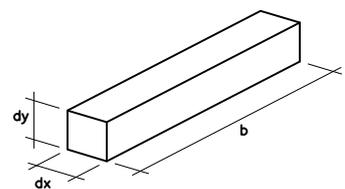
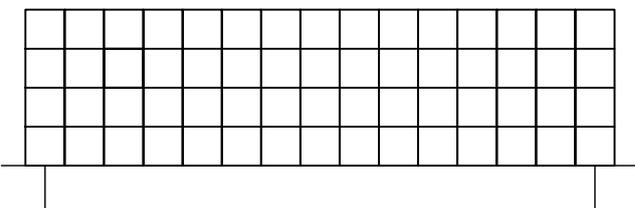
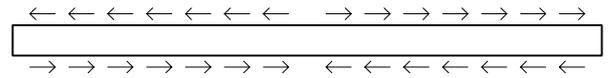
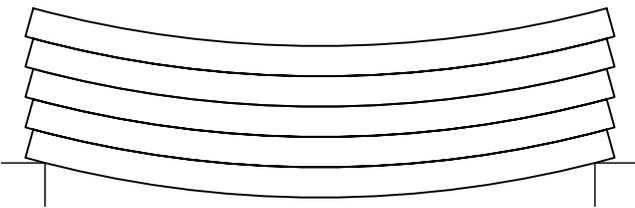
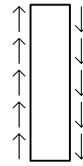
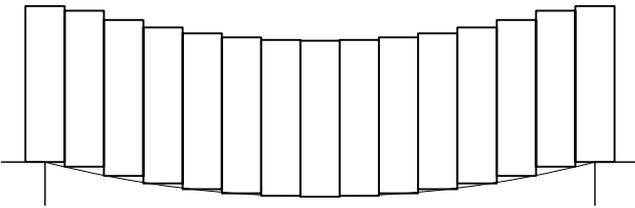
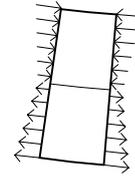
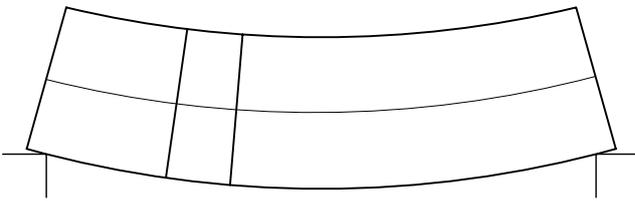
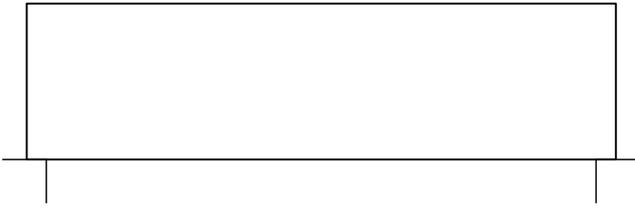
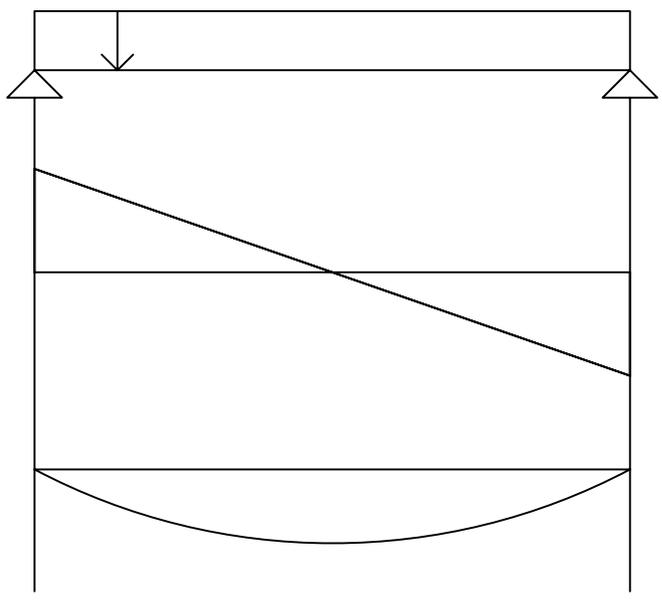


FLEXION EN BARRAS

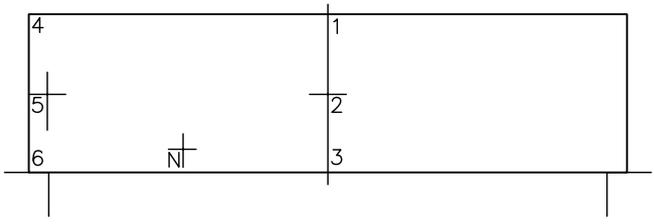


MODELO DE CALCULO

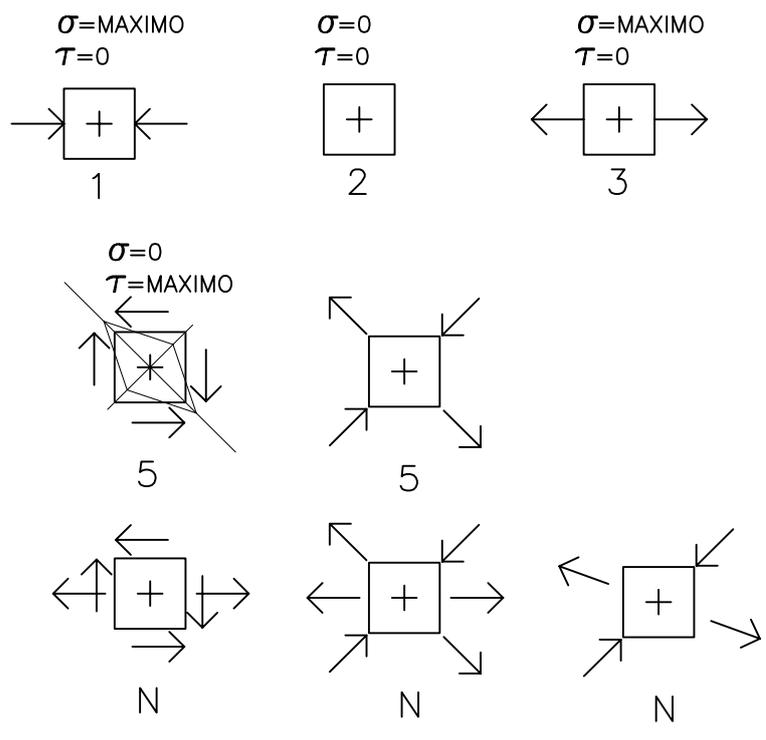


CORTANTE

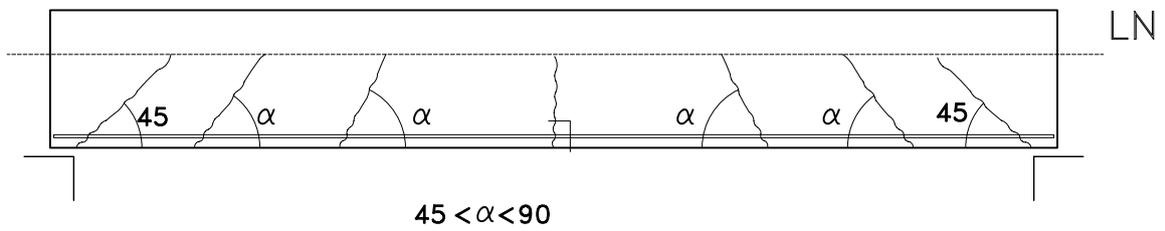
FLECTOR



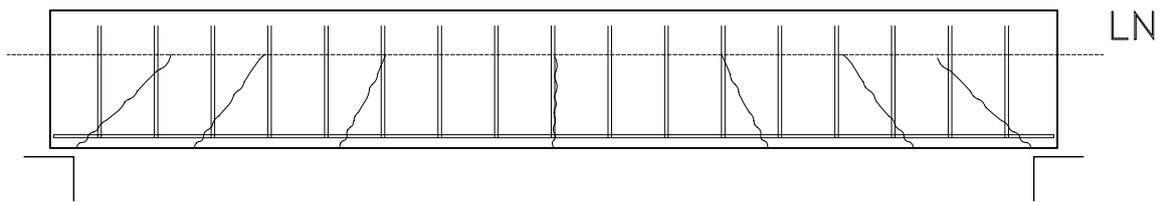
TENSIONES

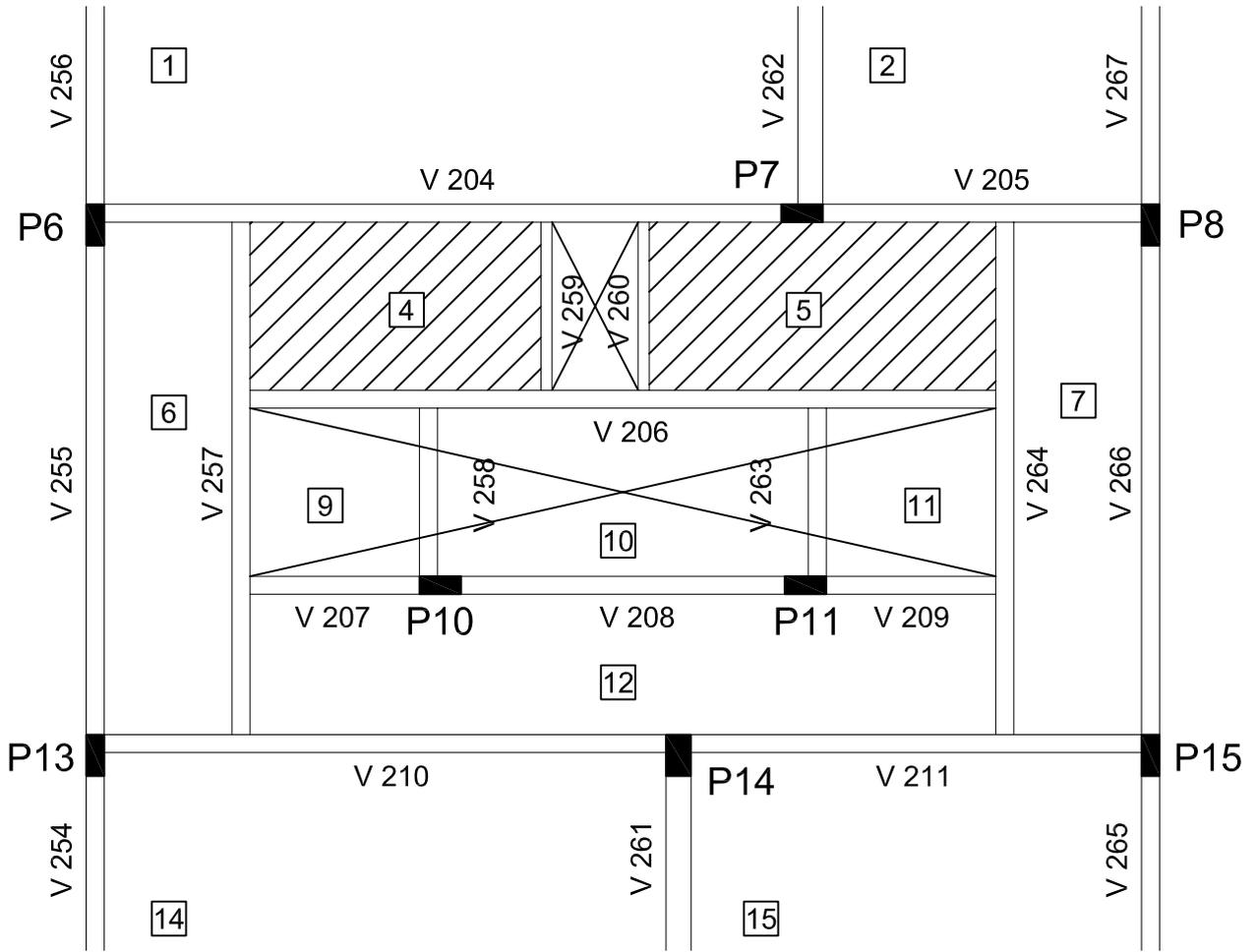


FISURACION PRODUCIDA POR LA FLEXION (FLECTOR + CORTANTE)

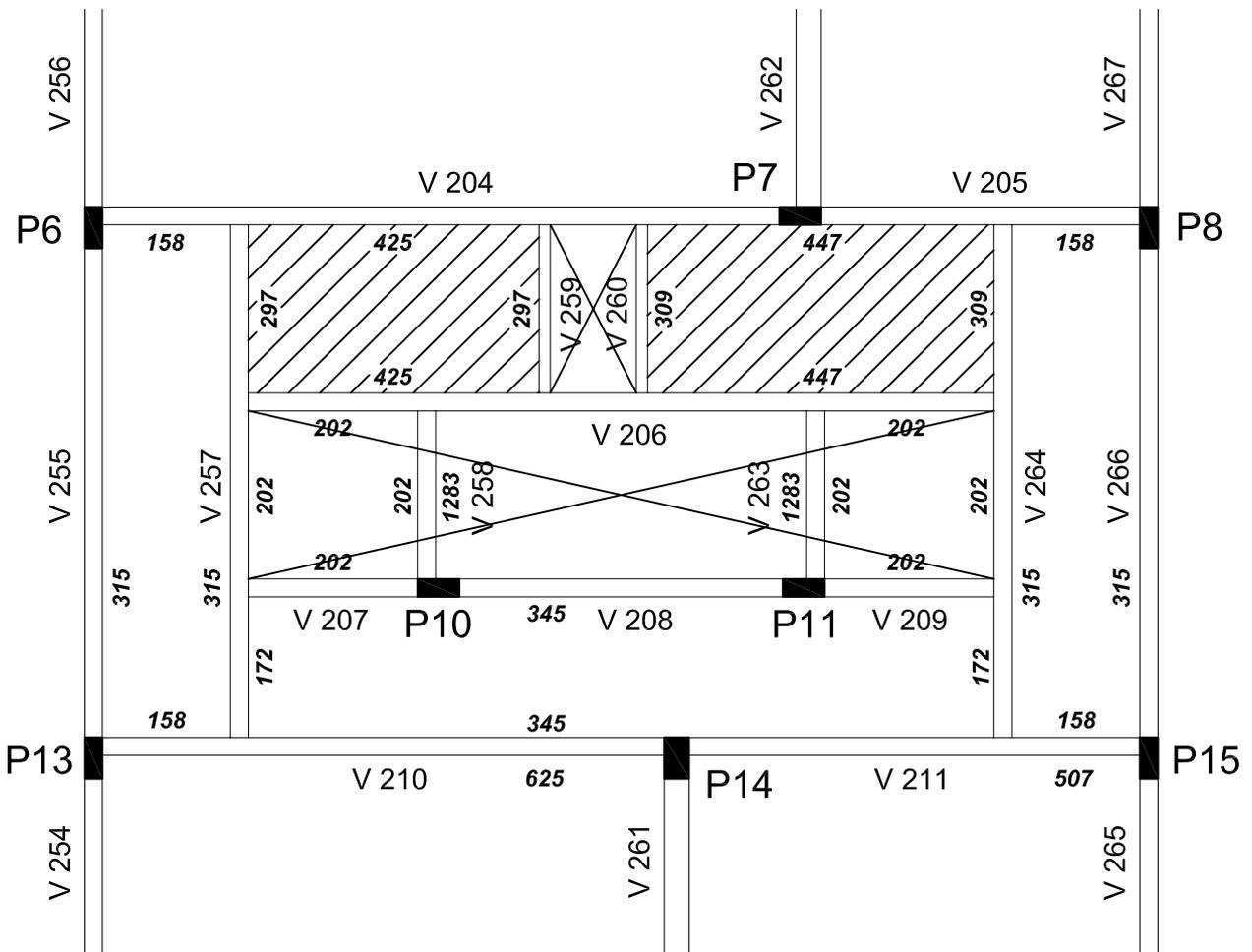


MATERIALIZACION





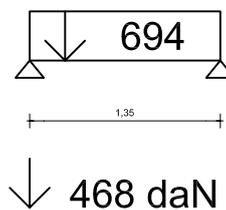
	Ly	Lx	ϵ	p	K	r1-r3	r2-r4	p1-3 TOTAL (daN)	p2-4 TOTAL (daN)	p1-3 (daN/m)	p2-4 (daN/m)
4	1,35	2,20	0,61	900	2673	0.350	0.150	936	401	425	297
5	1,35	2,60	0,52	900	3159	0.368	0.132	1163	417	447	309
6	3,85	1,05	3,67	600	-----	-----	-----	-----	-----	158	315
7	3,85	1,05	3,67	600	-----	-----	-----	-----	-----	158	315
9	1,35	1,35	1,00	600	1093	0.250	0.250	273	273	202	202
10	-----	2,85	-----	900	-----	-----	-----	-----	-----	-----	1283
11	1,35	1,35	1,00	600	1093	0.250	0.250	273	273	202	202
12	1,15	5,55	0,21	600	-----	-----	-----	-----	-----	345	172
14	4,80	4,20	1,14	600	12096	0.217	0.283	2625	3423	625	714
15	4,80	3,40	1,41	600	9792	0.179	0.321	1723	3143	507	655



V.259 (10x30)

pp
losa 4
muro

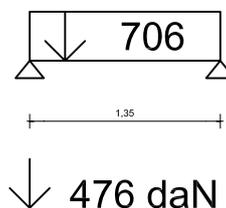
$$\begin{array}{r}
 75 \text{ daNm} \\
 297 \text{ daNm} \\
 \hline
 140 \times 2,3 \text{ daNm} \\
 694 \text{ daNm}
 \end{array}$$



V.260 (10x30)

pp
losa 5
muro

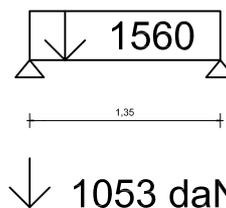
$$\begin{array}{r}
 75 \text{ daNm} \\
 309 \text{ daNm} \\
 \hline
 140 \times 2,3 \text{ daNm} \\
 706 \text{ daNm}
 \end{array}$$



V.258=V.263 (15x20)

pp
losa 9(11)
losa 10

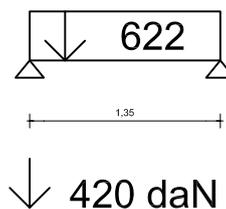
$$\begin{array}{r}
 75 \text{ daNm} \\
 202 \text{ daNm} \\
 \hline
 1283 \text{ daNm} \\
 1560 \text{ daNm}
 \end{array}$$



V.207=V.209 (15x20)

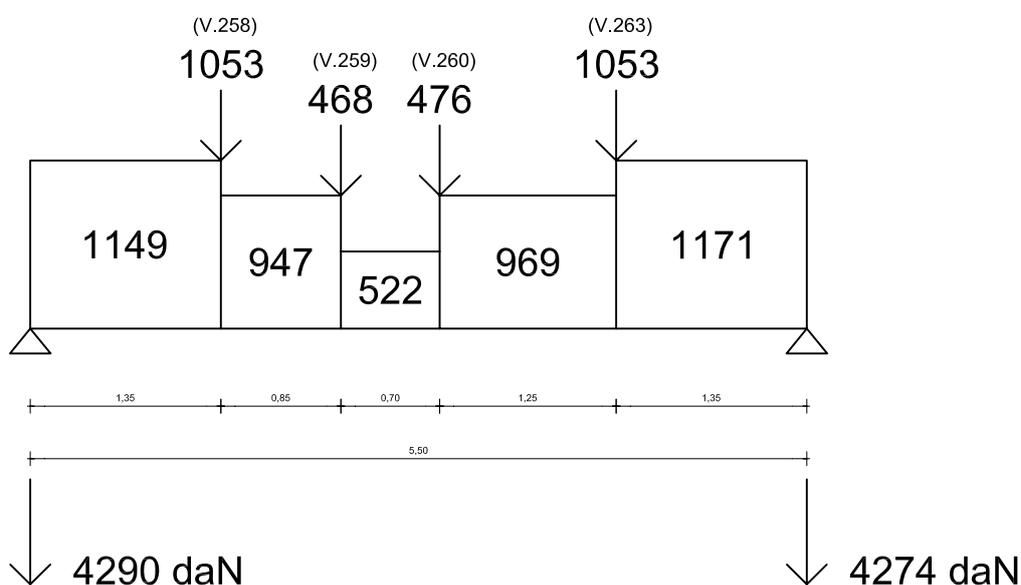
pp
losa 9(11)
losa 12

$$\begin{array}{r}
 75 \text{ daNm} \\
 202 \text{ daNm} \\
 \hline
 345 \text{ daNm} \\
 622 \text{ daNm}
 \end{array}$$



