

*Tanteo de Cálculo*

848.516  
26-7-58

Cubierta

Cargas de nieve = 65 kg/m<sup>2</sup>  
 Entablado y aluminis = 25 "

Entablado superior

Para tabla machihembrada de 22x195 mm

Tension de trabajo admisible a flexion = 65 kg/cm<sup>2</sup>

Momentos admisibles:  $M = \frac{65 \times 100 \times 2,2^2}{6} \times \frac{1}{100} = 52 \text{ mtg/m}$

Suponiendo que colaboran tres tablas de 195 mm de ancho y que la luz es de 1,2 m, la carga puntual en el centro admisible es de

$P = \frac{4M}{L} = \frac{4 \times 52 \times 0,195 \times 3}{1,2} = 102 \text{ kg}$

$\frac{6M}{bh^2} = \sigma$

1<sup>er</sup> ; A-t-on bien tenu compte de l'effet de  
dilatation des des bieles

Cables superiores

$$Luz = 6,00 \text{ m.}$$

$$\text{Distancia entre cables} = 1,2 \text{ m.}$$

$$\text{Carga de peso muerto, } 25 \times 1,2 + 11 = 41$$

$$\text{Carga de nieve } 65 \times 1,2 = 78$$

$$\text{" " viento } = 110 \times 0,8 \times 1,2 = 101$$

Vanos intermedios.

$$M_c = (41 + 78) \times \frac{6}{2} \times \frac{1}{18} = 238 \text{ mkg}$$

$$M_a = - ( \quad ) \times \frac{6}{2} \times \frac{1}{12} = - 357 \text{ "}$$

~~IP8 reforzada en arcos.~~

~~$$\sigma = \frac{238}{195} = 1,20 \text{ kg/cm}^2$$~~

~~$$f = \frac{1}{384} \times \frac{119 \times 6^4 \times 10^6}{2,1 \times 11,8 \times 10^6} = 2,46 \text{ cm} \approx \frac{L}{245}$$~~

IP10

$$f = 2,46 \times \frac{11,8}{17,9} = 1,62 \approx \frac{L}{535}$$

$$\sigma = \frac{35700}{34,2} = 1,040 \text{ kg/cm}^2$$

Nervios de 0,43 mm. de canto total

$L = 6,00$

P.m: Forjado y nervios:  $(0,06 \times 0,70 + 0,10 \times 0,43) \times 2.400 = 204$

Recercado  $(0,08 \times 0,45 + \frac{0,04}{2} \times 0,34) \times 2.200 = 96$   
 $300 \text{ Kg/m.}$

Sobrecarga  $500 \times 0,8 = 400 \text{ Kg/m.}$

Vano normal

$M_c = 400 \times \frac{6^2}{8} = 3.150 \text{ mkg.}$

$T = n \times 3 = 2.100 \text{ Kg.}$

$a = 45$

$b = 10$

$e = 6$

$d = 113$

$c = 39$

$t = 7 \text{ cm}^2 = 2\phi 16 + 2\phi 14$

$5g^2 + 315g - 4.425 = 0$

$g = 12,5$

$I = 45 \times \frac{12,5^3}{3} - 35 \times \frac{6,5^3}{3} + 105 \times 26,5 = 99.400$

$H = -39,5 \text{ Kg/cm}^2$

$A = 1.250 \text{ Kg/cm}^2$

$B = 95,5 \text{ cm}$

$\tau = \frac{2.100}{10 \times 35,5} = 5,9 \text{ Kg/cm}^2$

1 horquilla  $\phi 8$  a 20 cm en arcos y a 38 cm en el centro.

Vano con voladizo



Voladizo

$M_A = -400 \times \frac{1,25^2}{2} = -550 \text{ mkg}$

$T_A = 400 \times 1,25 = 845 \text{ Kg}$

$t = 2\phi 14$

1 horq.  $\phi 5$  a 20 cm.

