PRÁCTICO EXPOSITIVO
RESUMEN

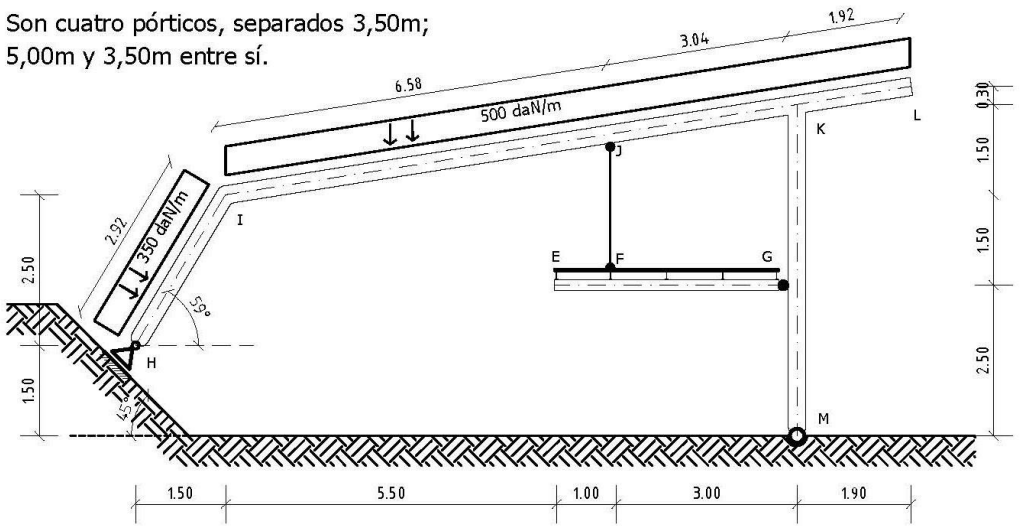
EXAMEN 14 – 02 - 2018

ESTRUCTURAS I

PLANTEO EJERCICIO N° 1
Referencias: capítulo 4 - examen 02/2018

En el gráfico se representa la estructura de acero de un hall de exposiciones, con cubierta liviana, y un entrepiso también de acero.

Son cuatro pórticos, separados 3,50m; 5,00m y 3,50m entre sí.

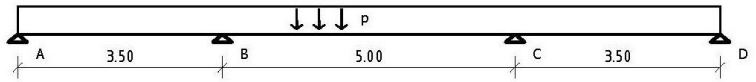


La cubierta descarga 500 daN/m de tramo en IJKL, como está indicado. Sobre el tramo HI de la izquierda se indica la descarga que produce el viento sobre el cerramiento vidriado. En H hay un apoyo deslizante sobre un plano a 45º.

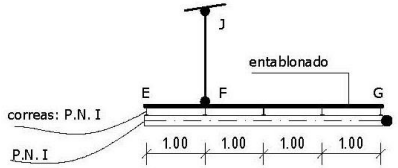
El entrepiso está construido con un entablonado, que se apoya en correas cada 1m, de perfiles normales I de acero continuos de 12m de largo, y éstas apoyadas en los perfiles I, EFG, suspendidos del tramo superior por un tensor y apoyados en el tramo vertical de la derecha. (Los esquemas de estos perfiles y las correas se indican aparte).

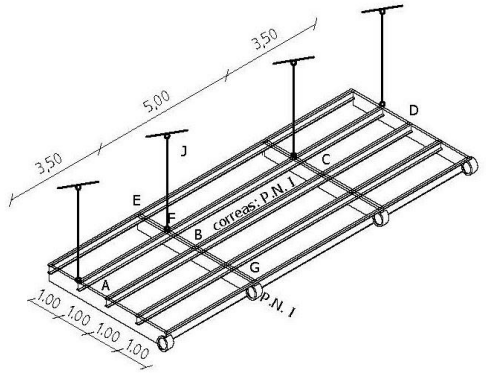
La carga total a considerar en el entrepiso (p.p. + sobrecarga de uso) es 450 daN/m².

ESQUEMA DE LAS CORREAS



ESQUEMA DE EFG





Se pide:

1) Hallar las solicitaciones de las correas más comprometidas, la descarga en los apoyos y dimensionarlas con un perfil normal I de acero, para que cumpla las condiciones de equilibrio.

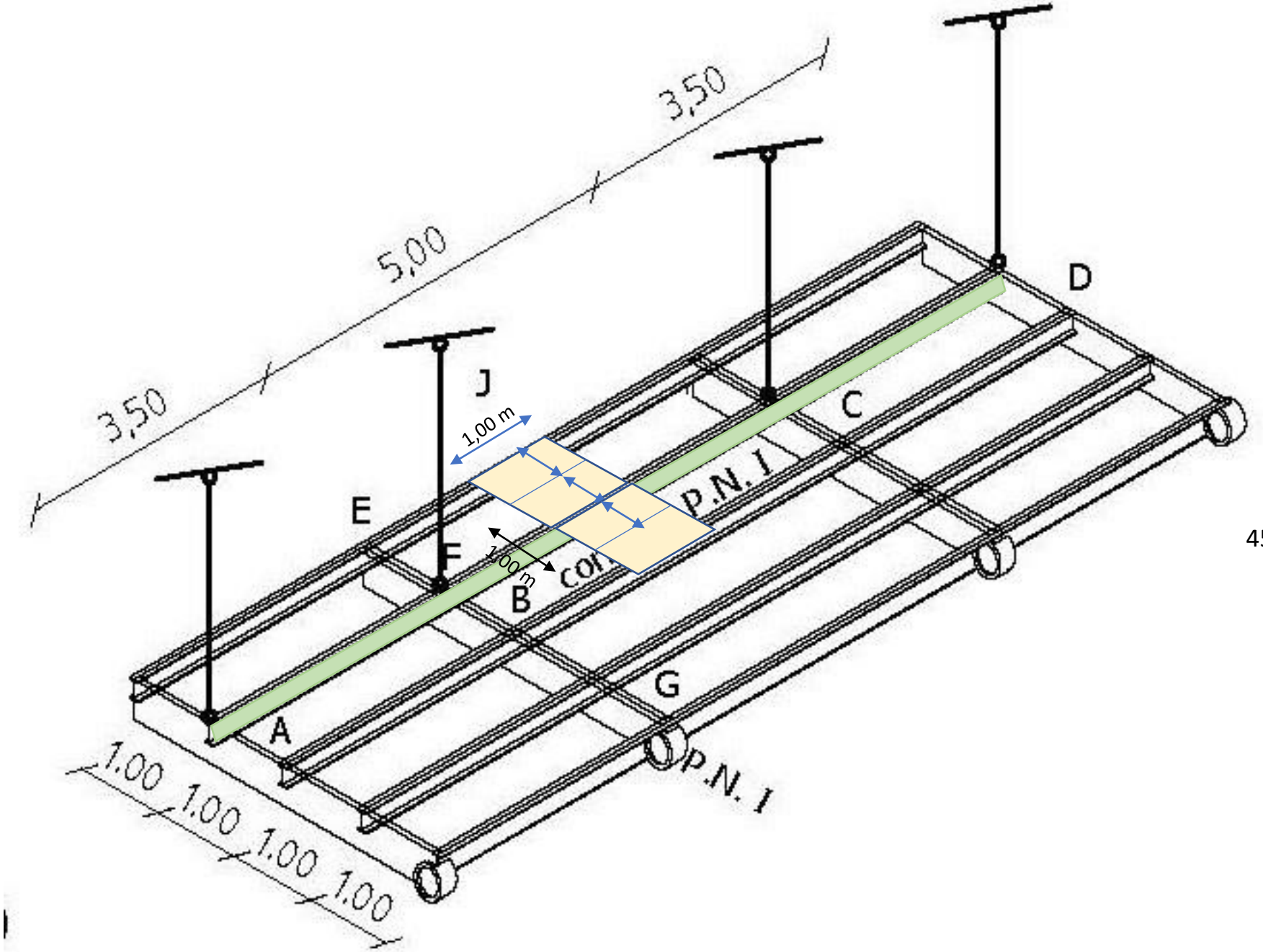
2) Hallar las solicitaciones en las barras EFG y sus descargas en el pórtico, en J y G.

3) Dimensionar el tensor FJ con una barra de acero de sección circular.

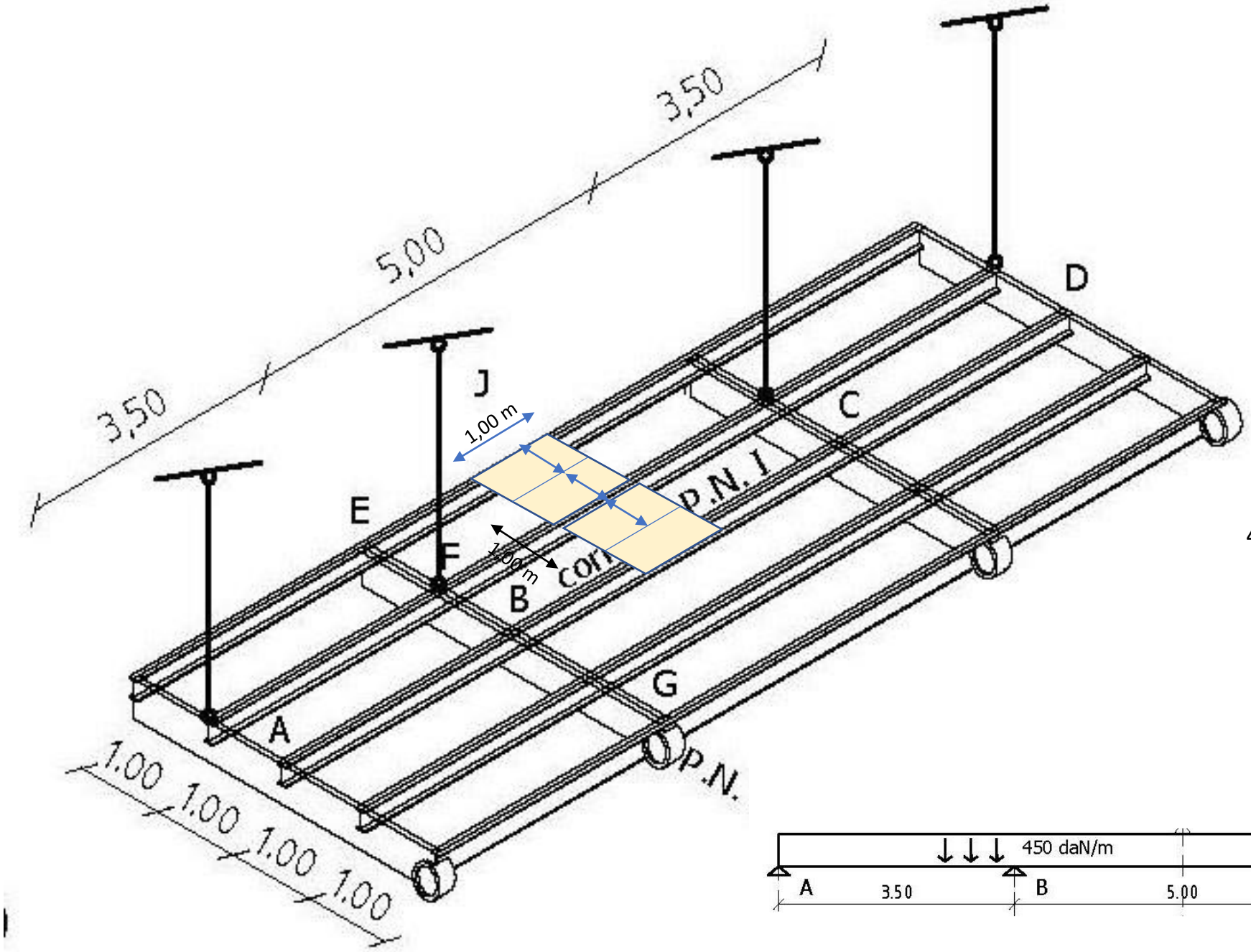
4) Hallar el equilibrio global del pórtico. Trazar los diagramas de solicitaciones del tramo superior IJKL y dimensionarlo con dos Perfiles Normales C de acero ([])

DATOS AUXILIARES:
- Tensión normal de dimensionado del acero: 1400 daN/cm²
- Tensión tangencial de dimensionado del acero: 1120 daN/cm²
- Módulo de Elasticidad del acero: 2.100.000 daN/cm²

Nota: Las cotas indicadas son a eje y en metros.



450 daN/m2 x 1 m = 450 daN/m



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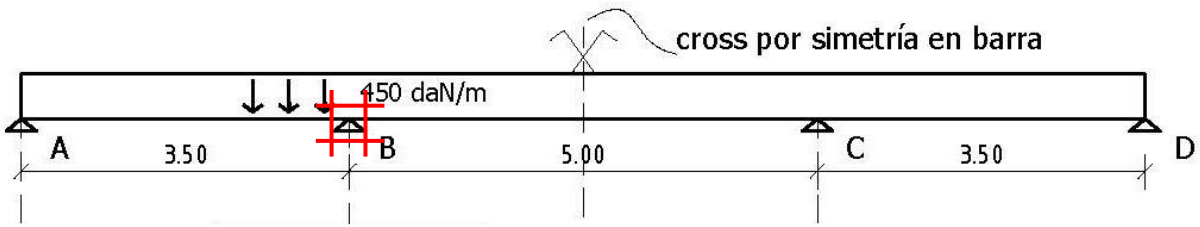
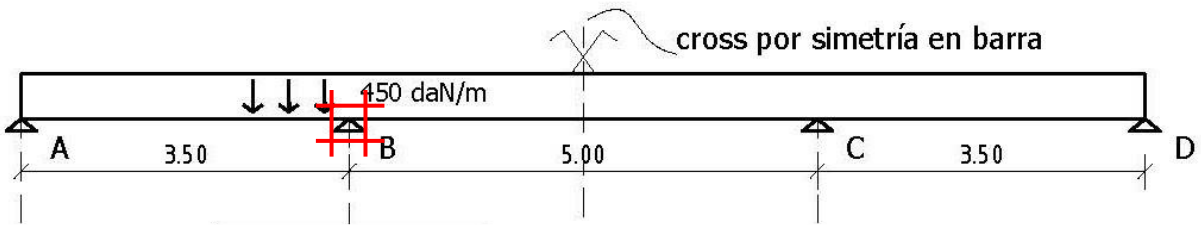
1- EQUILIBRIO DE LAS CORREAS



COEFICIENTES DE REPARTICIÓN EN NODO B

	L (m)	Ir	α	κ	α.κ	β	por ϒ	suma	coef.
AB	3,50	1	0,75	0,286	0,214	-		0,314	0,682
BC	5,00	1	1	0,20	0,2	0,5	0,10		0,318



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COEFICIENTES DE REPARTICIÓN EN NODO B

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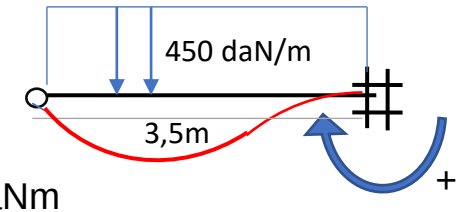
2- Momentos de Empotramiento Perfecto

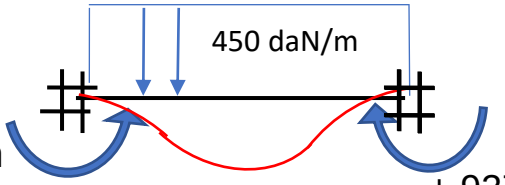
Tramo AB



+ 689 daNm

$$MBA = \frac{450 \times 3{,}50^2}{8} = 689 \text{ daNm}$$

Tramo BC

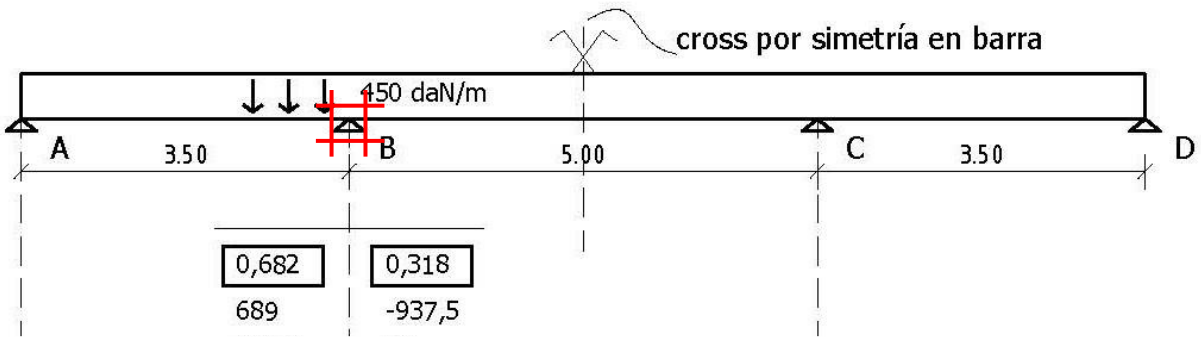


- 938 daNm

+ 937,5 daNm

$$MBC = MCB = \frac{450 \times 5{,}00^2}{12} = 937{,}5 \text{ daNm}$$

1- EQUILIBRIO DE LAS CORREAS



COEFICIENTES DE REPARTICIÓN EN NODO B

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Nudo B:

$\sum M = +689 - 937{,}5 = -248{,}5$ daNm

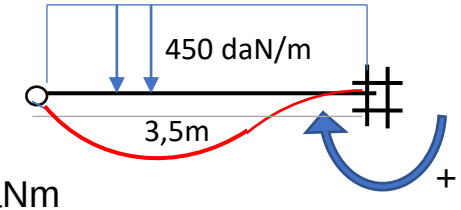
$-\sum M = +248{,}5\ daNm$

248,5x 0,682 = 169,5 daNm

248,5x 0,318 = 79 daNm

2- Momentos de Empotramiento Perfecto

Tramo AB



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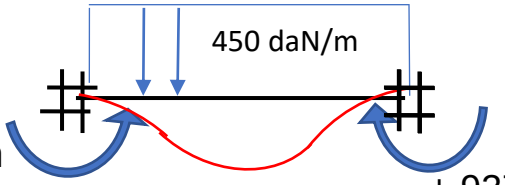
Tramo BC



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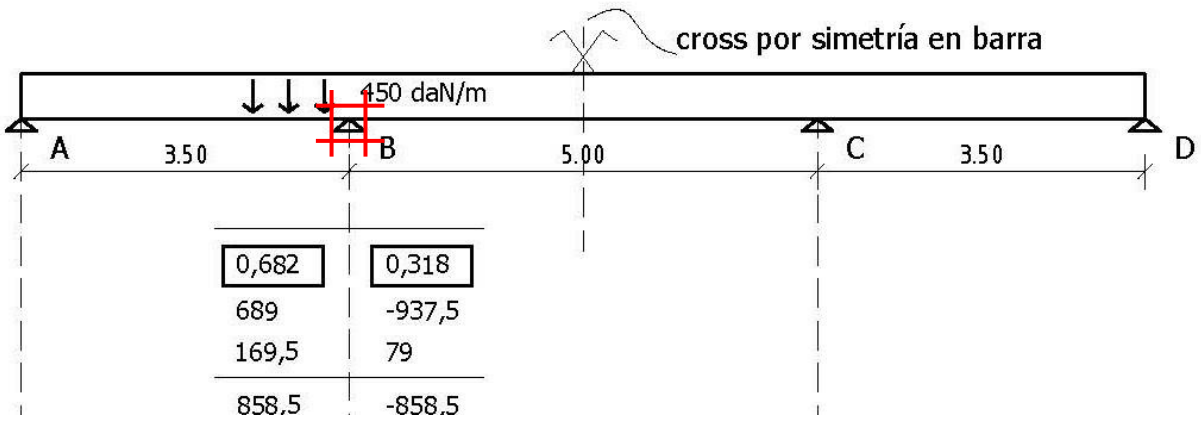

