COMPORTAMIENTO DE BARRAS FRENTE A ESFUERZOS AXILES

COMPORTAMIENTO DE BARRAS FRENTE A ESFUERZOS AXILES

TRACCIÓN SIMPLE

COMPRESIÓN SIMPLE

COMPORTAMIENTO DE BARRAS FRENTE A ESFUERZOS AXILES

TRACCIÓN SIMPLE

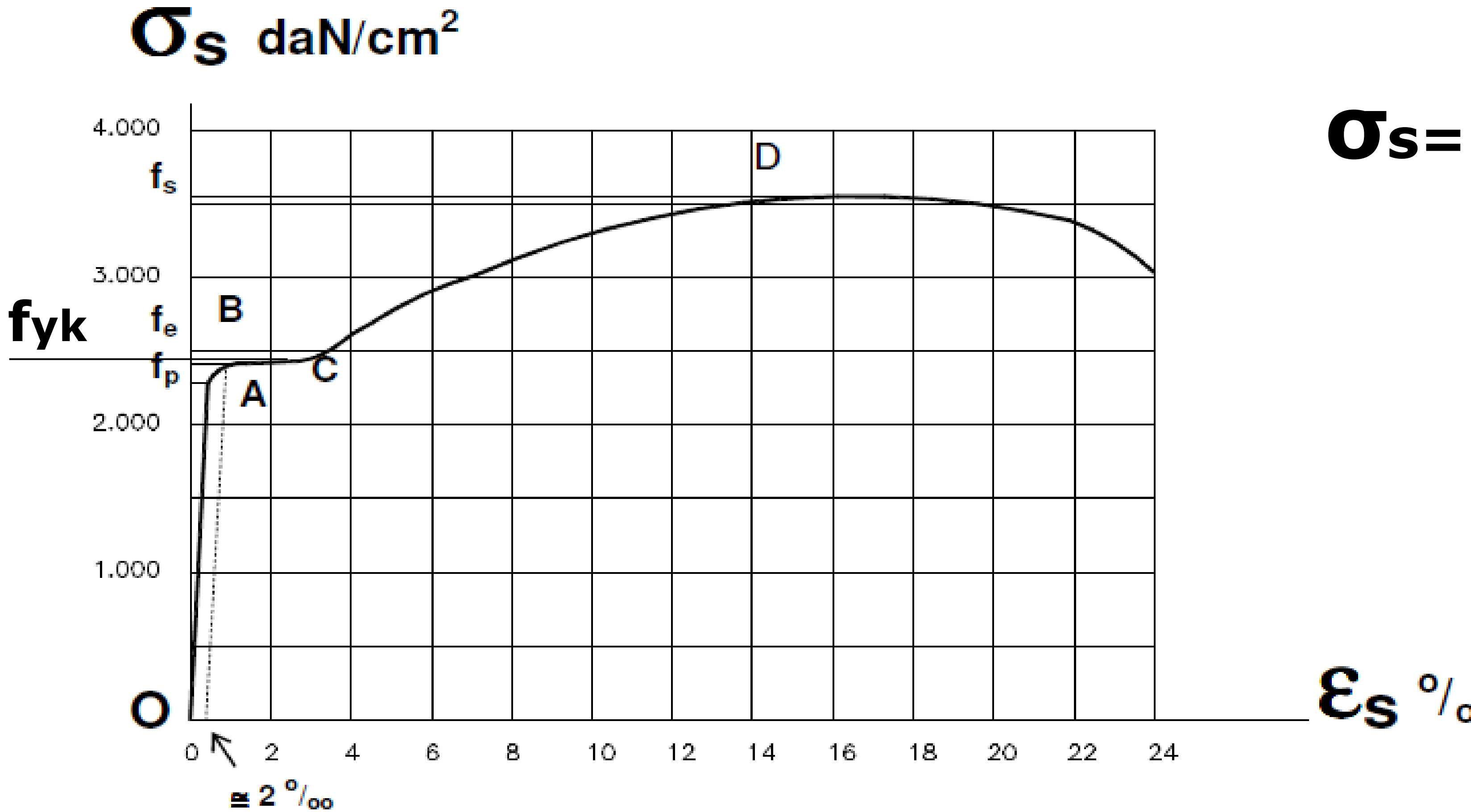
COMPRESIÓN SIMPLE

MATERIALES HOMOGÉNEOS

DIMENSIONADO

La resistencia de un material se determina a través de ensayos

Gráfico de tensiones-deformaciones del acero común



$\sigma s = E . \varepsilon\ s$

ACERO COMÚN

DIMENSIONADO

El dimensionado de las barras se realiza en el tramo en que el material tiene un comportamiento proporcional de tensiones y deformaciones.
En él se cumple:

$$\sigma_s = E \cdot \varepsilon_s$$

Donde
E = MÓDULO DE ELASTICIDAD
o MÓDULO DE YOUNG

Se define como límite de tensiones ,

*la **tensión característica :*** f_{yk}

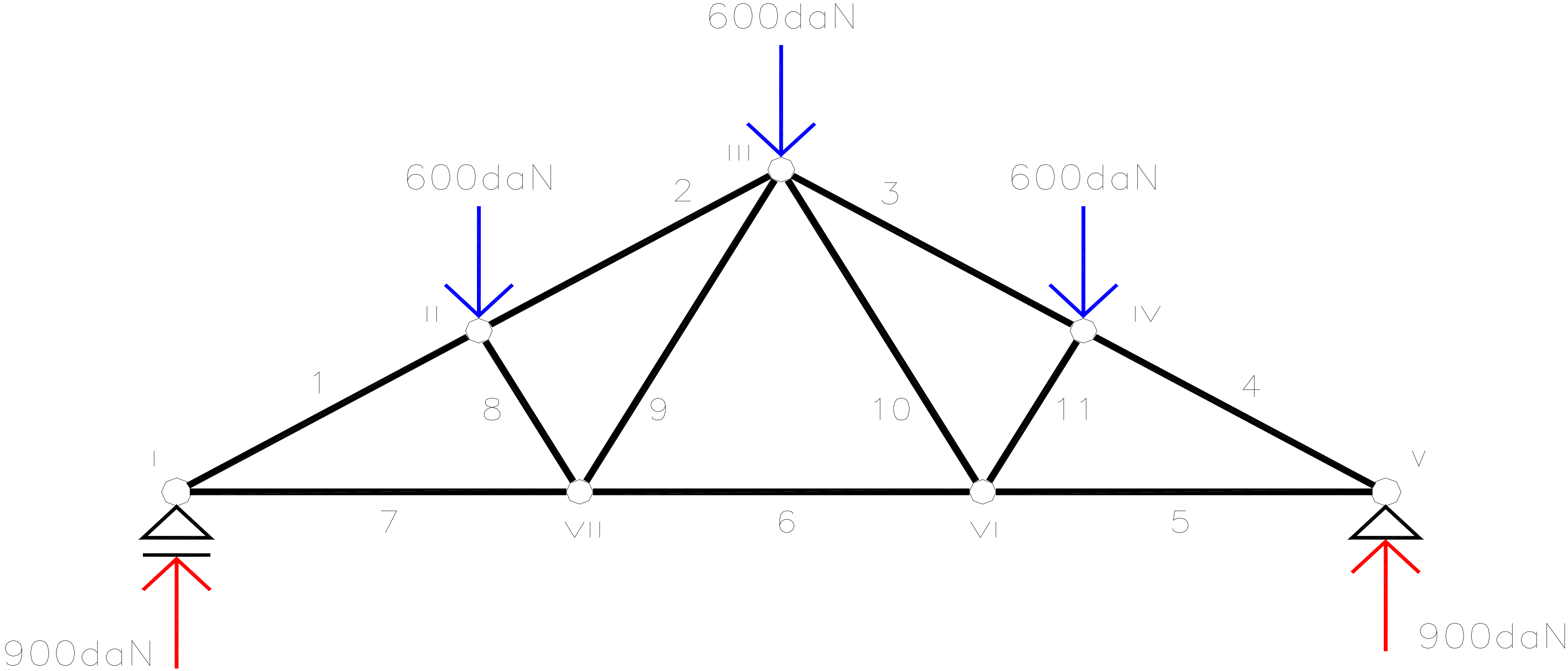
*Se define como límite de tensiones **admisibles** un valor menor, aplicando un **coeficiente de seguridad:***

TENSIÓN ADMISIBLE :

$$f_d = \frac{f_{yk}}{\gamma}$$

donde γ *es un **coeficiente de seguridad***

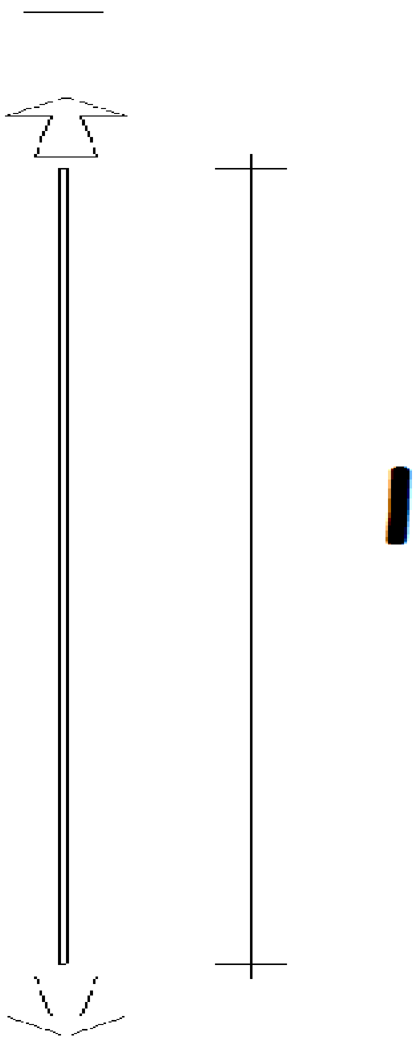
DIMENSIONADO DE LAS BARRAS

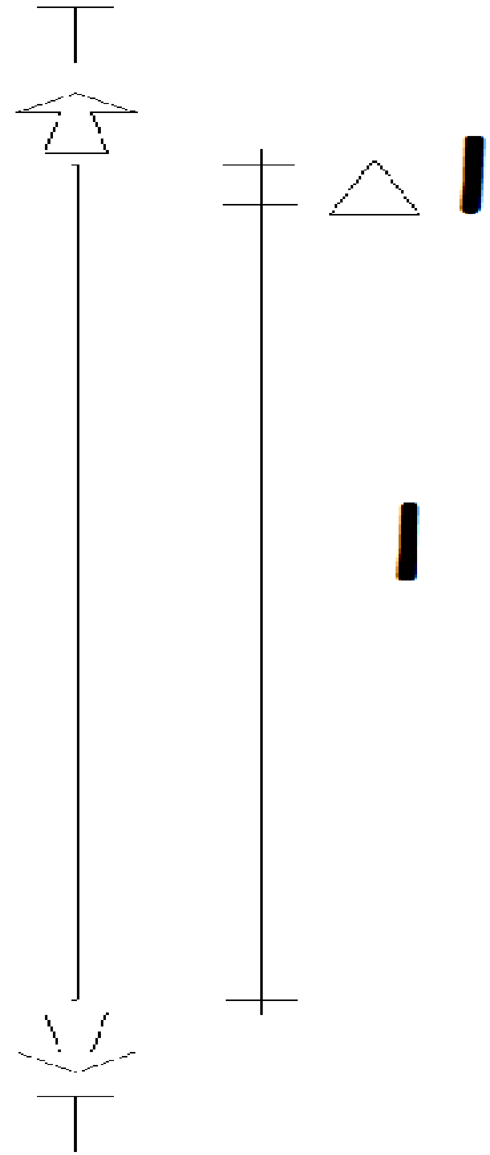


BARRA	COMPRESION	TRACCION	LONGITUD	SECCION	σ_{real}	σ_d EULER
1	1800daN		260cm			
2	1500daN		290cm			
3	1500daN		290cm			
4	1800daN		260cm			
5		1558 daN	300cm			
6		1039 daN	300cm			
7		1558 daN	300cm			
8	519 daN		150cm			
9		519 daN	260cm			
10		519 daN	260cm			
11	519 daN		150cm			

TRACCIÓN SIMPLE

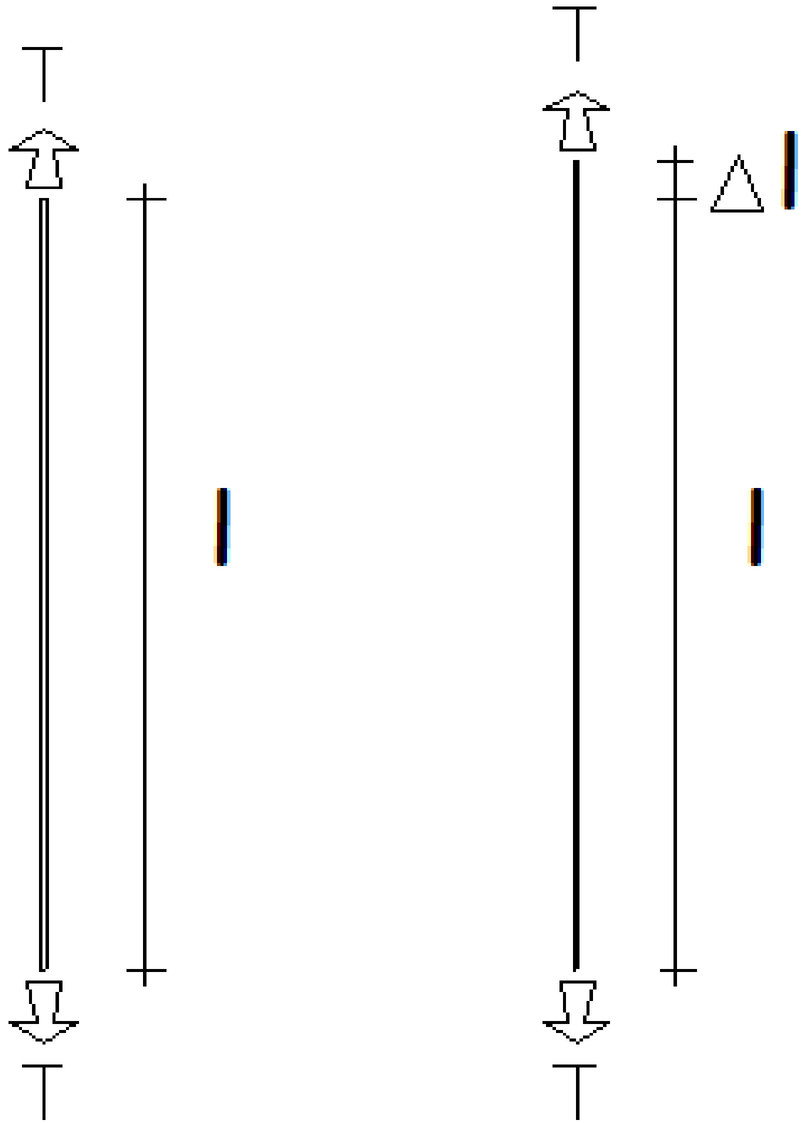
Deformación característica :
el ALARGAMIENTO



