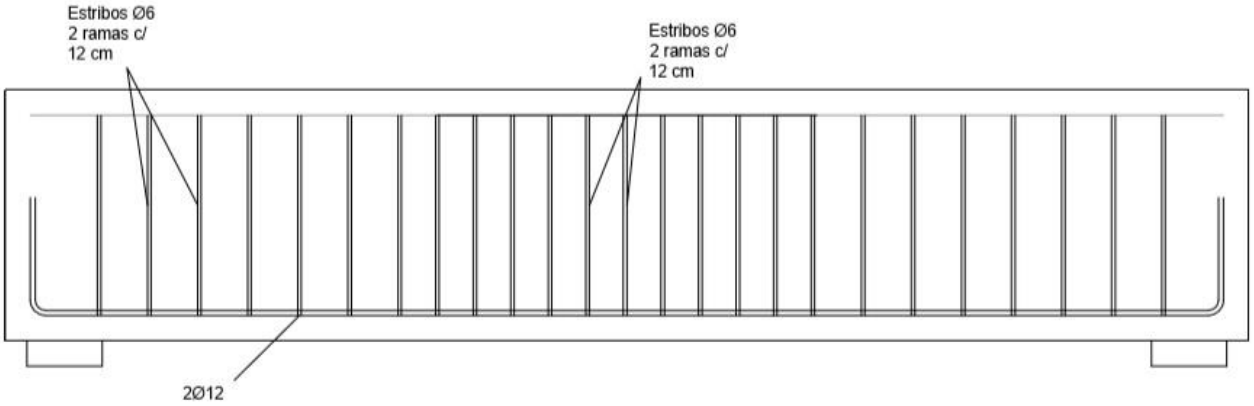
$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}256\ m = 0{,}0426\ MN$

Vc>Vn; Del Reglamento CIROSC 201-05: $Avmin = \frac{\sqrt{f`_c} * bw * s}{16fy} = 0{,}18\ cm^2$

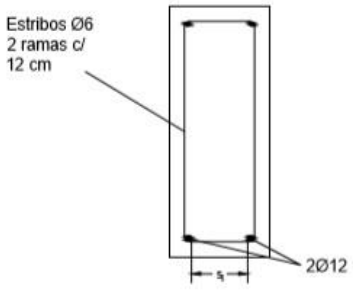
$s_{máx} = \frac{d}{2} = \frac{0{,}256\ m}{2} = 0{,}128\ m$; Adopto smax, Adoptando estribos Ø6 de 2 ramas.

Adopto estribos Ø6 de 2 ramas c/ 12 cm.

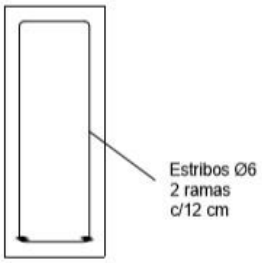
- Detalle de Armado



Tramo



Apoyo



Vigas V11-V12 IDEM V111-V112

- Predimensionado

$$h = \frac{l}{12} = \frac{540\ cm}{12} = 0{,}45\ m$$

Adopto h= 50 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}50\ m = 2{,}5\ kN/m$$

$$D = R_{L11D} + R_{L15D} + p_p = {}^{(6{,}63 + 6{,}79 + 2{,}5)kN}/_{m} =$$

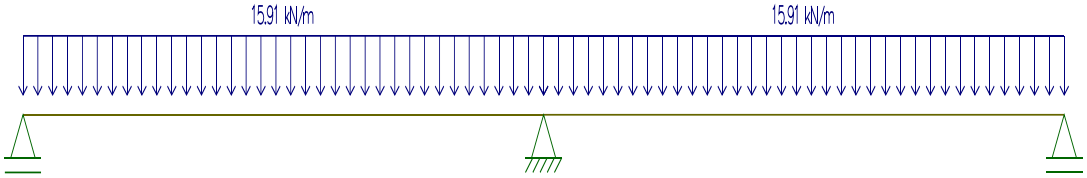
$$D = 15{,}91\ kN/m$$

$$L = R_{L11L} + R_{L15L} = {}^{(2{,}58 + 6{,}5)kN}/_{m} = 9{,}08 kN/m$$

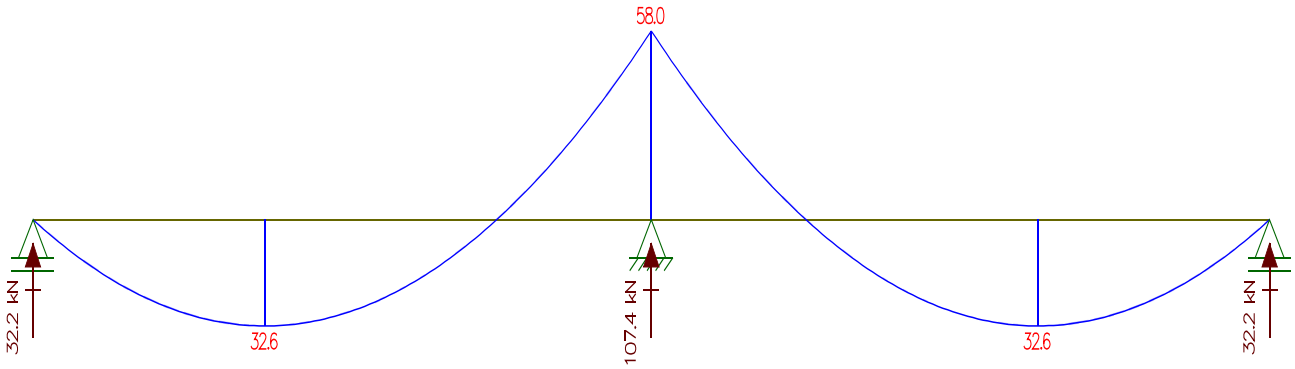
- Solicitaciones

Carga Permanente

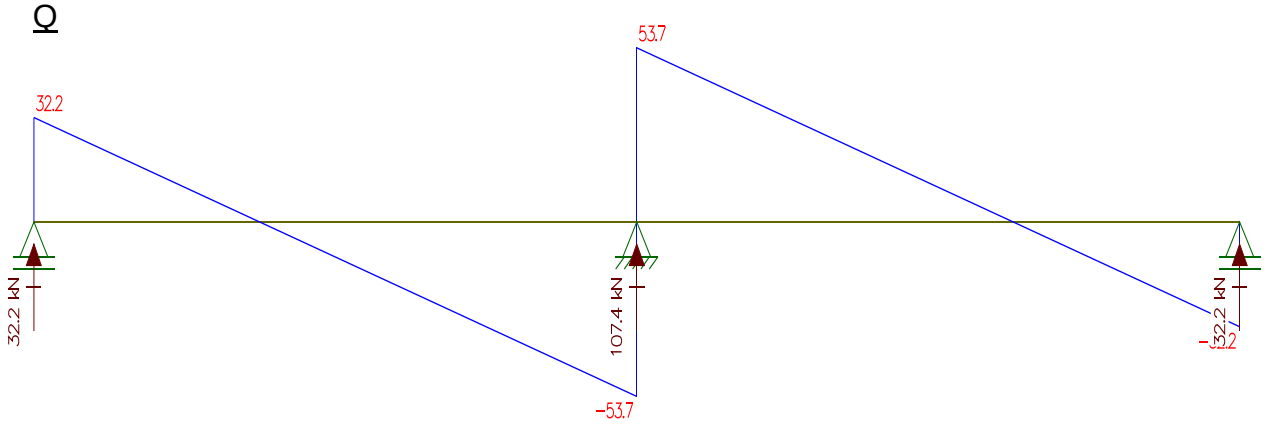
DCL



Mf

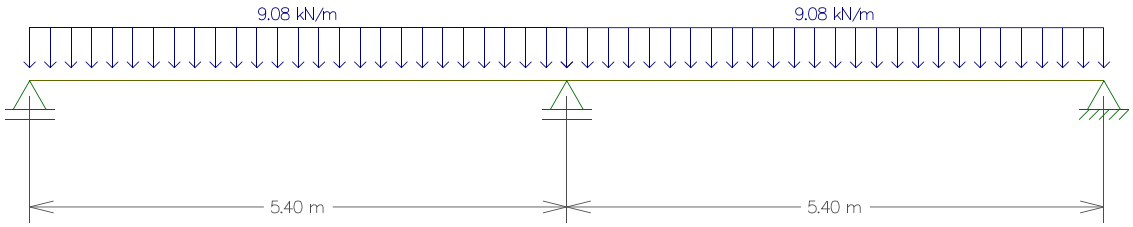


Q

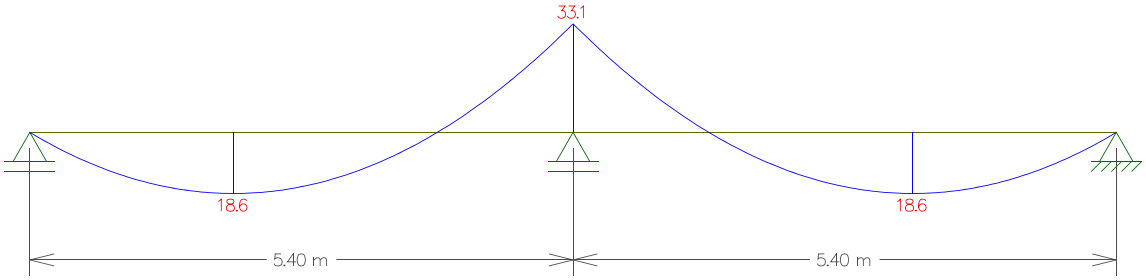


Sobrecarga

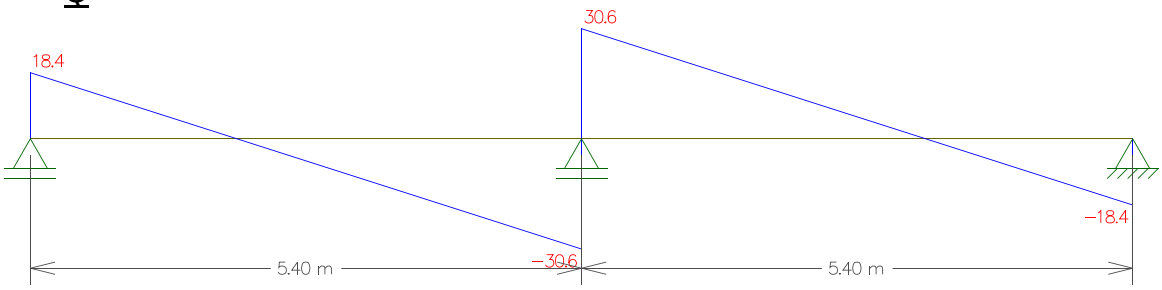
DCL



Mf



Q



- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 32{,}6 + 1{,}6 * 18{,}6) kNm = 68{,}9\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{68{,}9\ kNm}{0{,}9} = 76{,}55 kNm = 0{,}07655\ MNm$$

$$d = h - c_c - \frac{1}{2} d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}07655\ MNm}{0{,}20\ m}}} = 0{,}737$$

De tabla de Flexión 3: $k_e = 25{,}207\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 25{,}207\ {cm^2}/{MN} * \frac{0{,}0766 MNm}{0{,}456\ m} = 4{,}23\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 4Ø12 abajo. ($A_s = 4{,}52\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 4 * 12 - 2 * 30 - 2 * 6)}{3} = 26{,}6\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25 mm \\ \geq 1{,}33\ T.M.N \end{cases}$$

Verifica

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$

Verifica

Apoyo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 58 + 1{,}6 * 33{,}1)kNm = 122{,}56\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{122{,}56\ kNm}{0{,}9} = 136{,}1kNm = 0{,}1361\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}1361\ MNm}{0{,}20\ m}}} = 0{,}55$$

De tabla de Flexión 3: $k_e = 26{,}021\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 26{,}021\ {cm^2}/{MN} * \frac{0{,}1361 MNm}{0{,}456\ m} = 7{,}76\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 4Ø16 arriba en dos capas ($A_s = 8{,}04\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}{}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}{}_{espacios}}$$

$$s_l = \frac{(200 - 2 * 16 - 2 * 30 - 2 * 6)}{1} = 96\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín}\begin{cases}\geq d_b = 16\,mm\\ \geq 25mm\\ \geq 1{,}33\,T.M.N\end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s\begin{cases}\leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\,mm = 305\,mm\\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\,mm\end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 32{,}6 + 1{,}6 * 8{,}4)kN = 52{,}08\,kN$

$V_n = \frac{V_u}{\varphi} = \frac{52{,}08\,kN}{0{,}75} = 69{,}44\,kN = 0{,}06944\,MN$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\,MPa} * 0{,}2\,m * 0{,}456\,m = 0{,}076\,MN$

Vc>Vn; Del Reglamento CIROSC 201-05: $Avmin = \frac{\sqrt{f`_c} * bw * s}{16fy} = 0{,}33\,cm^2$

$s_{máx} = \frac{d}{2} = \frac{0{,}456\,m}{2} = 0{,}228\,m$; Adopto smax

Adopto estribos Ø6 de 2 ramas c/ 22 cm.

Apoyo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 53{,}7 + 1{,}6 * 30{,}65)kN = 113{,}5\,kN$

$V_n = \frac{V_u}{\varphi} = \frac{113{,}5\,kN}{0{,}75} = 1513\,kN = 0{,}1513\,MN$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\,MPa} * 0{,}2\,m * 0{,}456\,m = 0{,}076\,MN$

$$V_s = V_n - V_c = 0{,}1513\ MN - 0{,}076\ MN = 0{,}0753\ MN$$

Adoptando estribos Ø6 de 2 ramas.

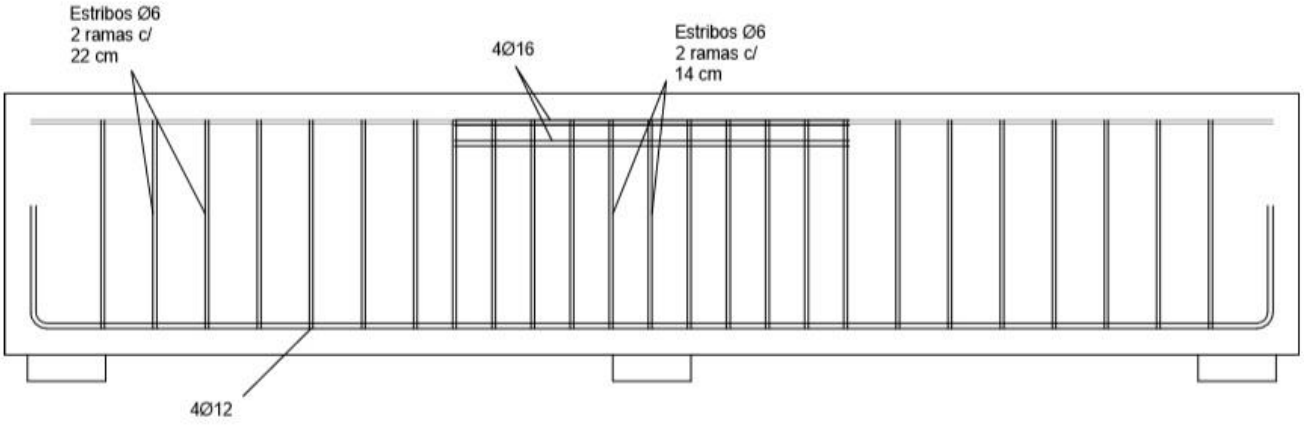
$$s_{máx} = \frac{d}{2} = \frac{0{,}456\ m}{2} = 0{,}228\ m$$

$$\frac{A_v}{s} = \frac{V_s * 10^4}{f_y * d} = \frac{0{,}076\ MN * 10^4}{420\ MPa * 0{,}456\ m} = 3{,}96\ cm^2/m$$

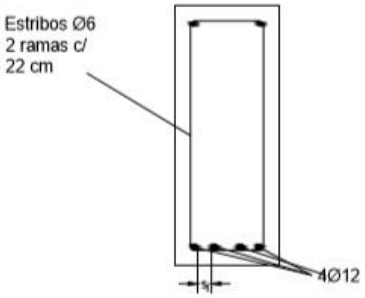
$$s = \frac{A_v}{3{,}96\ cm^2/m} = \frac{2 * 0{,}28\ cm^2}{3{,}96\ cm^2/m} = 0{,}14\ m$$

Adopto estribos Ø6 de 2 ramas c/ 14 cm.

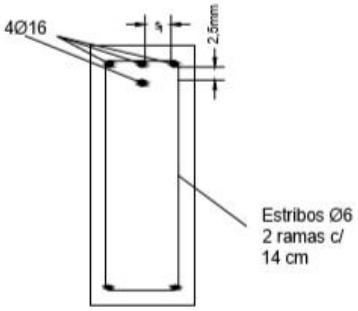
- Detalle de Armado



Tramo



Apoyo



Vigas V13-V14 IDEM V19-V110

- Predimensionado

$$h = \frac{l}{12} = \frac{540\ cm}{12} = 0{,}45\ m$$

Adopto h= 50 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}50\ m = 2{,}5\ kN/m$$

$$D = R_{L11D} + R_{L13D} + p_p = {}^{(6{,}63 + 7.66 + 2{,}5)kN}/_{m} =$$

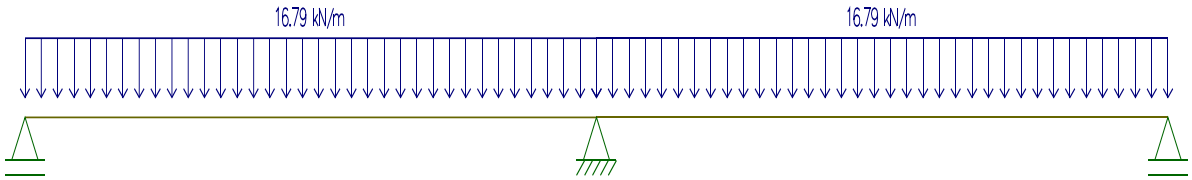
$$D = 16{,}79\ kN/m$$

$$L = R_{L11L} + R_{L13L} = {}^{(2{,}58 + 2{,}94)kN}/_{m} = 5{,}52kN/m$$

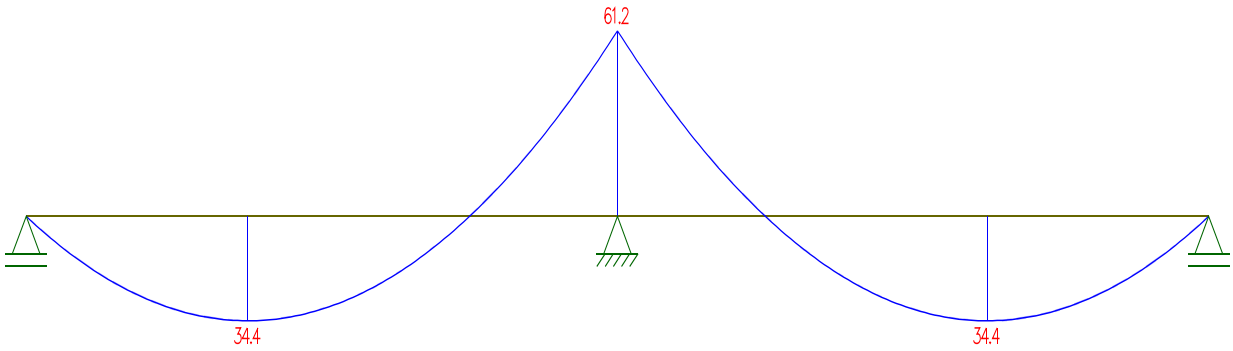
- Solicitaciones

Carga Permanente

DCL



Mf



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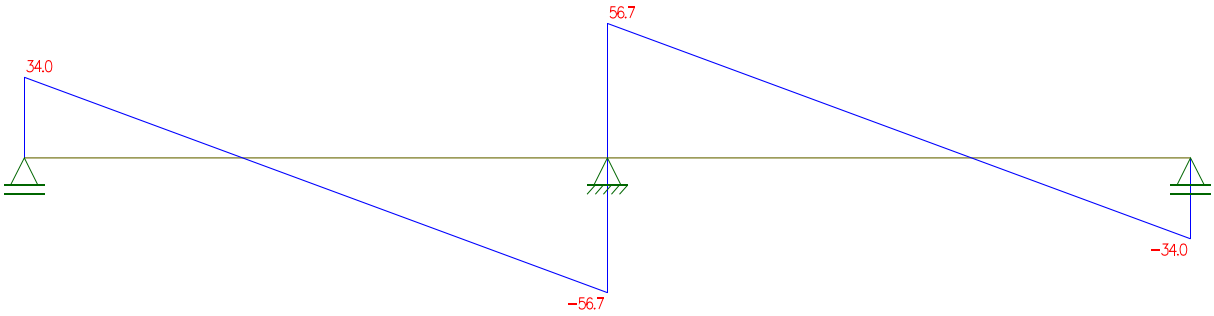
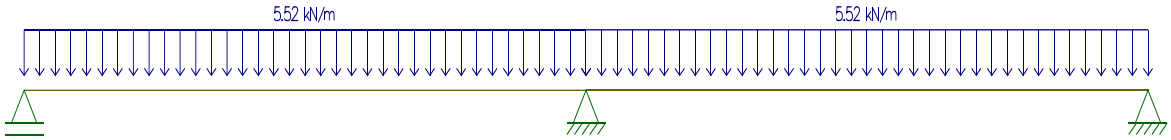


