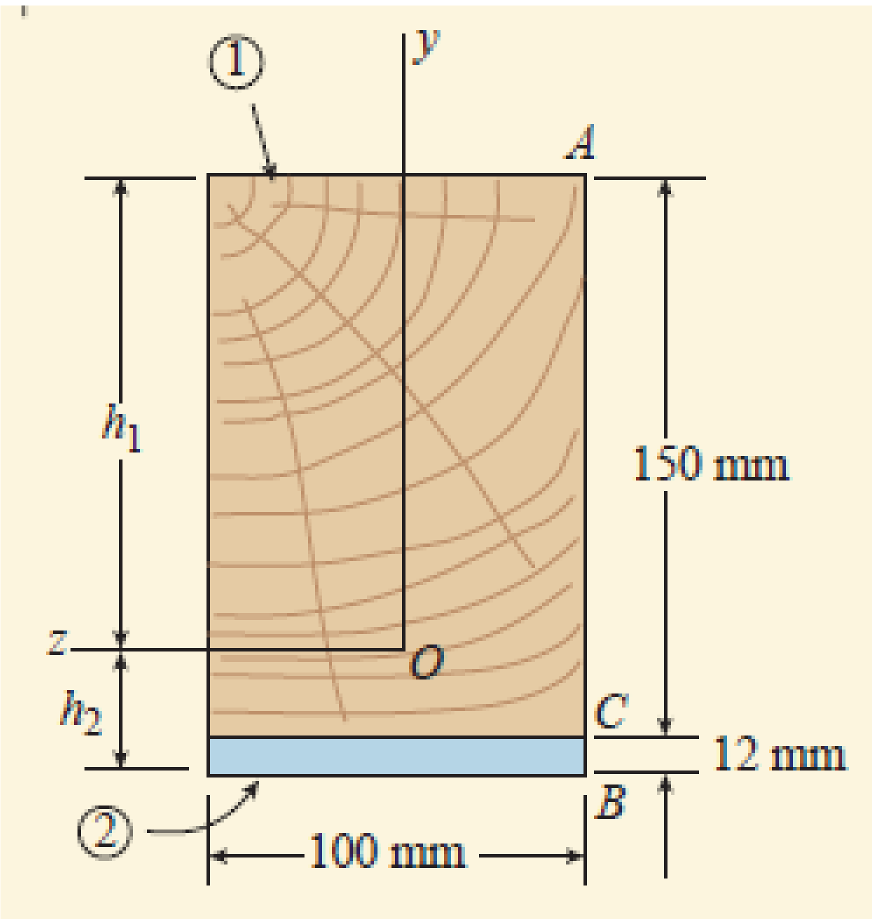
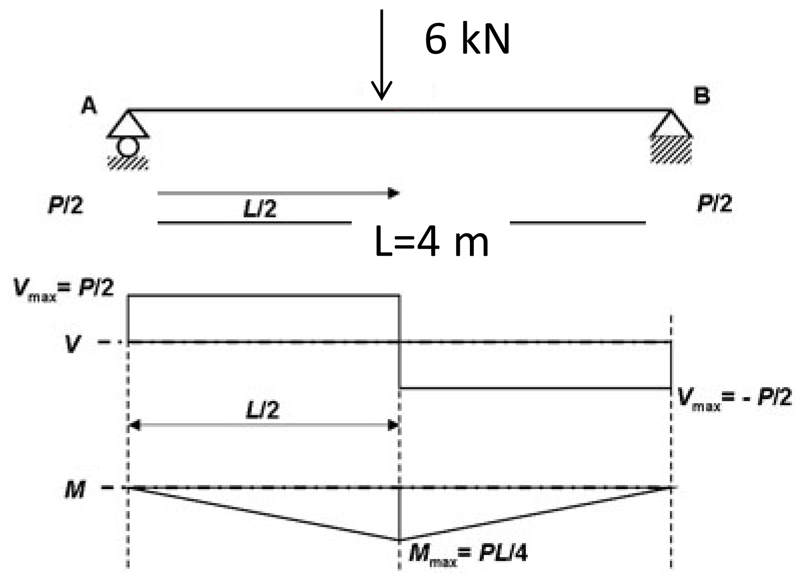
# Sección Compuesta

