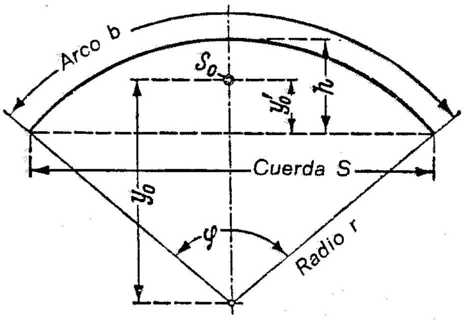
12.3.1.3. Arcos circulares
(ver también cap. 12.6.14.)



$$y_0 = \frac{r\,s}{b};\quad b = r\pi\,\frac{\varphi^\circ}{180^\circ};\quad s = 2\,r\,\text{sen}\,\frac{\varphi}{2};\quad h = r\left(1 - \cos\frac{\varphi}{2}\right).$$

Se obtienen los diferentes valores de y_0, b, s y h, multiplicando los valores de la tabla por el radio correspondiente r; p. e., cuánto vale b para $\varphi = 30^\circ$ (1/12 de circunferencia) y $r = 6\,000$ mm; $b = 0{,}523\,6 \cdot 6\,000 \approx 3\,142$ mm.

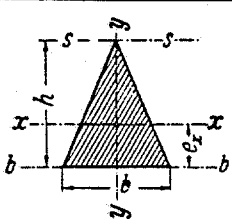
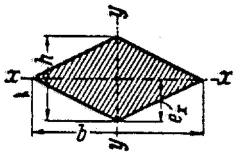
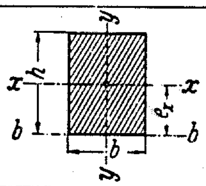
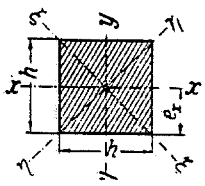
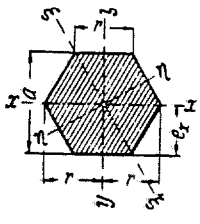
Círculo	φ°	φ^g	b	s	h	y_0
1/2	180	200	3,1416	2,00000	1,00000	0,6366
1/3	120	133 1/3	2,0944	1,73206	0,50000	0,8270
1/4	90	100	1,5708	1,41422	0,29289	0,9003
1/5	72	80	1,2566	1,17558	0,19098	0,9355
1/6	60	66 2/3	1,0472	1,00000	0,13397	0,9549
1/8	45	50	0,7854	0,76536	0,07612	0,9745
1/10	36	40	0,6283	0,61804	0,04894	0,9837
1/12	30	33 1/3	0,5236	0,51764	0,03407	0,9886
1/15	24	26 2/3	0,4189	0,41582	0,02185	0,9926
1/20	18	20	0,3142	0,31286	0,01230	0,9957

para el semicírculo $y_0 = \dfrac{2\,r}{\pi}$

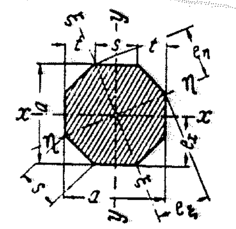
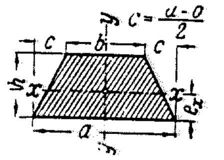
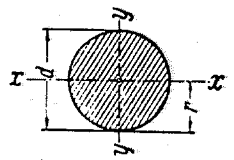
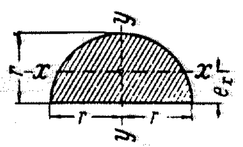
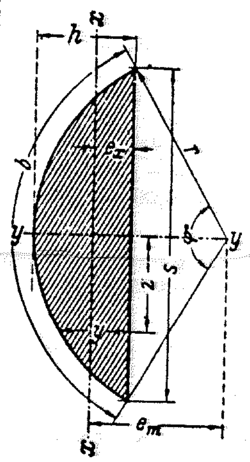
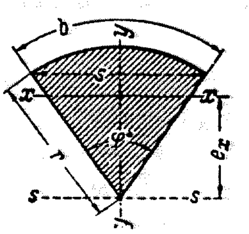
$y_0' = y_0 + h - r$; para arcos circulares rebajados puede hacerse aproximadamente $y_0' = \dfrac{2}{3}\,h$

12.3.2. Superficies

(Áreas, baricentros, momentos resistentes y de inercia y datos complementarios)