Vano

$M_x = 2.060 \times \frac{2,95^2}{2} = 3.030$

$T_A = 400 \times 3 + \frac{550}{6,0} = 2.190$

$T_B = n = \frac{235}{6} = 2.060$

$t = 2\phi 16 + 2\phi 14$   
 $38 \text{ cm en el centro.}$

1 horq.  $\phi 8$  a 20 cm. en arcos y a

105  
210

780  
3520

Cubierta Gantes

Parte superior

Adhesivos de miera = 65 Kg/m<sup>2</sup>

Entalados y cinc.  $0,030 \times 1.000 + 5,0 = 35$  "

Borneros  $l = 6,0$  m. p.p = 8  $lep = 1,3$   
 $v = 108 \times 1,3 = 140$  Kg/m.

M<sub>c</sub>

$M_a = -140 \times \frac{6,0^2}{12} = -1120$

IP10

A = 1.230

Parte inferior

Entalado y aluminio = 35 Kg/m<sup>2</sup>

Borneros  $l = 6,0$  p.p = 8 Carga puntual = 100 Kg.

$M_c = 70 \times \frac{6^{2,105}}{24} + 100 \times 6,0 \times 0,1105 = 207$

$v = 35 \times 2 = 70$  Kg/m.

$M_a = 210 \times \frac{6}{12} + 51 \times 0,0852 = -262$

IP8

Gercha  $L = 25$  m

Peso propio:  $(11,18 \times 5,6 + 24,0 \times 2,35 \times 2) \times \frac{1,4}{2,3} = 100$  Kg/m.l.

Adhesivos de miera  $65 \times 6 = 390$  "

Entalados y conros  $[70 + (\frac{10,6}{1,3} + \frac{3,0}{2,0}) \times 6,0] = 480$

$l = 25,0$  m

$M_a = 970 \times \frac{25^2}{2} = 303.00$

$T = 970 \times 25 = 24.300$

Brzo = 3,5

$H = \pm \frac{303}{3,5} = 86,5$  t.

Estructura cubierta del Estadio  
Metropolitano

Datos de cálculo.

Graderio inferior

Fojado.  $l = 0,80$   $S = 600 \text{ kg/m}^2$  p.p.  $= 0,06 \times 2.400 = 145 \text{ kg/m}^2$

$M_c = 145 \times \frac{0,8^2}{8} = 60 \text{ mkg}$   $d = 6$   $c = 4,0$   $t = 8 \phi 5 \text{ p m} = 1,54$

$50g^2 + 23,1g - 92,4 = 0$   $g = 1,15$   $I = 100 \times \frac{1,15^3}{3} + 23,18 \times \frac{2,85^2}{12} = 238$

$H = -$   $A =$

Arco de 0,43 m de canto  $l = 6,0 \text{ m}$ .

Barras. P.m. Fojado  $144 \times 0,35 = 50$   
Arco  $240 \times 0,43 = 103$   
Recurvo  $(0,08 \times 0,45 + 0,03 \times 0,37) \times 2.200 = 104$

Solera  $600 \times 0,8$   $= 258 \text{ kg/m.l}$   
 $= 180 \text{ kg/m.l}$

Vano extremo.

$M_x =$

$M_a = -(258 \times 0,1057 + 180 \times 0,1197) \times 6,0^2 = -3.050 \text{ mkg}$

$T_i = 138 \times 3,0 + \frac{84,8 \times 6^2}{0,0} = 2.423$

$T_d = n - \frac{316 \times 6^2}{6,0} = 1.900$

$b = 45$   $d = 43$   $c = 30$   $t_a = 6,0$   $b = 10$   $e = 6$

$3g^2 + 300g - 2.970 = 0$   $g = 9,1$   $I = 45 \times \frac{9,1^3}{3} - 35 \times \frac{3,1^3}{3} + 90 \times \frac{2,99^2}{12} = 91.400$   $H = -30,4$   $A = 1,500$

$B = 34$   $r = \frac{2.423}{10 \times 34} = 8,0$

Vano intermedio

$M_c =$

$M'_c =$

$M_a =$

$M'_a =$

$T_{max} = 138 \times 3,0 + \frac{600 \times (0,1139 - 0,0223) \times 6^2}{6} = 1.554 \text{ kg}$

$T_{min} = 258 \times n - \frac{600 \times (0,10306 + 0,0610) \times 6^2}{6} = 444 \text{ kg}$

154 66  
77 266  
231 726

25,4

Gradiente superior

anchuras de 0,685 m.