Ejemplos

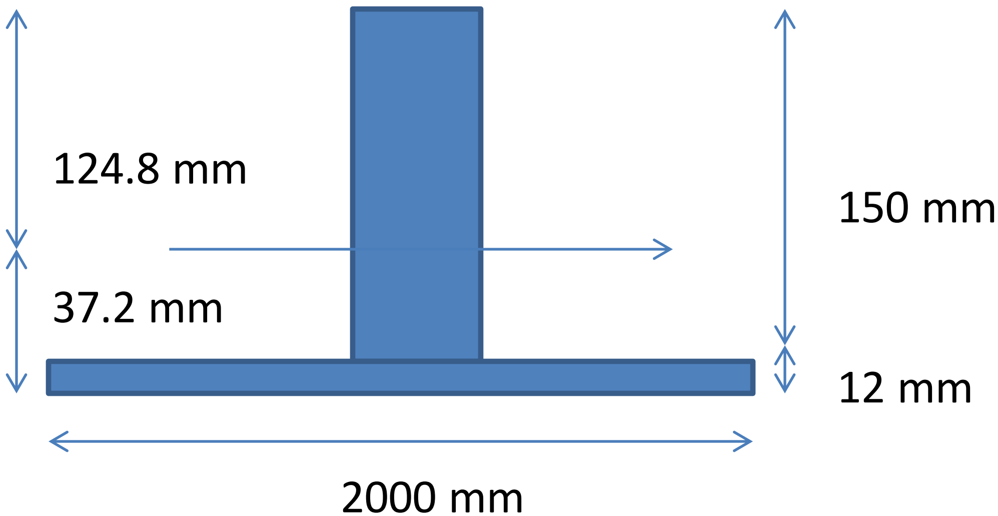
# Sección Compuesta

$E_{Madera}$= 10.5 GPa  $E_{Acero}$= 210 GPa



# Sección Compuesta



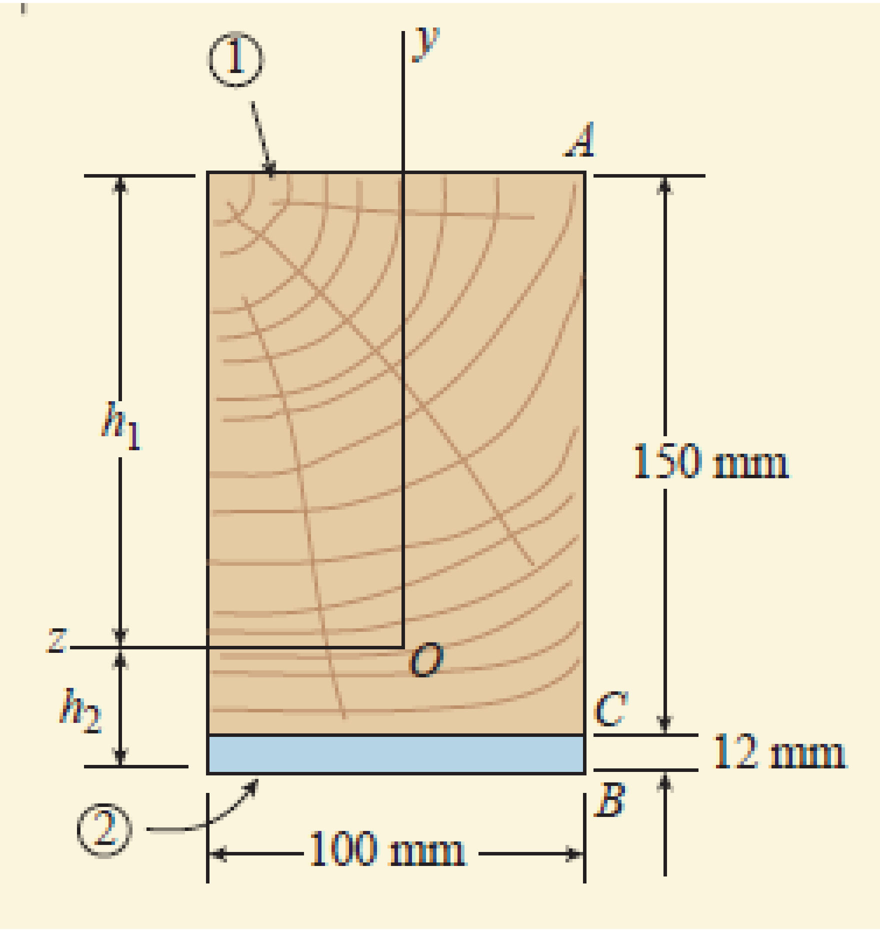

$$y_G = \frac{(150.100).75+(2000.12).156}{(150.100)+(2000.12)}$$

$$y_G = 124.8 \text{ mm}$$

$$I_{homog} = 100.(150)^3/12 +((124.8-75)^2.(100.150)+ 2000.\ 12^3/12+ 12.2000\ .(\ 37.2-6)^2$$