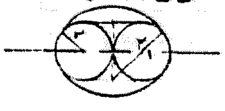
Sección		Área (y otros datos)	Distancia baricéntrica (y otros datos)	Momento de inercia	Momento resistente mínimo
Triángulo		$F = \dfrac{b\,h}{2}$	$e_x = \dfrac{1}{3}\,h$ *(ver también cap. 12.3.2., 5. cont.)*	$J_x = \dfrac{b\,h^3}{36}$; $J_y = \dfrac{h\,b^3}{48}$; $J_b = \dfrac{b\,h^3}{12}$; $J_s = \dfrac{b\,h^3}{4}$	$W_x = \dfrac{b\,h^2}{24}$; $W_y = \dfrac{h\,b^2}{24}$
		En un triángulo **equilátero** resulta $h = 0{,}8660\,b$			
		$F = 0{,}4330\,b^2$	$e_x = 0{,}2887\,b$; $e_y = 0{,}5\,b$	$J_x = J_y = 0{,}01804\,b^4$	$W_x = 0{,}03125\,b^3$; $W_y = 0{,}03608\,b^3$
Rombo		$F = \dfrac{b\,h}{2}$	$e_x = \dfrac{h}{2}$; $e_y = \dfrac{b}{2}$	$J_x = \dfrac{b\,h^3}{48}$; $J_y = \dfrac{h\,b^3}{48}$	$W_x = \dfrac{b\,h^2}{24}$; $W_y = \dfrac{h\,b^2}{24}$
Rectángulo		$F = b\,h$	$e_x = \dfrac{h}{2}$; $e_y = \dfrac{b}{2}$	$J_x = \dfrac{b\,h^3}{12}$; $J_y = \dfrac{h\,b^3}{12}$; $J_b = \dfrac{b\,h^3}{3}$	$W_x = \dfrac{b\,h^2}{6}$; $W_y = \dfrac{h\,b^2}{6}$
Cuadrado	 Polígonos, ver cap. 12.3.2., 5 cont.	$F = h^2$	$e_x = e_y = \dfrac{h}{2}$; $e_\xi = e_\eta = \dfrac{h}{2}\sqrt{2} \approx 0{,}7071\,h$	$J_x = J_y = \dfrac{h^4}{12}$; $J_\xi = J_\eta = \dfrac{h^4}{12}$	$W_x = W_y = \dfrac{h^3}{6}$; $W_\xi = W_\eta = \dfrac{\sqrt{2}}{12}\,h^3 \approx 0{,}1178\,h^3$
Hexágono regular		$F = \dfrac{\sqrt{3}}{2}\,a^2 \approx 0{,}866\,a^2$	$e_x = \dfrac{a}{2} \approx 0{,}866\,r$; $e_y = r$; $a = r\sqrt{3}$; $r = \dfrac{a}{\sqrt{3}}$	$\left.\begin{matrix}J_x = J_y\\ = J_\xi = J_\eta\end{matrix}\right\} = \dfrac{5\sqrt{3}}{144}\,a^4 \approx 0{,}0601\,a^4$	$W_x = W_\xi = \dfrac{5\sqrt{3}}{72}\,a^3 \approx 0{,}1203\,a^3$; $W_y = W_\eta = \dfrac{5}{48}\,a^3 \approx 0{,}1042\,a^3$