V.206 (13x45)

①	pp	146 daNm
	losa 4	425 daNm
	losa 9	202 daNm
	muro	<u>175x2,15 daNm</u>
		1149 daNm
②	pp	146 daNm
	losa 4	425 daNm
	muro	<u>175x2,15 daNm</u>
		947 daNm
③	pp	146 daNm
	muro	<u>175x2,15 daNm</u>
		522 daNm
④	pp	146 daNm
	losa 5	447 daNm
	muro	<u>175x2,15 daNm</u>
		969 daNm
⑤	pp	146 daNm
	losa 5	447 daNm
	losa 11	202 daNm
	muro	<u>175x2,15 daNm</u>
		1171 daNm

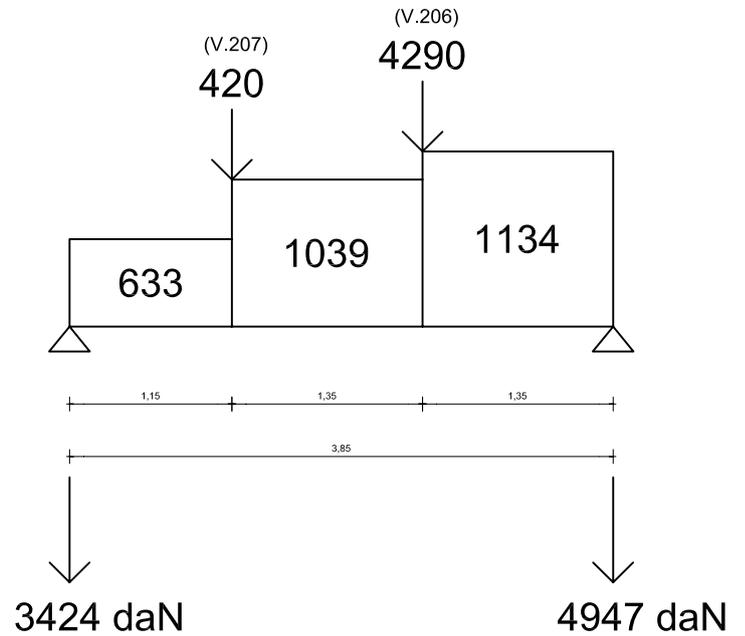


V.257 (13x45)

①	pp	146 daNm
	losa 6	315 daNm
	losa 12	<u>172 daNm</u>
		633 daNm

②	pp	146 daNm
	losa 6	315 daNm
	losa 9	202 daNm
	muro	<u>175x2,15 daNm</u>
		1039 daNm

③	pp	146 daNm
	losa 4	297 daNm
	losa 6	315 daNm
	muro	<u>175x2,15 daNm</u>
		1134 daNm

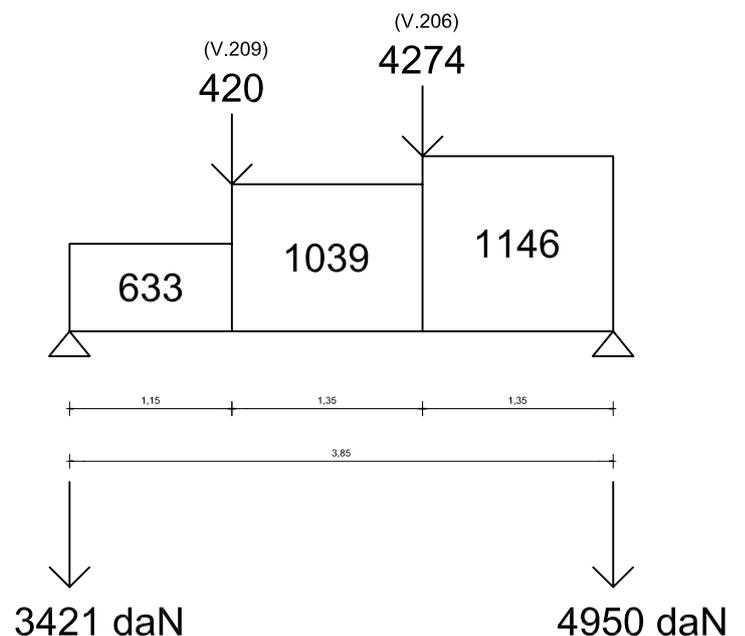


V.264 (13x45)

①	pp	146 daNm
	losa 7	315 daNm
	losa 12	<u>172 daNm</u>
		633 daNm

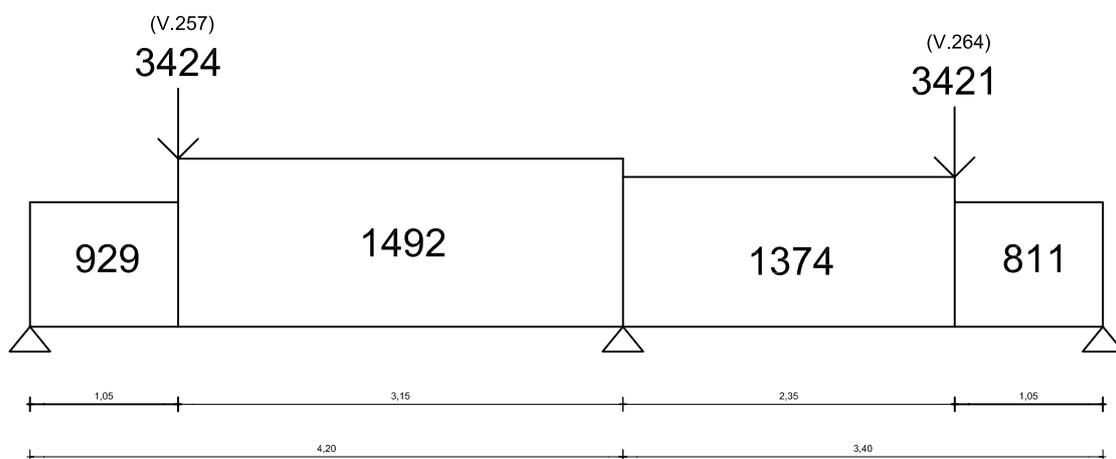
②	pp	146 daNm
	losa 7	315 daNm
	losa 11	202 daNm
	muro	<u>175x2,15 daNm</u>
		1039 daNm

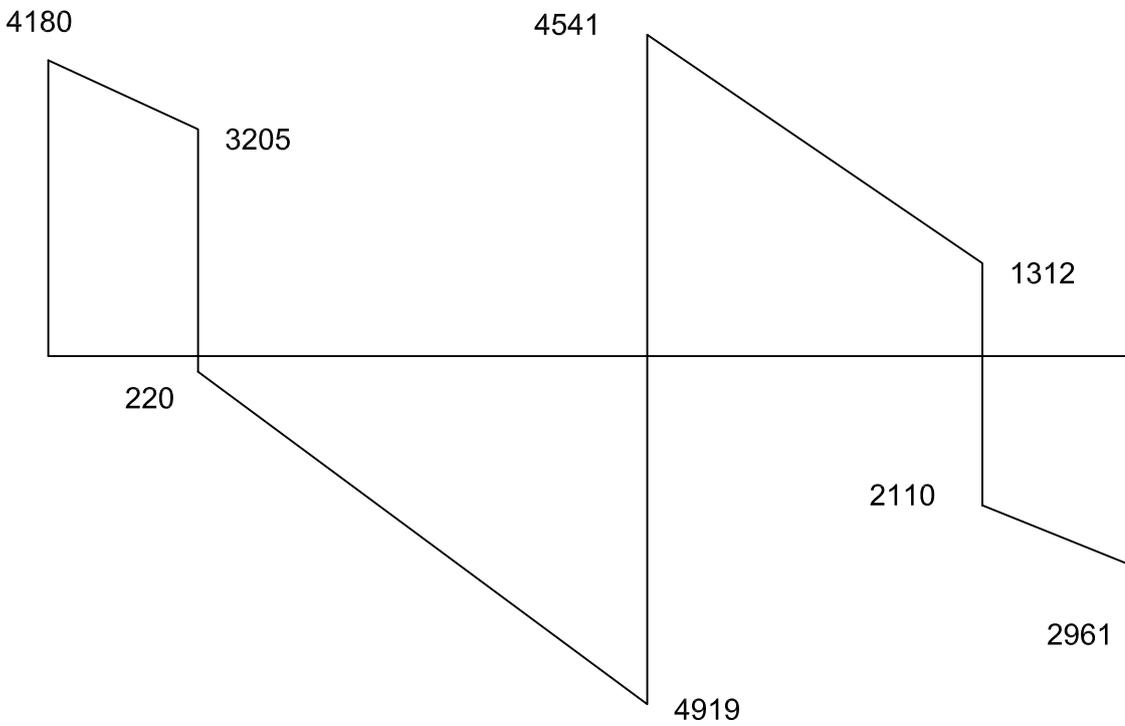
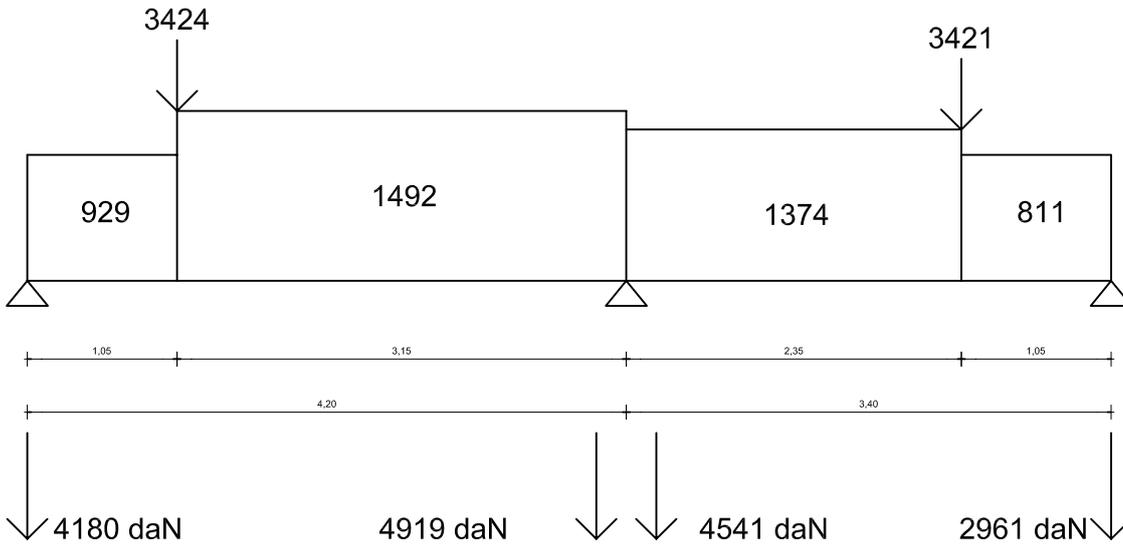
③	pp	146 daNm
	losa 5	309 daNm
	losa 7	315 daNm
	muro	<u>175x2,15 daNm</u>
		1146 daNm



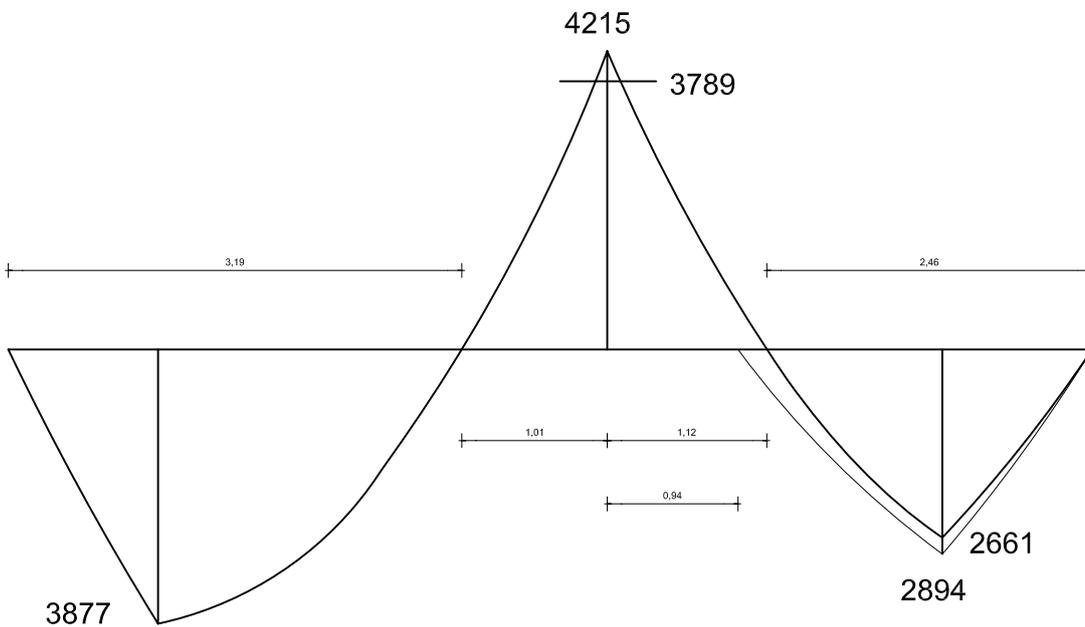
V.210-211 (13x45)

①	pp	146 daNm
	losa 6	158 daNm
	losa 14	<u>625 daNm</u>
		929 daNm
②	pp	146 daNm
	losa 12	345 daNm
	losa 14	625 daNm
	muro	<u>175x2,15 daNm</u>
		1492 daNm
③	pp	146 daNm
	losa 12	345 daNm
	losa 15	507 daNm
	muro	<u>175x2,15 daNm</u>
		1374 daNm
④	pp	146 daNm
	losa 7	158 daNm
	losa 15	<u>507 daNm</u>
		811 daNm

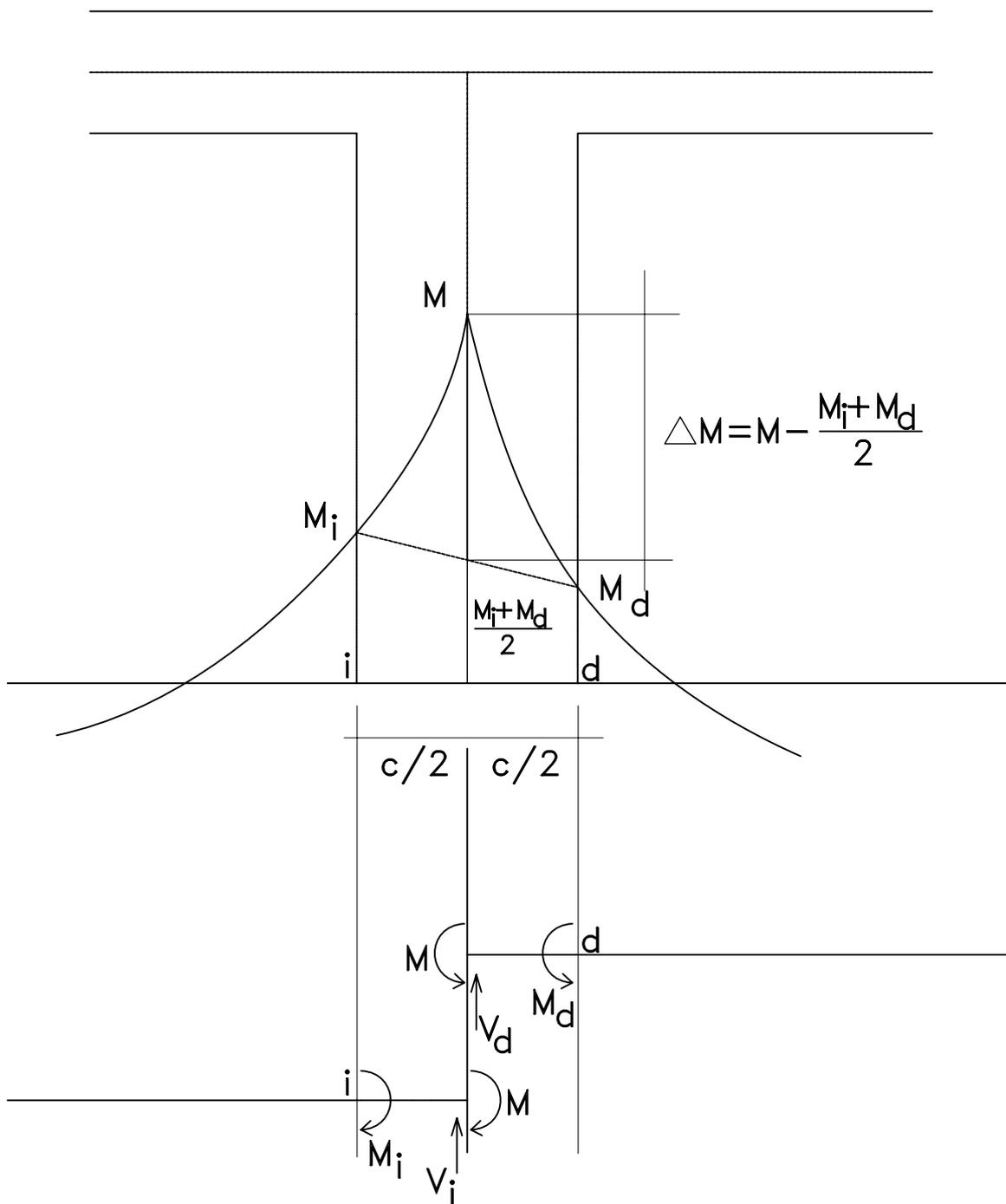




V



M



$$M_d = M - V_d \cdot c/2$$

$$M_i = M - V_i \cdot c/2$$

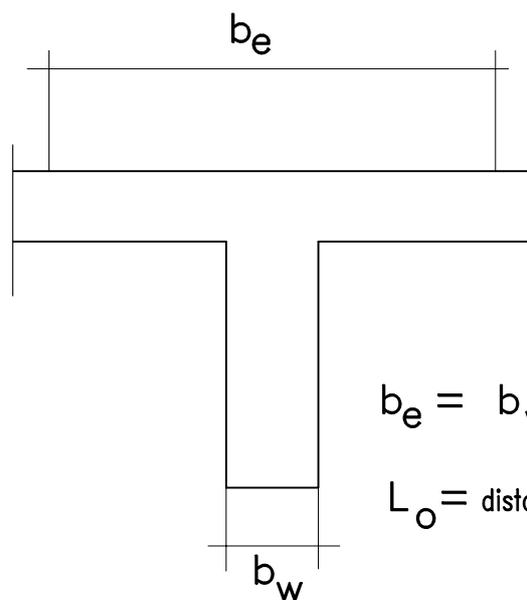
$$M_d + M_i = 2M - V_d \cdot c/2 - V_i \cdot c/2$$

