Cargas de la torsión de la viga tipo 2

849.527

28-3-58

Flexión lateral viga n° 2 (tanteo)

Las cargas terminan en el ala sup. con

$\sigma_s = 166\ kg/cm^2 \simeq 17\ kg/cm^2$

74
16
58 en 1.47

en 0,20 x kg $\frac{16.6}{8}$ } medio 20 kg/cm²
24.6

Superficie ala

$0,56 \times 0,22 = 0,123\ m^2 = 1230\ cm^2 \times 20 = 24600\ kg.$

Ex cent. ~~$\frac{1}{2}(56+14)$~~ $\frac{1}{2}(56-14) = 21$ cm.

56
14
42

$M = 516\,000$ cm kg.

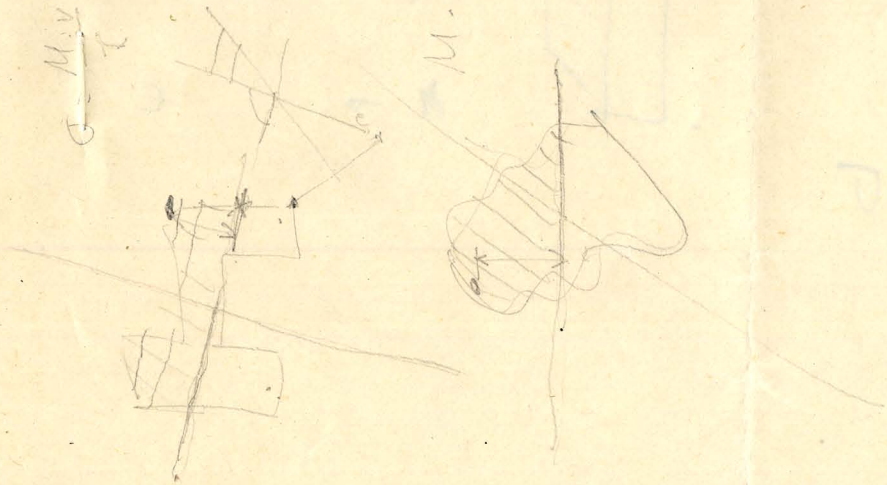
$I = \frac{1}{12} 23 \times 50^3 + \frac{1}{12} 96 \times 14^3 + \frac{1}{12} 22 \times 56^3 =$

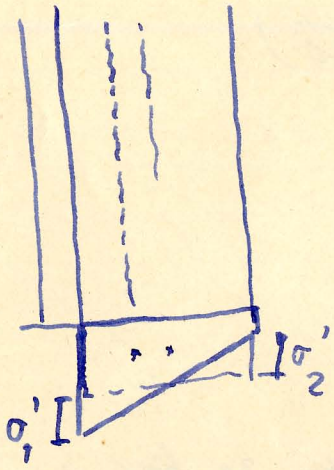
125 000 2750 176 000

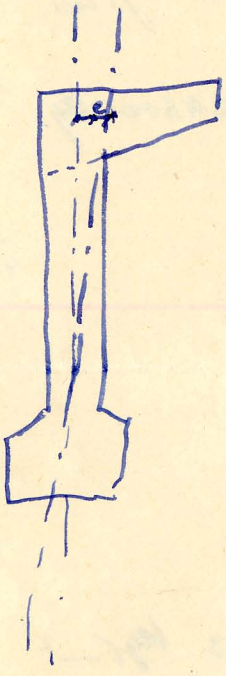
240 000
22 000
322
584 000 cm⁴

$\sigma = \frac{516\,000}{584\,000} \times \begin{cases} 15 + 13\ kg/cm^2 \\ 41 - 36\ kg/cm^2 \end{cases}$