1. Continuación: **Superficies**

Sección		Área	Distancia baricéntrica	Momento de inercia	Momento resistente mínimo
		y otros datos			
Octógono regular		$F \approx 0{,}8284\, a^2$	$e_x = e_y = \frac{a}{2}$ $e_\xi = e_\eta = \frac{\sqrt{s^2 + a^2}}{2}$ $\approx 0{,}5412\, a$ $s = \frac{a}{1+\sqrt{2}} \approx 0{,}4142\, a$ $t = \frac{s}{2}\sqrt{2} \approx 0{,}2929\, a$	$J_x = J_y = J_\eta = J_\xi$ $\approx 0{,}05473\, a^4$	$W_x = W_y$ $\approx 0{,}1095\, a^3$ $W_\xi = W_\eta$ $\approx 0{,}10107\, a^3$
Trapecio *)		$F = \frac{h}{2}(a + b)$	$e_x = \frac{h}{3}\,\frac{a+2b}{a+b}$	$J_x = \frac{h^3}{36}\,\frac{a^2 + 4ab + b^2}{a+b}$ $J_y =$ $\frac{h}{48}\left(a^3 + a^2 b + a b^2 + b^3\right)$	$W_x = \frac{J_x}{h - e_x}$ $W_y = \frac{2 J_y}{a}$
Círculo		$F = \pi r^2 = \frac{\pi d^2}{4}$ U = perímetro $= d\pi$ (ver tabla 12.8.5.3.)	$e_x = \frac{d}{2}$	$J_x = J_y = \frac{\pi d^4}{64} = \frac{\pi r^4}{4}$ $\approx 0{,}05\, d^4 \approx 0{,}7854\, r^4$	$W_x = W_y$ $= \frac{\pi d^3}{32} = \frac{\pi r^3}{4}$ $\approx 0{,}1\, d^3 \approx 0{,}7854\, r^3$
Semicírculo		$F = \frac{\pi}{2} r^2 = 1{,}57080\, r^2$	$e_x = \frac{4r}{3\pi} \approx 0{,}4244\, r$	$J_x = r^4\left(\frac{\pi}{8} - \frac{8}{9\pi}\right)$ $\approx 0{,}1098\, r^4$ $J_y = \frac{\pi r^4}{8} \approx 0{,}3297\, r^4$	$W_x \approx 0{,}1907\, r^3$ $W_y = \frac{\pi r^3}{8}$ $\approx 0{,}3927\, r^3$
Segmento circular		$F = \frac{r^2}{2}\left(\frac{\pi \varphi^0}{180^\circ} - \mathrm{sen}\,\varphi\right)$ $= \frac{r(b-s) + s h}{2}$ $r = \frac{s^2}{8h} + \frac{h}{2}$ Long. arco $b = r\pi\,\frac{\varphi^0}{180^\circ}$ $= 0{,}01745\, r\, \varphi^\circ$ $\tan\frac{\varphi}{2} = \frac{s}{2(r-h)}$	$e_m = \frac{s^3}{12 F}$ $= \frac{2}{3}\,\frac{r^3 \mathrm{sen}^3 \frac{\varphi}{2}}{F}$ $e_x = e_m - r\cos\frac{\varphi}{2}$ Long. de la cuerda $s = 2 r \,\mathrm{sen}\frac{\varphi}{2}$ $= 2\sqrt{h(2r - h)}$ $h = r\left(1 - \cos\frac{\varphi}{2}\right)$ $= r - \sqrt{r^2 - \left(\frac{s}{2}\right)^2}$ Ordenadas $y = \sqrt{r^2 - z^2} - (r - h)$	$J_x = \frac{r^4}{16}\left(\frac{\pi\varphi^0}{90^0} - \mathrm{sen}\,2\varphi\right)$ $- \frac{20\, r^4 (1 - \cos\varphi)^3}{\pi\varphi^\circ - 180^0 \mathrm{sen}\,\varphi}$ $J_y = \frac{r^4}{48}\left(\frac{\pi\varphi^\circ}{30^0} - A\right)$ $A = 8\,\mathrm{sen}\,\varphi - \mathrm{sen}\,2\varphi$ (tener en cuenta el signo de los valores del seno)	$W_x = \frac{J_x}{h - e_x}$ $W_y = \frac{2 J_y}{s}$
		Para $h = 1/2\, r$, a saber φ 120°, resulta			
		$F \approx 0{,}61418\, r^2$	$e_x \approx 0{,}2050\, r$	$J_x \approx 0{,}01066\, r^4$	$W_x \approx 0{,}03613\, r^3$
Sector circular		$F = \frac{b\, r}{2} = \frac{\varphi^0}{360^0}\, r^2 \pi$ b = Long. del arco $= r\pi\,\frac{\varphi^0}{180^0}$ $\approx 0{,}01745\, r\,\varphi^\circ$ $\varphi^\circ = \frac{180^\circ}{\pi}\,\frac{b}{r}$	$e_x = \frac{2}{3}\, r\, \frac{s}{b}$ $= \frac{2}{3}\,\mathrm{sen}\frac{\varphi}{2}\,\frac{360^\circ r}{\varphi^0 \pi}$ $= \frac{r^2 s}{3 F}$	$J_x = J_s - \frac{360^\circ}{\varphi^\circ \pi}\mathrm{sen}^2\frac{\varphi}{2}\,\frac{4 r^4}{9}$ $J_y = \frac{r^4}{8}\left[\pi\frac{\varphi^0}{180^\circ} - \mathrm{sen}\,\varphi\right]$ $J_s = \frac{r^4}{8}\left[\pi\frac{\varphi^0}{180^\circ} + \mathrm{sen}\,\varphi\right]$	$W_{x_o} = \frac{J_x}{r - e_x}$; $W_{x_u} = \frac{J_x}{e_x}$ $W_y = \frac{2}{s} J_y$

*) *Ver también cap. 12.3.2. (5. Cont.)* y *12.6.13.* y SAAL: Genaeue Bestimmung des Schwerpunktes im unregelmässigen Viereck, *Bautechn. 1957, C. 4, pág. 154.*

