

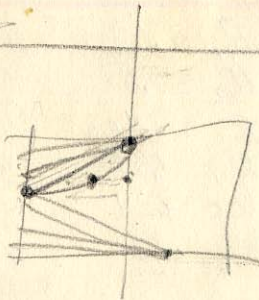
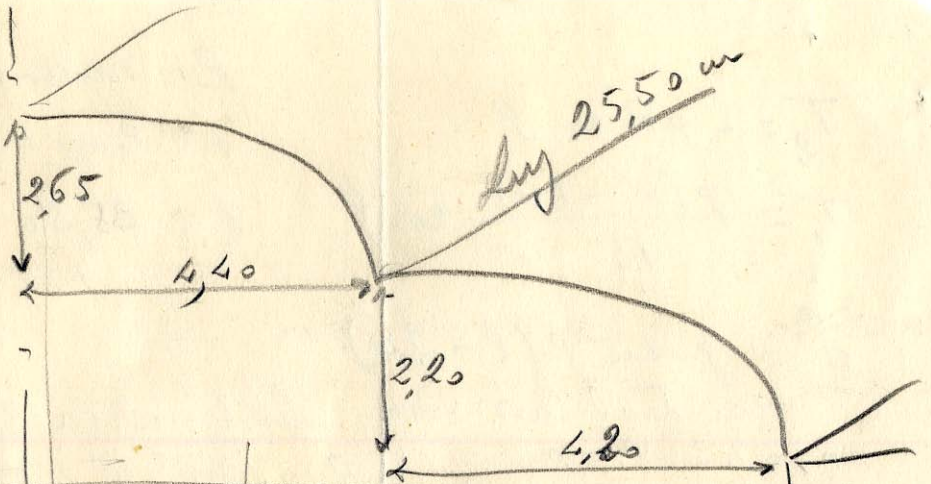
Iglesia de Villaverde

Tanteo de la estructura
de la cubierta

Nº 248.504

Fecha 4-10-34

Eje de simetria



Muro de apoyo.

$$T_2 = -pR \cos \varphi$$

$$T_1 = \frac{p(b^2 - l^2)}{R} \cos \varphi$$

$$S = p \sin \varphi (l - 2b)$$

Central (a=2,2 b=4,0)

$$R_1 = 7,3 \quad \varphi_1 = 0$$

$$R_2 = 6,24 \quad \varphi_2 = 13^\circ 40'$$

$$R_3 = 3,88 \quad \varphi_3 = 31^\circ 50'$$

$$R_4 = 2,44 \quad \varphi_4 = 51^\circ$$

$$R_5 = 1,75 \quad \varphi_5 = 72^\circ$$

$$R_6 = 1,60 \quad \varphi_6 = 90^\circ$$

R = radio de Curvatura

p = 600 kg/m²

l = 25,50

Lateral (a=2,65 b=4,40)

$$R_1 = 4,3 \quad \varphi_1 = 0$$

$$R_2 = 5,63 \quad \varphi_2 = 15^\circ 30'$$

$$R_3 = 3,10 \quad \varphi_3 = 35^\circ 20'$$

$$R_4 = 1,65 \quad \varphi_4 = 55^\circ 30'$$

$$R_5 = 1,24 \quad \varphi_5 = 75^\circ$$

$$R_6 = 1,21 \quad \varphi_6 = 90^\circ$$

$$T_{2n} = -n R \cos^4 \varphi$$

$$S_n = \frac{5}{2} n \cos^3 \varphi \sin \varphi (l - 2x)$$

$$T_{1n} = \frac{5}{2} n \frac{x^2 - lx}{R} (\cos^4 \varphi - 3 \cos^2 \varphi \sin^2 \varphi)$$