$$I_{homog} = 8.898 \times 10^7 \text{ mm}^4$$

# Sección Compuesta




$\sigma = E.\varepsilon \qquad k = M/E_1 I_{homog}$

$\sigma_{mat1} = E_1.\varepsilon = E_1.k.y = E_1.y.M/(E_1 I_{homog})$

$\sigma_{mat2} = E_2.\varepsilon = E_2.k.y = E_2.y.M/(E_1 I_{homog})$

$\sigma_A = -\ 10.5\ \text{GPa}\ 6\ \text{kNm}\ 0.1248/(E_1 I_{homg})$

$\sigma_A = -\ 8.4\ \text{MPa}$

$\sigma_{C1} = 10.5\ \text{Gpa}\ 6\ \text{kNm}\ 0.0252/(E_1 I_{homg})$

$\sigma_{C1} = 1.7\ \text{MPa}$

$\sigma_{C2} = 210\ \text{GPa}\ 6\ \text{kNm}\ 0.0252/(E_1 I_{homg})$

$\sigma_{C2} = 34\ \text{MPa}$

$\sigma_B = 210\ \text{GPa}\ 6\ \text{kNm}\ 0.0372/(E_1 I_{homg})$

$\sigma_B = 50.2\ \text{MPa}$

# Sección Compuesta

$\tau_G = 3kN. (124.8*100)*124.8/2/(I_{homog}*b)=262$ kPa

$\tau_{C1} = 3kN. ((124.8*100)*124.8/2)-$

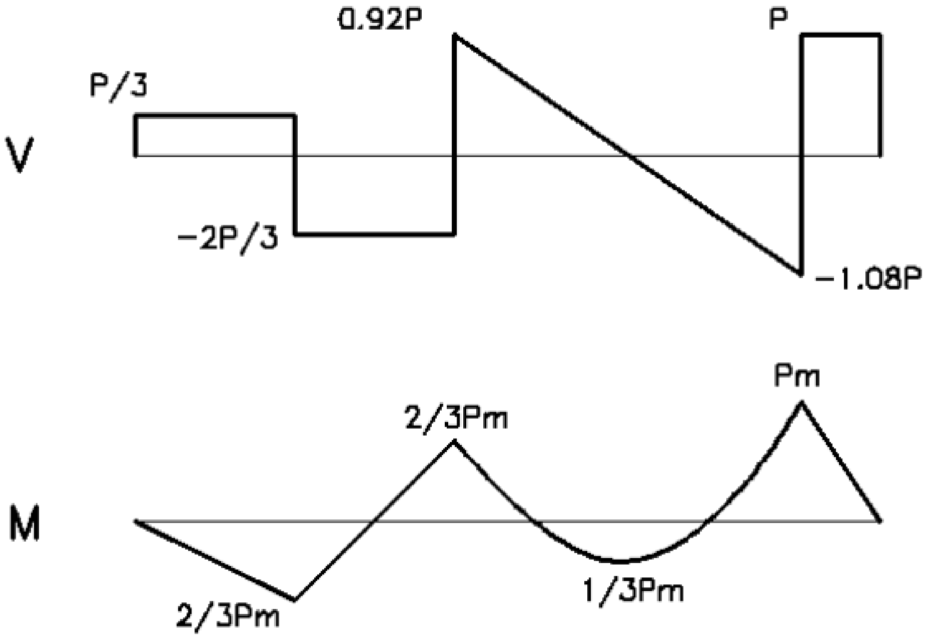
$(25.2*100)*25.2/2)/(I_{homog}*b)=252$ kPa

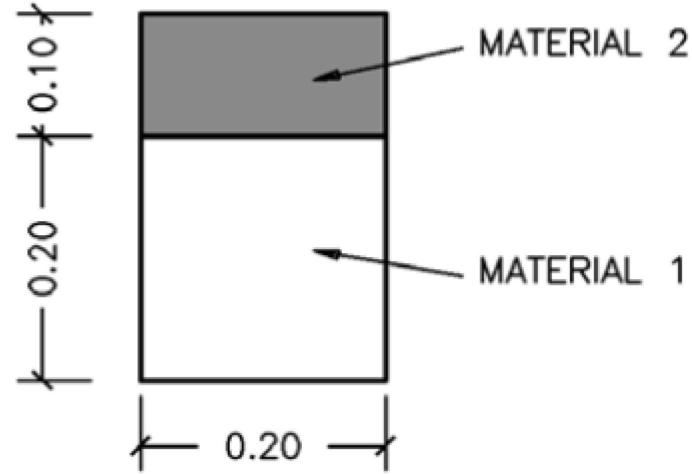
$\tau_{C2} = 3kN. ( (2000*12)*(25.2+6)/(I_{homog}*b_h)= 12.6$ kPa ??