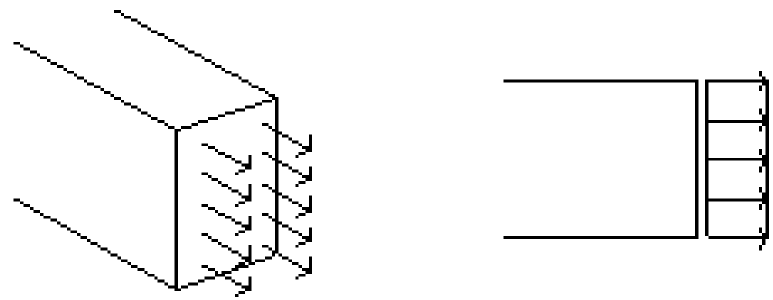


TRACCIÓN SIMPLE

Deformación característica : el ALARGAMIENTO



ESQUEMA TENSIONAL

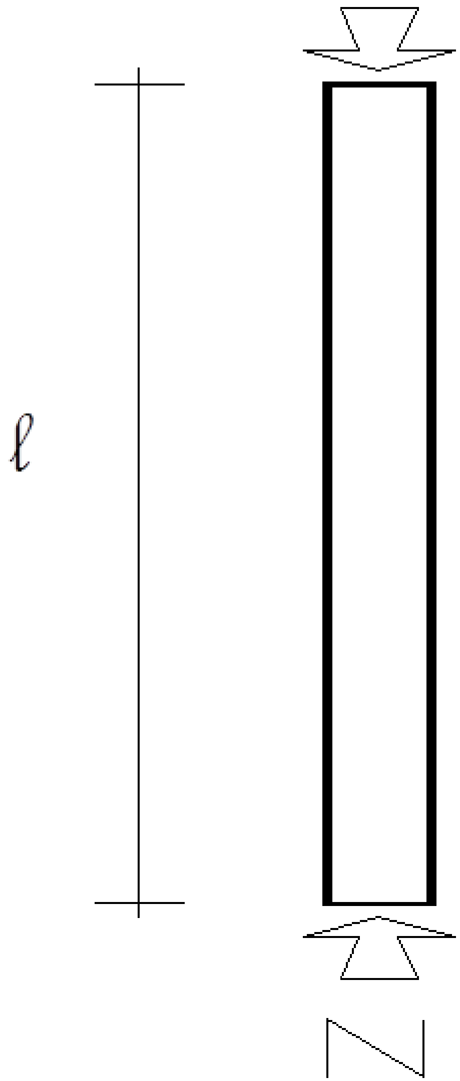


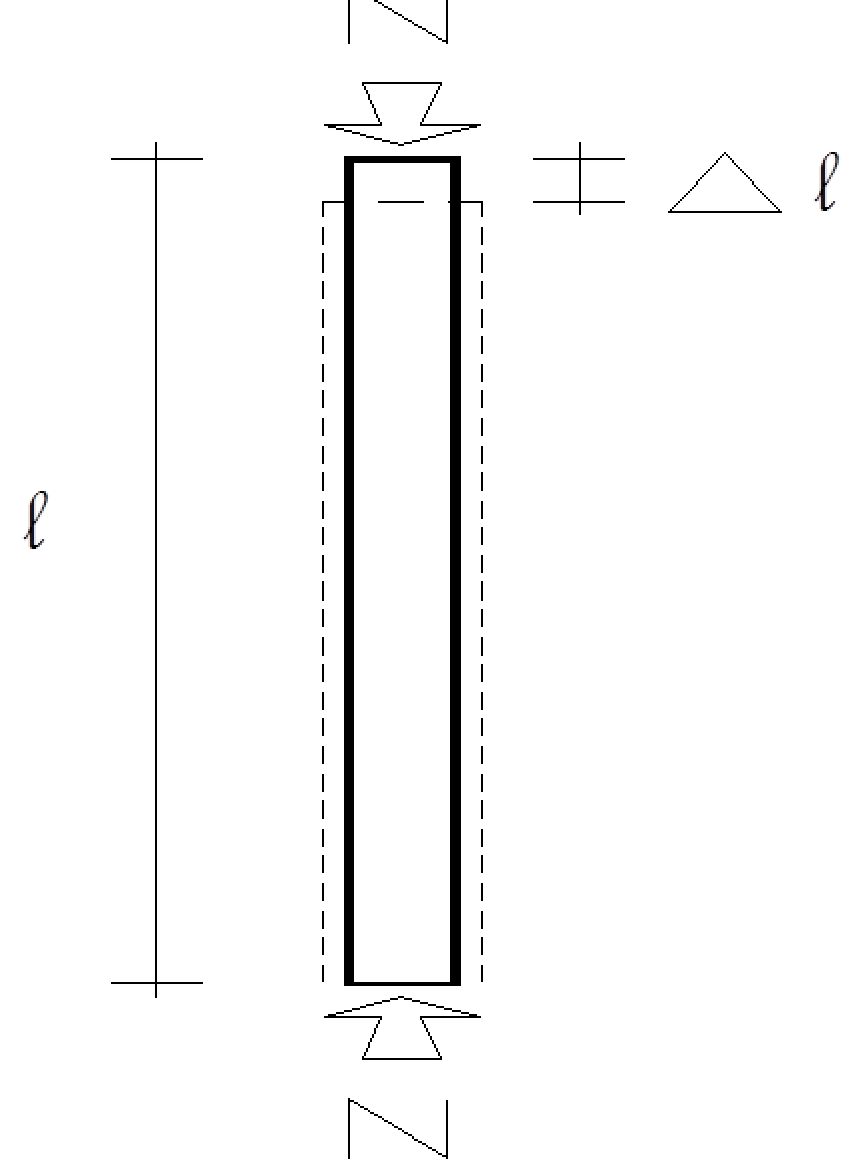
$$\sigma_{real} = \frac{T}{A}$$

$$\sigma_{real} = \frac{T}{A} \leq f_d$$

COMPRESIÓN SIMPLE

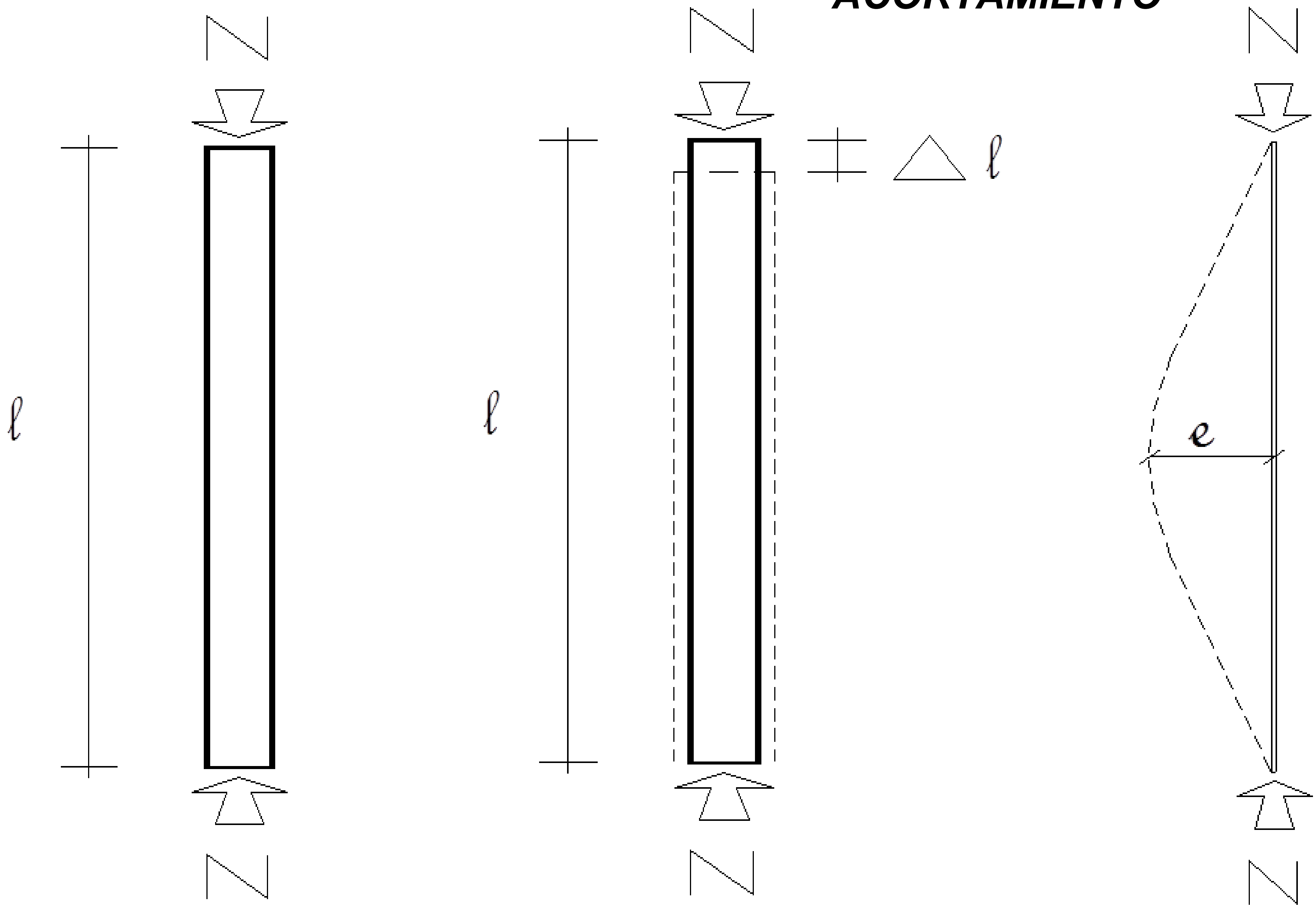
Deformación característica : el ACORTAMIENTO