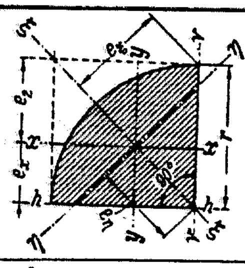
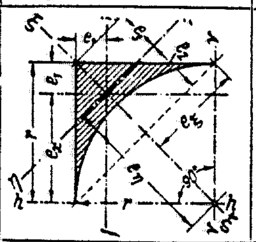
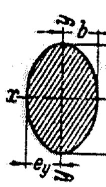
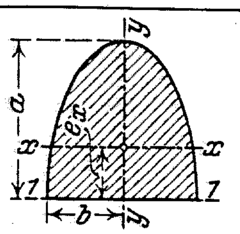
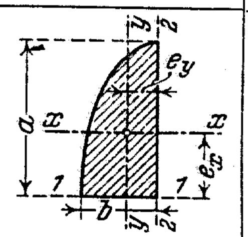
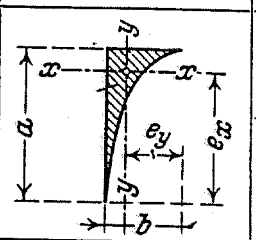
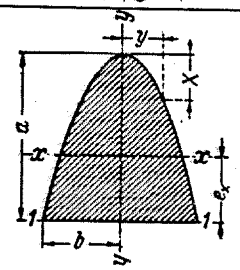
OVALO



F= 8.72607·r² r_1 = 2.4142135 r

P= 10.72607·r   a = 2r ; b = r√2

2. Continuación : **Superficies**

Sección	Área	Distancia baricéntrica y otros datos	Momento de inercia	Momento resistente mínimo
Cuadrante circular 	$F = \frac{\pi}{4} r^2 \approx 0{,}7854\, r^2$	$e_x \approx 0{,}4244\, r$ $e_2 \approx 0{,}5756\, r$ $e_\eta \approx 0{,}6002\, r$ $e_\xi \approx 0{,}7071\, r$	$J_x = J_y \approx 0{,}05488\, r^4$ $J_h = J_v \approx 0{,}1963\, r^4$ $J_\xi \approx 0{,}07135\, r^4$ $J_\eta \approx 0{,}03841\, r^4$ Momentos centrífugos $J_{rv} \approx 0{,}01647\, r^4$ $J_{hv} = \frac{r^4}{8}$	$W_x = W_y \approx 0{,}09534\, r^3$ — $W_\xi \approx 0{,}1009\, r^3$ $W_\eta \approx 0{,}06399\, r^3$
Triángulo cóncavo circular  ∢ ángulos diferentes de 90° *ver cap. 12. 6. 1.*	$F = r^2 \left(1 - \frac{\pi}{4}\right)$ $\approx 0{,}2146\, r^2$	$e_1 \approx 0{,}2234\, r$ $e_x \approx 0{,}7766\, r$ $e_\eta \approx 1{,}0983\, r$ $e_\xi \approx 0{,}7071\, r$ $e_3 \approx 0{,}3159\, r$ $e_2 \approx 0{,}3912\, r$	$J_x = J_y \approx 0{,}00755\, r^4$ $J_h = J_v \approx 0{,}1370\, r^4$ $J_\xi \approx 0{,}011984\, r^4$ $J_\eta \approx 0{,}003105\, r^4$ Momentos centrífugos $J_{xy} \approx 0{,}00444\, r^4$ $J_{hv} = \frac{r^4}{8} = 0{,}125\, r^4$	$W_x = W_y \approx 0{,}00972\, r^3$ — $W_\xi \approx 0{,}016950\, r^3$ $W_\eta \approx 0{,}007937\, r^3$
Ellipse [1]  Const. ver cap. 12.7.7.	$F = a\, b\, \pi$	$e_x = a;\ e_y = b$	$J_x = \frac{\pi}{4} b\, a^3 \approx 0{,}7854\, b\, a^3$ $J_y = \frac{\pi}{4} a\, b^3 \approx 0{,}7854\, a\, b^3$	$W_x = \frac{\pi}{4} b a^2 \approx 0{,}7854\, b\, a^2$ $W_y = \frac{\pi}{4} a\, b^2 \approx 0{,}7854\, a\, b^2$
Semielipse 	$F = \frac{\pi}{2} a\, b \approx 1{,}571\, a\, b$	$e_x = \frac{4}{3\pi} a \approx 0{,}4244\, a$	$J_x \approx 0{,}1098\, b\, a^3$ $J_y = \frac{\pi}{8} a\, b^3 \approx 0{,}3927\, a\, b^3$ $J_1 = \frac{\pi}{8} b\, a^3 \approx 0{,}3927 b\, a^3$	$W_x = \frac{J_x}{a - e_x}$ $\approx 0{,}1907\, b\, a^2$ $W_y = \frac{\pi}{8} a\, b^2$ $\approx 0{,}3927\, a\, b^2$ —
Cuadrante de elipse 	$F = \frac{\pi}{4} a\, b \approx 0{,}7854\, a\, b$	$e_x = \frac{4}{3\pi} a \approx 0{,}4244\, a$ $e_y = \frac{4}{3\pi} b \approx 0{,}4244\, b$	$J_x \approx 0{,}05488\, b\, a^3$ $J_y \approx 0{,}05488\, a\, b^3$ $J_1 \approx 0{,}1963\, b\, a^3$ $J_2 \approx 0{,}1963\, a\, b^3$	$W_x = \frac{J_x}{a - e_x}$ $\approx 0{,}09534\, b\, a^2$ $W_y = \frac{J_y}{b - e_y}$ $\approx 0{,}09534\, a\, b^2$ — —
Triángulo cóncavo elíptico 	$F = \left(1 - \frac{\pi}{4}\right) a\, b$ $\approx 0{,}2146\, a\, b$	$e_x \approx 0{,}7766\, a$ $e_y \approx 0{,}7766\, b$	$J_x \approx 0{,}00755\, b\, a^3$ $J_y \approx 0{,}00755\, a\, b^3$	$W_x = \frac{J_x}{e_x} \approx 0{,}00972\, b\, a^2$ $W_y = \frac{J_y}{e_y} \approx 0{,}00972\, a\, b^2$
Parábola  Const., *ver cap. 12.7.9.*	$F = \frac{4}{3} a\, b$	$e_x = \frac{2}{5} a$	$J_x = \frac{16}{175} b\, a^3$ $= 0{,}09143\, b\, a^3$ $J_y = \frac{4}{15} a\, b^3$ $= 0{,}2666\, a\, b^3$ $J_1 = \frac{32}{105} b\, a^3$ $= 0{,}3048\, b\, a^3$	$W_x = \frac{16}{105} b\, a^2$ $= 0{,}1524\, b\, a^2$ $W_y = \frac{4}{15} a\, b^2$ $= 0{,}2666\, a\, b^2$ —