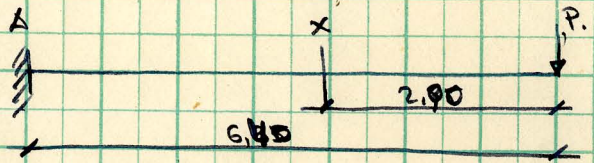
Barras.	P.m.	Forjado	4.44 x 0,35	=	51
		Arco	$0,10 \times 2,40 \times 0,685$	=	165
		Revecido.	$(0,175 \times 0,45 + 0,03 \times 0,625) \times 2,200$	=	214
					<u>430</u> Kg/m. l
Sub.			600 x 0,8	=	<u>480</u> "

Vano central

- M<sub>c</sub>
- M'<sub>c</sub>
- M<sub>a</sub>
- M'<sub>a</sub>
- T



Yoladizo



Peso muertos:

$$P_1 = 0,1 \times 0,45 \times 6,0 \times 2,40 = \underline{650 \text{ Kg}}$$

Abanico. densidad:  $\frac{430 \times 6,0}{0,8} = 3,230$

P.p.  $\frac{0,62 \times 0,4 \times 2,40}{2} = \frac{300}{3,530 \text{ Kg/m}}$

Triangular. P.p.  $2,3 \times 0,4 \times 2,40 = \underline{2,200 \text{ N}}$

Carga maxima:  $500 \times 6,0 \times (1,0 + 0,0916 \times 2) = \underline{3,550 \text{ Kg/m}}$

minima:  $" \times 0,0916 = \underline{2,15 \text{ N}}$

$$M_x = -(650 + 4,080 \times \frac{2,9}{2} + \frac{2,200}{6,40} \times 2,9 \times \frac{2,9}{6}) \times 2,9 = -33,000$$

$b=40 \quad d=100 \quad c=95,5 \quad t=30$

$$20g^2 + 450g - 42,900 = 0 \quad g = 36,4 \quad I = 40 \times \frac{36,4^3}{3} + 450 \times 59,1^2 = 2,210,000$$

$H = -54,4 \quad A = 1,330$

$$M_a = -(650 + 4,080 \times \frac{6,4}{2} + 2,200 \times \frac{6,4}{6}) \times 6,4 = -164,000$$

$$T_a = 650 + 4,080 \times 6,4 + 2,200 \times 3,2 = 53,000$$

$b=40 \quad d=180 \quad c=112 \quad t=11 \phi 30 = 48$

$$20g^2 + 1,170g - 201,200 = 0 \quad g = 45,5 \quad I = 40 \times \frac{45,5^3}{3} + 1,170 \times 96,5^2 = 16,800,000$$

$H = -74,6 \quad A = 1,430$

77  
45,3  
25

Valedizo  $L = 5,38$

$$\frac{20630}{650} = 21,280$$

$$M_{max} = - \left( 650 + \frac{18,370}{9500} \times \frac{5,38^2}{2} + \frac{1,660}{6,4} \times \frac{5,38^3}{6} \right) \times 5,38 = -114,400$$

$$\frac{11,160}{650} = 11,810$$

$$M_{min} = - \left( u + 3,530 \times u + u \right) \times u = -63,600$$

$b = 110$        $d = 152$        $e = 70$

$S = 10,4 \text{ cm}^2$  (27  $\phi$  7)       $\sigma_c = 11 \text{ t/cm}^2$        $t_f = 9,35$

$N_i = -114,4$

$N_f = -97,2$

$e = 0,7$

$M_i = -63,6 + 114,4 \times 0,7 = -16,5$

$\sigma = \frac{-114,400}{40 \times 152^2} + \frac{6 \times 16500 \times 100}{40 \times 152^2} = -18,8 \pm 10,8 =$