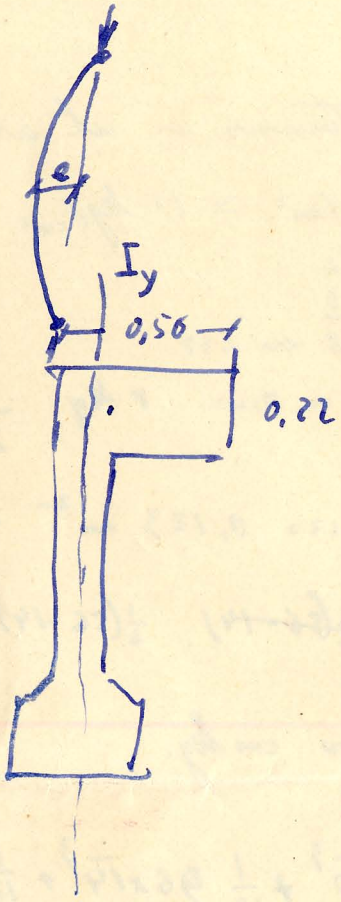
17
+19 tracción

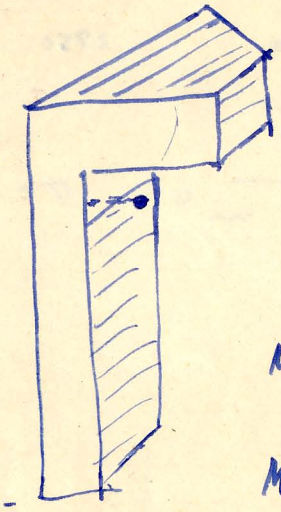






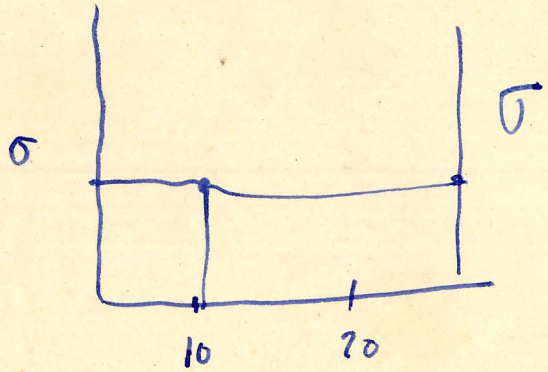
$$\sigma' = \frac{M \cdot r}{I_y}$$

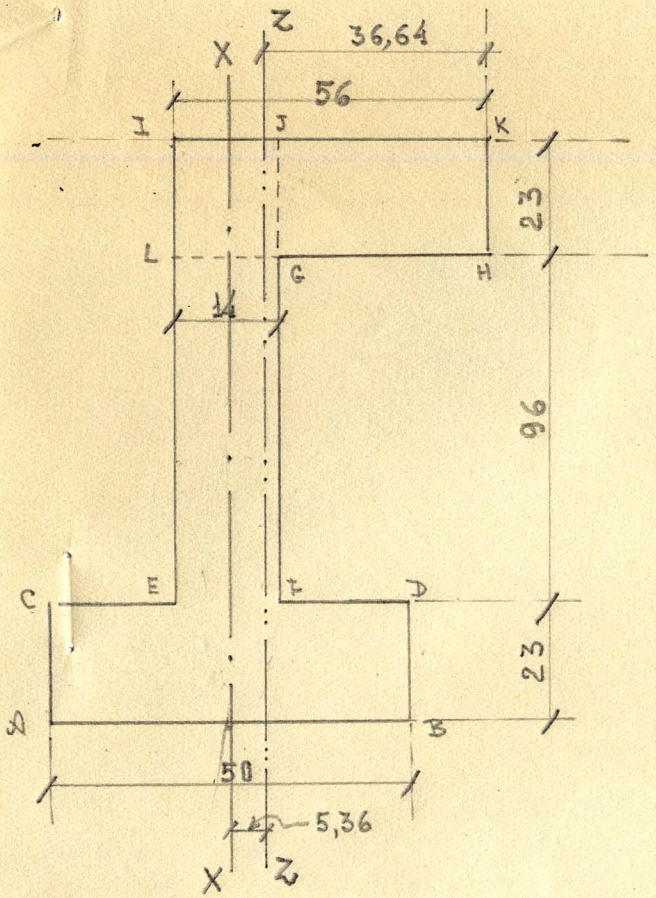




$M \rightarrow \sigma_1 \cdot \sigma_2 \cdot e$

$M \rightarrow \qquad e$





Superficies:

Area ABCD = 50 x 23 = 1150 cm²

" EFIJ = 14 x 119 = 1666 cm²

" GHJK = 23 x 42 = 966 cm²

Determinación de la posición de la fibra neutra:

(Aproximada)

Tomando momentos respecto $\overline{HK}$:

$1150 \times 42 + 1666 \times 42 + 966 \times 21 =$

$(1150 + 1666 + 966)\, x$

$$x = \frac{48.300 + 69.972 + 20.286}{1150 + 1666 + 966} = \frac{138.558}{3782} =$$

$x = 36,64$ cm.

Momentos de inercia respecto Z-Z:

Parciales: De A-B-C-D.- $\frac{23 \times \overline{30,36}^3}{3} + \frac{23 \times \overline{19,64}^3}{3} = 214.541,7 + 58.080,5 =$

$= 272.622,2 \text{ cm}^4 \simeq 272.600 \text{ cm}^4$

De E-F-L-G: $\frac{96 \times \overline{12,36}^3}{3} + \frac{96 \times \overline{1,64}^3}{3} = 60.423,36 + 141,15 = 60.564,5 \text{ cm}^4$

De L-H-I-K.- $\frac{23 \times \overline{12,36}^3}{3} + \frac{23 \times \overline{36,64}^3}{3} = 14.476,43 + 377.114,36 =$

$= 391.590,8 \text{ cm}^4 \simeq 391.600 \text{ cm}^4$.

Total: $272.600 + 60.600 + 391.600 = 724.800 \text{ cm}^4$.

Tensiones originadas por un momento de 200.000 Kg/cm².

$\sigma_K = \frac{200.000 \times 36,64}{724.800} = 0,276 \times 36,64 = 10,1 \text{ Kg/cm}^2$ (−)

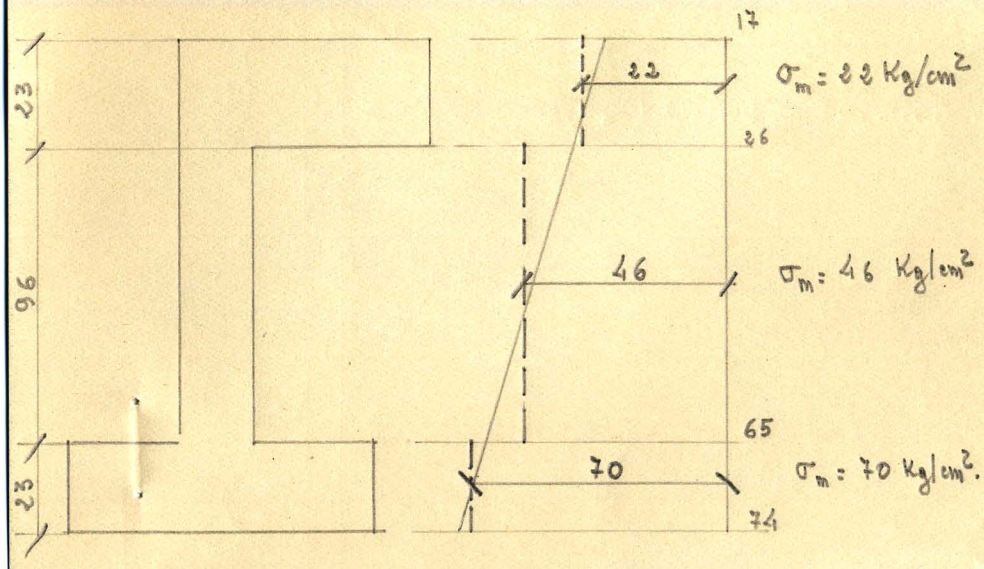
$\sigma_I = 0,276 \times 12,36 = 3,4 \text{ Kg/cm}^2$ (+)

$\sigma_G = 0,276 \times 1,64 = 0,5 \text{ Kg/cm}^2$ (−)

$\sigma_D = 0,276 \times 19,64 = 5,4 \text{ Kg/cm}^2$ (−)

$\sigma_C = 0,276 \times 30,36 = 8,4 \text{ Kg/cm}^2$ (+)

Estado inicial de tensiones:-



Volumen de compresiones:-

Ala superior: $23 \times 56 \times 22 = 28.336$ Kg.