Ellipse — Perímetro $U = \mu\,(a + b)$:

$\frac{a-b}{a+b}$	0,10	0,20	0,30	0,40	0,50	0,60	0,70	0,80	0,90
$\mu =$	3,1495	3,1731	3,2127	3,2686	3,3412	3,4314	3,5401	3,6691	3,8208

Parábola:

Perímetro $U = 2\, b$ + longitud del arco
Longitud del arco

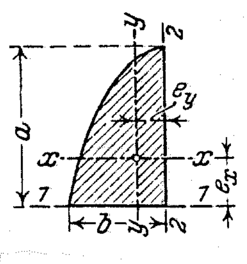
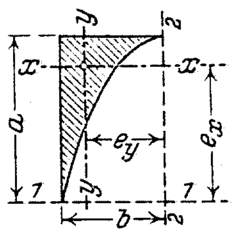
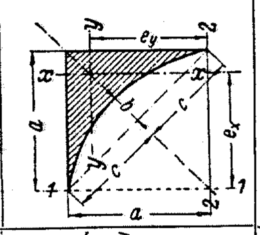
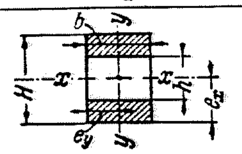
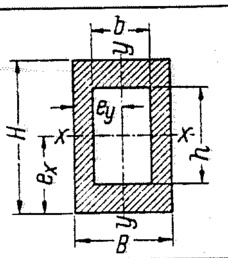
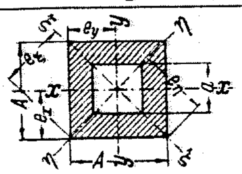
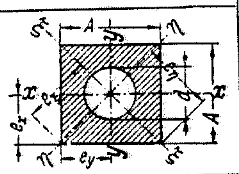
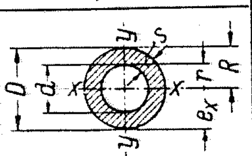
$$p \left[\frac{b}{p^2} \sqrt{p^2 + b^2} + \ln\left(b + \sqrt{p^2 + b^2}\right) - \ln p \right],$$

en donde $2\,p$ es el parám., x e y las orden. (Ec. de la parábola) $y^2 = 2\,px$.
Fórmula aprox. para la paráb. rebajada:

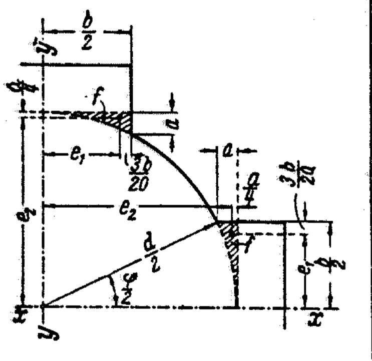
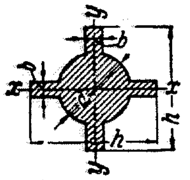
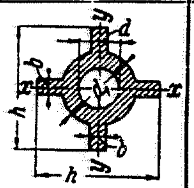
Long. del arco $\approx 2\,b \left[1 + \frac{2}{3}\alpha^2 - \frac{2}{5}\alpha^4\right]$, en donde $\alpha = \frac{a}{b}$

[1]) *A este respecto ver cap. 12.7.7. y* MEINCKE : Näherung für den Umfang der Ellipse, *Bauing. 1960, C. 2 pág. 52:* GOLDBERGER : Näherungskonstruktion der Ellipse, *VDJ-Z. 1959, C. 26, pág. 1236.*