$M_f = -114,4 + 97,2 \times 11 = -46,4$

$\sigma = \frac{-97,200}{40 \times 152^2} + \frac{6 \times 46,400}{40 \times 152^2} = -16,0 \pm 30,2 = +14,2$

~~12~~

$S = 11,5 = 30 \phi 7$

$N_i = -126,5$

$N_f = -107,5$

$M_i = -63,6 + 126,5 \times 0,7 = +25,0$

$\sigma = -20,8 \pm 16,2 =$

$M_f = -114,4 + 107,5 \times 11 = -39,2$

$\sigma = -17,7 \pm 25,4 = +7,7$

$$\frac{17,6}{27,2}$$

Voladizo  $l = 4,8$

$\frac{18384}{650}$   
 $\frac{9790}{650}$   
 $\frac{10440}{650}$

$$M_a = - \left( 650 + 4,080 \times \frac{4,8}{2} + \frac{2,200}{6,4} \times \frac{4,8^2}{6} \right) \times 4,8 = -91,100$$

$$M'_a = - \left( 3,530 \times 4,8 + \frac{2,200}{6,4} \times \frac{4,8^2}{2} \right) \times 4,8 = -50,300$$

$d = 100$

$b = 40$

$S = 10,4 \text{ cm}^2$

$N_t = 10,4 \times 9,8 = 97 \text{ t.}$

$N'_t = 114,5 \text{ t.}$

$e = 0,4$

$M_p = 91,1 - 97 \times 0,4 = 52,3$

$100 \times 40$

$$\sigma = - \frac{97.000}{10.000} + \frac{6 \times 52300 \times 100}{40 \times 100^2} = - \frac{97}{4} + \frac{6 \times 523}{40} = +54,3$$

$\frac{523}{4 \times 100}$

$$\sigma = - \frac{97.000}{40 \times 100} + \frac{6 \times 52300}{4 \times 100^2} = -20,2 \pm$$

$e = \frac{50,3}{114,5} = 0,44$

$M_p = 91,1 - 97 \times 0,44 = 48,4$

$120 \times 40$

$e = 0,6$

$M'_t = -50,3 + 114,5 \times 0,55 = -12,8$

$N = -114,5$

$d = 125$

$b = 40$

$$\sigma = - \frac{114500}{40 \times 125^2} + \frac{6 \times 12.800 \times 100}{40 \times 125^2} = -22,9 \pm 12,2 =$$