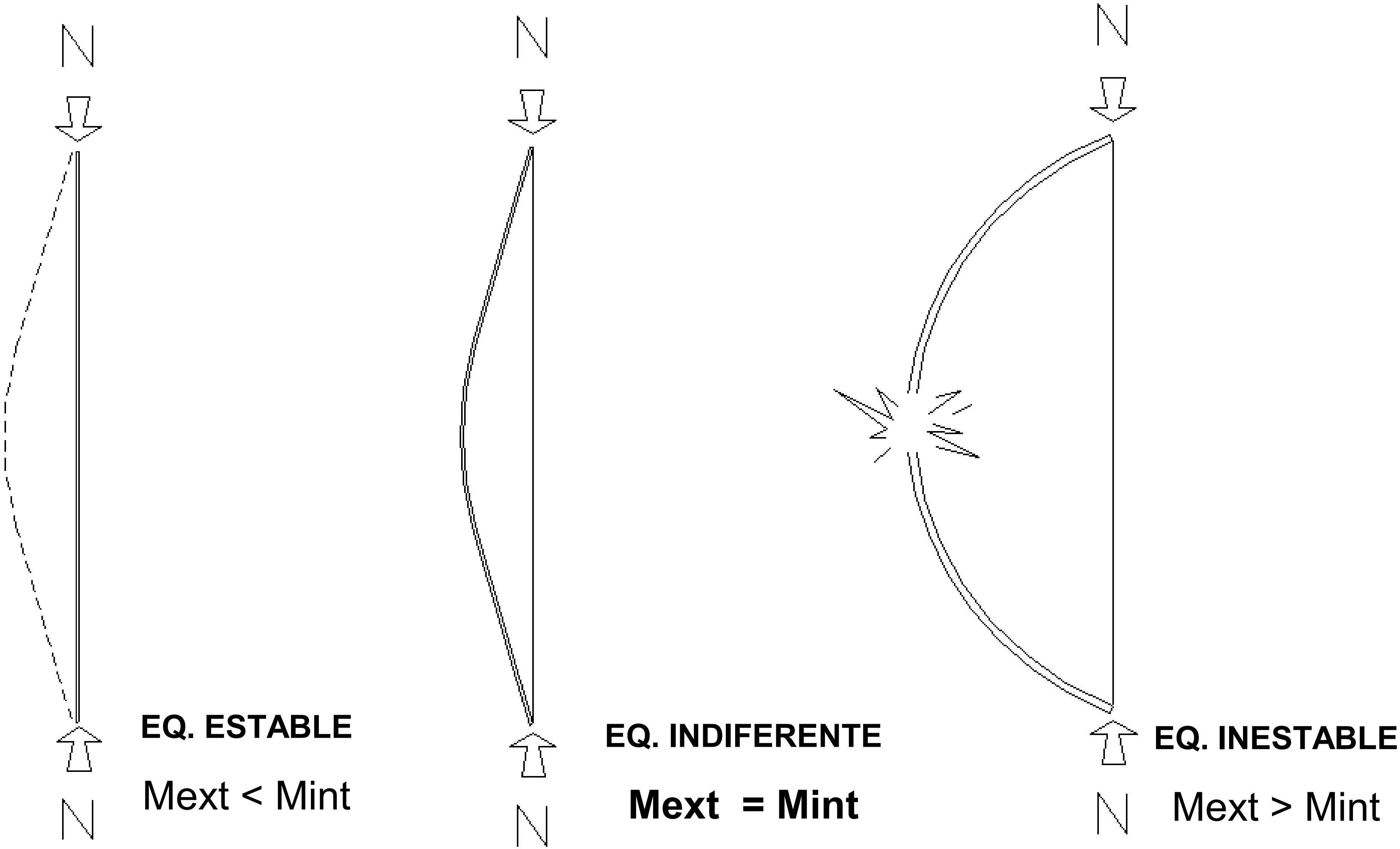


COMPRESIÓN SIMPLE

Deformación característica : el ACORTAMIENTO



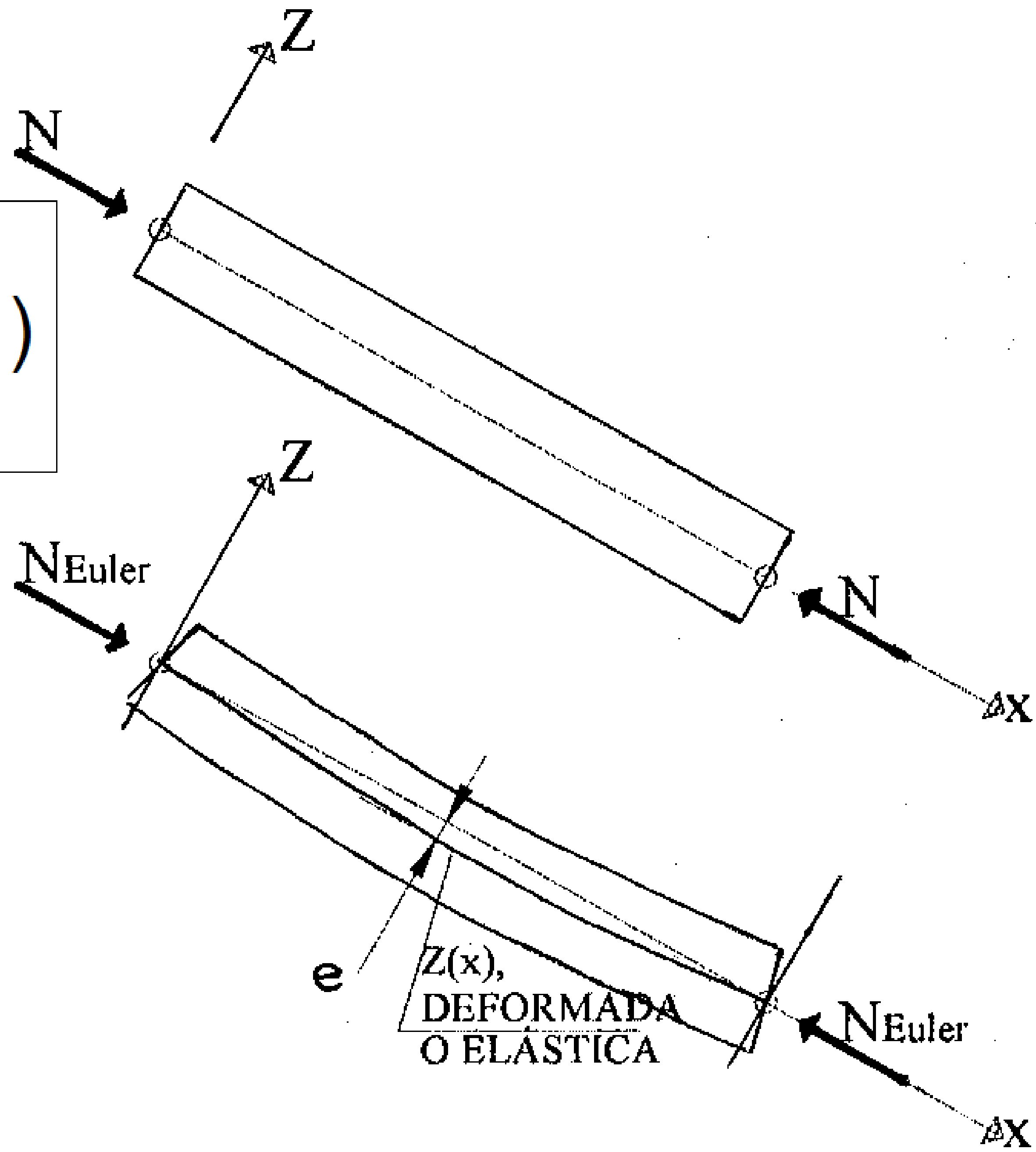
Momento externo – Momento interno



Analizaremos la situación límite, en la que se cumple: **Mext = Mint**

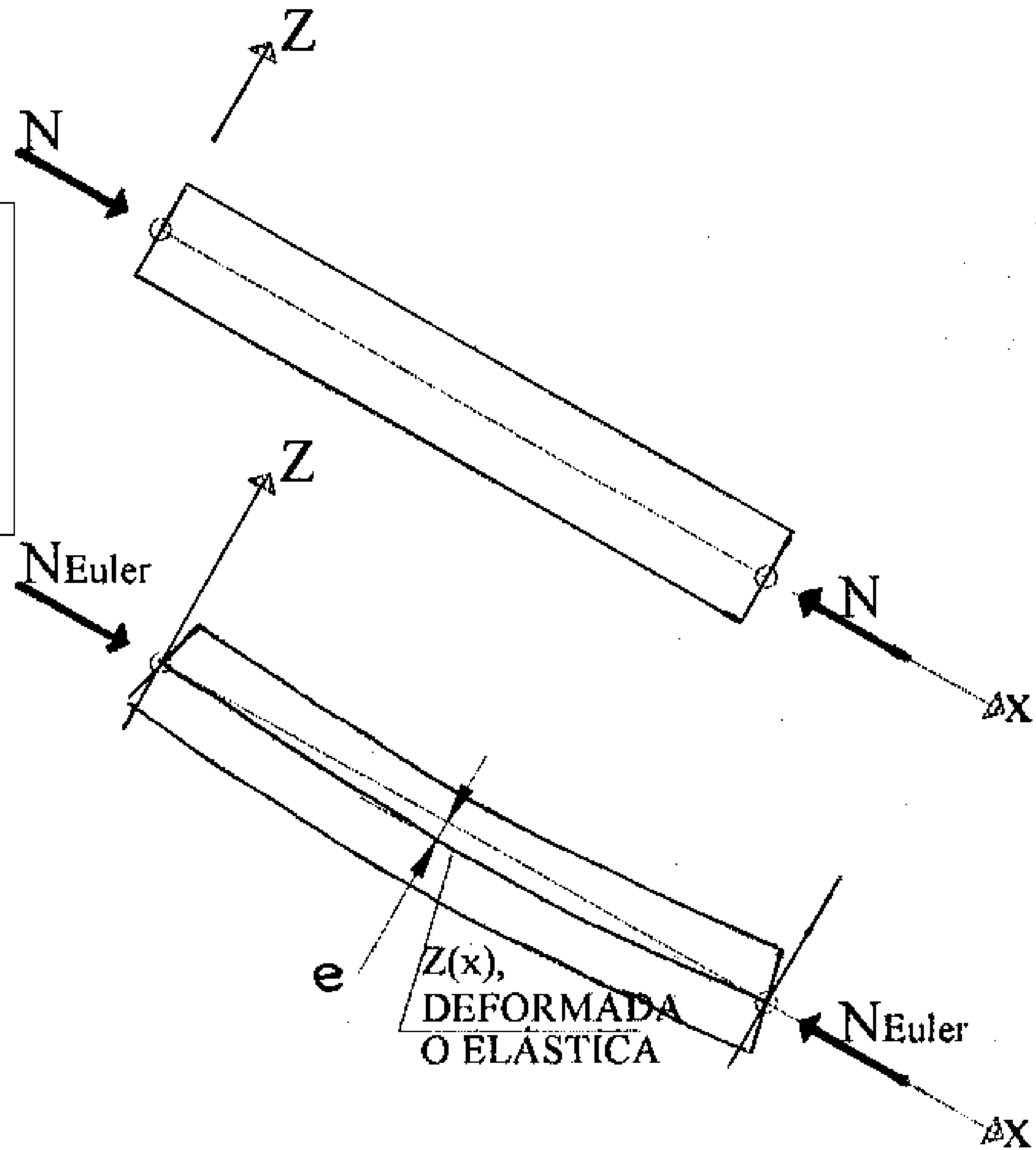
Tensión de Euler - Momento externo

$$Mf(x) = N_{EULER} \cdot z(x)$$



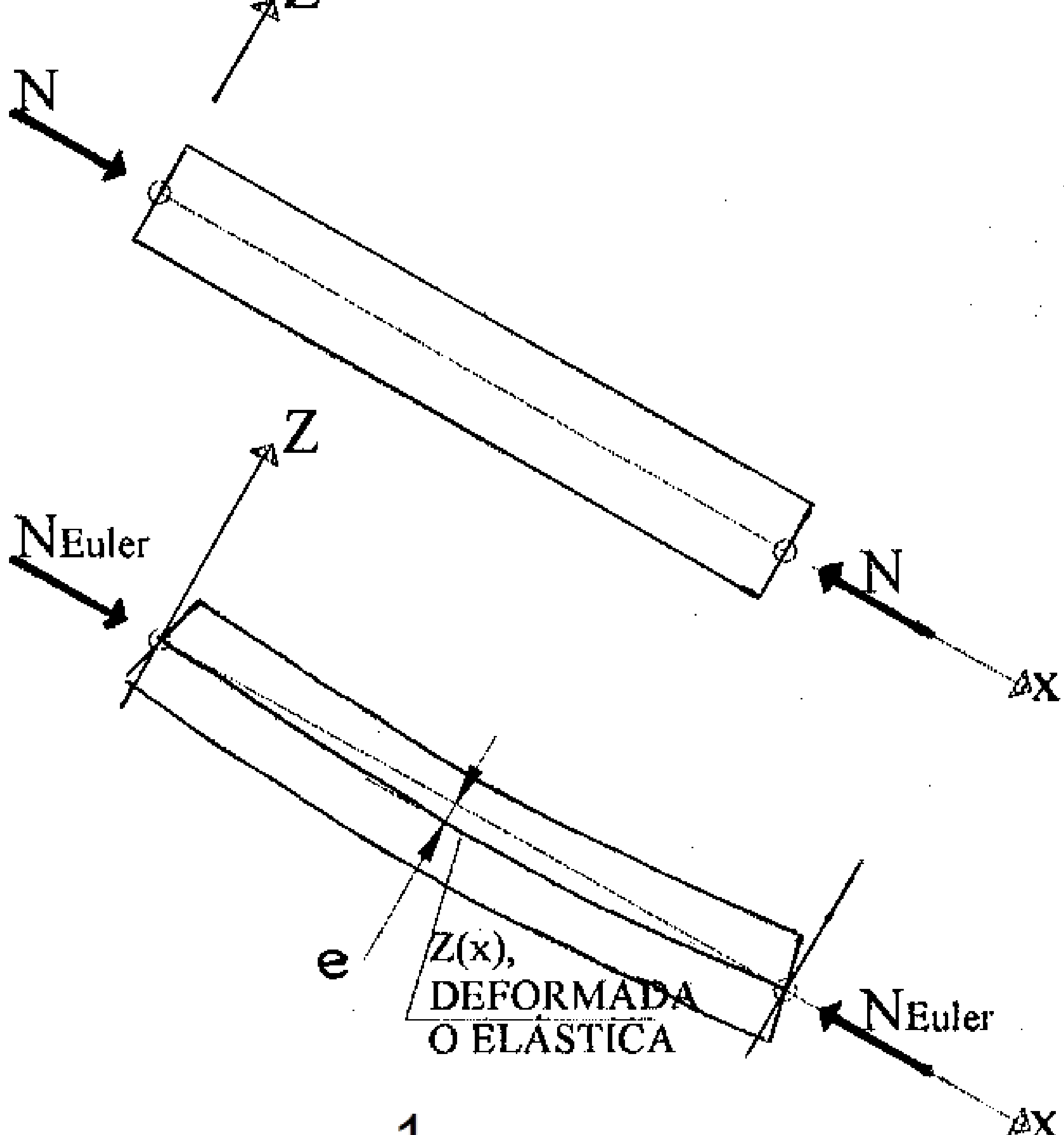
Tensión de Euler - Momento interno

$$K(x) \tilde{=} z''(x)$$



Tensión de Euler - Momento interno

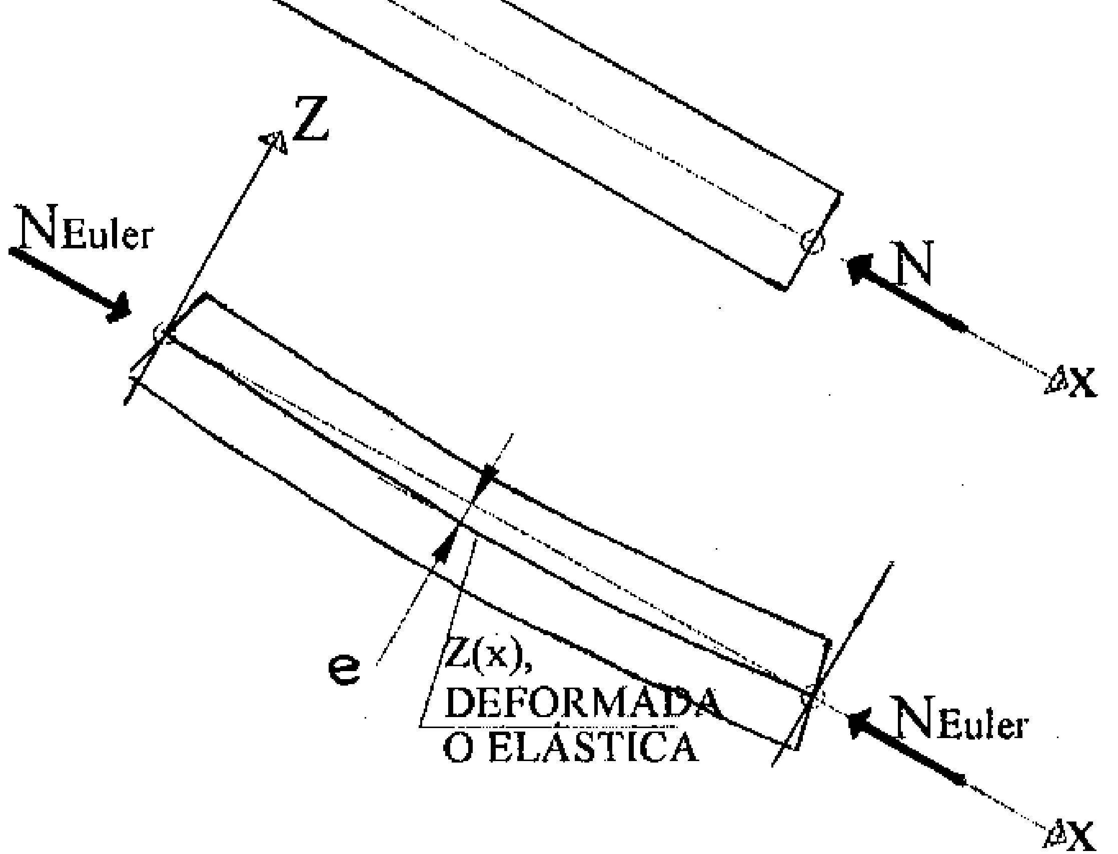
$$K(x) \cong z''(x)$$



$$\rho(x) = \frac{1}{K(x)}$$

Tensión de Euler - Momento interno

$$K(x) \cong z''(x)$$



$$\rho(x) = \frac{1}{K(x)}$$

$$Mf(x) = cte.\,K(x)$$

$$K(x) \cong z''(x)$$

Tensión de Euler - Momento interno

$$\rho(x) = \frac{1}{K(x)}$$

$$Mf(x) = cte . K(x)$$

$$Mf(x) = E . I . K(x)$$

$$K(x) \cong z''(x)$$

Tensión de Euler - Momento interno

$$\rho(x) = \frac{1}{K(x)}$$

$$Mf(x) = cte.\,K(x)$$

$$Mf(x) = E.I.K(x)$$

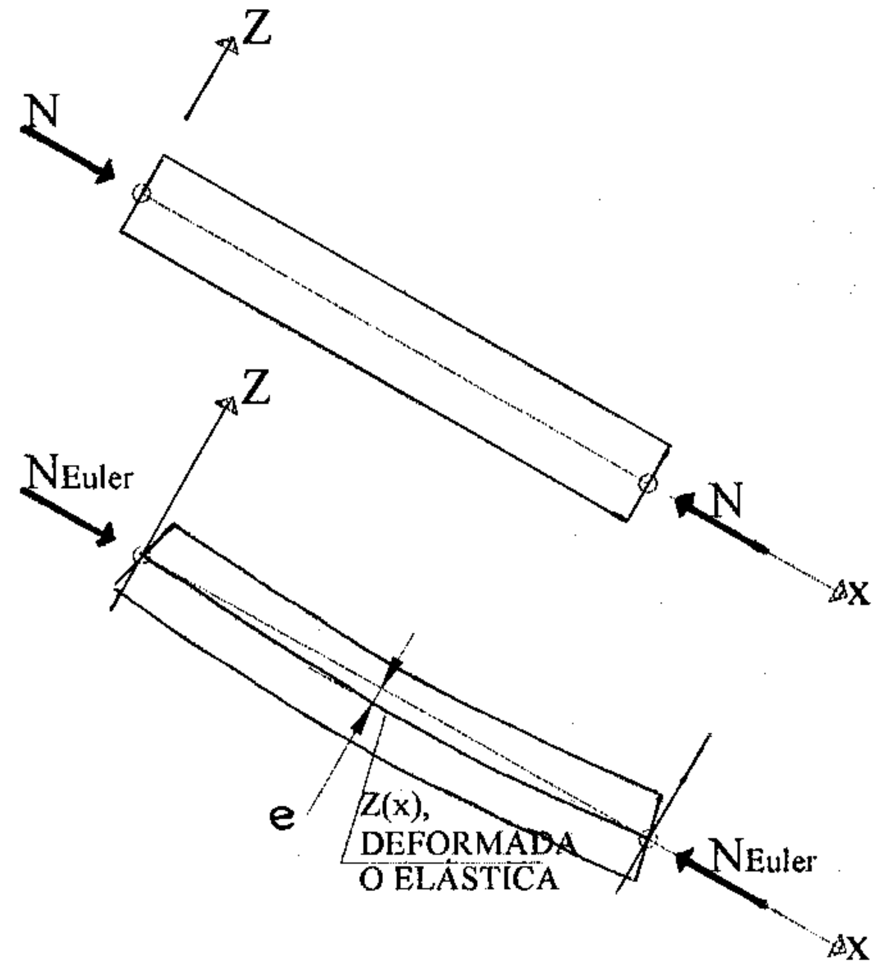
