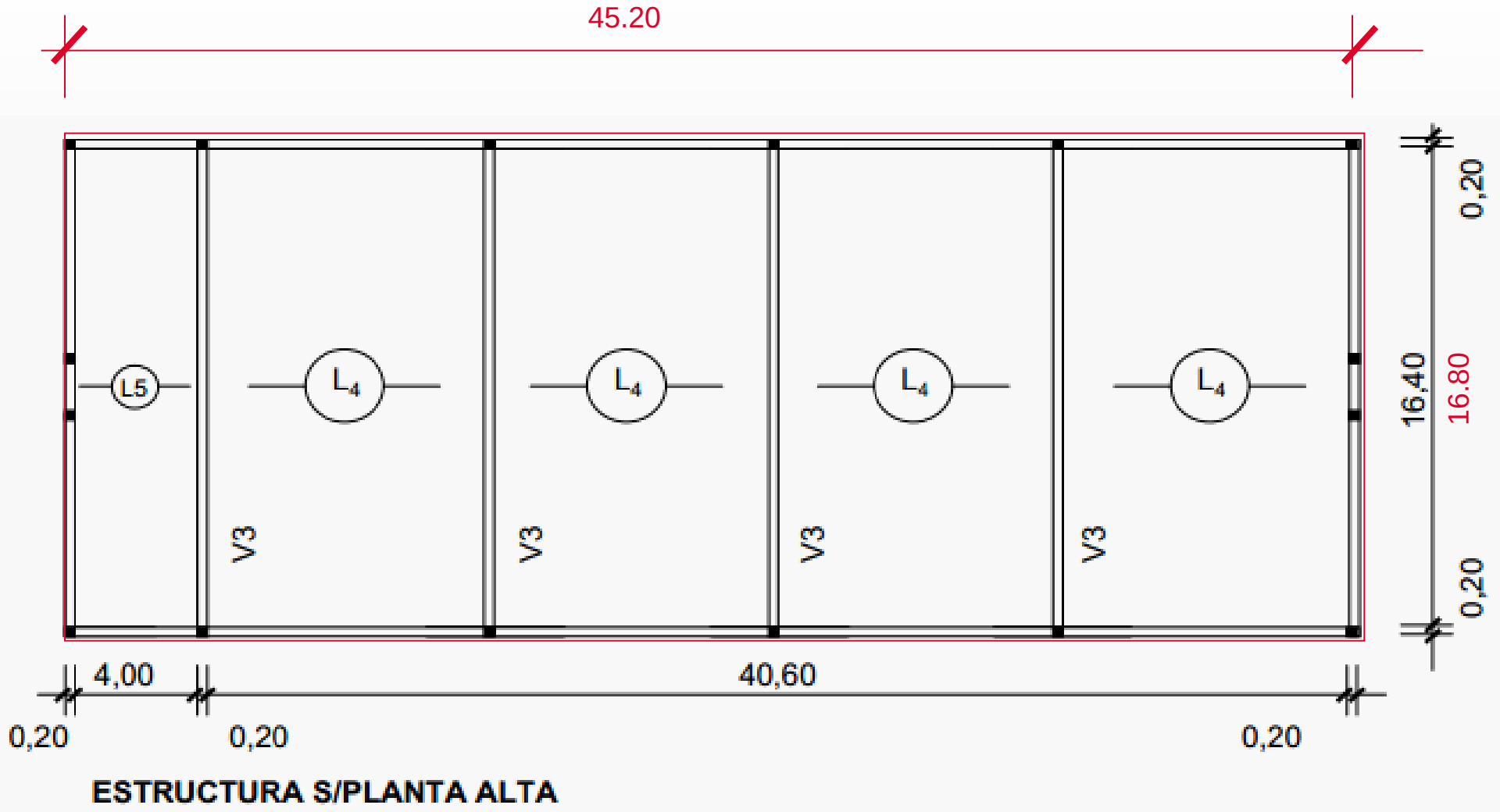
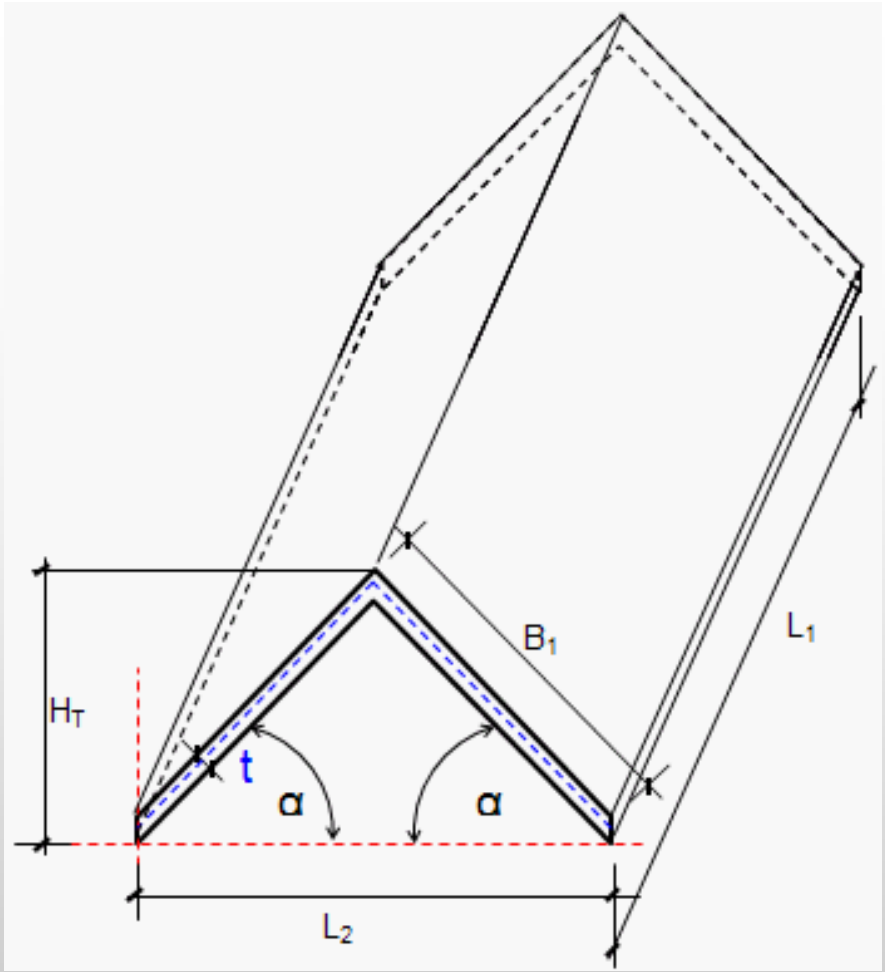
# LAMINAS PLEGADAS

TP Nº 5
LAMINA TIPO V
Año 2016

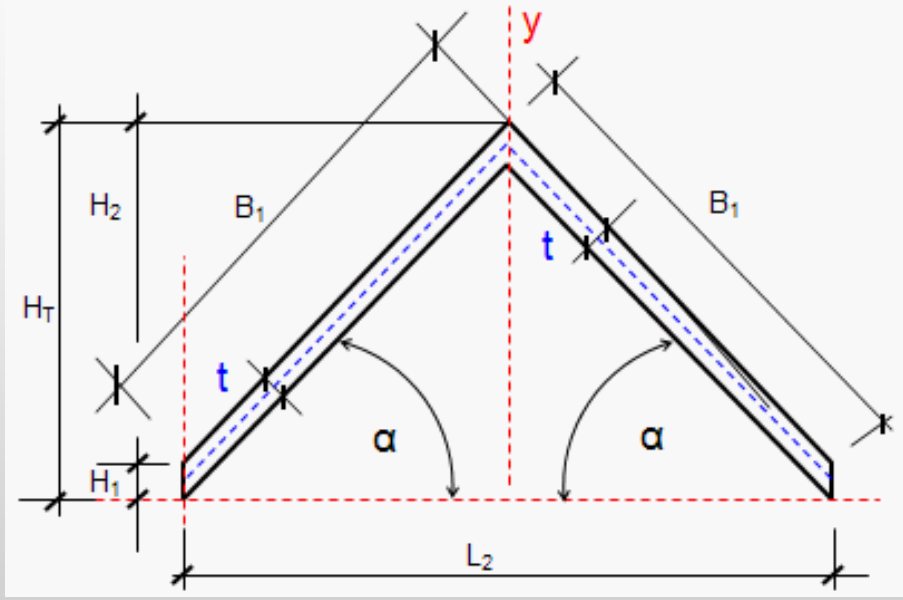
## Trabajo Práctico de LAMINA TIPO V




**ESTRUCTURA S/PLANTA ALTA**




| Ingresar datos | | |
|---|---|---|
| $L_1$= | 16.60 | en (m) |
| $L_2$= | 2.66 | en (m) |
| α= | 40.0 | en grados |
| t= | 6.0 | en (cm) |