$$M_d + M_i = 2M - c/2(V_d + V_i)$$

$$\frac{M_d + M_i}{2} = M - c/4(V_d + V_i)$$

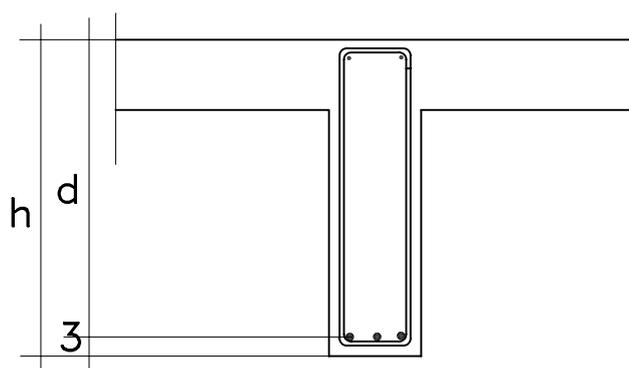
$$M - \frac{M_d + M_i}{2} = c/4(V_d + V_i)$$

$$\Delta M = c/4(V_d + V_i)$$

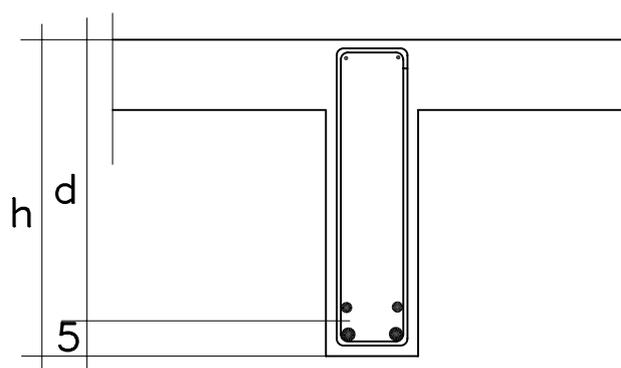


$$b_e = b_w + 2L_o/10$$

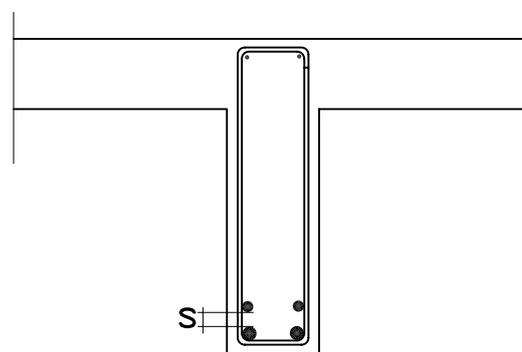
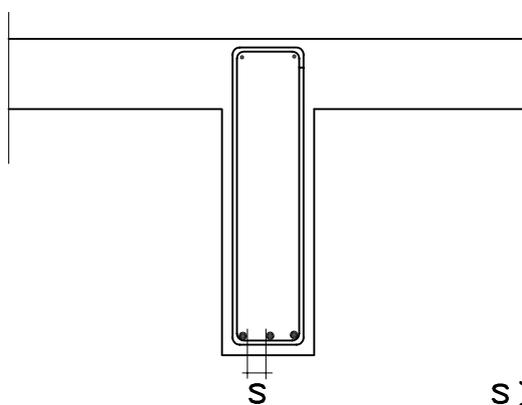
L_o = distancia entre puntos de momento nulo del tramo de viga



armadura en una capa

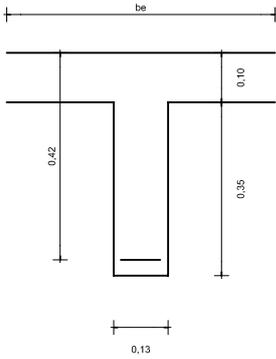
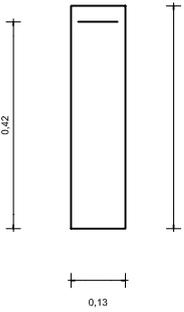
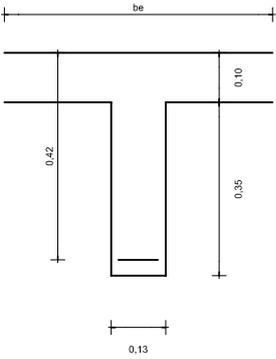


armadura en dos capas

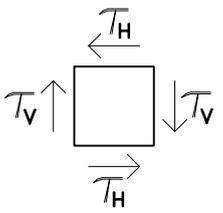
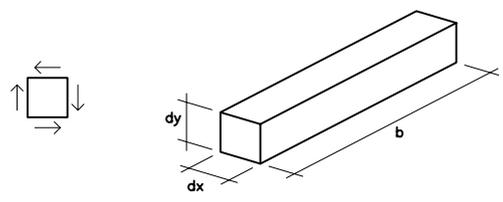
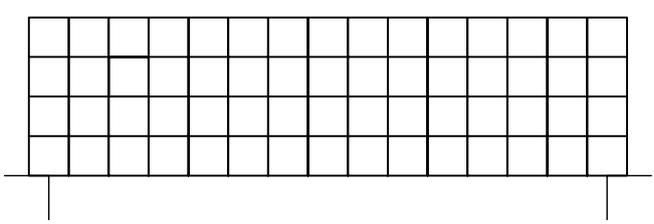
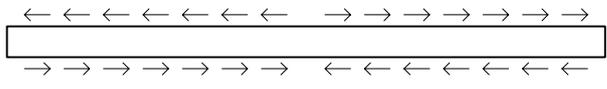
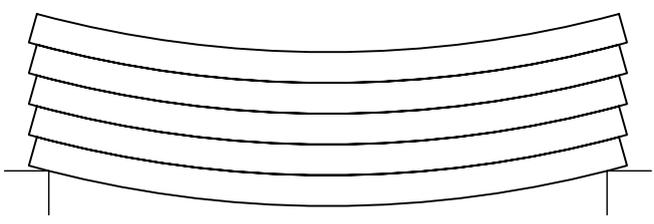
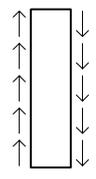
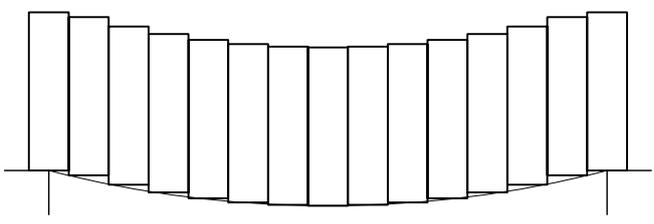


$$s \geq \emptyset \quad s \leq 2\text{cm}$$

DIMENSIONADO

	V.210	APOYO	V.211
Sección			
M (daNm)	3877	3789	2894
Md (daNm)	6203	6062	4630
Lo (cm)	319	-----	246
bw (cm)	13	13	13
be (cm)	77	13	62
e/d	$0,24 \approx 0,25$	-----	$0,24 \approx 0,25$
be/bw	$77/13 = 5,9$	1	$62/13 = 4,8$
μ_d	0,05	0,264	0,04
ω	0,053	0,323	0,042
As nec.	4,70 cm ²	4,83 cm ²	3,00 cm ²

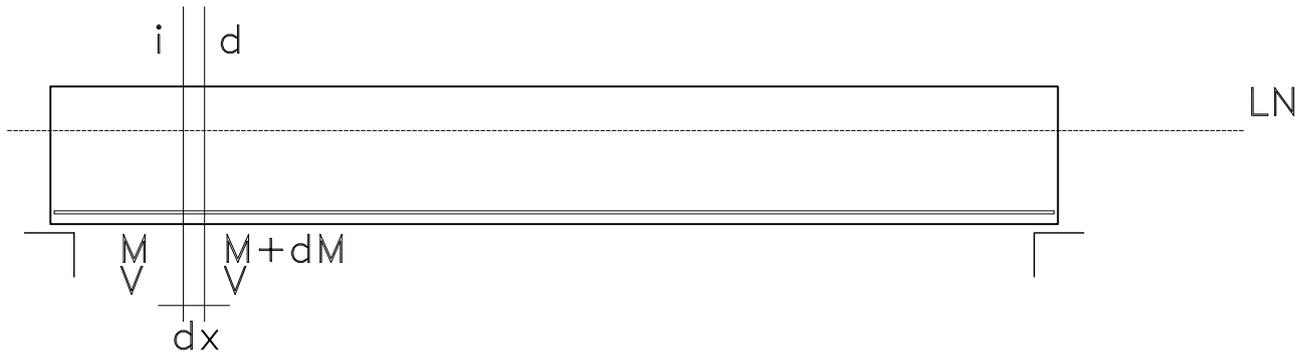
ESTUDIO DE LAS TENSIONES PRODUCIDAS POR EL CORTANTE EN BARRAS DE HORMIGON ARMADO



HORIZONTALES = $\tau_H \cdot b \cdot dx$
 VERTICALES = $\tau_V \cdot b \cdot dy$

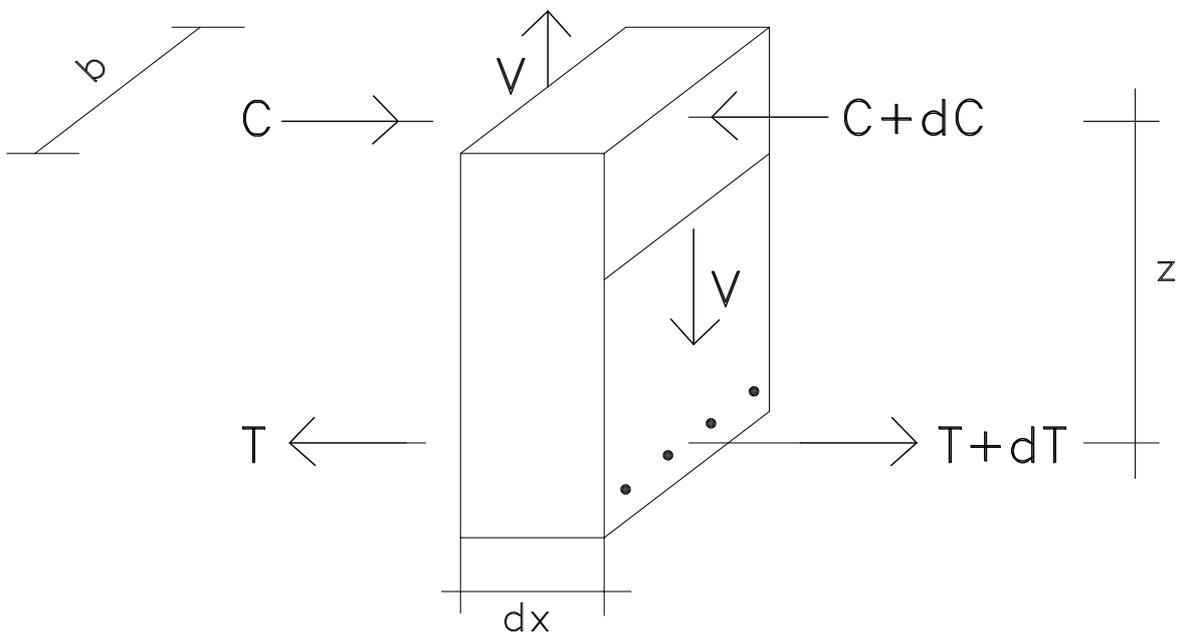
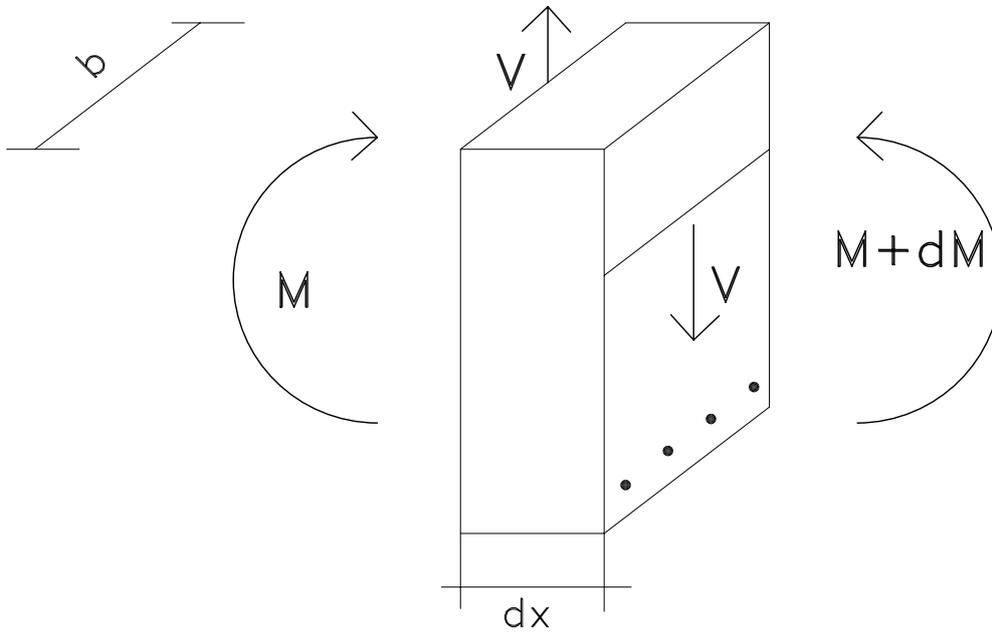
$$\tau_H \cdot b \cdot dx \cdot dy = \tau_V \cdot b \cdot dy \cdot dx$$

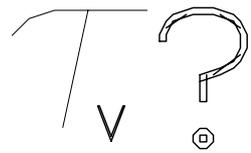
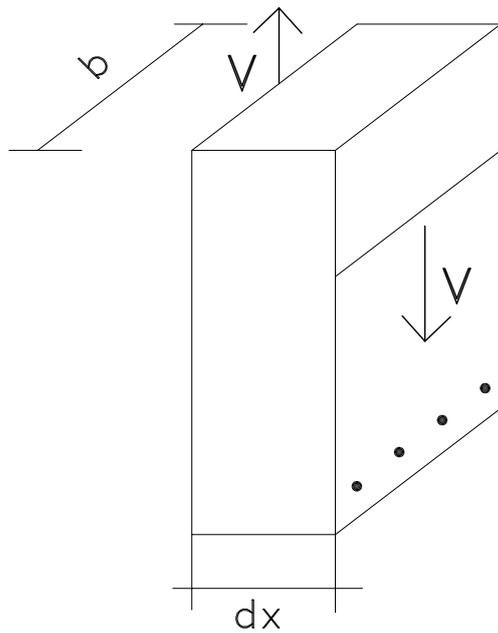
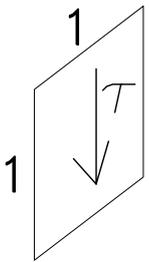
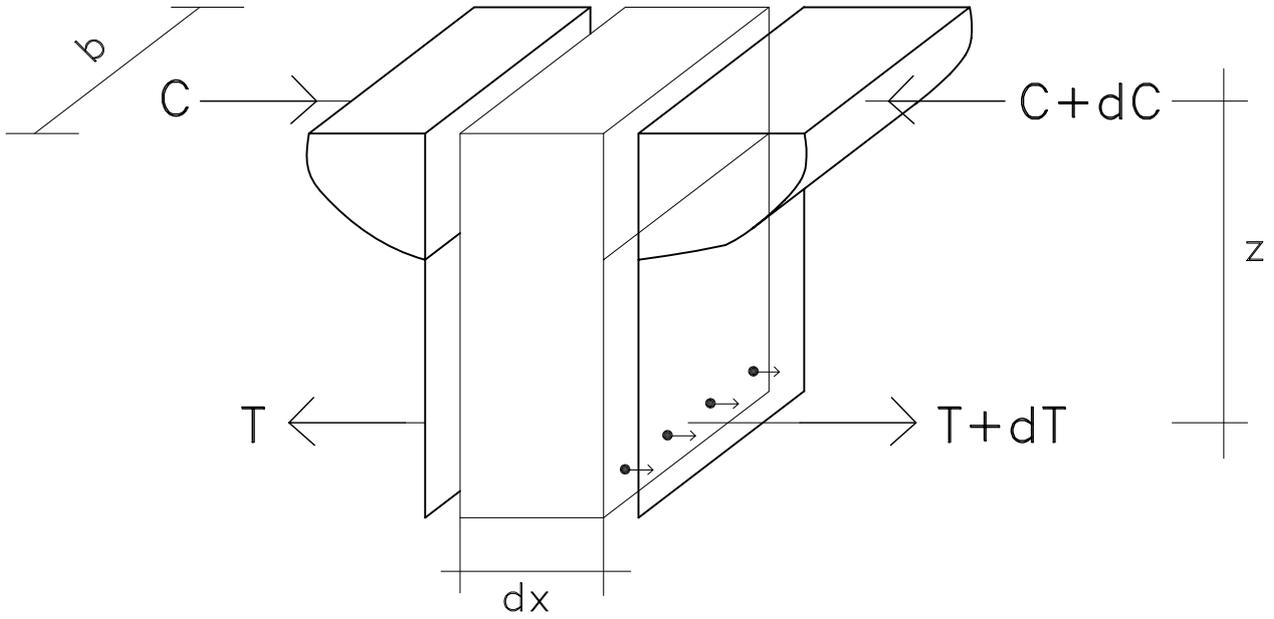
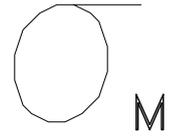
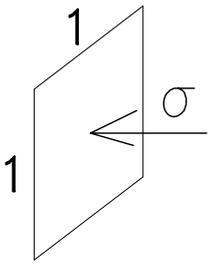
$$\tau_H = \tau_V = \tau$$