$M_t = -91,1 + 97 \times 0,55 = -34,4$

$\sigma = - \frac{97000}{5.000} + \dots = -19,4 \pm 36,2 \pm 16,8$

$e = 0,6$

$M'_t = -50,3 + 114,5 \times 0,6 = -18,4$

$d = 137$

$b = 40$

Pieza AB

$$N = -46,5$$

$$30 \times 40$$

$$S = 1,15 \times 1,200 = 1,380$$

$$H = \frac{-46,500}{1,380} = -34$$

Pieza AB

$$N = +85$$

$$t = 60 \text{ cm}^2 = 6 \phi 35$$

Pieza BC

$$N = -66$$

$$30 \times 40$$

CD

$$N = -96$$

$$40 \times 40$$

$$S = 1,600 \times 1,15 = 1,840$$

$$H = \frac{-96000}{1,840} = -52$$

DE

$$N = +133 \text{ t}$$

EF

$$N = -102 \text{ t}$$

$$50 \times 40$$

$$S = 2,300$$

$$H = \frac{102.000}{2,300} = -44$$

DF

$$N = -253 \text{ t}$$

$$60 \times 60$$

$$S = 3600 \times 1,15 = 4,140$$

$$H = -61$$

BG

$$N = +71,7$$

$$S_{\text{exp}} = \frac{71,7}{9,35} = 7,65 \text{ cm}^2 = 20 \phi 7$$

DG

$$N = 122$$

$$S_{\text{exp}} = 10,4 \text{ cm}^2 = 27 \phi 7$$

FG

$$N = -126$$

$$50 \times 40$$

$$H = -55$$

GH

$$N = 217,8$$

$$S = 23,3 \text{ cm}^2 = 60 \phi 7$$

$$40 \times 30$$

$$H = -100$$

HI

$$N = -344$$

$$M = 0,100 \times 6,0 \times 13,0 \times 1,8 = 11,16 \text{ mt}$$

$$60 \times 100$$

Para D. Eduardo

Carga de nieve =  $65 \text{ kg/m}^2$

Viento

Carga en gradenios

2 personas de  $100 \text{ kg}$  por  $\text{m}^2$  de grader dan  
una carga de  $\frac{200}{0.8} = 250$

Impacto del 50% =  $\frac{125}{375 \text{ kg/m}^2}$

La  $\text{C}^{\circ}$  general de Argentina dice en relación  
a las de espectáculos  $400 \text{ a } 500 \text{ kg/m}^2$

Parece que se podría tomar

$500 \text{ kg/m}^2$  en techos y forjados de gradenios

$400 \text{ "}$  " forjados y galerías

$500 \text{ "}$  " escaleras

Se puede dar la simultaneidad.

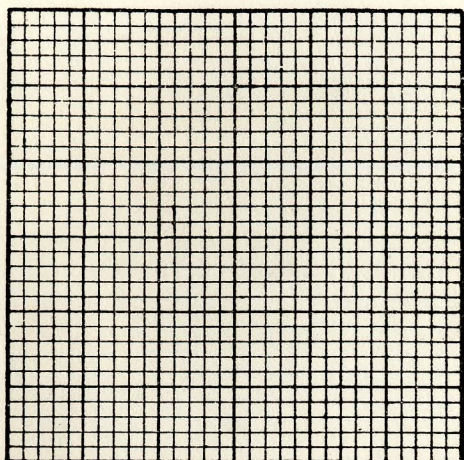
Juntas de dilatación en cubiertas y en gradenios

Articulación provisional y enclavamiento posterior del soporte

Soporte posterior =  $220 \text{ t}$ . Se debe llevar al soporte y la  
componente horizontal parece que resulte económica. Por  
lo menos una parte de las bases.

111,3

Flexión ó compresión compuesta  
Elemento ..... Sección.....



N = 72.000 kg	T = .....
S = 24 cm	M = 1833.000 cm.kg
a = 40 cm	t = 20 cm <sup>2</sup>
b = 40 cm	u = 6 cm <sup>2</sup>
c = 195 cm	v = .....
d = 100 cm	w = .....
e = .....	s = .....
f = .....	o = .....
r = 5 cm	m = .....

Profundidad del eje neutro = g = 188 cm

$+\frac{a}{6} = \dots g^3 - \frac{a}{6} \cdot 35 = \dots g^3$	$+(a-b)e(\frac{e}{2} - S) = \dots g$	$-(a-b)e^2(\frac{e}{3} - \frac{S}{2}) = \dots = 0$
$-\frac{a-b}{6} = \dots + \frac{a-b}{6} \cdot 35 = \dots$	$+b'd(\frac{d}{2} - S) = \dots$	$-b'd^2(\frac{d}{3} - \frac{S}{2}) = \dots$
$-\frac{b'}{6} = \dots + \frac{b'}{6} \cdot 35 = \dots$	$-mu(S-r) = \dots$	$+mur(S-r) = \dots$
	$-mt(S-c) = \dots$	$+mtc(S-c) = \dots$
$+ 667 g^3$	$- 480 g^2$	$+ 19.590 g$
		$- 2.015.000 = 0$

Momento de inercia

$+\frac{ag^3}{3} = 19.100.000$
$-\frac{(a-b)(g-e)^3}{3} = \dots$
$-\frac{b'(g-d)^3}{3} = \dots$
$+mu(g-r)^2 = 56$
$+mt(g-c)^2 = \dots$

$i = 9.690.000 \text{ cm}^4$

Cargas máximas unitarias.