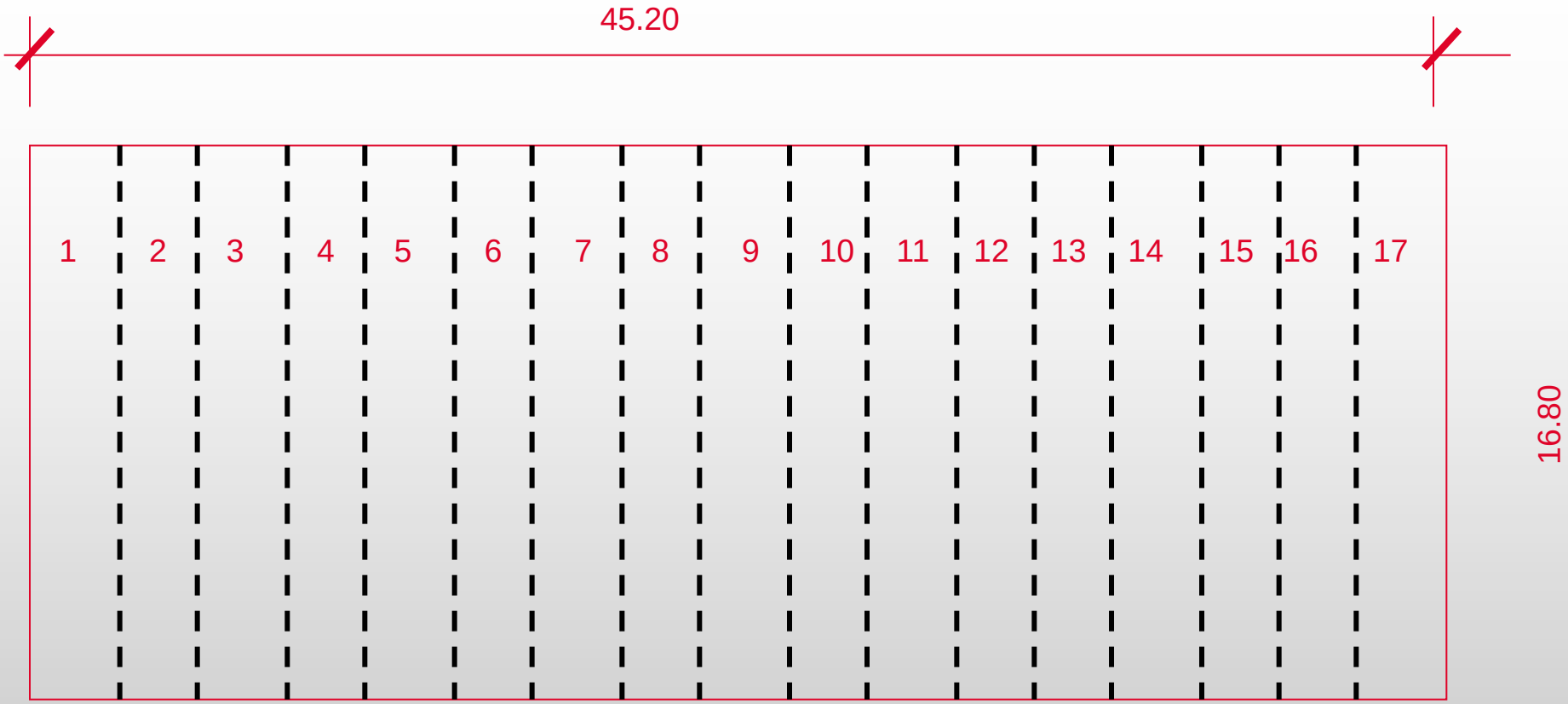



$$6 < \frac{L_1}{L_2} < 7{,}5$$

Relación aproximada para obtener $L_2$

$L_2 = 16{,}60 / 6{,}2 = 2{,}6$ m

Luego se ajusta a la geometría

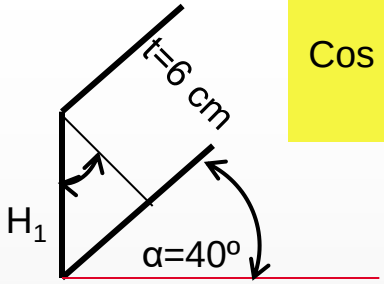



45.20 / 17 = 2.6588 = 2.66 m

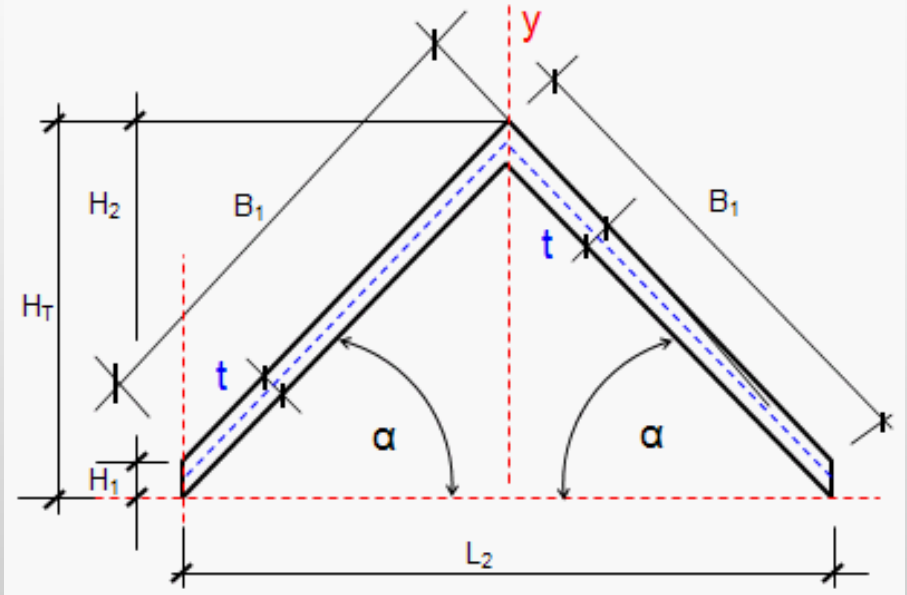
| Ingresar datos | | |
|---|---|---|
| $L_1$= | 16.60 | en (m) |
| $L_2$= | 2.66 | en (m) |
| α= | 40.0 | en grados |
| t= | 6.0 | en (cm) |