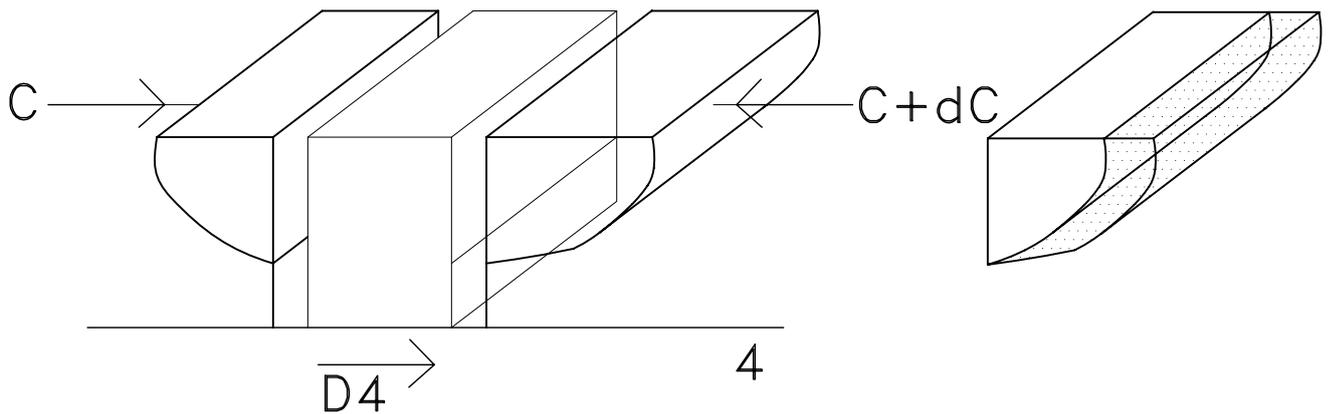
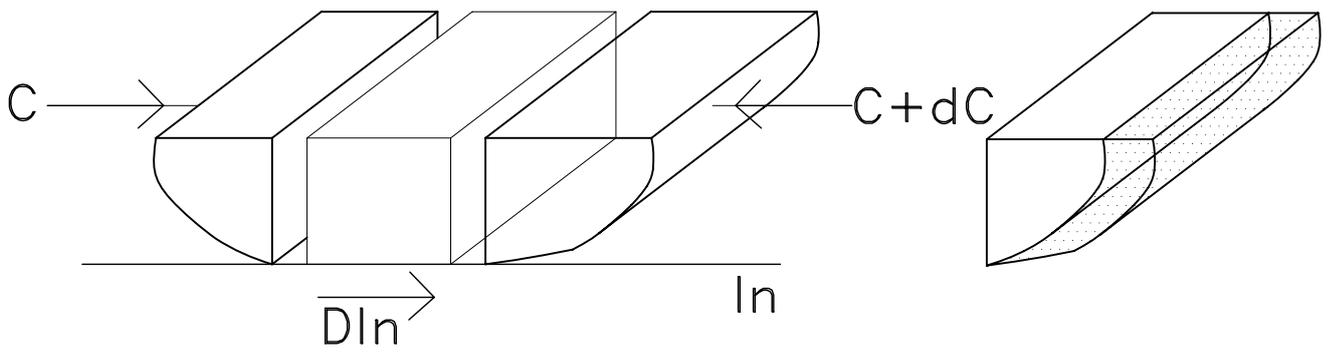
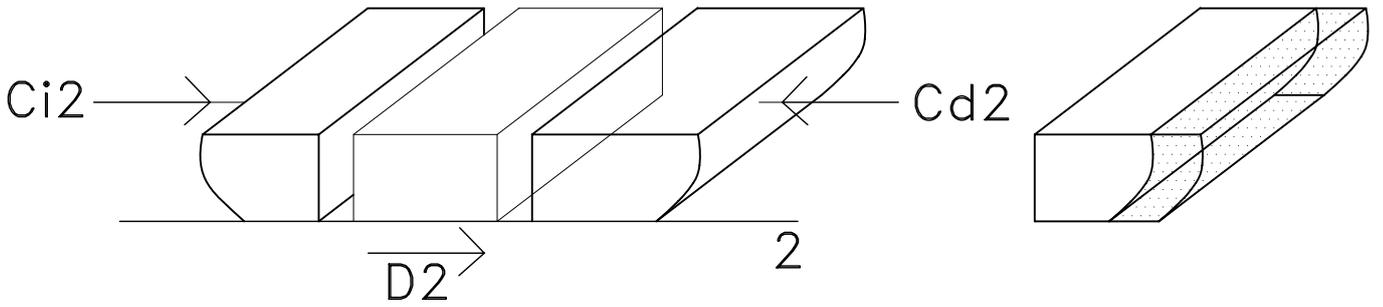
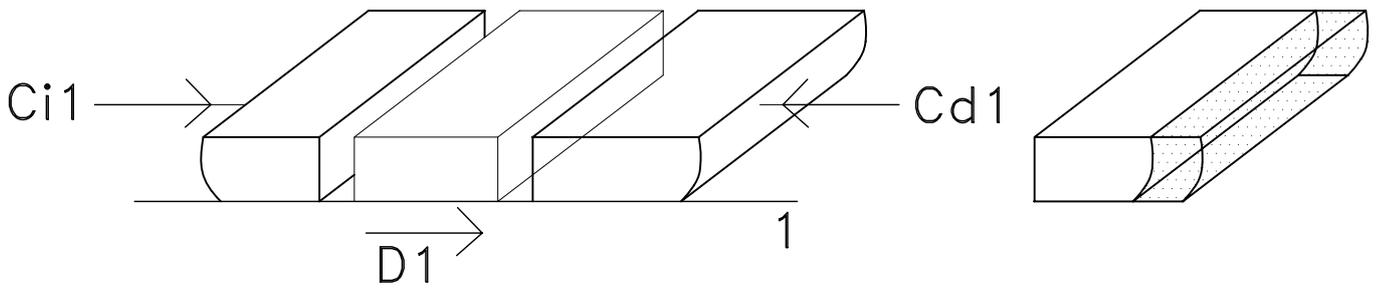
$$M+dM = M+V \cdot dx$$

$$dM = V \cdot dx$$



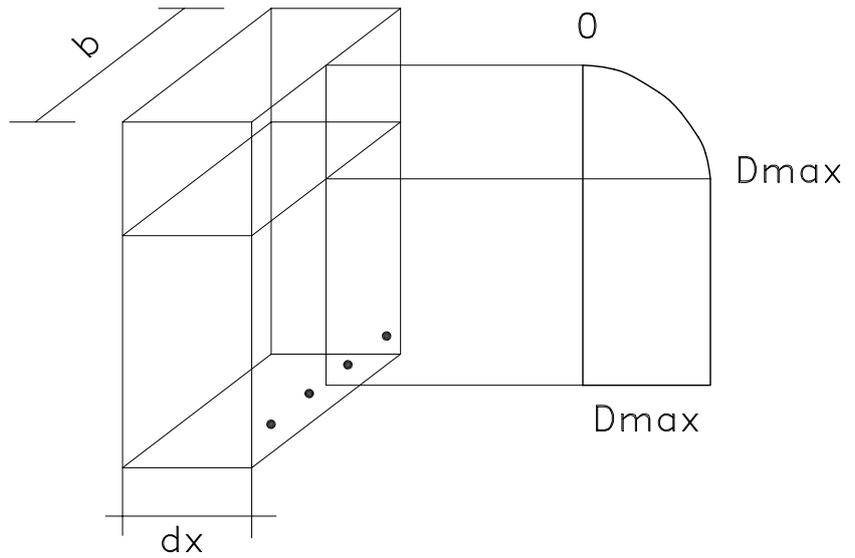


z

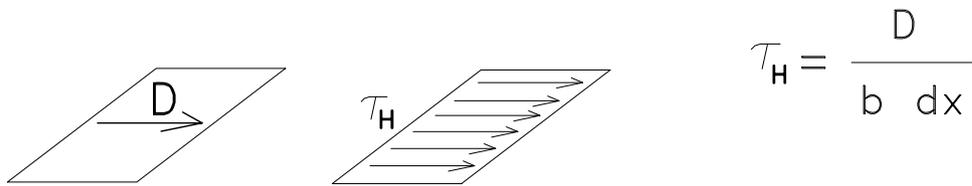


$D1 < D2 < DIn$ $D4 = DIn$ $DIn = dC$

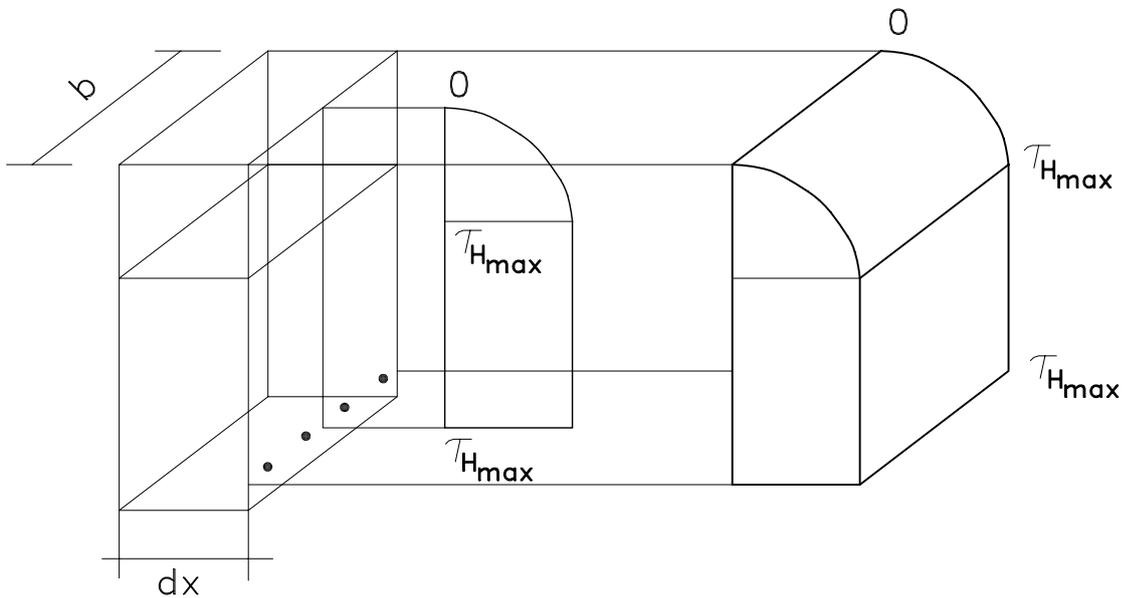
DIAGRAMA DE LA FUERZA D



LA FUERZA D PRODUCE TENSIONES UNIFORMES τ_H



$$\tau_H = \frac{D}{b \cdot dx}$$



$$M = Cz$$

$$M + dM = (C + dC)z$$

$$M + dM = Cz + dCz$$

$$dM = dC \cdot z$$

$$dC = \frac{dM}{z}$$

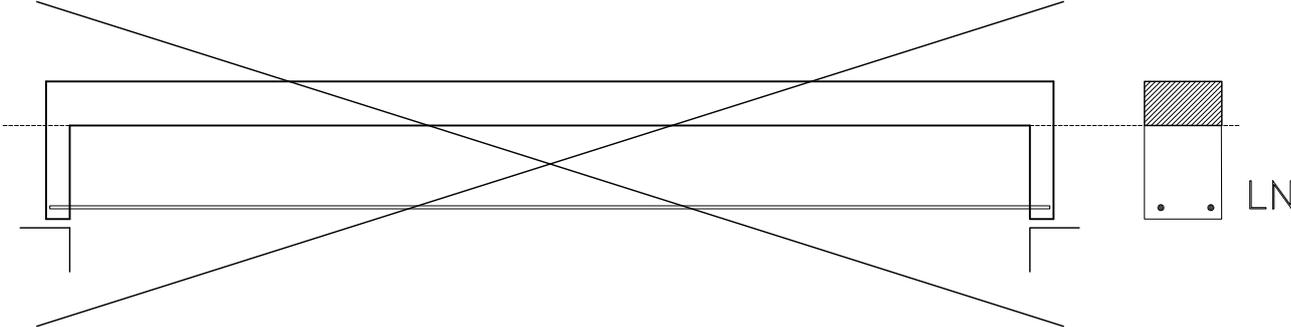
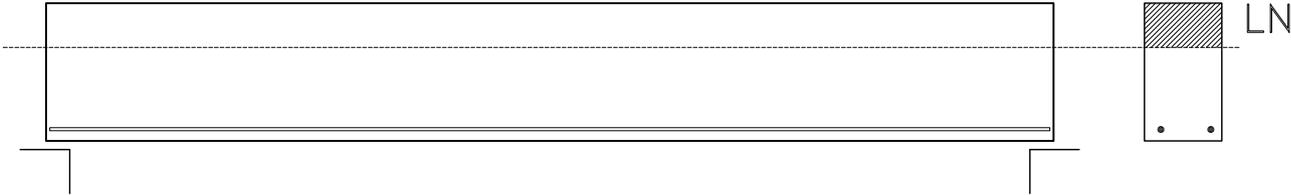
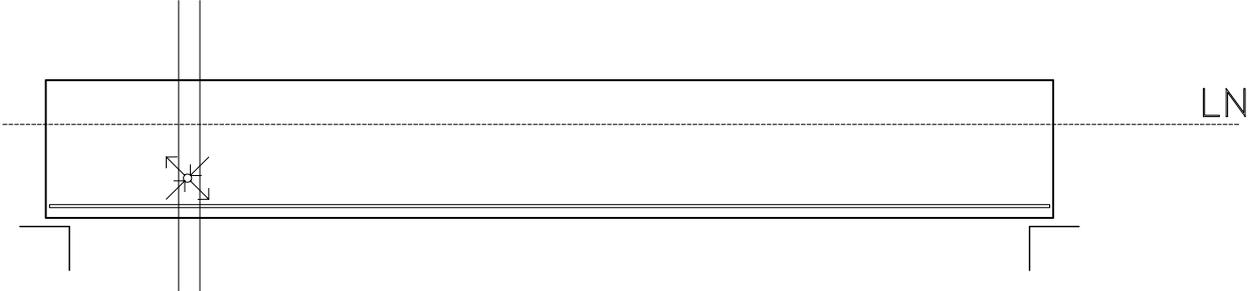
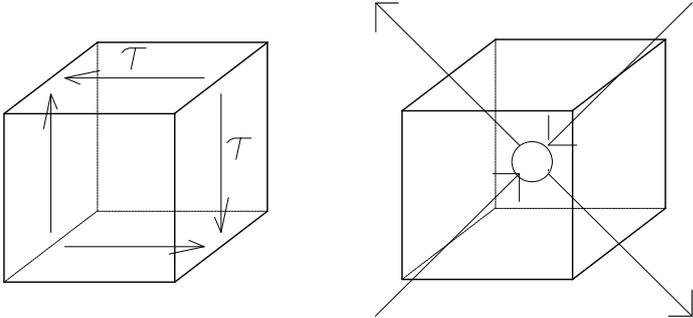
$$dM = V \cdot dx$$

$$dC = \frac{V \cdot dx}{z}$$

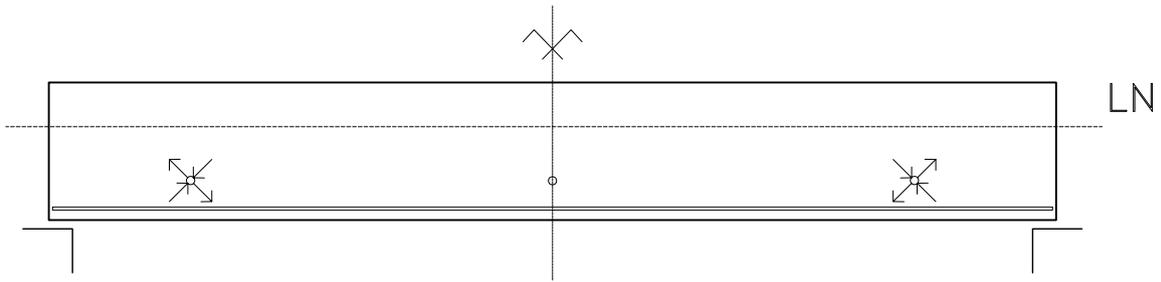
$$\tau_{Hmax} = \frac{D_{max}}{b \cdot dx} = \frac{dC}{b \cdot dx} = \frac{V \cdot dx}{b \cdot dx \cdot z} = \frac{V}{b \cdot z}$$

$$\tau_H = \tau_V = \tau$$

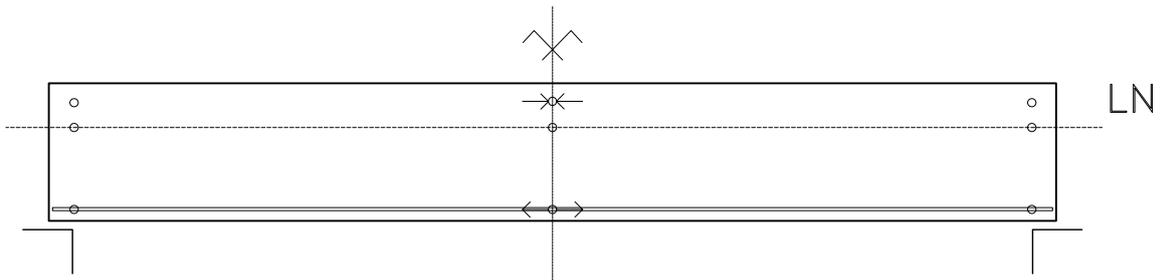
$$\tau_{\max} = \frac{V}{b.z}$$



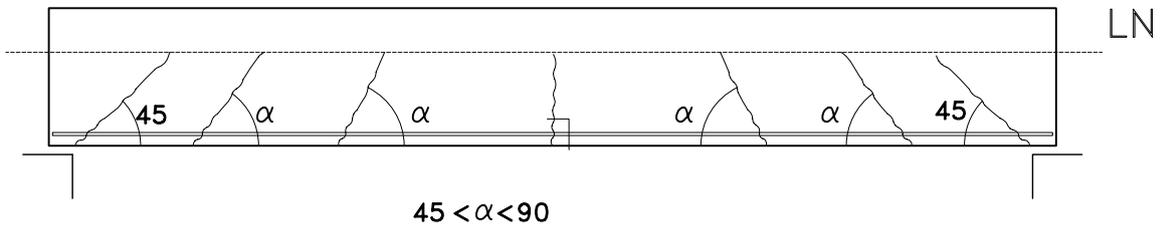
RESUMEN DE TENSIONES PRODUCIDAS POR EL CORTANTE



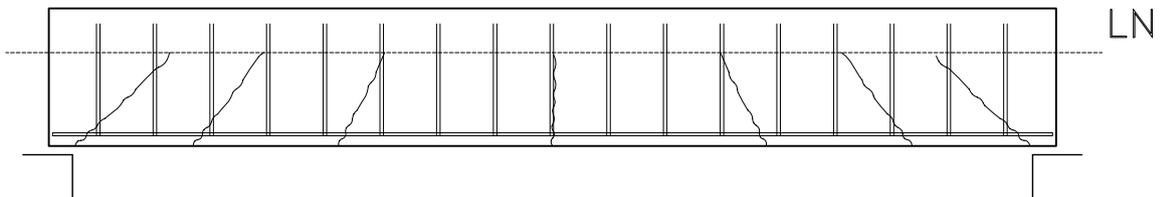
RESUMEN DE TENSIONES PRODUCIDAS POR EL FLECTOR



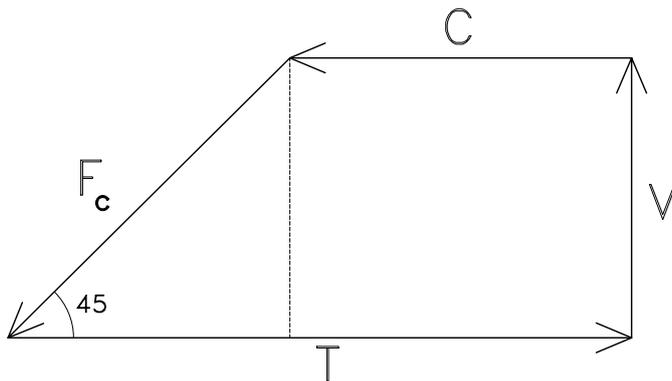
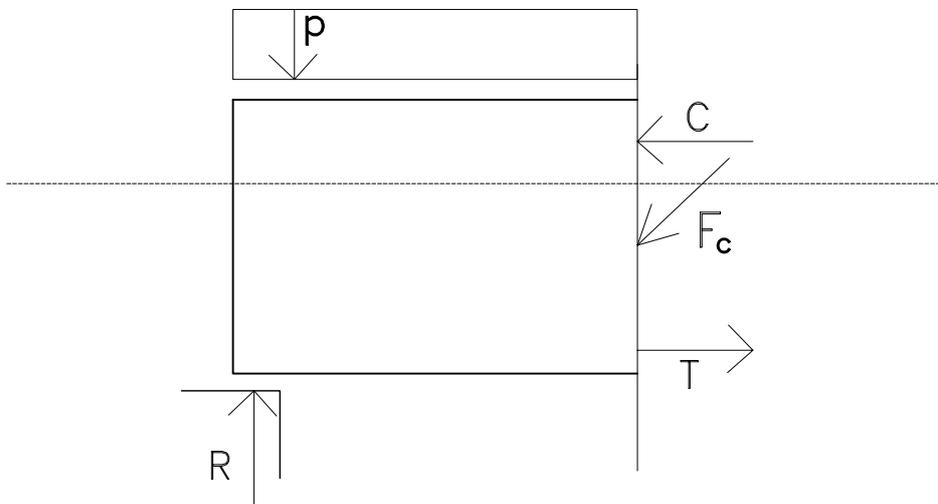
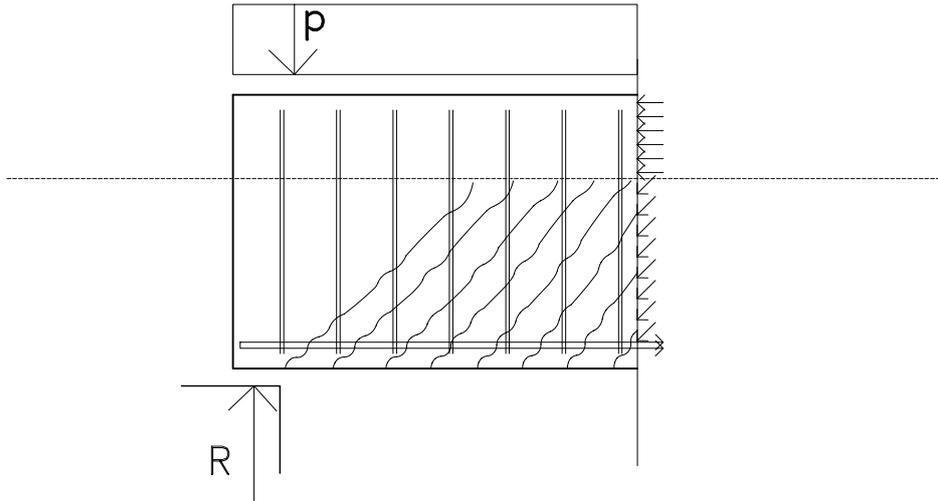
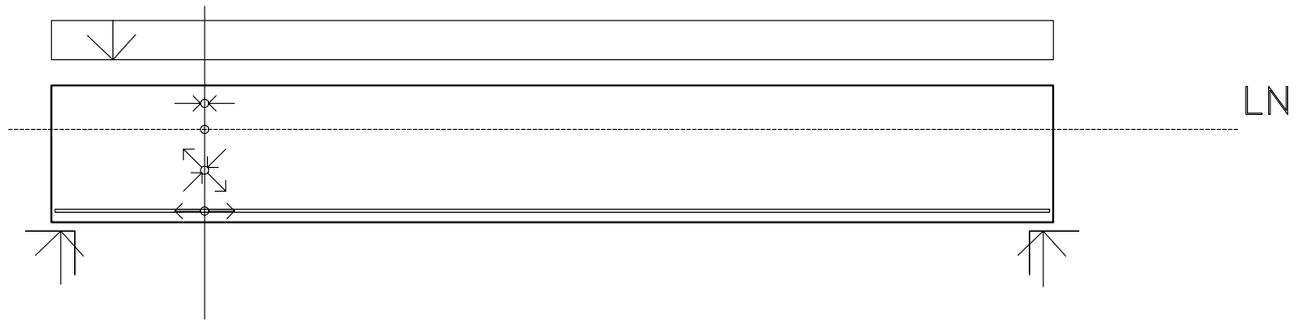
FISURACION PRODUCIDA POR LA FLEXION (FLECTOR + CORTANTE)