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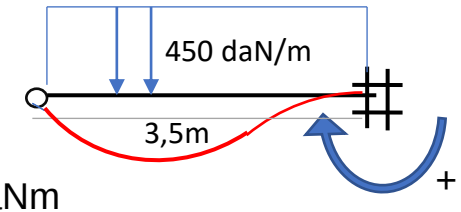

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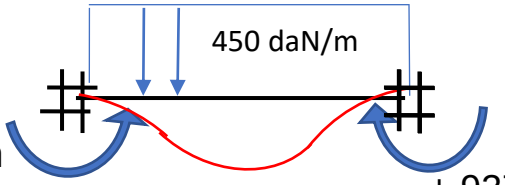

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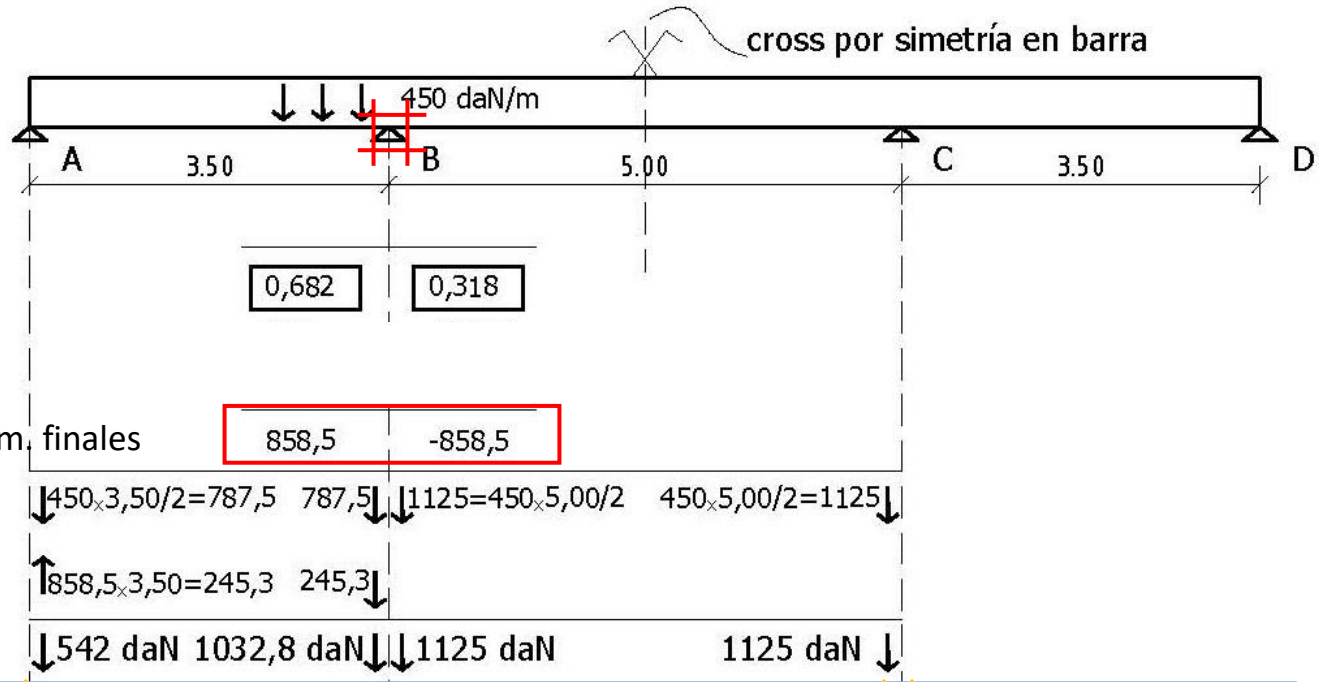
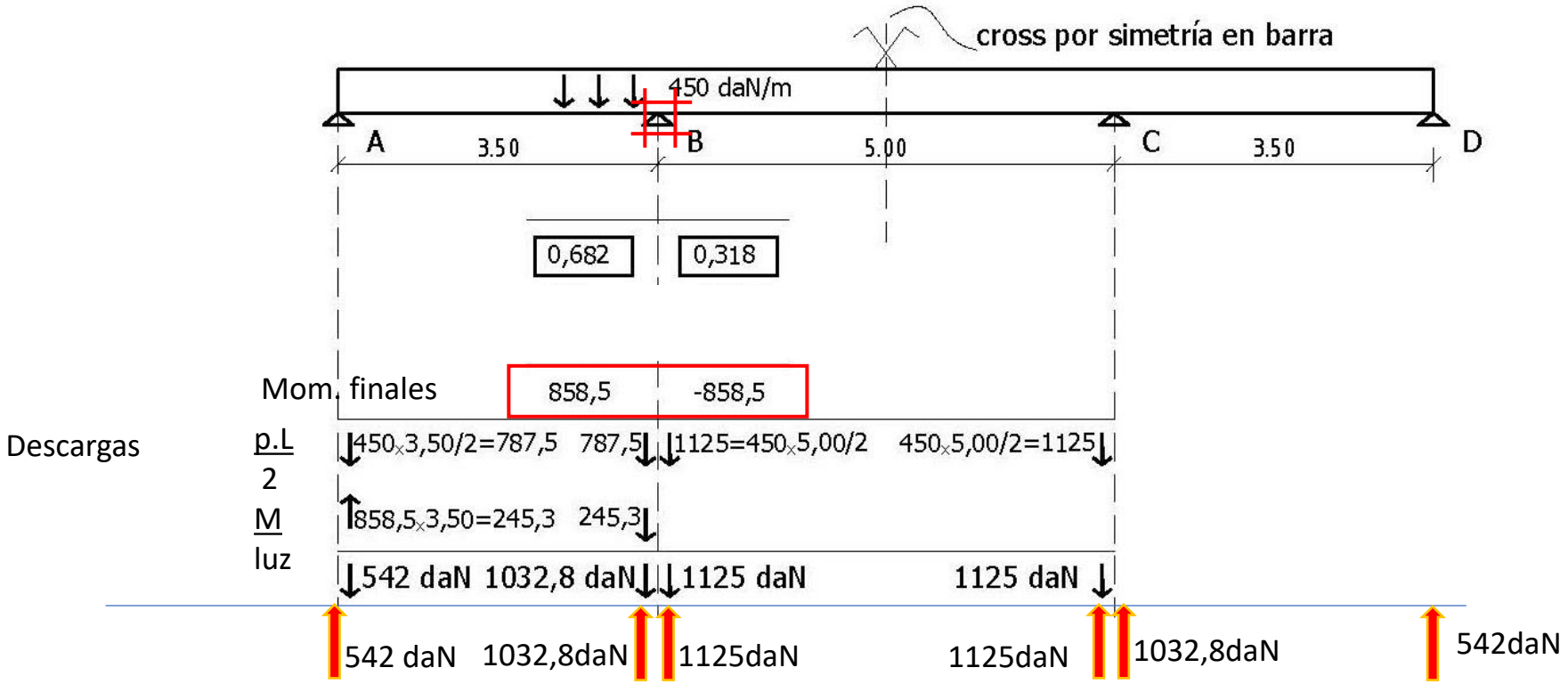

cross por simetría en barra
450 daN/m
A
3.50
B
5.00
C
3.50
D
0,682
0,318
Mom. finales
858,5
-858,5
Descargas
p.L
2
450x3,50/2=787,5
787,5
1125=450x5,00/2
450x5,00/2=1125
M
luz
858,5x3,50=245,3
245,3
542 daN
1032,8 daN
1125 daN
1125 daN


cross por simetría en barra
450 daN/m
A
3.50
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5.00
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D
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0,318
Mom. finales
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Descargas
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450x3,50/2=787,5
787,5
1125=450x5,00/2
450x5,00/2=1125
M
luz
858,5x3,50=245,3
245,3
542 daN
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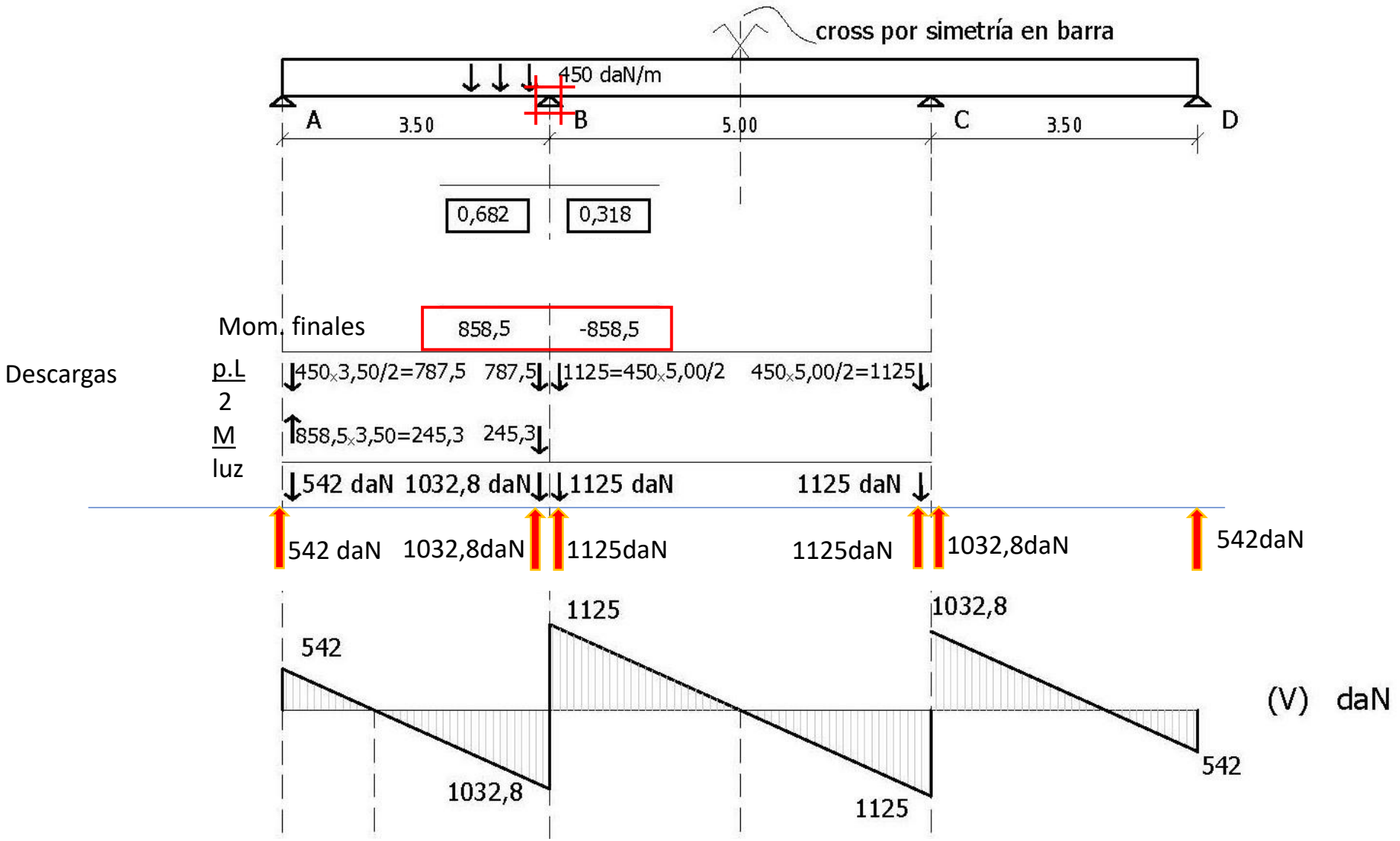
542 daN
1032,8daN
1125daN
1125daN
1032,8daN
542daN


cross por simetría en barra
450 daN/m
A
3.50
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5.00
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D
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Descargas
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858,5x3,50=245,3
245,3
542 daN
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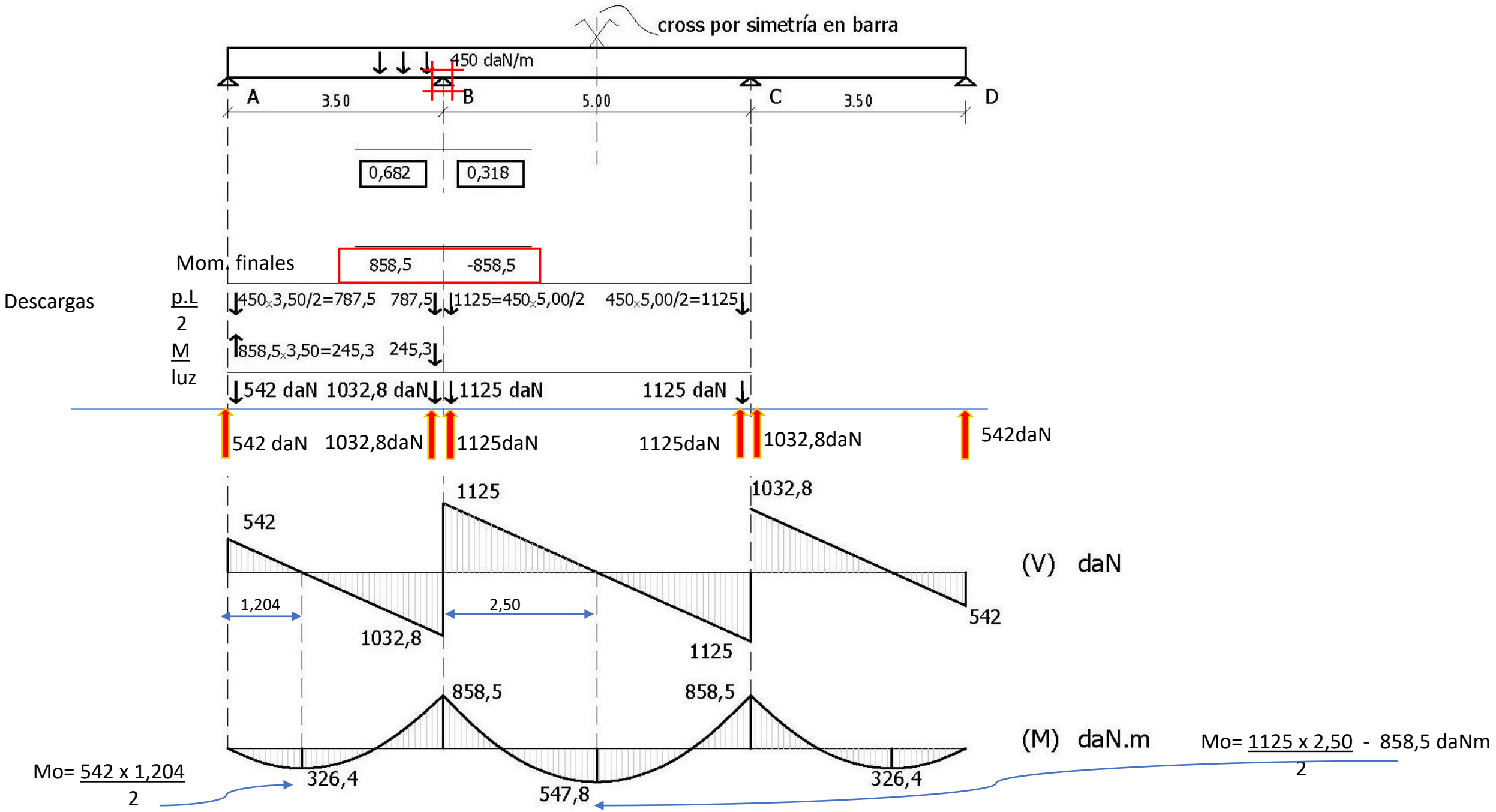
1125 daN
1125 daN
542 daN
1032,8daN
1125daN
1125daN
1032,8daN
542daN
1125
1032,8
542
1032,8
1125
542
(V) daN


cross por simetría en barra
450 daN/m
A
3.50
B
5.00
C
3.50
D
0,682
0,318
Mom. finales
858,5
-858,5
Descargas
p.L
2
450x3,50/2=787,5
787,5
1125=450x5,00/2
450x5,00/2=1125
M
luz
858,5x3,50=245,3
245,3
542 daN
1032,8 daN
1125 daN
1125 daN
542 daN
1032,8daN
1125daN
1125daN
1032,8daN
542daN
1125
1032,8
542
1,204
2,50
1032,8
1125
542
(V) daN
858,5
858,5
326,4
547,8
326,4
(M) daN.m
Mo= 542 x 1,204
2
Mo= 1125 x 2,50 - 858,5 daNm
2

TENSIONES NORMALES

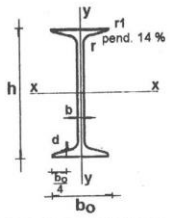
W_{nec} = 85850 daN.cm/1400 daN/cm^2 = 61,32 cm^3

PNI Nº 14 W_{res} = 81,09 cm^3

T_{real} = 85850 daN.cm/81,09 cm^3 =1058,7 daN/cm^2

verifica

Caracteristicas geométricas de elementos estructurales
PERFILES DE ACERO I



segun DIN 1025

largos normales: 4 a 15 m

h,bo,b,r,r1,d	mms
A	cms2
g	daN/m
Iy,Ix	cms4
Wx,Wy	cms3
ix,iy	cms
SLn	cms3

I	h	bo	b=r	d	r1	A	g	Ix	Wx	ix	Iy	Wy	iy	SLN
8	80	42	3.9	5.9	2.3	7.54	5.94	77.8	19.5	3.20	6.3	3.00	0.91	11.4
10	100	50	4.5	6.8	2.7	10.6	8.34	171	34.2	4.01	12.2	4.88	1.07	19.9
12	120	58	5.1	7.7	3.1	14.2	11.1	328	54.7	4.81	21.5	7.41	1.23	31.8
14	140	66	5.7	8.6	3.4	18.2	14.3	573	81.09	5.61	35.2	10.70	1.40	47.7
16	160	74	6.3	9.5	3.8	22.8	17.9	935	117	6.40	54.7	14.80	1.55	68.0
18	180	82	6.9	10.4	4.1	27.9	21.9	1450	161	7.20	81.3	19.80	1.71	93.4