$$H_1 = \frac{t=6\text{ cm}}{\cos\alpha}$$

$$H_1 = \frac{t=6\text{ cm}}{0.766} = 7.8\text{ cm}$$




$$\cos\alpha = \frac{t}{H_1}$$



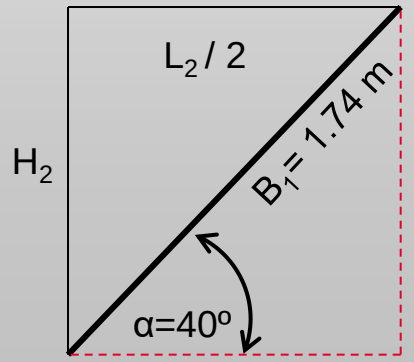

$$\text{tag } \alpha = \frac{H_2}{L_2/2 = 1.33}$$

$$H_2 = 0.839 \times 1.33$$

$$H_2 = 1.116\text{ m} = 1.12\text{ m}$$

$$B_1 = \sqrt{[L_2/2 = 1.33]^2 + [H_2 = 1.12]^2} = 1.738\text{ m}$$

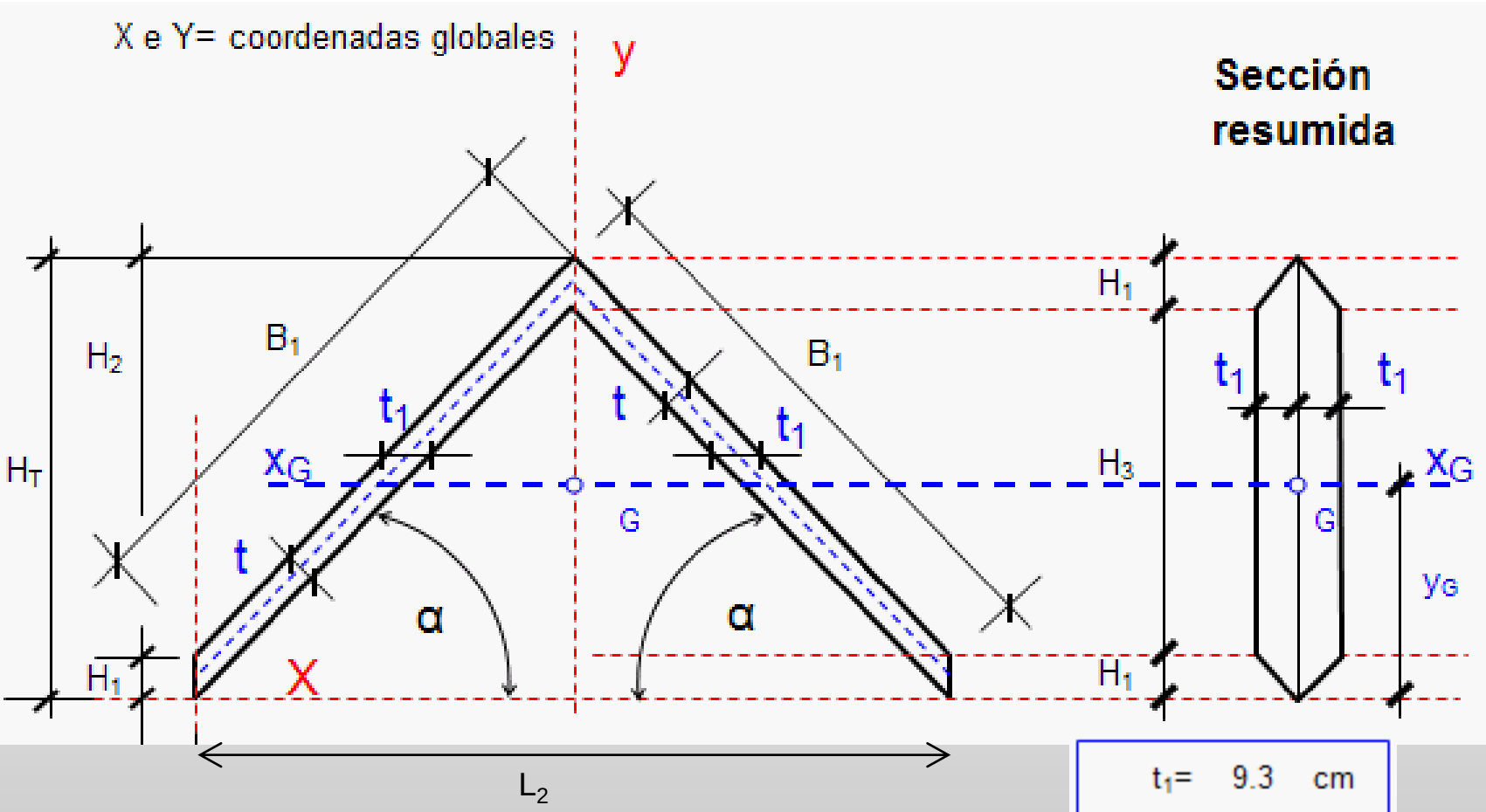
$B_1$= 1.74 m

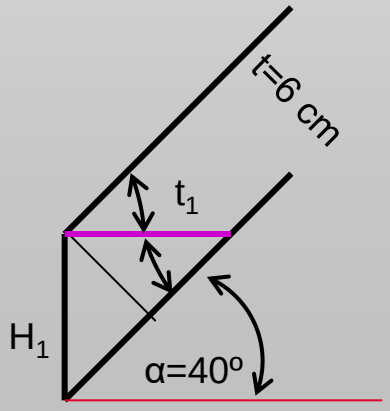



| Resultados | | |
|---|---|---|
| H1= | 7.8 | cm |
| H2= | 1.12 | m |
| $H_T$= | 1.194 | m |
| B1= | 1.74 | m |
| Area= | 0.208 | m2 |

$H_T$= 1.116 + 0,078 = 1.194 m

A= 1.74 m x 0.06 x 2 = 0.208 $m^2$




$$\text{Sen } \alpha = \frac{t}{t_1}$$

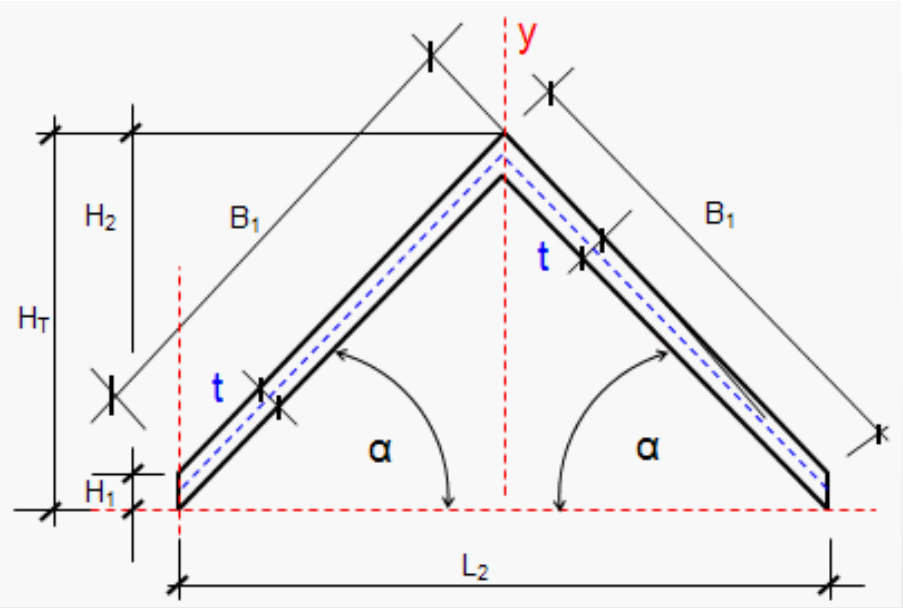
$$t_1 = \frac{t=6\text{ cm}}{0.643} = 9.33\text{ cm}$$