Sobrecarga

DCL



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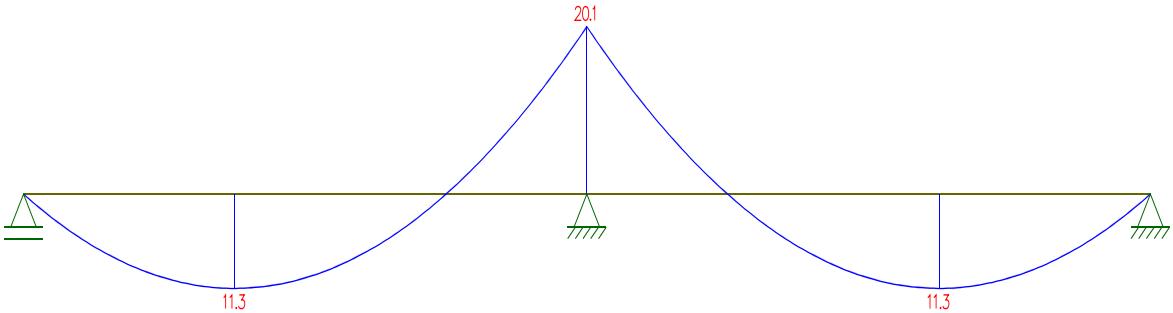

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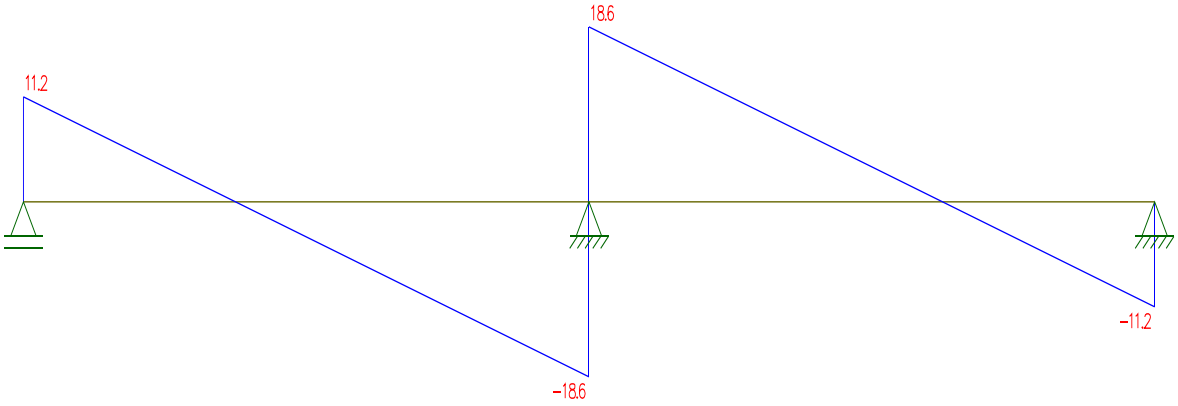


- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 34{,}4 + 1{,}6 * 11{,}32) kNm = 59{,}4\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{59{,}4\ kNm}{0{,}9} = 66 kNm = 0{,}066\ MNm$$

$$d = h - c_c - \frac{1}{2} d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}066\ MNm}{0{,}20\ m}}} = 0{,}793$$

De tabla de Flexión 3: $k_e = 25{,}207\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 25{,}207\ {cm^2}/{MN} * \frac{0{,}066 MNm}{0{,}456\ m} = 3{,}65\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 4Ø12 abajo. ($A_s = 4{,}52\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 4 * 12 - 2 * 30 - 2 * 6)}{3} = 26{,}6\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

Apoyo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 61{,}2 + 1{,}6 * 20{,}12)kNm = 105{,}6\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{105{,}6\ kNm}{0{,}9} = 117{,}4kNm = 0{,}1174\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}1174\ MNm}{0{,}20\ m}}} = 0{,}595$$

De tabla de Flexión 3: $k_e = 26{,}201 cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 26{,}201\ {cm^2}/{MN} * \frac{0{,}1174 MNm}{0{,}456\ m} = 6{,}74\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 4Ø16 arriba en dos capas ($A_s = 8{,}04\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 4 * 16 - 2 * 30 - 2 * 6)}{3} = 26{,}6\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín}\begin{cases} \geq d_b = 16\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s\begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 34 + 1{,}6 * 11{,}32)kN = 58{,}67\ kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{58{,}67\ kN}{0{,}75} = 78{,}23\ kN = 0{,}07823MN$$

$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}456\ m = 0{,}076\ MN$$

$$V_s = V_n - V_c = 0{,}07823\ MN - 0{,}076\ MN = 0{,}00223\ MN$$

Adoptando estribos Ø6 de 2 ramas.

$$s_{máx} = \frac{d}{2} = \frac{0{,}456\ m}{2} = 0{,}228\ m$$

$$\frac{A_v}{s} = \frac{V_s * 10^4}{f_y * d} = \frac{0{,}00223\ MN * 10^4}{420\ MPa * 0{,}456\ m} = 0{,}116\ cm^2/m$$

$s = \frac{A_v}{0{,}116\ cm^2/m} = \frac{2*0{,}28\ cm^2}{0{,}116\ cm^2/m} = 4{,}8\ m$; Adopto smax

Adopto estribos Ø6 de 2 ramas c/ 22 cm.

Apoyo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 56{,}7 + 1{,}6 * 18{,}63) kN = 97{,}8\ kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{97{,}8\ kN}{0{,}75} = 130{,}4\ kN = 0{,}1304\ MN$$

$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}456\ m = 0{,}076\ MN$$

$$V_s = V_n - V_c = 0{,}1304\ MN - 0{,}076\ MN = 0{,}0544\ MN$$

Adoptando estribos Ø6 de 2 ramas.

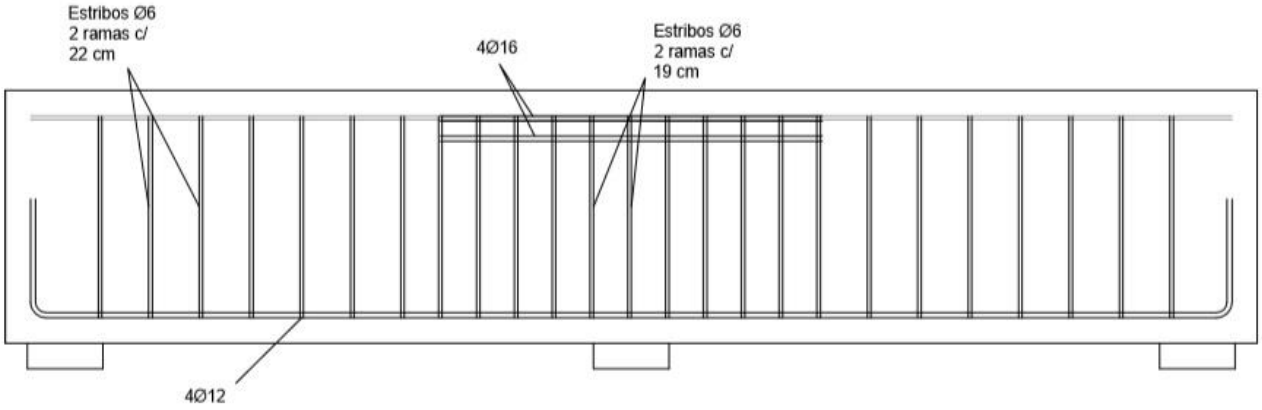
$$s_{máx} = \frac{d}{2} = \frac{0{,}456\ m}{2} = 0{,}228\ m$$

$$\frac{A_v}{s} = \frac{V_s * 10^4}{f_y * d} = \frac{0{,}0544\ MN * 10^4}{420\ MPa * 0{,}456\ m} = 2{,}84\ cm^2/m$$

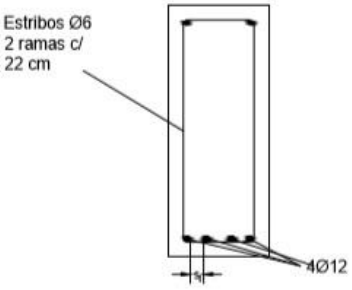
$$s = \frac{A_v}{2{,}84\ cm^2/m} = \frac{2 * 0{,}28\ cm^2}{2{,}84\ cm^2/m} = 0{,}197\ m$$

Adopto estribos Ø6 de 2 ramas c/ 19 cm.

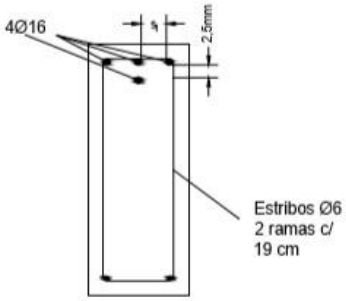
- Detalle de Armado



Tramo



Apoyo



Vigas V15-V16 IDEM V17-V18

- Predimensionado

$$h = \frac{l}{12} = \frac{540\ cm}{12} = 0{,}45\ m$$

Adopto h= 50 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}50\ m = 2{,}5\ kN/m$$

$$D = R_{L13D} + p_p = {}^{(4{,}43+2{,}5)kN}/_{m} =$$

$$D = 6{,}93\ kN/m\ ;\ R_{V125D} = 18{,}12\ KN\ ;\ R_{V126D} = 8{,}8\ KN\ ;\ R_{V129D} = 4{,}9\ KN$$

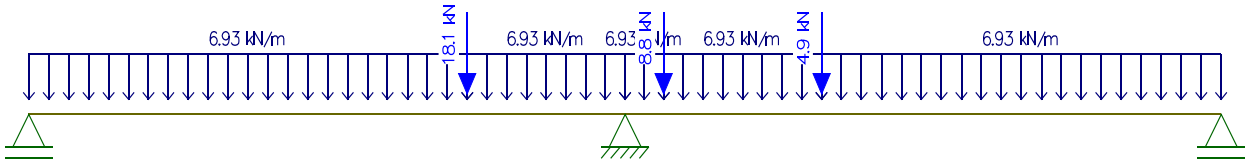
$$L = R_{L13L} = {}^{(1{,}7)kN}/_{m} = 1{,}7kN/m\ ;\ R_{V125L} = 5{,}3\ KN$$

$$R_{V126L} = 3{,}1\ KN\ ;\ R_{V129L} = 1{,}4\ KN$$

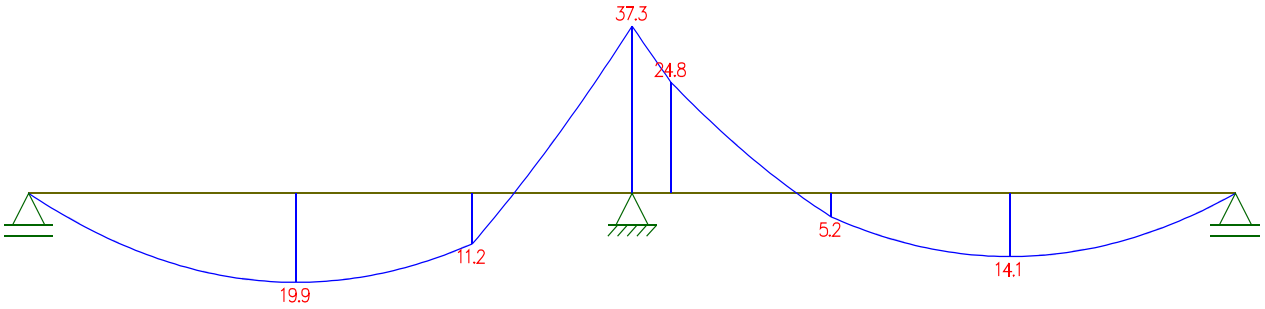
- Solicitaciones

Carga Permanente

DCL



Mf



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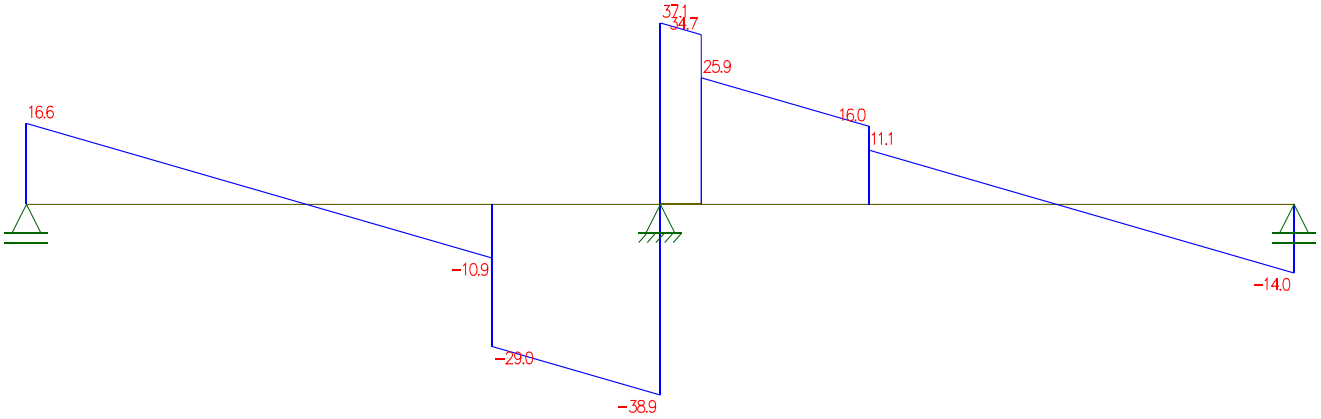
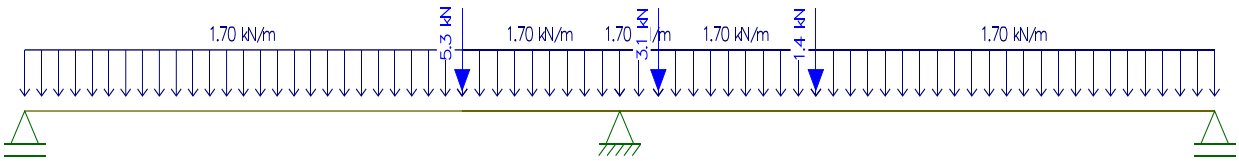


Sobrecarga

DCL



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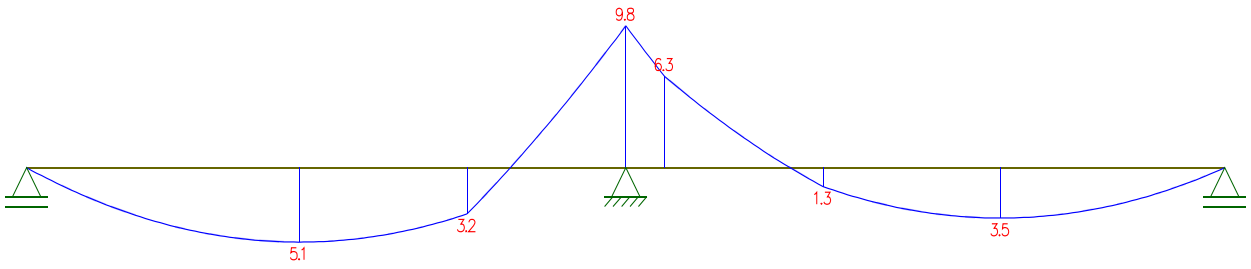

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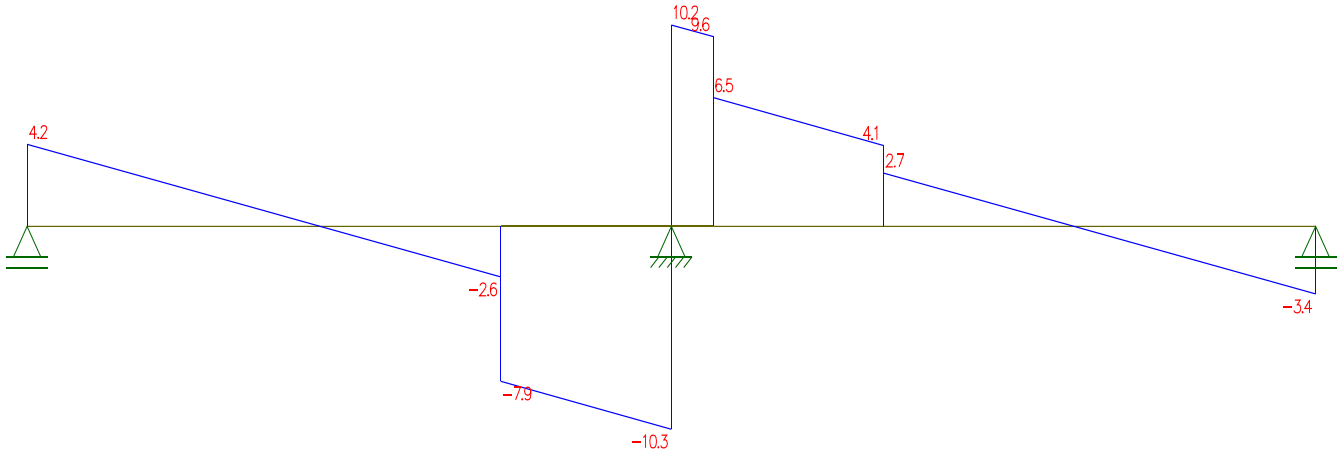


- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 19{,}9 + 1{,}6 * 5{,}1)kNm = 32{,}04\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{32{,}04\ kNm}{0{,}9} = 35{,}6kNm = 0{,}0356\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}0356\ MNm}{0{,}20\ m}}} = 1{,}08$$

De tabla de Flexión 3: $k_e = 24{,}301 cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}301\ {cm^2}/{MN} * \frac{0{,}0356 MNm}{0{,}456\ m} = 1{,}89\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 3Ø12 abajo. ($A_s = 3{,}39\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 12 - 2 * 30 - 2 * 6)}{2} = 46\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

Apoyo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 37{,}3 + 1{,}6 * 9{,}8)kNm = 60{,}44\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{60{,}44kNm}{0{,}9} = 67{,}15kNm = 0{,}06715\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 50\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 45{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}456\ m}{\sqrt{\frac{0{,}06715\ MNm}{0{,}20\ m}}} = 0{,}78$$

De tabla de Flexión 3: $k_e = 25{,}207\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 25{,}207\ {cm^2}/{MN} * \frac{0{,}06715MNm}{0{,}456\ m} = 3{,}71\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 45{,}6\ cm}{420\ MPa} = 3{,}04\ cm^2$$

Adopto 4Ø12 arriba ($A_s = 4{,}52\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 4 * 12 - 2 * 30 - 2 * 6)}{3} = 26{,}6\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 16{,}6 + 1{,}6 * 4{,}2)kN = 26{,}64\ kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{26{,}64\ kN}{0{,}75} = 35{,}52\ kN = 0{,}03552\ MN$$

$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}456\ m = 0{,}076\ MN$$

Vc>Vn; Del Reglamento CIROSC 201-05: $Avmin = \frac{\sqrt{f`_c} * bw * s}{16fy} = 0{,}33\ cm^2$

$s_{máx} = \frac{d}{2} = \frac{0{,}456\ m}{2} = 0{,}228\ m$; Adopto smax, Adopto estribos Ø6 de 2 ramas c/ 22 cm.

Apoyo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 38{,}9 + 1{,}6 * 10{,}3)kN = 63{,}16\ kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{63{,}16\ kN}{0{,}75} = 84{,}21\ kN = 0{,}08421\ MN$$

$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}456\ m = 0{,}076\ MN$$

$$V_s = V_n - V_c = 0{,}08421\ MN - 0{,}076\ MN = 0{,}00821 MN$$

Adoptando estribos Ø6 de 2 ramas.