Hay que mayor la tensión por n

$\tau_{C2} = 20. 12.6$ kPa = 252 kPa

# Ejemplo Curso RII

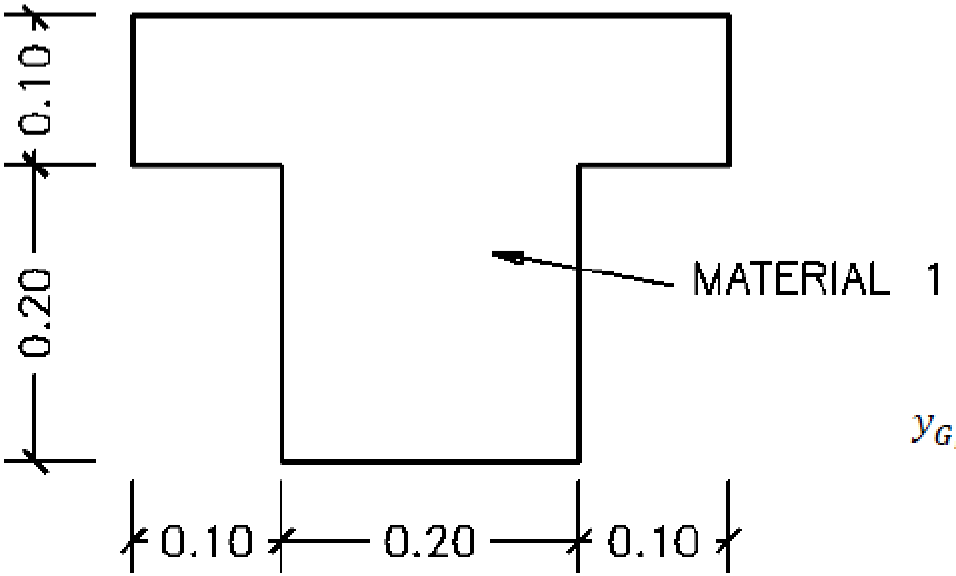



- $E_2/E_1=2$
- P=20 kN
- Tensiones admisibles: $\sigma_{adm,1}$ = 6 MPa y $\sigma_{adm,2}$ = 9 MPa
- Aplastamiento: $\sigma_{adm}^{aplast}$ (mat.1) = 10 MPa y $\sigma_{adm}^{aplast}$ (mat. 2) = 15 MPa.

Ejemplo práctico elaborado por Ing. Russi y Ing. Reboredo para el curso de RII

# Sección Homogeneizada




$$y_{G,hom} = \frac{20^2 \cdot 10 + 40 \cdot 10 \cdot 25}{20^2 + 40 \cdot 10} = 17.5\ cm$$

$$I_{x,hom} = \frac{20^4}{12} + 20^2 \cdot (10 - 17.5)^2 + \frac{40 \cdot 10^3}{12} + 40 \cdot 10 \cdot (25 - 17.5)^2 = 61666.7\ cm^4$$

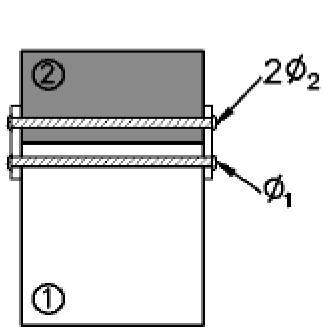
# Conectores

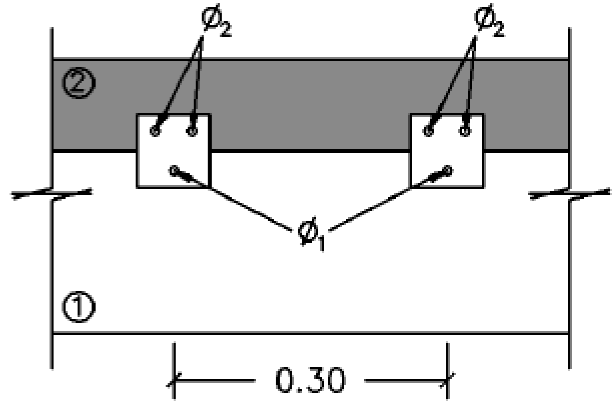
$$\tau \cdot b = \frac{V \cdot \mu_{hom}(\text{unión})}{I_{x,hom}}$$