$$n = 65 \text{ kg.}$$

$$\mu = 150 \text{ kg.}$$

$$\int_{\phi=90}^{\pi} \cancel{c \cos^n \phi} = C$$

$$\int_{\phi=0}^{\pi} c \cdot \cos^n \phi \, d\phi = C$$

$$C = c \int_0^{\pi/2} R \cos^n \phi \, d\phi$$

$$9 \times 50 = 450$$

$$450 \quad \text{---} \quad 250$$

$$18 \quad \text{---} \quad 2$$

$$\lambda = \frac{18 \times 250}{450} = 10$$

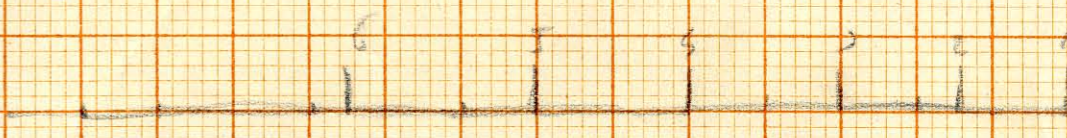
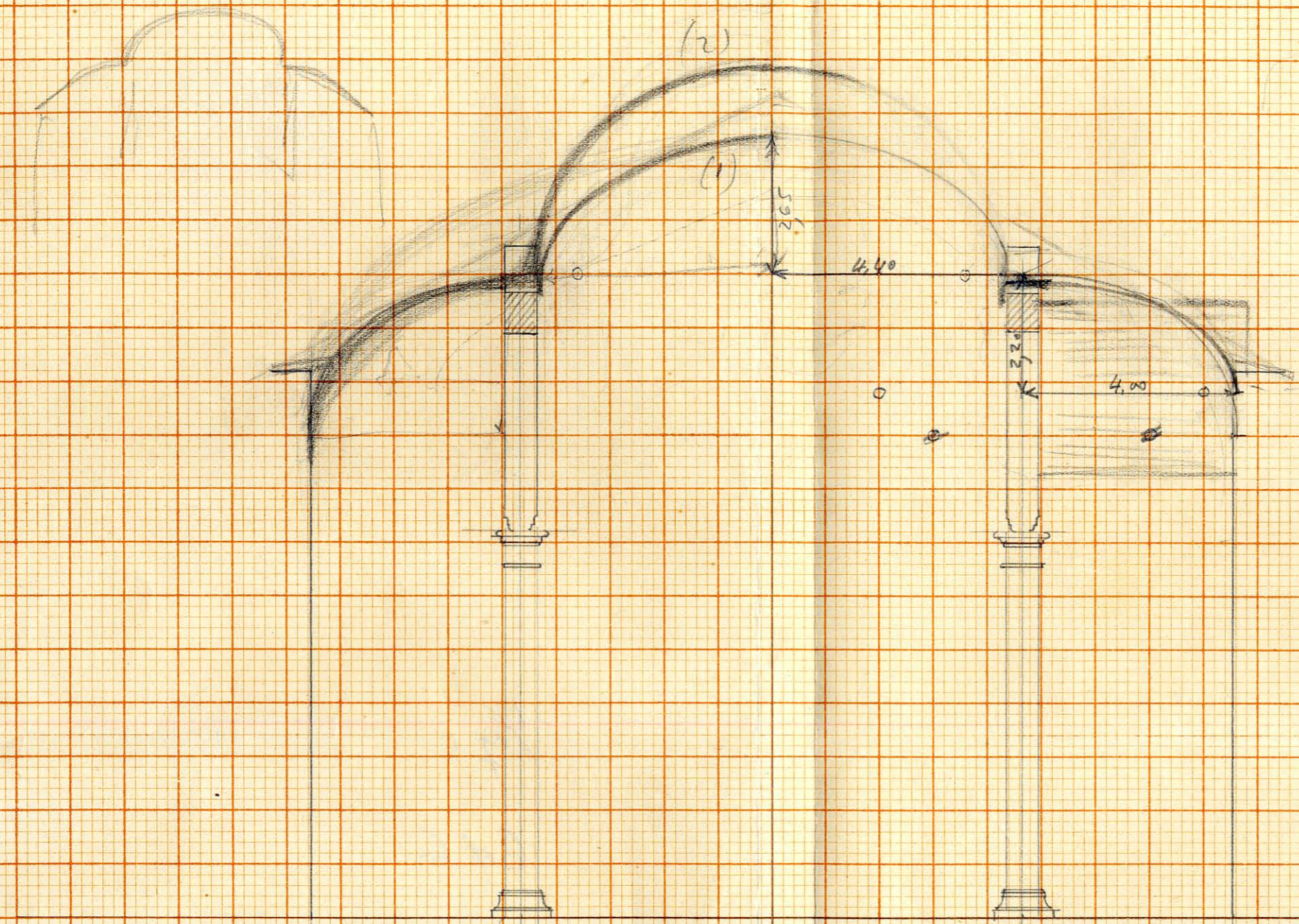
$$T_{2c} = -cR \operatorname{re} u^u y \cos y$$