$H = \frac{N(g-S)g}{I} = \dots \text{ kg/cm}^2$	$H' = \frac{N(g-S)(g-d)}{I} = \dots \text{ kg/cm}^2$
$A = 15 \frac{N(g-S)(g-c)}{I} = \dots \text{ kg/cm}^2$	$A' = 15 \frac{N(g-S)(g-r)}{I} = \dots \text{ kg/cm}^2$
$j = \frac{N(c-S)}{N-At} = \dots \text{ cm}^2$	$C' = \frac{T}{jB} = \dots \text{ kg/cm}^2$
$B = \frac{T}{j(\frac{v}{3} + \frac{w}{6}\sqrt{2})} = \dots \text{ kg/cm}^2$	

Observaciones: si  $g < d$ , se suprime  $b'$  (Flexión compuesta).....

..... si  $g \geq e$ , se suprime  $(a-b)$ .....

..... si  $g \geq d$ , se da a  $b'$  el valor de  $b$  (Compresión compuesta).....

$s = \frac{d}{2} - \frac{M}{N} = 50 - 26 = 24$

x=4,25

$$M_y = - \left[ \overset{6.630}{1.580} \times 4,2 + \overset{15.930}{4.300} \times 3,7 + \overset{35.470}{5.210} \times (2,9 + 2,1 + 1,3 + 0,50) + 0,4 \times \frac{4,32}{2} \times 1,3 \times 2,400 \times 1,44 + \overset{3.880}{0,4} \times \frac{0,16}{2} \times 0,45 \times (3,45 + 2,65 + 1,85 + 1,05) \right] \times 2,400 = -63,080$$

$$P = \overset{20.840}{1.580} + 4.300 + \overset{520}{5.210} \times 4 + 2,700 + 130 \times 4 = 29.940$$

$$N = 29.940 \times 0,52 = 15.500$$

$$Q = n \times 0,86 = 25.800$$

$$N = -72.000 \quad M = 18.330$$

$$b = 40 \quad d = 120 \quad c = 115 \quad t = \quad u = 6$$

$$M' = 18.330 + 72.000 \times 0,55 =$$

$$\begin{array}{r} 39.670 \\ \hline 58.000 \end{array}$$

$$t' = 46$$

$$20g^2 + 690g - 79.350 = 0$$

$$g = 48$$

$$I = 40 \times \frac{48^3}{3} + 690 \times 6 \times 48^2 = 4.560.000$$

$$M' = 18.330 + 13.000 \times 0,55 = 25.160$$

45.600

70.000  
6.500.000

$$\begin{array}{r} +1.760 - 2.015 \\ \hline 4860 \\ \hline 6.620 \end{array} \quad \begin{array}{r} 4315 \\ \hline 6330 \end{array}$$

$$\begin{array}{r} 1.722 \\ \hline 4540 \\ \hline 6.262 \end{array}$$

$$\begin{array}{r} 4.22 \\ \hline 2.015 \\ \hline 6.235 \end{array}$$

$$\begin{array}{r} 21.300 \\ \hline 95 \\ \hline 1065 \\ \hline 1917 \\ \hline 2023500 \end{array}$$



EDUARDO TORROJA  
OFICINA TECNICA N.º

/ 19

ORD.