$$Mf(x) = E.I.z''(x)$$

COMPRESIÓN SIMPLE

Tensión de Euler - M externo = M interno

Analizaremos la situación límite, en la que se cumple: **Mext = Mint**

$$N_{EULER}.z(x) = E.I.z''(x)$$

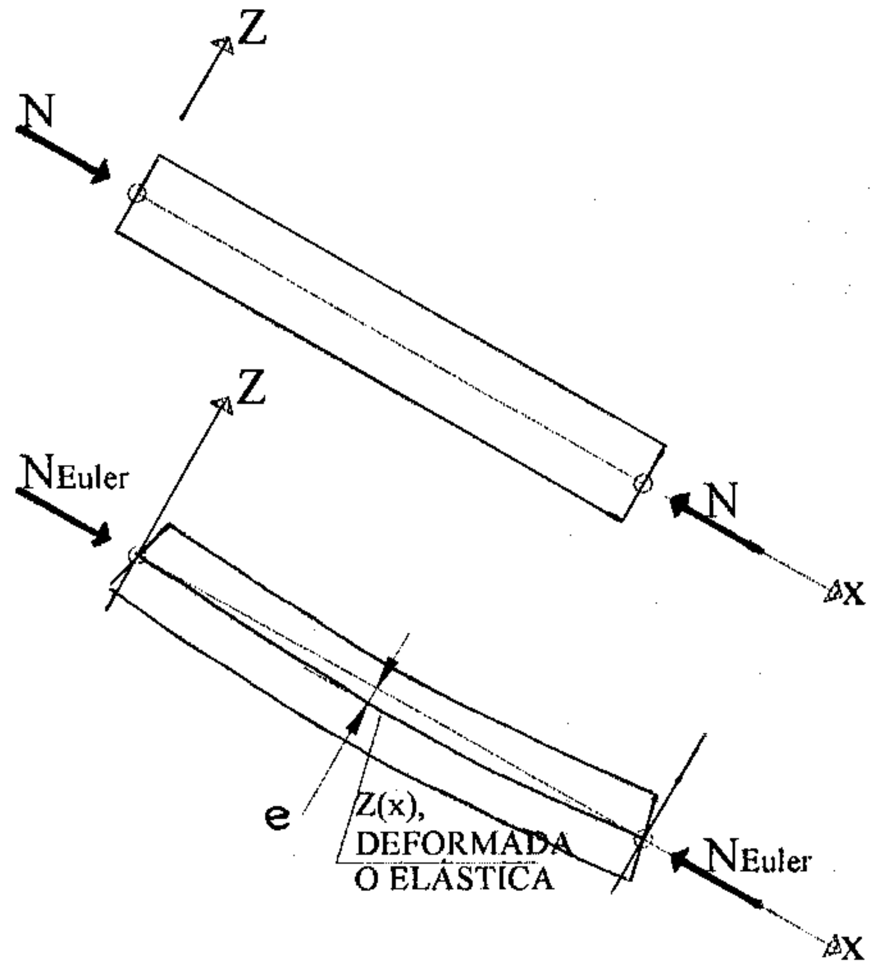


COMPRESIÓN SIMPLE

Tensión de Euler - M externo = M interno

$$N_{EULER}.z(x) = E.I.z''(x)$$

$$z(x) = e.sen\,\frac{\pi x}{\ell}$$



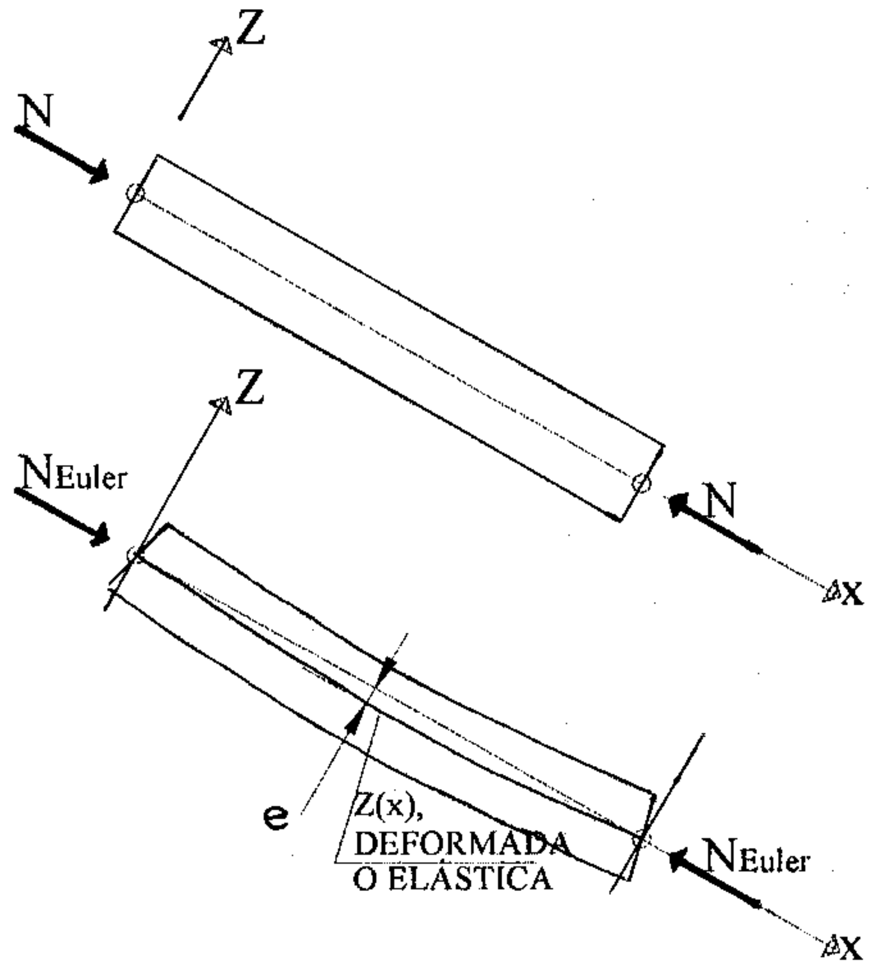
COMPRESIÓN SIMPLE

Tensión de Euler - M externo = M interno

$$N_{EULER} . z(x) = E.I.\, z''(x)$$

$$z(x) = e.\text{sen}\, \frac{\pi x}{\ell}$$

$$z''(x) = e \frac{\pi^2}{\ell^2}\, \text{sen}\, \frac{\pi x}{\ell}$$



COMPRESIÓN SIMPLE

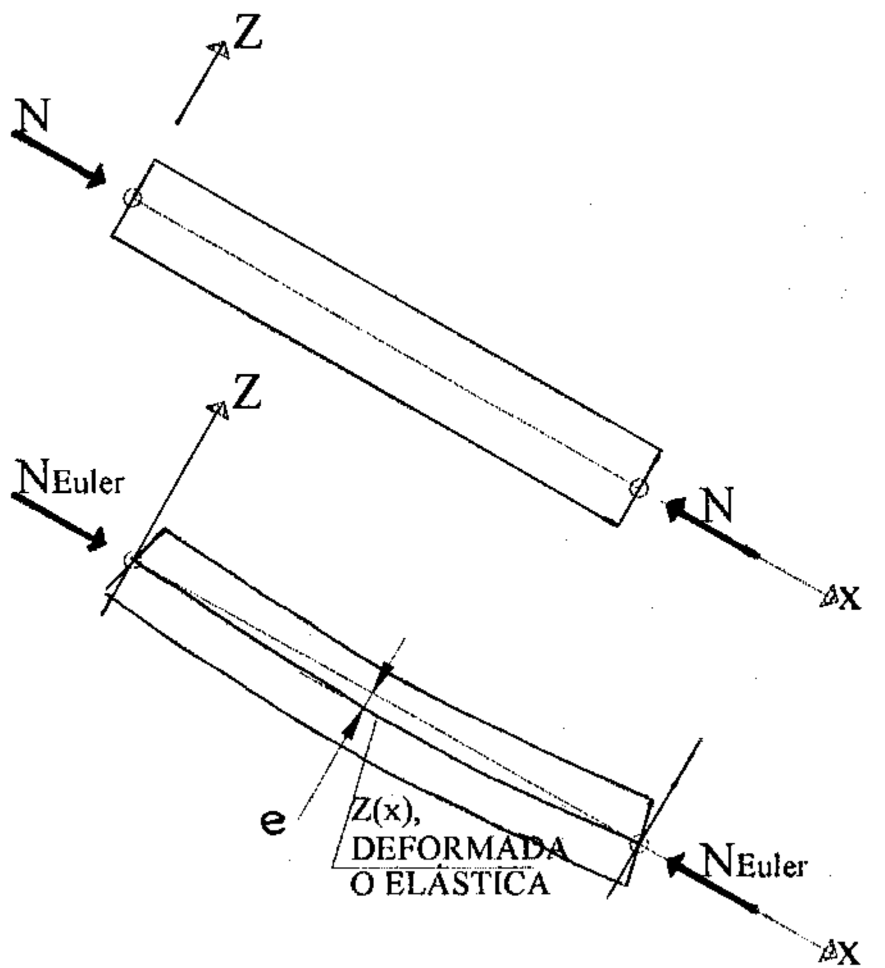
Tensión de Euler - M externo = M interno

$$N_{EULER} \cdot z(x) = E \cdot I \cdot z''(x)$$

$$z(x) = e \cdot \text{sen} \frac{\pi x}{\ell}$$

$$z''(x) = e \frac{\pi^2}{\ell^2} \text{sen} \frac{\pi x}{\ell}$$

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



COMPRESIÓN SIMPLE

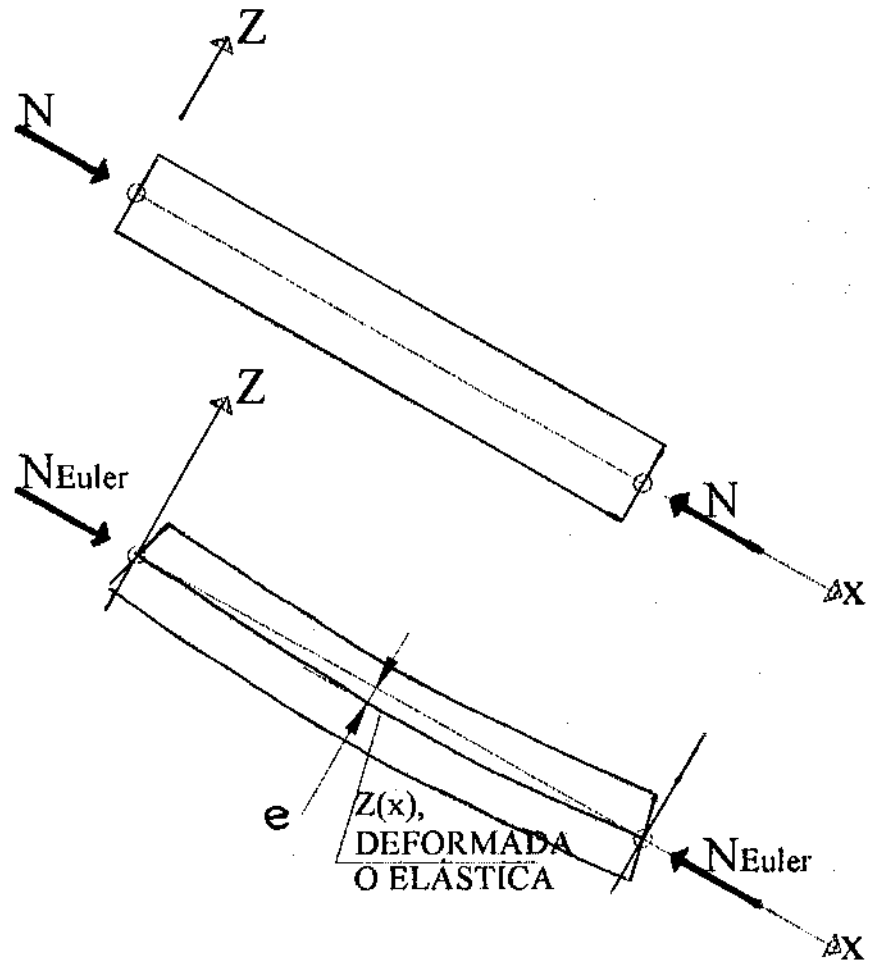
Tensión de Euler - M externo = M interno