$$S_{2c} = \frac{c(l-2p)}{2} \left[(n+2) \operatorname{re} u^{n+1} y - n \operatorname{re} u^{n-1} y \right]$$

$$T'_{1c} = -\frac{c(p^2 - lp) \cos y}{2R} \left[n(n-1) \operatorname{re} u^{n-2} y - (n+2)(n+1) \operatorname{re} u^{n+2} y \right]$$

$$c = \cancel{10 \times 2} = \cancel{250} \text{ Pf} = 1000 \text{ V}$$

S_{2c} para $p=0$ y $n=100$ y l variable



$\varphi = 0$ //

$\varphi = 0 \quad S = 0$

$\varphi = 14,75 \quad S = 200 \times 0,252 (25,5 - 0) = 1260$

$\varphi = 31,30 \quad S = 200 \times 0,52 (25,5 - 0) = 2650$

$\varphi = 55,50 \quad S = 200 \times 0,81 (25,5 - 0) = 4100$

$\varphi = 90 \quad S = 200 \times 1,00 (25,5 - 0) = 5100$

245
4900

$R_0 = 7,05 \quad \varphi = 0 \quad \sin \varphi = 0 \quad \cos \varphi = 1$

$\varphi = 1$

$S = 0$

$T_1 = \frac{200(1 - 25,5)}{7,05} = -695$

$T_2 = -200 \times 7,05 = -1410$

$\varphi = 2$

$S = 0$

$T_1 = \frac{200(4 - 51)}{7,05} = -1330$

$T_2 = -200 \times 7,05 = -1410$

$\varphi = 3$

$S = 0$

$T_1 = \frac{200(9 - 76,5)}{7,05} = -1900$

$T_2 = -1410$

$\varphi = 4$

$S = 0$

$T_1 = \frac{200(16 - 102)}{7,05} = -2450$

$T_2 = -1410$

47
9400

86
17200

$R = 0,90$ $\gamma = 90^\circ$ $\text{sen} = 1$ $\text{cos} = 0$

$x = 0$ $S = 200 (25,5 - 2) = 4700$ $5,100$
 $x = 1$

$x = 2$ $S = 200 (25,5 - 4) = 4200$

$x = 3$ $S = 200 (25,5 - 6) = 3,900$

$x = 4$ $S = 200 (25,5 - 8) = 3,500$

$x = 5$ $S = 200 (25,5 - 10) = 3,100$

$x = 6$ $= 2,700$

$x = 7$ $= 2,300$

$x = 8$ $= 1,900$

$x = 9$ $= 1,500$

$x = 10$ $= 1,100$

$x = 11$ $= 700$

$x = 12$ $= 300$

$x = 12,75$ $= 0$

35,100

2200
 $\frac{7}{10}$

1500
 $\frac{65}{10}$

$$\frac{50}{200}$$

$$P_0 = 6,30 \quad Y = 14,25 \quad \text{sen } Y = 0,252 \quad \text{cos } Y = 0,9677$$

$$x = 1$$

$$S = 200 \times 0,252 (25,5 - 2) = +1190$$

$$T_1 = \frac{200}{6,0} \times 0,968 (1 - 25,5) = -760$$

$$T_2 = -200 \times 6,3 \times 0,968 = -1220$$

$$x = 2$$

$$S = 200 \times 0,252 (25,5 - 4) = +1060$$

$$T_1 = 31 (4 - 51) = -1450$$

$$T_2 = -1220$$

$$x = 3$$

$$S = 50,4 (25,5 - 6) = +960$$

$$T_1 = 31 (9 - 76,5) = -$$

$$T_2 = -1220$$

$$x = 4$$

$$S = 50,4 (25,5 - 8) = +860$$

$$T_1 = 31 (16 - 102) = -2660$$

$$T_2 = -1220$$

504
1

86

$$\underline{\varphi = 90^\circ}$$

$$P_{2e} = 500 \times 25,5 \times 2 = 25,500 \text{ Kg}$$

$$P = 7,3 \quad S = 0 \quad \text{per } y = 0 \quad \text{ev } y = 1 \quad P = 1 \quad l = 255$$