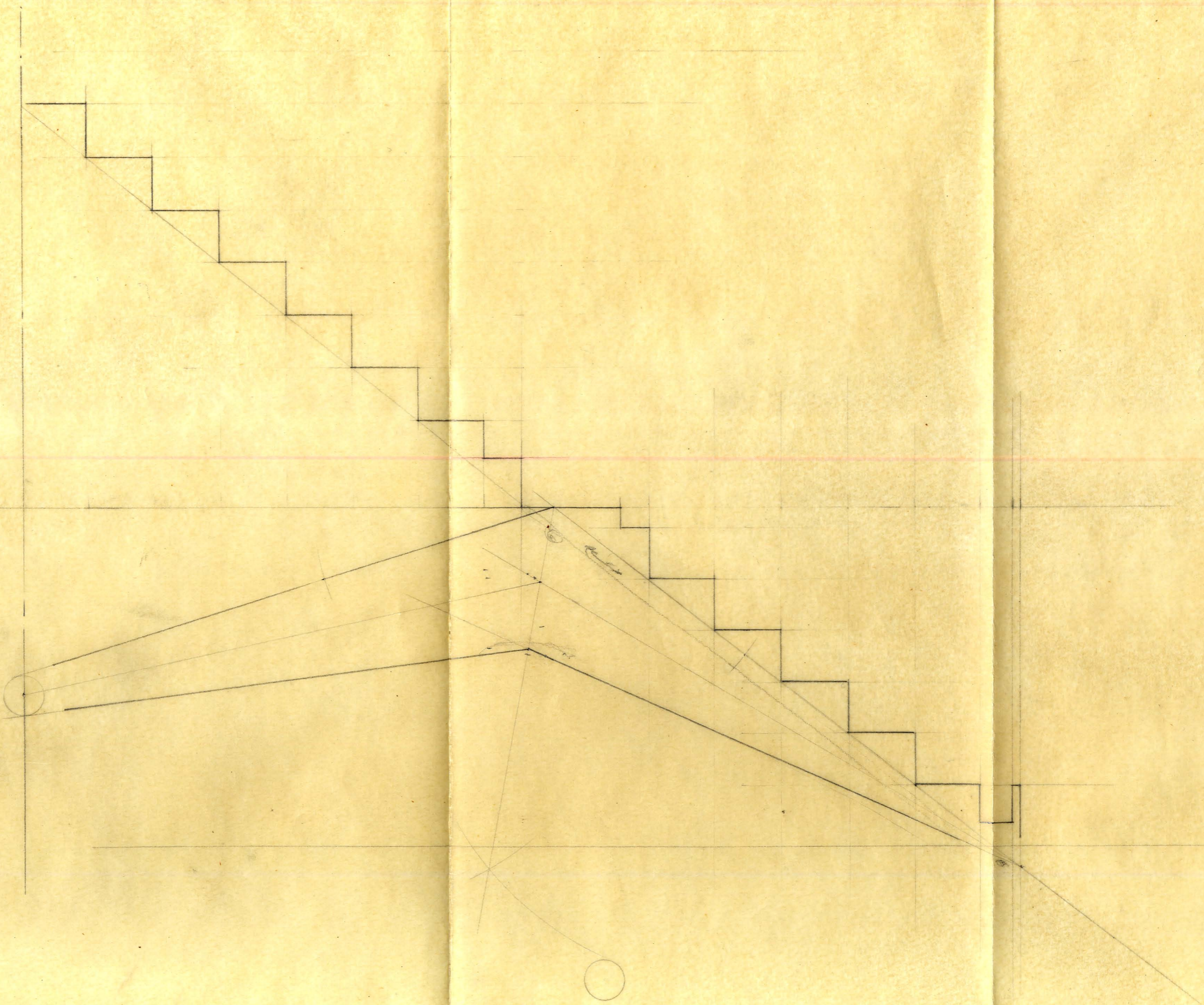
TRAZ.

DIB.

COMP.

ANULA AL

PROC.



EDUARDO TORROJA / 19 / ORD. / TRAZ. / DIB. / COMP. / ANULA AL / PROC.

OFICINA TECNICA N.º

+102T

-126T

-157T

-94T

-102t

+133T

4313

4248

$gradenio: (0,65 + 7,08 \times \frac{12}{2}) \times 12$   
 $0,96 \times \frac{21}{2} \times 7,3 \times 7,8$   
 $0,96 \times 0,6 \times 7,6 \times 3,0$   
 $0,96 \times 1,0 \times \frac{7,5}{2} \times 3,7$   
 $0,96 \times 0,5 \times 5,2 \times 2,6$   
 $0,96 \times 0,5 \times 4,0 \times 2,0$   
 $0,7 \times 6 \times 6,0 \times 3,0$

= 509 mt  
 = 57,4  
 = 13,2  
 = 13,4  
 = 6,5  
 = 3,8  
 = 75,7  


---

 679,0

$P = \frac{679}{6,65} = 102t$

247T

P