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verifica

TENSIONES RASANTES

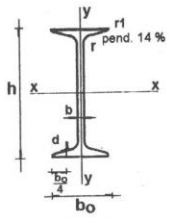
T_{adm}=1120 daN.cm^2

A_{alma}= 0,57(14-0,86x2)=6,999 cm^2

T_{real} =1125 daN/6,999 cm^2 = 160,7 daN/cm^2

verifica

Caracteristicas geométricas de elementos estructurales
PERFILES DE ACERO I



segun DIN 1025

largos normales: 4 a 15 m

h,bo,b,r,r1,d	mms
A	cms2
g	daN/m
Iy,Ix	cms4
Wx,Wy	cms3
ix,iy	cms
SLn	cms3

I	h	bo	b=r	d	r1	A	g	Ix	Wx	ix	Iy	Wy	iy	SLN
8	80	42	3.9	5.9	2.3	7.54	5.94	77.8	19.5	3.20	6.3	3.00	0.91	11.4
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12	120	58	5.1	7.7	3.1	14.2	11.1	328	54.7	4.81	21.5	7.41	1.23	31.8
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18	180	82	6.9	10.4	4.1	27.9	21.9	1450	161	7.20	81.3	19.80	1.71	93.4

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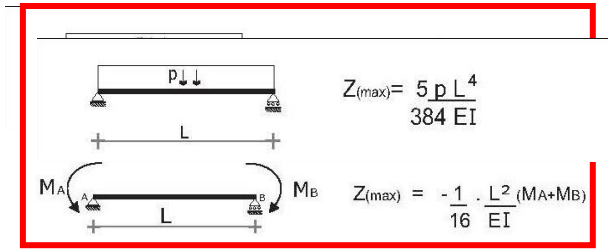
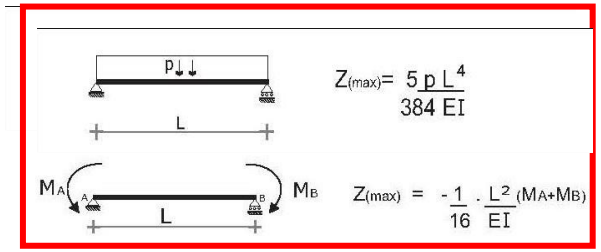


DEFORMACIONES

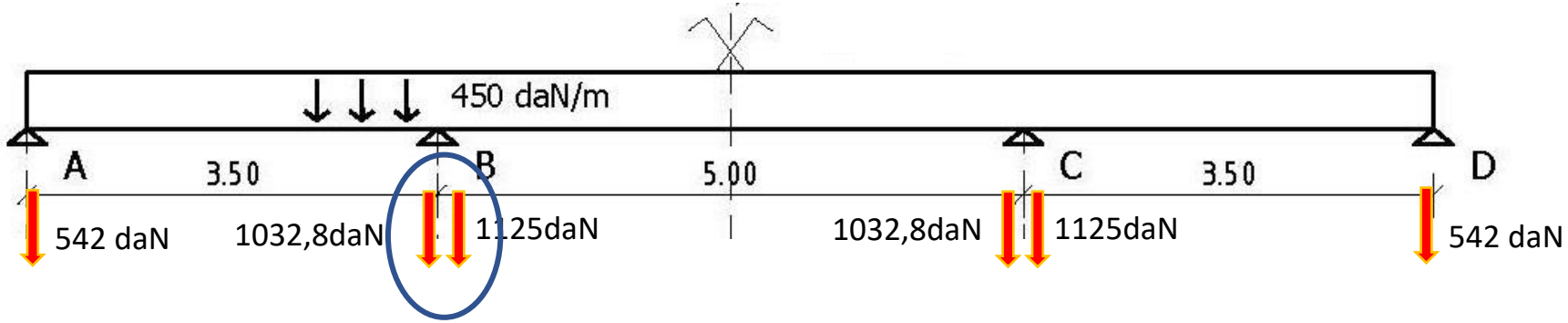


$$Z_{máx} = \frac{5 \cdot 4{,}50 daN/cm \cdot 500^4 cm}{384 \cdot 2100000 \cdot 573} - \frac{1}{16} \cdot \frac{500^2 (858{,}5 + 858{,}5)}{2100000 \cdot 573}$$

Zmáx= 0,814 cm – 0,022cm = 0,818 cm

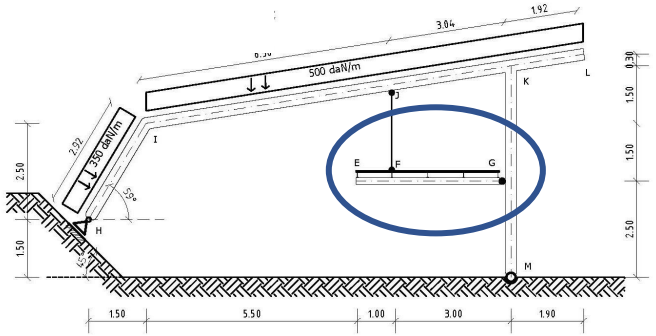
Zadm= $\frac{luz}{500}$ Zadm= $\frac{500}{500}$ = 1 cm

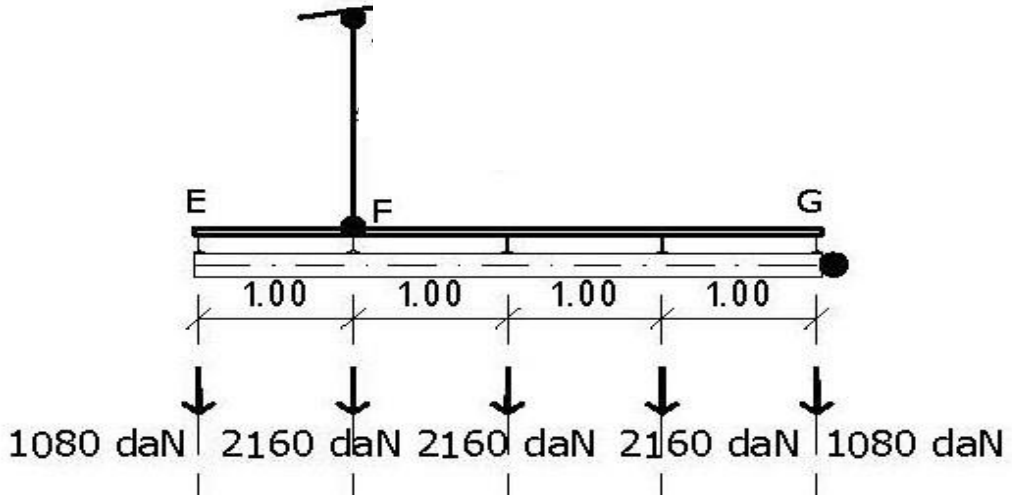
verifica

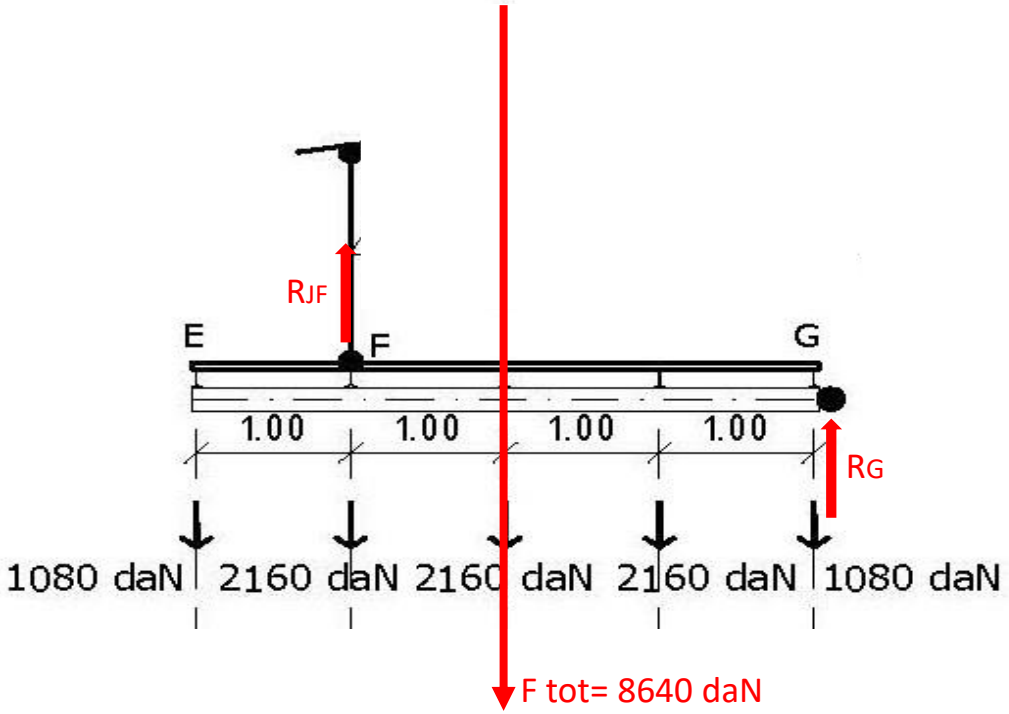


2160 daN

Descarga sobre EFG
Entrepiso de pórtico intermedio







Equilibrio EFG

F tot= 2160 x 3 + 1080 x 2 = 8640 daN

$\sum F\ V = 0$

R JF + RG = 8640 daN

$\sum FH = 0$

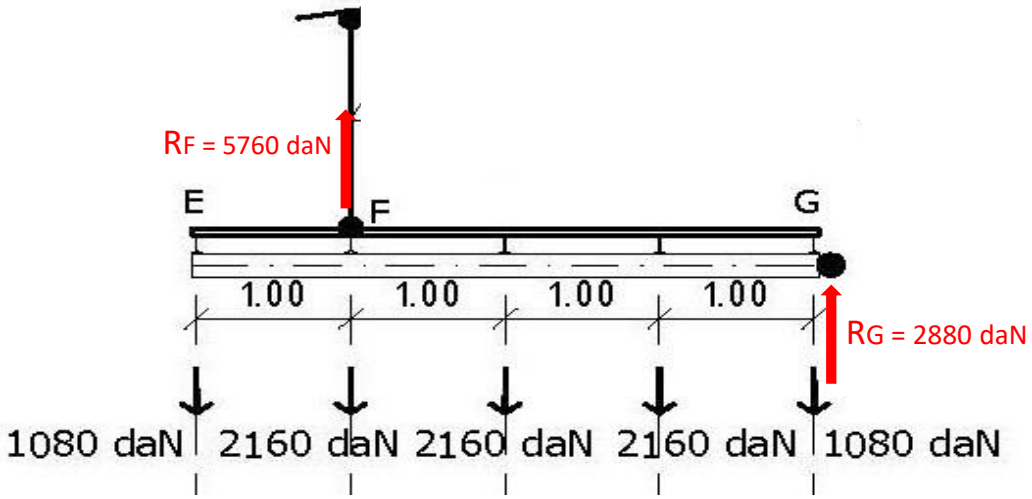
$\sum M = 0$

MG= 8640 x 2 – RF x 3 = 0

$RF = \frac{8640 \times 2}{3}$

RF= 5760 daN

RG= 2880 daN



Equilibrio EFG

F tot= 2160 x 3 + 1080 x 2 = 8640 daN

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R F + RG = 8640 daN

$\sum$ FH = 0

$\sum$ M = 0
MG= 8640 x 2 – RF x 3 = 0
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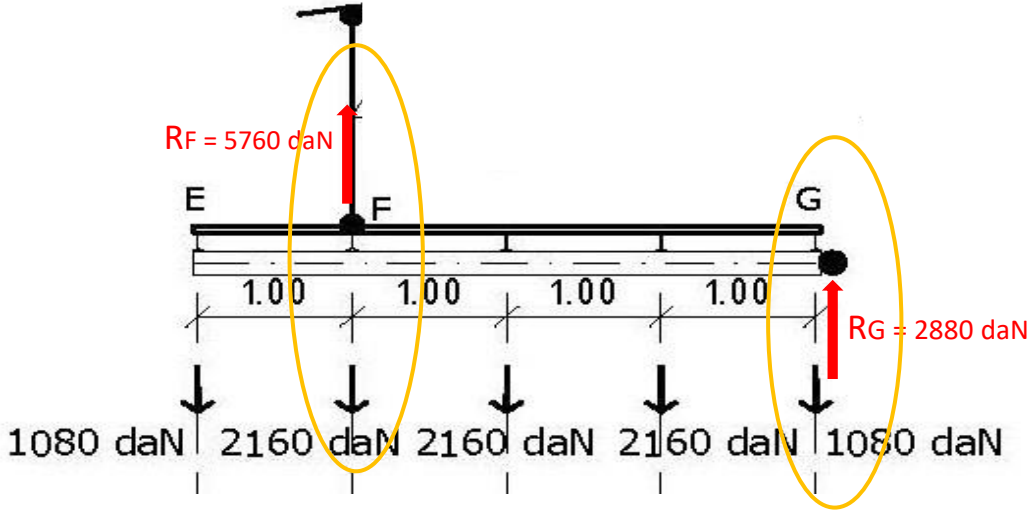
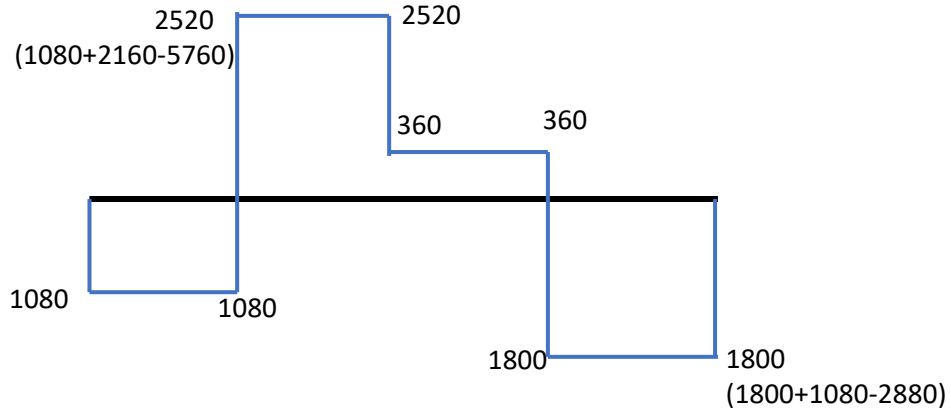
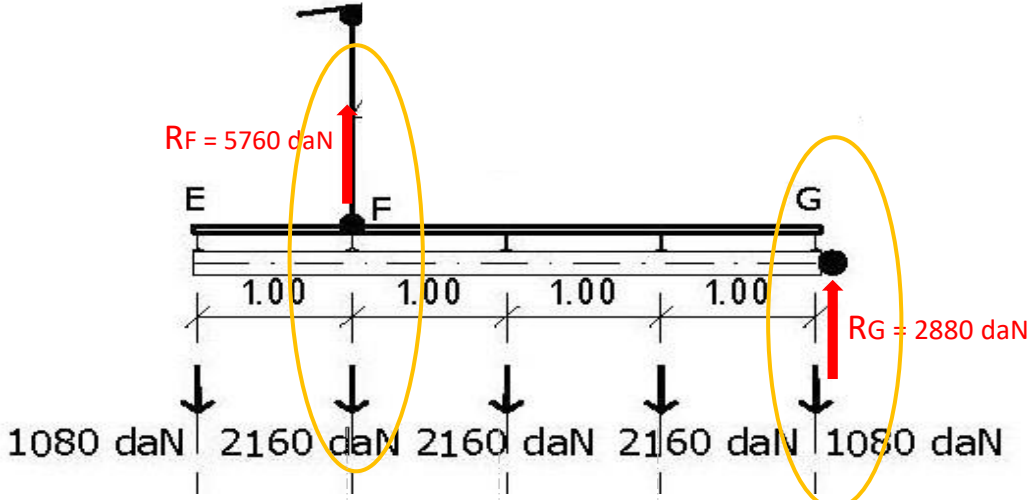
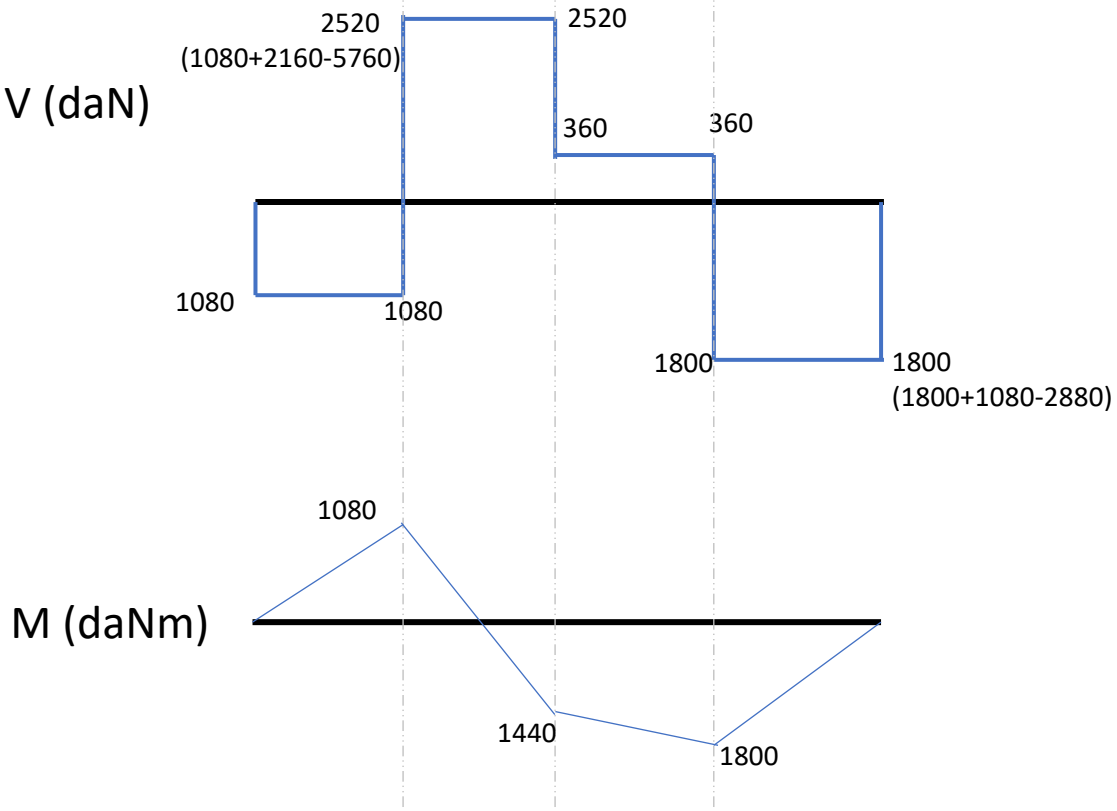
RF= 5760 daN
RG= 2880 daN


RF = 5760 daN
E
F
G
1.00
1.00
1.00
1.00
RG = 2880 daN
1080 daN
2160 daN
2160 daN
2160 daN
1080 daN