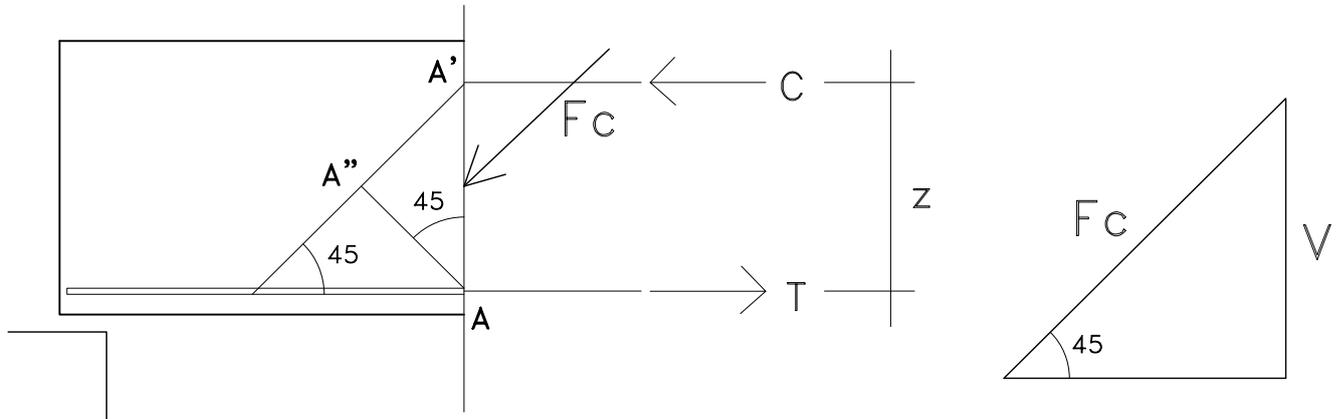


MATERIALIZACION

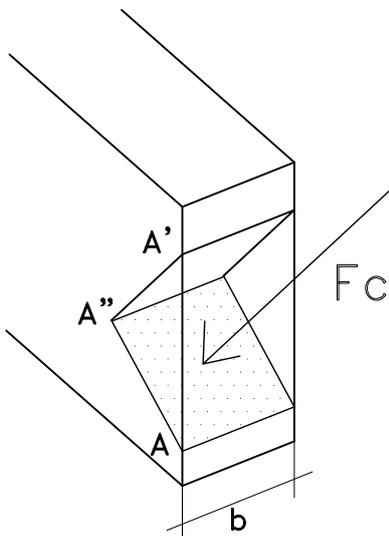


A.- VERIFICAR LA COMPRESION EN EL HORMIGON





TENSION DE COMPRESION = $\frac{\text{FUERZA DE COMPRESION}}{\text{AREA NORMAL}}$



$$AA'' = \frac{AA'}{\sqrt{2}} = \frac{z}{\sqrt{2}}$$

$$F_c = V\sqrt{2}$$

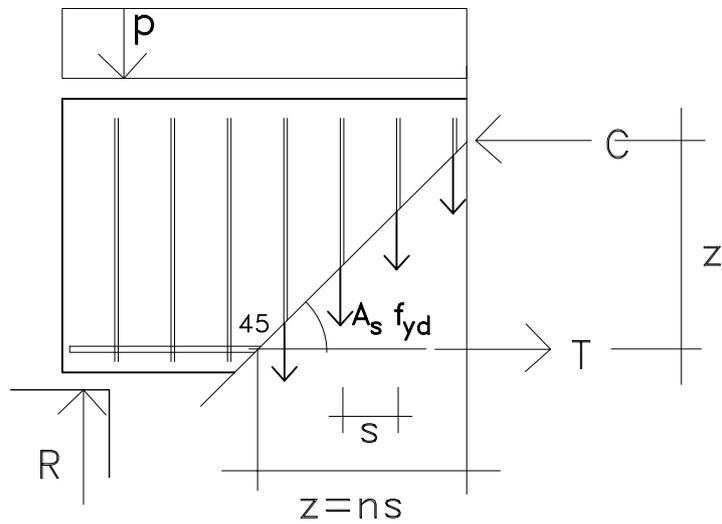
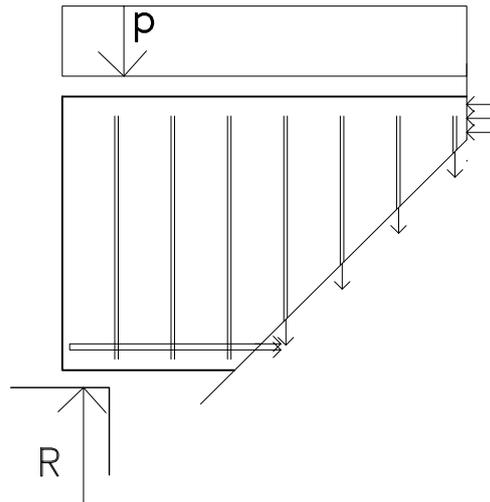
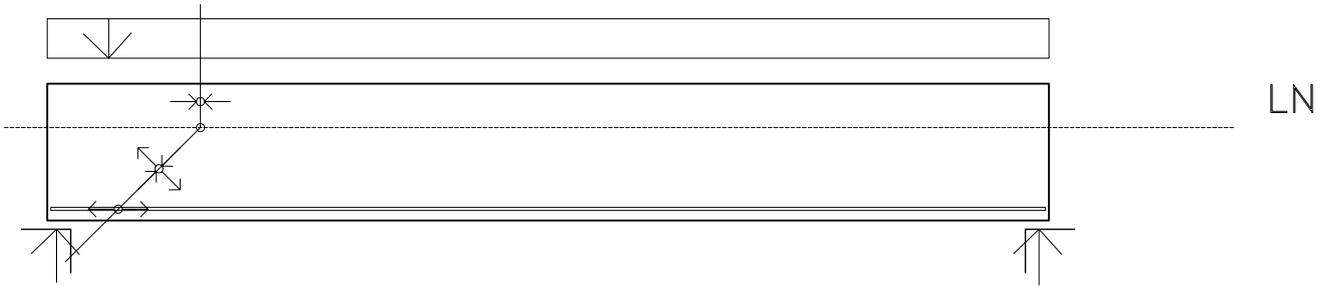
$$\sigma_c = \frac{F_c}{b \cdot AA''} = \frac{F_c}{b \cdot \frac{z}{\sqrt{2}}} = \frac{V\sqrt{2}}{b \cdot \frac{z}{\sqrt{2}}} = \frac{V\sqrt{2}\sqrt{2}}{b z}$$

$$\sigma_c = \frac{2V}{b z} \leq 0,6f_{cd}$$

$$V \leq \frac{0,6f_{cd} b z}{2} \quad z=0,9d$$

$$V \leq 0,27bdf_{cd}$$

B.- DETERMINAR LAS ARMADURAS TRANSVERSALES



$$V = n A_s f_{yd}$$

$$n = z/s \quad z = 0,9d$$

$$V = \frac{0,9d}{s} A_s f_{yd}$$

CRITERIO DE VERIFICACION

1.- LA VERIFICACION DE LA COMPRESION SE DEBE HACER CON EL VALOR DEL CORTANTE MEDIDO EN EL APOYO (V_{d1})

$$V_{d1} \leq 0,27 b d f_{cd}$$

2.- LA VERIFICACION DE LA TRACCION SE DEBE HACER CON EL VALOR DEL CORTANTE MEDIDO A UNA DISTANCIA "d" DEL APOYO (V_{d2})