Fuerza de EULER

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

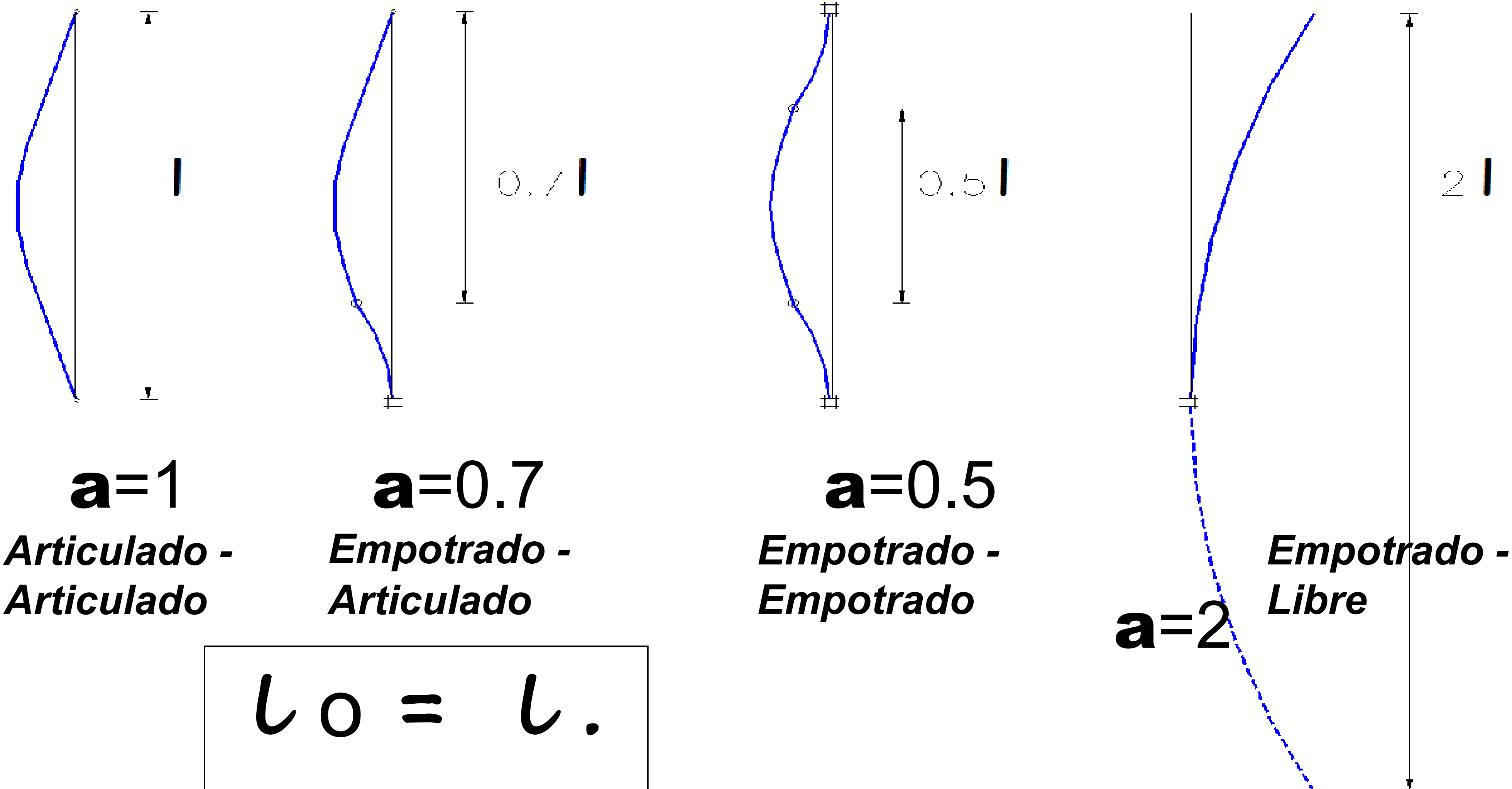
$$\sigma_{EULER} = \frac{N_{EULER}}{A}$$

Tensión de EULER



COMPRESIÓN SIMPLE

Incidencia de los vínculos en la longitud de pandeo:



a=1
Articulado - Articulado

a=0.7
Empotrado - Articulado

a=0.5
Empotrado - Empotrado

a=2
Empotrado - Libre

$$l_o = l \cdot \mathbf{a}$$

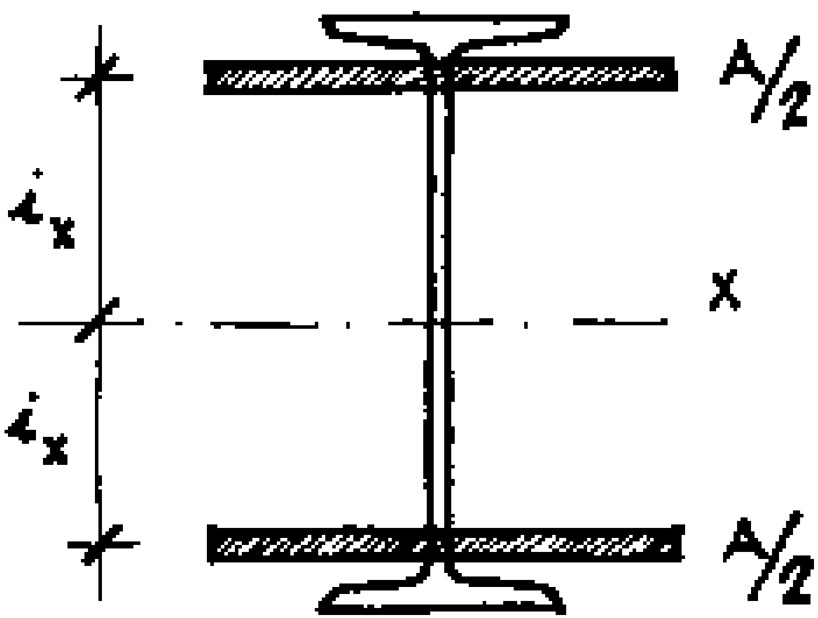
COMPRESIÓN SIMPLE

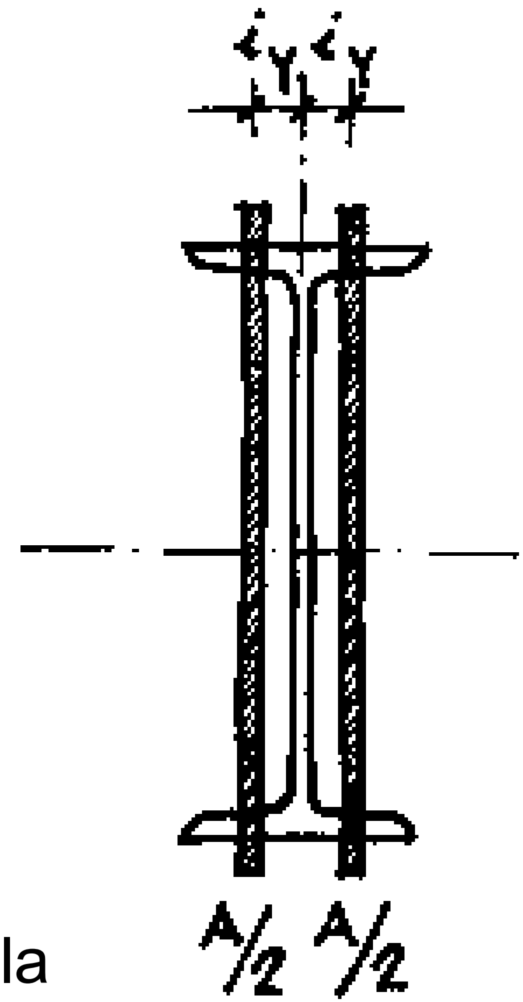
Tensión de Euler en función de la ESBELTEZ $l = \ell_o / i$

I= Inercia A= Área i= Radio de giro

$I = A.i^2$

$$i^2 = I/A$$





El Radio de giro es una característica geométrica de la sección, que relaciona la inercia y el área de la misma.

COMPRESIÓN SIMPLE

Tensión de Euler en función de la ESBELTEZ $\lambda = \ell_o / i$

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

$$\sigma_{EULER} = \frac{E\,I\,\pi^2}{\ell^2\,A}$$

$$i^2 = I/A$$

$$\sigma_{EULER} = \frac{E\,\pi^2}{\ell^2 / i^2}$$

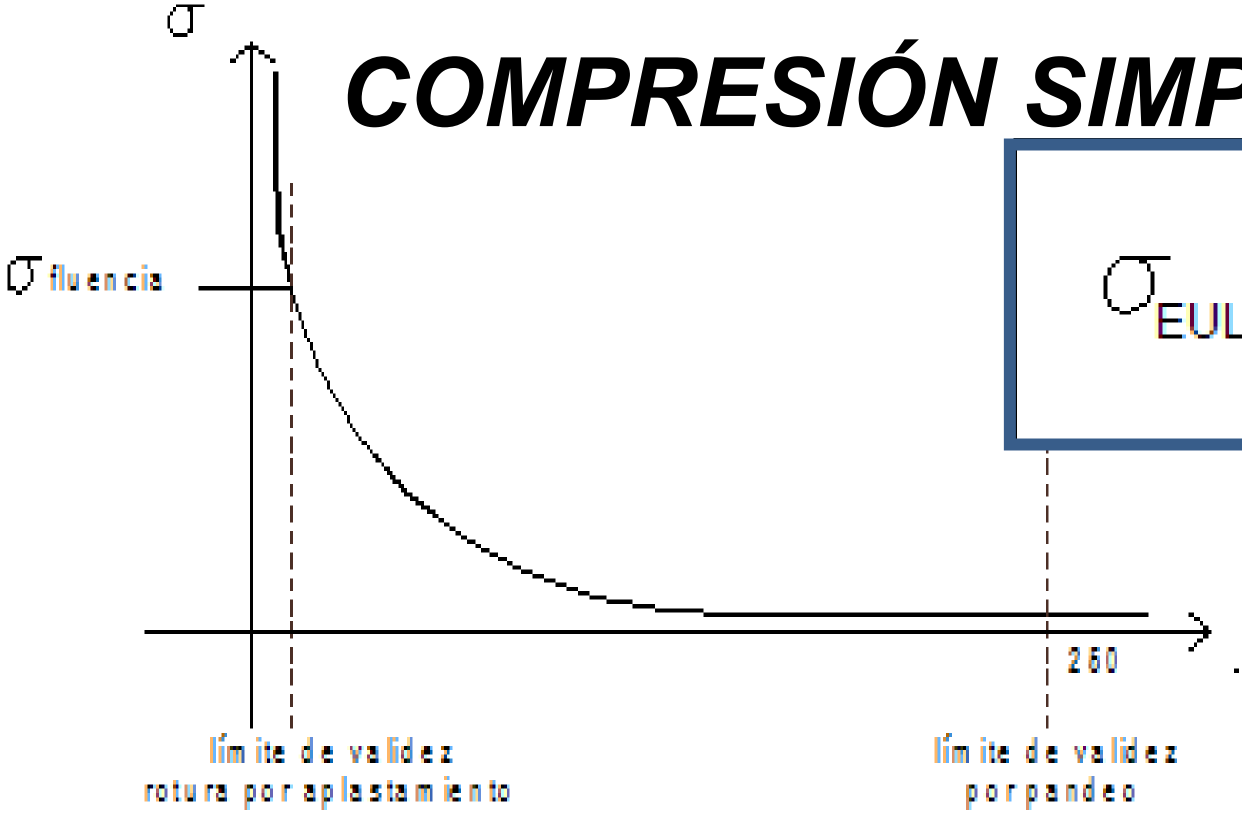
$$\lambda = \ell_o / i$$

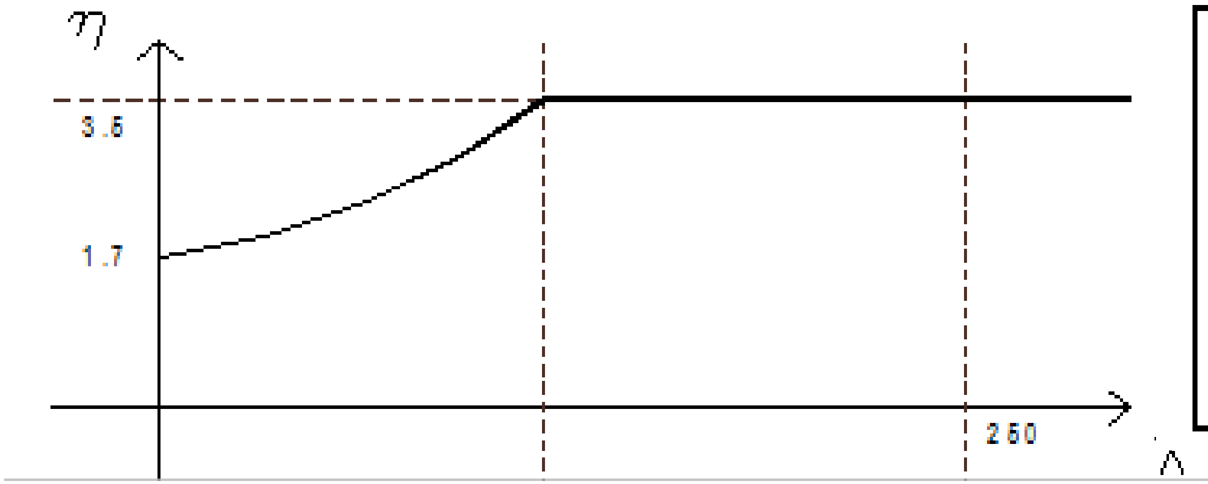
$$\sigma_{EULER} = \frac{E\,\pi^2}{\lambda^2}$$