3. Continuación: **Superficies**

Sección		Área	Distancia baricéntrica	Momento de inercia	Momento resistente mínimo
		y otros datos			
Semiparábola		$F = \frac{2}{3} a b$	$e_x = \frac{2}{5} a$ $e_y = \frac{3}{8} b$	$J_x = \frac{8}{175} b a^3$ $\approx 0{,}04571\ b a^3$ $J_y = \frac{19}{480} a b^3$ $\approx 0{,}03958\ a b^3$ $J_1 = \frac{16}{105} b a^3$ $\approx 0{,}1524\ b a^3$ $J_2 = \frac{2}{15} a b^3$ $\approx 0{,}1333\ a b^3$	$W_x = \frac{8}{105} b a^2$ $\approx 0{,}07619\ b a^2$ $W_y = \frac{19}{300} a b^2$ $\approx 0{,}06333\ a b^2$ — —
Triángulo cóncavo semiparabólico		$F = \frac{1}{3} a b$	$e_x = \frac{7}{10} a$ $e_y = \frac{3}{4} b$	$J_x = \frac{37}{2\,100} b a^3$ $\approx 0{,}01762\ b a^3$ $J_y = \frac{1}{80} a b^3$ $= 0{,}01250\ a b^3$ $J_1 = \frac{19}{105} b a^3$ $\approx 0{,}1810\ b a^3$ $J_2 = \frac{1}{5} a b^3$	$W_x = \frac{37}{1\,470} b a^2$ $\approx 0{,}02517\ b a^2$ $W_y = \frac{1}{60} a b^2$ $\approx 0{,}01667\ a b^2$ — —
Triángulo cóncavo parabólico	en este caso: $b = c/2$ 	$F = \frac{1}{6} a^2$	$e_x = e_y = \frac{4}{5} a$ $c = \frac{\sqrt{2}}{2} a \approx 0{,}7071\ a$	$J_x = J_y = \frac{11}{2\,100} a^4$ $\approx 0{,}00524\ a^4$ $J_1 = J_2 = \frac{47}{420} a^4$ $\approx 0{,}1119\ a^4$	$W_x = W_y = \frac{11}{1\,680} a^3$ $\approx 0{,}00655\ a^3$ —
Rectángulo (incompleto)		$F = b(H - h)$	$e_x = \frac{H}{2}$ $e_y = \frac{b}{2}$	$J_x = \frac{b}{12}(H^3 - h^3)$ $J_y = \frac{b^3}{12}(H - h)$	$W_x = \frac{b}{6H}(H^3 - h^3)$ $W_y = \frac{b^2}{6}(H - h)$
Rectángulo hueco		$F = BH - bh$	$e_x = \frac{H}{2}$ $e_y = \frac{B}{2}$	$J_x = \frac{1}{12}(BH^3 - bh^3)$ $J_y = \frac{1}{12}(HB^3 - hb^3)$	$W_x = \frac{1}{6H}(BH^3 - bh^3)$ $W_y = \frac{1}{6B}(HB^3 - hb^3)$
Cuadrado hueco		$F = A^2 - a^2$	$e_x = e_y = \frac{A}{2}$ $e_\xi = e_\eta \approx 0{,}7071\ A$	$J_x = J_y = J_\xi = J_\eta$ $= \frac{A^4 - a^4}{12}$	$W_x = W_y = \frac{1}{6} \frac{A^4 - a^4}{A}$ $W_\xi = W_\eta = \frac{\sqrt{2}}{12} \frac{A^4 - a^4}{A}$ $\approx 0{,}11785 \frac{A^4 - a^4}{A}$
		$F = A^2 - \frac{\pi d^2}{4}$	$e_x = e_y = \frac{A}{2}$ $e_\xi = e_\eta \approx 0{,}7071\ A$	$J_x = J_y = J_\xi = J_\eta$ $= \frac{1}{12}\left(A^4 - \frac{3\pi}{16} d^4\right)$	$W_x = W_y$ $= \frac{1}{6A}\left(A^4 - \frac{3\pi}{16} d^4\right)$ $W_\xi = W_\eta \approx \frac{J_\xi}{0{,}7071\ A}$
Corona circular		$F = \frac{\pi}{4}(D^2 - d^2)$ $= \pi s (D - s)$	$e_x = e_y = \frac{D}{2}$	$J_x = J_y$: $= \frac{\pi}{64}(D^4 - d^4)$ $= \frac{\pi}{4}(R^4 - r^4)$	$W_x = W_y$: $= \frac{\pi}{32} \frac{D^4 - d^4}{D}$ $= \frac{\pi}{4} \frac{R^4 - r^4}{R}$