A LA CAPACIDAD DE LOS ACEROS SE SUMA UNA CAPACIDAD DEL HORMIGON EN TRACCION

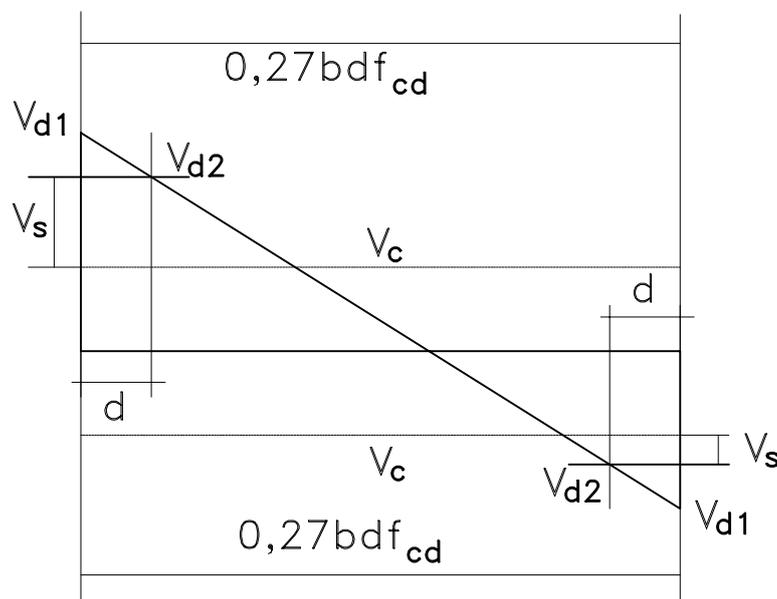
$$V_{d1} = V_c + V_s$$

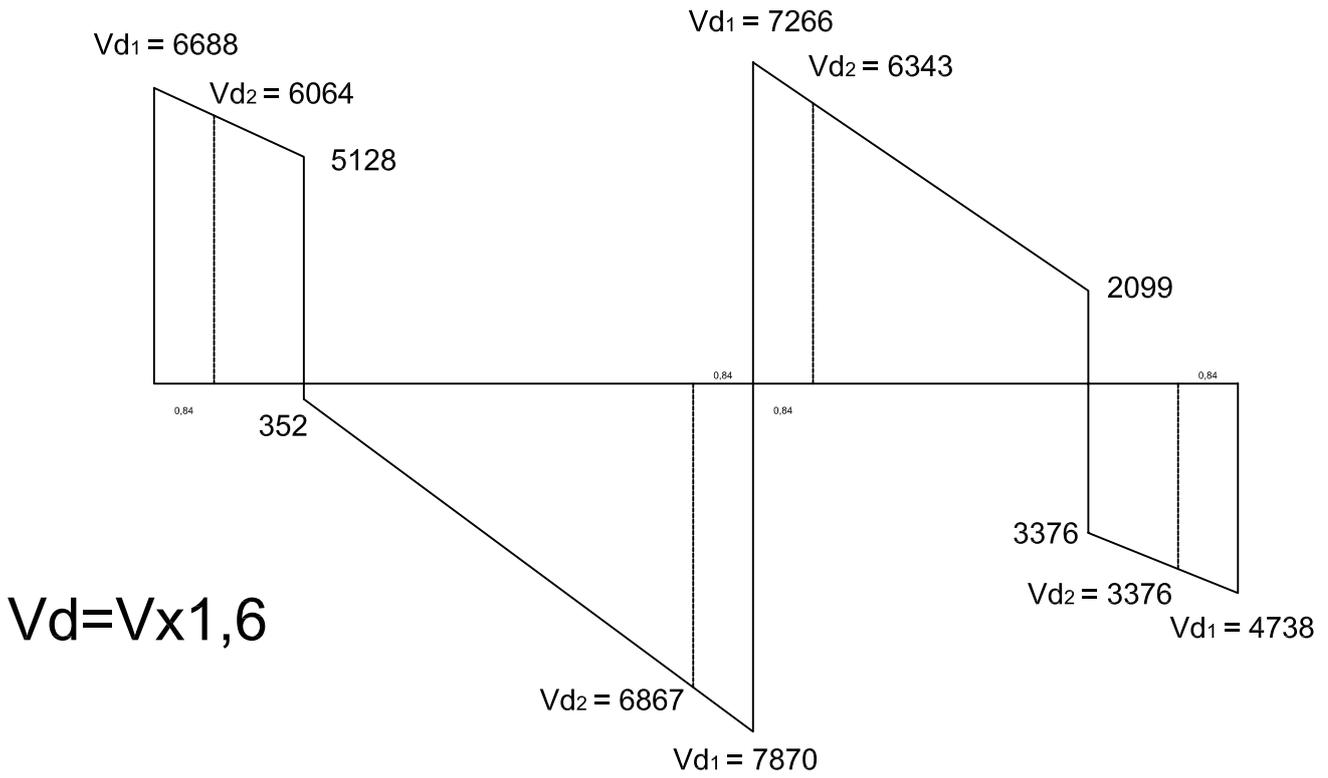
$$V_c = b d f_{cv}$$

$$f_{cv} = 0,5 \sqrt{f_{cd}}$$

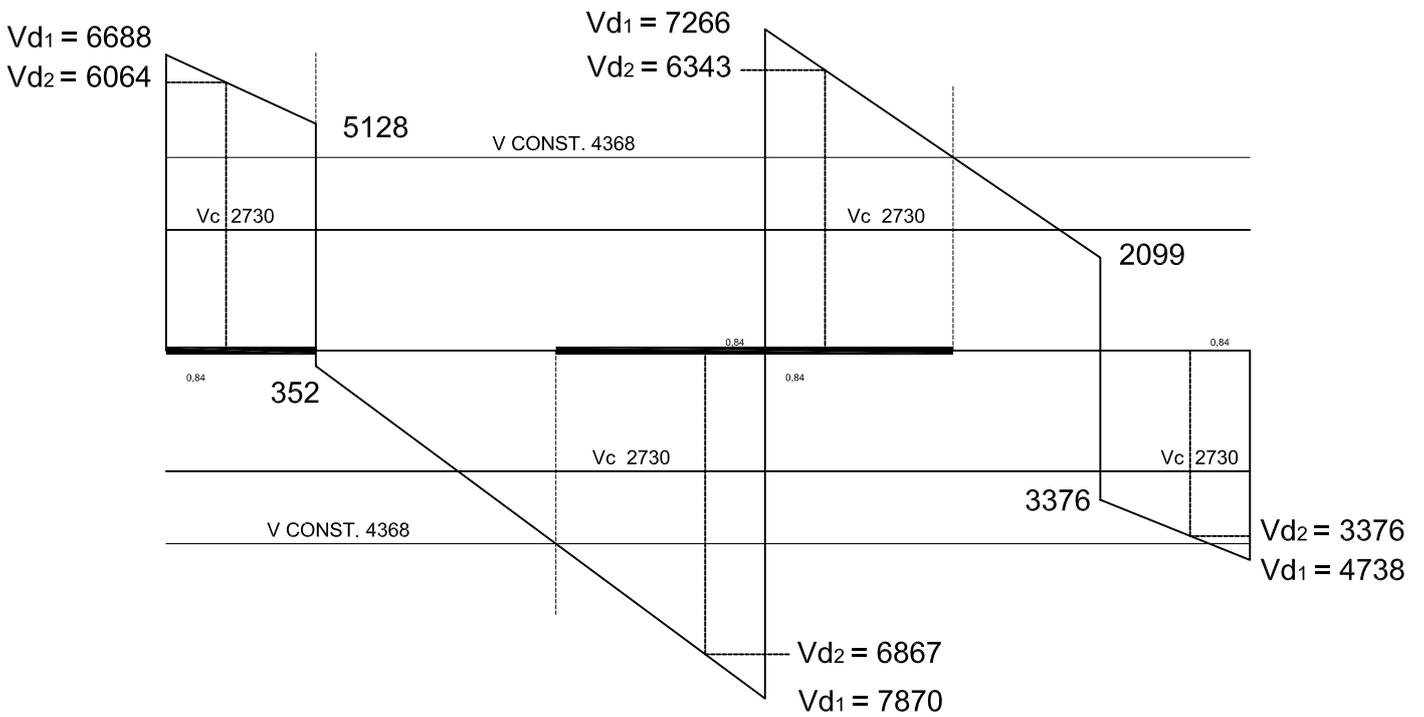
$$V_s = \frac{0,9d}{s} A_s f_{yd}$$

GRAFICACION DEL CRITERIO DE DIMENSIONADO





$Vd_{MAX.} = 14742$



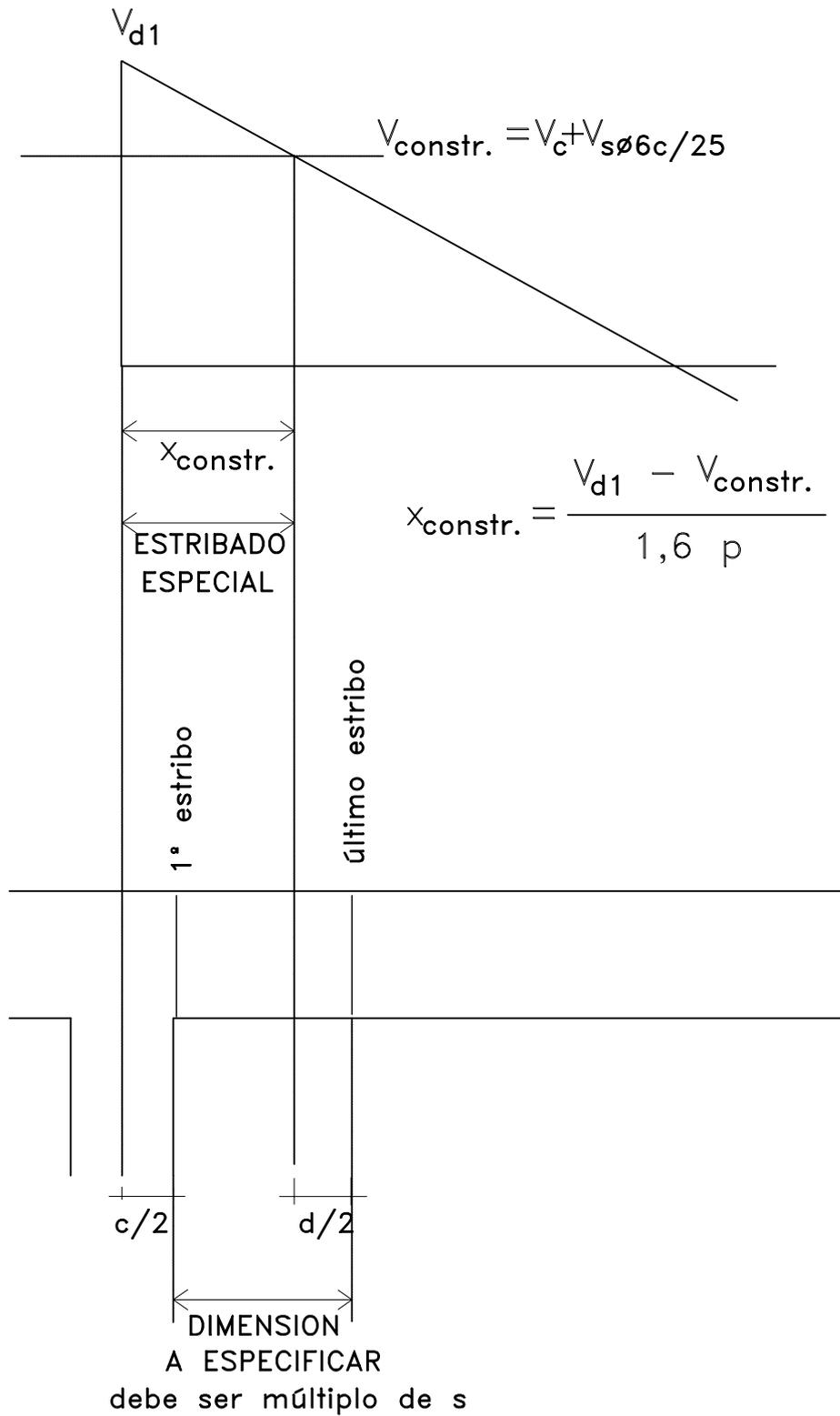
$Vd_{MAX.} = 14742$

VERIFICACION AL CORTANTE

26

CALIDAD DEL HORMIGON: RESISTENCIA CARACTERISTICA 150 daN/cm²

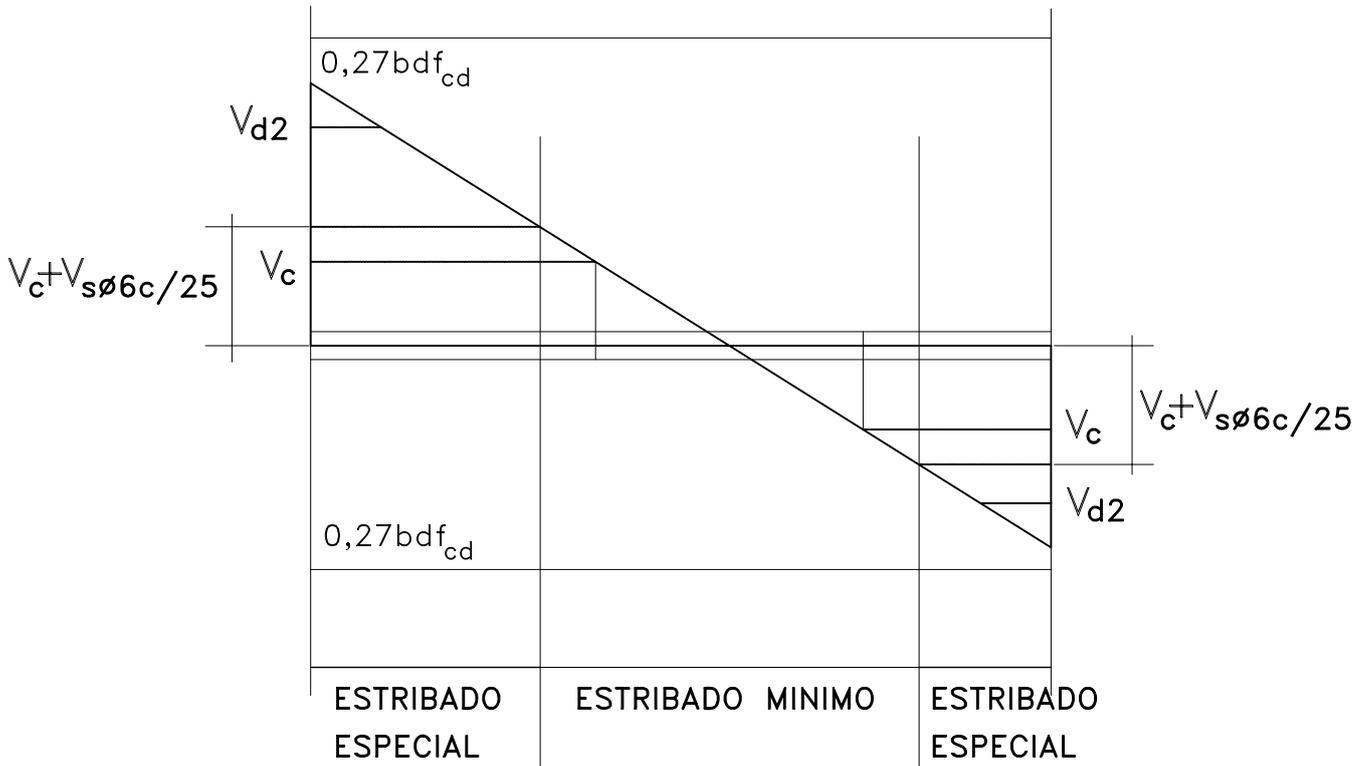
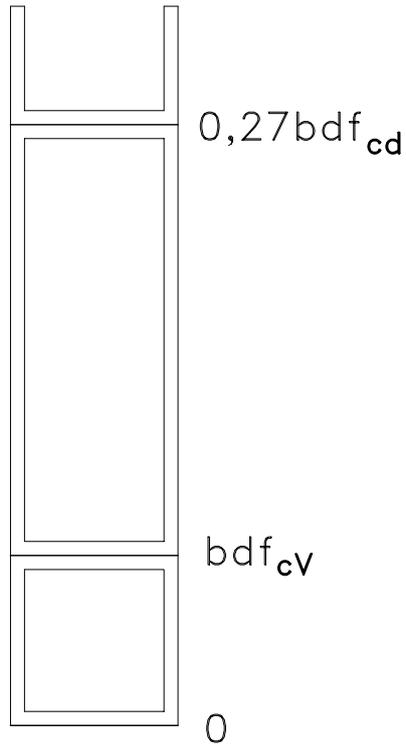
			V210 (izq.)	V210 (der.)	V211 (izq.)	V211 (der.)
DATOS	ANCHO DE VIGA (b)	cm	13	13	13	13
	ALTURA UTIL DE VIGA (d)	cm	42	42	42	42
	ANCHO DE PILAR (c)	cm	13	17	17	13
	CORTANTE (V)	daN	4.855	5.592	5.571	3.889
	CORTANTE DE DIM. (V _{d1})	daN	7.768	8.947	8.914	6,222
	CARGA UNIFORME (p)	daN/m	1.519	1.706	1.818	1.631
COMPRESION						
DATOS	0,27 b d f_{cd}	daN	14.742	14.742	14.742	14.742
	V _{d1}	daN	7.768	8.947	8.914	6.222
VERIFICACION			SI	SI	SI	SI
TRACCION						
DATOS	V _{d2} = V _{d1} - p d 1,6	daN	6.747	7.801	7.692	5.126
	V _c = b d f _{cv}	daN	2.730	2.730	2.730	2.730
	V _s constructivo	daN	1.638	1.638	1.638	1.638
	V _{constructivo}	daN	4.368	4.368	4.368	4.368
	V _s = V _{d2} - V _c	daN	4.017	5.071	4.962	2.396
	v _s = V _s / d		95,6	120,7	118,1	57,1
ESTRIBOS	DIAMETRO	mm	6	6	6	6
	CALIDAD DE ACERO (f _{yd})	daN/cm ²	4.200	4.200	4.200	2.200
	SEPARACION (s)	cm	19	15	15	17
ESPECIFICACION	X _{constructivo} =(V _{d1} -V _{constr})/1,6p	m	1,05	1,68	1,57	0,71
	X _{corregido} =X _{constr} -c/2+d/2	m	1,19	1,80	1,69	0,85
	X_{final} (múltiplo de s)	m	1,33	1,80	1,80	0,85
	CANTIDAD DE ESTRIBOS		8	13	13	6



$$x_{corregido} = x_{constr.} - c/2 + d/2 \leq n \cdot s$$

$$\text{CANTIDAD DE ESTRIBOS} = n + 1$$

ORGANIZACION DE LA ARMADURA



PROYECTAR LA ARMADURA LONGITUDINAL TRACCIONADA

- DETERMINAR LAS ZONAS EN LAS QUE ES NECESARIA

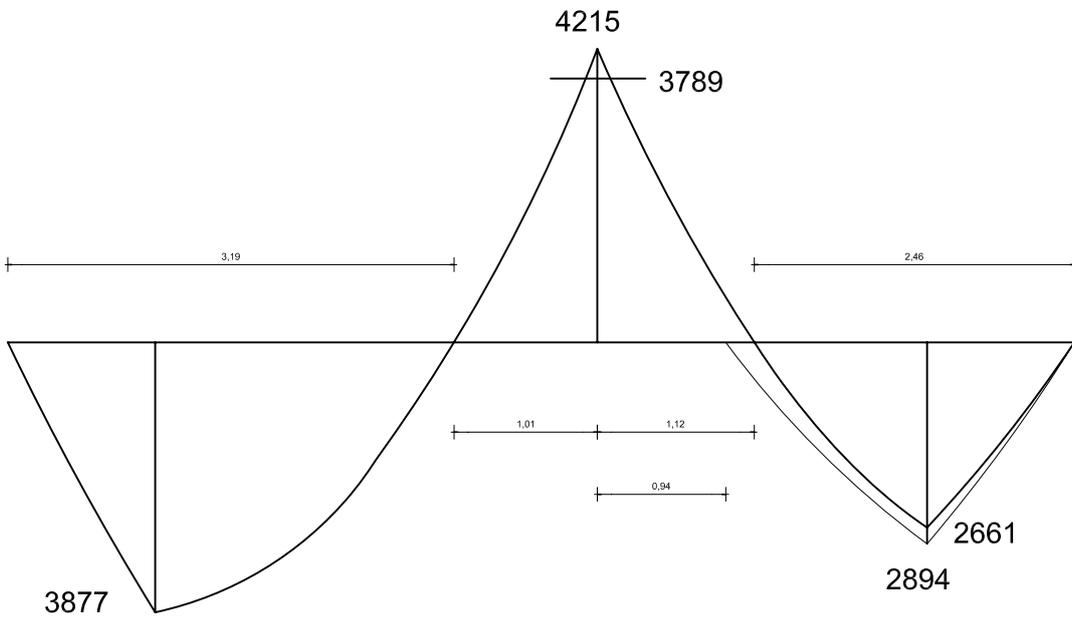
ESTUDIO DE LA DEFORMACIÓN

- ESTUDIAR SU POSIBLE VARIACIÓN A PARTIR DE VALORES MÁXIMOS

ESTUDIO DE LA FUERZA DE TRACCIÓN
SOBRE LAS ARMADURAS

- DETERMINAR LAS LONGITUDES DE LAS DISTINTAS VARILLAS

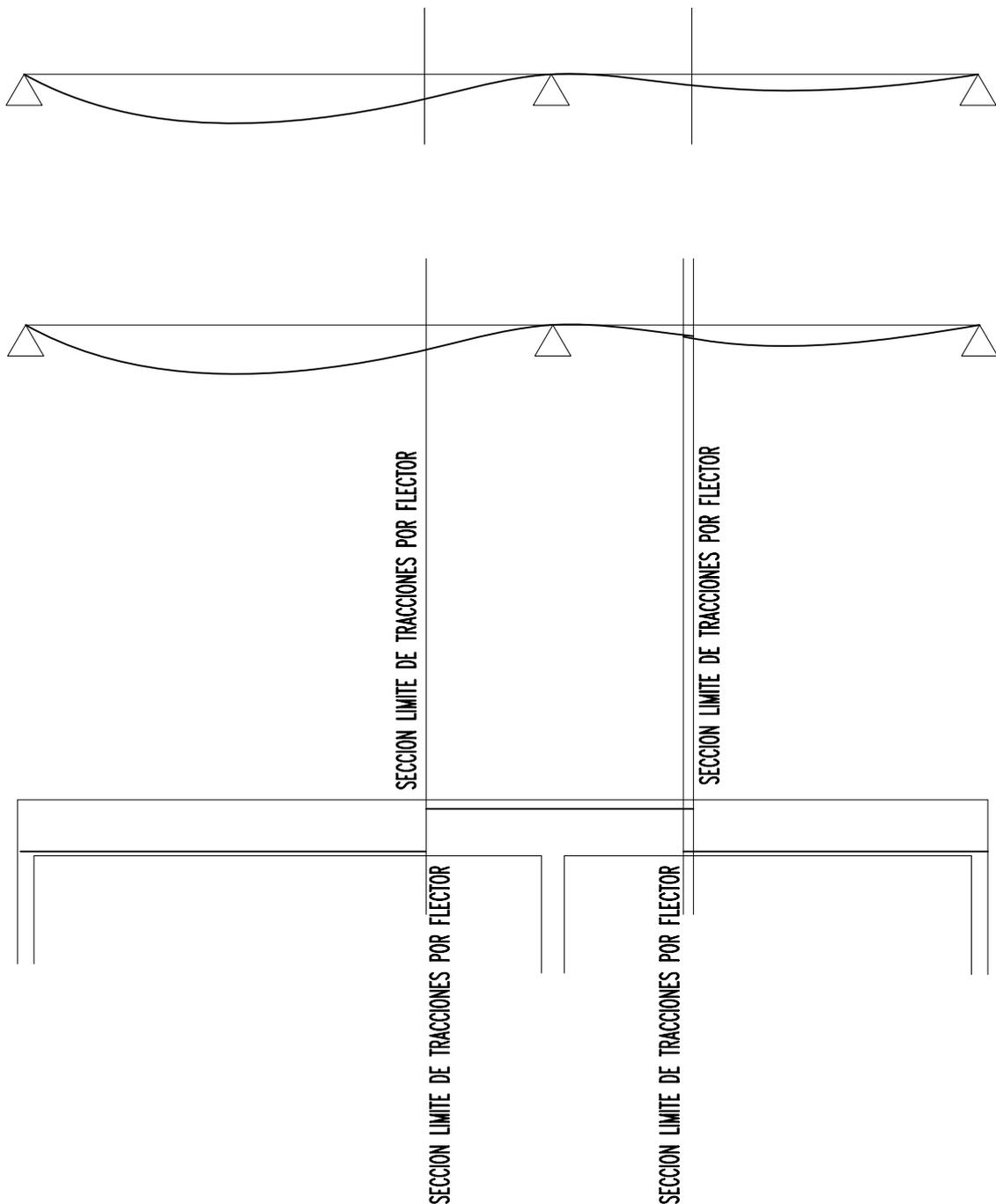
ANCLAJES



M

DETERMINAR LAS ZONAS EN LAS QUE ES NECESARIA

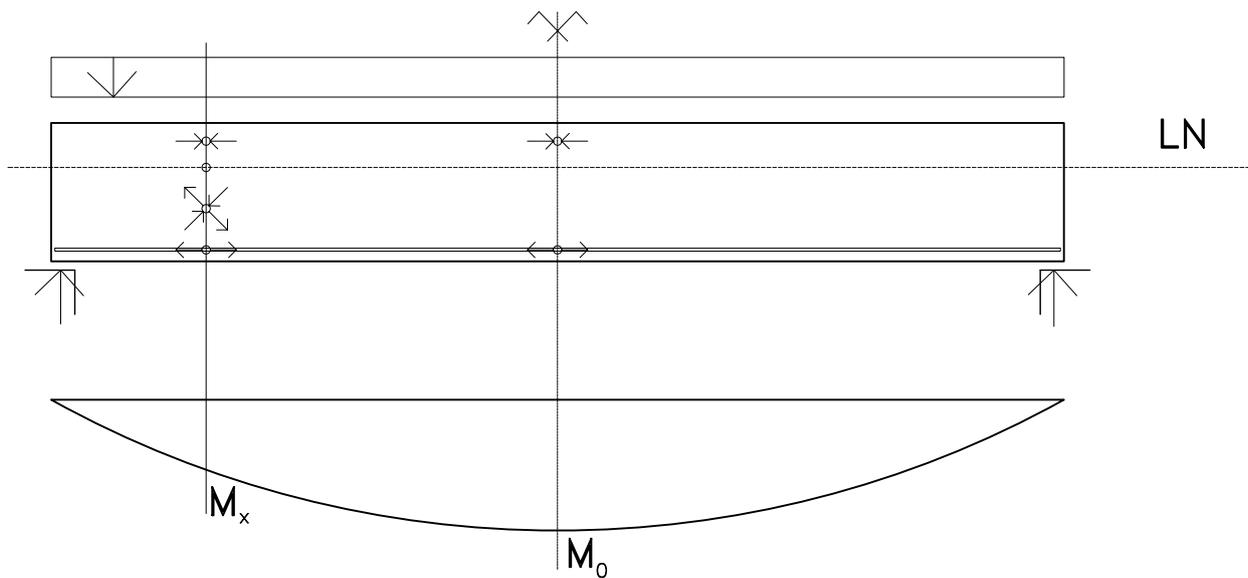
1.- ESTUDIO DE LA DEFORMACIÓN



2.- ESTOS LIMITES DEBEN SER MODIFICADOS EN FUNCION DE LAS TRACCIONES QUE PRODUCE EL CORTANTE SOBRE LA ARMADURA LONGITUDINAL

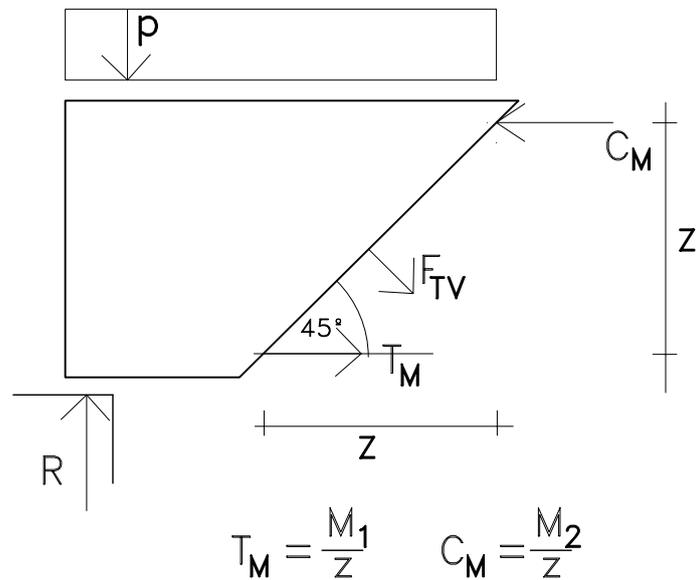
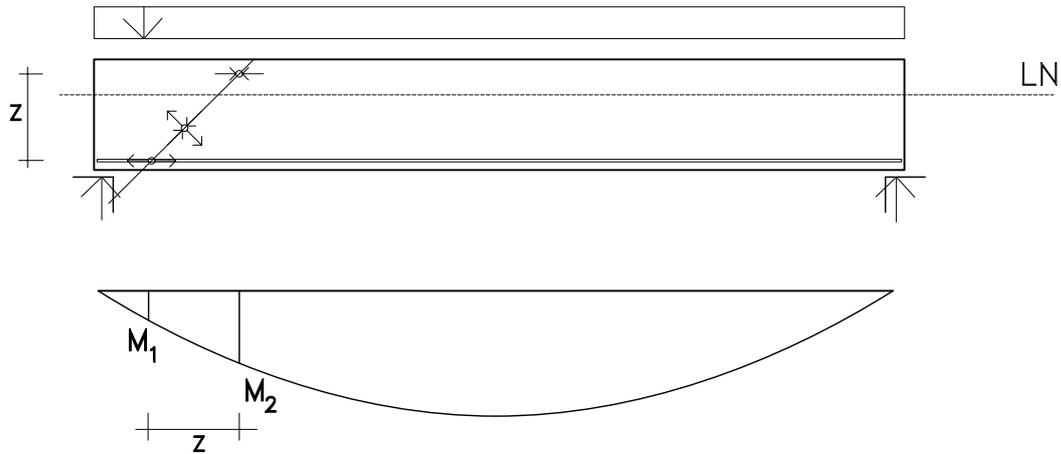
FUERZA SOBRE LAS ARMADURAS