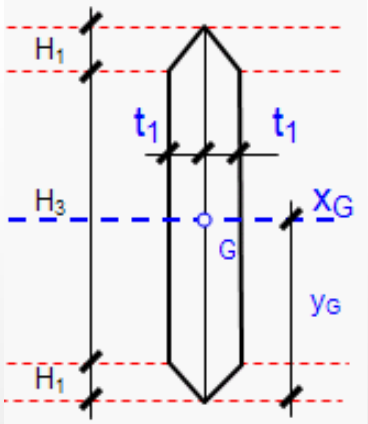
$H_3 = H_T - 2xH_1$

$H_3 = 1{,}194 - 2x0{,}078$

$H_3 = 1{,}038$

| | | |
|---|---|---|
| $t_1$= | 9.3 | cm |
| 2 x $t_1$= | 18.7 | cm |
| $H_1$= | 0.078 | m |
| $H_3$= | 1.038 | m |
| $H_T$= | 1.194 | m |
| $y_G$= | 0.597 | m |
| Jx= | 0.022 | $m^4$ |
| $W_{sup}$= | 0.036 | $m^3$ |
| $W_{inf}$= | 0.036 | $m^3$ |




| | | |
|---|---|---|
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| 2 x $t_1$= | 18.7 | cm |
| $H_1$= | 0.078 | m |
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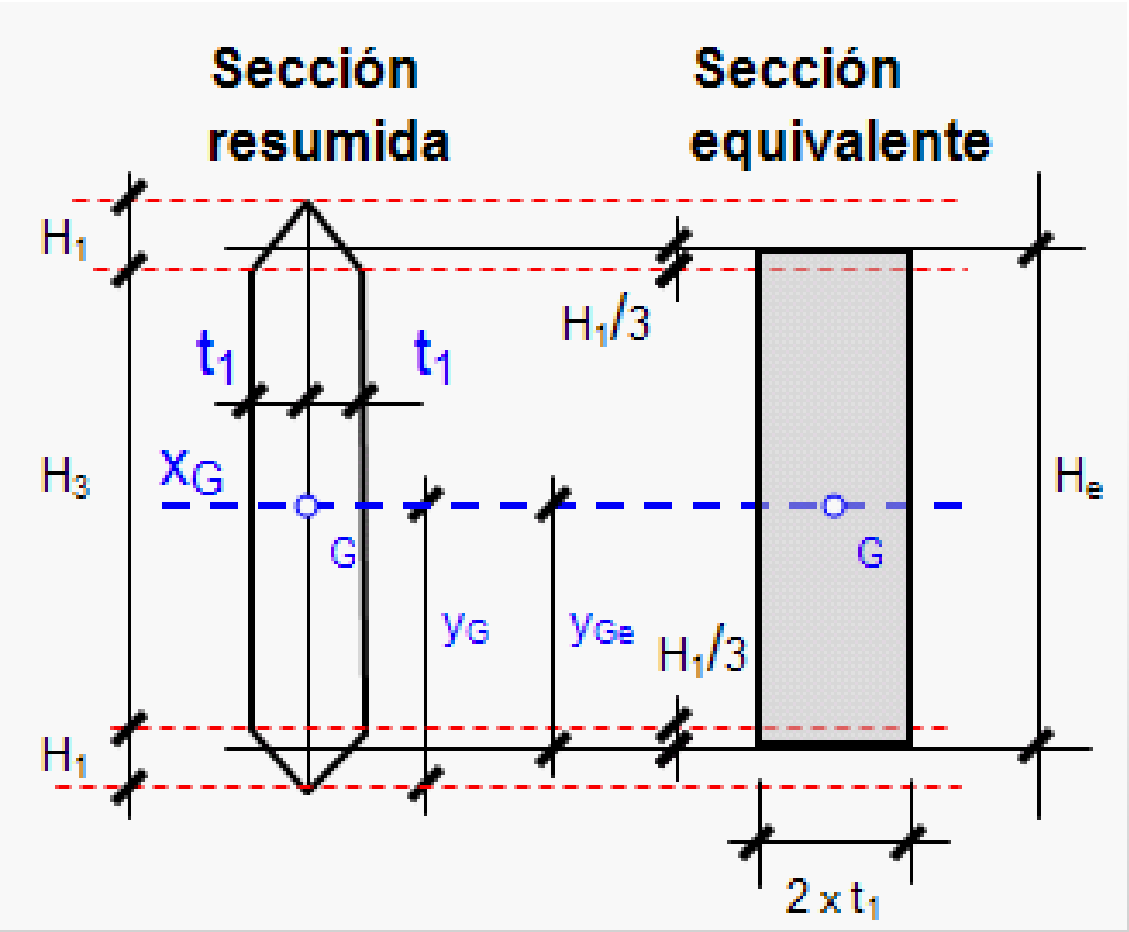
| $H_T$= | 1.194 | m |
| $y_G$= | 0.597 | m |
| Jx= | 0.022 | $m^4$ |
| $W_{sup}$= | 0.036 | $m^3$ |
| $W_{inf}$= | 0.036 | $m^3$ |

$H_T = H_1 + H_2 = 0.078 + 1.116 = 1.194$ m

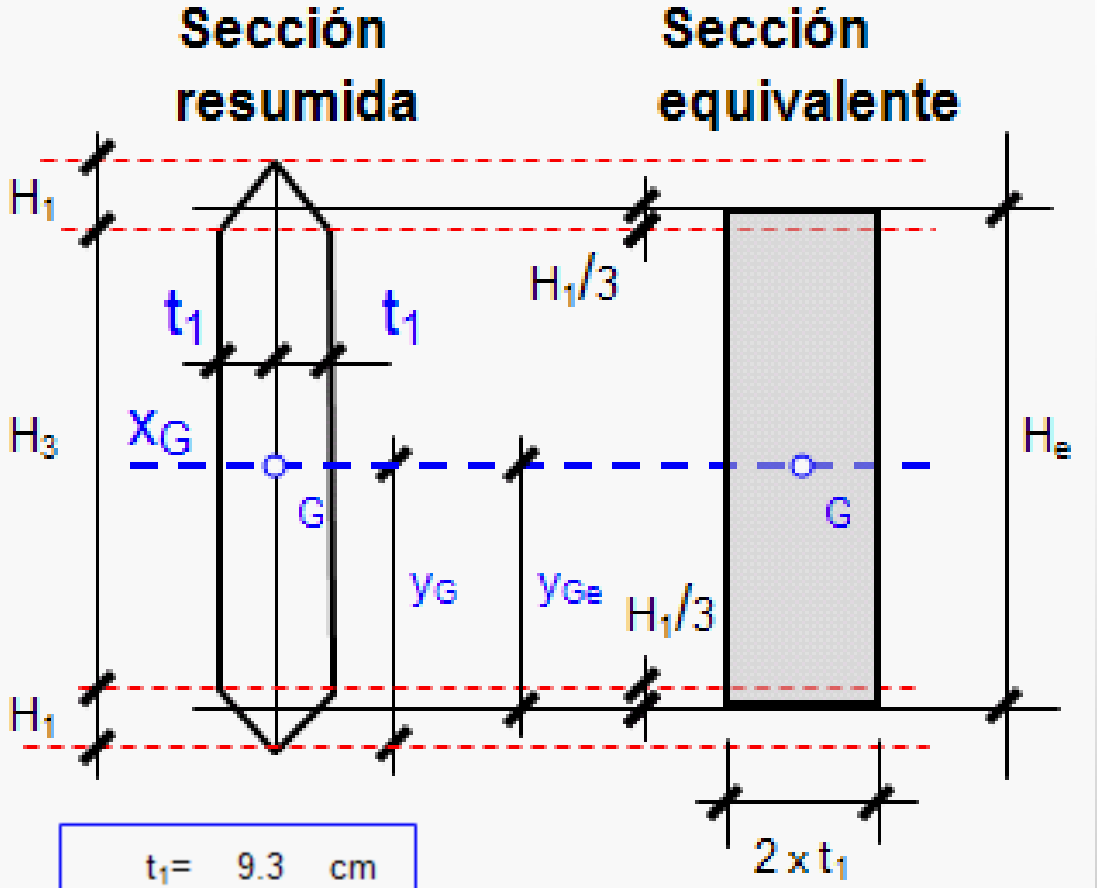
$H_3 = H_T - 2\,H_1 = 1.194\text{ m} - 2 \times 0.078\text{ m} = 1.038$ m