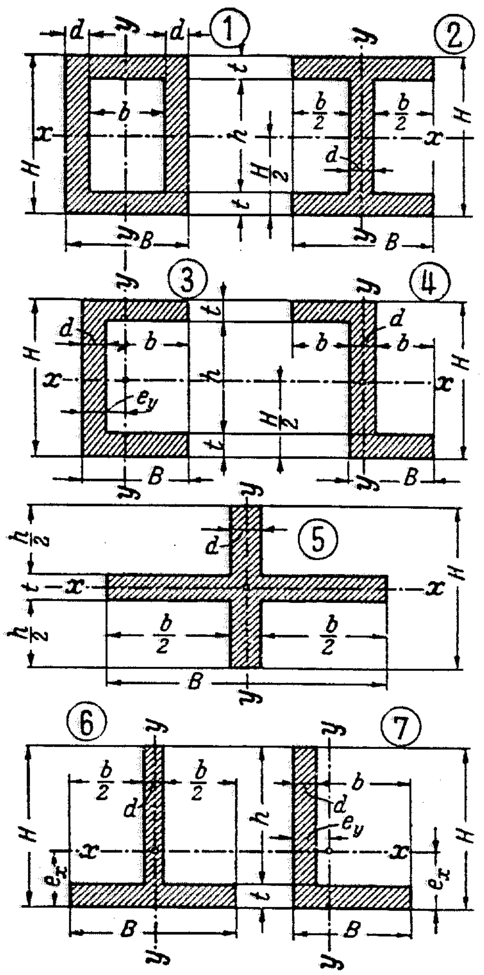
4. Continuación : **Superficies**

Sección		Áreas, momentos de inercia, y otros datos	Momento resistente mínimo
		$F = 2b(h-d) + \frac{\pi d^2}{4}$ $J_x = J_y$ $= \frac{1}{12}\left[\frac{3\pi}{16} d^4 + b(h^3 - d^3) + b^3(h-d)\right]$	$W_x = W_y$ $= \frac{2J_x}{h}$
		$F = 2b(h-d_1) + \frac{\pi}{4}(d_1^2 - d^2)$ $J_x = J_y =$ $\frac{1}{12}\left[\frac{3\pi}{16}(d_1^4 - d^4) + b(h^3 - d_1^3) + b^3(h-d_1)\right]$	$W_x = W_y$ $= \frac{2J_x}{h}$

En las fórmulas anteriores no se tienen en cuenta los 8 elementos de superficie f ; sus **incrementos** a F y J valen :

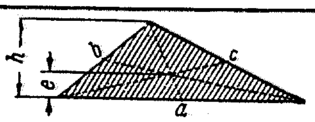
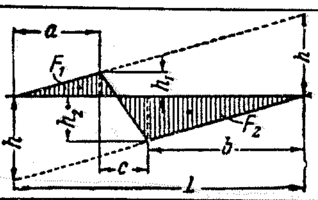
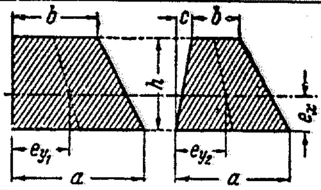
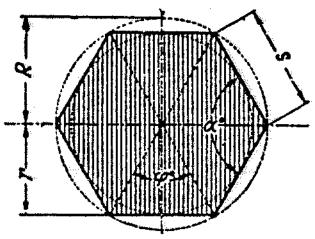
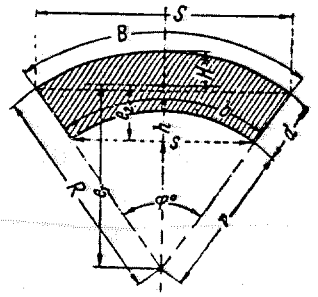
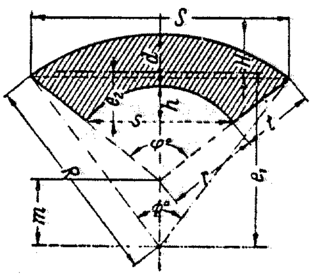
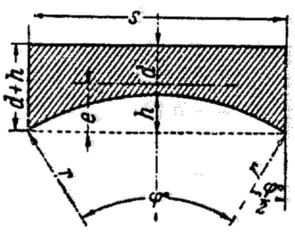
$$F_z = 4\left[a\,b - \frac{d^2}{8}\left(\frac{\varphi^\circ \pi}{180^\circ} - \text{sen}\varphi^\circ\right)\right], \quad J_z = \frac{F_z}{2}(e_1^2 + e_2^2), \ldots\ldots\ldots$$

en donde $a = \frac{1}{2}\left(d - \sqrt{d^2 - b^2}\right)$; $\text{sen}\,\frac{\varphi^\circ}{2} = \frac{b}{d}$; $e_1 = \frac{7}{20}b$; $e_2 = \frac{d}{2} - \frac{a}{4}$.