RESPONDE A TRACCIONES
DERIVADAS DEL FLECTOR Y DEL CORTANTE



PARA DETERMINARLA SE TOMA UN TROZO DE VIGA LIMITADO POR UNA FISURA EN LAS PROXIMIDADES DEL APOYO, AL ESTUDIAR LOS ESFUERZOS QUE SE PRODUCEN EN ESTE PLANO DE CORTE SE PONDRÁ DE MANIFIESTO EL VALOR DE LA TRACCIÓN SOBRE LAS ARMADURAS LONGITUDINALES

SOBRE EL ACTUAN LA REACCIÓN DEL APOYO Y UNA CIERTA PARTE DE LAS CARGAS, ESTAS ACCIONES SE EQUILIBRAN EN EL PLANO DE ESTUDIO CON LOS ESFUERZOS INTERNOS DE TRACCIÓN Y COMPRESIÓN DERIVADOS DEL FLECTOR Y LAS TRACCIONES QUE PRODUCE EL CORTANTE. NO INTERVIENEN LAS COMPRESIONES PROVOCADAS POR ESTA SOLICITACIÓN

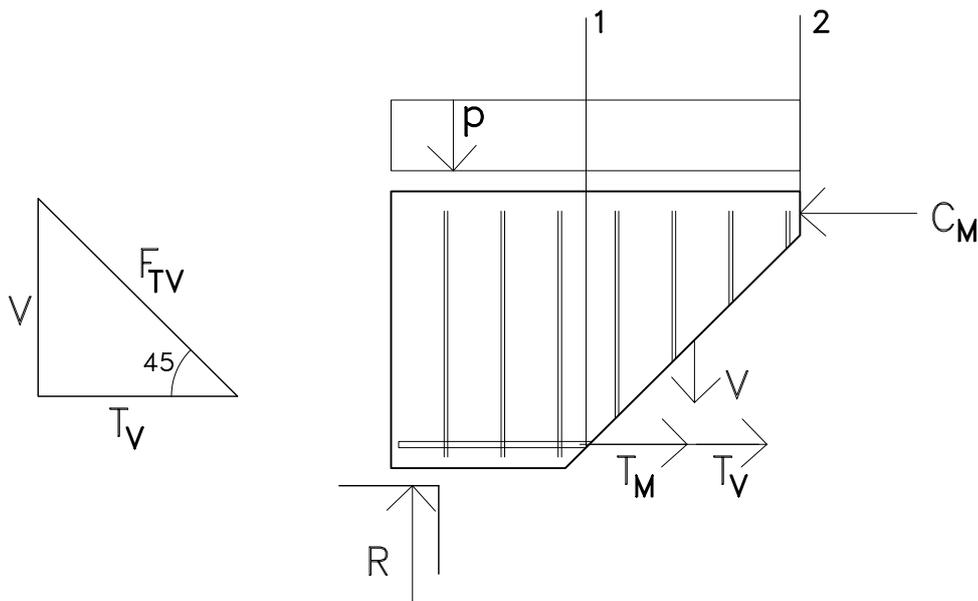


LA COMPRESION C_M PRODUCIDA POR EL FLECTOR VALE M_2/z Y LA TRACCION T_M , M_1/z

LA ORGANIZACIÓN MATERIAL (ORGANIZACIÓN DE LA ARMADURA) ELEGIDA PARA CONDUCIR LA TRACCIÓN PRODUCIDA POR EL CORTANTE DEFINE UNA COMPONENTE VERTICAL DE LA MISMA Y OTRA HORIZONTAL

LA COMPONENTE VERTICAL TRACCIONA A LA ARMADURA TRANSVERSAL CON EL VALOR V YA DEFINIDO Y QUE SE APRECIA EN LA DESCOMPOSICIÓN DE F_{TV}

LA COMPONENTE HORIZONTAL T_V SE CANALIZA A TRAVÉS DE LA ARMADURA LONGITUDINAL SUMÁNDOSE A T_M



EL EQUILIBRIO IMPONE LA IGUALDAD ENTRE LA COMPRESIÓN Y EL TOTAL DE LAS TRACCIONES HORIZONTALES

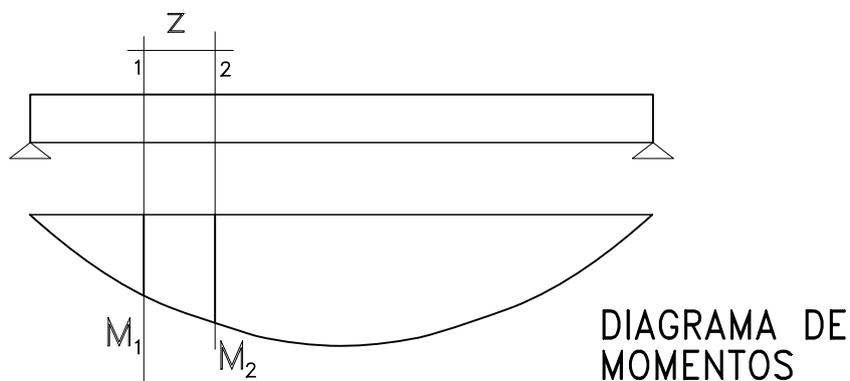
$$C_M = T_M + T_V$$

$$C_M = T_{TOTAL}$$

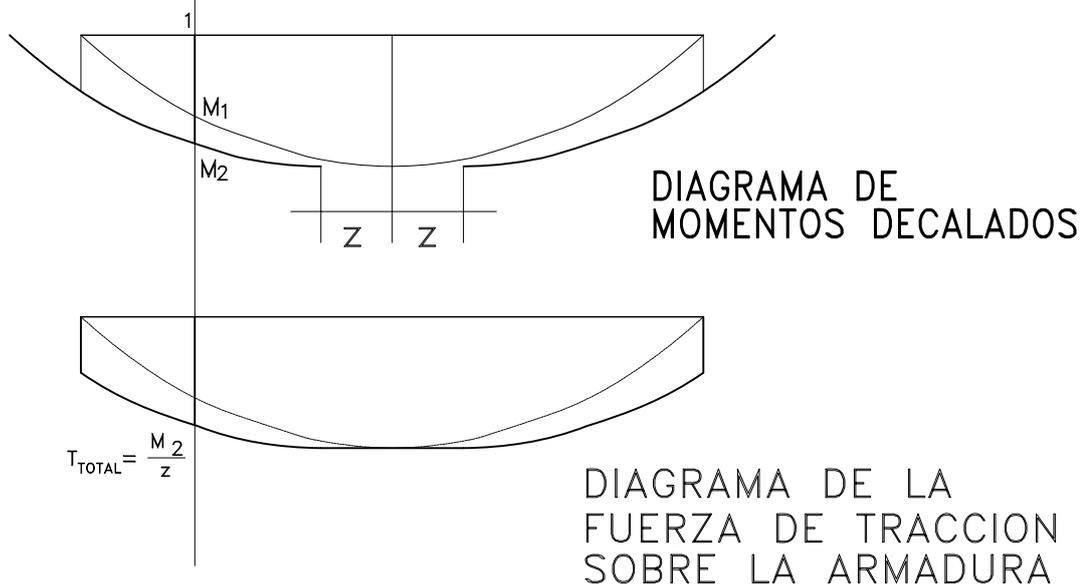
$$T_{TOTAL} = \frac{M_2}{Z}$$

SI BIEN LA FUERZA DE TRACCIÓN QUE ACTÚA SOBRE LAS ARMADURAS LONGITUDINALES ES SUMA DE DOS COMPONENTES, UNA PRODUCIDA POR EL FLECTOR Y OTRA POR EL CORTANTE, ES POSIBLE DETERMINARLA SOLAMENTE A PARTIR DEL VALOR DEL FLECTOR

PARA ELLO EN LUGAR DE TOMAR EL VALOR DEL MOMENTO CORRESPONDIENTE A LA SECCIÓN EN ESTUDIO SE DEBE TOMAR EL QUE CORRESPONDE A UNA SECCIÓN DISTANTE z HACIA DONDE CRECEN LOS VALORES



ESTO PERMITE VISUALIZAR (DIAGRAMAR) LA VARIACIÓN DE LA FUERZA DE TRACCIÓN SOBRE LAS ARMADURAS LONGITUDINALES COMO UN DIAGRAMA DERIVADO DEL DE MOMENTOS FLECTORES



AREA DE ACERO NECESARIA PARA LA ARMADURA
LONGITUDINAL TRACCIONADA
VARIACIÓN EN LA LUZ DE LA VIGA

CONOCIDA LA FUERZA DE TRACCION SOBRE LAS
ARMADURAS SE PUEDE DETERMINAR EL AREA DE ACERO
NECESARIA EN CADA SECCIÓN DE LA VIGA YA QUE:

$$A_{S \text{ nec}} = \frac{T_d}{f_{yd}}$$

EL DIAGRAMA DE AREAS NECESARIAS SE PUEDE DEDUCIR
DEL DE LA FUERZA DE TRACCIÓN YA QUE f_{yd} ES UNA
CONSTANTE, LOS DOS DIAGRAMAS SERÁN SEMEJANTES

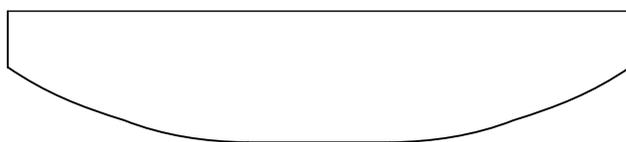
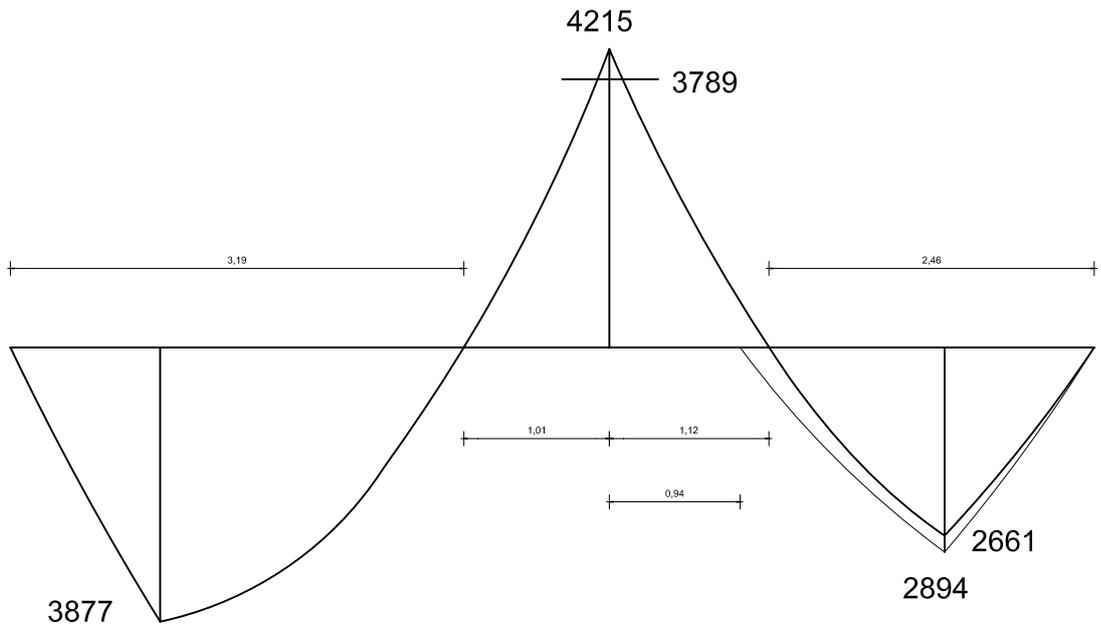


DIAGRAMA DE LA
FUERZA DE TRACCION
SOBRE LA ARMADURA

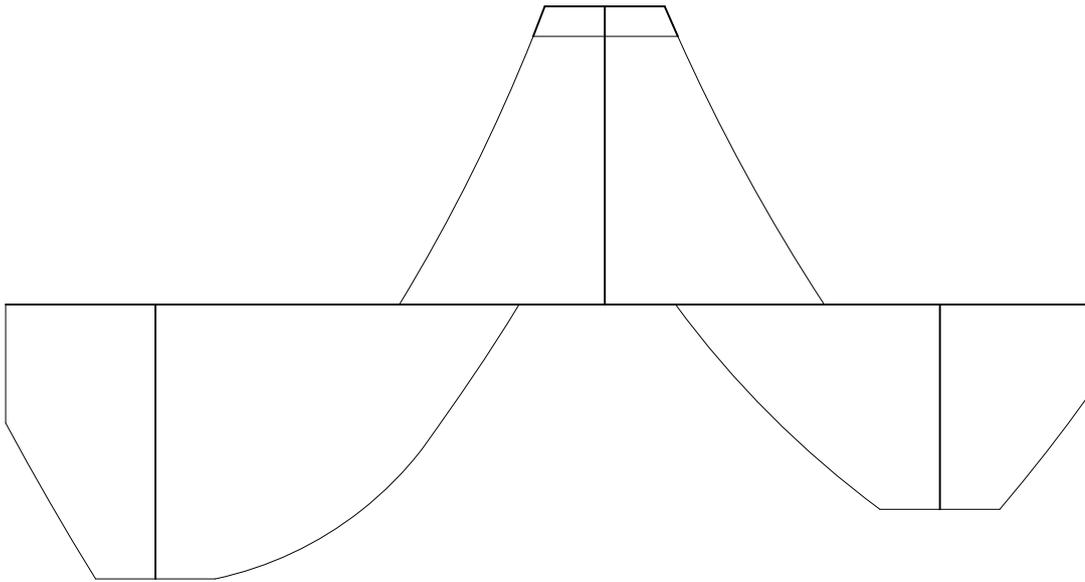


DIAGRAMA DE LAS AREAS
DE ACERO NECESARIAS EN
CADA SECCIÓN

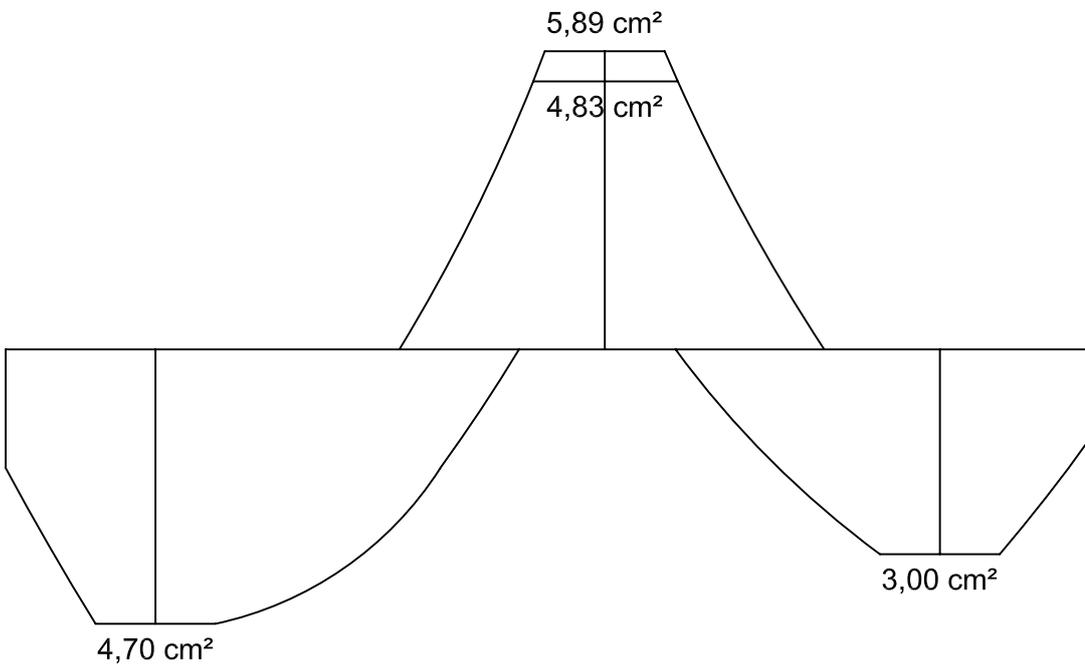


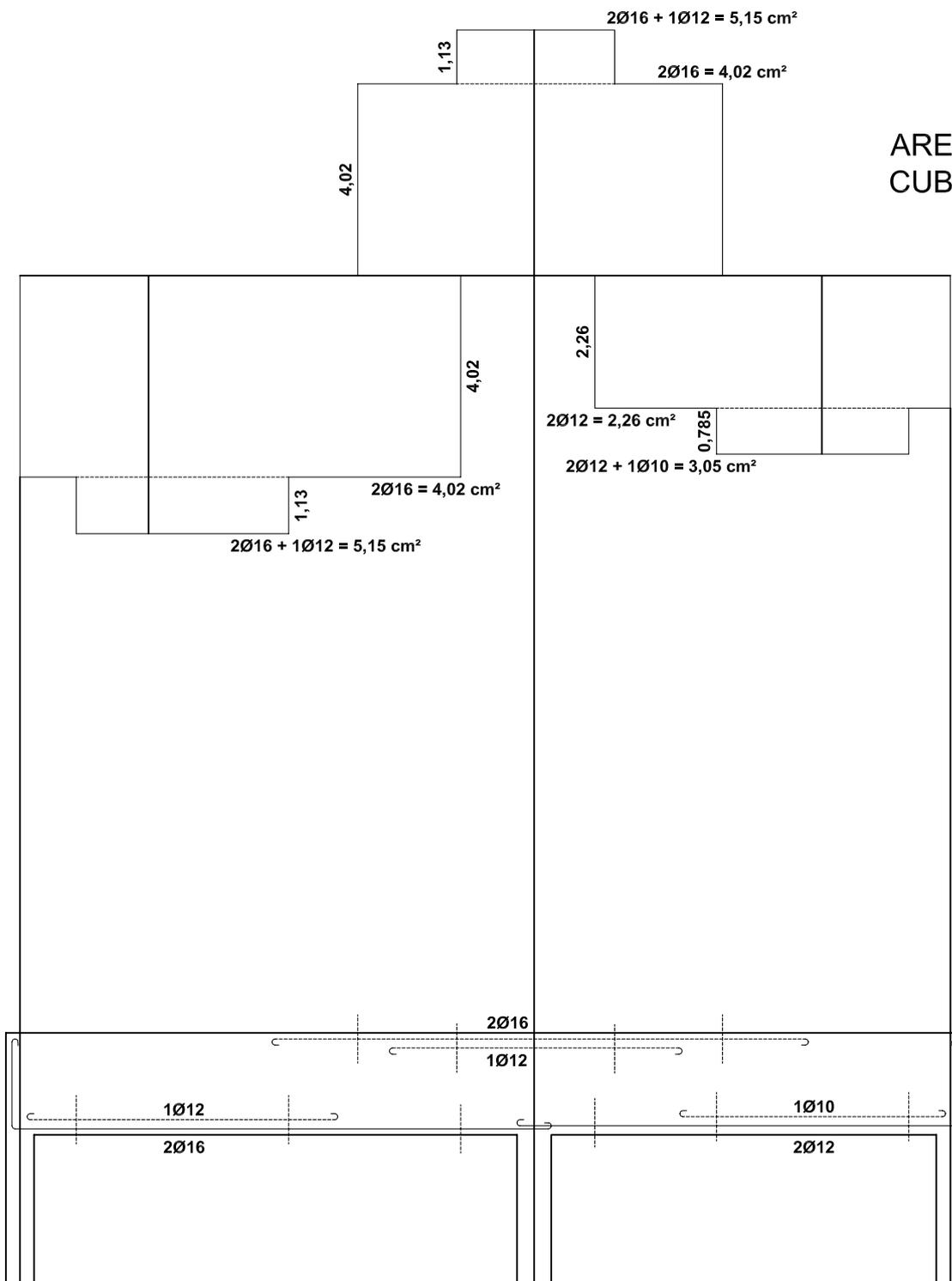
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FUERZA DE TRACCION SOBRE LAS ARMADURAS