COMPRESIÓN SIMPLE *Verificación de tensiones*

$$\sigma_{EULER} = \frac{E\,\pi^2}{\lambda^2}$$

$$\sigma_{d\ EULER} = \frac{\sigma_{EULER}}{\eta}$$



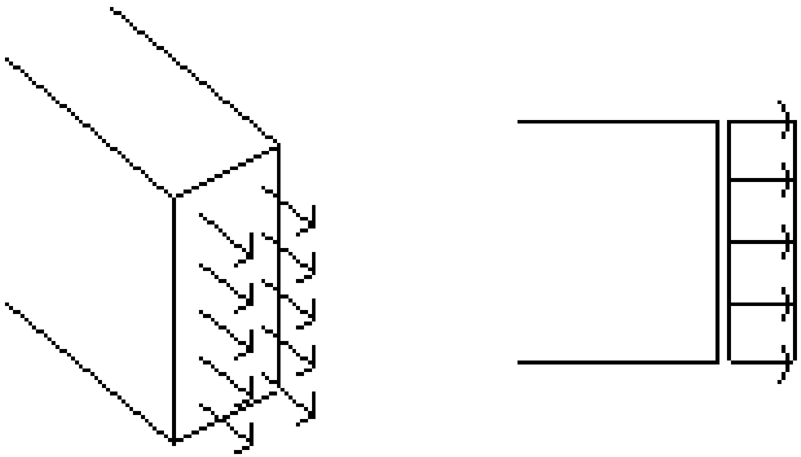


$$\sigma_{real} < \sigma_{d\ EULER}$$

$$\frac{N}{A} < \frac{f_d}{\omega}$$

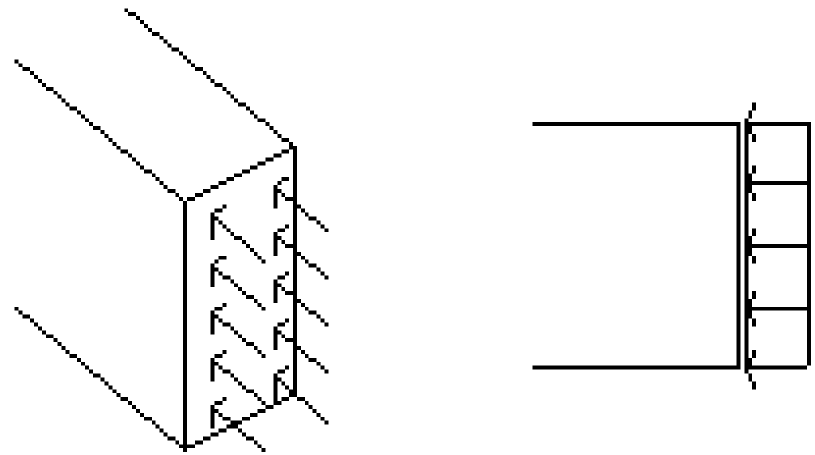
SÍNTESIS ***Esquemas tensionales***

TRACCIÓN SIMPLE



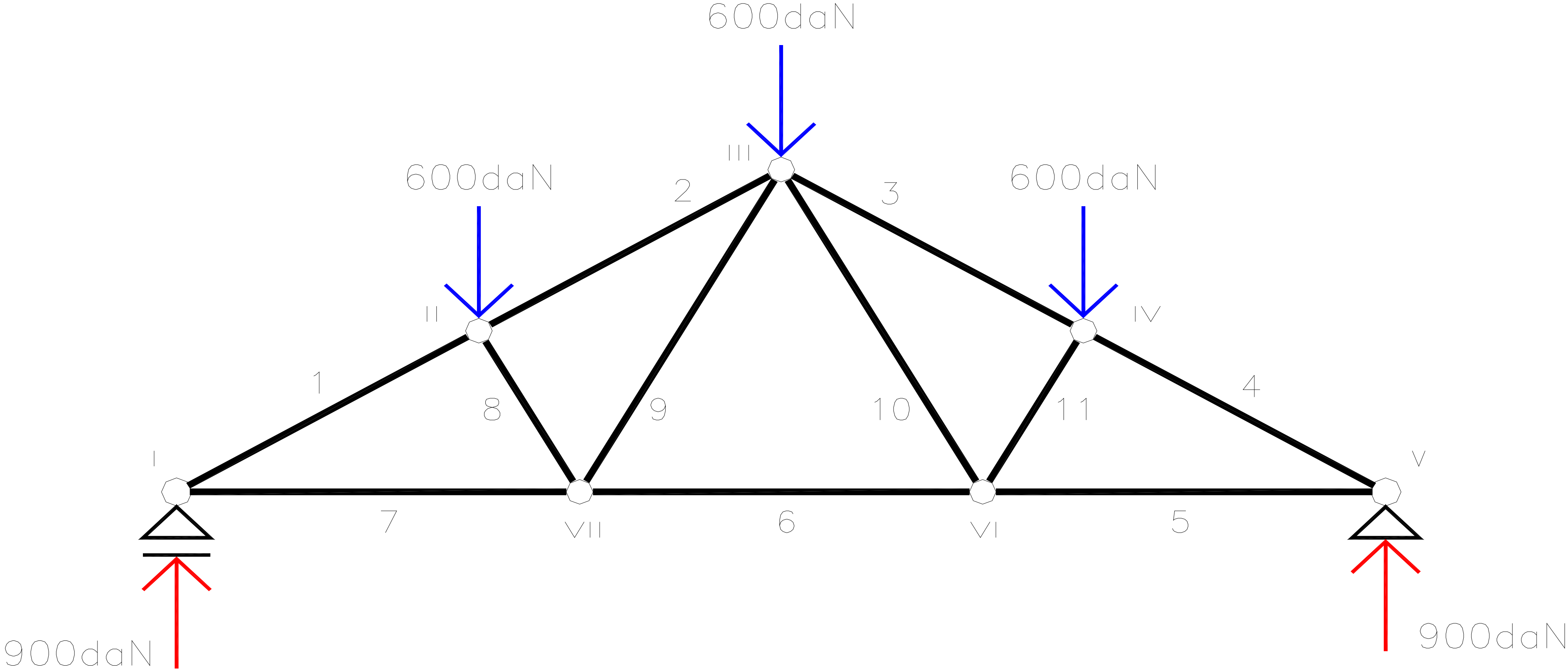
$$\sigma_{real} = \frac{T}{A} \leq f_d$$

COMPRESIÓN SIMPLE



$$\sigma_{real} = \frac{N}{A} \leq \sigma_{euler} = \frac{f_d}{\omega}$$

DIMENSIONADO DE LAS BARRAS



BARRA	COMPRESION	TRACCION	LONGITUD	SECCION	σ_{real}	σ_d EULER
1	1800daN		260cm			
2	1500daN		290cm			
3	1500daN		290cm			
4	1800daN		260cm			
5		1558daN	300cm			
6		1039daN	300cm			
7		1558daN	300cm			
8	519daN		150cm			
9		519daN	260cm			
10		519daN	260cm			
11	519daN		150cm			

TRACCIÓN

$$\sigma = \frac{F}{A} \leqslant f_d$$

$$A = \frac{F}{f_d}$$

COMPRESIÓN

$$\left.\begin{array}{l} \sigma = \dfrac{F}{A} < \sigma_{d\ EULER} \leqslant f_d \\ \sigma_{d\ EULER} = \dfrac{f_d}{\omega} \end{array}\right\} \frac{F}{A} < \frac{f_d}{\omega} \leqslant f_d$$

$$A = \frac{F}{f_d} \cdot \omega$$

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

TRACCIÓN

$$\sigma = \frac{F}{A} \leqslant f_d$$

$$A = \frac{F}{f_d}$$

TRACCIÓN Acero redondo

BARRA 5
BARRA 7

$$A = \frac{1558 \text{ daN}}{1400 \text{ daN/cm}^2} = 1.11 \text{ cm}^2$$

Hierro de sección circular

Tabla 7.3.2 - pág 87

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

TRACCIÓN

$$\sigma = \frac{F}{A} \leqslant f_d$$

$$A = \frac{F}{f_d}$$

TRACCIÓN   Acero redondo

BARRA 5
BARRA 7

$$A = \frac{1558 \ daN}{1400 \ daN/cm^2} = 1.11 \ cm^2 \xrightarrow{\text{SECCIÓN}} \phi 12 \quad (1.13 \ cm^2)$$

$$\sigma = \frac{1558 \ daN}{1.13 \ cm^2} = 1379 \ daN/cm^2$$

BARRA	COMPRESION	TRACCION	LONGITUD	SECCION	σ_{real}	σ_d EULER
1	1800 daN		260cm			
2	1500 daN		290cm			
3	1500 daN		290cm			
4	1800 daN		260cm			
5		1558 daN	300cm	Φ 12	1379 daN/cm^2	
6		1039 daN	300cm	Φ 12	919 daN/cm^2	
7		1558 daN	300cm	Φ 12	1379 daN/cm^2	
8	519 daN		150cm			
9		519 daN	260cm	Φ 12	459 daN/cm^2	
10		519 daN	260cm	Φ 12	459 daN/cm^2	
11	519 daN		150cm			

COMPRESIÓN

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

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

$$\Rightarrow \frac{F}{A} < \frac{f_d}{\omega} \leqslant f_d$$

$$A = \frac{F}{f_d} \cdot \omega$$

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

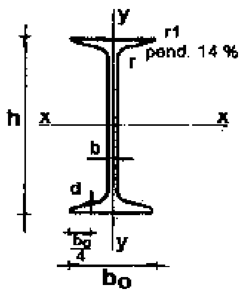
COMPRESIÓN Perfil Normalizado I

BARRA 1
BARRA 4

$$A = \frac{1800\ daN}{1400\ daN/cm^2} = 1.29\ cm^2 \xrightarrow{\text{TABLA}}$$

Perfil "I" de acero

Características 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
20	200	90	7.5	11.3	4.5	33.4	26.2	2140	214	8.00	117	26.00	1.87	125
22	220	98	8.1	12.2	4.9	39.5	31.1	3060	278	8.80	162	33.10	2.02	162
24	240	106	8.7	13.1	5.2	46.1	36.2	4250	354	9.59	221	41.70	2.20	206
26	260	113	9.4	14.1	5.6	53.3	41.9	5740	442	10.4	288	51.00	2.32	257
28	280	119	10.1	15.2	6.1	61.0	47.9	7590	542	11.1	364	61.20	2.45	316
30	300	125	10.8	16.2	6.5	69.0	54.2	9800	653	11.9	451	72.20	2.56	381
32	320	131	11.5	17.3	6.9	77.7	61.0	12510	782	12.7	555	84.70	2.67	457
34	340	137	12.2	18.3	7.3	86.7	68.0	15700	923	13.5	674	98.40	2.80	540
36	360	143	13.0	19.5	7.8	97.0	76.1	19610	1090	14.2	818	114	2.90	638

Perfil "I" de acero

I	h	bo	b=r	d	r1	A	g	Iy	Wy	iy	SLN
8	80	42	3.9	5.9	2.3	7.54	5.9	6.3	3.00	0.91	11.4
10	100	50	4.5	6.8	2.7	10.6	8.3	12.2	4.88	1.07	19.9

PNI N°8 $A = 7.54\ cm^2$

$i - 0.91\ cm$

COMPRESIÓN

$$\left.\begin{array}{l} \sigma = \dfrac{F}{A} < \sigma_{d\ EULER} \leq f_d \\ \sigma_{d\ EULER} = \dfrac{f_d}{\omega} \end{array}\right\} \dfrac{F}{A} < \dfrac{f_d}{\omega} \leq f_d$$

$$A = \frac{F}{f_d} \cdot \omega$$

$$\lambda = \frac{l_0}{i_{min}} \qquad l_0 = l_{real} \cdot \alpha$$

COMPRESIÓN Perfil Normalizado I

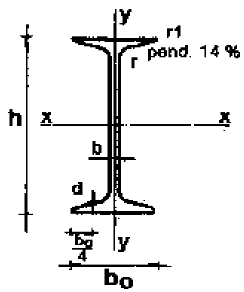
BARRA 1
BARRA 4

$$A = \frac{1800\ daN}{1400\ daN/cm^2} = 1{,}29\ cm^2 \xrightarrow{\text{TABLA}} \text{PNI N°8} \quad A = 7{,}54\ cm^2,\ i = 0{,}91\ cm$$

$$\lambda = \frac{260\ cm}{0{,}91\ cm} = 286 \nless 250 \quad \text{NO CUMPLE}$$

Perfil "I" de acero

Características 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
20	200	90	7.5	11.3	4.5	33.4	26.2	2140	214	8.00	117	26.00	1.87	125
22	220	98	8.1	12.2	4.9	39.5	31.1	3060	278	8.80	162	33.10	2.02	162
24	240	106	8.7	13.1	5.2	46.1	36.2	4250	354	9.59	221	41.70	2.20	206
26	260	113	9.4	14.1	5.6	53.3	41.9	5740	442	10.4	288	51.00	2.32	257
28	280	119	10.1	15.2	6.1	61.0	47.9	7590	542	11.1	364	61.20	2.45	316
30	300	125	10.8	16.2	6.5	69.0	54.2	9800	653	11.9	451	72.20	2.56	381
32	320	131	11.5	17.3	6.9	77.7	61.0	12510	782	12.7	555	84.70	2.67	457
34	340	137	12.2	18.3	7.3	86.7	68.0	15700	923	13.5	674	98.40	2.80	540
36	360	143	13.0	19.5	7.8	97.0	76.1	19610	1090	14.2	818	114	2.90	638

Perfil “I” de acero

I	h	bo	b=r	d	r1	A	g	Iy	Wy	iy	SLN
8	80	42	3.9	5.9	2.3	7.54	5.94	6.3	3.00	0.91	11.4
10	100	50	4.5	6.8	2.7	10.6	8.34	12.2	4.88	1.07	19.9