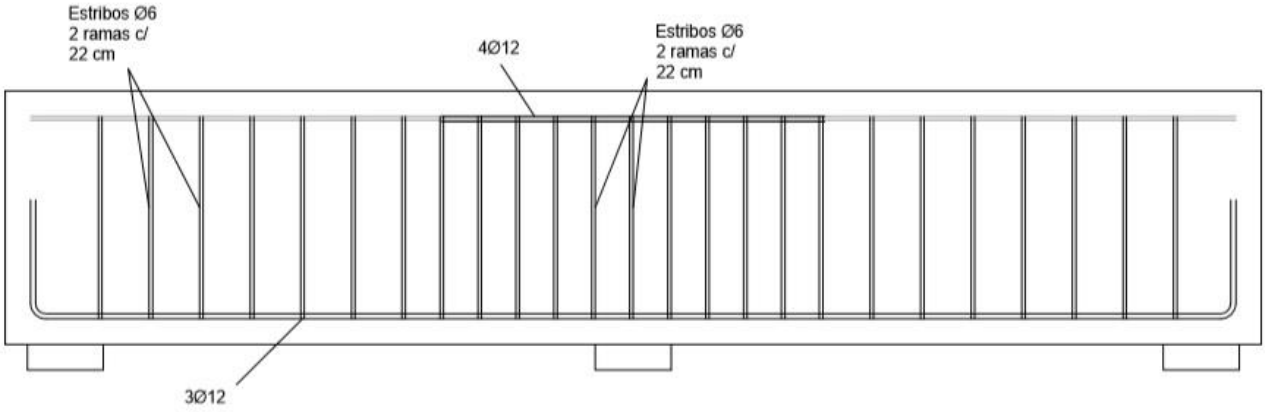
$$s_{máx} = \frac{d}{2} = \frac{0{,}456\ m}{2} = 0{,}228\ m$$

$$\frac{A_v}{s} = \frac{V_s * 10^4}{f_y * d} = \frac{0{,}00821\ MN * 10^4}{420\ MPa * 0{,}456\ m} = 0{,}428\ cm^2/m$$

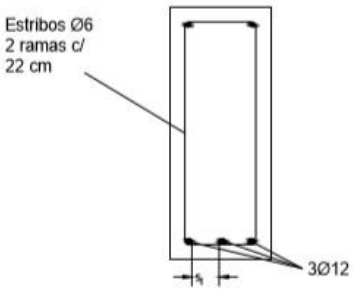
$s = \frac{A_v}{0{,}428\ cm^2/m} = \frac{2*0{,}28\ cm^2}{0{,}428\ cm^2/m} = 1{,}31\ m$; Adopta smax

Adopto estribos Ø6 de 2 ramas c/ 22 cm.

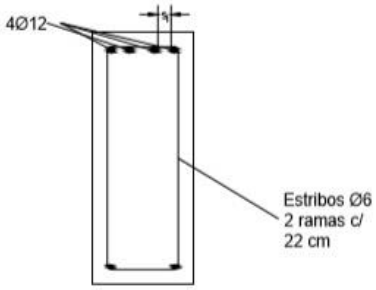
- Detalle de Armado



Tramo



Apoyo



Vigas V113-V114 IDEM V115-V116 ‖ V121-V122 ‖ V123-V124

- Predimensionado

$$h = \frac{l}{12} = \frac{338\ cm}{12} = 0{,}28\ m$$

Adopto h= 30 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}30\ m = 1{,}5\ kN/m$$

$$D114 = R_{L13D} + p_p = {}^{(3{,}21 + 1{,}5)kN}/_{m} =$$

$$D114 = 4{,}71\ kN/m$$

$$D113 = R_{L11D} + p_p = {}^{(2{,}53 + 1{,}5)kN}/_{m} =$$

$$D113 = 4{,}03\ kN/m$$

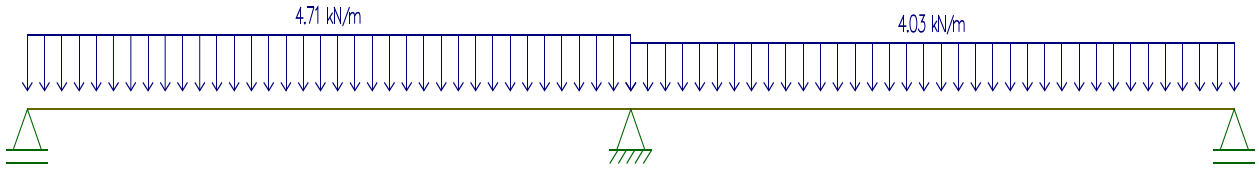
$$L114 = R_{L13L} = {}^{(1{,}23)kN}/_{m} = 1{,}23 kN/m$$

$$L113 = R_{L11L} = {}^{(0{,}98)kN}/_{m} = 0{,}98 kN/m$$

- Solicitaciones

Carga Permanente

DCL



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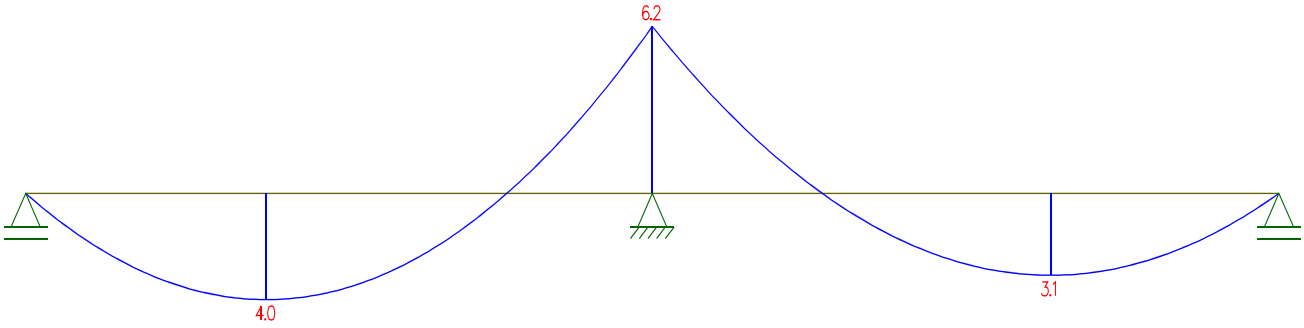

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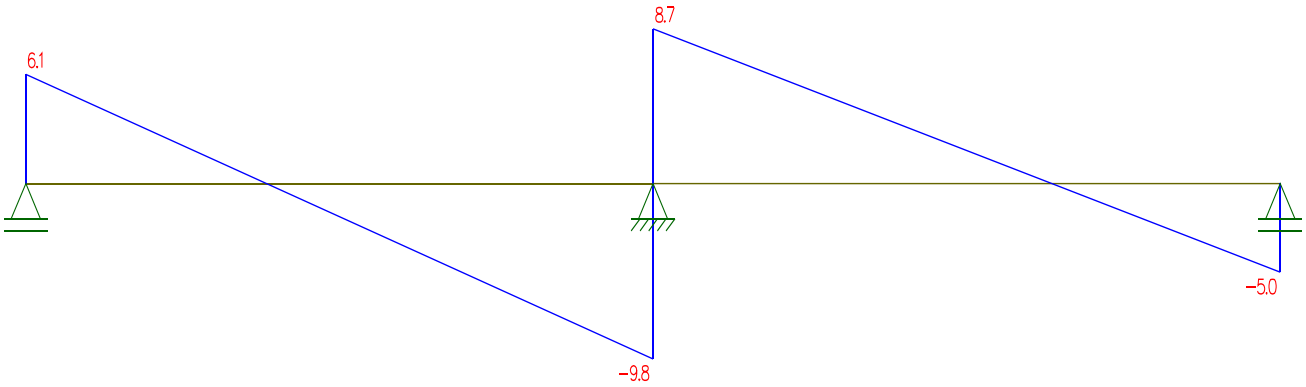
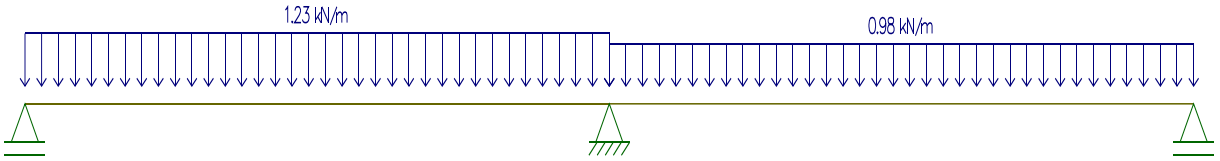


Sobrecarga

DCL



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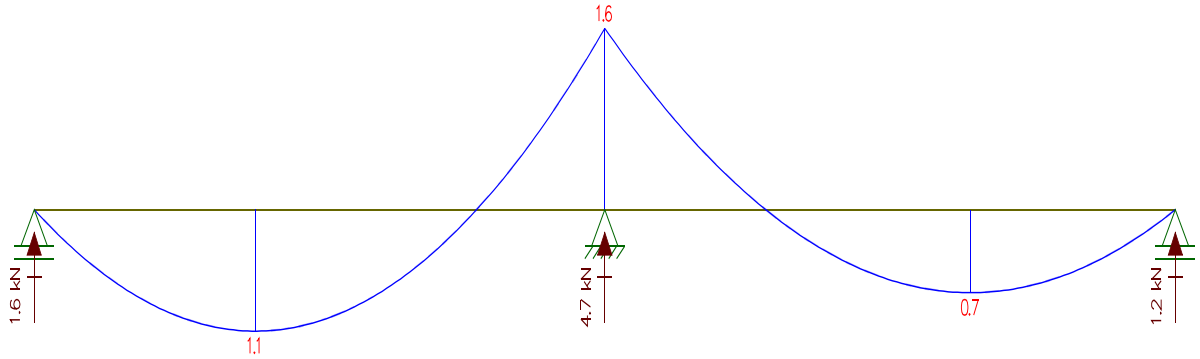
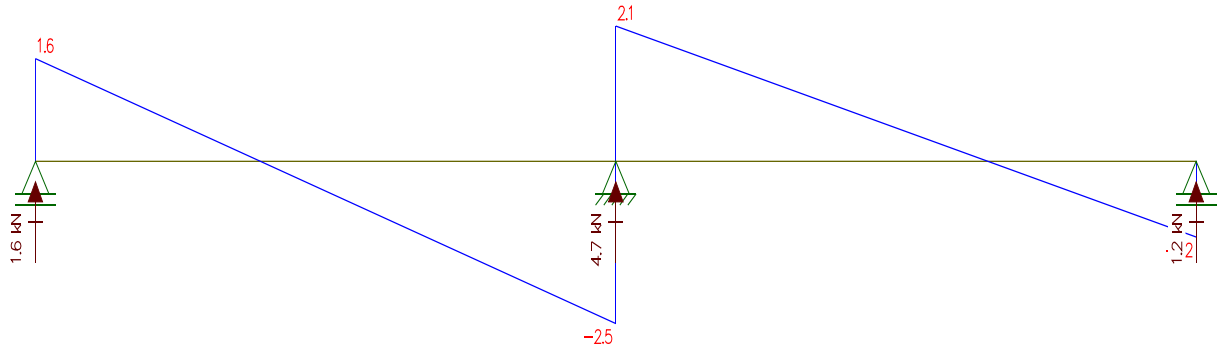


Q



- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 4 + 1{,}6 * 1{,}1)kNm = 6{,}56\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{6{,}56\ kNm}{0{,}9} = 7{,}29kNm = 0{,}00729\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 30\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 25{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}256\ m}{\sqrt{\frac{0{,}00729\ MNm}{0{,}20\ m}}} = 1{,}34$$

De tabla de Flexión 3: $k_e = 24{,}301\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}301\ {cm^2}/{MN} * \frac{0{,}00729 MNm}{0{,}256\ m} = 0{,}69\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 25{,}6\ cm}{420\ MPa} = 1{,}7\ cm^2$$

Adopto 2Ø12 abajo. ($A_s = 2{,}26\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 2 * 12 - 2 * 30 - 2 * 6)}{1} = 114{,}8\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25 mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

Apoyo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 6{,}2 + 1{,}6 * 1{,}6) kNm = 10\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{10\ kNm}{0{,}9} = 11{,}11 kNm = 0{,}01111\ MNm$$

$$d = h - c_c - \frac{1}{2} d_b - d_{est} = 30\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 25{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}256\ m}{\sqrt{\frac{0{,}01111\ MNm}{0{,}20\ m}}} = 1{,}08$$

De tabla de Flexión 3: $k_e = 24{,}766\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}766\, {cm^2}/{MN} * \frac{0{,}01111 MNm}{0{,}256\, m} = 1{,}07\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 25{,}6\ cm}{420\ MPa} = 1{,}7\ cm^2$$

Adopto 2Ø12 arriba ($A_s = 2{,}26\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 2 * 12 - 2 * 30 - 2 * 6)}{1} = 114{,}8\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 6{,}1 + 1{,}6 * 1{,}6) kN = 9{,}88\ kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{9{,}88\ kN}{0{,}75} = 13{,}17\ kN = 0{,}01317\ MN$$

$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}256\ m = 0{,}0426 MN$$

Vc>Vn; Del Reglamento CIROSC 201-05: $Avmin = \frac{\sqrt{f`_c} * bw * s}{16 fy} = 0{,}18\ cm^2$

$s_{máx} = \frac{d}{2} = \frac{0{,}256\ m}{2} = 0{,}128\ m$; Adopto smax, Adopto estribos Ø6 de 2 ramas c/ 12 cm.

Apoyo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 9{,}8 + 1{,}6 * 2{,}5) kN = 15{,}76\ kN$

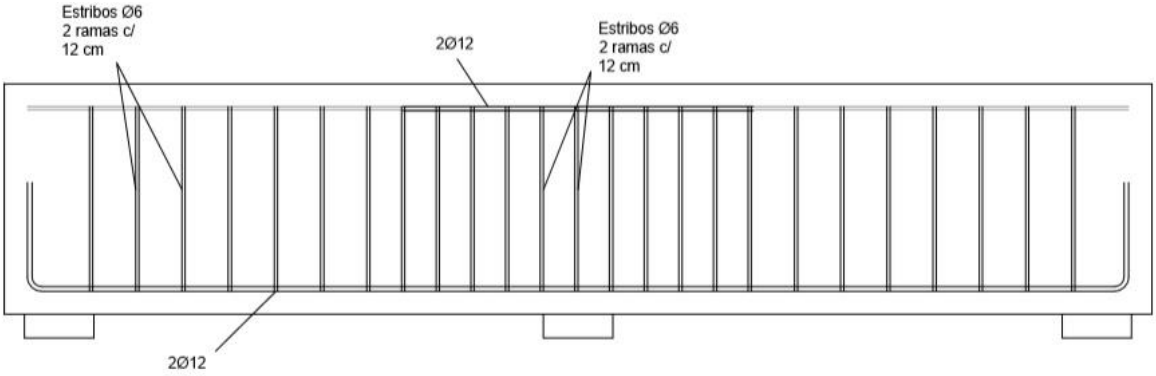
$V_n = \frac{V_u}{\varphi} = \frac{15{,}76\ kN}{0{,}75} = 21{,}01\ kN = 0{,}02101\ MN$

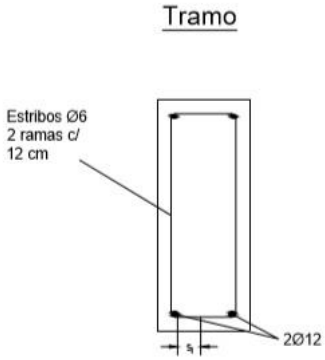
$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}256\ m = 0{,}0426\ MN$

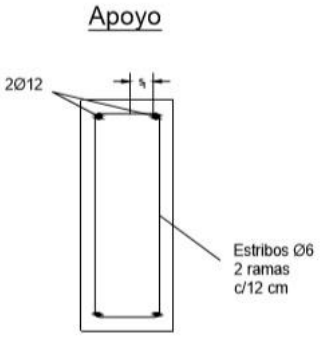
Vc>Vn; Del Reglamento CIROSC 201-05: $Avmin = \frac{\sqrt{f`_c} * bw * s}{16fy} = 0{,}18\ cm^2$

$s_{máx} = \frac{d}{2} = \frac{0{,}256\ m}{2} = 0{,}128\ m$; Adopto smax, Adopto estribos Ø6 de 2 ramas c/ 12 cm.

- Detalle de Armado







Vigas V117-V118 IDEM V119-V120

- Predimensionado

$$h = \frac{l}{12} = \frac{338\ cm}{12} = 0{,}28\ m$$

Adopto h= 30 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}30\ m = 1{,}5\ kN/m$$

$$D117 = R_{L11D} + R_{L12D} + p_p = {}^{(4{,}39 + 4{,}39 + 1{,}5)kN}/_{m} =$$

$$D117 = 10{,}28\ kN/m$$

$$D118 = R_{L13D} + R_{L14D} + p_p = {}^{(5{,}58 + 5{,}58 + 1{,}5)kN}/_{m} =$$

$$D118 = 12{,}66\ kN/m$$

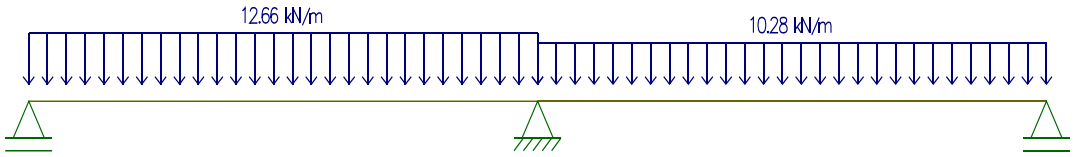
$$L117 = R_{L11L} + R_{L12L} = {}^{(1{,}71 + 1{,}71)kN}/_{m} = 3{,}42 kN/m$$

$$L118 = R_{L13L} + R_{L14L} = {}^{(2{,}14 + 2{,}14)kN}/_{m} = 4{,}28 kN/m$$

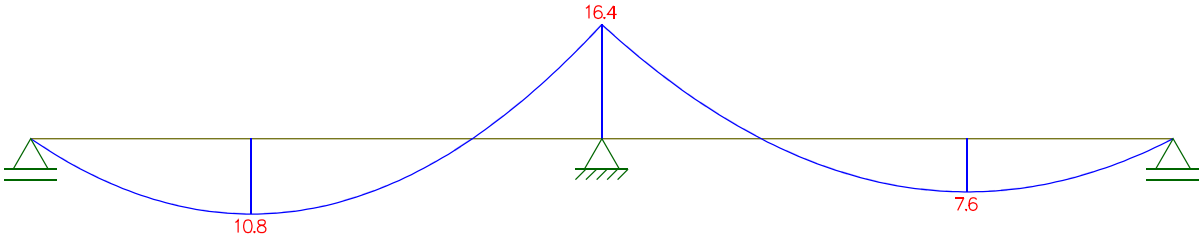
- Solicitaciones

Carga Permanente

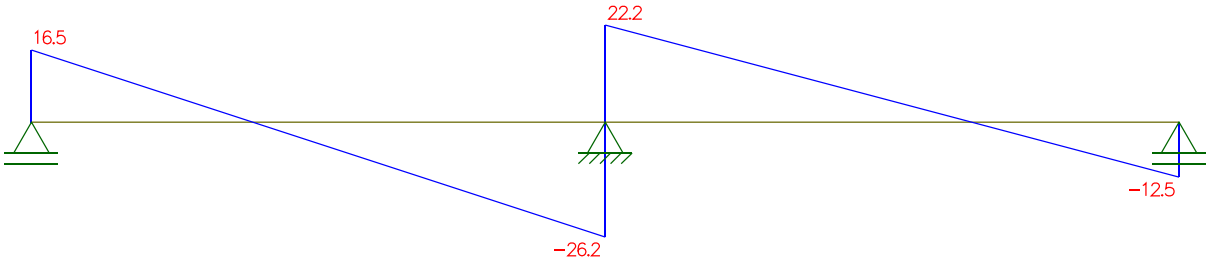
DCL



Mf

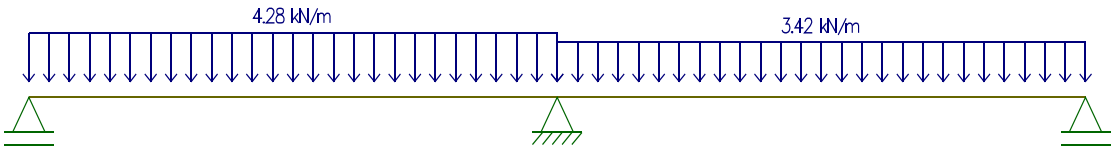


Q

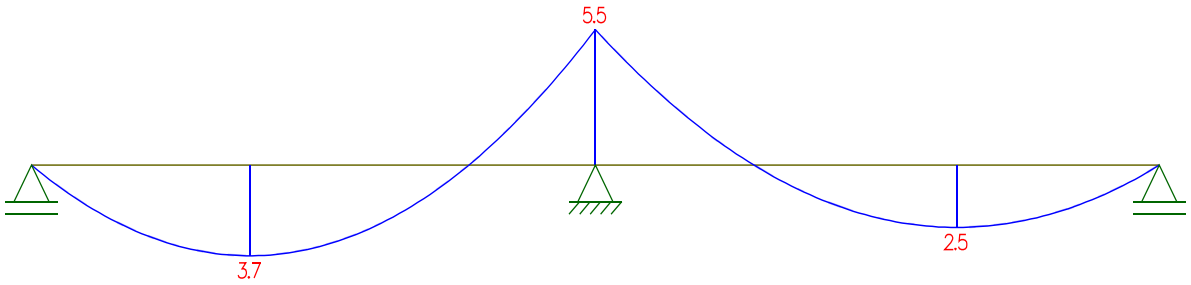


Sobrecarga

DCL



Mf



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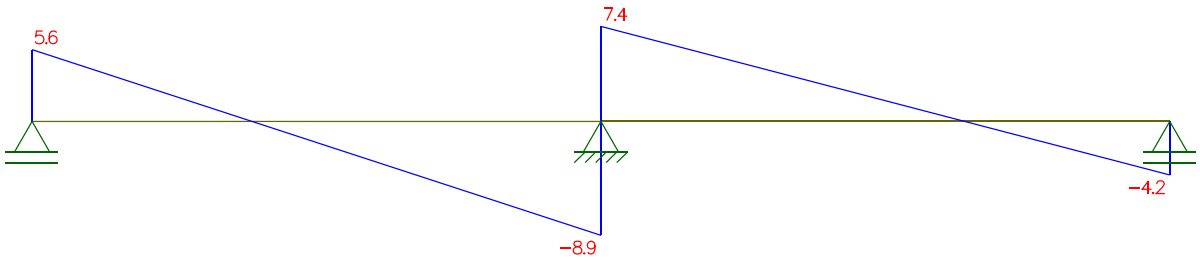


- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 10{,}8 + 1{,}6 * 3{,}7)kNm = 18{,}88\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{18{,}88\ kNm}{0{,}9} = 20{,}97kNm = 0{,}02097\ MNm$$

$$d = h - c_c - \frac{1}{2}d_b - d_{est} = 30\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 25{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}256\ m}{\sqrt{\frac{0{,}02097\ MNm}{0{,}20\ m}}} = 0{,}79$$

De tabla de Flexión 3: $k_e = 25{,}207 cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 25{,}207\ {}^{cm^2}/_{MN} * \frac{0{,}02097 MNm}{0{,}256\ m} = 2{,}06\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 25{,}6\ cm}{420\ MPa} = 1{,}70\ cm^2$$

Adopto 2Ø12 abajo. ($A_s = 2{,}26\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}{}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}{}_{espacios}}$$

$$s_l = \frac{(200 - 2 * 12 - 2 * 30 - 2 * 6)}{1} = 104\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

Apoyo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 16{,}4 + 1{,}6 * 5{,}5) kNm = 28{,}48\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{28{,}48\ kNm}{0{,}9} = 31{,}64 kNm = 0{,}03164\ MNm$$

$$d = h - c_c - \frac{1}{2} d_b - d_{est} = 30\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 25{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}256\ m}{\sqrt{\frac{0{,}03164\ MNm}{0{,}20\ m}}} = 0{,}64$$

De tabla de Flexión 3: $k_e = 25{,}625\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 25{,}625\ {cm^2}/{MN} * \frac{0{,}03164 MNm}{0{,}256\ m} = 3{,}16\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 25{,}6\ cm}{420\ MPa} = 1{,}7\ cm^2$$

Adopto 3Ø12 arriba ($A_s = 3{,}39\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^o{}_{d_b} * d_b - 2c_c - 2d_{est}}{n^o{}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 12 - 2 * 30 - 2 * 6)}{2} = 46\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 12\ mm \\ \geq 25 mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5 c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 16{,}5 + 1{,}6 * 5{,}6) kN = 28{,}76\ kN$

$V_n = \frac{V_u}{\varphi} = \frac{28{,}76\ kN}{0{,}75} = 38{,}34\ kN = 0{,}03834\ MN$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}256\ m = 0{,}0426\ MN$

Vc>Vn; Del Reglamento CIROSC 201-05: $Avmin = \frac{\sqrt{f`_c} * bw * s}{16 fy} = 0{,}18\ cm^2$

$s_{máx} = \frac{d}{2} = \frac{0{,}256\ m}{2} = 0{,}128\ m$; Adopto smax, Adopto estribos Ø6 de 2 ramas c/ 12 cm.