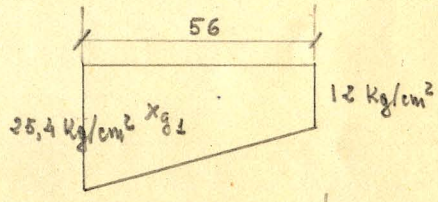
Nervio: $14 \times 96 \times 46 = 61.824$ Kg.

Ala inferior: $23 \times 50 \times 70 = 80.500$ Kg.

Estado final de tensiones:-

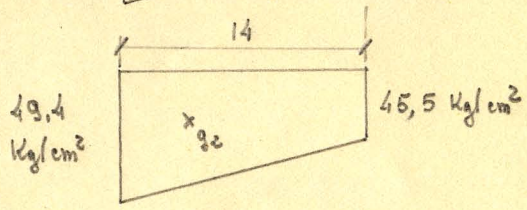
Ala superior: $\sigma_k = 22 - 10 = 12$ Kg/cm² (+)

$\sigma_I = 22 + 3,4 = 25,4$ Kg/cm² (+)



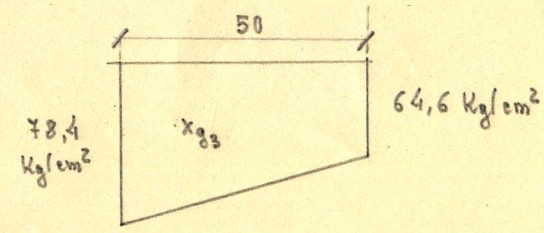
Nervio: $\sigma_G = 46 - 0,5 = 45,5$ Kg/cm² (+)

$\sigma_L = 46 + 3,4 = 49,4$ Kg/cm² (+)



Ala inferior: $\sigma_D = 70 - 5,4 = 64,6$ Kg/cm² (+)

$\sigma_c = 70 + 8,4 = 78,4$ Kg/cm² (+)



Alturas de los c.d.g. sobre la base mayor:-

$$g_2 = \frac{h}{3}\,\frac{a+2b}{a+b} = \frac{56}{3}\,\frac{25,4+2\times12}{25,4+12} = \frac{56}{3}\,\frac{49,4}{37,4} = \frac{2.766,4}{112,2} = 24,65 \text{ cm.}$$

$$g_2 = \frac{14}{3}\ \frac{49,4 + 2\times 45,5}{49,4 + 45,5} = \frac{14}{3}\ \frac{140,4}{94,9} = \frac{1965,6}{284,7} = 6,9 \text{ cm.}$$

$$g_3 = \frac{50}{3}\ \frac{78,4 + 2\times 64,6}{78,4 + 64,6} = \frac{50}{3}\ \frac{207,6}{143} = \frac{10.380}{429} = 24,2 \text{ cm.}$$

Excentricidades:- (Respecto al eje antiguo X-X)

$e_1 = 24,65 - 7 = 17,65$ cm. (+)

$e_2 = 7 - 6,9 = 0,1$ cm. (-)

$e_3 = 25 - 24,2 = 0,8$ cm. (-)

Momentos producidos:

$28.336 \times 17,65 - 61.824 \times 0,1 - 80.500 \times 0,8 =$

$500.130,4 - 6.182,4 - 64.400 = 429.548 \text{ cm.Kg} \neq 200.000 \text{ cm.Kg.}$

Luego no vale y hay que tantear otro momento:

2º Tanteo: M = 600.000 Kg.cm.