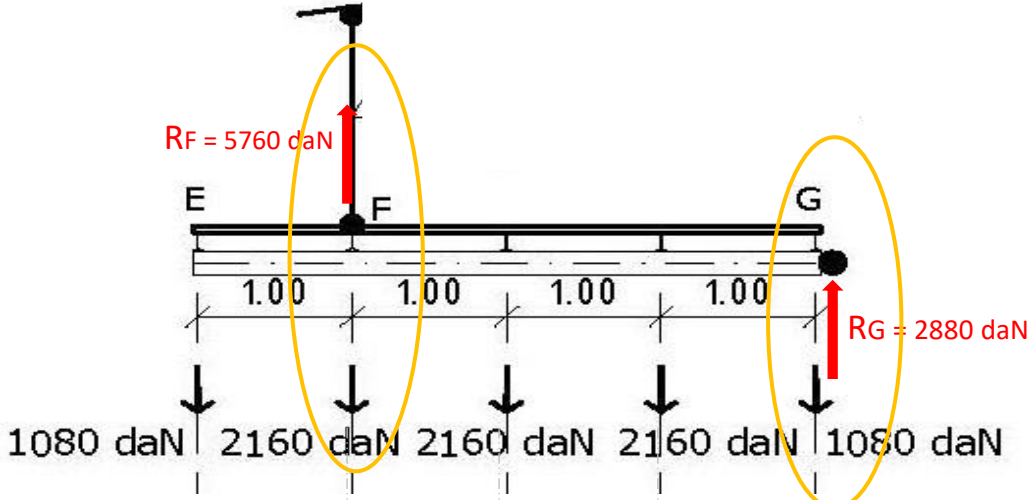
V (daN)

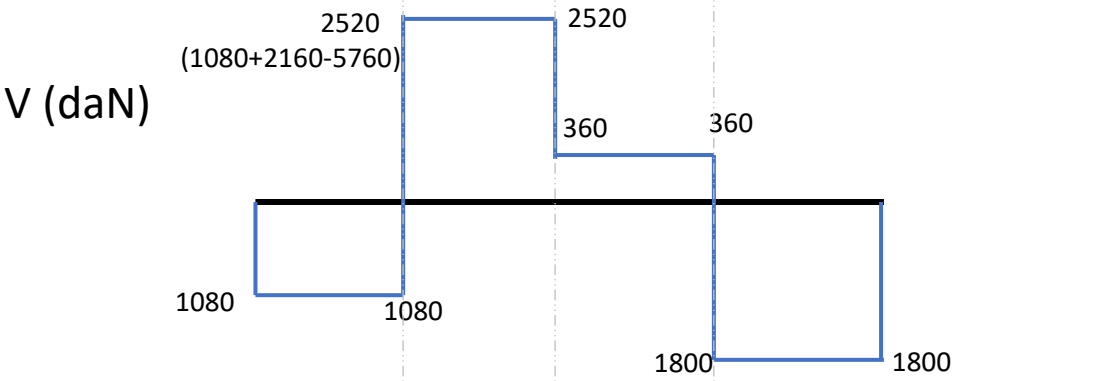

2520
(1080+2160-5760)
2520
360
360
1080
1080
1800
1800
(1800+1080-2880)

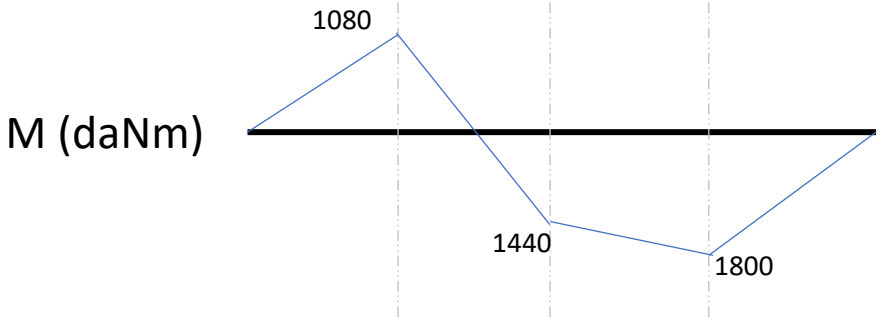

RF = 5760 daN
E
F
G
1.00
1.00
1.00
1.00
RG = 2880 daN
1080 daN
2160 daN
2160 daN
2160 daN
1080 daN


V (daN)
2520
(1080+2160-5760)
2520
360
360
1080
1080
1800
1800
(1800+1080-2880)

M (daNm)
1080
1440
1800







BARRAS DE SECCION CIRCULAR										
DIAMETRO (mm)	6	8	10	12	14	16	20	25	32	40
PERIMETRO (cm)	1.885	2.513	3.142	3.770	4,398	5,026	6,283	7.854	10,053	12,566
PESO (daN/ml)	0.222	0.395	0.617	0.888	1,208	1,578	2,466	3,853	6,313	9.865
SECCION (cm2)	0.283	0.503	0.785	1.131	1,539	2,011	3,141	4.909	8,042	12,566