PNI N°10 $A = 10{,}60\ cm^2$

$i = 1{,}07\ cm$

COMPRESIÓN

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

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

$$\left.\right\} \frac{F}{A} < \frac{f_d}{\omega} \leqslant f_d$$

$$A = \frac{F}{f_d} \cdot \omega$$

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

COMPRESIÓN Perfil Normalizado I

BARRA 1
BARRA 4

PNI N°10 $A = 10{,}60\ cm^2$
$i = 1{,}07\ cm$

$$\lambda = \frac{260\ cm}{1{,}07\ cm} = 243 < 250$$ CUMPLE —TABLA→

COEFICIENTE DE PANDEO W PARA ACERO

BARRAS DE SECCION CONSTANTE
según DIN 1050
acero St 00.12 ; acero de calidad corriente y St 37.12

$$\lambda = \frac{l_k}{\rho_{min}}$$

$$A \geq \frac{w F}{\sigma_{ad}}$$

unidades

si se trabaja con σ : t/cm²

F : k

A : cm^2

λ	0	1	2	3	4	5	6	7	8	9
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02
20	1.02	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.05	1.05
30	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.10
40	1.10	1.11	1.11	1.12	1.13	1.13	1.14	1.15	1.15	1.16
50	1.17	1.18	1.18	1.19	1.20	1.21	1.22	1.23	1.24	1.25
60	1.26	1.27	1.29	1.30	1.31	1.32	1.34	1.35	1.36	1.38
70	1.39	1.41	1.43	1.44	1.46	1.48	1.50	1.52	1.54	1.56
80	1.59	1.61	1.63	1.66	1.69	1.71	1.74	1.78	1.81	1.84
90	1.88	1.92	1.95	2.00	2.04	2.09	2.14	2.19	2.24	2.30
100	2.36	2.41	2.46	2.51	2.56	2.61	2.66	2.71	2.76	2.81
110	2.86	2.91	2.97	3.02	3.07	3.13	3.18	3.24	3.29	3.35
120	3.40	3.46	3.52	3.58	3.64	3.69	3.75	3.81	3.87	3.93
130	4.00	4.06	4.12	4.18	4.25	4.31	4.37	4.44	4.50	4.57
140	4.63	4.70	4.77	4.83	4.90	4.97	5.04	5.11	5.18	5.25
150	5.32	5.39	5.48	5.53	5.61	5.68	5.75	5.83	5.90	5.98
160	6.05	6.13	6.20	6.28	6.36	6.44	6.51	6.59	6.67	6.75
170	6.83	6.91	6.99	7.08	7.16	7.24	7.32	7.41	7.49	7.57
180	7.66	7.75	7.83	7.92	8.00	8.09	8.18	8.27	8.36	8.44
190	8.53	8.62	8.72	8.81	8.90	8.99	9.08	9.17	9.27	9.36
200	9.46	9.55	9.65	9.74	9.84	9.94	10.03	10.13	10.23	10.33
210	10.43	10.53	10.63	10.73	10.83	10.93	11.03	11.13	11.24	11.34
220	11.44	11.55	11.65	11.76	11.86	11.97	12.08	12.18	12.29	12.40
230	12.51	12.62	12.72	12.83	12.94	13.06	13.17	13.28	13.39	13.50
240	13.62	13.73	13.84	13.96	14.08	14.19	14.31	14.42	14.54	14.66
250	14.78									

λ	0	1	2	3	4	5	6	7	8	9
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02
200	9.46	9.55	9.65	9.74	9.84	9.94	10.03	10.13	10.23	10.33
210	10.43	10.53	10.63	10.73	10.83	10.93	11.03	11.13	11.24	11.34
220	11.44	11.55	11.65	11.76	11.86	11.97	12.08	12.18	12.29	12.40
230	12.51	12.62	12.72	12.83	12.94	13.06	13.17	13.28	13.39	13.50
240	13.62	13.73	13.84	13.96	14.08	14.19	14.31	14.42	14.54	14.66
250	14.78									

$$\lambda = \frac{260\ cm}{1.07\ cm} = 243 < 250 \quad \text{CUMPLE} \quad \xrightarrow{\text{TABLA}} \quad \omega = 13.96$$

COMPRESIÓN

$$\left.\begin{array}{l}\sigma = \dfrac{F}{A} < \sigma_{d\ EULER} \leqslant f_d \\ \sigma_{d\ EULER} = \dfrac{f_d}{\omega}\end{array}\right\} \dfrac{F}{A} < \dfrac{f_d}{\omega} \leqslant f_d$$

$$A = \frac{F}{f_d} \cdot \omega$$

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

COMPRESIÓN Perfil Normalizado I

BARRA 1
BARRA 4

PNI N°10 $A = 10.60\,cm^2$
$i = 1.07\,cm$

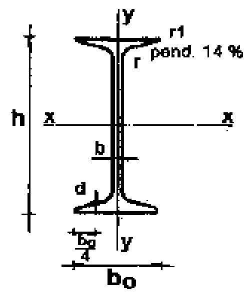
$$\lambda = \frac{260\,cm}{1.07\,cm} = 243 < 250 \text{ CUMPLE} \xrightarrow{\text{TABLA}} \omega = 13.96$$

$$\frac{1800\,daN}{10.60\,cm^2} < \frac{1400\,daN/cm^2}{13.96}$$

$$170\,daN/cm^2 \nleq 100\,daN/cm^2 \quad \text{NO VERIFICA}$$

Perfil "I" de acero

Características 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
20	200	90	7.5	11.3	4.5	33.4	26.2	2140	214	8.00	117	26.00	1.87	125
22	220	98	8.1	12.2	4.9	39.5	31.1	3060	278	8.80	162	33.10	2.02	162
24	240	106	8.7	13.1	5.2	46.1	36.2	4250	354	9.59	221	41.70	2.20	206
26	260	113	9.4	14.1	5.6	53.3	41.9	5740	442	10.4	288	51.00	2.32	257
28	280	119	10.1	15.2	6.1	61.0	47.9	7590	542	11.1	364	61.20	2.45	316
30	300	125	10.8	16.2	6.5	69.0	54.2	9800	653	11.9	451	72.20	2.56	381
32	320	131	11.5	17.3	6.9	77.7	61.0	12510	782	12.7	555	84.70	2.67	457
34	340	137	12.2	18.3	7.3	86.7	68.0	15700	923	13.5	674	98.40	2.80	540
36	360	143	13.0	19.5	7.8	97.0	76.1	19610	1090	14.2	818	114	2.90	638

Perfil "I" de acero

I	h	bo	b=r	d	r1	A	g	Iy	Wy	iy	SLN
8	80	42	3.9	5.9	2.3	7.54	5.94	6.3	3.00	0.91	11.4
10	100	50	4.5	6.8	2.7	10.6	8.34	12.2	4.88	1.07	19.9
12	120	58	5.1	7.7	3.1	14.2	11.1	21.5	7.41	1.23	31.8

PNI Nº 12

$A = 14.20\ cm^2$

$i = 1.23\ cm$

COMPRESIÓN

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

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

$$\left.\begin{matrix} \\ \\ \end{matrix}\right\} \frac{F}{A} < \frac{f_d}{\omega} \leqslant f_d$$

$$A = \frac{F}{f_d} \cdot \omega$$

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

COMPRESIÓN   Perfil Normalizado]

BARRA 1
BARRA 4

PNI N°12 $A = 14.20\,cm^2$
$i = 1.23\,cm$

$$\lambda = \frac{260\,cm}{1.23\,cm} = 211 < 250 \quad \text{CUMPLE} \xrightarrow{\text{TABLA}}$$

COEFICIENTE DE PANDEO W PARA ACERO

BARRAS DE SECCION CONSTANTE
según DIN 1050
acero St 00.12; acero de calidad corriente y St 37.12

$$\lambda = \frac{l_k}{\rho_{min}}$$

$$A \geq \frac{w F}{\sigma_{ad}}$$

unidades

si se trabaja con σ: t/cm²

F : t

A : cm²

λ	0	1	2	3	4	5	6	7	8	9
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02
20	1.02	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.05	1.05
30	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.10
40	1.10	1.11	1.11	1.12	1.13	1.13	1.14	1.15	1.15	1.16
50	1.17	1.18	1.18	1.19	1.20	1.21	1.22	1.23	1.24	1.25
60	1.26	1.27	1.29	1.30	1.31	1.32	1.34	1.35	1.36	1.38
70	1.39	1.41	1.43	1.44	1.46	1.48	1.50	1.52	1.54	1.56
80	1.59	1.61	1.63	1.66	1.69	1.71	1.74	1.78	1.81	1.84
90	1.88	1.92	1.95	2.00	2.04	2.09	2.14	2.19	2.24	2.30
100	2.36	2.41	2.46	2.51	2.56	2.61	2.66	2.71	2.76	2.81
110	2.86	2.91	2.97	3.02	3.07	3.13	3.18	3.24	3.29	3.35
120	3.40	3.46	3.52	3.58	3.64	3.69	3.75	3.81	3.87	3.93
130	4.00	4.06	4.12	4.18	4.25	4.31	4.37	4.44	4.50	4.57
140	4.63	4.70	4.77	4.83	4.90	4.97	5.04	5.11	5.18	5.25
150	5.32	5.39	5.46	5.53	5.61	5.68	5.75	5.83	5.90	5.98
160	6.05	6.13	6.20	6.28	6.36	6.44	6.51	6.59	6.67	6.75
170	6.83	6.91	6.99	7.08	7.16	7.24	7.32	7.41	7.49	7.57
180	7.66	7.75	7.83	7.92	8.00	8.09	8.18	8.27	8.36	8.44
190	8.53	8.62	8.72	8.81	8.90	8.99	9.08	9.17	9.27	9.36
200	9.46	9.55	9.65	9.74	9.84	9.94	10.03	10.13	10.23	10.33
210	10.43	10.53	10.63	10.73	10.83	10.93	11.03	11.13	11.24	11.34
220	11.44	11.55	11.65	11.76	11.86	11.97	12.08	12.18	12.29	12.40
230	12.51	12.62	12.72	12.83	12.94	13.06	13.17	13.28	13.39	13.50
240	13.62	13.73	13.84	13.96	14.08	14.19	14.31	14.42	14.54	14.66
250	14.78									

λ	0	1	2	3	4	5	6	7	8	9
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02
200	9.46	9.55	9.65	9.74	9.84	9.94	10.03	10.13	10.23	10.33
210	10.43	10.53	10.63	10.73	10.83	10.93	11.03	11.13	11.24	11.34
220	11.44	11.55	11.65	11.76	11.86	11.97	12.08	12.18	12.29	12.40
230	12.51	12.62	12.72	12.83	12.94	13.06	13.17	13.28	13.39	13.50
240	13.62	13.73	13.84	13.96	14.08	14.19	14.31	14.42	14.54	14.66
250	14.78									

$$\lambda = \frac{260\,\text{cm}}{1.23\,\text{cm}} = 211 < 250 \quad \text{CUMPLE} \xrightarrow{\text{TABLA}} \omega = 10.53$$

COMPRESIÓN

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

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

$$\left.\right\} \frac{F}{A} < \frac{f_d}{\omega} \leq f_d$$

$$A = \frac{F}{f_d} \cdot \omega$$

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

COMPRESIÓN Perfil Normalizado]

BARRA 1
BARRA 4

PNI N°12 $A = 14.20\,cm^2$
$i = 1.23\,cm$

$$\lambda = \frac{260\,cm}{1.23\,cm} = 211 < 250 \quad \text{CUMPLE} \xrightarrow{\text{TABLA}} \omega = 10.53$$

$$\frac{1800\,daN}{14.20\,cm^2} < \frac{1400\,daN/cm^2}{10.53}$$

$$127\,daN/cm^2 < 133\,daN/cm^2 \quad \text{VERIFICA}$$

COMPRESIÓN

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

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

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

$$A = \frac{F}{f_d} \cdot \omega$$

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

COMPRESIÓN Perfil Normalizado I

BARRA 2
BARRA 3

PNI Nº12 $A = 14{,}20\ cm^2$
$i = 1{,}23\ cm$

$$\lambda = \frac{290\ cm}{1{,}23\ cm} = 236 < 250 \quad \text{CUMPLE} \xrightarrow{\text{TABLA}}$$

COEFICIENTE DE PANDEO W PARA ACERO

BARRAS DE SECCION CONSTANTE
según DIN 1050
acero St 00.12; acero de calidad corriente y St 37.12

$\lambda = \frac{l_k}{\rho_{min}}$

$A \geq \frac{w F}{\sigma_{ad}}$

unidades
si se trabaja con σ: k/cm²

F : k
A : cm²

λ	0	1	2	3	4	5	6	7	8	9
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02
20	1.02	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.05	1.05
30	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.10
40	1.10	1.11	1.11	1.12	1.13	1.13	1.14	1.15	1.15	1.16
50	1.17	1.18	1.18	1.19	1.20	1.21	1.22	1.23	1.24	1.25
60	1.26	1.27	1.29	1.30	1.31	1.32	1.34	1.35	1.36	1.38
70	1.39	1.41	1.43	1.44	1.46	1.48	1.50	1.52	1.54	1.56
80	1.59	1.61	1.63	1.66	1.69	1.71	1.74	1.78	1.81	1.84
90	1.88	1.92	1.95	2.00	2.04	2.09	2.14	2.19	2.24	2.30
100	2.36	2.41	2.46	2.51	2.56	2.61	2.66	2.71	2.76	2.81
110	2.86	2.91	2.97	3.02	3.07	3.13	3.18	3.24	3.29	3.35
120	3.40	3.46	3.52	3.58	3.64	3.69	3.75	3.81	3.87	3.93
130	4.00	4.06	4.12	4.18	4.25	4.31	4.37	4.44	4.50	4.57
140	4.63	4.70	4.77	4.83	4.90	4.97	5.04	5.11	5.18	5.25
150	5.32	5.39	5.46	5.53	5.61	5.68	5.75	5.83	5.90	5.98
160	6.05	6.13	6.20	6.28	6.36	6.44	6.51	6.59	6.67	6.75
170	6.83	6.91	6.99	7.08	7.16	7.24	7.32	7.41	7.49	7.57
180	7.66	7.75	7.83	7.92	8.00	8.09	8.18	8.27	8.36	8.44
190	8.53	8.62	8.72	8.81	8.90	8.99	9.08	9.17	9.27	9.36
200	9.46	9.55	9.65	9.74	9.84	9.94	10.03	10.13	10.23	10.33
210	10.43	10.53	10.63	10.73	10.83	10.93	11.03	11.13	11.24	11.34
220	11.44	11.55	11.65	11.76	11.86	11.97	12.08	12.18	12.29	12.40
230	12.51	12.62	12.72	12.83	12.94	13.06	13.17	13.28	13.39	13.50
240	13.62	13.73	13.84	13.96	14.08	14.19	14.31	14.42	14.54	14.66
250	14.78									

λ	0	1	2	3	4	5	6	7	8	9
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02
200	9.46	9.55	9.65	9.74	9.84	9.94	10.03	10.13	10.23	10.33
210	10.43	10.53	10.63	10.73	10.83	10.93	11.03	11.13	11.24	11.34
220	11.44	11.55	11.65	11.76	11.86	11.97	12.08	12.18	12.29	12.40
230	12.51	12.62	12.72	12.83	12.94	13.06	13.17	13.28	13.39	13.50
240	13.62	13.73	13.84	13.96	14.08	14.19	14.31	14.42	14.54	14.66
250	14.78									

$$\lambda = \frac{290\,cm}{1{,}23\,cm} = 236 < 250 \quad \text{CUMPLE} \xrightarrow{\text{TABLA}} \omega = 13{,}17$$