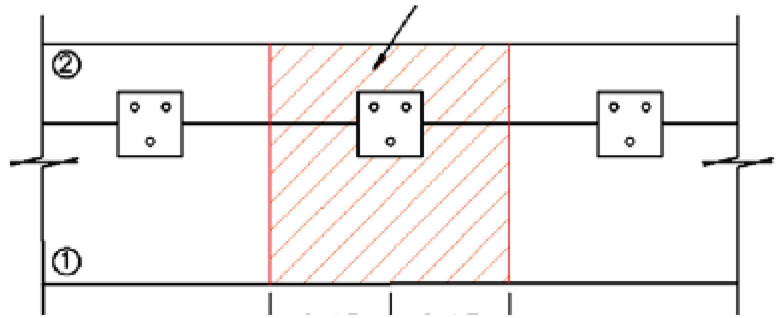
$$\mu_{hom}(\text{unión}) = 40 \cdot 10 \cdot (25 - 17.5) = 3000\ cm^3$$
$$I_{x,hom} = 61667\ cm^4$$
$$V = 1.08 \cdot P = 21.6\ kN$$

$$\tau \cdot b = \frac{21.6 \cdot 3000}{61667} = 1.05 \frac{kN}{cm}$$

# Conectores



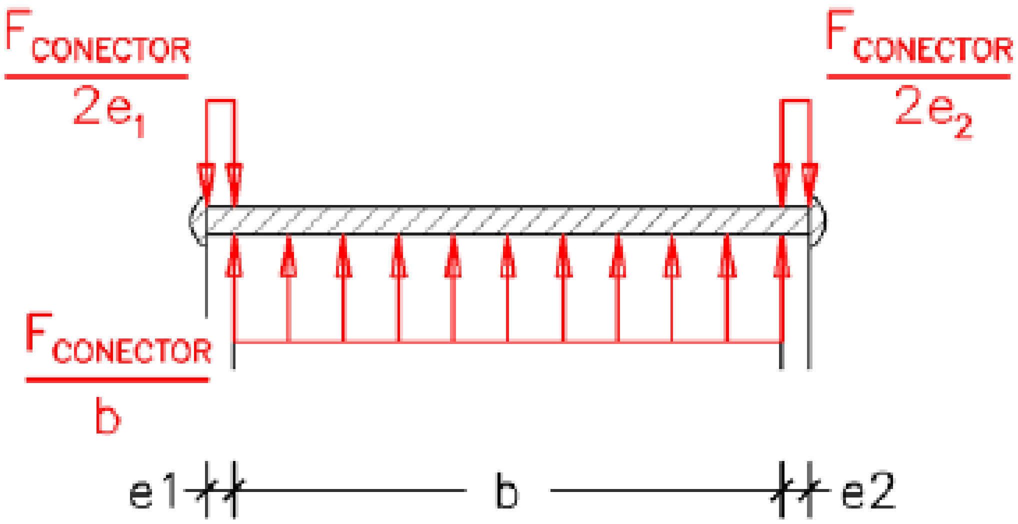




$$F_{conexión} = \tau \cdot b \cdot s = 1.05 \frac{kN}{cm} \cdot 30\ cm = 31.5\ kN$$

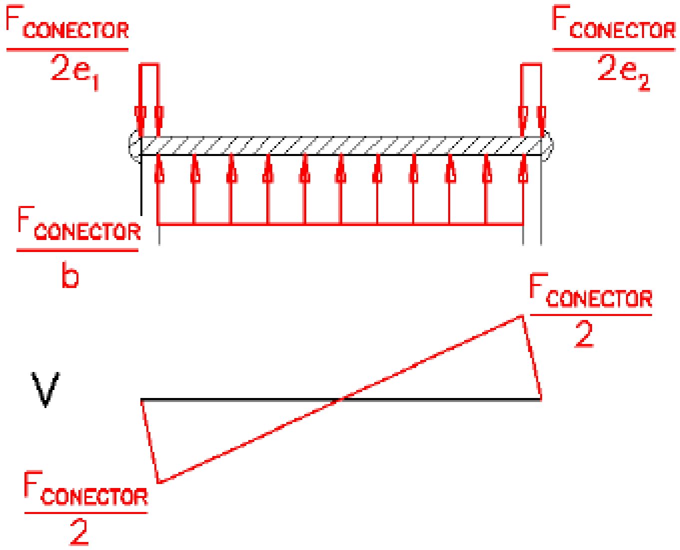
# Conectores

$$F_{conectores\ sup} = \frac{F_{conexión}}{2} = \frac{31.5\ kN}{2} = 15.75\ kN$$

$$F_{conectores\ inf} = \frac{F_{conexión}}{1} = \frac{31.5\ kN}{1} = 31.5\ kN$$



# Conectores




**resistencia admisible al corte** $(\tau_{adm} = 70\ MPa)$

$$V_{conector}^{máx}\ (\text{corte doble}) = \frac{F_{conector}}{2}$$

Tenemos que:

$$\tau_{conector\ sup}^{máx} = \frac{V_{conector\ sup}^{máx}}{A_{conector\ sup}} = \frac{\frac{15.75\ kN}{2}}{\pi \cdot {\emptyset_2}^2/_4} \leq \tau_{adm} = 7\frac{kN}{cm^2} \rightarrow \boldsymbol{\emptyset_2 \geq 1.20\ cm}$$

$$\tau_{conector\ inf}^{máx} = \frac{V_{conector\ inf}^{máx}}{A_{conector\ inf}} = \frac{\frac{31.5\ kN}{2}}{\pi \cdot {\emptyset_1}^2/_4} \leq \tau_{adm} = 7\frac{kN}{cm^2} \rightarrow \boldsymbol{\emptyset_1 \geq 1.69\ cm}$$

# Aplastamiento del Material

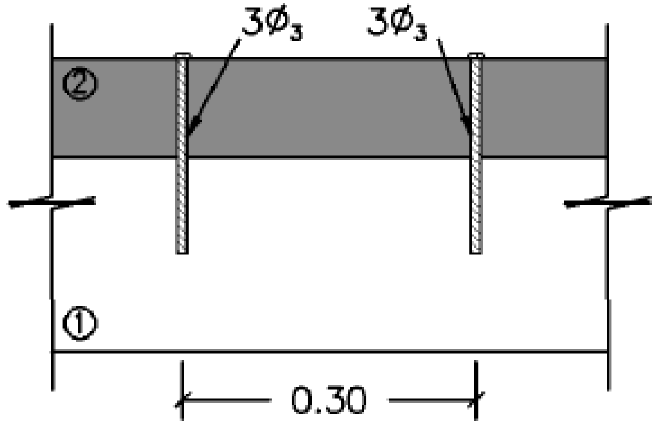
$$\sigma_{aplast} = \frac{F_{conector}}{\emptyset \cdot l}$$

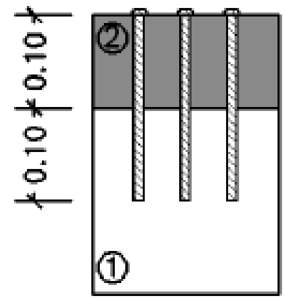
El material 2 está en contacto con los conectores superiores:

$$\sigma_{aplast} = \frac{F_{conectores\ sup}}{\emptyset_2 \cdot l} = \frac{15.75\ kN}{\emptyset_2 \cdot 20\ cm} \leq \sigma_{aplast,adm} = 1.50 \frac{kN}{cm^2} \rightarrow \emptyset_2 \geq \mathbf{0.53\ cm}$$

$$\sigma_{aplast} = \frac{F_{conectores\ inf}}{\emptyset_1 \cdot l} = \frac{31.5\ kN}{\emptyset_1 \cdot 20\ cm} \leq \sigma_{aplast,adm} = 1.00 \frac{kN}{cm^2} \rightarrow \emptyset_1 \geq \mathbf{1.58\ cm}$$

# Conectores



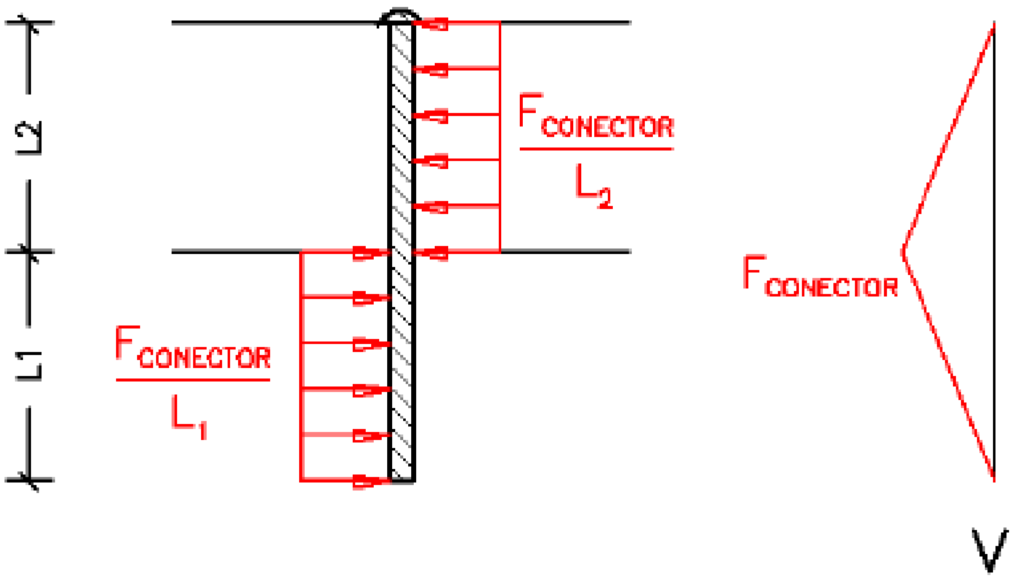




$$\tau \cdot b = \frac{21.6 \cdot 3000}{61667} = 1.05 \frac{kN}{cm}$$

$$F_{conexión} = \tau \cdot b \cdot s = 1.05 \frac{kN}{cm} \cdot 30\ cm = 31.5\ kN$$