3- DIMESIONADO DEL TENSOR FJ

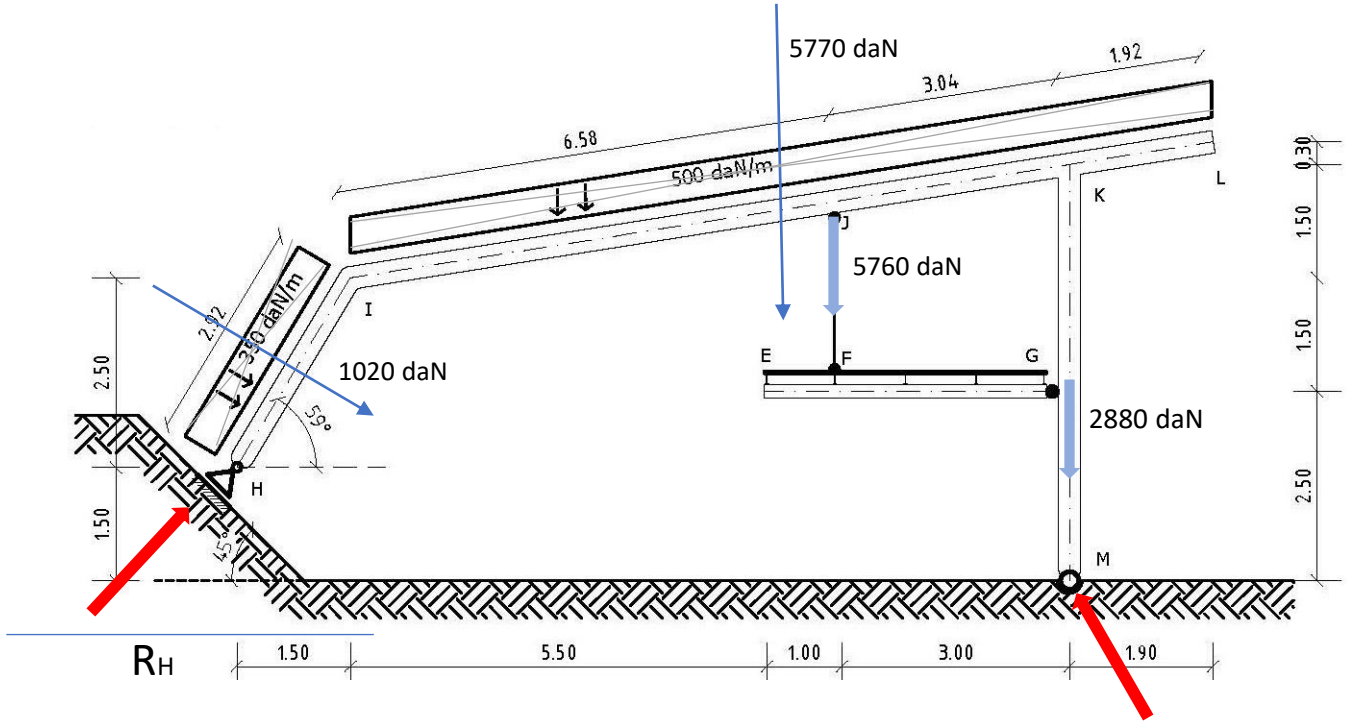
TENSIONES NORMALES

A_{nec} = 5760 daN /1400 daN/cm^2 = 4,11 cm^2

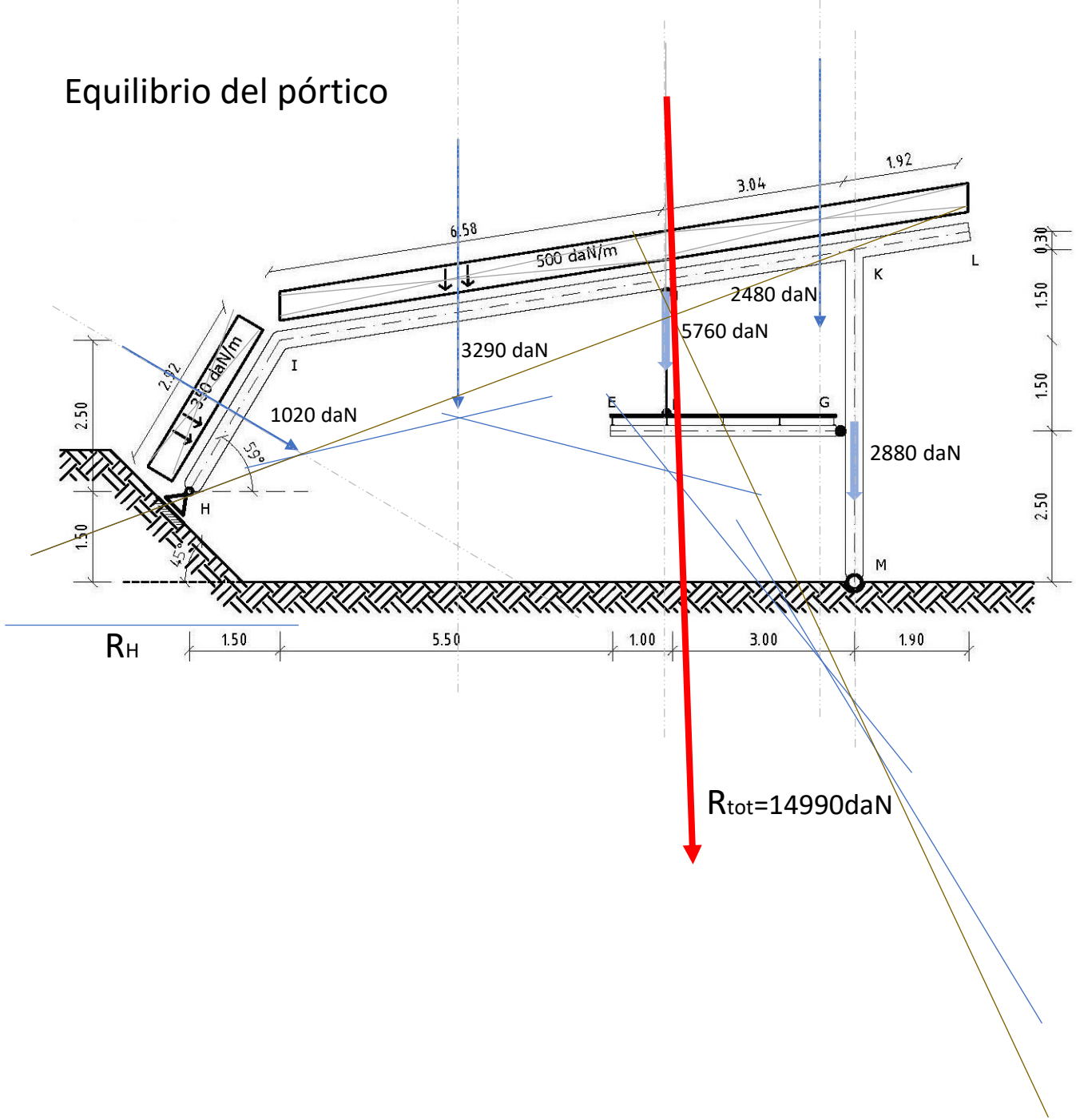
Ø 25 A= 4,909 cm2

Tensión Real= 5760 daN/4,909 cm2 = 1173 daN/cm2 verifica

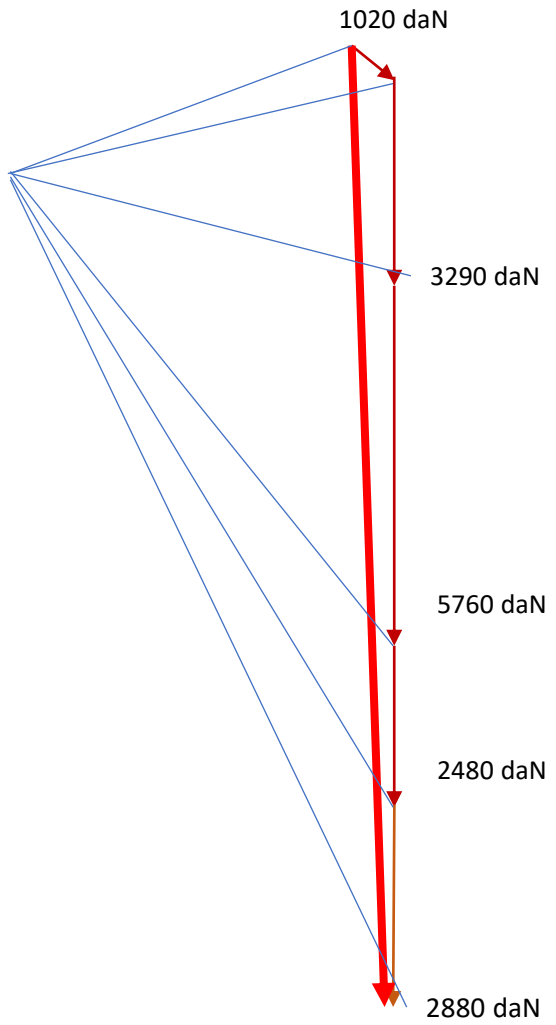
Equilibrio del pórtico



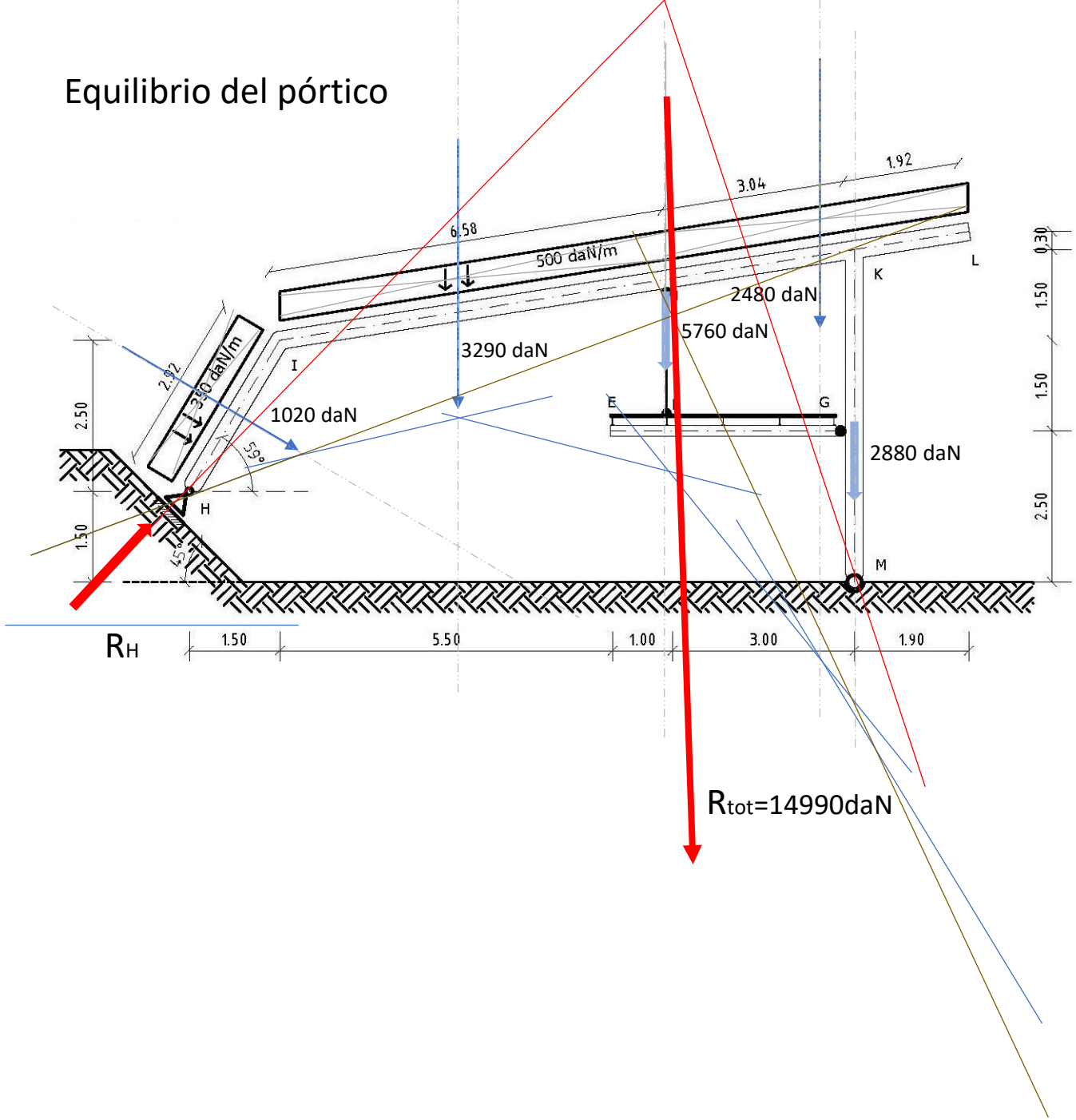
Equilibrio del pórtico



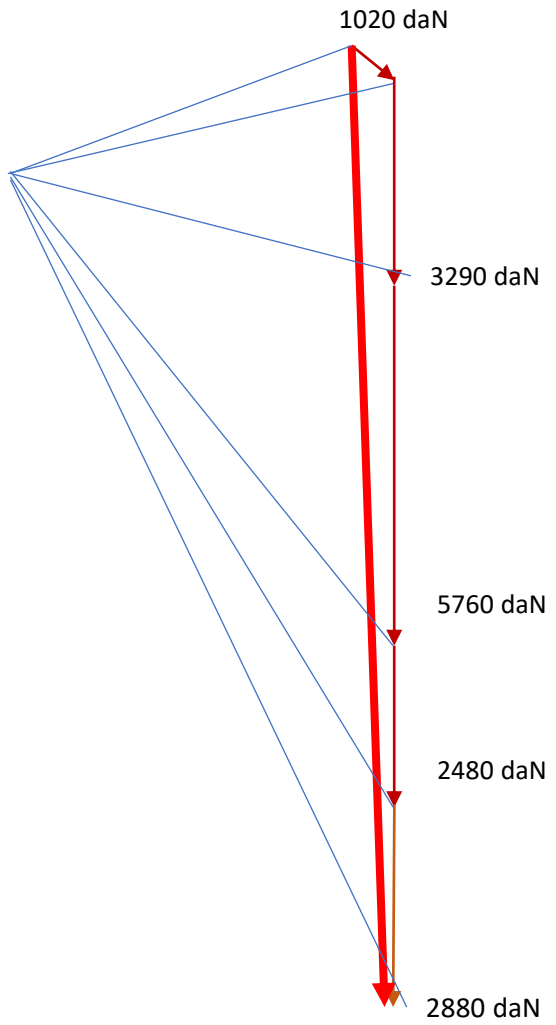
Plano Operatorio



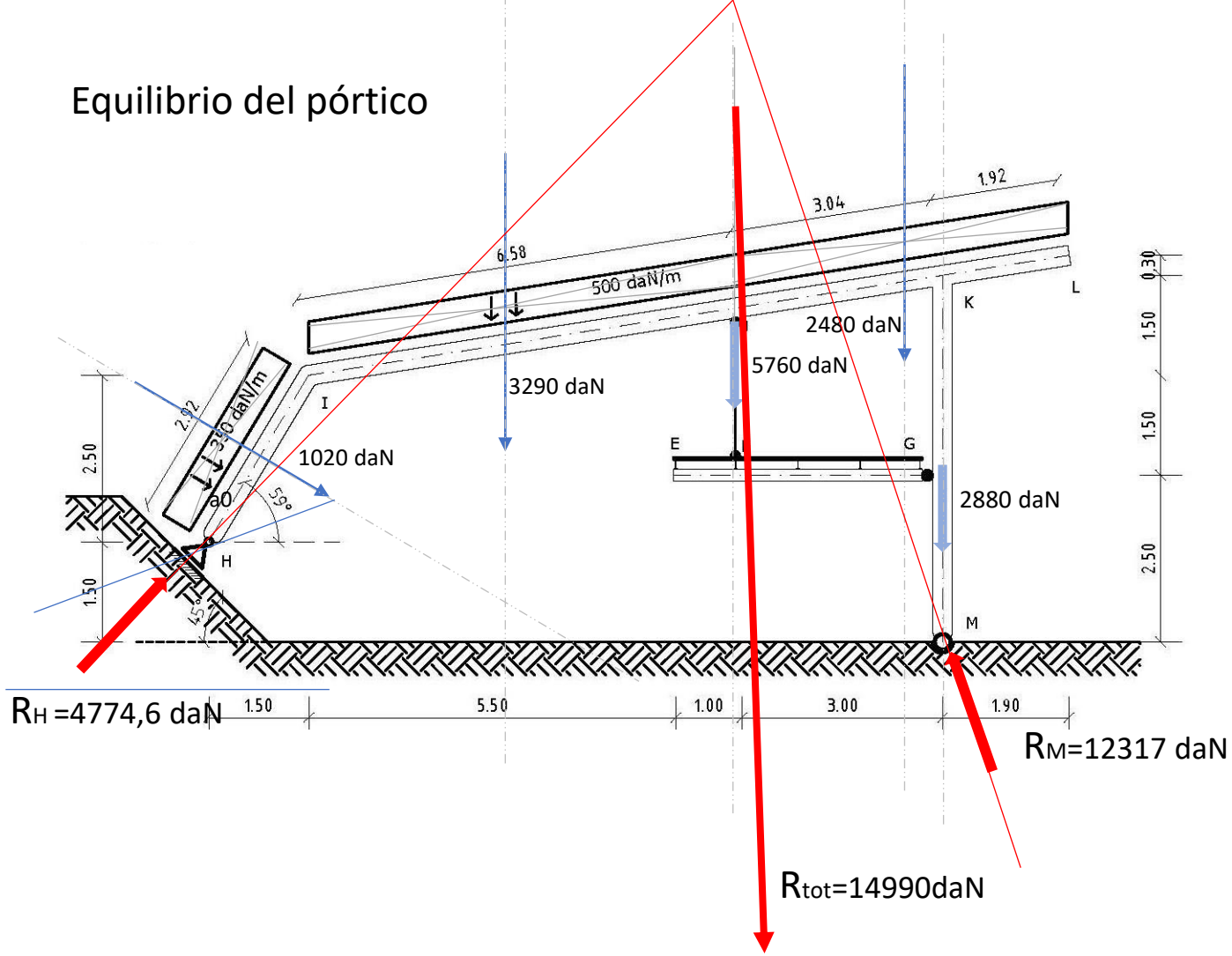
Equilibrio del pórtico



Plano Operatorio



Equilibrio del pórtico

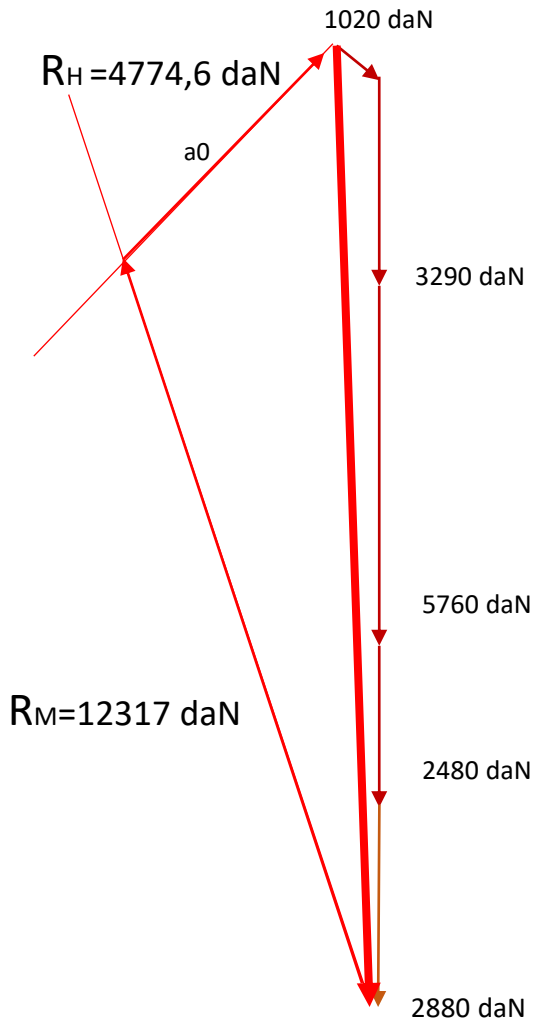


R_H =4774,6 daN

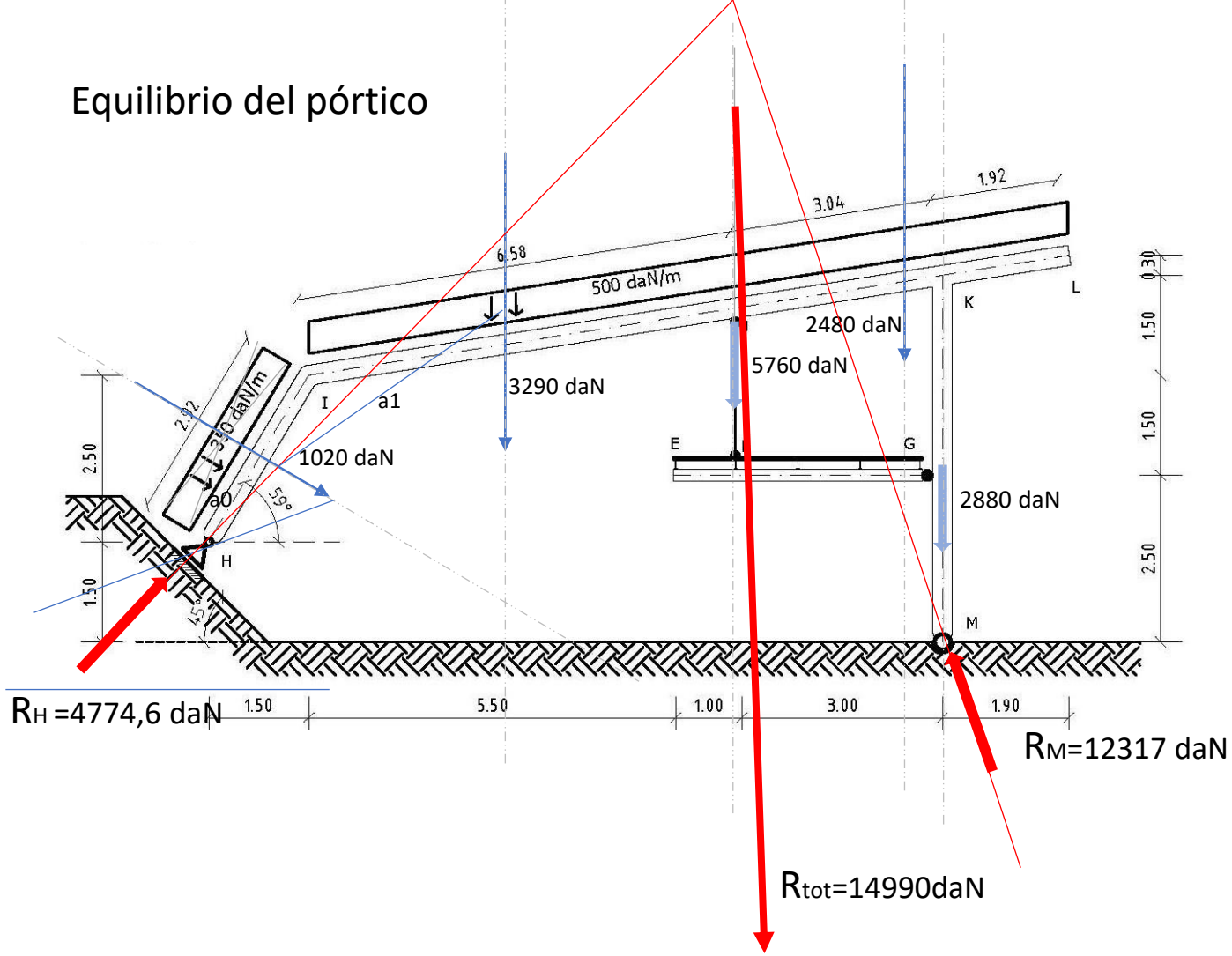
R_M=12317 daN

R_{tot}=14990daN

Plano Operatorio