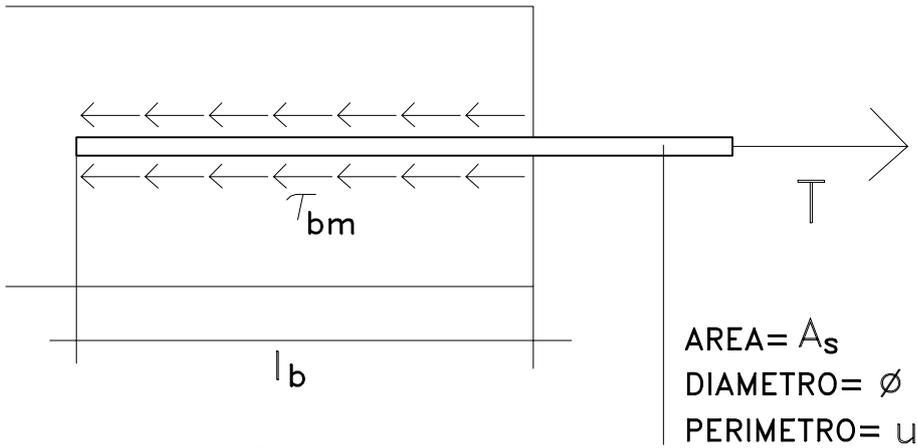


AREAS NECESARIAS (AS NEC)





AREAS CUBIERTAS



$$T_{max} = A_s f_{yd}$$

$$u l_b \tau_{bm} = A_s f_{yd}$$

$$u = \phi \pi \quad A_s = \frac{\phi^2 \pi}{4}$$

$$\phi \pi l_b \tau_{bm} = \frac{\phi^2 \pi}{4} f_{yd}$$

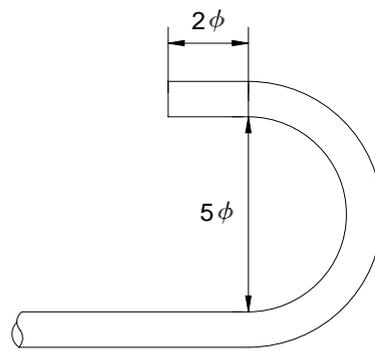
$$l_b \tau_{bm} = \frac{\phi}{4} f_{yd}$$

$$l_b = \frac{\phi f_{yd}}{4 \tau_{bm}}$$

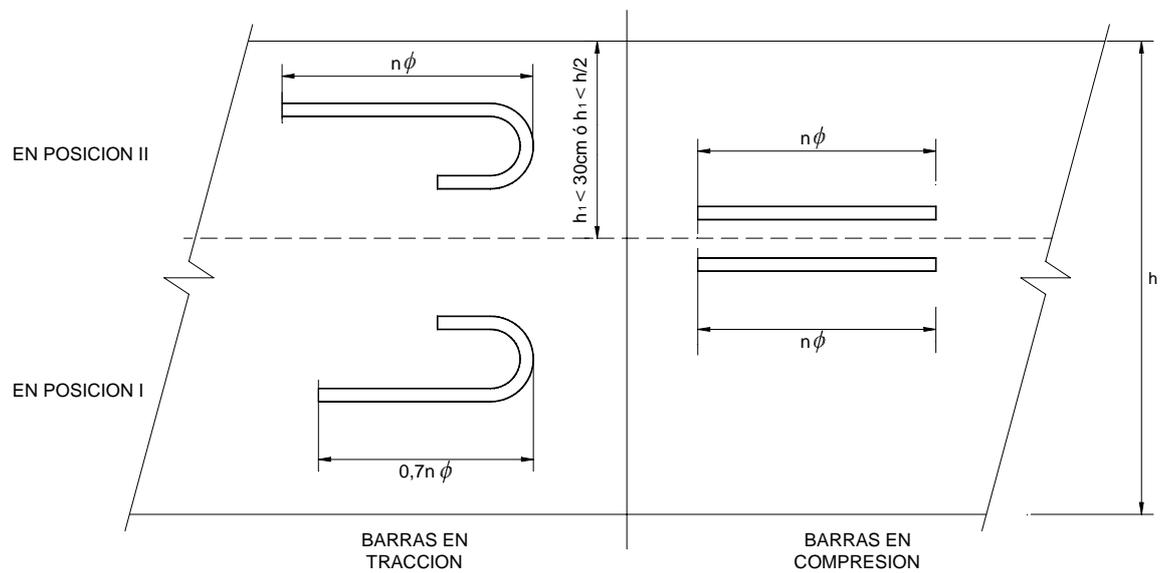
$$\tau_{bm} \leq \tau_{bd}$$

$$\tau_{bd} = \frac{1,2}{\gamma_c} \sqrt{f_{ck}}$$

	POSICION II	HIERROS F	$h/2$	$h \leq 60$
	POSICION I	HIERROS A	$h/2$	
	POSICION II	HIERROS F	30	$h > 60$
	POSICION I	HIERROS A		

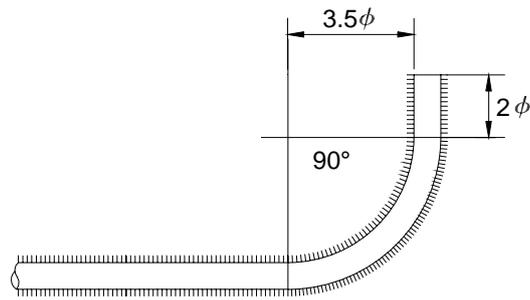


GANCHO

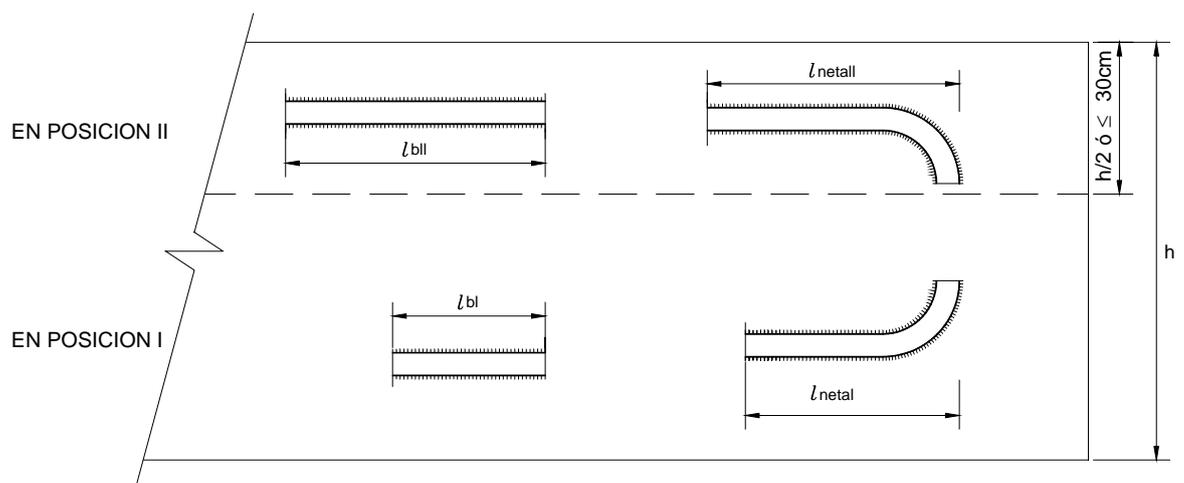


Valores de n en función de la calidad del hormigón

Hormigón	n
C - 12,5	47
C - 15,0	43
C - 17,5	40
C - 20,0	37
C - 22,5	35
C - 25,0	33
C - 30,0 o mayor	30



ESCUADRA O PATILLA



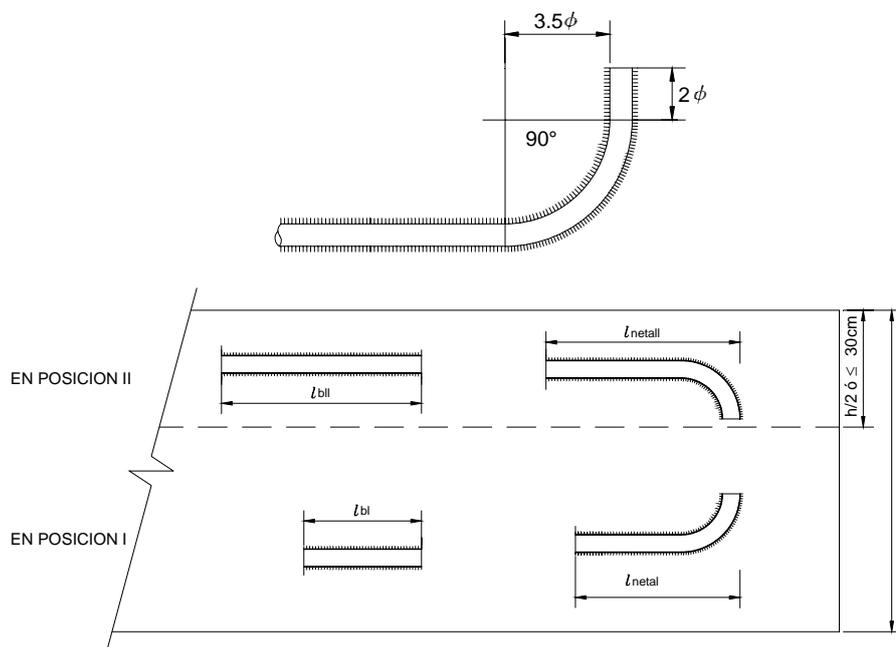
Para barras en posición I: $l_{bl} = m\phi^2 \leq \frac{f_{yk}}{200}\phi \leq 15\text{cm}$

Para barras en posición II: $l_{bII} = 1,4m\phi^2 \leq \frac{f_{yd}}{140}\phi \leq 15\text{cm}$

Valores de m

Hormigón	m
	ADN 500 ADM 500
C – 12,5	-
C – 15,0	-
C – 17,5	21
C – 20,0	19
C – 22,5	17
C – 25,0	15
C – 30,0	13
C – 35,0	12
C – 40,0	11
C – 50,0	10

$$l_{\text{neta}} = 0,7l_b$$



Para el caso de $f_{ck}=200$ y ADN 500

Diámetros de 8, 10 y 12 mm

Para barras en posición I: $l_{bI} = 25\phi$

Para barras en posición II: $l_{bII} = 36\phi$

Diámetros de 16 mm y mayores

Para barras en posición I: $l_{bI} = 19\phi^2$

Para barras en posición II: $l_{bII} = 26,6\phi^2$

Para el caso de $f_{ck}=150$ y ADN 500 usado como 420*

Diámetros de 8, 10 y 12 mm

Para barras en posición I: $l_{bI} = 25\phi$

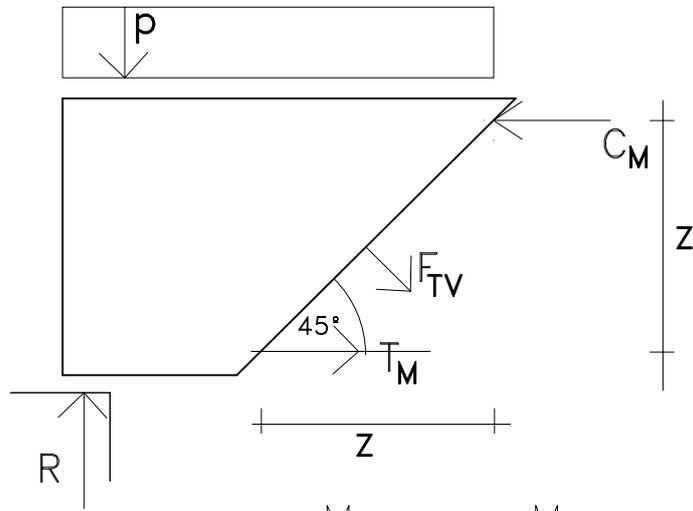
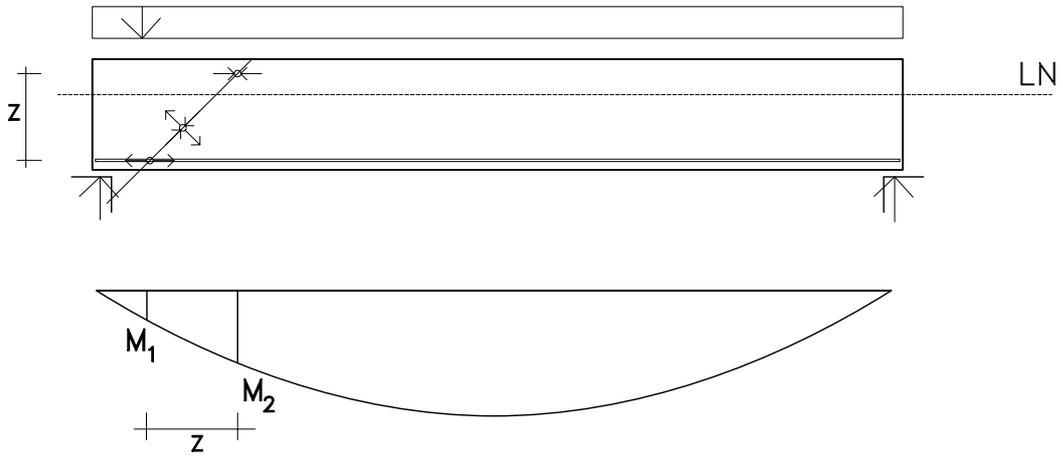
Para barras en posición II: $l_{bII} = 36\phi$

Diámetros de 16 mm y mayores

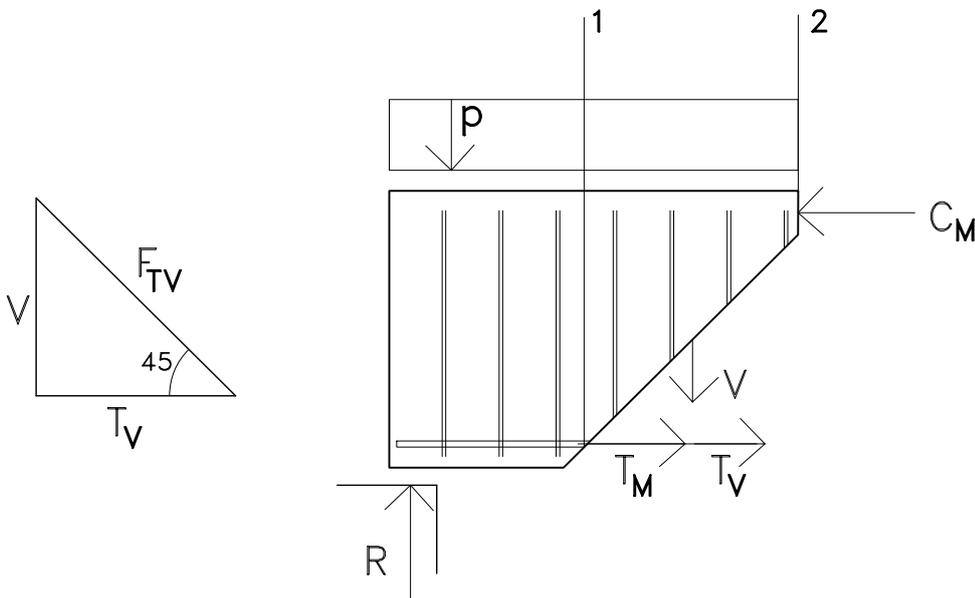
Para barras en posición I: $l_{bI} = 24\phi^2$

Para barras en posición II: $l_{bII} = 34\phi^2$

*Estos valores no pertenecen a la norma son responsabilidad del cuerpo docente de Estabilidad III



$$T_M = \frac{M_1}{z} \quad C_M = \frac{M_2}{z}$$



$$C_M = T_M + T_V$$

$$C_M = T_{TOTAL \text{ EN } 1}$$

$$T_{TOTAL \ 1} = \frac{M_2}{z}$$

$$T_{TOTAL \ 1} = \frac{M_2}{Z}$$

DIAGRAMA DE MOMENTOS

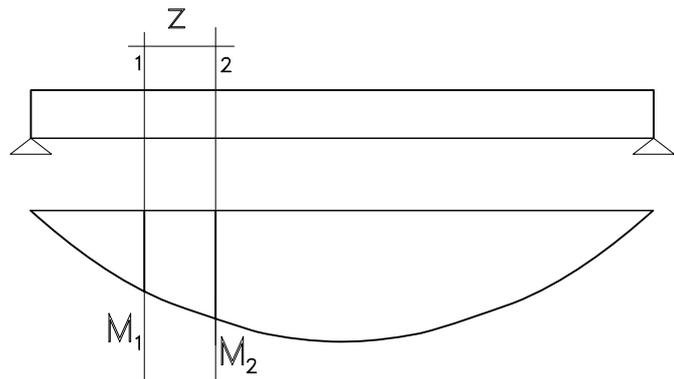


DIAGRAMA DE MOMENTOS DECALADOS

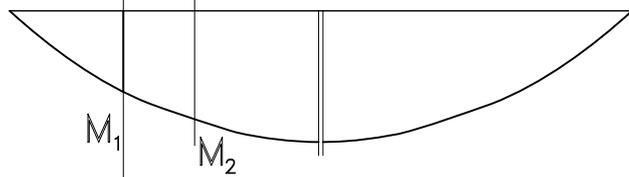


DIAGRAMA DE LA FUERZA DE TRACCION SOBRE LA ARMADURA

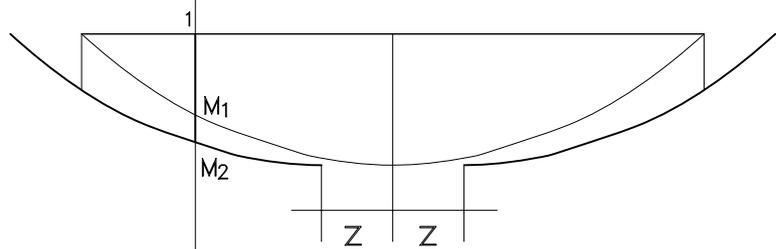
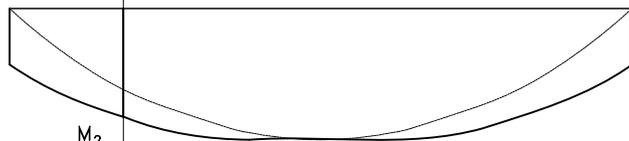


DIAGRAMA DE LAS AREAS DE ACERO NECESARIAS EN CADA SECCIÓN

$$T_{TOTAL \ EN \ 1} = \frac{M_2}{Z}$$



$$A_{S \ nec} = \frac{T_d}{f_{yd}}$$