$Y_G = H_T / 2 = 1.194\text{ m} / 2 = 0.597$ m




$H_e = H_3 + 2\ H_1 / 3 = 1.038\ m + 2 \times 0.078\ m / 3 = 1.09\ m$

$2 \times t_1 = 2 \times 0.0933\ m = 0.1866\ m = 0.187\ m$




| | | |
|---|---|---|
| $t_1$= | 9.3 | cm |
| 2 x $t_1$= | 18.7 | cm |
| $H_1$= | 0.078 | m |
| $H_3$= | 1.038 | m |
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| $y_G$= | 0.597 | m |
| Jx= | 0.022 | $m^4$ |
| $W_{sup}$= | 0.036 | $m^3$ |
| $W_{inf}$= | 0.036 | $m^3$ |

$H_e$= 1.09 m

2 x $t_1$= 0.187 m

$$J_x = \frac{b \times h^3}{12}$$

$$J_x = \frac{0.187 \times 1.09^3}{12}$$

$J_x$= 0.020 $m^4$

$$W_x = \frac{b \times h^2}{6}$$

$$W_x = \frac{0.187 \times 1.09^2}{6}$$

$W_x$= 0.037 $m^3$

# Análisis de cargas

Area de la sección en m2: 0.208 $m^2$

Ancho total del plegado $L_2$= 2.66 m

$L_2 = b_t$

**Peso propio:**

Impermeabilización e= 2.00 cm *(e(cm).2200kg/m².bt(m)/100)*

Otras cargas, aberturas, c. raso, etc.

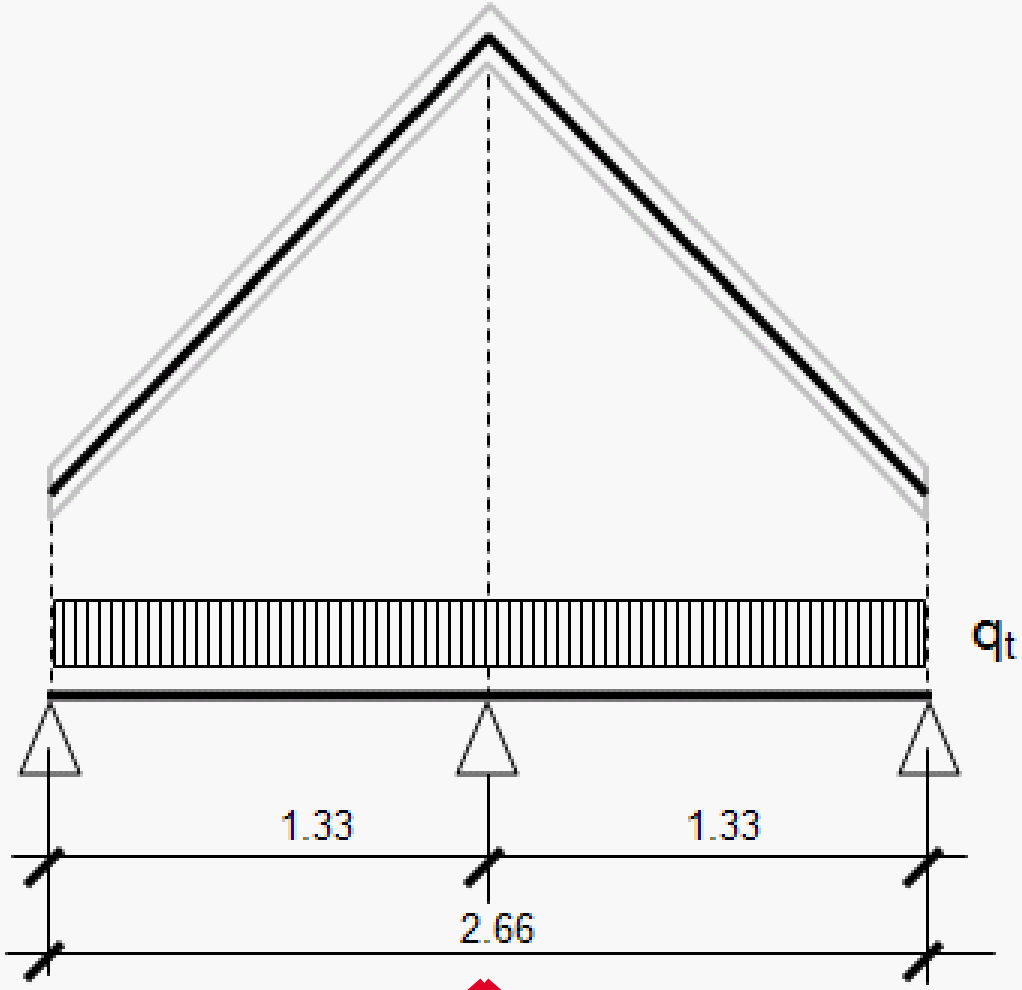
**Sobrecarga**

Sobrecarga p= 15.0kg/m² x bt =

| | Toda la sección en 1 metro de profundidad | |
|---|---|---|
| | 500 | kg |
| | 117 | kg |
| | 20 | kg |
| **g =** | **637** | **kg** |
| **p =** | **40** | **kg** |
| **q =** | **677.0** | **kg** |

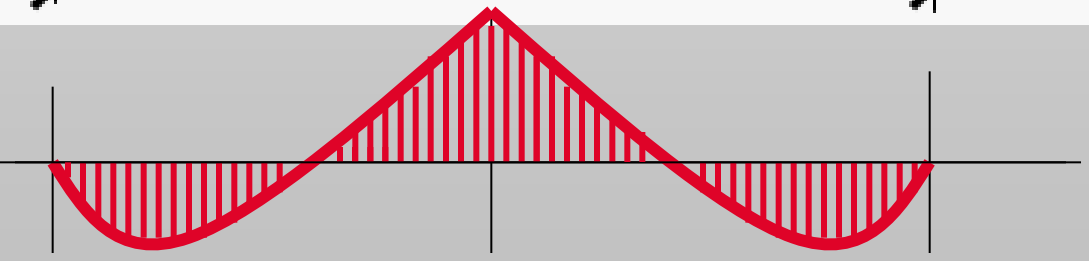
Tabla de sobrecargas en kg/m2

| | | | | | | |
|---|---|---|---|---|---|---|
| | | α | ≤ | *3* | 100 | Kg/m2 |
| *3* | < | α | ≤ | *10* | 45 | Kg/m2 |
| *10* | < | α | ≤ | *15* | 33 | Kg/m2 |
| *15* | < | α | ≤ | *20* | 23 | Kg/m2 |
| *20* | < | α | ≤ | *30* | 18 | Kg/m2 |
| *30* | < | α | | | 15 | Kg/m2 |