$$x = 0$$

$$S = 0$$

$$T_1 = 0$$

$$T_2 = -7,3$$

$$x = 1$$

$$S = 0$$

$$T_1 = \frac{1 - 25,5}{7,3} = -3,4$$

$$T_2 = -7,3$$

$$x = 2$$

$$S = 0$$

$$T_1 = \frac{4 - 51}{7,3} = -6,45$$

$$T_2 = -7,3$$

$$x = 4$$

$$S = 0$$

$$T_1 = \frac{16 - 102}{7} = -12,3$$

$$T_2 = -7,3$$

$$x = 6$$

$$S = 0$$

$$T_1 = \frac{36 - 153}{7,3} = -16,7$$

$$T_2 = -7,3$$

$$x = 8$$

$$S = 0$$

$$T_1 = \frac{64 - 204}{7,3} = -19,2$$

$$T_2 = -7,3$$

$$x = 10$$

$$S = 0$$

$$T_1 = \frac{100 - 255}{7,3} = -21,2$$

$$T_2 = -7,3$$

$$x = 12$$

$$S = 0$$

$$T_1 = \frac{144 - 306}{7,3} = -22,2$$

$$T_2 = -7,3$$

$$x = 12,5$$

$$S = 0$$

$$T_1 = \frac{156 - 318}{7,3} = -22,2$$

$$T_2 = -7,3$$

$$R = 3,88 \quad \varphi = 31,5^\circ \quad \sin \varphi = 0,527 \quad \cos \varphi = 0,849$$

$$P = 1 \quad l = 25,5$$

$$x = 0$$

$$S = 0,527(25,5 - 0) = 13,4 \quad T_1 = 0 \quad T_2 = 0,849 \times 3,88 = 3,3$$

$$x = 1$$

$$S = 0,527(25,5 - 2) = 12,4 \quad T_1 = \frac{1 - 25,5}{3,88} \times 0,849 = -5,35 \quad T_2 = 0,3$$

$$x = 2$$

$$S = 0,527(25,5 - 4) = 11,3 \quad T_1 = \frac{4 - 51}{3,88} \times 0,849 = -9,85 \quad T_2 = 0,3$$

$$x = 4$$

$$S = 0,527(25,5 - 8) = 9,4 \quad T_1 = \frac{16 - 102}{3,88} \times 0,849 = -18,7 \quad T_2 = 0,3$$

$$x = 6$$

$$S = 0,527(25,5 - 12) = 7,2 \quad T_1 = \frac{36 - 153}{3,88} \times 0,849 = -25,5 \quad T_2 = 0,3$$

$$x = 8$$

$$S = 0,527(25,5 - 16) = 5,0 \quad T_1 = \frac{64 - 204}{3,88} \times 0,849 = -30,5 \quad T_2 = 0,3$$

95

$$x = 10$$

$$S = 0,527(25,5 - 20) = 2,9 \quad T_1 = \frac{100 - 255}{3,88} \times 0,849 = -34 \quad T_2 = 0,3$$

$$x = 12$$

$$S = 0,527(25,5 - 24) = 0,8 \quad T_1 = \frac{144 - 306}{3,88} \times 0,849 = -35,5 \quad T_2 = 0,3$$

$$x = 12,75$$

$$S = 0$$

$$T_1 = \frac{158 - 319}{3,88} \times 0,849 = -35,6 \quad T_2 = 0,3$$

$0,849 \times 0,24$
 $0,97 \times 0,89$

1,405

1,63

325
163
162

$$R = 6,24 \quad P = 1 \quad l = 25,5$$

$$P = 13^\circ 40' \quad \text{Sen } \rho = 0,236 \quad \text{Cos } \rho = 0,972$$