COMPRESIÓN

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

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

$$\left.\right\} \frac{F}{A} < \frac{f_d}{\omega} \leqslant f_d$$

$$A = \frac{F}{f_d} \cdot \omega$$

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

COMPRESIÓN Perfil Normalizado I

BARRA 2
BARRA 3

PNI Nº12 $A = 14.20\ cm^2$
$i = 1.23\ cm$

$$\lambda = \frac{290\ cm}{1.23\ cm} = 236 < 250 \text{ CUMPLE} \xrightarrow{\text{TABLA}} \omega = 13.17$$

$$\frac{1500\ daN}{14.20\ cm^2} < \frac{1400\ daN/cm^2}{13.17}$$

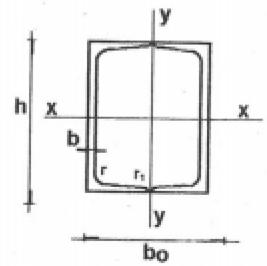
$$105\ daN/cm^2 < 106\ daN/cm^2 \text{ VERIFICA}$$

BARRA	COMPRESION	TRACCION	LONGITUD	SECCION	σ_{real}	σ_d EULER
1	1800daN		260cm	PNI 12	127 daN/cm²	133 daN/cm²
2	1500daN		290cm	PNI 12	105 daN/cm²	106 daN/cm²
3	1500daN		290cm	PNI 12	105 daN/cm²	106 daN/cm²
4	1800daN		260cm	PNI 12	127 daN/cm²	133 daN/cm²
5		1558daN	300cm	Φ12	1379 daN/cm²	
6		1039daN	300cm	Φ12	919 daN/cm²	
7		1558daN	300cm	Φ12	1379 daN/cm²	
8	519daN		150cm	PNI 12	37 daN/cm²	398 daN/cm²
9		519daN	260cm	Φ12	459 daN/cm²	
10		519daN	260cm	Φ12	459 daN/cm²	
11	519daN		150cm	PNI 12	37 daN/cm²	398 daN/cm²

Perfil
“doble C”
de acero

Perfil “doble C” de acero

Caracteristicas geometricas de elementos estructurales
COMBINACION DE PERFILES [DE ACERO

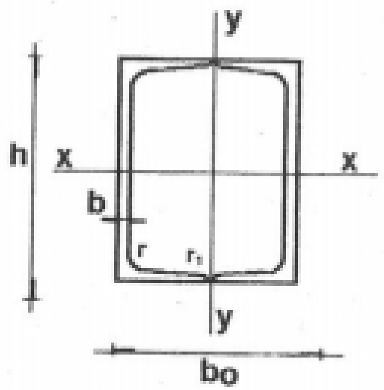


h,bo,b,d,r,r1	mm
A	cms2
g	daN/m
Iy,Ix	cms4
Wx,Wy	cms3
ix,iy	cms

	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

Caracteristicas geometr
COMBINACION

lementos estructurales
FILES [DE ACERO



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	
3	30	66.00	5.00	7.0	3.50	10.88	8.
4	40	70.00	5.00	7.0	3.50	12.42	9.
5	50	76.00	5.00	7.0	3.50	14.24	11

Ix	Wx	ix	Iy	Wy	iy
.78	8.52	1.08	53.55	1.63	2.22
.20	14.10	1.50	71.84	2.05	2.41
.80	21.12	1.92	102.33	2.69	2.68

PN[] N°4 $A = 12{,}42 \, cm^2$

$i = 1{,}50 \, cm$

COMPRESIÓN

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

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

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

$$A = \frac{F}{f_d} \cdot \omega$$

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

COMPRESIÓN Perfil Normalizado []

BARRA 1
BARRA 4

PN[] N°4 $A = 12{,}42\ cm^2$
$i = 1{,}50\ cm$

$$\lambda = \frac{260\ cm}{1{,}50\ cm} = 173 < 250$$ CUMPLE → TABLA

COEFICIENTE DE PANDEO ω PARA ACERO

BARRAS DE SECCION CONSTANTE
según DIN 1050
acero St 00.12; acero de calidad corriente y St 37.12

$$\lambda = \frac{l_k}{\rho_{min}}$$

$$A \geq \frac{\omega F}{\sigma_{ad}}$$

unidades
si se trabaja con σ: t/cm^2

F : k
A : cm^2

λ	0	1	2	3	4	5	6	7	8	9
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02
20	1.02	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.05	1.05
30	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.10
40	1.10	1.11	1.11	1.12	1.13	1.13	1.14	1.15	1.15	1.16
50	1.17	1.18	1.18	1.19	1.20	1.21	1.22	1.23	1.24	1.25
60	1.26	1.27	1.29	1.30	1.31	1.32	1.34	1.35	1.36	1.38
70	1.39	1.41	1.43	1.44	1.46	1.48	1.50	1.52	1.54	1.56
80	1.59	1.61	1.63	1.66	1.69	1.71	1.74	1.78	1.81	1.84
90	1.88	1.92	1.95	2.00	2.04	2.09	2.14	2.19	2.24	2.30
100	2.36	2.41	2.46	2.51	2.56	2.61	2.66	2.71	2.76	2.81
110	2.86	2.91	2.97	3.02	3.07	3.13	3.18	3.24	3.29	3.35
120	3.40	3.46	3.52	3.58	3.64	3.69	3.75	3.81	3.87	3.93
130	4.00	4.06	4.12	4.18	4.25	4.31	4.37	4.44	4.50	4.57
140	4.63	4.70	4.77	4.83	4.90	4.97	5.04	5.11	5.18	5.25
150	5.32	5.39	5.46	5.53	5.61	5.68	5.75	5.83	5.90	5.98
160	6.05	6.13	6.20	6.28	6.36	6.44	6.51	6.59	6.67	6.75
170	6.83	6.91	6.99	7.08	7.16	7.24	7.32	7.41	7.49	7.57
180	7.66	7.75	7.83	7.92	8.00	8.09	8.18	8.27	8.36	8.44
190	8.53	8.62	8.72	8.81	8.90	8.99	9.08	9.17	9.27	9.36
200	9.46	9.55	9.65	9.74	9.84	9.94	10.03	10.13	10.23	10.33
210	10.43	10.53	10.63	10.73	10.83	10.93	11.03	11.13	11.24	11.34
220	11.44	11.55	11.65	11.76	11.86	11.97	12.08	12.18	12.29	12.40
230	12.51	12.62	12.72	12.83	12.94	13.06	13.17	13.28	13.39	13.50
240	13.62	13.73	13.84	13.96	14.08	14.19	14.31	14.42	14.54	14.66
250	14.78									

λ	0	1	2	3	4	5	6	7	8	9
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02
150	5.32	5.39	5.46	5.53	5.61	5.68	5.75	5.83	5.90	5.98
160	6.05	6.13	6.20	6.28	6.36	6.44	6.51	6.59	6.67	6.75
170	6.83	6.91	6.99	7.08	7.16	7.24	7.32	7.41	7.49	7.57
180	7.66	7.75	7.83	7.92	8.00	8.09	8.18	8.27	8.36	8.44
190	8.53	8.62	8.72	8.81	8.90	8.99	9.08	9.17	9.27	9.36
200	9.46	9.55	9.65	9.74	9.84	9.94	10.03	10.13	10.23	10.33
210	10.43	10.53	10.63	10.73	10.83	10.93	11.03	11.13	11.24	11.34
220	11.44	11.55	11.65	11.76	11.86	11.97	12.08	12.18	12.29	12.40

$$\lambda = \frac{260\,cm}{1{,}50\,cm} = 173 < 250 \quad \text{CUMPLE} \quad \xrightarrow{\text{TABLA}} \quad \omega = 7.08$$

COMPRESIÓN

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

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

$$\left.\right\} \frac{F}{A} < \frac{f_d}{\omega} \leqslant f_d$$

$$A = \frac{F}{f_d} \cdot \omega$$

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

COMPRESIÓN Perfil Normalizado []

BARRA 1
BARRA 4

PN[] N°4 $A = 12{,}42\ cm^2$

$i = 1{,}50\ cm$

$$\lambda = \frac{260\ cm}{1{,}50\ cm} = 173 < 250 \quad \text{CUMPLE} \xrightarrow{\text{TABLA}} \omega = 7{,}08$$

$$\frac{1800\ daN}{12{,}42\ cm^2} < \frac{1400\ daN/cm^2}{7{,}08}$$

$$145\ daN/cm^2 < 198\ daN/cm^2 \quad \text{VERIFICA}$$

COMPRESIÓN

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

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

$$\left.\right\} \frac{F}{A} < \frac{f_d}{\omega} \leqslant f_d$$

$$A = \frac{F}{f_d} \cdot \omega$$

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

COMPRESIÓN Perfil Normalizado []

BARRA 2
BARRA 3

PN[] N°4 $A = 12.42\,cm^2$
$i = 1,50\,cm$

$$\lambda = \frac{290\,cm}{1,50\,cm} = 193 < 250 \quad \text{CUMPLE} \xrightarrow{\text{TABLA}}$$

COEFICIENTE DE PANDEO W PARA ACERO

BARRAS DE SECCION CONSTANTE
según DIN 1050
acero St 00.12; acero de calidad corriente y St 37.12

$$\lambda = \frac{l_k}{\rho_{mín}}$$

$$A \geq \frac{w F}{\sigma_{ad}}$$

unidades
si se trabaja con σ: t/cm²
F : k
A : cm²

λ	0	1	2	3	4	5	6	7	8	9
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02
20	1.02	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.05	1.05
30	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.10
40	1.10	1.11	1.11	1.12	1.13	1.13	1.14	1.15	1.15	1.16
50	1.17	1.18	1.18	1.19	1.20	1.21	1.22	1.23	1.24	1.25
60	1.26	1.27	1.29	1.30	1.31	1.32	1.34	1.35	1.36	1.38
70	1.39	1.41	1.43	1.44	1.46	1.48	1.50	1.52	1.54	1.56
80	1.59	1.61	1.63	1.66	1.69	1.71	1.74	1.78	1.81	1.84
90	1.88	1.92	1.95	2.00	2.04	2.09	2.14	2.19	2.24	2.30
100	2.36	2.41	2.46	2.51	2.56	2.61	2.66	2.71	2.76	2.81
110	2.86	2.91	2.97	3.02	3.07	3.13	3.18	3.24	3.29	3.35
120	3.40	3.46	3.52	3.58	3.64	3.69	3.75	3.81	3.87	3.93
130	4.00	4.06	4.12	4.18	4.25	4.31	4.37	4.44	4.50	4.57
140	4.63	4.70	4.77	4.83	4.90	4.97	5.04	5.11	5.18	5.25
150	5.32	5.39	5.46	5.53	5.61	5.68	5.75	5.83	5.90	5.98
160	6.05	6.13	6.20	6.28	6.36	6.44	6.51	6.59	6.67	6.75
170	6.83	6.91	6.99	7.08	7.16	7.24	7.32	7.41	7.49	7.57
180	7.66	7.75	7.83	7.92	8.00	8.09	8.18	8.27	8.36	8.44
190	8.53	8.62	8.72	8.81	8.90	8.99	9.08	9.17	9.27	9.36
200	9.46	9.55	9.65	9.74	9.84	9.94	10.03	10.13	10.23	10.33
210	10.43	10.53	10.63	10.73	10.83	10.93	11.03	11.13	11.24	11.34
220	11.44	11.55	11.65	11.76	11.86	11.97	12.08	12.18	12.29	12.40
230	12.51	12.62	12.72	12.83	12.94	13.06	13.17	13.28	13.39	13.50
240	13.62	13.73	13.84	13.96	14.08	14.19	14.31	14.42	14.54	14.66
250	14.78									

λ	0	1	2	3	4	5	6	7	8	9
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02
150	5.32	5.39	5.46	5.53	5.61	5.68	5.75	5.83	5.90	5.98
160	6.05	6.13	6.20	6.28	6.36	6.44	6.51	6.59	6.67	6.75
170	6.83	6.91	6.99	7.08	7.16	7.24	7.32	7.41	7.49	7.57
180	7.66	7.75	7.83	7.92	8.00	8.09	8.18	8.27	8.36	8.44
190	8.53	8.62	8.72	8.81	8.90	8.99	9.08	9.17	9.27	9.36
200	9.46	9.55	9.65	9.74	9.84	9.94	10.03	10.13	10.23	10.33
210	10.43	10.53	10.63	10.73	10.83	10.93	11.03	11.13	11.24	11.34
220	11.44	11.55	11.65	11.76	11.86	11.97	12.08	12.18	12.29	12.40

$$\lambda = \frac{290\,\text{cm}}{1{,}50\,\text{cm}} = 193 < 250 \quad \text{CUMPLE} \xrightarrow{\text{TABLA}} \omega = 8{,}81$$

COMPRESIÓN

$$\left.\begin{array}{l}\sigma = \dfrac{F}{A} < \sigma_{d\ EULER} \leq f_d \\ \sigma_{d\ EULER} = \dfrac{f_d}{\omega}\end{array}\right\} \dfrac{F}{A} < \dfrac{f_d}{\omega} \leq f_d$$

$$A = \frac{F}{f_d} \cdot \omega$$

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

COMPRESIÓN Perfil Normalizado []

BARRA 2
BARRA 3

PN[] N°4 $A = 12{,}42\ cm^2$
$i = 1{,}50\ cm$

$$\lambda = \frac{290\ cm}{1{,}50\ cm} = 193 < 250 \quad \text{CUMPLE} \xrightarrow{\text{TABLA}} \omega = 8{,}81$$

$$\frac{1500\ daN}{12{,}42\ cm^2} < \frac{1400\ daN/cm^2}{8{,}81}$$

$$121\ daN/cm^2 < 159\ daN/cm^2 \quad \text{VERIFICA}$$

COMPRESIÓN

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

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

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

$$A = \frac{F}{f_d} \cdot \omega$$

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

COMPRESIÓN Perfil Normalizado]

BARRA 1
BARRA 4

PNI N°12 $A = 14.20\,cm^2$, $i = 1.23\,cm$

COMPRESIÓN Perfil Normalizado I

BARRA 2
BARRA 3

PNI N°12 $A = 14.20\,cm^2$, $i = 1.23\,cm$

COMPRESIÓN Perfil Normalizado []

BARRA 1
BARRA 4

PN[] N°4 $A = 12.42\,cm^2$, $i = 1.50\,cm$

COMPRESIÓN Perfil Normalizado []

BARRA 2
BARRA 3

PN[] N°4 $A = 12.42\,cm^2$, $i = 1.50\,cm$