# Conectores

$$F_{conector} = \frac{F_{conexión}}{3} = \frac{31.5\ kN}{3} = 10.5\ kN$$




$$V_{conector}^{máx}\ (\text{corte simple}) = F_{conector}$$

# Conectores

$$\tau_{conector} = \frac{V_{conector}}{A_{conector}}$$

$$\tau_{conector}^{máx} = \frac{V_{conector}^{máx}}{A_{conector}} = \frac{10.5\ kN}{\pi \cdot {\emptyset_3}^2/_4} \leq \tau_{adm} = 7\,\frac{kN}{cm^2} \ \rightarrow \ \emptyset_3 \geq \mathbf{1.38\ cm}$$

En el material 2:

$$\sigma_{aplast} = \frac{F_{conectores}}{\emptyset_3 \cdot l} = \frac{10.5\ kN}{\emptyset_3 \cdot 10\ cm} \leq \sigma_{aplast,adm} = 1.50\,\frac{kN}{cm^2} \ \rightarrow \ \emptyset_3 \geq \mathbf{0.70\ cm}$$

En el material 1:

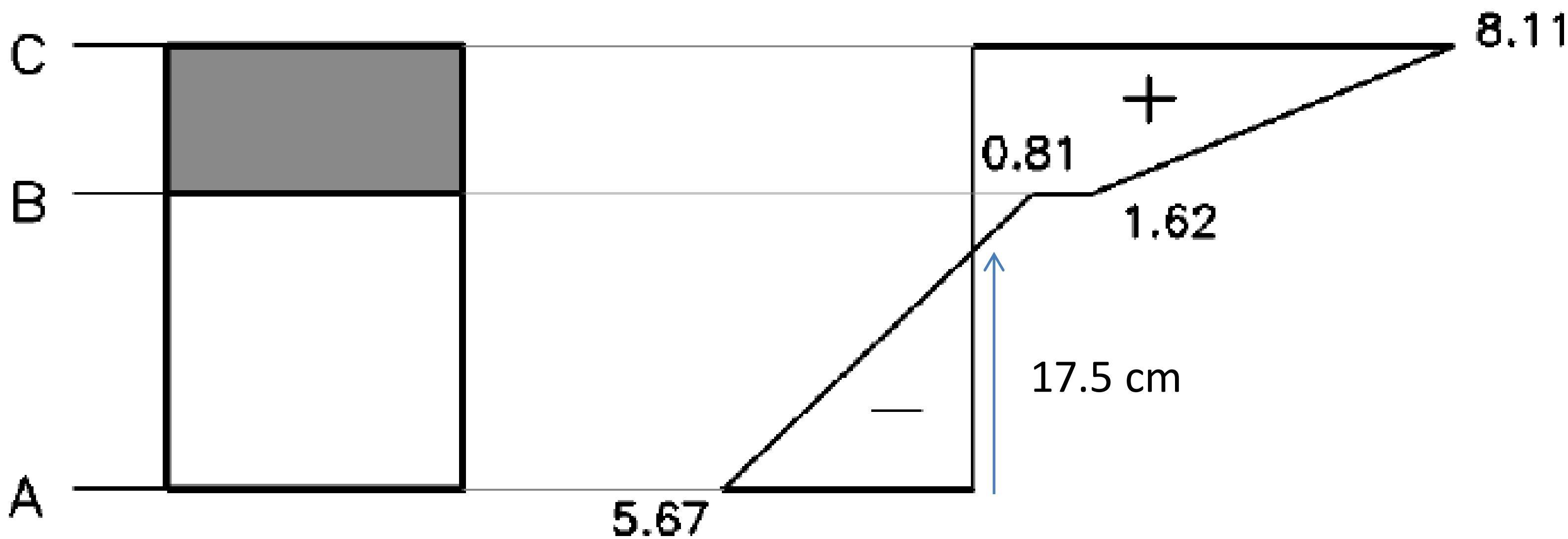
$$\sigma_{aplast} = \frac{F_{conectores}}{\emptyset_3 \cdot l} = \frac{10.5\ kN}{\emptyset_3 \cdot 10\ cm} \leq \sigma_{aplast,adm} = 1.00\,\frac{kN}{cm^2} \ \rightarrow \ \emptyset_3 \geq \mathbf{1.05\ cm}$$