Equilibrio del pórtico

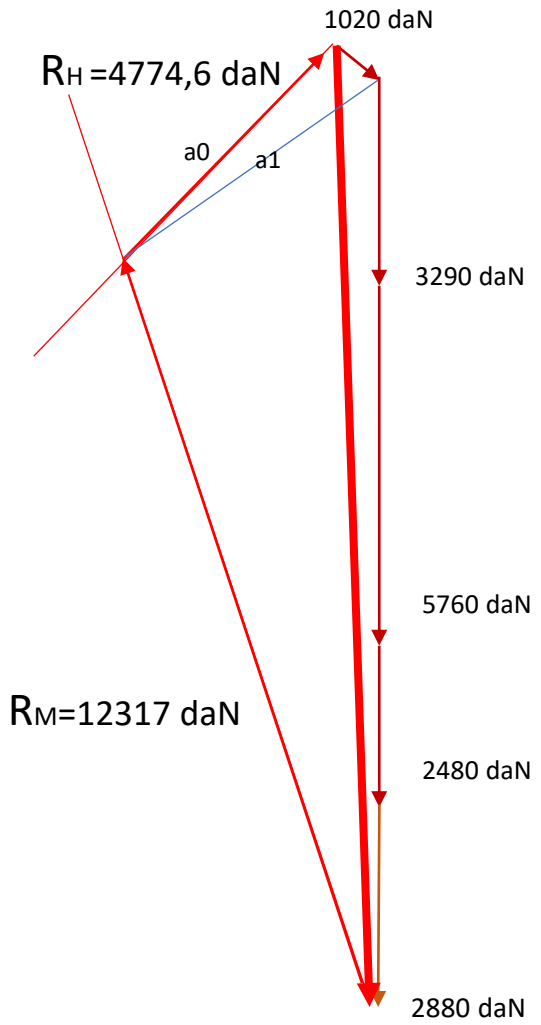


R_H =4774,6 daN

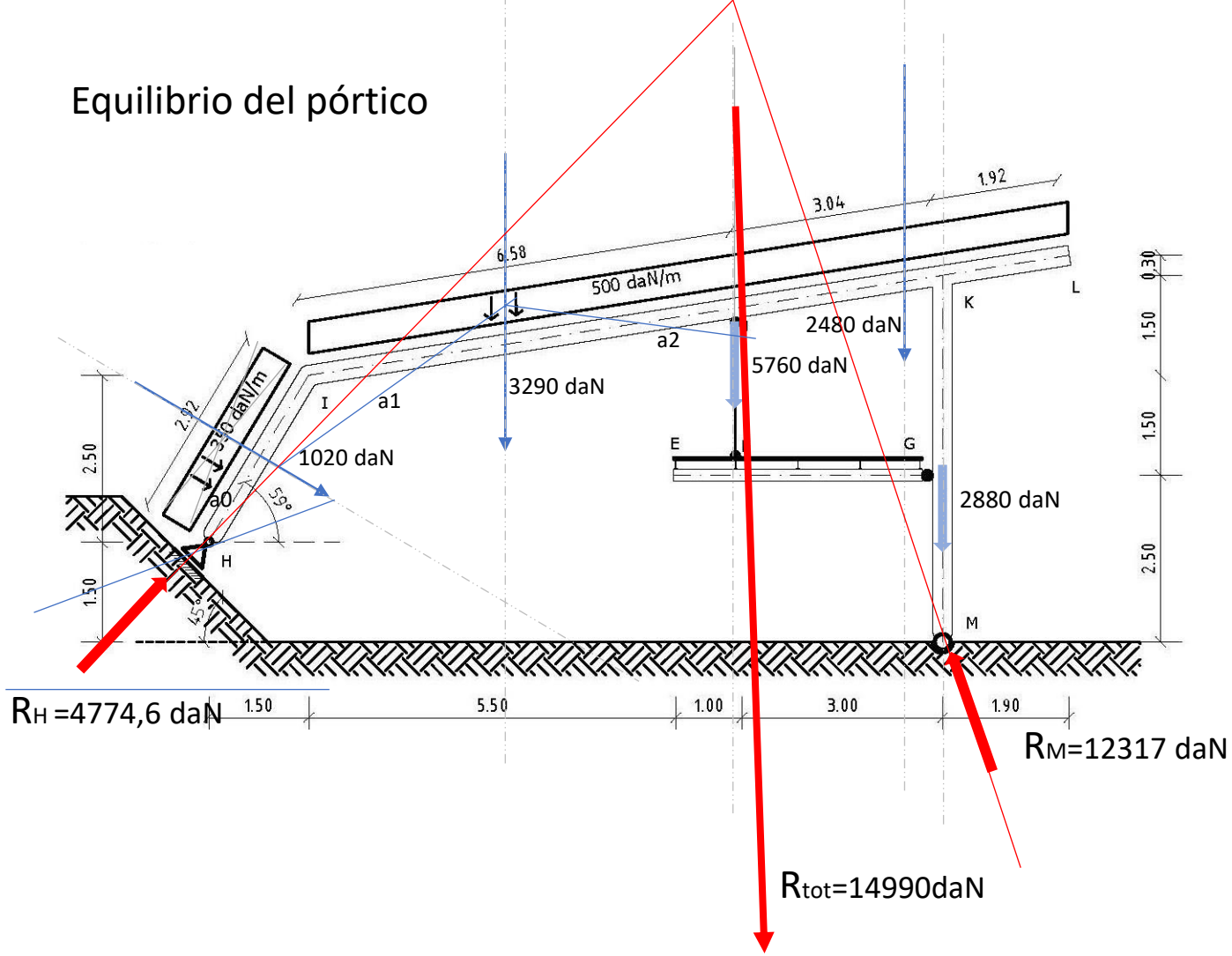
R_M=12317 daN

R_{tot}=14990daN

Plano Operatorio



Equilibrio del pórtico

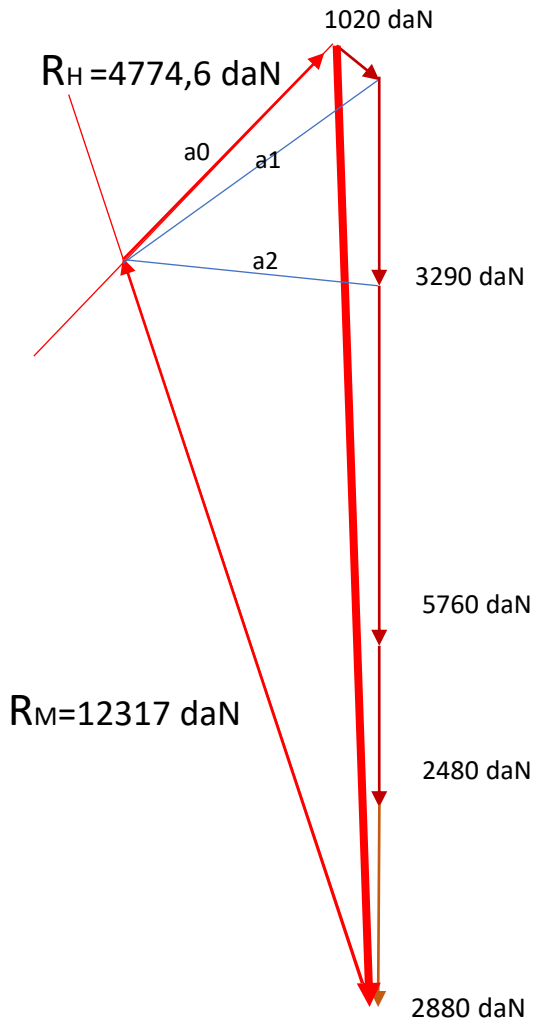


R_H =4774,6 daN

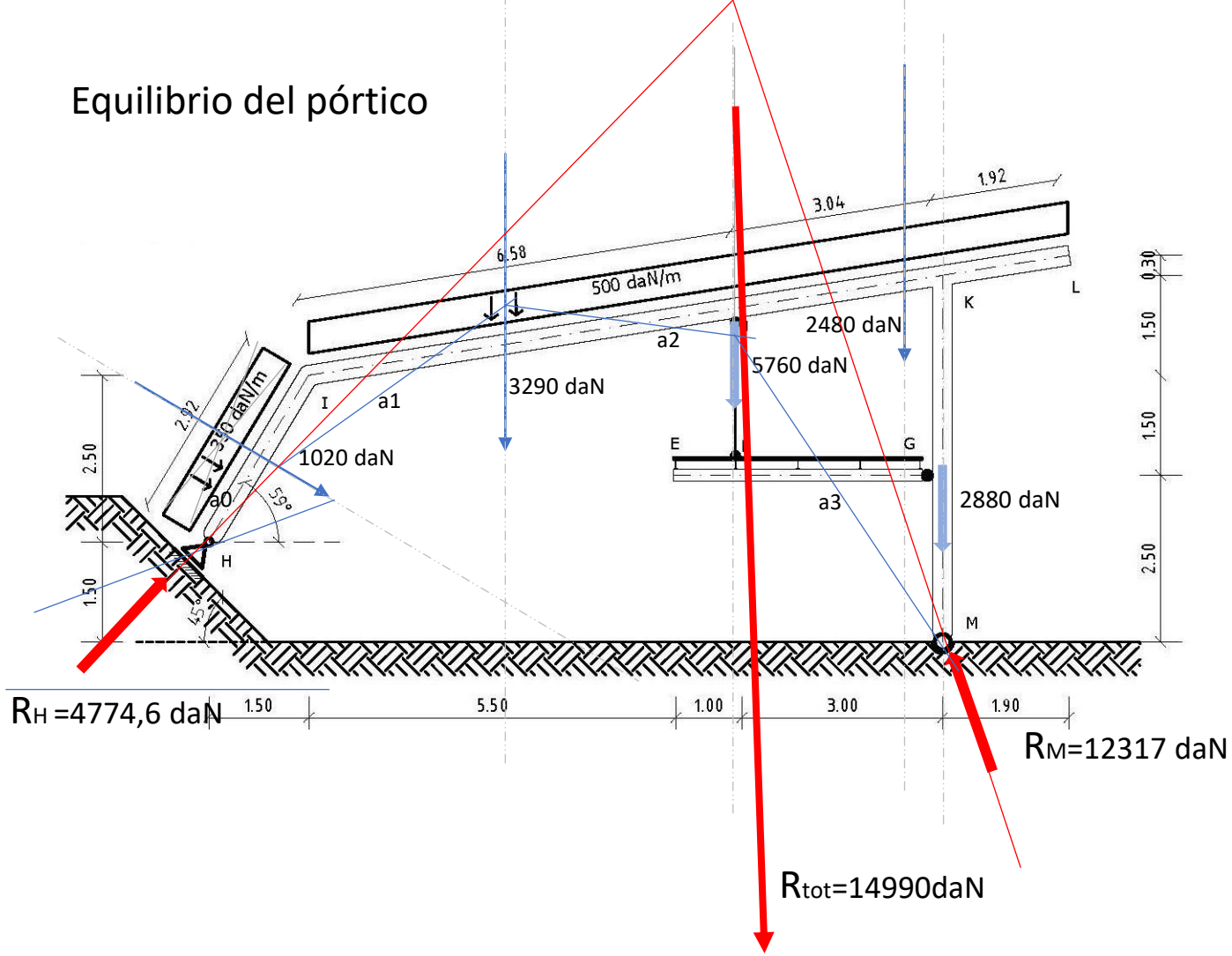
R_M=12317 daN

R_{tot}=14990daN

Plano Operatorio



Equilibrio del pórtico

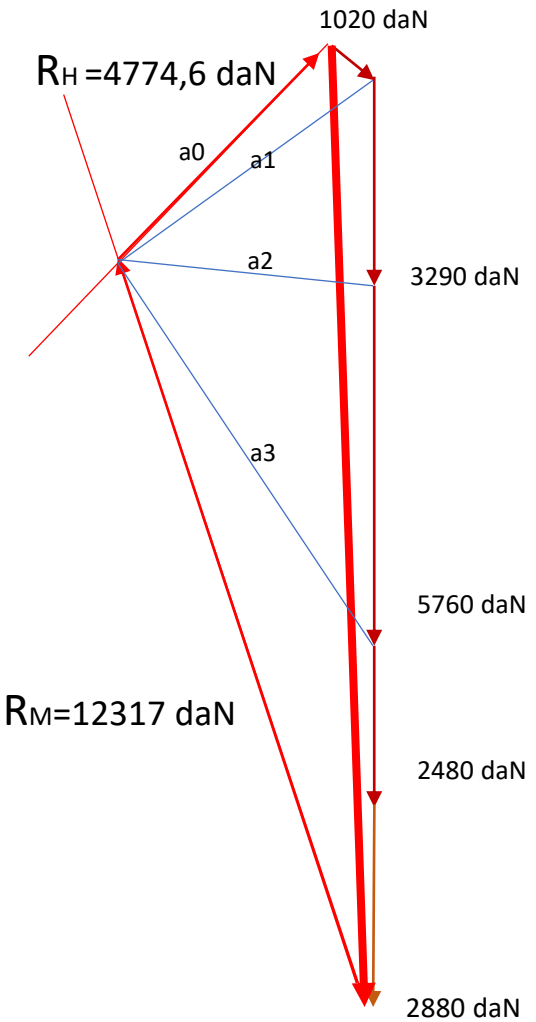


R_H =4774,6 daN

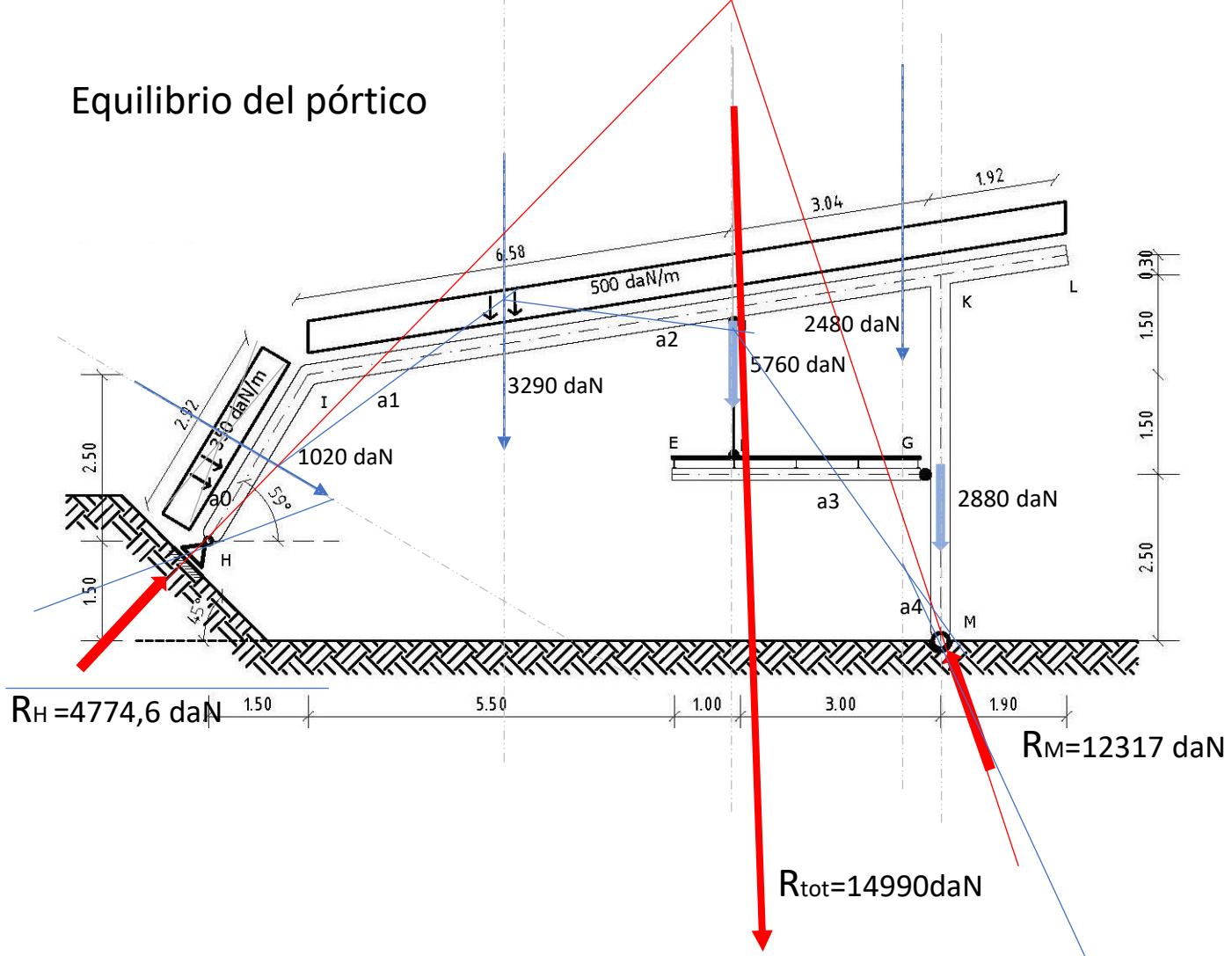
R_M=12317 daN

R_{tot}=14990daN

Plano Operatorio



Equilibrio del pórtico

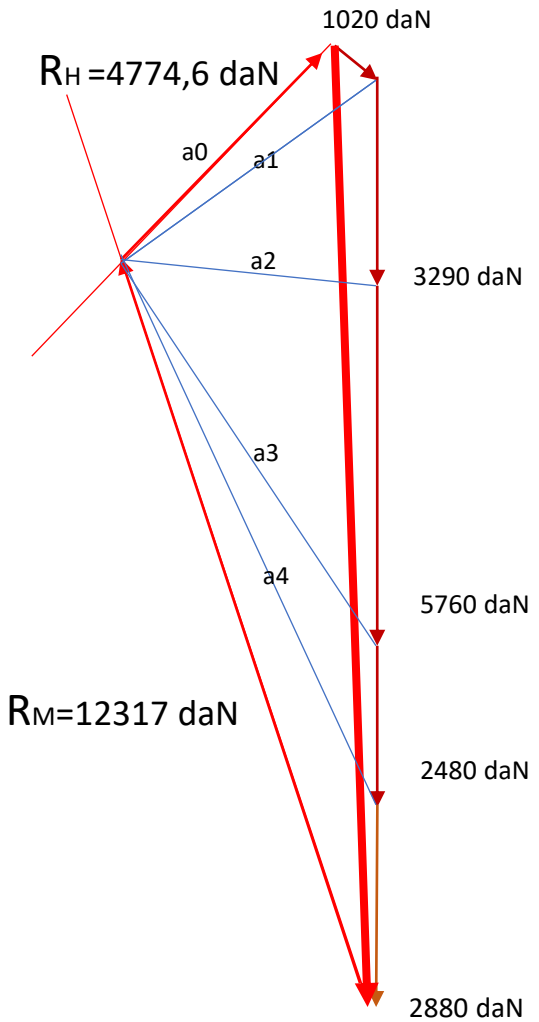


R_H =4774,6 daN

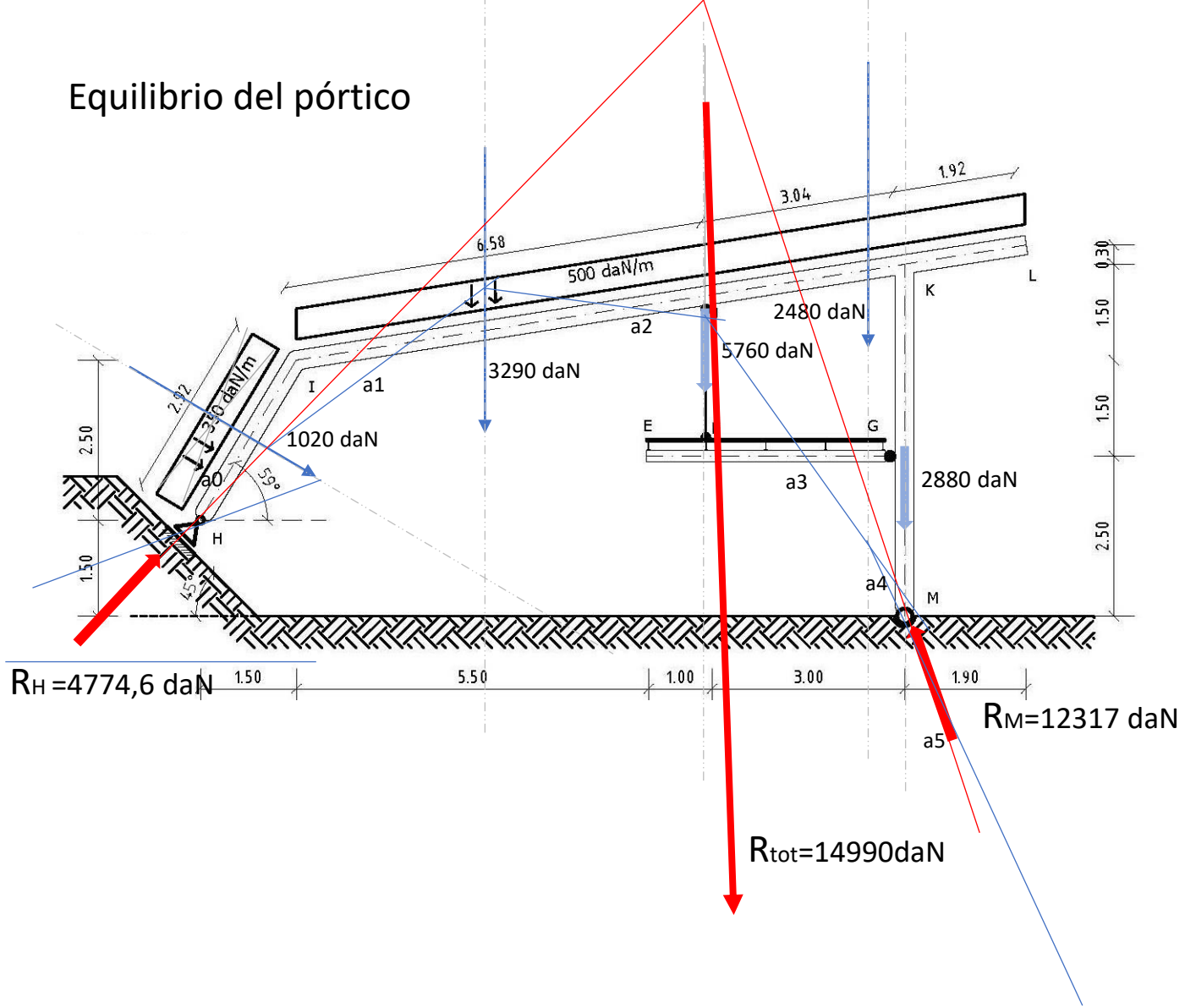
R_M=12317 daN

R_{tot}=14990daN

Plano Operatorio