$$p = 0$$

$$S = 0,236(25,5 - 0) = 6 \quad T_1 = 0 \quad T_2 = -6,24 \times 0,972 = -6,1$$

$$p = 1$$

$$S = 0,236(25,5 - 2) = 5,5 \quad T_1 = \frac{1 - 25,5}{6,24} \times 0,972 = -3,8 \quad T_2 = -6,1$$

$$p = 2$$

$$S = 0,236(25,5 - 4) = 5,1 \quad T_1 = \frac{4 - 51}{6,24} \times 0,972 = -7 \quad T_2 = -6,1$$

$$p = 4$$

$$S = 0,236(25,5 - 8) = 4,1 \quad T_1 = \frac{16 - 102}{6,24} \times 0,972 = -13,3 \quad T_2 = -6,1$$

$$p = 6$$

$$S = 0,236(25,5 - 12) = 3,2 \quad T_1 = \frac{36 - 153}{6,24} \times 0,972 = -18,2 \quad T_2 = -6,1$$

$$p = 8$$

$$S = 0,236(25,5 - 16) = 2,2 \quad T_1 = \frac{64 - 204}{6,24} \times 0,972 = -21,6 \quad T_2 = -6,1$$

$$p = 10$$

$$S = 0,236(25,5 - 20) = 1,3 \quad T_1 = \frac{100 - 255}{6,24} \times 0,972 = -24,1 \quad T_2 = -6,1$$

$$p = 12$$

$$S = 0,236(25,5 - 24) = 0,3 \quad T_1 = \frac{144 - 306}{6,24} \times 0,972 = -25,2 \quad T_2 = -6,1$$

$$p = 12,5$$

$$S = 0$$

$$T_1 = \frac{156 - 319}{6,24} \times 0,972 = -25,3 \quad T_2 = -6,1$$

$$R_0 = 2,44 \quad \rho = 51 \quad \sin \varphi = 0,777 \quad \cos \varphi = 0,629$$

$$p = 1 \quad l = 25,5$$

$$x = 0$$

$$S = 0,777 \times 25,5 = 19,8 \quad T_1 = 0$$

$$x = 1$$

$$S = 0,777 \times (25,5 - 2) = 18,2 \quad T_1 = \frac{1 - 25,5}{2,44} \times 0,629 = -12,1$$

$$x = 2$$

$$S = 0,777 \times (25,5 - 4) = 16,7 \quad T_1 = -15,6$$

$$x = 4$$

$$S = 0,777 \times (25,5 - 8) = 13,6 \quad T_1 = -25,5$$

$$x = 6$$

$$S = 0,777 \times (25,5 - 12) = 10,5 \quad T_1 = -35,4$$

$$x = 8$$

$$S = 0,777 \times (25,5 - 16) = 7,4 \quad T_1 = -45,3$$

$$x = 10$$

$$S = 0,777 \times (25,5 - 20) = 4,3 \quad T_1 = -55,2$$

$$x = 12$$

$$S = 0,777 \times (25,5 - 24) = 1,2 \quad T_1 = -65,1$$

$$x = 12,75$$

$$S = 0$$

153
36
117

153
36
117

95

$$p = 120 \quad r = 100$$

$S = S + S_n$ para $\varnothing = 0$ y $P = 160$ P (variable)

$$S_1 = 0 + 0 = 0$$

$$S_2 = 160 \times 0,236(25,5) + 2,5 \times 65 \times 0,217 \times 25,5 = 945 + 890 = 1835$$

$$S_3 = 160 \times 0,527 \times 25,5 + 162 \times 25,5 \times 0,223 = 2100 + 1320 = 3420$$