Tensiones originadas por el momento M = 600.000 cm.Kg.

$$\sigma_K = \frac{600.000 \times 36,64}{724.800} = 3 \times 10,1 = 30,3 \text{ Kg/cm}^2 \text{ (-)}$$

$\sigma_I = 3 \times 3,4 = 10,2$ Kg/cm² (+)

$\sigma_G = 3 \times 0,5 = 1,5$ Kg/cm² (-)

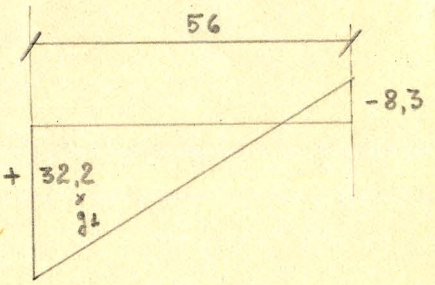
$\sigma_D = 3 \times 5,4 = 16,2$ Kg/cm² (-)

$\sigma_C = 3 \times 8,4 = 25,2$ Kg/cm² (+)

Estado final de tensiones:

Ala superior: $\sigma_K = 22 - 30,3 = -8,3$ Kg/cm²

$\sigma_I = 22 + 10,2 = +32,2$ Kg/cm²

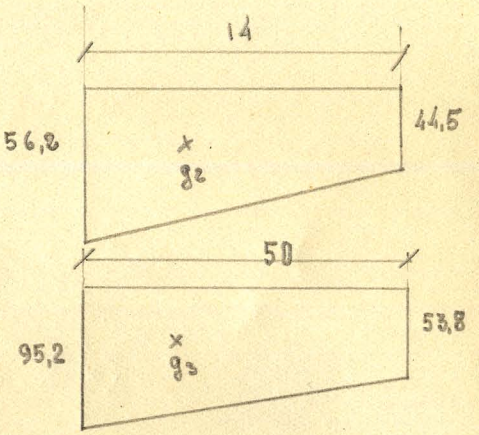


Nervio: $\sigma_C = 46 - 1,5 = +44,5 \ Kg/cm^2$

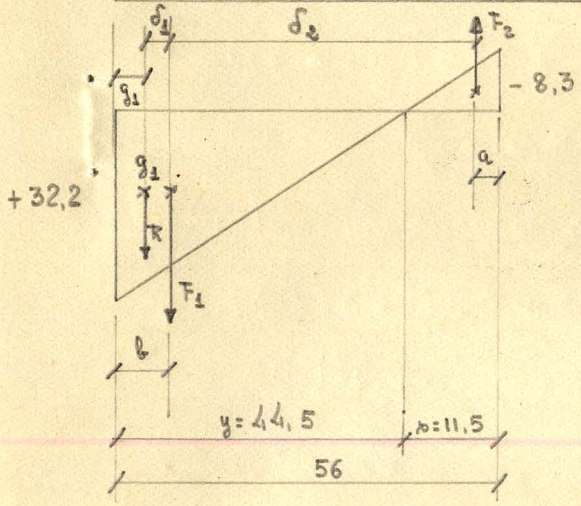
$\sigma_L = 46 + 10,2 = +56,2 \ Kg/cm^2$

Ala inferior: $\sigma_D = 70 - 16,2 = +53,8 \ Kg/cm^2$

$\sigma_C = 70 + 25,2 = +95,2 \ Kg/cm^2$



Alturas de los centros de gravedad sobre la base mayor:



$\frac{8,3}{p} = \frac{32,2}{y} = \frac{8,3+32,2}{56}$

$p = \frac{56 \times 8,3}{40,5} = 11,5 \text{ cm}$; $y = \frac{56 \times 32,2}{40,5} = 44,5 \text{ cm.}$

$a = \frac{1}{3} p = \frac{11,5}{3} = 3,8 \text{ cm.}$ $\quad b = \frac{1}{3} y = \frac{44,5}{3} = 14,8 \text{ cm.}$