Equilibrio del pórtico

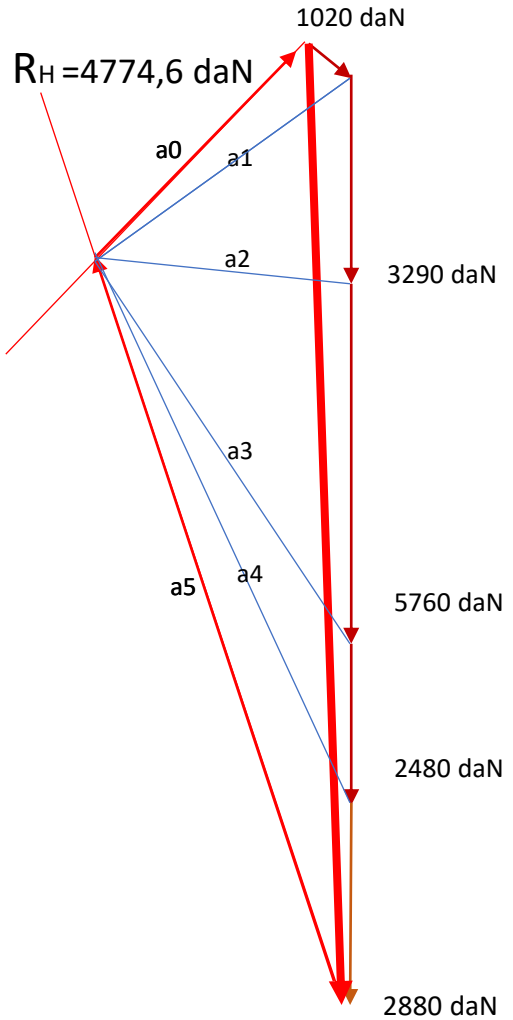


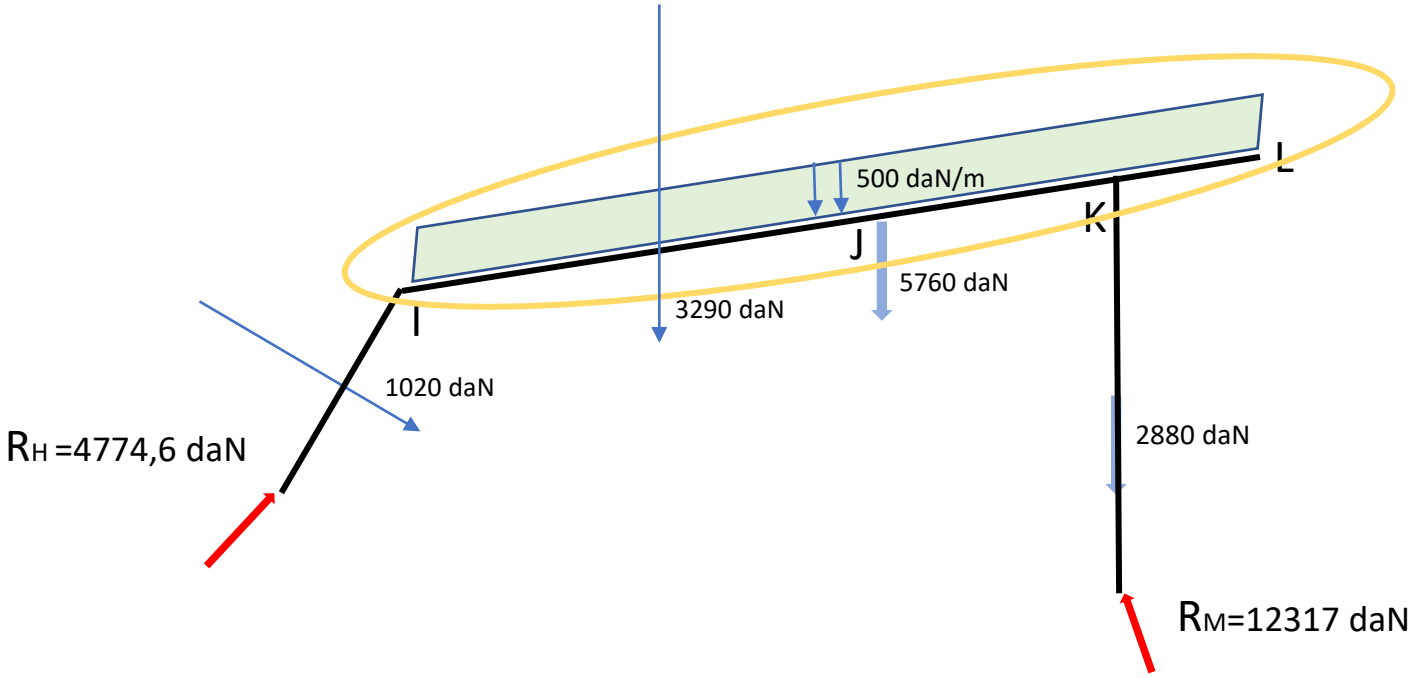
R_H =4774,6 daN

R_M=12317 daN

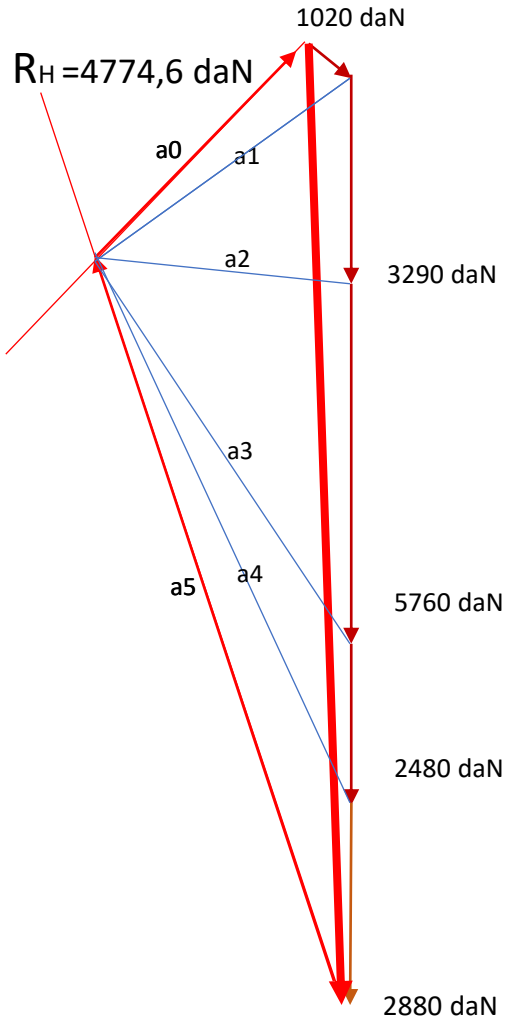
R_{tot}=14990daN

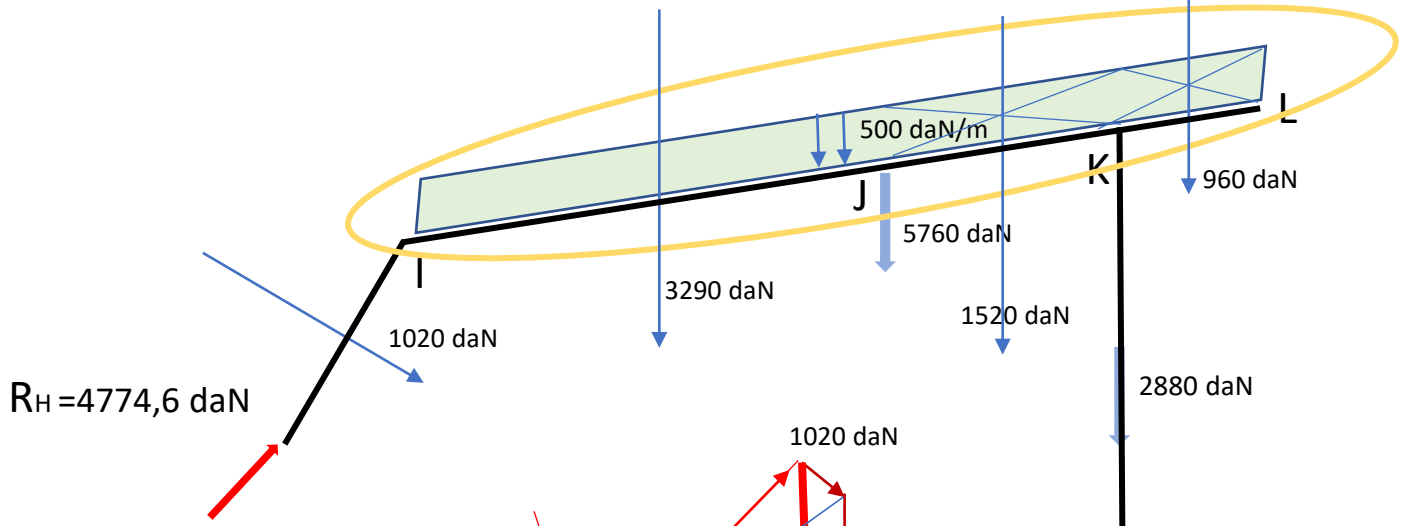
Plano Operatorio





Plano Operatorio





Plano Operatorio

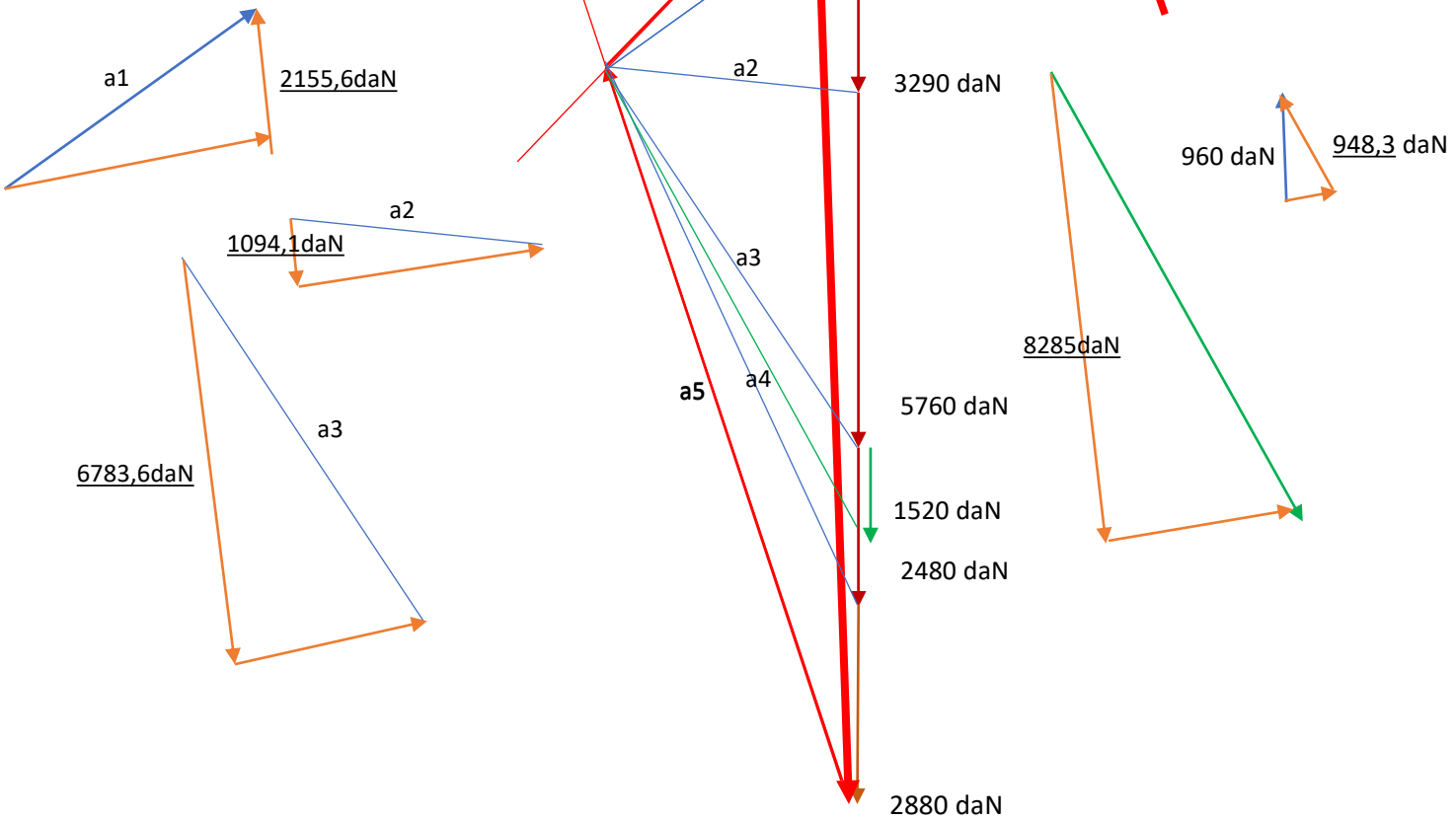
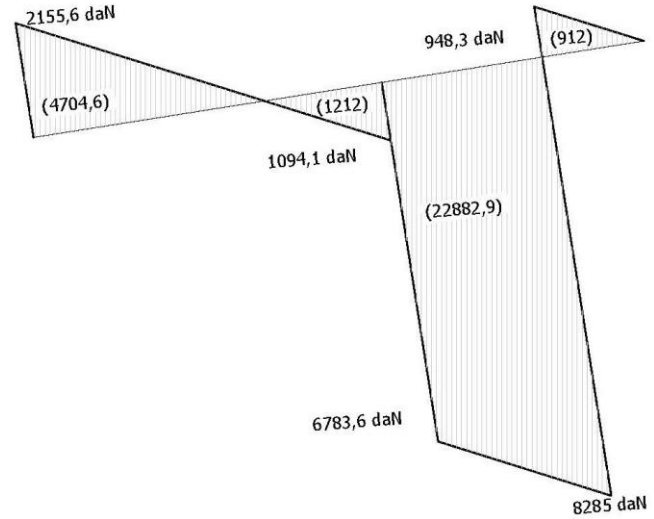
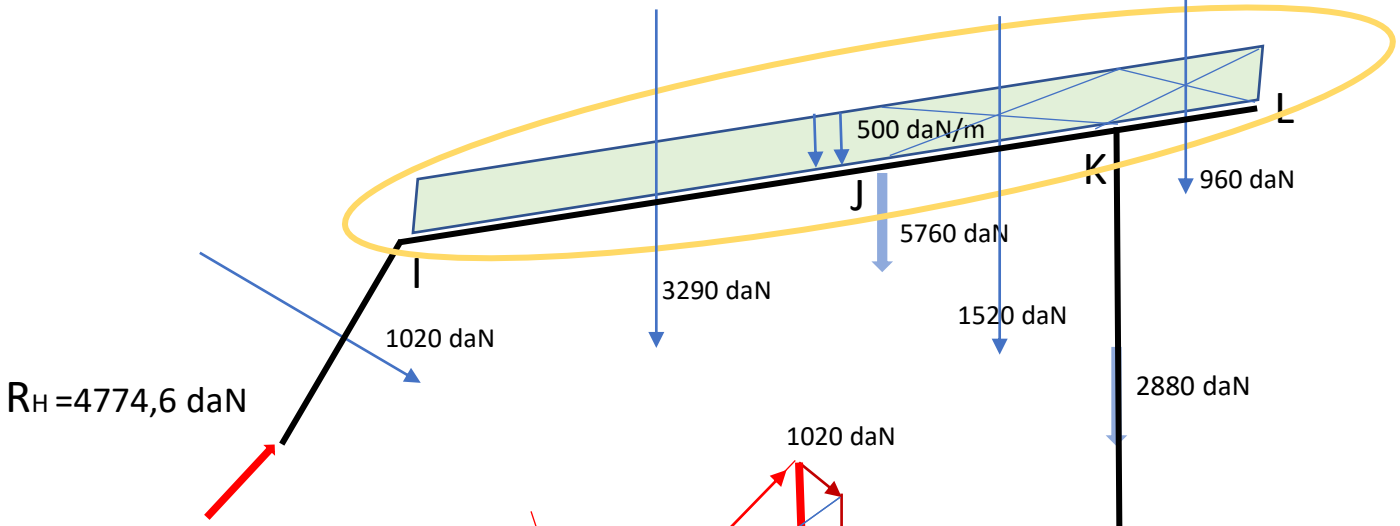


Diagrama CORTANTE (daN)





Plano Operatorio

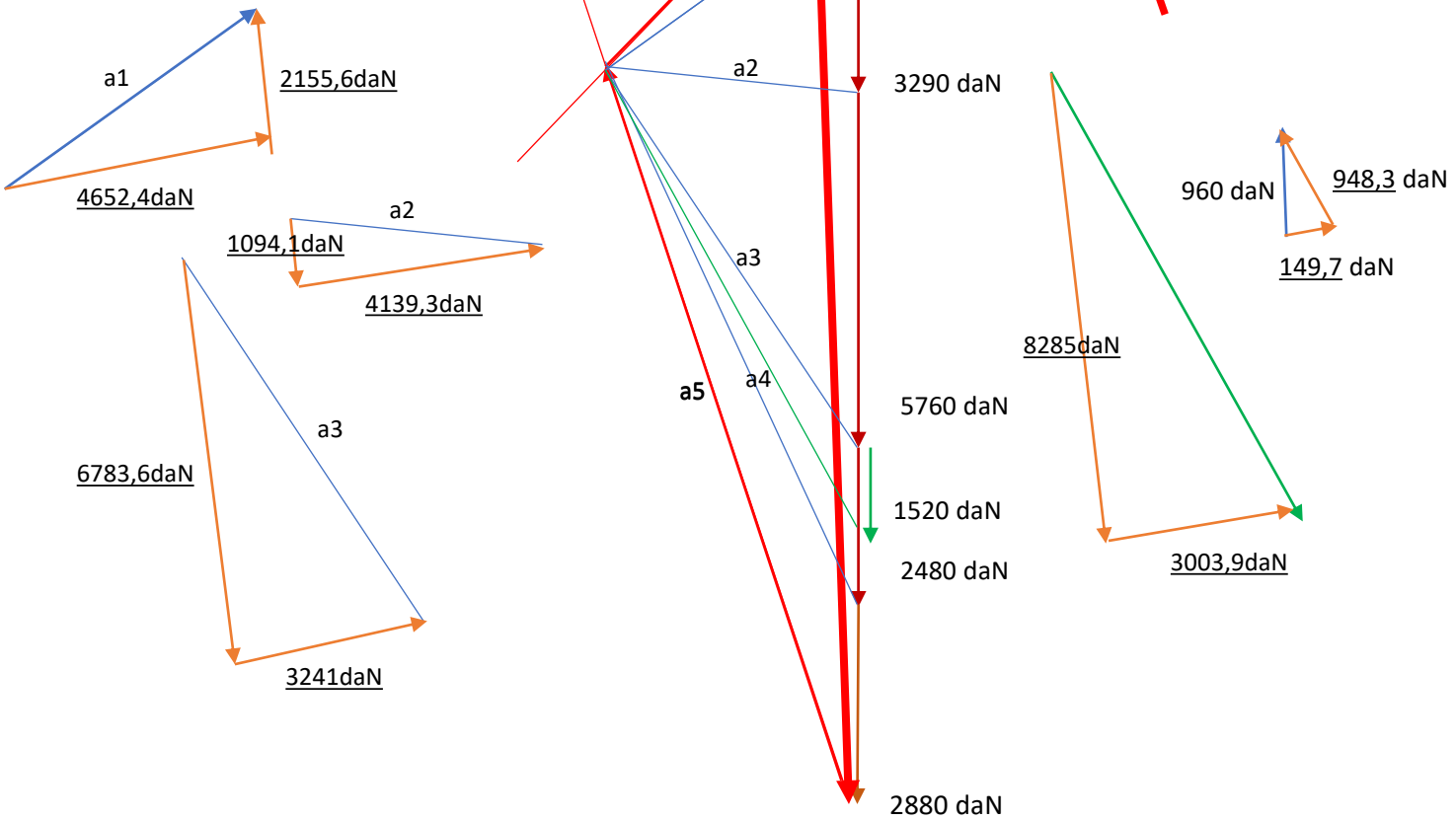


Diagrama CORTANTE (daN)

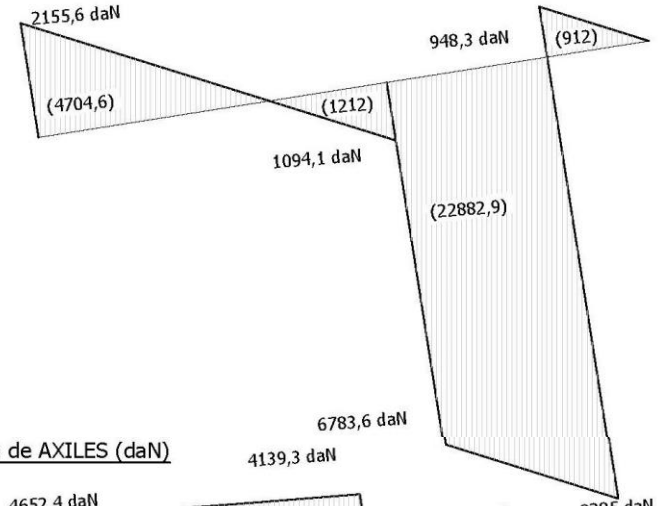
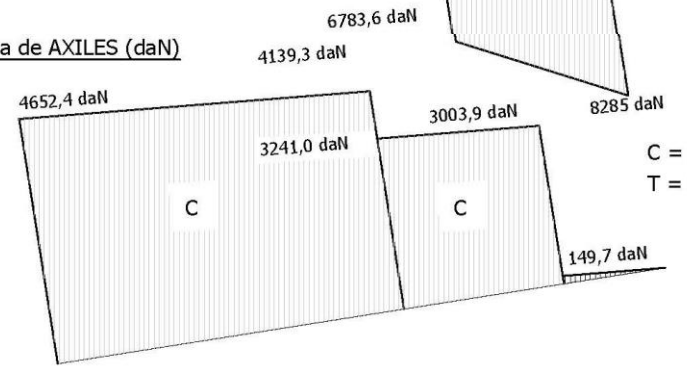
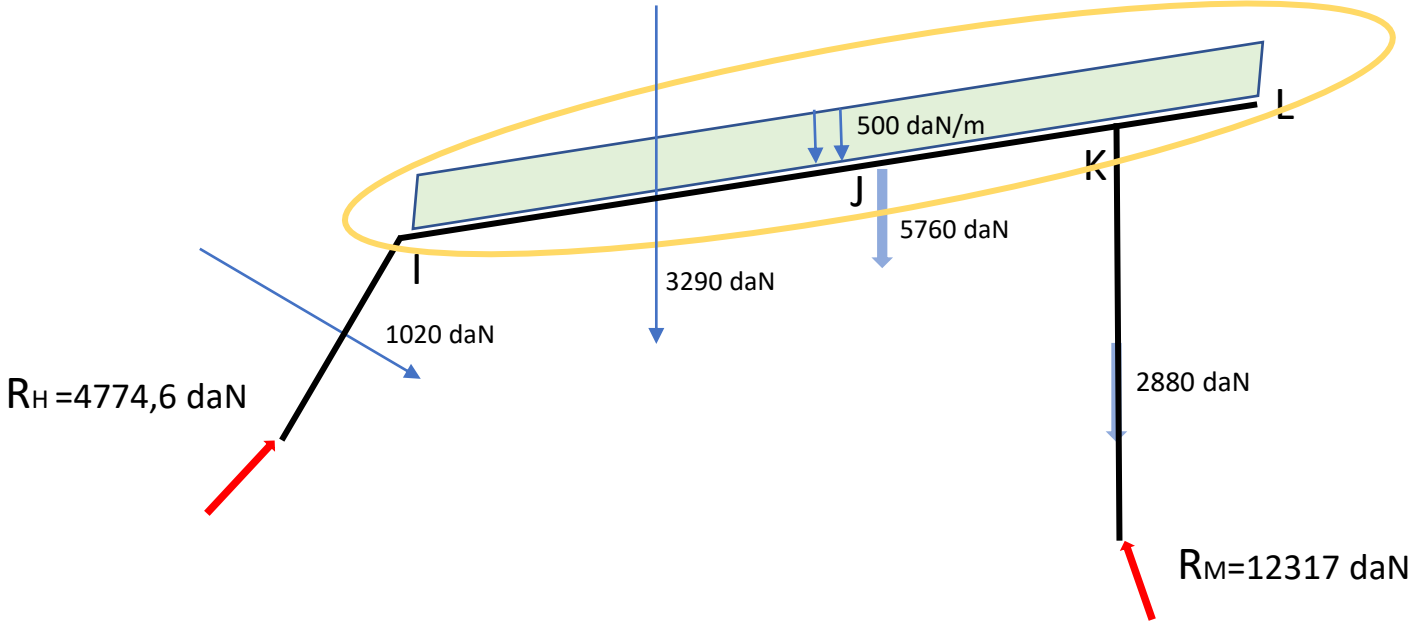
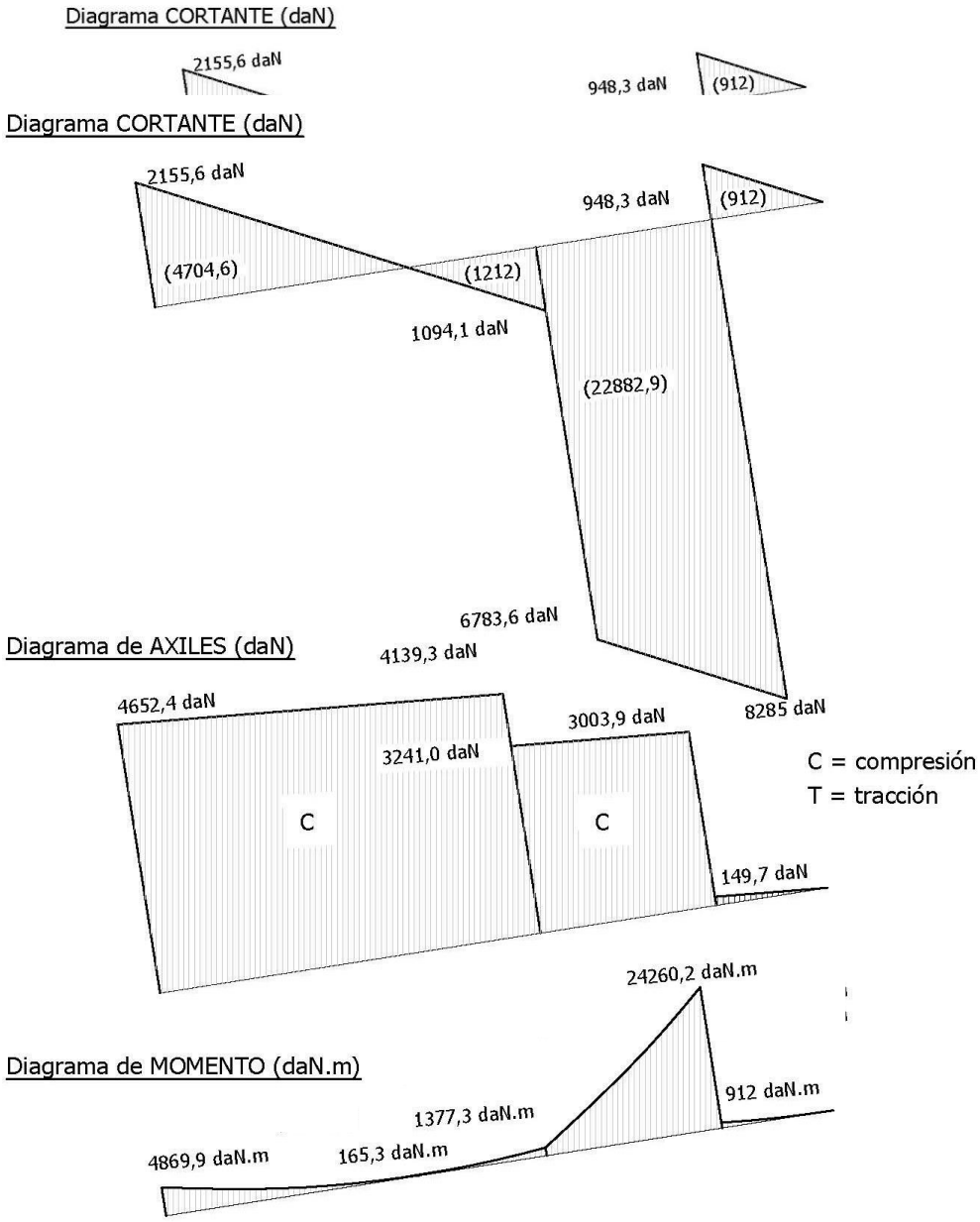