Apoyo

$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 26{,}2 + 1{,}6 * 8{,}9) kN = 45{,}68\ kN$

$V_n = \frac{V_u}{\varphi} = \frac{45{,}68\ kN}{0{,}75} = 60{,}9\ kN = 0{,}0609\ MN$

$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}256\ m = 0{,}0426\ MN$

$V_s = V_n - V_c = 0{,}0609\ MN - 0{,}0426\ MN = 0{,}0183\ MN$

Adoptando estribos Ø6 de 2 ramas.

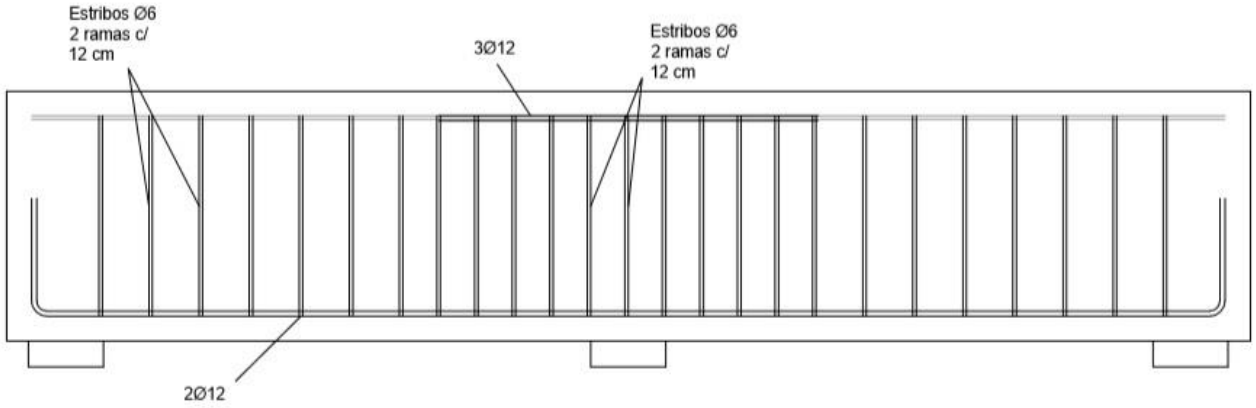
$s_{máx} = \frac{d}{2} = \frac{0{,}256\ m}{2} = 0{,}128\ m$

$\frac{A_v}{s} = \frac{V_s * 10^4}{f_y * d} = \frac{0{,}0183\ MN * 10^4}{420\ MPa * 0{,}256\ m} = 1{,}7\ cm^2/m$

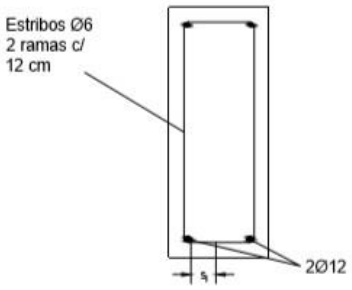
$s = \frac{A_v}{1{,}7\ cm^2/m} = \frac{2 * 0{,}28\ cm^2}{1{,}7\ cm^2/m} = 0{,}33\ m$; Adopto smax

Adopto estribos Ø6 de 2 ramas c/ 12 cm.

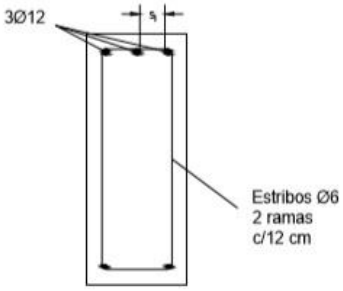
- Detalle de Armado



Tramo



Apoyo



Viga V231

- Predimensionado

$$h = \frac{l}{12} = \frac{215\ cm}{12} = 0{,}18\ m$$

Adopto h= 25 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}25\ m = 1{,}25\ kN/m$$

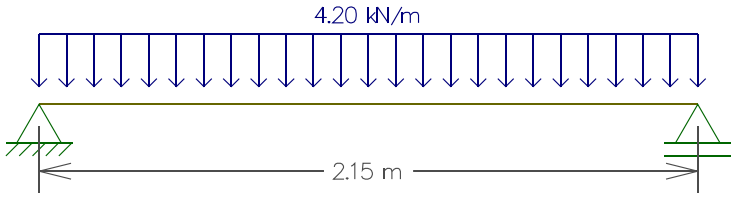
$$D = R_{L214D} = 4{,}2\ {}^{kN}/_{m}$$

$$L = R_{L214L} = 0{,}89\ {}^{kN}/_{m}$$

- Solicitaciones

Carga Permanente

DCL



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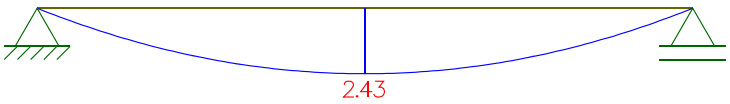

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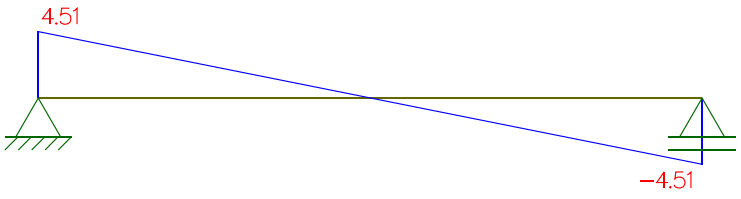
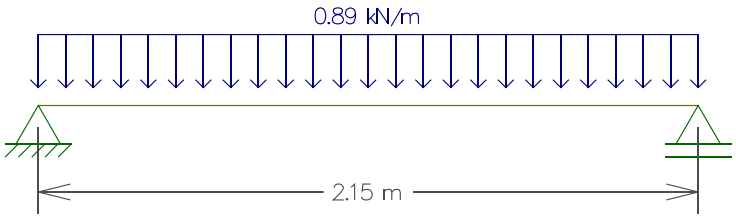


Sobrecarga

DCL



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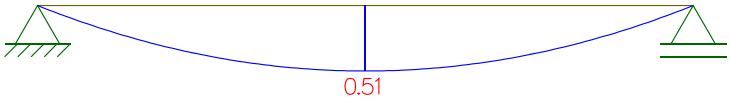

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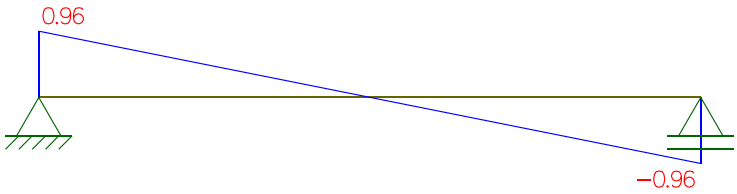


- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 2{,}43 + 1{,}6 * 0{,}51) kNm = 3{,}73\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{3{,}73\ kNm}{0{,}9} = 4{,}14 kNm = 0{,}00414\ MNm$$

$$d = h - c_c - \frac{1}{2} d_b - d_{est} = 25\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 20{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}206\ m}{\sqrt{\frac{0{,}00414\ MNm}{0{,}20\ m}}} = 1{,}43$$

De tabla de Flexión 3: $k_e = 24{,}301\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}301\ {cm^2}/{MN} * \frac{0{,}00414 MNm}{0{,}206\ m} = 0{,}49\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 20{,}6\ cm}{420\ MPa} = 1{,}37\ cm^2$$

Adopto 2Ø10 abajo ($A_s = 1{,}56\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 2 * 10 - 2 * 30 - 2 * 6)}{1} = 108\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 10\ mm \\ \geq 25 mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 4{,}51 + 1{,}6 * 0{,}96) kN = 6{,}95 kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{6{,}95\ kN}{0{,}75} = 9{,}27\ kN = 0{,}00927\ MN$$

$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}206\ m = 0{,}0343\ MN$$

Vc>Vn; Del Reglamento CIROSC 201-05:

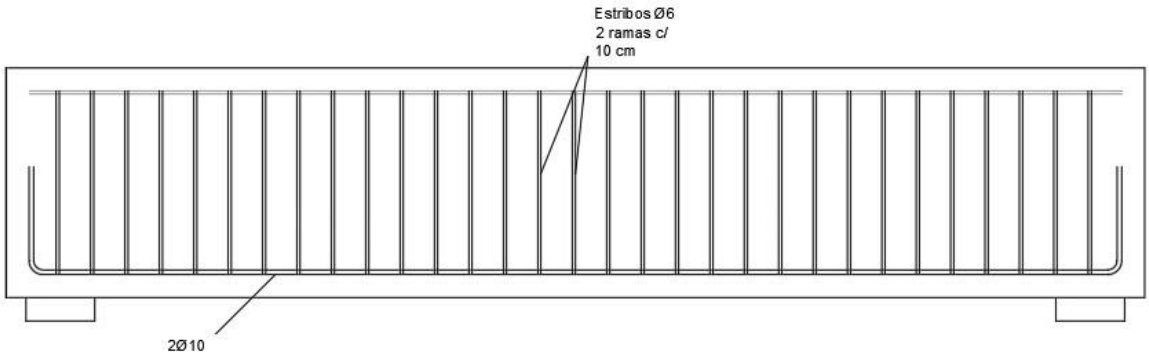
$$s_{máx} = \frac{d}{2} = \frac{0{,}206\ m}{2} = 0{,}103\ m$$

$$Avmin = \frac{\sqrt{f`c} * bw * s}{16fy} = \frac{\sqrt{25MPa} * 20cm * 10cm}{16 * 420MPa} = 0{,}15cm^2$$

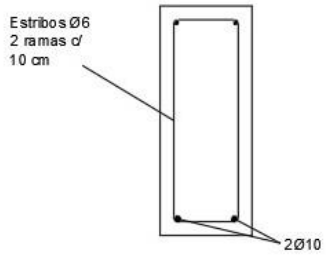
Adopto smax, Adoptando estribos Ø6 de 2 ramas (A= 0,56 cm²)

Adopto estribos Ø6 de 2 ramas c/ 10 cm.

- Detalle de Armado



Tramo



Viga V232

- Predimensionado

$$h = \frac{l}{12} = \frac{215\ cm}{12} = 0{,}18\ m$$

Adopto h= 25 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}25\ m = 1{,}25\ kN/m$$

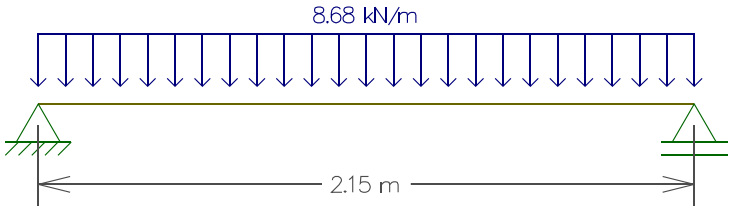
$$D = R_{L214D} + R_{L215D} = (4{,}2 + 4{,}48)\ {}^{kN}/_{m} = 8{,}68\ kN/m$$

$$L = R_{L214L} + R_{L215L} = (0{,}89 + 0{,}95)\ {}^{kN}/_{m} = 1{,}84\ kN/m$$

- Solicitaciones

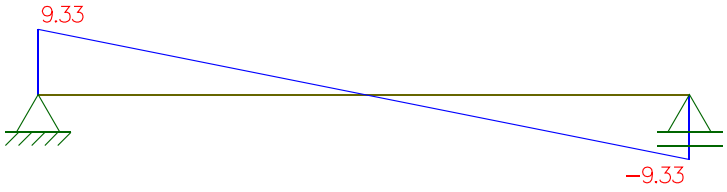
Carga Permanente

DCL



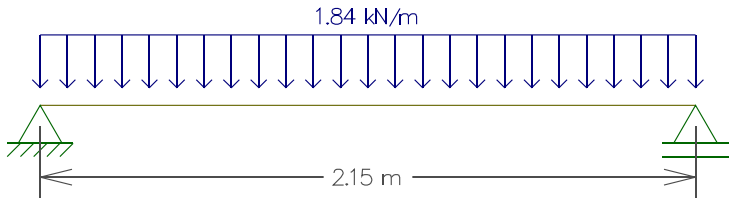
Mf

Q



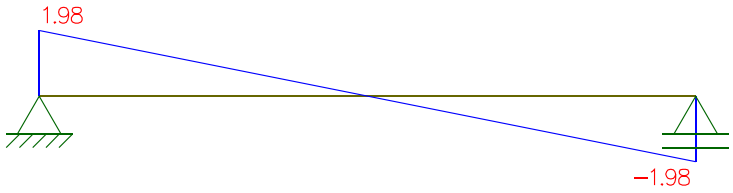
Sobrecarga

DCL



Mf

Q



- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 5{,}02 + 1{,}6 * 1{,}06) kNm = 7{,}72\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{7{,}72\ kNm}{0{,}9} = 8{,}58\ kNm = 0{,}00858\ MNm$$

$$d = h - c_c - \frac{1}{2} d_b - d_{est} = 25\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 20{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}206\ m}{\sqrt{\frac{0{,}00858\ MNm}{0{,}20\ m}}} = 0{,}99$$

De tabla de Flexión 3: $k_e = 24{,}766\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}766\ {}^{cm^2}/_{MN} * \frac{0{,}00858 MNm}{0{,}206\ m} = 1{,}03\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 20{,}6\ cm}{420\ MPa} = 1{,}37\ cm^2$$

Adopto 2Ø10 abajo ($A_s = 1{,}56\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 10 - 2 * 30 - 2 * 6)}{1} = 108\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 10\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 9{,}33 + 1{,}6 * 1{,}98)kN = 14{,}36kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{14{,}36\ kN}{0{,}75} = 19{,}15\ kN = 0{,}01915\ MN$$

$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}206\ m = 0{,}0343\ MN$$

Vc>Vn; Del Reglamento CIROSC 201-05:

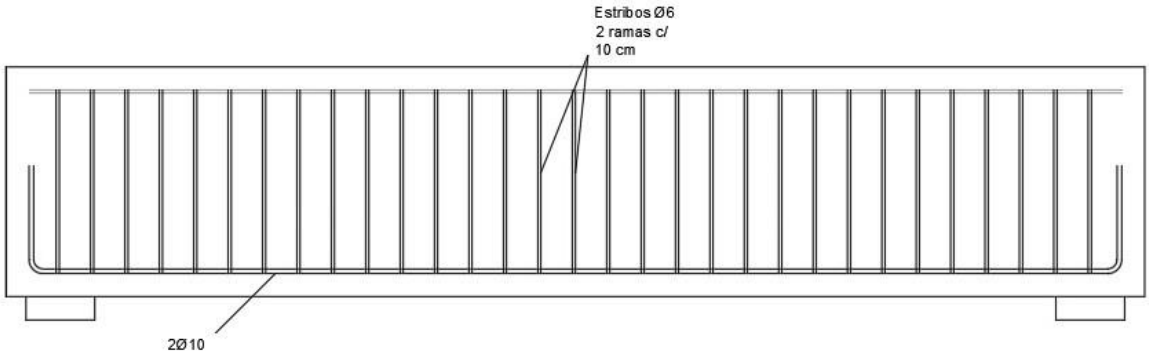
$$s_{máx} = \frac{d}{2} = \frac{0{,}206\ m}{2} = 0{,}103\ m$$

$$Avmin = \frac{\sqrt{f`c} * bw * s}{16fy} = \frac{\sqrt{25MPa} * 20cm * 10cm}{16 * 420MPa} = 0{,}15cm^2$$

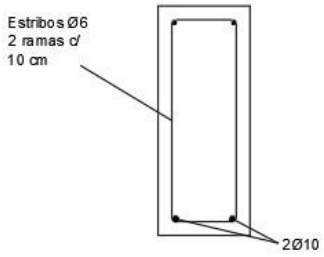
Adopto smax, Adoptando estribos Ø6 de 2 ramas (A= 0,56 cm²)

Adopto estribos Ø6 de 2 ramas c/ 10 cm.