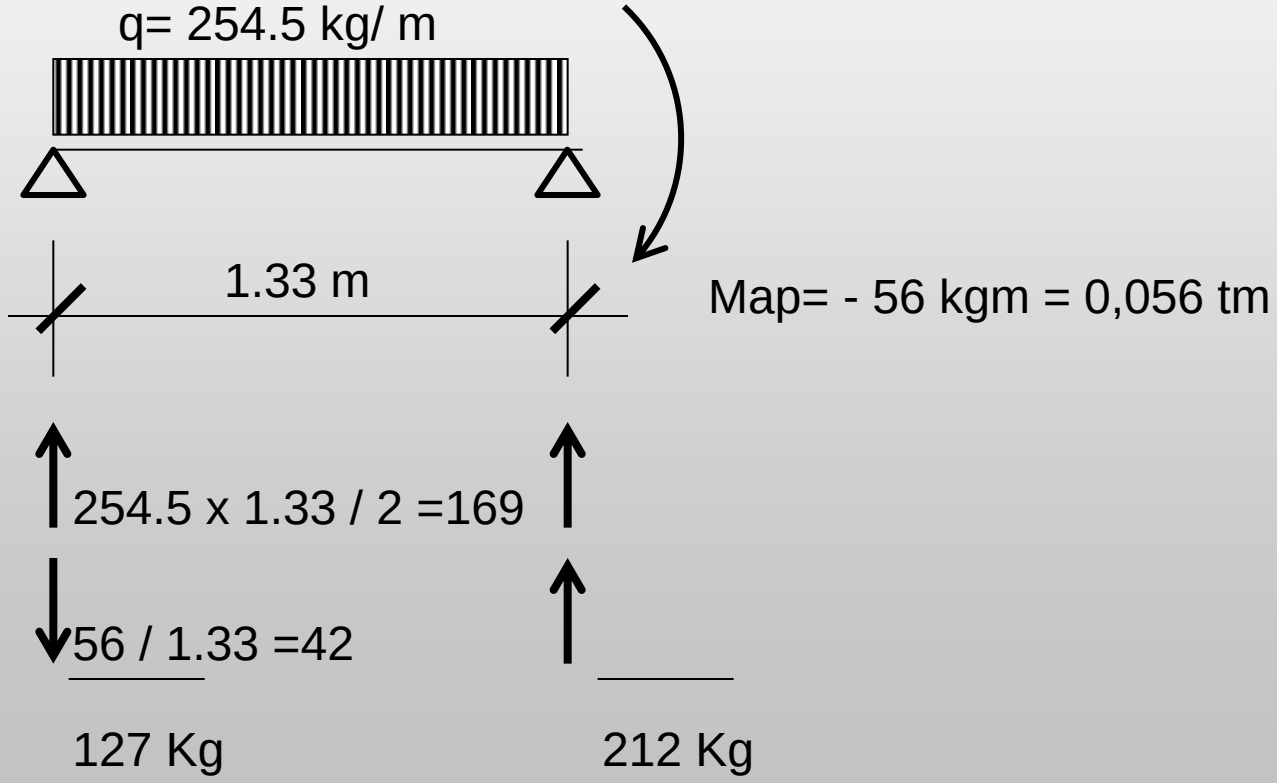

## CARGAS Y LUCES

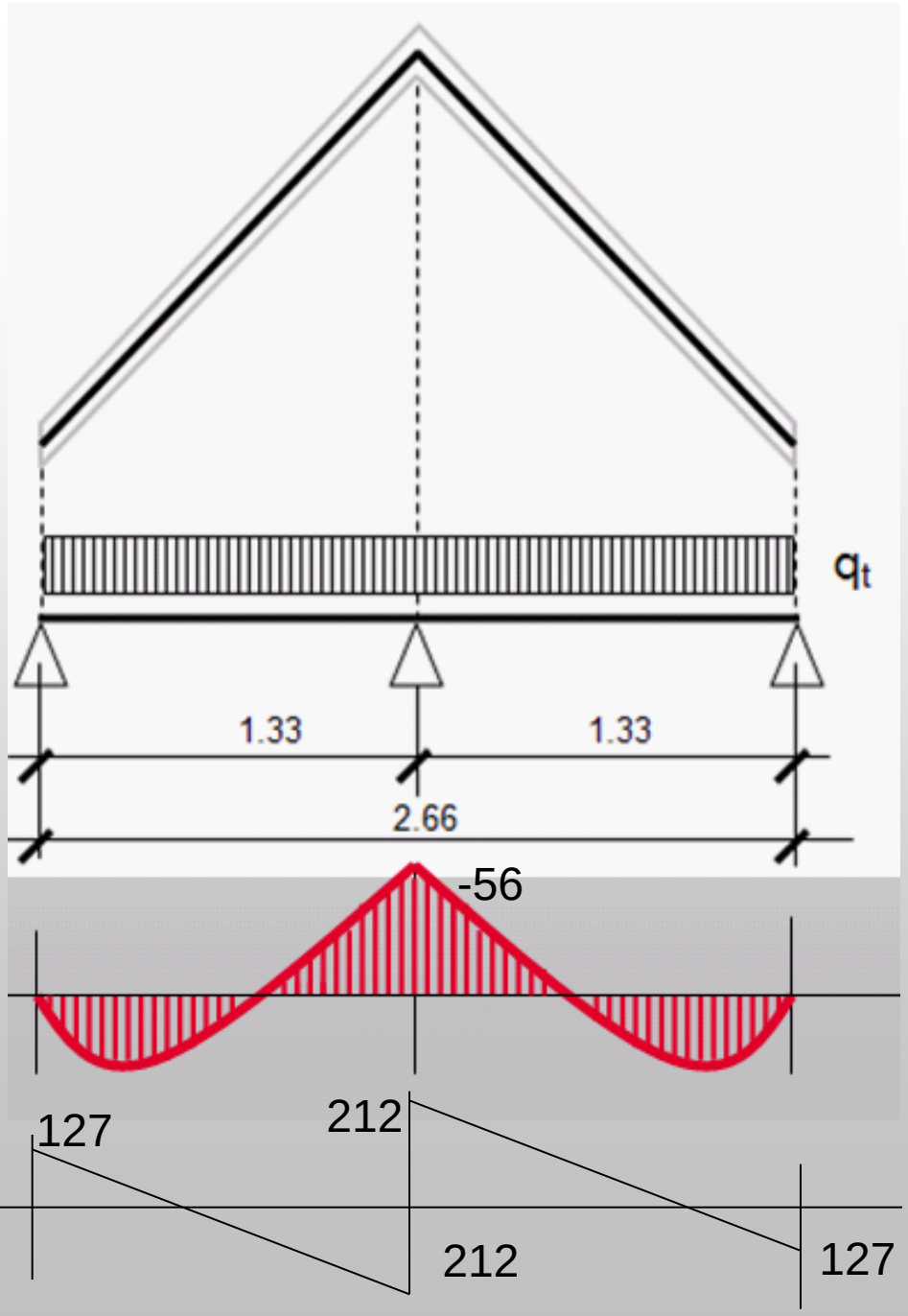
| | | |
|---|---|---|
| q = | 677.0 | kg |
| $L_2$= | 2.66 | m |
| $q_t$ = | 254.5 | kg/m |
| $L_{tramo1}$= | 1.33 | m |
| $L_{tramo2}$= | 1.33 | m |



$$Map = -\frac{q \times L^2}{8}$$

$$Map = -\frac{q \times L^2}{8} = -\frac{254.5 \times 1.33^2}{8} = -56.3 \text{ kgm}$$