$$S_4 = 4,000 \times 0,777 + 4100 \times 0,194 = 3008 + 795 = 3803$$

$$S_5 = 4,000 \times 0,951 + 4100 \times 0,0285 = 3800 + 117 = 3917$$

$$S_6 = 4,000 \times 1 + 0 = 4000 = 4000$$

$S = S + S_n$ para $\varnothing = 0$ y $P = 120$

$$S_1 = 0$$

$$S_2 = 3060 \times 0,236 + 890 = 720 + 890 = 1610$$

$$S_3 = " \times 0,527 + 1320 = 1610 + 1320 = 2930$$

$$S_4 = " \times 0,777 + 795 = 2360 + 795 = 3155$$

$$S_5 = " \times 0,951 + 117 = 2910 + 117 = 3027$$

$$S_6 = " \times 1 + 0 = 3060 + 0 = 3060$$

$$U = S + S_n \text{ para } p = 160 \text{ } q = 90: \text{ y } x \text{ variable}$$

$$U_1 = 160(25.5 - 0 \times 0) + \cancel{160} 0 = 4000$$

$$U_2 = 160(25.5 - 2 \times 1) + 0 = 3760$$

$$U_3 = 160(25.5 - 2 \times 2) + 0 = 3440$$

$$U_4 = 160(25.5 - 2 \times 4) + 0 = 2800$$

$$U_5 = 160(25.5 - 2 \times 6) + 0 = 2160$$

$$U_6 = 160(25.5 - 2 \times 8) + 0 = 1520$$

$$U_7 = 160(25.5 - 2 \times 10) + 0 = 880$$

$$U_8 = 160(25.5 - 2 \times 12) + 0 = 240$$

$$U_9 = 160(25.5 - 2 \times 12.5) + 0 = 0$$

$$U = S + S_n \text{ para } p = 120 \text{ } q = 90: \text{ y } x \text{ variable}$$

$$0 \ U_1 = 3060$$

$$1 \ U_2 = \cancel{2745}$$

$$2 \ U_3 = 2580$$

$$4 \ U_4 = 2100$$

$$6 \ U_5 = 1620$$

$$8 \ U_6 = 1140$$

$$10 \ U_7 = 660$$

$$12 \ U_8 = 180$$

$$12.5 \ U_9 = 0$$

$$11340$$

$$22680 \text{ Kg}$$

Boveda Central

Dovela Central

$\varphi = 0$

φ	$\frac{p^2 - l^2}{R}$	$p \cos \varphi$	$\frac{5}{2} N (\cos^4 \varphi - 3 \cos^2 \varphi \sin^2 \varphi)$	$\frac{B}{2} \cos \varphi [(n+2)(n+1) \tan^n \varphi - n(n-1) \tan^{n-2} \varphi]$	T_i
0	0	120,0	-326	0	0
13°40'	0	116,5	+119	0	0
31°50'	0	102,0	-12,6	0	0
51°	0	75,4	-98,4	0	0
72°	0	37,1	-40,8	430 x 0,309 (67,9 - 72) = -542	0
90°	0	0	0	0	0

$\varphi = 2$

φ		x	
0	-6,4	x - 206	= +1318
13°40'	-7,5	x + 232	= -1740
31°50'	-12,1	x - 89	= +1076
51°	-19,3	x - 16	= +308
72°	-26,8	x - 546	= +14632
90°	-29,4	x 0	= 0

$\varphi = 4$

-11,7	x - 206	= +2410
-13,7	x + 232	= -2178
-22,1	x - 89	= +1967
-35,3	x - 16	= +565
-49,0	x - 546	= +26754
x 0		= 0

Poveda Central

Valores de S , T_1 y T_2 para distintos valores de R , ρ y φ .

Valores de S

φ	$l-2\rho$	$\rho \operatorname{sen} \varphi$	$162 \operatorname{sen}^3 \varphi \operatorname{sen} \varphi$	$480 [102 \operatorname{sen}^{\overset{M+1}{\varphi}} - 100 \operatorname{sen}^{\overset{n-1}{\varphi}}]$	S
0	25,5	0	0	$480 (0 - 0) = 0$	0
13°40'	"	28,32	35,22	0	1620
31°50'	"	63,00	52,5	0	2945
51°	"	93,00	30,8	0	3157
72°	"	114,50	4,55	$480 (0,638 - 0,691) = -25,4$	2388
90°	"	120,00	0	$480 (102 - 100) = +960,0$	27540