- Detalle de Armado



Tramo



Viga V233

- Predimensionado

$$h = \frac{l}{12} = \frac{215\ cm}{12} = 0{,}18\ m$$

Adopto h= 25 cm

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b * h = 25\ {}^{kN}/_{m^3} * 0{,}20\ m * 0{,}25\ m = 1{,}25\ kN/m$$

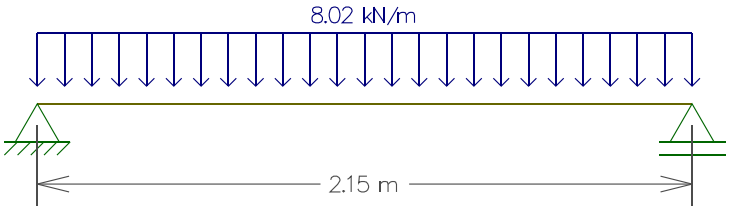
$$D = R_{L215D} + R_{L216D} = (4{,}48 + 3{,}54)\ {}^{kN}/_{m} = 8{,}02\ kN/m$$

$$L = R_{L215L} + R_{L216L} = (0{,}95 + 3{,}75)\ {}^{kN}/_{m} = 4{,}7\ kN/m$$

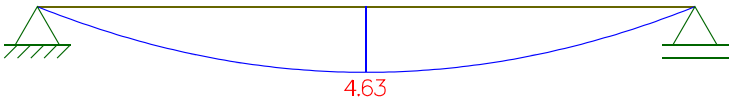
- Solicitaciones

Carga Permanente

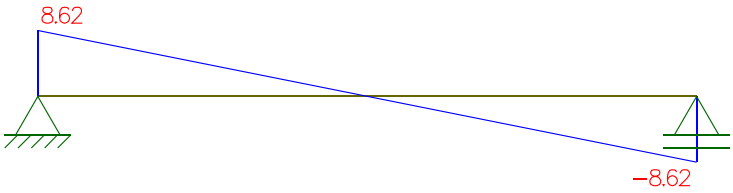
DCL



Mf

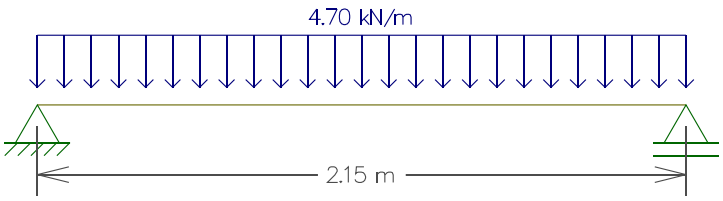


Q

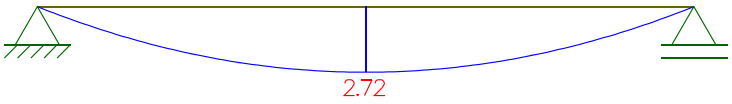


Sobrecarga

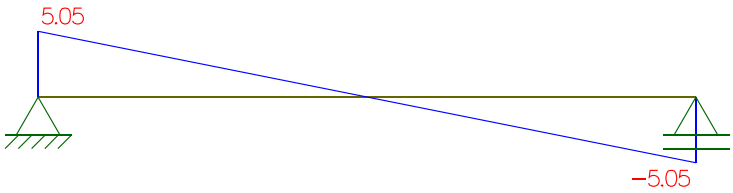
DCL



Mf



Q



- Dimensionamiento a Flexión

Tramo

$$M_u = 1{,}2 * M_D + 1{,}6 * M_L = (1{,}2 * 4{,}63 + 1{,}6 * 2{,}72) kNm = 9{,}91\ kNm$$

$$M_n = \frac{M_u}{\varphi} = \frac{9{,}91\ kNm}{0{,}9} = 11{,}01\ kNm = 0{,}01101\ MNm$$

$$d = h - c_c - \frac{1}{2} d_b - d_{est} = 25\ cm - 3\ cm - 0{,}8\ cm - 0{,}6\ cm = 20{,}6\ cm$$

$$k_d = \frac{d}{\sqrt{\frac{M_n}{b}}} = \frac{0{,}206\ m}{\sqrt{\frac{0{,}01101\ MNm}{0{,}20\ m}}} = 0{,}88$$

De tabla de Flexión 3: $k_e = 24{,}766\ cm^2/MN$

$$A_s = K_e * \frac{M_n}{d} = 24{,}766\ {}^{cm^2}/_{MN} * \frac{0{,}01101\ MNm}{0{,}206\ m} = 1{,}32\ cm^2$$

$$A_{s,mín} = \frac{1{,}4 * b_w * d}{f_y} = \frac{1{,}4 * 20\ cm * 20{,}6\ cm}{420\ MPa} = 1{,}37\ cm^2$$

Adopto 2Ø10 abajo ($A_s = 1{,}56\ cm^2$)

Verificación de la separación mínima de la armadura

$$s_l = \frac{b - n^{o}_{d_b} * d_b - 2c_c - 2d_{est}}{n^{o}_{espacios}}$$

$$s_l = \frac{(200 - 3 * 10 - 2 * 30 - 2 * 6)}{1} = 108\ mm$$

S/ CIRSOC 201-7.6.1

$$s_{l,mín} \begin{cases} \geq d_b = 10\ mm \\ \geq 25mm \\ \geq 1{,}33\ T.M.N \end{cases}$$ **Verifica**

S/ CIRSOC 201-10.6.4

$$s \begin{cases} \leq 380\left(\frac{280}{f_s}\right) - 2{,}5c_c = 380\left(\frac{280}{280}\right) - 2{,}5 * 30\ mm = 305\ mm \\ \leq 300\left(\frac{280}{f_s}\right) = 300\left(\frac{280}{280}\right) = 300\ mm \end{cases}$$ **Verifica**

- Dimensionamiento al Corte

Tramo

$$V_u = 1{,}2 * V_D + 1{,}6 * V_L = (1{,}2 * 8{,}02 + 1{,}6 * 5{,}05)kN = 17{,}7kN$$

$$V_n = \frac{V_u}{\varphi} = \frac{17{,}7\ kN}{0{,}75} = 23{,}6\ kN = 0{,}0236\ MN$$

$$V_c = \frac{1}{6}\sqrt{f`_c} * b_w * d = \frac{1}{6}\sqrt{25\ MPa} * 0{,}2\ m * 0{,}206\ m = 0{,}0343\ MN$$

Vc>Vn; Del Reglamento CIROSC 201-05:

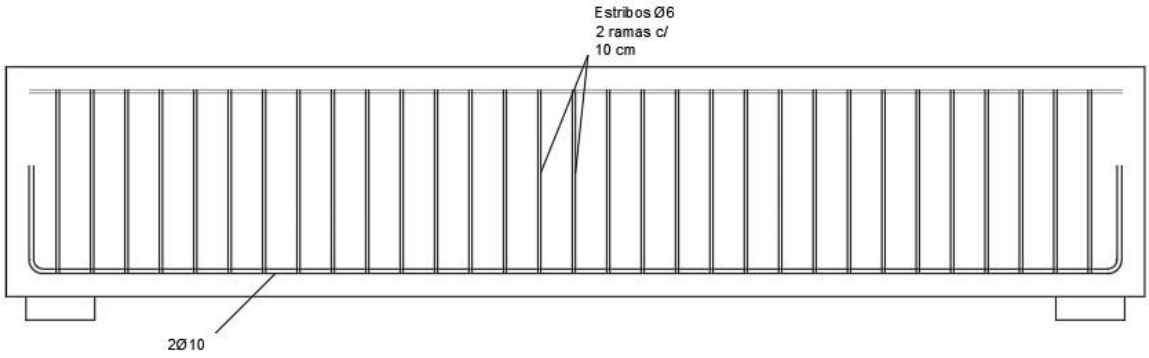
$$s_{máx} = \frac{d}{2} = \frac{0{,}206\ m}{2} = 0{,}103\ m$$

$$Avmin = \frac{\sqrt{f`c} * bw * s}{16fy} = \frac{\sqrt{25MPa} * 20cm * 10cm}{16 * 420MPa} = 0{,}15cm^2$$

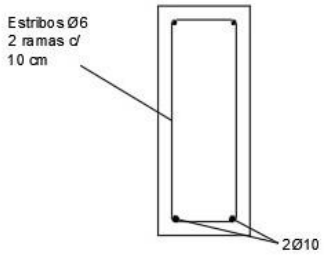
Adopto smax, Adoptando estribos Ø6 de 2 ramas (A= 0,56 cm²)

Adopto estribos Ø6 de 2 ramas c/ 10 cm.

- Detalle de Armado



Tramo



Longitudes de anclaje de las vigas (ld)

Datos: fy= 420 MPa; f´c= 25 MPa; ψe=1(armadura sin revestir); λ=1(Hormigon de densidad normal); ψt=1; ψs=0,8(db≤16mm); adopto ($\frac{cb+ktr}{db}$)=2,5

S/ CIRSOC 201-12.2: ANCLAJE DE LAS BARRAS SOLICITADAS A TRACCION

Para apoyos intermedios:

$$ld = \frac{9*fy*\psi t*\psi e*\psi s*\lambda}{10*\sqrt{f'c}*(\frac{cb+ktr}{db})} * db = \frac{9*420*1*1*0,8*1}{10*\sqrt{25}*2,5} * db = 24,19 * db$$

Para las vigas V013-V014 ‖ V017-V018 ‖ V113-V114 ‖ V117-V118 ‖ V15-V16 con db=12mm:

$$ld = 24,19 * db = 290,3\ mm = 29\ cm$$

Para las vigas V01-V02/V03-V04/V05-V06/V11-V12/V13-V14 con db=16mm:

$$ld = 24,19 * db = 387,04\ mm = 38,7\ cm$$

Verificación:

ld≥300mm ; Para las barras con db=12mm no verifica, entonces, se adopta 30 cm de longitud de anclaje para estas barras.

S/ CIRSOC 201-12.5: ANCLAJE DE LAS BARRAS TRACCIONADAS CON GANCHOS NORMALES

Para apoyos extremos:

$$ld = \frac{0,24*fy*\psi e*\lambda}{\sqrt{f'c}} * db = \frac{0,24*420*1*1}{\sqrt{25}} * db = 20,16 * db$$

Para las vigas V01-V02 ‖ V05-V06 ‖ V013-V014 ‖ V017-V018 ‖ V11-V12 ‖ V13-V14 ‖ V113-V114 ‖ V117-V118 ‖ V15-V16 ‖ V026 ‖ V027 ‖ V025 con db= 12 mm:

ld=20,16*db= 241,92 mm= 24,19 cm

Para las vigas V03-V04 con db= 16 mm:

ld=20,16*db= 322,56 mm= 32,25 cm

Verificación:

$$\text{ld} \begin{cases} \geq 8 * d_b = 8 * 12\ mm = 96\ mm \\ \geq 150mm \end{cases} \quad \textbf{Verifica}$$

$$\text{ld} \begin{cases} \geq 8 * d_b = 8 * 16mm = 128\ mm \\ \geq 150mm \end{cases} \quad \textbf{Verifica}$$

DECALAJE (v)

Para estribos: α=90° $\rightarrow$ $v = 0{,}75 * z$; $z = k_z * d$

Vigas V01-V02

Tramo

k_z =0,929; $z = k_z * d = 0{,}929 * 0{,}456\ m = 0{,}423m$; $v = 0{,}75 * z = 0{,}75 * 0{,}423m = 0{,}32m$

Apoyo

k_z =0,89; $z = k_z * d = 0{,}89 * 0{,}456\ m = 0{,}405m$; $v = 0{,}75 * z = 0{,}75 * 0{,}405m = 0{,}3\ m$

Vigas V03-V04 IDEM PARA V017-V018

Tramo

$k_z = 0{,}945$; $z = k_z * d = 0{,}945 * 0{,}456\ m = 0{,}43m$; $v = 0{,}75 * z = 0{,}75 * 0{,}43m = 0{,}32m$

Apoyo

k_z =0,902; $z = k_z * d = 0{,}902 * 0{,}456\ m = 0{,}41m$; $v = 0{,}75 * z = 0{,}75 * 0{,}41m = 0{,}31\ m$

Vigas V05-V06

Tramo

k_z =0,961; $z = k_z * d = 0{,}961 * 0{,}456\ m = 0{,}438m$; $v = 0{,}75 * z = 0{,}75 * 0{,}438m = 0{,}33m$

Apoyo

k_z =0,929; $z = k_z * d = 0{,}929 * 0{,}456\ m = 0{,}423m$; $v = 0{,}75 * z = 0{,}75 * 0{,}423m = 0{,}32m$

Vigas V013-V014

Tramo

k_z =0,961; $z = k_z * d = 0{,}961 * 0{,}456\ m = 0{,}438m$; $v = 0{,}75 * z = 0{,}75 * 0{,}438m = 0{,}33m$

Apoyo

$k_z = 0{,}945$; $z = k_z * d = 0{,}945 * 0{,}456\ m = 0{,}43m$; $v = 0{,}75 * z = 0{,}75 * 0{,}43m = 0{,}32m$

Vigas V11-V12 IDEM PARA V13-V14

Tramo

$k_z = 0{,}945$; $z = k_z * d = 0{,}945 * 0{,}456\ m = 0{,}43m$; $v = 0{,}75 * z = 0{,}75 * 0{,}43m = 0{,}32m$

Apoyo

k_z =0,915; $z = k_z * d = 0{,}915 * 0{,}456\ m = 0{,}41m$; $v = 0{,}75 * z = 0{,}75 * 0{,}41m = 0{,}31\ m$

Vigas V113-V114

Tramo

k_z =0,98; $z = k_z * d = 0{,}98 * 0{,}456\, m = 0{,}44m$; $v = 0{,}75 * z = 0{,}75 * 0{,}44m = 0{,}33m$

Apoyo

k_z =0,961; $z = k_z * d = 0{,}961 * 0{,}456\, m = 0{,}438m$; $v = 0{,}75 * z = 0{,}75 * 0{,}438m = 0{,}33m$

Vigas V117-V118

Tramo

$k_z = 0{,}945$; $z = k_z * d = 0{,}945 * 0{,}456\, m = 0{,}43m$; $v = 0{,}75 * z = 0{,}75 * 0{,}43m = 0{,}32m$

Apoyo

k_z =0,929; $z = k_z * d = 0{,}929 * 0{,}456\, m = 0{,}423m$; $v = 0{,}75 * z = 0{,}75 * 0{,}423m = 0{,}32m$

Vigas V15-V16

Tramo

k_z =0,98; $z = k_z * d = 0{,}98 * 0{,}456\, m = 0{,}44m$; $v = 0{,}75 * z = 0{,}75 * 0{,}44m = 0{,}33m$

Apoyo

$k_z = 0{,}945$; $z = k_z * d = 0{,}945 * 0{,}456\, m = 0{,}43m$; $v = 0{,}75 * z = 0{,}75 * 0{,}43m = 0{,}32m$

Viga V026 IDEM PARA V029

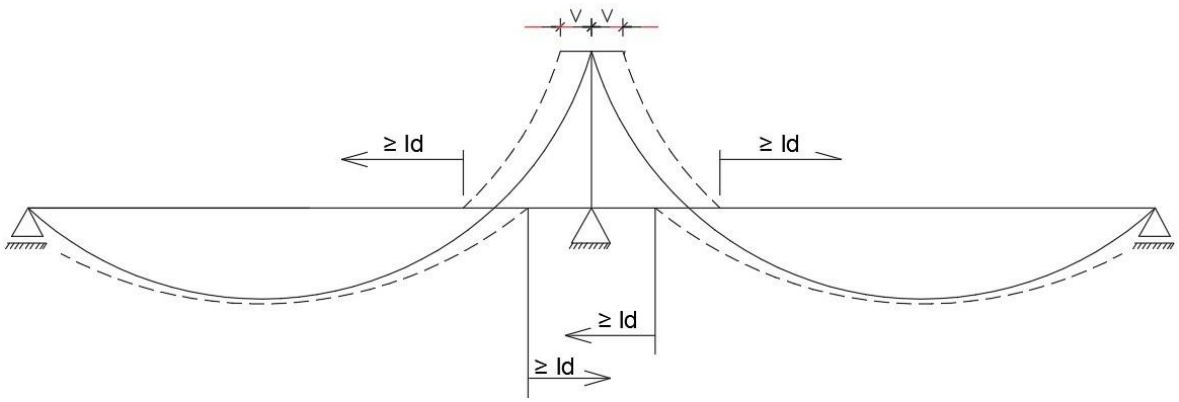
k_z =0,98; $z = k_z * d = 0{,}98 * 0{,}456\, m = 0{,}44m$; $v = 0{,}75 * z = 0{,}75 * 0{,}44m = 0{,}33m$

Viga V027

$k_z = 0{,}945;\ z = k_z * d = 0{,}945 * 0{,}456\ m = 0{,}43m\ ;\ v = 0{,}75 * z = 0{,}75 * 0{,}43m = 0{,}32m$

Viga V025

k_z =0,961; $z = k_z * d = 0{,}961 * 0{,}456\ m = 0{,}438m$; $v = 0{,}75 * z = 0{,}75 * 0{,}438m = 0{,}33m$



Columnas

Columna C11 IDEM C13 ‖ C116 ‖ C118:

Longitud de columna: 3 m

Recubrimiento: 0,03 m

Dimensiones: 0,20 m x 0,20 m

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b^2 * h = 25\ {}^{kN}/_{m^3} * (0{,}20\ m)^2 * 3\ m = 3\ kN$$

$$D = R_{V11D} + R_{V113D} + p_p = (32{,}2 + 5 + 3)\ kN = 40{,}5\ kN$$

$$L = R_{V11L} + R_{V113L} = (18{,}4 + 1{,}2) kN = 19{,}6\ kN$$

$$P_u = 1{,}2 * P_D + 1{,}6 * P_L = (1{,}2 * 40{,}5 + 1{,}6 * 19{,}6) kN = 79{,}96\ kN$$

En eje x:

Columna Superior

$$C_s = 0$$

$$C_i = \frac{L_v * I_{ci}}{L_{ci} * I_v} = \frac{5{,}4m * (20cm)^4}{3m * 20cm * (50cm)^3} = 0{,}12$$

$$q_u = 1{,}2 * q_{V11D} + 1{,}6 * q_{V11L} = (1{,}2 * 15{,}91 + 1{,}6 * 9{,}08) kN/m =$$

$$q_u = 33{,}62\ kN/m$$

$$M_e = \frac{q * l^2}{12} = \frac{33{,}62 * 5{,}40^2}{12} = 81{,}70\ kNm$$

$$M_3 = M_e * \frac{c_s + c_i}{1 + c_s + c_i} = 81{,}70 * \frac{0{,}12}{1{,}12} = 4{,}18\ kNM$$

$$M_i = 0$$

$$M_s = M_3 * \frac{c_i}{c_s + c_i} = 4{,}18 kNm * \frac{0{,}33}{0{,}33} = 8{,}75\ kNm$$

Columna Inferior

$$C_i = \frac{L_v * I_{ci}}{L_{ci} * I_v} = \frac{5{,}4m * (30cm)^4}{3{,}5m * 20cm * (50cm)^3} = 0{,}5$$

$$C_s = \frac{L_v * I_{cs}}{L_{cs} * I_v} = \frac{5{,}4m * (20cm)^4}{3m * 20cm * (50cm)^3} = 0{,}12$$

$$q_u = 1{,}2 * q_{V01D} + 1{,}6 * q_{V01L} = (1{,}2 * 22{,}22 + 1{,}6 * 9{,}08)kN/m =$$

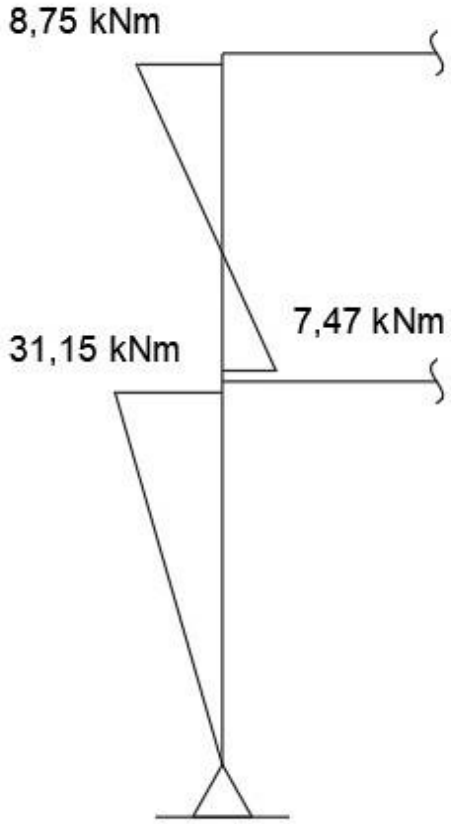
$$q_u = 41{,}19\ kN/m$$

$$M_e = \frac{q * l^2}{12} = \frac{41{,}19 * 5{,}4^2}{12} = 100{,}09\ kNm$$

$$M_3 = M_e * \frac{c_s + c_i}{1 + c_s + c_i} = 100{,}09 * \frac{0{,}12 + 0{,}5}{1 + 0{,}12 + 0{,}5} = 38{,}62\ kNM$$

$$M_i = M_3 * \frac{c_s}{c_s + c_i} = 38{,}62\ kNm * \frac{0{,}12}{0{,}12 + 0{,}5} = 7{,}47\ kNm$$

$$M_s = M_3 * \frac{c_i}{c_s + c_i} = 38{,}62\ kNm * \frac{0{,}5}{0{,}12 + 0{,}5} = 31{,}15\ kNm$$



En eje y:

Columna Superior

$C_s = 0$

$$C_i = \frac{L_v * I_{ci}}{L_{ci} * I_v} = \frac{3{,}37m * (20cm)^4}{3 * 20cm * (30cm)^3} = 0{,}33$$

$$q_u = 1{,}2 * q_{V113D} + 1{,}6 * q_{V113L} = (1{,}2 * 4{,}03 + 1{,}6 * 0{,}98)kN/m =$$

$$q_u = 6{,}4\ kN/m$$

$$M_e = \frac{q * l^2}{12} = \frac{17{,}81 * 3{,}37^2}{12} = 6{,}06\ kNm$$

$$M_3 = M_e * \frac{c_s + c_i}{1 + c_s + c_i} = 6{,}06 * \frac{0{,}33}{1{,}33} = 1{,}5\ kNM$$

$M_i = 0$

$$M_s = M_3 * \frac{c_i}{c_s + c_i} = 1{,}5kNm * \frac{0{,}33}{0{,}33} = 1{,}5\ kNm$$

Columna Inferior

$$C_i = \frac{L_v * I_{ci}}{L_{ci} * I_v} = \frac{3{,}37m * (30cm)^4}{3{,}5 * 20cm * (30cm)^3} = 1{,}44$$

$$C_s = \frac{L_v * I_{cs}}{L_{cs} * I_v} = \frac{3{,}37m * (20cm)^4}{3 * 20cm * (30cm)^3} = 0{,}33$$

$$q_u = 1{,}2 * q_{V013D} + 1{,}6 * q_{V013L} = (1{,}2 * 10{,}33 + 1{,}6 * 0{,}98)kN/m =$$