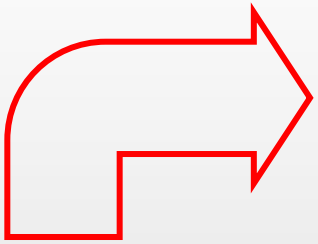



$$Mt = \frac{q \times L^2}{14.2}$$

$$Mt = \frac{254.5 \times 1.33^2}{14.2}$$

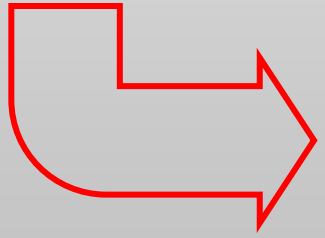
Mt= 32 kgm

# Cálculo de armaduras



$$A = \frac{M}{\mathfrak{z} \times \sigma_{adm}}$$

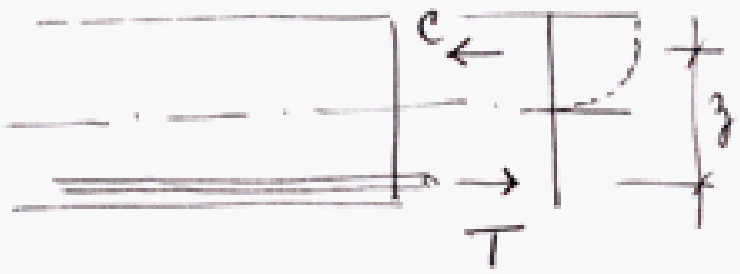
Es indistinto usar una u otra fórmula



$$A = \frac{0{,}5 \quad M\ (tm)}{h\ (m)}$$

# Cálculo de armaduras

$$A = \frac{M}{\zeta \times \sigma_{adm}}$$




$T \cdot \zeta = M$

Tomando $\zeta = 0{,}85\ h$


$\sigma_{adm}$ acero: $2{,}4 \frac{t}{cm^2} = 2400 \frac{kg}{cm^2}$

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

# Cálculo de armaduras

$$A \cdot \sigma_{adm} \cdot 0{,}85\, h = M$$

$$[cm^2] \quad \left[\frac{t}{cm^2}\right] \qquad [m] \quad [tm]$$

$$A = \frac{M}{h} \cdot \frac{1}{2{,}4 \times 0{,}85} = \frac{M}{h \times 2{,}04} = 0{,}5 \frac{M}{h} \; \frac{(tm)}{(m)}$$

# Armaduras mínimas

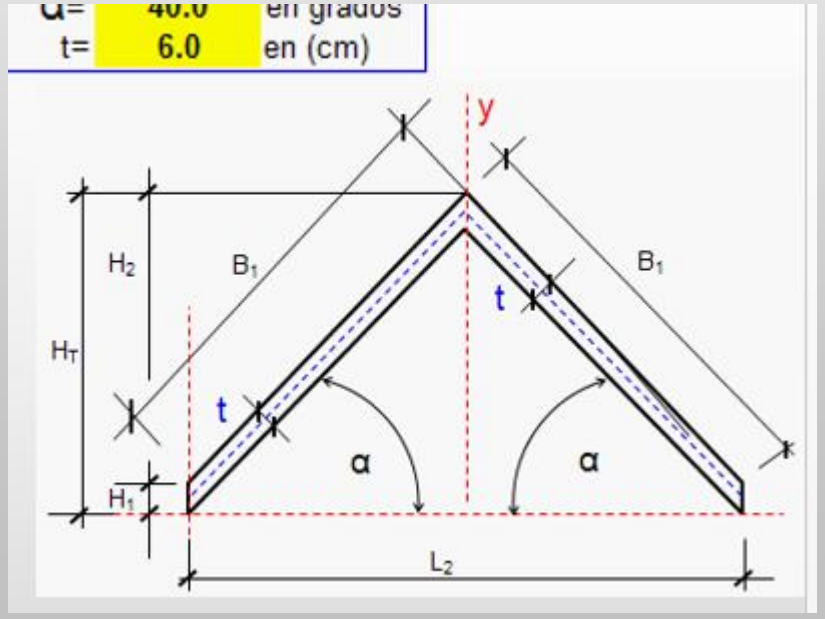
$$\omega = \mu_o \frac{\beta st}{\beta_R}$$

$\omega$= cuantía mecánica >0,03

$\mu_o$= cuantía geométrica = A/B

A= sección de acero

B= sección de hormigón




Bst : resistencia del acero

$B_R$ : resistencia del hormigón

## DIMENSIONAMIENTO A FLEXION

Tabla 7. Valores de cálculo $\beta_R$ de la resistencia del hormigón, valores de cálculo del módulo de elasticidad del hormigón y del acero y $\beta_S/\beta_R$

| Clase de hormigón | | H-I | | H-II | |
|---|---|---|---|---|---|
| Tipo de hormigón | | H-13 | H-17 | H-21 | H-30 |
| Valores de cálculo $\beta_R$ (MN/m²) | | 10,5 | 14 | 17,5 | 23 |
| Módulo de elasticidad $E_b$ (MN/m²) | | 24 000 | 27 500 | 30 000 | 34 000 |
| Módulo de elasticidad del acero $E_s$ (MN/m²) | | 210 000 | | | |
| Coeficiente de cálculo | | $\beta_S/\beta_R$ | | | |
| $\beta_S$ MN/m² | 220 (I) | 21 | 15,7 | 12,6 | 9,6 |
| | 420 (III) | 40 | 30 | 24 | 18,3 |
| | 500 (IV) | 47,6 | 35,7 | 28,6 | 21,7 |
| | 600 (V) | 57,1 | 42,8 | 34,3 | 26,1 |

$B_R$: resistencia del hormigón

17,5 MN/m²

175 kg/cm²

Bst: resistencia del acero

420 MN/m²

4200 kg/cm²

# Armaduras mínimas

$$\omega = \mu_o \frac{\beta st}{\beta_R}$$

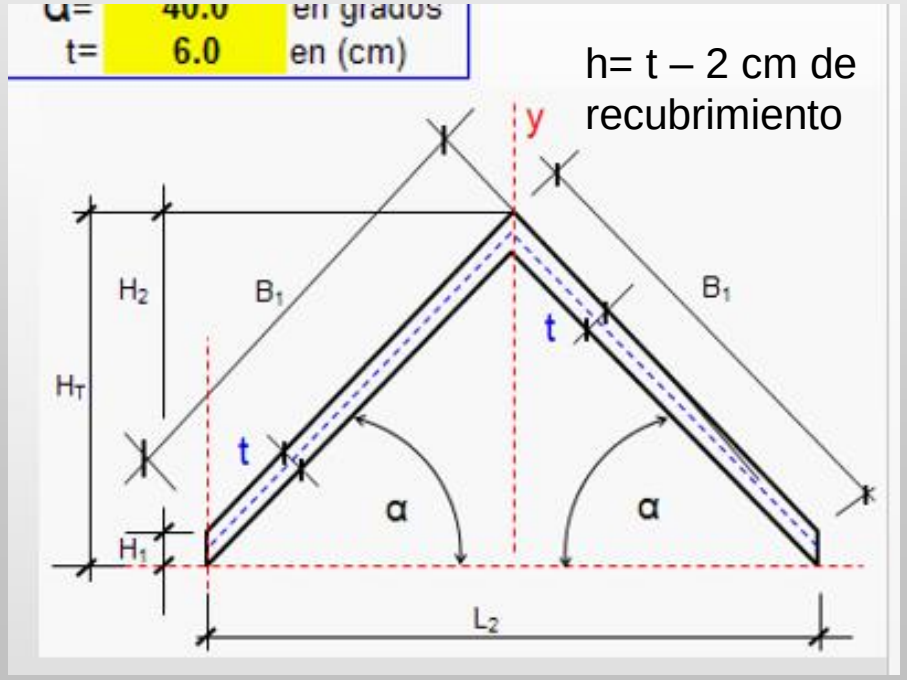
A= sección de acero

B= sección de hormigón = h x 100 cm

Bst : 4200 kg/cm$^2$

$B_R$ : 175 kg/cm$^2$

$\omega$= 0,03 $\mu_o$= A/B




h= t – 2 cm de recubrimiento

$$\omega = \frac{A}{h \times 100} \quad \frac{4200\ kg/cm^2}{175\ kg/cm^2} = 0,03$$

h = 4 cm

$$A_{min} = \frac{0,03 \times 4\ cm \times 100\ cm \times 175\ kg/cm^2}{4200\ kg/cm^2}$$

$A_{min}$= 0,5 cm$^2$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Apoyo:** | espesor de la placa plegada | | | 0.06m | | | |
| | h= 0.04m | | M= -0.06 | tm | A= | 0.70 | cm² |
| | | | | | Amin = | 0.50 | cm² |
| | Se adopta para: | 0.70 | cm2 / m | Ø 6 c / 25 | | 1.13 | cm² |
| **Tramo:** | h= 0.04m | | M= 0.03 | tm | A= | 0.40 | cm² |
| | | | | | Amin = | 0.50 | cm² |
| | Se adopta para: | 0.50 | cm2 / m | Ø 6 c / 25 | | 1.13 | cm² |