# Tensiones Normales

$$\sigma_1 = E_1 \varepsilon = E_1 k y = E_1 \frac{M}{E_1 \cdot I_{hom}} y = \frac{2000}{61666.7} y = 0.0324y$$

$$\sigma_2 = E_2 \varepsilon = E_2 k y = E_2 \frac{M}{E_1 \cdot I_{hom}} y = 2 \frac{2000}{61666.7} y = 0.0649y$$

# Tensiones Normales




$$\sigma_1\,(A) = 0.0324 \cdot 17.5 = 0.567\,\frac{kN}{cm^2} = 5.67\;MPa < 6\;MPa$$

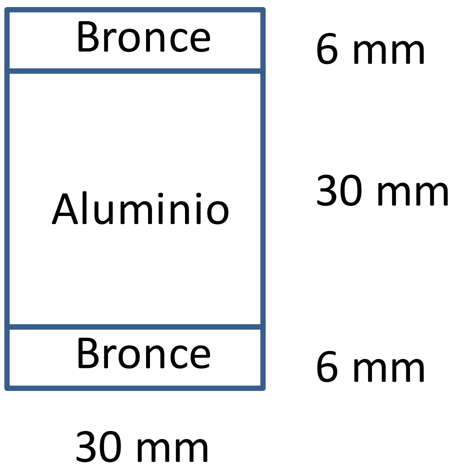
$$\sigma_1\,(B) = 0.0324 \cdot 2.5 = 0.081\,\frac{kN}{cm^2} = 0.81\;MPa < 6\;MPa$$

$$\sigma_2\,(B) = 0.0649 \cdot 2.5 = 0.162\,\frac{kN}{cm^2} = 1.62\;MPa < 9\;MPa$$

$$\sigma_2\,(C) = 0.0649 \cdot 12.5 = 0.811\,\frac{kN}{cm^2} = 8.11\;MPa < 9\;MPa$$

# Ejemplo

Hallar el momento máximo que puede resistir una viga de sección:




Alumino E= 70 GPa Tensión Adm= 100 MPa

Bronce E= 105 GPa Tensión Adm= 160 MPa

n= 105/70 = 1.5

$$I = 30.\ 30^3/12 + 2.\ 1.5.(\ (30.6^3)/12 + 30.6.18^2) = 244.08 \times 10^3\ mm^4 = 244.08 \times 10^{-5} m^4$$

# Tensiones

**Tensión normal = M/W**

Tensión Max Aluminio = M/(I/0.015)

100 MPa $\geq$ M/0.1672

M $\leq$ 16.3 MN.m

La tensión en el material homogeneizado debe ser mayorada por 1.5

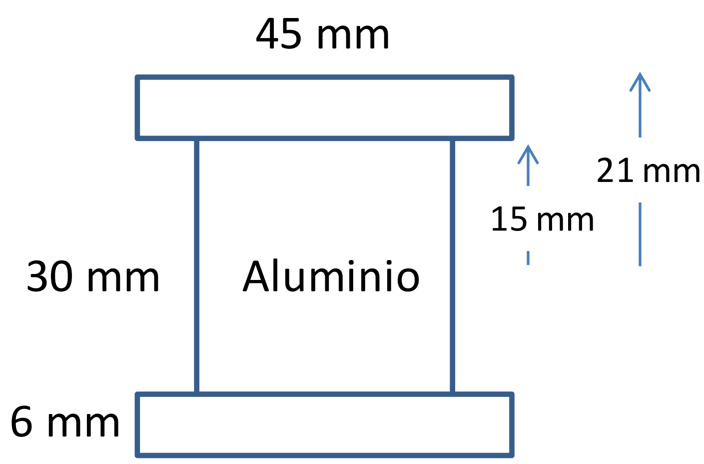
Tensión Max Bronce = n. M/(I/0.021)

M $\leq$ 18.6 MN.m /1.5

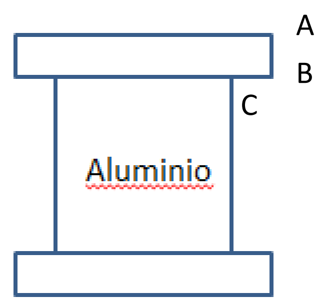
M $\leq$ 12.4 kN.m

El menor de los valore M, es el que puede resistir la sección.

**Sección Homogeniezada**




M=12.4 kN.m




$\sigma_A$= 106.65 x 1.5=160 MPa

$\sigma_B$= 76.2 x 1.5=114.3 MPa

$\sigma_C$= 76.2 MPa