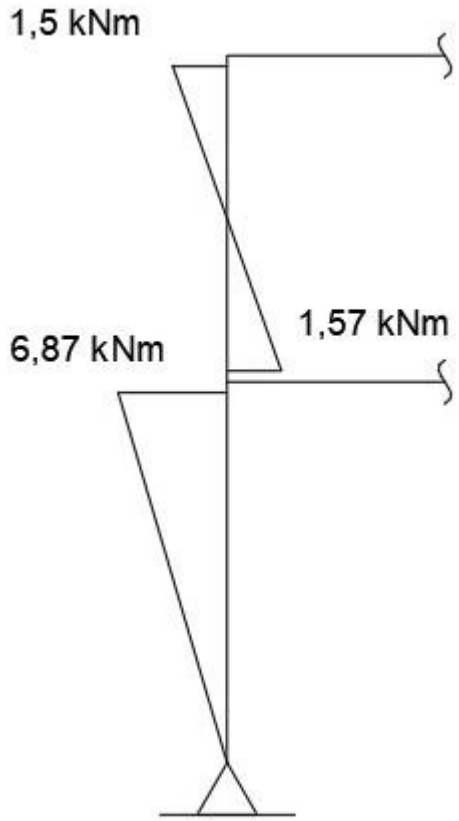
$$q_u = 13{,}96\ kN/m$$

$$M_e = \frac{q * l^2}{12} = \frac{13{,}96 * 3{,}37^2}{12} = 13{,}21\ kNm$$

$$M_3 = M_e * \frac{c_s + c_i}{1 + c_s + c_i} = 13{,}21 * \frac{0{,}33 + 1{,}44}{1 + 0{,}33 + 1{,}44} = 8{,}44\ kNM$$

$$M_i = M_3 * \frac{c_s}{c_s + c_i} = 8{,}44\ kNm * \frac{0{,}33}{0{,}33 + 1{,}44} = 1{,}57\ kNm$$

$$M_s = M_3 * \frac{c_i}{c_s + c_i} = 8{,}44\ kNm * \frac{1{,}44}{0{,}33 + 1{,}44} = 6{,}87\ kNm$$



- Determinación del Grado de Esbeltez

$$\Psi_A = \frac{\frac{0{,}7 * 20^4}{12 * 300}}{\frac{0{,}35 * 20 * 30^3}{12 * 337} + \frac{0{,}35 * 20 * 50^3}{12 * 540}} = 0{,}17$$

$$\Psi_B = \frac{\frac{0{,}7 * 20^4}{12 * 300} + \frac{0{,}7 * 30^4}{12 * 350}}{\frac{0{,}35 * 20 * 30^3}{12 * 337} + \frac{0{,}35 * 20 * 50^3}{12 * 540}} = 0{,}91$$

S/ Nomograma k= 0,74

S/ CIRSOC 201-10.12.2:

$$\lambda = \frac{k * l_u}{r} \leq \lambda_{lim} = 34 - 12 * \frac{M_1}{M_2}$$

$M_1 = 1{,}5\ kNm$

$M_2 = 1{,}57\ kNm$

$$r_x = r_y = \frac{b}{\sqrt{12}} = \frac{20\ cm}{\sqrt{12}} = 5{,}77\ cm$$

Para eje x:

$$l_u = 3m - 0{,}5\ m = 2{,}5\ m = 250\ cm$$

$$\lambda = \frac{0{,}74 * 250}{5{,}77} = 32{,}06 \leq 40 \qquad \therefore \qquad Columna\ Corta$$

Para eje y:

$$l_u = 3m - 0{,}3\ m = 2{,}7\ m = 270\ cm$$

$$\lambda = \frac{0{,}74 * 270}{5{,}77} = 34{,}63 \leq 40 \qquad \therefore \qquad Columna\ Corta$$

- <u>Determinación de la Armadura Longitudinal</u>

$$n = \frac{P_u}{b * h} = \frac{0{,}07996\ MN}{0{,}20\ m * 0{,}20\ m} = 2\ MPa$$

$$m = \frac{M_u}{b * h^2} = \frac{0{,}00157\ MNm}{0{,}20m * (0{,}20m)^2} = 0{,}2\ MPa$$

S/ Diagrama II.8: $\rho = 0{,}01$

$$A_s = 0{,}01 A_g = 0{,}01 * (20cm)^2 = 4\ cm^2$$

Se adopta armadura mínima: 4 Ø12 ($A_s = 4{,}52\ cm^2$)

- <u>Determinación de Estribos</u>

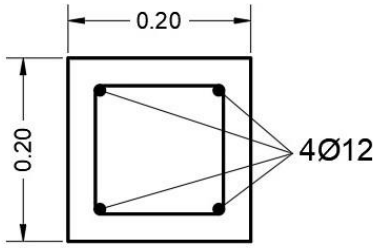
S/ CIRSOC 201-7.10.5.1:

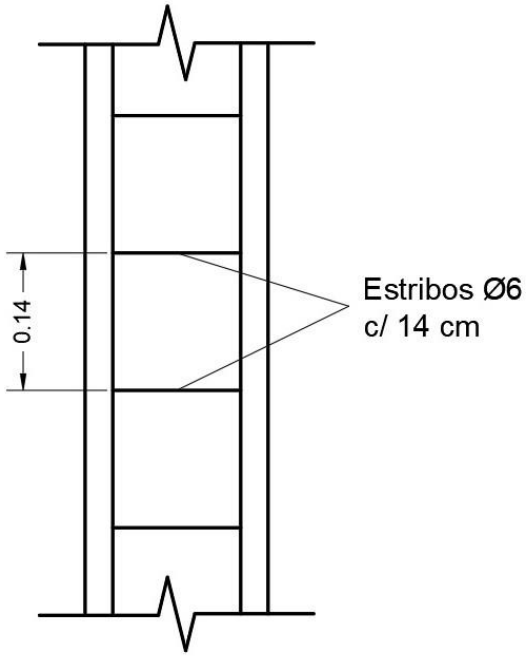
Para $d_b = 12\ mm \qquad \rightarrow \qquad d_{be} = 6\ mm$

$$s \begin{cases} \leq 12 d_b = 144\ mm \\ \leq 48 d_{be} = 288\ mm \\ \leq b = 200\ mm \end{cases}$$

Se adoptan estribos Ø6 c/ 14 cm.

- Detalle de Armado





Columna C01 IDEM C03 ‖ C016 ‖ C018:

Longitud de columna: 3,5 m

Recubrimiento: 0,03 m

Dimensiones: 0,30 m x 0,30 m

- Análisis de Carga

Peso propio:

$p_p = \gamma * b^2 * h = 25\,{}^{kN}/_{m^3} * (0{,}30\ m)^2 * 3{,}5\ m = 7{,}88\ kN$

$D = R_{C11D} + R_{V01D} + R_{V013} + p_p = (40{,}5 + 45 + 12{,}9 + 7{,}88)\ kN =$

$D = 106{,}28\ kN$

$L = R_{C11L} + R_{V01L} + R_{V013L} = (19{,}6 + 18{,}4 + 1{,}2) kN = 39{,}2\ kN$

$P_u = 1{,}2 * P_D + 1{,}6 * P_L = (1{,}2 * 106{,}28 + 1{,}6 * 39{,}2) kN = 190{,}26\ kN$

- Determinación del Grado de Esbeltez

$$\Psi_A = \frac{\frac{0{,}7 * 20^4}{12 * 300} + \frac{0{,}7 * 30^4}{12 * 350}}{\frac{0{,}35 * 20 * 30^3}{12 * 337} + \frac{0{,}35 * 20 * 50^3}{12 * 540}} = 0{,}91$$

$$\Psi_B = \infty$$

S/ Nomograma k= 0,97

S/ CIRSOC 201-10.12.2:

$$\lambda = \frac{k * l_u}{r} \leq \lambda_{lim} = 34 - 12 * \frac{M_1}{M_2}$$

$$M_1 = 0$$

$$M_2 = 31{,}15$$

$$r_x = r_y = \frac{b}{\sqrt{12}} = \frac{30\ cm}{\sqrt{12}} = 8{,}66\ cm$$

Para eje x:

$$l_u = 3{,}5m - \frac{0{,}5\ m}{2} = 3{,}25\ m = 325\ cm$$

$$\lambda = \frac{0{,}97 * 325}{8{,}66} = 36{,}4 > 34 \qquad \therefore \qquad Columna\ Esbelta$$

Para eje y:

$$l_u = 3{,}5m - \frac{0{,}3\ m}{2} = 3{,}35\ m = 335\ cm$$

$$\lambda = \frac{0{,}97 * 335}{8{,}66} = 37{,}52 > 34 \qquad \therefore \qquad Columna\ Esbelta$$

$$\lambda = 37{,}52 < 100$$

Es posible utilizar el método de los Momentos Amplificados

- Momento Amplificado

$$\beta_d = \frac{1{,}2P_D}{1{,}2P_D + 1{,}6P_L} = \frac{1{,}2 * 106{,}28\ kN}{190{,}26\ kN} = 0{,}67$$

$$EI = \frac{0{,}4E_cI_g}{1 + \beta_d} = \frac{0{,}4 * 23500MPa * 6{,}75 * 10^{-4}m^4}{1 + 0{,}67} = 3{,}8\ MNm^2$$

$$P_c = \frac{\pi^2 EI}{(k * l_u)^2} = \frac{\pi^2 * 3{,}8\ MNm^2}{(0{,}97 * 3{,}35\ m)^2} = 3{,}55\ MN$$

$$C_m = 0{,}6 + 0{,}4 * \frac{M_1}{M_2} = 0{,}6$$

$$\delta_{ns} = \frac{C_m}{1 - \frac{P_u}{0{,}75 P_c}} = \frac{0{,}6}{1 - \frac{0{,}19026\ MN}{0{,}75 * 3{,}55\ MN}} = 0{,}65$$

$$\delta_{ns} = 1$$

$$M_{2,mín} = P_u(0{,}015 + 0{,}03h) = 190{,}26 * (0{,}015 + 0{,}03 * 0{,}30) = 4{,}57\ kNm$$

$$M_c = \delta_{ns} * M_2 = 1 * 31{,}15\ kNm = 31{,}15\ kNm$$

- <u>Determinación de la Armadura Longitudinal</u>

$$n = \frac{P_u}{b * h} = \frac{0{,}19026\ MN}{0{,}30\ m * 0{,}30\ m} = 2{,}11\ MPa$$

$$m = \frac{M_u}{b * h^2} = \frac{0{,}03115\ MNm}{0{,}30m * (0{,}30m)^2} = 1{,}15$$

S/ Diagrama II.8: $\rho = 0{,}01$

$$A_s = 0{,}01 A_g = 0{,}01 * (30cm)^2 = 9\ cm^2$$

Se adopta armadura: 8 Ø12 ($A_s = 9{,}05\ cm^2$)

- <u>Determinación de Estribos</u>

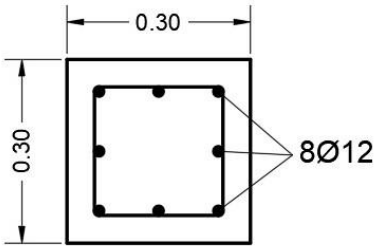
S/ CIRSOC 201-7.10.5.1:

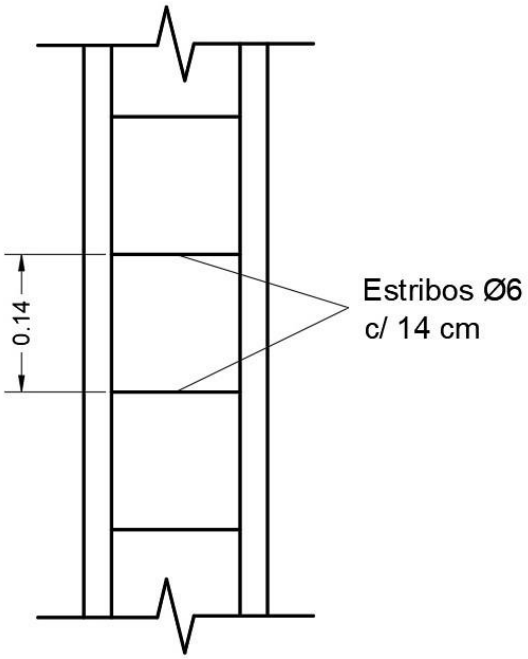
Para $d_b = 12\ mm$ → $d_{be} = 6\ mm$

$$s \begin{cases} \leq 12 d_b = 144\ mm \\ \leq 48 d_{be} = 288\ mm \\ \leq b = 300\ mm \end{cases}$$

Se adoptan estribos Ø6 c/ 14 cm.

- Detalle de Armado





Columna C12 IDEM C117:

Longitud de columna: 3 m

Recubrimiento: 0,03 m

Dimensiones: 0,20 m x 0,20 m

- Análisis de Carga

Peso propio:

$p_p = \gamma * b^2 * h = 25\,{}^{kN}/_{m^3} * (0{,}20\ m)^2 * 3\ m = 3\ kN$

$D = R_{V11-V12D} + R_{V117D} + p_p = (107{,}4 + 12{,}5 + 3)\ kN = 122{,}9\ kN$

$L = R_{V11-V12L} + R_{V117L} = (61{,}2 + 4{,}2) kN = 65{,}4\ kN$

$P_u = 1{,}2 * P_D + 1{,}6 * P_L = (1{,}2 * 122{,}9 + 1{,}6 * 65{,}4) kN = 252{,}12\ kN$

En eje y:

Columna Superior

$C_s = 0$

$$C_i = \frac{L_v * I_{ci}}{L_{ci} * I_v} = \frac{3{,}37m * (20cm)^4}{3 * 20cm * (30cm)^3} = 0{,}33$$

$$q_u = 1{,}2 * q_{V117D} + 1{,}6 * q_{V117L} = (1{,}2 * 10{,}28 + 1{,}6 * 3{,}42)kN/m =$$

$$q_u = 17{,}81\ kN/m$$

$$M_e = \frac{q * l^2}{12} = \frac{17{,}81 * 3{,}37^2}{12} = 16{,}85\ kNm$$

$$M_3 = M_e * \frac{c_s + c_i}{1 + c_s + c_i} = 16{,}85 * \frac{0{,}33}{1{,}33} = 4{,}18\ kNM$$

$M_i = 0$

$$M_s = M_3 * \frac{c_i}{c_s + c_i} = 4{,}18kNm * \frac{0{,}33}{0{,}33} = 4{,}18\ kNm$$

Columna Inferior

$$C_i = \frac{L_v * I_{ci}}{L_{ci} * I_v} = \frac{3{,}37m * (30cm)^4}{3{,}5 * 20cm * (30cm)^3} = 1{,}44$$

$$C_s = \frac{L_v * I_{cs}}{L_{cs} * I_v} = \frac{3{,}37m * (20cm)^4}{3 * 20cm * (30cm)^3} = 0{,}33$$

$$q_u = 1{,}2 * q_{V017D} + 1{,}6 * q_{V017L} = (1{,}2 * 16{,}58 + 1{,}6 * 3{,}42)kN/m =$$

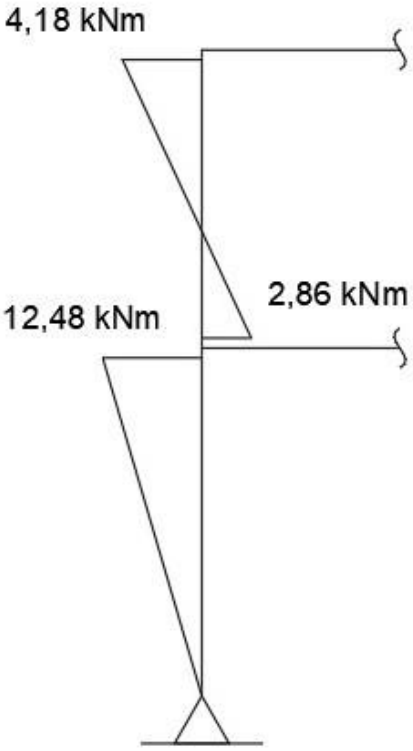
$$q_u = 25{,}37\ kN/m$$

$$M_e = \frac{q * l^2}{12} = \frac{25{,}37 * 3{,}37^2}{12} = 24{,}01\ kNm$$

$$M_3 = M_e * \frac{c_s + c_i}{1 + c_s + c_i} = 24{,}01 * \frac{0{,}33 + 1{,}44}{1 + 0{,}33 + 1{,}44} = 15{,}34\ kNM$$

$$M_i = M_3 * \frac{c_s}{c_s + c_i} = 15{,}34\ kNm * \frac{0{,}33}{0{,}33 + 1{,}44} = 2{,}86\ kNm$$

$$M_s = M_3 * \frac{c_i}{c_s + c_i} = 15{,}34\ kNm * \frac{1{,}44}{0{,}33 + 1{,}44} = 12{,}48\ kNm$$



- Determinación del Grado de Esbeltez

$$\Psi_A = \frac{\frac{0{,}7 * 20^4}{12 * 300}}{\frac{0{,}35 * 20 * 30^3}{12 * 337} + \frac{2 * 0{,}35 * 20 * 50^3}{12 * 540}} = 0{,}01$$

$$\Psi_B = \frac{\frac{0{,}7 * 20^4}{12 * 300} + \frac{0{,}7 * 30^4}{12 * 350}}{\frac{0{,}35 * 20 * 30^3}{12 * 337} + \frac{2 * 0{,}35 * 20 * 50^3}{12 * 540}} = 0{,}52$$

S/ Nomograma k= 0,59

S/ CIRSOC 201-10.12.2:

$$\lambda = \frac{k * l_u}{r} \leq \lambda_{lim} = 34 - 12 * \frac{M_1}{M_2}$$

$M_1 = 2{,}86$

$M_2 = 4{,}18\ kNm$

$r_x = r_y = \frac{b}{\sqrt{12}} = \frac{20\ cm}{\sqrt{12}} = 5{,}77\ cm$

Para eje x:

$l_u = 3m - 0{,}5\ m = 2{,}5\ m = 250\ cm$

$\lambda = \frac{0{,}59 * 250}{5{,}77} = 25{,}56 \leq 40 \qquad \therefore \qquad Columna\ Corta$

Para eje y:

$l_u = 3m - 0{,}3\ m = 2{,}7\ m = 270\ cm$

$\lambda = \frac{0{,}59 * 270}{5{,}77} = 27{,}61 \leq 40 \qquad \therefore \qquad Columna\ Corta$

- <u>Determinación de la Armadura Longitudinal</u>

$n = \frac{P_u}{b * h} = \frac{0{,}25212\ MN}{0{,}20\ m * 0{,}20\ m} = 6{,}3\ MPa$

$m = \frac{M_u}{b * h^2} = \frac{0{,}00418\ MNm}{0{,}20m * (0{,}20m)^2} = 0{,}52\ MPa$

S/ Diagrama II.8: $\rho = 0{,}01$

$A_s = 0{,}01 A_g = 0{,}01 * (20cm)^2 = 4\ cm^2$

Se adopta armadura mínima: 4 Ø12 ($A_s = 4{,}52\ cm^2$)

- <u>Determinación de Estribos</u>

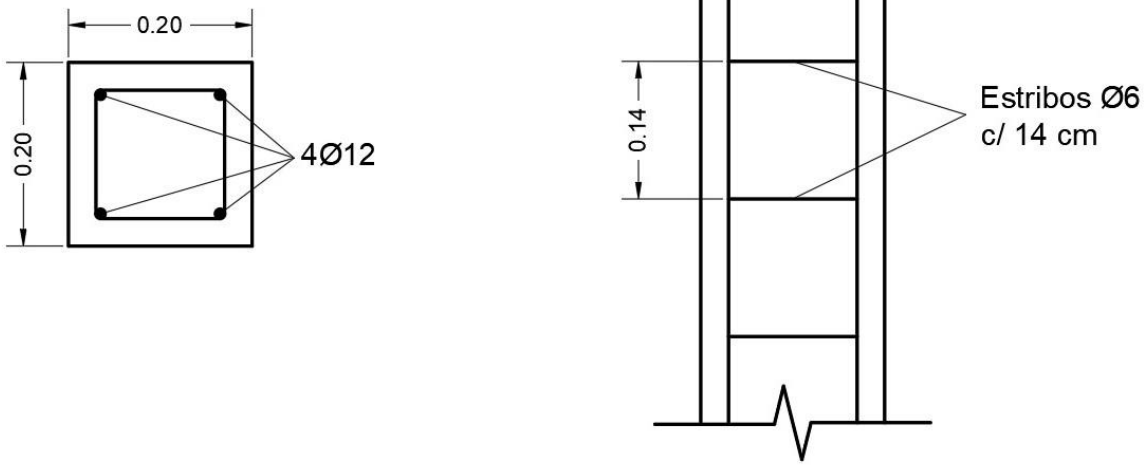
S/ CIRSOC 201-7.10.5.1:

Para $d_b = 12\ mm \qquad \rightarrow \qquad d_{be} = 6\ mm$

$$s \begin{cases} \leq 12 d_b = 144\ mm \\ \leq 48 d_{be} = 288\ mm \\ \leq b = 200\ mm \end{cases}$$

Se adoptan estribos Ø6 c/ 14 cm.