**Armadura en Apoyo**

$$A_{nec} = \frac{0{,}5 \times 0{,}056 \text{ tm}}{0{,}04 \text{ m}} = 0{,}70 \text{ cm}^2$$

**Armadura en Tramo**

$$A_{nec} = \frac{0{,}5 \times 0{,}032 \text{ tm}}{0{,}04 \text{ m}} = 0{,}40 \text{ cm}^2$$

## Análisis en el plano longitudinal

Solicitaciones, se analizan en sentido longitudinal (global)

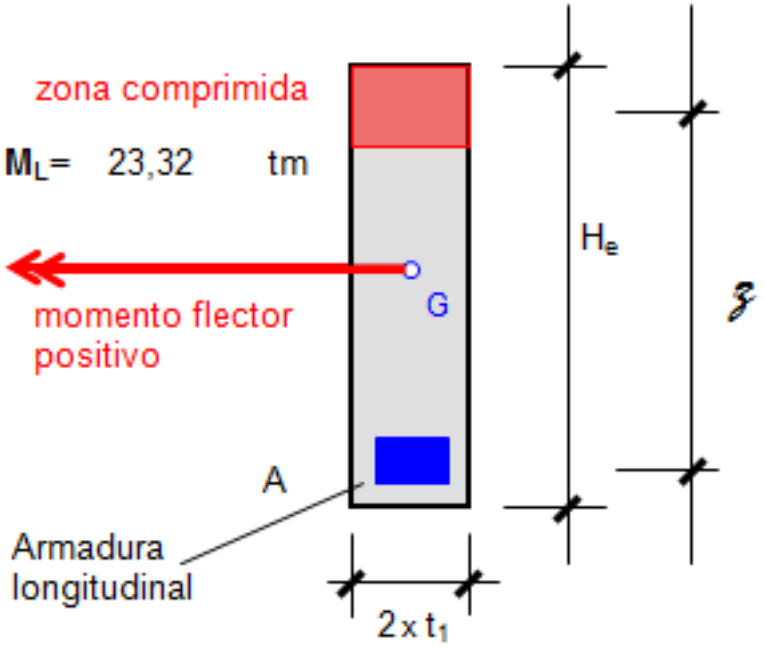
$M = q.l^2/8 =$ $M_L =$ **23318** **kgm** **23,32** tm

**Luz a cubrir $L_1$=** 16,6m

Carga **q=** 677 kg/m

| | | |
|---|---|---|
| He= | 1,09 | m |
| 2 x t1= | 18,7 | cm |
| h= | 0,92 | m |
| ℊ= | 0,79 | m |
| A= | 12,62 | cm2 |
| Amín= | 2,16 | cm2 |

**Sección equivalente**




| | | |
|---|---|---|
| Se adopta para: | 12,62 | cm2 |
| | **16 Ø 10** | |
| A= | **12,57** | **cm2** |

$$W_x = \frac{b \times h^2}{6} \qquad W_x = \frac{0.187 \times 1.09^2}{6} \qquad W_x = 0.037\ m^3$$

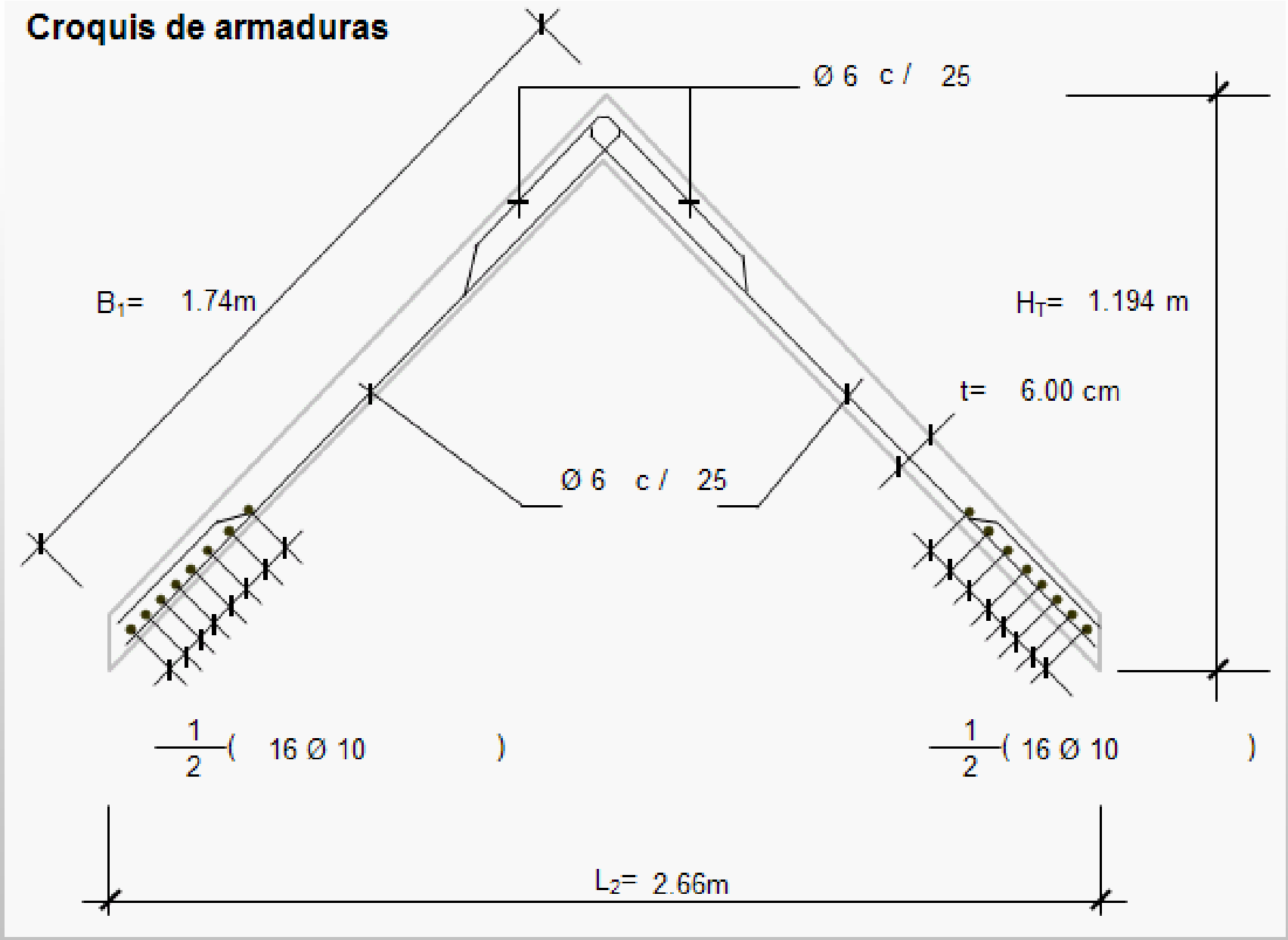
## Verificación de las tensiones del hormigón

$\sigma'_{bk} = 175\ kg/cm^2$ $\qquad \sigma'_{b\,adm} = 80\ kg/cm^2$

$W_{sup} = W_{inf} = 0.037\ m^3$ $\qquad M_L = 23.32\ tm$

$$\sigma'_b = \frac{M_L}{W_{sup}} = \frac{23.32}{0.037} = 630.9\ t/m^2 = 63.09\ kg/cm^2$$

Debe cumplirse que: $\sigma'_b \leq \sigma'_b = 80\ kg/cm^2$


Croquis de armaduras
Ø 6 c / 25
B1= 1.74m
HT= 1.194 m
t= 6.00 cm
Ø 6 c / 25
1/2 ( 16 Ø 10 )
1/2 ( 16 Ø 10 )
L2= 2.66m

# ... fin