$R = F_1 - F_2$; $\quad F_1 = \frac{1}{2} 32,2 \times 44,5 = 716,45 \ Kg.$

$F_2 = \frac{1}{2} 8,3 \times 11,5 = 47,725 \ Kg.$

$R = 716,45 - 47,725 = 668,725 \ Kg.$

$R \delta_1 = F_2 \delta_2$; $\quad \delta_2 = 56 - (a+b) = 56 - (3,8 + 14,8) = 56 - 18,6 = 37,4 \text{ cm.}$

$\delta_1 = \frac{47,725 \times 37,4}{668,725} = 2,67 \text{ cm.}$; $\quad g_1 = b - \delta_1 = 14,8 - 2,7 = 12,1 \text{ cm.}$

$g_2 = \frac{14}{3} \frac{56,2 + 2 \times 44,5}{56,2 + 44,5} = \frac{14}{3} \frac{145,2}{100,7} = \frac{2032,8}{302,1} = 6,7 \text{ cm.}$

$g_3 = \frac{50}{3} \frac{95,2 + 2 \times 53,8}{95,2 + 53,8} = \frac{50}{3} \frac{202,8}{149} = \frac{10.104}{447} = 22,6 \text{ cm.}$

Excentricidades: (Respecto X-X)

$e_1 = 12,1 - 7 = 5,1 \text{ cm} \ (+)$

$e_2 = 7 - 6,7 = 0,3 \text{ cm} \ (-)$

$e_3 = 25 - 22,6 = 2,4 \text{ cm} \ (-)$

Momentos producidos.

$28.336 \times 5,1 - 61.824 \times 0,3 - 80.500 \times 2,4 = 144.513,6 - 18.547,2 -$

$- 193.200 = - 67.233,6$ cm Kg. $\neq$ 600.000 cm. Kg.

Luego no vale y hay que tantear otro momento.

3er Tanteo.- M = 400.000

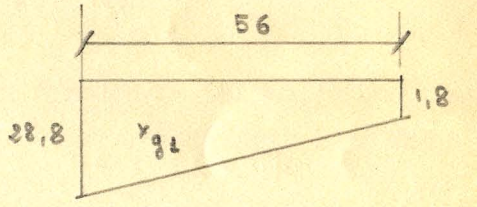
Tensiones originadas por el momento M = 400.000.- cm. Kg.

$\sigma_K = 2 \times 10,1 = 20,2$ Kg/cm^2 (−) " $\sigma_I = 2 \times 3,4 = 6,8$ Kg/cm^2 (+)

$\sigma_G = 2 \times 0,5 = 1$ Kg/cm^2 (−) " $\sigma_D = 2 \times 5,4 = 10,8$ Kg/cm^2 (−)

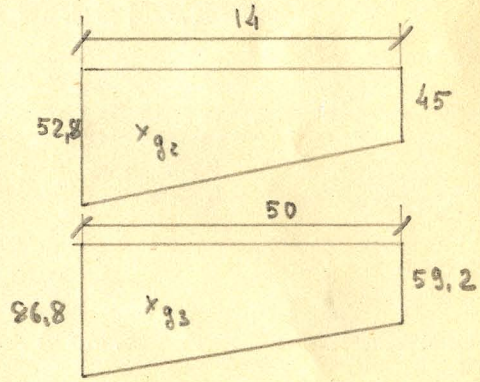
$\sigma_C = 2 \times 8,4 = 16,8$ Kg/cm^2 (+)

Estado final de tensiones.