- Detalle de Armado



Columna C02 IDEM C017:

Longitud de columna: 3,5 m

Recubrimiento: 0,03 m

Dimensiones: 0,30 m x 0,30 m

- Análisis de Carga

Peso propio:

$p_p = \gamma * b^2 * h = 25\,{}^{kN}/_{m^3} * (0{,}30\ m)^2 * 3{,}5\ m = 7{,}88\ kN$

$D = R_{C12D} + R_{V01-V02D} + R_{V017} + p_p = (122{,}9 + 150 + 20{,}5 + 7{,}88)\ kN =$

$D = 301{,}28\ kN$

$L = R_{C12L} + R_{V01-V02L} + R_{V017L} = (65{,}4 + 61{,}2 + 4{,}2) kN = 130{,}8\ kN$

$P_u = 1{,}2 * P_D + 1{,}6 * P_L = (1{,}2 * 301{,}28 + 1{,}6 * 130{,}8) kN = 570{,}82\ kN$

- Determinación del Grado de Esbeltez

$$\Psi_A = \frac{\frac{0{,}7 * 20^4}{12 * 300} + \frac{0{,}7 * 30^4}{12 * 350}}{\frac{0{,}35 * 20 * 30^3}{12 * 337} + \frac{2 * 0{,}35 * 20 * 50^3}{12 * 540}} = 0{,}52$$

$$\Psi_B = \infty$$

S/ Nomograma k= 0,82

S/ CIRSOC 201-10.12.2:

$$\lambda = \frac{k * l_u}{r} \leq \lambda_{lim} = 34 - 12 * \frac{M_1}{M_2}$$

$$M_1 = 0$$

$$M_2 = 12{,}48$$

$$r_x = r_y = \frac{b}{\sqrt{12}} = \frac{30\ cm}{\sqrt{12}} = 8{,}66\ cm$$

Para eje x:

$$l_u = 3{,}5m - \frac{0{,}5\ m}{2} = 3{,}25\ m = 325\ cm$$

$$\lambda = \frac{0{,}82 * 325}{8{,}66} = 30{,}77 < 34 \quad \therefore \quad Columna\ Corta$$

Para eje y:

$$l_u = 3{,}5m - \frac{0{,}3\ m}{2} = 3{,}35\ m = 335\ cm$$

$$\lambda = \frac{0{,}82 * 335}{8{,}66} = 31{,}72 < 34 \quad \therefore \quad Columna\ Corta$$

- Determinación de la Armadura Longitudinal

$$n = \frac{P_u}{b * h} = \frac{0{,}57082\ MN}{0{,}30\ m * 0{,}30\ m} = 6{,}34\ MPa$$

$$m = \frac{M_u}{b * h^2} = \frac{0{,}01248\ MNm}{0{,}30m * (0{,}30m)^2} = 0{,}46$$

S/ Diagrama II.8: $\rho = 0{,}01$

$$A_s = 0{,}01 A_g = 0{,}01 * (30cm)^2 = 9\ cm^2$$

Se adopta armadura: 8 Ø12 ($A_s = 9{,}05\ cm^2$)

- <u>Determinación de Estribos</u>

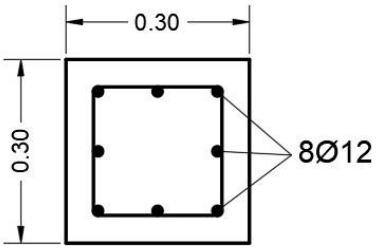
  S/ CIRSOC 201-7.10.5.1:

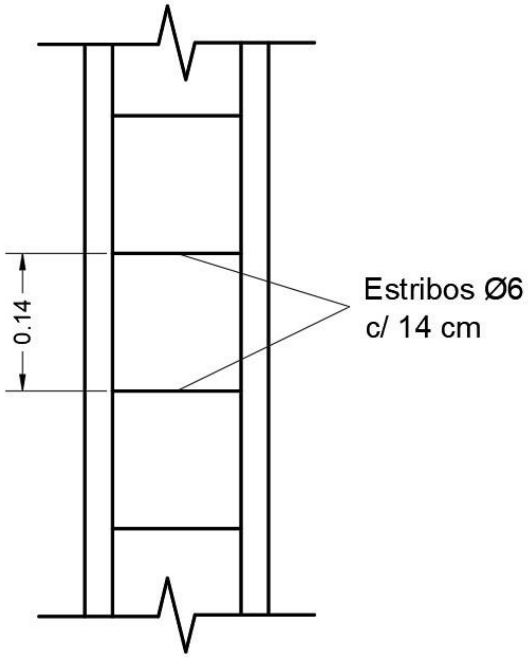
  Para $d_b = 12\ mm$ → $d_{be} = 6\ mm$

$$s \begin{cases} \leq 12 d_b = 144\ mm \\ \leq 48 d_{be} = 288\ mm \\ \leq b = 300\ mm \end{cases}$$

Se adoptan estribos Ø6 c/ 14 cm.

- <u>Detalle de Armado</u>





Columna C15 IDEM C114:

Longitud de columna: 3 m

Recubrimiento: 0,03 m

Dimensiones: 0,20 m x 0,20 m

- Análisis de Carga

Peso propio:

$$p_p = \gamma * b^2 * h = 25\,{}^{kN}/_{m^3} * (0{,}20\ m)^2 * 3\ m = 3\ kN$$

$$D = R_{V13-V14D} + R_{V117-V118D} + p_p = (113{,}4 + 48{,}4 + 3)\ kN = 164{,}8\ kN$$

$$L = R_{V13-V14L} + R_{V117-V118L} = (37{,}26 + 16{,}3) kN = 53{,}56\ kN$$

$$P_u = 1{,}2 * P_D + 1{,}6 * P_L = (1{,}2 * 164{,}8 + 1{,}6 * 53{,}56) kN = 283{,}46\ kN$$

- Determinación del Grado de Esbeltez

$$\Psi_A = \frac{\frac{0{,}7 * 20^4}{12 * 300}}{\frac{2 * 0{,}35 * 20 * 30^3}{12 * 337} + \frac{2 * 0{,}35 * 20 * 50^3}{12 * 540}} = 0{,}0856$$

$$\Psi_B = \frac{\frac{0{,}7 * 20^4}{12 * 300} + \frac{0{,}7 * 30^4}{12 * 350}}{\frac{2 * 0{,}35 * 20 * 30^3}{12 * 337} + \frac{2 * 0{,}35 * 20 * 50^3}{12 * 540}} = 0{,}46$$

S/ Nomograma k= 0,6

S/ CIRSOC 201-10.12.2:

$$\lambda = \frac{k * l_u}{r} \leq \lambda_{lim} = 34 - 12 * \frac{M_1}{M_2}$$

$$M_1 = M_2 = 0$$

$$r_x = r_y = \frac{b}{\sqrt{12}} = \frac{20\ cm}{\sqrt{12}} = 5{,}77\ cm$$

Para eje x:

$l_u = 3m - 0{,}5\ m = 2{,}5\ m = 250\ cm$

$\lambda = \frac{0{,}6 * 250}{5{,}77} = 26 \leq 34 \qquad \therefore \qquad Columna\ Corta$

Para eje y:

$l_u = 3m - 0{,}3\ m = 2{,}7\ m = 270\ cm$

$\lambda = \frac{0{,}6 * 270}{5{,}77} = 28{,}08 \leq 34 \qquad \therefore \qquad Columna\ Corta$

- Determinación de la Armadura Longitudinal

$n = \frac{P_u}{b * h} = \frac{0{,}28346\ MN}{0{,}20\ m * 0{,}20\ m} = 7{,}09\ MPa$

$m = 0$

S/ Diagrama II.8: $\rho = 0{,}01$

$A_s = 0{,}01 A_g = 0{,}01 * (20cm)^2 = 4\ cm^2$

Se adopta armadura mínima: 4 Ø12 ($A_s = 4{,}52\ cm^2$)

- Determinación de Estribos

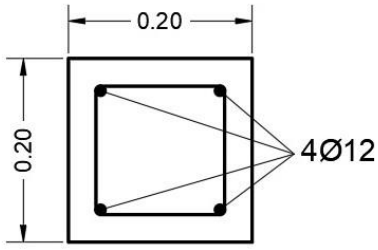
S/ CIRSOC 201-7.10.5.1:

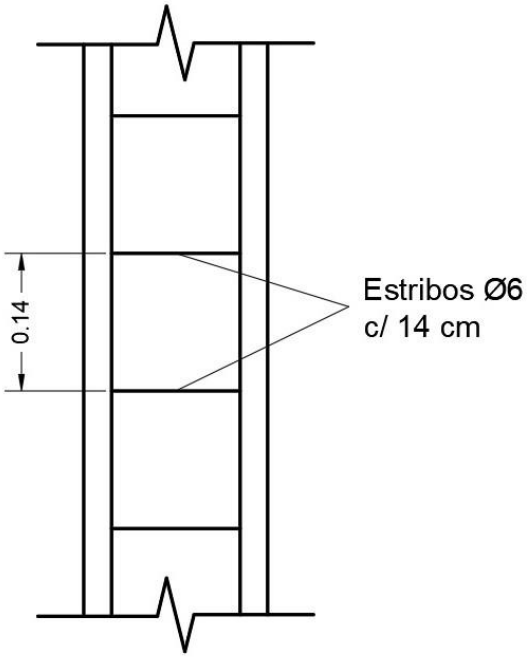
Para $d_b = 12\ mm \qquad \rightarrow \qquad d_{be} = 6\ mm$

$$s \begin{cases} \leq 12 d_b = 144\ mm \\ \leq 48 d_{be} = 288\ mm \\ \leq b = 200\ mm \end{cases}$$

Se adoptan estribos Ø6 c/ 14 cm.

- Detalle de Armado





Columna C05 IDEM C014:

Longitud de columna: 3,5 m

Recubrimiento: 0,03 m

Dimensiones: 0,30 m x 0,30 m

- Análisis de Carga

Peso propio:

$p_p = \gamma * b^2 * h = 25\,{}^{kN}/_{m^3} * (0{,}30\ m)^2 * 3{,}5\ m = 7{,}88\ kN$

$D = R_{C15D} + R_{V03-V04D} + R_{V017-V018D} + p_p =$

$D = (164{,}8 + 155{,}84 + 75{,}1 + 7{,}88)\ kN =$

$D = 403{,}62\ kN$

$L = R_{C15L} + R_{V13-V14L} + R_{V117-V118L} = (53{,}56 + 37{,}26 + 16{,}3) kN = 107{,}12\ kN$

$P_u = 1{,}2 * P_D + 1{,}6 * P_L = (1{,}2 * 403{,}62 + 1{,}6 * 107{,}12) kN = 655{,}74\ kN$

- Determinación del Grado de Esbeltez

$$\Psi_A = \frac{\frac{0{,}7 * 20^4}{12 * 300} + \frac{0{,}7 * 30^4}{12 * 350}}{\frac{2 * 0{,}35 * 20 * 30^3}{12 * 337} + \frac{2 * 0{,}35 * 20 * 50^3}{12 * 540}} = 0{,}46$$

$$\Psi_B = \infty$$

S/ Nomograma k= 0,81

S/ CIRSOC 201-10.12.2:

$$\lambda = \frac{k * l_u}{r} \leq \lambda_{lim} = 34 - 12 * \frac{M_1}{M_2}$$

$$M_1 = M_2 = 0$$

$$r_x = r_y = \frac{b}{\sqrt{12}} = \frac{30\ cm}{\sqrt{12}} = 8{,}66\ cm$$

Para eje x:

$$l_u = 3{,}5m - \frac{0{,}5\ m}{2} = 3{,}25\ m = 325\ cm$$

$$\lambda = \frac{0{,}81 * 325}{8{,}66} = 30{,}40 < 34 \qquad \therefore \qquad Columna\ Corta$$

Para eje y:

$$l_u = 3{,}5m - \frac{0{,}3\ m}{2} = 3{,}35\ m = 335\ cm$$

$$\lambda = \frac{0{,}81 * 335}{8{,}66} = 31{,}33 < 34 \qquad \therefore \qquad Columna\ Corta$$

- Determinación de la Armadura Longitudinal

$$n = \frac{P_u}{b * h} = \frac{0{,}65574\ MN}{0{,}30\ m * 0{,}30\ m} = 7{,}3\ MPa$$

$$m = \frac{M_u}{b * h^2} = 0$$

S/ Diagrama II.8: $\rho = 0{,}01$

$A_s = 0{,}01 A_g = 0{,}01 * (30cm)^2 = 9\ cm^2$

Se adopta armadura mínima: 8Ø12 ($A_s = 9{,}05\ cm^2$)

- Determinación de Estribos

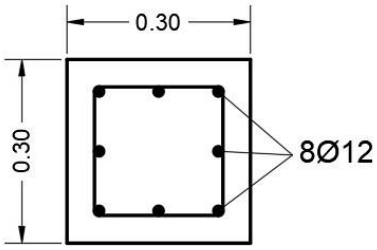
  S/ CIRSOC 201-7.10.5.1:

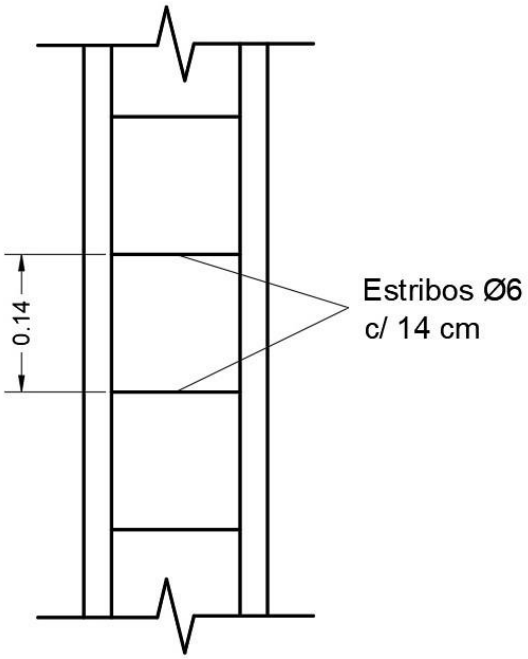
  Para $d_b = 12\ mm$ $\rightarrow$ $d_{be} = 6\ mm$

$$s \begin{cases} \leq 12 d_b = 144\ mm \\ \leq 48 d_{be} = 288\ mm \\ \leq b = 300\ mm \end{cases}$$

  Se adoptan estribos Ø6 c/ 14 cm.

- Detalle de Armado





Columna C14 IDEM C16 ‖ C113 ‖ C115:

Longitud de columna: 3 m

Recubrimiento: 0,03 m

Dimensiones: 0,20 m x 0,20 m

- Análisis de Carga

Peso propio:

$p_p = \gamma * b^2 * h = 25\,{}^{kN}/_{m^3} * (0{,}20\ m)^2 * 3\ m = 3\ kN$

$D = R_{V13D} + R_{V113-V114D} + p_p = (34 + 18{,}5 + 3)\ kN = 55{,}5\ kN$

$L = R_{V13L} + R_{V113-V114L} = (4{,}7 + 11{,}2) kN = 15{,}9\ kN$

$P_u = 1{,}2 * P_D + 1{,}6 * P_L = (1{,}2 * 55{,}5 + 1{,}6 * 15{,}9) kN = 92{,}04\ kN$

Columna C04 IDEM C06 ‖ C013 ‖ C015:

Longitud de columna: 3,5 m

Recubrimiento: 0,03 m

Dimensiones: 0,30 m x 0,30 m

- Análisis de Carga

Peso propio:

$p_p = \gamma * b^2 * h = 25\,{}^{kN}/_{m^3} * (0{,}30\ m)^2 * 3{,}5\ m = 7{,}88\ kN$

$D = R_{C14D} + R_{V03D} + R_{V013-V014D} + p_p = (55{,}5 + 46{,}8 + 45{,}1 + 7{,}88)\ kN =$

$D = 155{,}28\ kN$

$L = R_{C14L} + R_{V03L} + R_{V013-V014L} = (15{,}9 + 11{,}2 + 4{,}7) kN = 31{,}8\ kN$

$P_u = 1{,}2 * P_D + 1{,}6 * P_L = (1{,}2 * 155{,}28 + 1{,}6 * 31{,}8) kN = 237{,}22\ kN$

Columna C17 IDEM C19 ‖ C110 ‖ C112:

Longitud de columna: 3 m

Recubrimiento: 0,03 m

Dimensiones: 0,20 m x 0,20 m

- Análisis de Carga

Peso propio:

$p_p = \gamma * b^2 * h = 25\,{}^{kN}/_{m^3} * (0{,}20\ m)^2 * 3\ m = 3\ kN$

$D = R_{V15D} + R_{V114D} + p_p = (16{,}6 + 6{,}1 + 3)\ kN = 25{,}7\ kN$

$L = R_{V15L} + R_{V114L} = (4{,}2 + 1{,}6) kN = 5{,}8\ kN$

$P_u = 1{,}2 * P_D + 1{,}6 * P_L = (1{,}2 * 25{,}7 + 1{,}6 * 5{,}8) kN = 40{,}12\ kN$

Columna C07 IDEM C09 ‖ C010 ‖ C012:

Longitud de columna: 3,5 m

Recubrimiento: 0,03 m

Dimensiones: 0,30 m x 0,30 m

- Análisis de Carga

Peso propio:

$p_p = \gamma * b^2 * h = 25\,{}^{kN}/_{m^3} * (0{,}30\ m)^2 * 3{,}5\ m = 7{,}88\ kN$

$D = R_{C17D} + R_{V05D} + R_{V014D} + p_p = (25{,}7 + 29{,}3 + 14{,}1 + 7{,}88)\ kN =$

$D = 76{,}98\ kN$

$L = R_{C17L} + R_{V05L} + R_{V014L} = (5{,}8 + 4{,}2 + 1{,}6) kN = 11{,}6\ kN$

$P_u = 1{,}2 * P_D + 1{,}6 * P_L = (1{,}2 * 76{,}98 + 1{,}6 * 11{,}6) kN = 110{,}94\ kN$

Columna C18 IDEM C111:

Longitud de columna: 3 m

Recubrimiento: 0,03 m

Dimensiones: 0,20 m x 0,20 m

- Análisis de Carga

Peso propio:

$p_p = \gamma * b^2 * h = 25\,{}^{kN}/_{m^3} * (0{,}20\ m)^2 * 3\ m = 3\ kN$

$D = R_{V15-V16D} + R_{V118D} + p_p = (76 + 16{,}5 + 3)\ kN = 95{,}5\ kN$

$L = R_{V15-V16L} + R_{V118L} = (20{,}5 + 5{,}6) kN = 26{,}1\ kN$

$P_u = 1{,}2 * P_D + 1{,}6 * P_L = (1{,}2 * 95{,}5 + 1{,}6 * 26{,}1) kN = 156{,}36\ kN$

Columna C08 IDEM C011:

Longitud de columna: 3,5 m

Recubrimiento: 0,03 m

Dimensiones: 0,30 m x 0,30 m

- Análisis de Carga

Peso propio:

$p_p = \gamma * b^2 * h = 25\,{}^{kN}/_{m^3} * (0{,}30\ m)^2 * 3{,}5\ m = 7{,}88\ kN$

$D = R_{C18D} + R_{V05-V06D} + R_{V018D} + p_p = (95{,}5 + 118{,}6 + 24{,}5 + 7{,}88)\ kN =$

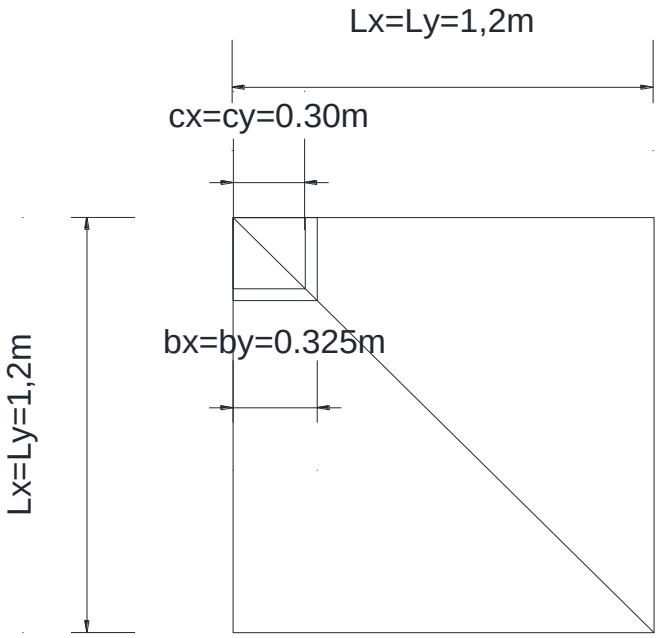
$D = 246{,}48\ kN$

$L = R_{C18L} + R_{V05-V06L} + R_{V018L} = (26{,}1 + 20{,}5 + 5{,}6) kN = 52{,}2\ kN$

$P_u = 1{,}2 * P_D + 1{,}6 * P_L = (1{,}2 * 246{,}48 + 1{,}6 * 52{,}2) kN = 379{,}3\ kN$

Zapatas

Zapata de esquina (C01)



- Datos:

Cx=Cy= 30cm=0.3m Pc=145.5 KN Pu= 190.3KN αs=20

Y=0.5 бadm= 1.05kg/cm2=105KN/m2

Rt=Pc Rtu(mayorada)=Pu

- Resolución

Propongo Lx=Ly

бadm= Rt/ (LxLy) = Rt/Lx^2 → Lx= $\sqrt{\frac{Rt}{\sigma\,\partial dm}}$ = 1.17m Adopto Lx=Ly= 1.2m

qu =Rtu/ (Lx.Ly) =132,15 KN/m2

bx=by= cx + 0.025m= 0,325m

kx= Lx – cx = 0.9m= ky

- Verificaciones

a) Verificación al Punzonado:

Pu – qu.Ao ≤ 0.75 Y Fmín bo d $\sqrt{f'c}$ / 12 $\beta = \frac{CX}{CY} = 1 \leq 2$ F1=4

F2= αs.d/bo+2 Mux=qu.Lx.ky^2/2 = 64.2KNm

d= dy=dx = $\sqrt{\frac{6.5Mnx}{byf'c}}$ = 0.24m Mnx=Mux/ϕ = 71.3KNm

Ao= (Cx+d/2) . (Cy+d/2) = 0.17m2 bo= (Cx+d/2) + (Cy+ d/2) = 0.84m

.: Pu – qu.Ao = 167.8 KN F2 = αs.d/bo+2 = 7.39 Fmín=F1=4

0.75 Y F bo d $\sqrt{f'c}$ / 12 = 133.5 KN → **NO VERIFICA**

Aumento d → d= 0.35m

.: Ao = 0.23 m2 bo= 0.95m Pu- qu. Ao= 159.9 KN

0.75 Y F bo d $\sqrt{f'c}$ / 12 = 207,8 KN → **VERIFICA**

b) Verificación al Corte

Vux ≤ ϕ $\frac{1}{6}$ $\sqrt{f'c}$ bwy.dx Vux=Vuy

bwy= bwx= (5bmín(by) +3bmáx(Ly)) / 8 = 0.65m

Vux= qu.Ly. (kx –dx) = 87.2 KN

ϕ 1/6 √(f´c) bwy.dx = 142.2 KN → **VERIFICA**

- Dimensionado a Flexión

Kdx = dx / $\sqrt{\frac{Mnx}{by}}$ = 0.75 → ke =25,207

h= d+db+cc = 0,41m= 41cm

Asx= ke Mnx/dx = 5.13cm2 → Asx=Asy

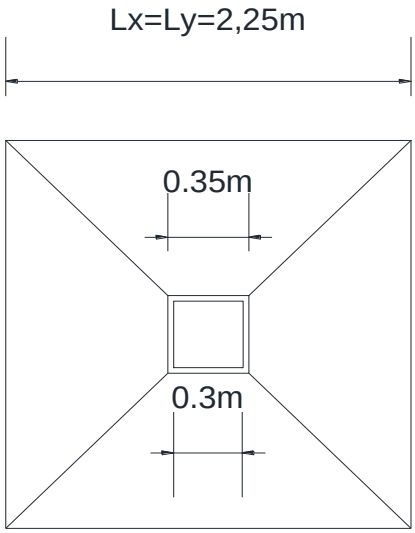
Asmín = $\frac{2{,}8\ bx\ dy}{fy}$ = 7.58 cm2 → 7 ϕ12 (7.92cm2) en ambas direcciones

Sep= $\frac{\mathrm{L} - 2\mathrm{cc} - 6\mathrm{db}}{5espacios}$ = 17 cm → 1 ϕ12 c/16cm

- Altura de talon (ht)

ht = cc+db+db+0.15m = 0.22m

Zapata centrada (C05)



- Datos:

Cx=Cy= 30cm=0.3m Pc= (403.62 + 107.12) KN = 510.74KN Pu= 655,74KN

αs=40

Y=1 бadm= 1.05kg/cm2=105KN/m2

Rt=Pc Rtu(mayorada)=Pu

- Resolución

Propongo Lx=Ly

бadm= Rt/ (LxLy) = Rt/Lx^2 → Lx=Ly= $\sqrt{\frac{Rt}{\sigma\, \partial dm}}$ = 2.21 m ≅ 2.25m

qu =Rtu/ (Lx.Ly) =129,53 KN/m2

bx=by= cx + 0.05m = 0,35m

kx=ky=(Lx – cx)/2 = 0.975m

- Verificaciones

a) Verificación al Punzonado :

Pu – qu.Ao ≤ 0.75 Y Fmín bo d $\sqrt{f'c}$ / 12 $\beta = \frac{CX}{CY}$ = 1 ≤ 2 F1=4

Mux=qu.Ly.kx^2/2 = 138.5KNm

d= dy=dx = $\sqrt{\frac{6.5Mnx}{byf'c}}$ = 0.32m ≅ → adopto d=0.40m

ny= Mnx=Mux/ϕ = 153.9 KNm

Ao= (Cx+d) . (Cy+d) = 0.49m2 bo= (Cx+d) + (Cy+ d) = 1.4m

.: Pu – qu.Ao = 592.2 KN F2 = αs.d/bo+2 = 12.7 Fmín=F1=4

0.75 Y F bo d $\sqrt{f'c}$ / 12 = 700 KN → **VERIFICA**

b) Verificación al Corte

Vux ≤ ϕ $\frac{1}{6}$ $\sqrt{f'c}$ bwy.dx Vux=Vuy

bwy= bwx= (5bmín(by) +3bmáx(Ly)) / 8 = 1.06m

Vux= qu.Ly. (kx –dx) = 167.6KN

ϕ 1/6 √(f´c) bwy.dx = 265 KN → **VERIFICA**

- Dimensionado a Flexión

Kdx = dx / $\sqrt{\frac{Mnx}{by}}$ = 0.60 → ke =25,625

h= d+db+cc = 0,46m= 46cm

Asx= ke Mnx/dx = 9.85cm2

Asmín = $\frac{2{,}8\ bx\ dy}{fy}$ = 9.33 cm2 → 9 ϕ12 (10,18cm2) en ambas direcciones

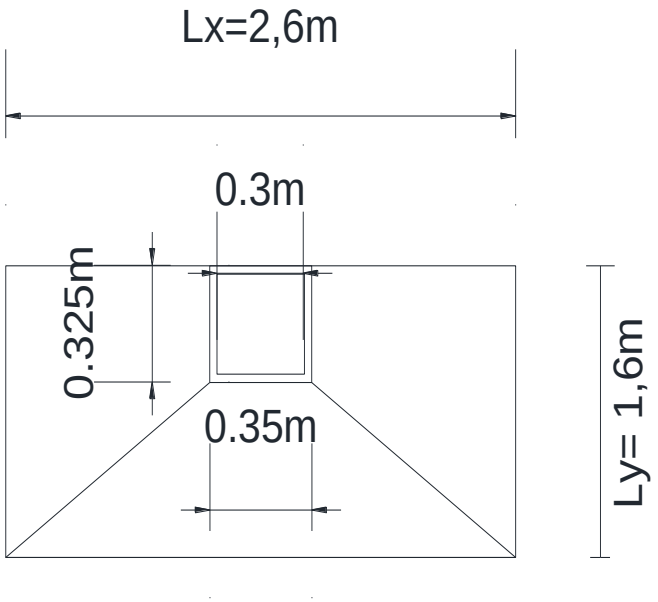
Asx=Asy

Sep= $\frac{\mathrm{L} - 2\mathrm{cc} - 9\mathrm{db}}{8espacios}$ = 25.5 cm → 1 ϕ12 c/20cm

- Altura de talon (ht)

ht = cc+db+db+0.15m = 0.22m

Zapata excéntrica Medianera (C02)



- Datos:

Cx=Cy= 20cm=0.2m Pc= 432.1KN Pu= 570.82KN

αs=30

Y=0,75 бadm= 1.05kg/cm2=105KN/m2

Rt=Pc Rtu(mayorada)=Pu

- Resolución

Propongo Ly= 1,6m

бadm= Rt/ (Lx.Ly) → Lx= Rt/ (бadm.Ly) = 2,57m Adopto Lx= 2,6m

qu =Rtu/ (Lx.Ly) =137,2 KN/m2

bx= cx + 0.05m = 0,35m by=cy+0,025m =0,325m

kx=(Lx – cx)/2 = 1,15m ky= (Ly – cy) = 0.65m

Mux=qu.Ly.kx^2/2 = 145.2KNm Muy=qu.Lx.ky^2/2 = 75.35KNm

Mnx= Mux/ ϕ= 161.33KNM Mny= Muy/ ϕ= 83.73KNm

dx= $\sqrt{\frac{6.5Mnx}{byf'c}}$ =0,36m dy= $\sqrt{\frac{6.5Mny}{bxf'c}}$ = 0,25m

d= (dx+dy)/2 = 0,32m

.: dx= d+ db/2 = 0,325m dy=d- db/2 = 0,315m

- Verificaciones

a) Verificación al Punzonado :

Pu – qu.Ao ≤ 0.75 Y Fmín bo d $\sqrt{f'c}$ / 12 $\beta = \frac{CX}{CY}$ = 1 ≤ 2

F1=4 F2= αs.d/bo+2 =9.74 Fmín=F1=4

Ao= (Cx+d) . (Cy+d/2) = 0.38m2 bo= (Cx+d) + (Cy+ d/2) = 1,24m

.: Pu – qu.Ao = 518 KN

0.75 Y F bo d $\sqrt{f'c}$ / 12 = 372 KN → **NO VERIFICA**

Adopto d= 0.45m dx= 0.455m dy=0.445m

Ao=0.56m2 bo=1.5m

Pu - qu.Ao= 494 KN

0.75 Y F bo d $\sqrt{f'c}$ / 12 = 632.8 KN **VERIFICA**

b) Verificación al Corte

Vux ≤ $\phi \frac{1}{6} \sqrt{f'c}$ bwy.dx Vuy ≤ $\phi \frac{1}{6} \sqrt{f'c}$ bwx.dy

bwy= (5bmín(by) +3bmáx(Ly)) / 8 = 0.8m

bwx= (5bmín(bx) +3bmáx(Lx)) / 8 =1,20m

Vux= qu.Ly. (kx –d) = 153.66KN Vuy= qu.Lx. (ky –d) =71.34KN

Vux= ϕ 1/6 √(f´c) bwy.dx = 225 KN **VERIFICA**

Vuy = ϕ 1/6 √(f´c) bwx.dy = 337.5 KN **VERIFICA**

- Dimensionado a Flexión

En eje x:

Kdx = dx / $\sqrt{\frac{Mnx}{by}}$ = 0.64 → ke =25,625

h= d+db+cc = 0,51m= 51cm

Asx= ke Mnx/dx = 9.18cm2

Asxmín = $\frac{2{,}8\ by\ dx}{fy}$ = 9.85cm2 → adopto 9 ϕ12 (10.18cm2)

Sepx = $\frac{\mathrm{Lx} - 2\mathrm{cc} - 9\mathrm{db}}{8espacios}$ = 0,3 cm → 1 ϕ12 c/20cm

En eje y:

Kdy = dy / $\sqrt{\frac{Mny}{bx}}$ = 0.93 → ke =24.766

Asy= ke Mny/dy = 4.67cm2

Asymín = $\frac{2{,}8\ bx\ dy}{fy}$ = 10,38 cm2 → adopto 6 ϕ 16 (12.06cm2)

Sepy = $\frac{\mathrm{Ly} - 2\mathrm{cc} - 9\mathrm{db}}{8espacios}$ = 28cm → 1 ϕ16c/20cm

- Altura de talon (ht)

ht = cc+db+db+0.15m = 0.22m

- Separación máxima

$$smin\begin{cases}2{,}5h\\25\emptyset\\30cm\end{cases};\ smin\begin{cases}2{,}5.30cm = 75cm\\25.0{,}8cm = 20cm\\30cm\end{cases}$$

VERIFICAN LAS 3 ZAPATAS

Longitud de Anclaje de Zapatas

$$ldh \geq \begin{cases} 8db \\ 150mm \\ - \end{cases}$$

Ldh = $\frac{0,24\psi e\ \lambda fy}{\sqrt{f'c}}$ db

λ= 1 fy=420Mpa f´c= 25Mpa ψe = 1

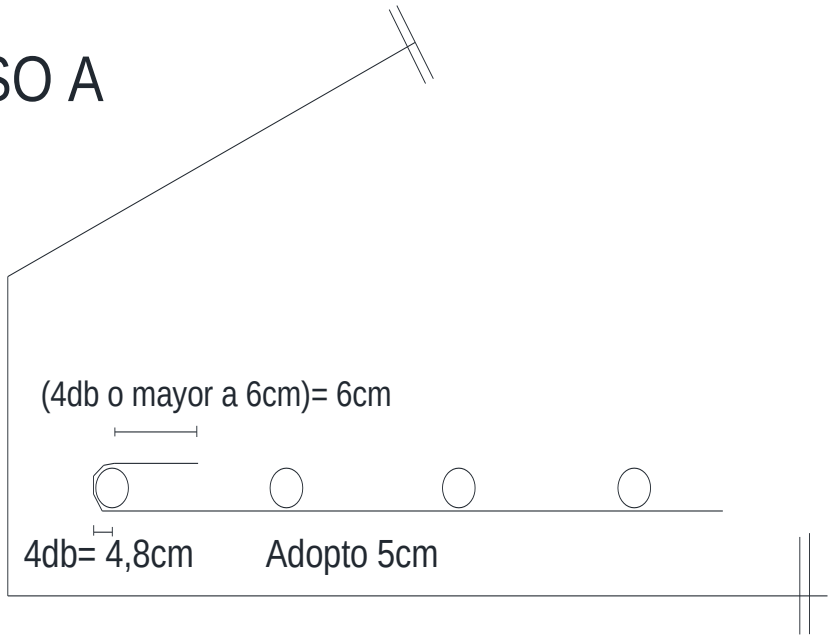
Ldh = 20,16 db

. Para zapata con doble excentricidad

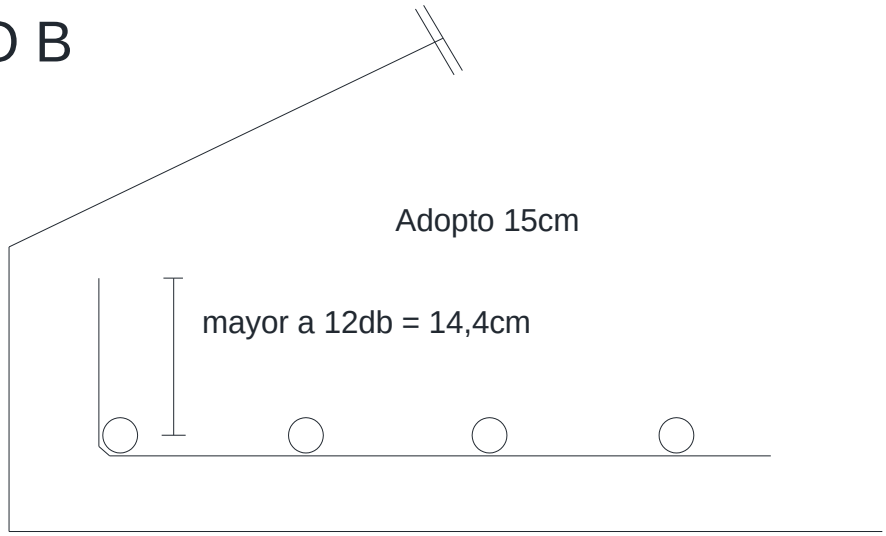
Ldh= 24,19cm con db=12mm

$$ldh \geq \begin{cases} 8db = 9,6cm \\ 150mm \end{cases}$$ **VERIFICA**

CASO A


(4db o mayor a 6cm)= 6cm
4db= 4,8cm
Adopto 5cm

CASO B


Adopto 15cm
mayor a 12db = 14,4cm

Para Zapata centrada: db= 12mm ldh = 20db = 24cm

Para Zapata con excentricidad: db=12mm - ldh = 20db = 24cm (eje x)

db= 16mm - ldh = 20db= 32cm (eje y)

Planilla Resumen de Losas H-25 ADN 420

Losa	Luz [m]		Dirección	Cargas [kN/m²]		Solicitaciones											
						R(izq)		R(der)		R(sup)		R(inf)		Mux Tramo	Mux Apoyo	Muy Tramo	Muy Apoyo
	x	y		D	L	D	L	D	L	D	L	D	L				
L01	5,4	3,37	Cruzada	5,22	2	2,53	0,99	4,39	1,71	6,63	2,58	6,63	2,58	0,73	-6,15	4,12	-8,83
L02	5,4	3,37	Cruzada	5,22	2	4,39	1,71	2,53	0,99	6,63	2,58	6,63	2,58	0,73	-6,15	4,12	-8,83
L03	5,4	3,37	Cruzada	5,22	2	3,21	2,14	5,58	1,23	7,67	2,94	4,43	1,7	1,52	-8,66	5,17	-11,8
L04	5,4	3,37	Cruzada	5,22	2	5,58	1,23	3,21	2,14	7,67	2,94	4,43	1,7	1,52	-8,66	5,17	-11,8
L05	-	1,3	Derecha	5,22	5	-	-	-	-	-	-	6,79	6,5	-	-	-	12,04
L011	1,78	-	Derecha	4,72	2	4,2	1,78	4,2	1,78	-	-	-	-	3,51	-	-	-
L012	1,43	-	Derecha	4,72	2	3,4	1,4	3,4	1,4	-	-	-	-	2,24	-	-	-
L214	1,78	-	Derecha	4,72	1	4,2	0,89	4,2	0,89	-	-	-	-	2,88	-	-	-
L215	1,9	-	Derecha	4,72	1	4,48	0,95	4,48	0,95	-	-	-	-	3,28	-	-	-
L216	1,5	-	Derecha	4,72	5	3,54	3,75	3,54	3,75	-	-	-	-	3,85	-	-	-
LEsc	3,53	-	Derecha	8,23	2	14,29	3,47	15,58	3,86	-	-	-	-	23,61	-	-	-

Planilla Resumen de Losas			H-25			ADN 420			C_c=2,5 cm
Losa	h [cm]	d [cm]	Armadura						Observaciones
			Arm. Pricipal			Arm. Secundaria/ de Rep.			
			cm² nec.	Ø	sep. [cm]	cm² nec.	Ø	sep. [cm]	
L01=L06	12	9	2,16	6	13	2,16	6	13	Se colocará armadura de esquina igual a la del tramo
L02=L07	12	9	2,16	6	13	2,16	6	13	
L03=L08	12	9	2,16	6	13	2,16	6	13	
L04=L09	12	9	2,16	6	13	2,16	6	13	
L05=L010	12	9	3,75	8	13	2,16	6	13	
Apoyo L01-L02/L06-L07	12	9	2,16	6	13	-	-	-	
Apoyo L01-L03/L06-L08	12	9	3,16	8	15	-	-	-	
Apoyo L02-L04/L07-L09	12	9	3,16	8	15	-	-	-	
Apoyo L03-L04/L08-L09	12	9	2,98	8	16,5	-	-	-	
L011	10	7	1,8	6	15	1,8	6	15	
L012=L013	10	7	1,8	6	15	1,8	6	15	
L214	10	7	1,8	6	15	1,8	6	15	
L215	10	7	1,8	6	15	1,8	6	15	
L216	10	7	1,8	6	15	1,8	6	15	
Lesc	19	16	3,98	8	12,5	3,42	8	14	

Planilla Resumen de Columnas **H-25** **ADN 420** **C_c=3 cm**

Columna	Tramo	Altura [m]	Cargas [kN]		Momentos		Dimensiones			Ast Nec. [cm²]	Ast Adoptado			Estribos d_{be}		Observaciones
			Servicio	Últimas	Mu [kNm]		hx [cm]	hx [cm]	Ag [cm²]		cant.	Ø	Ast	Ø	sep. [cm]	
			Pc	Pu	x	y										
C11	1º	3	60,1	79,96	-	-	20	20	400	4	4	12	4,52	6	14	IDEM C13=C116=C118
C01	P.B.	3,5	145,48	190,26	-	-	30	30	900	9	8	12	9,05	6	14	IDEM C03=C016=C018
C12	1º	3	188,3	252,12	-	-	20	20	400	4	4	12	4,52	6	14	IDEM C117
C02	P.B.	3,5	432,08	570,82			30	30	900	9	8	12	9,05	6	14	IDEM C017
C15	1º	3	218,36	283,46	-	-	20	20	400	4	4	12	4,52	6	14	IDEM C114
C05	P.B.	3,5	510,74	655,74	-	-	30	30	900	9	8	12	9,05	6	14	IDEM C014
C14	1º	3	71,4	92,04	-	-	20	20	400							IDEM C16=C113=C115
C04	P.B.	3,5	187,08	237,22	-	-	30	30	900							IDEM C06=C013=C015
C17	1º	3	31,2	40,12	-	-	20	20	400							IDEM C19=C110=C112
C07	P.B.	3,5	88,58	110,94	-	-	30	30	900							IDEM C09=C010=C012
C18	1º	3	121,6	156,36	-	-	20	20	400							IDEM C111
C08	P.B.	3,5	298,68	379,3	-	-	30	30	900							IDEM C011