Diagrama de AXILES (daN)



C = compresión
T = tracción





MOMENTOS POR Rizq

MI = (RH+1022)x0,95 = 5125,1x0,95 = 4869,9 daN.m

MJ = (RH+1022+3290)x0,32 = 4278,8x0,32

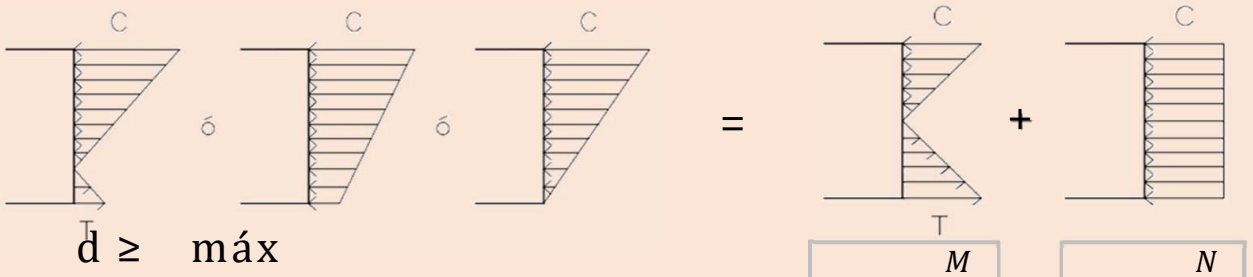
MJ = 4278,8x0,32 = 1369,2 daN.m

MK(ijk) = (RM+2880+960)x2,76 = 8811,8x2,76

MK(ijk) = 8811,8x2,76 **=24260** daN.m

1. TENSIONES NORMALES

$$f_d \geq \sigma_{máx}$$



$$d \geq \quad máx$$

$$\sigma_{máx} = \frac{M}{W} \qquad \sigma_{máx} = \frac{N}{A}$$

1er ORDEN

$$f_d \geq \sigma_{máx} = \frac{M_1}{W} + \frac{N}{A}$$

2º ORDEN

(Presoflexión)

$$f_d \geq \sigma_{máx} = \frac{M_2}{W} + \frac{N}{A}$$

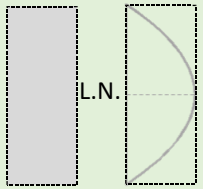
$$M_2 = \frac{M_1}{1 - \frac{N}{N_{EULER}}}$$

$$N_{EULER} = \frac{\pi^2}{l_o^2} E \cdot I$$

$$l_o = l_{real} \cdot \alpha$$

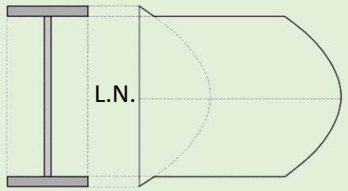
2. TENSIONES TANGENCIALES

$$\tau_d \geq \tau_{máx}$$



Tensión tangencial para una sección rectangular

$$\tau_{máx} = \frac{V}{\frac{2}{3} \cdot b \cdot h}$$



Tensión tangencial para una sección variable

$$\tau_{máx} = \frac{V}{A_{alma}}$$

$$A_{alma} = b \cdot (h - 2d)$$

b = ancho del alma
h = altura del perfil
d = espesor del ala

3. Control plano de menor INERCIA

$$f_d \geq \sigma_{dEULER} > \sigma_{máx}$$

$$\sigma = \frac{F}{A} < \sigma_{d\ EULER} \leq f_d$$

$$\sigma_{d\ EULER} = \frac{f_d}{\omega}$$

$$\sigma_{real} < \sigma_{d\ EULER} \leq f_d$$

$$\frac{F}{A} < \frac{f_d}{\omega} \leq f_d$$

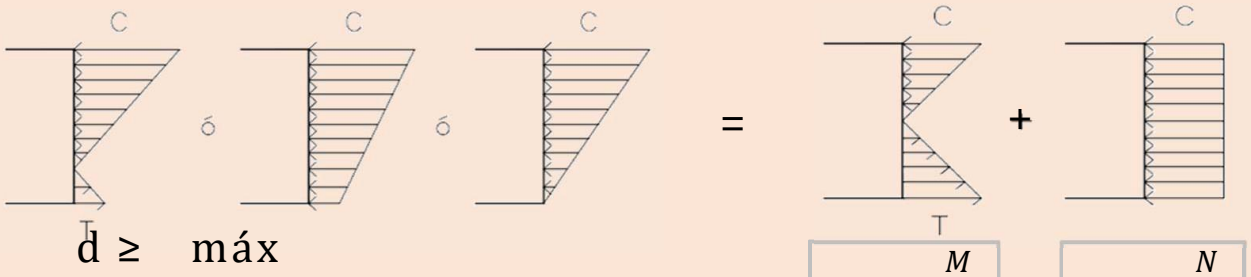
$$\lambda = \frac{l_o}{i_{min}}$$

$$l_o = l_{real} \cdot \alpha$$

4. CONTROL DE LA DEFORMACIÓN

1. TENSIONES NORMALES

$$f_d \geq \sigma_{máx}$$



$$d \geq \text{máx}$$

$$\sigma_{máx} = \frac{M}{W} \qquad \sigma_{máx} = \frac{N}{A}$$

1er ORDEN

$$f_d \geq \sigma_{máx} = \frac{M_1}{W} + \frac{N}{A}$$

2º ORDEN

(Presoflexión)

$$f_d \geq \sigma_{máx} = \frac{M_2}{W} + \frac{N}{A}$$

$$M_2 = \frac{M_1}{1 - \frac{N}{N_{EULER}}}$$

$$N_{EULER} = \frac{\pi^2}{\ell^2} E \cdot I$$

$$l_o = \rho_{real} \cdot \alpha$$

1er ORDEN - Sección K (IK)

M: 24260 daNm

M: 2426000daNcm

N: 3004 daN

$$f_d \geq \sigma_{máx} = \frac{Mf}{w_{res}} \qquad w_{res} = \frac{Mf}{fd}$$

$$W_{res} = \frac{2426000\ \text{daNcm}}{1400\ \text{daN/cm}^2} = 1732{,}8\ \text{cm}^3$$

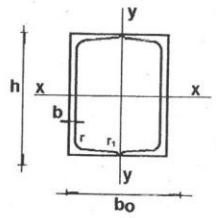
$$f_d \geq \sigma_{máx} = \frac{M1}{W} + \frac{N}{A}$$

2PNC Nº 40

W_x: 2034 cm³

A: 183 cm²

$$\sigma_{máx} = \frac{2426000\ daNcm}{2034 cm^3} + \frac{3004\ daN}{183 cm^2} = 1209\ daN/cm^2 \not\geq 1400\ daN/cm^2$$

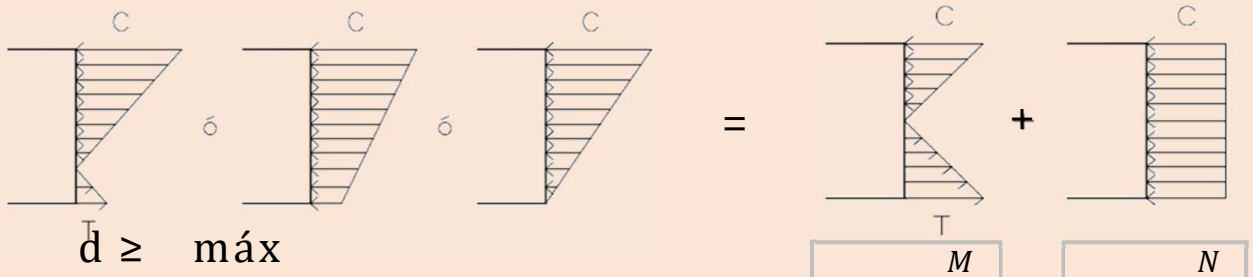


h,bo,b,d,r,r1	mm
A	cms2
g	daN/m
Iy,Ix	cms4
Wx,Wy	cms3
ix,iy	cms

	h	bo	b	d=r	r1	A	g	Ix	Wx	ix	Iy	Wy	iy
3	30	66.00	5.00	7.0	3.50	10.88	8.54	12.78	8.52	1.08	53.55	1.63	2.22
4	40	70.00	5.00	7.0	3.50	12.42	9.74	28.20	14.10	1.50	71.84	2.05	2.41
5	50	76.00	5.00	7.0	3.50	14.24	11.18	52.80	21.12	1.92	102.33	2.69	2.68
6 1/2	65	84.00	5.50	7.5	4.00	18.06	14.18	115.00	35.38	2.52	167.77	3.99	3.05
8	80	90.00	6.00	8.0	4.00	22.00	17.28	212.00	53.00	3.10	243.46	5.41	3.33
10	100	100.00	6.00	8.5	4.50	27.00	21.20	412.00	82.40	3.91	379.97	7.60	3.75
12	120	110.00	7.00	9.0	4.50	34.00	26.80	728.00	121.33	4.62	603.54	10.97	4.21
14	140	120.00	7.00	10.0	5.00	40.80	32.00	1210.00	172.86	5.45	862.35	14.37	4.60
16	160	130.00	7.50	10.5	5.50	48.00	37.60	1850.00	231.25	6.21	1212.95	18.66	5.03
18	180	140.00	8.00	11.0	5.50	56.00	44.00	2700.00	300.00	6.95	1673.16	23.90	5.47
20	200	150.00	8.50	11.5	6.00	64.40	50.60	3820.00	382.00	7.7	2237.02	29.83	5.89
22	220	160.00	9.00	12.5	6.50	74.80	58.80	5380.00	489.09	8.48	2962.60	37.03	6.29
24	240	170.00	9.50	13.0	6.50	84.60	66.40	7200.00	600.00	9.22	3821.87	44.96	6.72
26	260	180.00	10.00	14.0	7.00	96.60	75.80	9640.00	741.54	9.99	4893.06	54.37	7.12
28	280	190.00	10.00	15.0	7.50	106.60	83.60	12560.00	897.14	10.9	5976.72	62.91	7.49
30	300	200.00	10.00	16.0	8.00	117.60	92.40	16060.00	1070.67	11.7	7256.90	72.57	7.86
32	320	200.00	14.00	17.5	8.75	151.60	119.00	21740.00	1358.75	12.1	9495.62	94.96	7.91
35	350	200.00	14.00	16.0	8.00	154.60	121.20	25680.00	1467.43	12.9	10069.70	100.70	8.07
38	380	204.00	13.34	16.0	8.00	160.80	126.20	31520.00	1658.95	14.10	11048.60	108.32	8.33
40	400	220.00	14.00	18.0	9.00	183.00	143.60	40700.00	2035.00	14.9	14451.20	131.38	8.89

1. TENSIONES NORMALES

$$f_d \geq \sigma_{máx}$$



$$d \geq \quad máx$$

$\sigma_{máx} = \frac{M}{W}$ $\qquad$ $\sigma_{máx} = \frac{N}{A}$

1er ORDEN $\qquad f_d \geq \sigma_{máx} = \frac{M_1}{W} + \frac{N}{A}$

2º ORDEN (Presoflexión) $\qquad f_d \geq \sigma_{máx} = \frac{M_2}{W} + \frac{N}{A}$

$$M_2 = \frac{M_1}{1 - \frac{N}{N_{EULER}}}$$

$$N_{EULER} = \frac{\pi^2}{\ell^2} E \cdot I$$

$l_o = l_{real} \cdot \alpha$

2º ORDEN (Presoflexión) $\qquad f_d \geq \sigma_{máx} = \frac{M_2}{W} + \frac{N}{A}$

$$M_2 = \frac{M_1}{1 - \frac{N}{N_{EULER}}}$$

$N_{EULER} = \frac{\pi^2}{l_o^2} E.I$ $\qquad$ $N_{EULER} = \frac{\pi^2}{577^2} 2100000.40700$

$N_{EULER} = 2533738$ daN

$l_o = l \cdot \alpha$

$l_o = 9{,}62 \cdot 0{,}6 = 5{,}77$ m

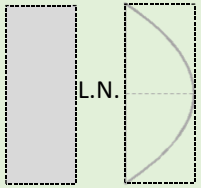
$M_2 = \frac{2426000 \text{ daNcm}}{1 - \frac{3004 \text{ daN}}{2533738 \text{ daN}}}$

$M_2 = 2430862$ daNcm

$$f_d \geq \sigma_{máx} = \frac{2430862}{2035} + \frac{3004}{183} = 1211 \, daN/cm^2 \not\geq 1400 \, daN/cm^2$$

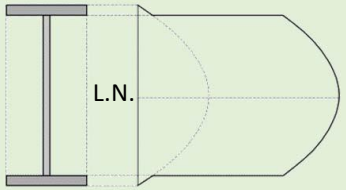
2. TENSIONES TANGENCIALES

$$\tau_d \geq \tau_{máx}$$



Tensión tangencial para una sección rectangular

$$\tau_{máx} = \frac{V}{\frac{2}{3} . b . h}$$



Tensión tangencial para una sección variable

$$\tau_{máx} = \frac{V}{A_{alma}}$$

$A_{alma} = b \cdot (h-2d)$

b = ancho del alma
h = altura del perfil
d = espesor del ala

Sección K (IK)

V: 8285 daN

$A_{alma} = b \cdot (h-2d).2$ $\quad A_{alma} = 1,4\ (40 - 2\ .\ 1,8).2 = 101,92\ cm^2$

2PNC Nº 40

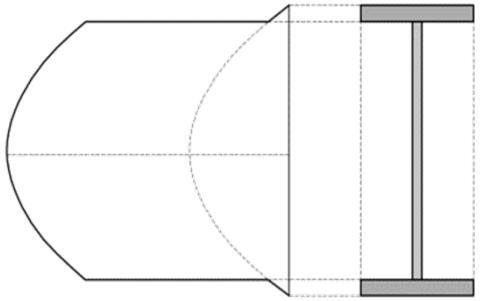
b: 1,4 cm

h: 40 cm

d: 1,8 cm

$$\tau_{máx} = \frac{V}{A_{alma}}$$

$$\tau_{máx} = \frac{8285\ daN}{101,92 cm^2} = 81,29\ daN/cm^2$$



$$\tau_d = 1120\ daN/cm^2 \geq \tau_{máx} = 81,29\ daN/cm^2$$

3. Control plano de menor INERCIA

$$f_d \geq \sigma_{dEULER} > \sigma_{máx}$$

$$\sigma = \frac{F}{A} < \sigma_{d\ EULER} \leqslant f_d \qquad \sigma_{d\ EULER} = \frac{f_d}{\omega}$$

$$\sigma_{real} < \sigma_{d\ EULER} \leqslant f_d \qquad \frac{F}{A} < \frac{f_d}{\omega} \leqslant f_d$$

$$\lambda = \frac{l_o}{i_{min}} \qquad l_o = l_{real} \cdot \alpha$$

Sección I (IK)

N: 4652 daN

Lo = 577 cm

$$\lambda = \frac{577}{8{,}89} = 65 < 250 \qquad \omega \xrightarrow{\text{TABLA}} = 1{,}32$$

2PNC Nº 40

i_y: 8,89 cm

A: 183 cm²

$$\sigma_{real} = \frac{4652\ \text{daN}}{183 cm2} < \frac{1400\ da/cm^2}{1{,}32} = \sigma_{d\ EULER}$$

$$\sigma_{real} = 25{,}42\ daN/cm^2 < 1060\ daN/cm^2\ \sigma_{d\ EULER}$$

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