Ala superior: $\sigma_K = 22 - 20,2 = +1,8$ Kg/cm^2

$\sigma_I = 22 + 6,8 = +28,8$ Kg/cm^2



Nervio: $\sigma_G = 46 - 1 = 45$ Kg/cm^2

$\sigma_L = 46 + 6,8 = 52,8$ Kg/cm^2

Ala inferior: $\sigma_D = 70 - 10,8 = 59,2$ Kg/cm^2

$\sigma_C = 70 + 16,8 = 86,8$ Kg/cm^2

Altura de los centros de gravedad sobre la base mayor.-

$$g_1 = \frac{56}{3}\ \frac{28,8 + 2 \times 1,8}{28,8 + 1,8} = \frac{56}{3}\ \frac{32,4}{30,6} = \frac{1814,4}{91,8} = 19,8 \text{ cm.}$$

$$g_2 = \frac{14}{3}\ \frac{52,8 + 2 \times 45}{52,8 + 45} = \frac{14}{3}\ \frac{142,8}{97,8} = \frac{1999,2}{293,4} = 6,8 \text{ cm.}$$

$$g_3 = \frac{50}{3}\ \frac{86,8 + 2 \times 59,2}{86,8 + 59,2} = \frac{50}{3}\ \frac{205,2}{146} = \frac{10.260}{438} = 23,4 \text{ cm.}$$

Excentricidades (Respecto X-X).-

$e_1 = 19,8 - 7 = 12,8$ cm (+) $\qquad e_2 = 7 - 6,8 = 0,2$ (-) cm.

$e_3 = 25 - 23,4 = 1,6$ cm (-)

Momentos producidos:-

$28.336 \times 12,8 - 61.824 \times 0,2 - 80.500 \times 1,6 = 362.700,8 - 12.364,8 - 128.800 =$

$= 221.535,2 \neq 400.000$ cm.Kg.

4º Tanteo.- M = 320.000 cm.Kg.

Tensiones originadas por el momento M = 320.000 cm. Kg.-

$\sigma_K = \frac{320.000 \times 36,64}{724.800} = 0,44 \times 36,64 = 16,12$ Kg/cm² (-)

$\sigma_I = 0,44 \times 12,36 = 5,44$ Kg/cm² (+) $\qquad \sigma_G = 0,44 \times 1,64 = 0,72$ Kg/cm² (-)

$\sigma_D = 0,44 \times 19,64 = 8,64$ Kg/cm² (-) $\qquad \sigma_C = 0,44 \times 30,36 = 13,36$ Kg/cm² (+)

Estado final de tensiones.-

Ala superior: $\sigma_K = 22 - 16,12 = +5,88$ Kg/cm²

$\sigma_I = 22 + 5,44 = +27,44$ Kg/cm²

Nervio: $\sigma_G = 46 - 0,72 = +45,28$ Kg/cm²

$\sigma_L = 46 + 5,44 = +51,44$ Kg/cm²

Ala inferior: $\sigma_D = 70 - 8,64 = +61,36$ Kg/cm²

$\sigma_C = 70 + 13,36 = +83,36$ Kg/cm²

Altura de los centros de gravedad sobre la base mayor:

$$g_1 = \frac{56}{3} \frac{27,44 + 2 \times 5,88}{27,44 + 5,88} = \frac{56}{3} \frac{39,20}{33,32} = \frac{2.195,20}{99,96} = 21,96 \text{ cm.}$$

$$g_2 = \frac{14}{3} \frac{51,44 + 2 \times 45,28}{51,44 + 45,28} = \frac{14}{3} \frac{142}{96,72} = \frac{1.988}{290,16} = 6,85 \text{ cm.}$$

$$g_3 = \frac{50}{3}\ \frac{83,36 + 2 \times 61,36}{83,36+61,36} = \frac{50}{3}\ \frac{206,08}{144,72} = \frac{10.304}{434,16} = 23,73 \text{ cm.}$$

Excentricidades (Respecto x-x)

e_1: 21,96 - 7 = 14,96 cm (+)

e_2: 7 - 6,85 = 0,15 cm (-)

e_3: 25 - 23,73 = 1,27 cm (-)

Momentos producidos:

$$28.336 \times 14,96 - 61.824 \times 0,15 - 80.500 \times 1,27 =$$

$$423.906,56 - 9.273,6 - 102.235 = 312.397,96 \text{ cm Kg} \simeq 320.000 \text{ cm kg.}$$