Para la sección 1 a 7 : $F = BH - bh$		
Para la sección :		
1 a 4	$J_x = \frac{1}{12}(BH^3 - bh^3)$	$W_x = \frac{2J_x}{H}$
1	$J_y = \frac{1}{12}(HB^3 - hb^3)$	$W_y = \frac{2J_y}{B}$
2	$J_y = \frac{1}{12}(2tB^3 + hd^3)$	$W_y = \frac{2J_y}{B}$
3	$J_y = \frac{1}{3}(2tB^3 + hd^3) - (2tB + dh)e_y^2$ $e_y = \frac{1}{2}\frac{2tB^2 + hd^2}{2tB + hd}$	$W_y = \frac{J_y}{B - e_y}$
4	$J_y = \frac{1}{12}\left[(2B - d)^3 t + (h + t)d^3\right]$	$W_y = \frac{2J_y}{2B - d}$
5	$J_x = \frac{1}{12}(dH^3 + bt^3)$ $J_y = \frac{1}{12}(tB^3 + hd^3)$	$W_x = \frac{2J_x}{H}$ $W_y = \frac{2J_y}{B}$
6	$J_x = \frac{1}{3}(dH^3 + bt^3) - (dH + bt)e_x^2$ $e_x = \frac{1}{2}\frac{dH^2 + bt^2}{dH + bt}$ $J_y = \frac{1}{12}(tB^3 + hd^3)$	$W_x = \frac{J_x}{H - e_x}$ $W_y = \frac{2J_y}{B}$
7	$J_x = \frac{1}{3}(dH^3 + bt^3) - (dH + bt)e_x^2$ $e_x = \frac{1}{2}\frac{dH^2 + bt^2}{dH + bt}$ $J_y = \frac{1}{3}(hd^3 + tB^3) - (dH + bt)e_y^2$ $e_y = \frac{1}{2}\frac{tB^2 + hd^2}{tB + hd}$	$W_x = \frac{J_x}{H - e_x}$ $W_y = \frac{J_y}{B - e_y}$

5. Continuación: **Superficies**

	Sección	Área	Distancia baricéntrica y otros datos
Triángulo	 a, b, c = long. de los lados h = altura normal al lado a	$F = \frac{ah}{2} = \frac{ab\,\mathrm{sen}\,\gamma}{2}$ $= \sqrt{s(s-a)(s-b)(s-c)}$ $s = \frac{a+b+c}{2}$.	$e = \frac{h}{3}$ El baricentro se encuentra en el punto de corte de las medianas que unen los vértices con el centro del lado opuesto
Superficie de influencia		$F_1 = \frac{h}{2}\frac{a^2}{a+b}$ $F_2 = \frac{h}{2}\frac{b^2}{a+b}$ $F_2 - F_1 = \frac{h}{2}(b-a)$	Situación del centro de gravedad para cada una de las superficies ver « triángulo ». $h_1 = \frac{ah}{l}$; $h_2 = \frac{bh}{l}$, en donde $l = a + b + c$
Trapecio *(ver también 12.3.2. 1. cont.)*		$F = \frac{h}{2}(a+b)$	$e_x = \frac{h}{3}\frac{a+2b}{a+b}$ $e_{y_1} = \frac{1}{3}\frac{a^2+ab+b^2}{a+b}$ $e_{y_2} = \frac{1}{3}\left(a+b+c-b\frac{a-c}{a+b}\right)$ Solución gráfica, *ver caps. 12.7.2 y 12.7.3*
Polígono regular		$F = \frac{ns^2}{4}\cot\frac{\varphi}{2}$ $= \frac{nR^2}{2}\mathrm{sen}\,\varphi$ $= nr^2\tan\frac{\varphi}{2}$ (n = número de lados ≥ 3)	$R = \frac{r}{\cos\frac{180°}{n}} = \frac{s}{2\,\mathrm{sen}\frac{180°}{n}}$; $\varphi° = \frac{360°}{n}$ $r = R\cos\frac{180°}{n} = \frac{s}{2}\cot\frac{180°}{n}$; $\alpha° = 180° - \varphi°$ $s = 2R\,\mathrm{sen}\frac{180°}{n} = 2\sqrt{R^2 - r^2}$
		Momento de inercia respecto a cada eje baricéntrico $= \frac{F}{24}(6R^2 - s^2)$	
Formas curvas		$F = \frac{\varphi°\pi}{360°}(R^2 - r^2)$ $= \frac{\varphi°\pi}{180°}R_m d = \frac{1}{2}(RB - rb)$	$e_1 = \frac{2}{3}\frac{R^3 - r^3}{R^2 - r^2}\mathrm{sen}\frac{\varphi}{2}\frac{360°}{\varphi°\pi}$ $e_2 = e_1 - r + h$
		en donde	
		Radio medio $R_m = \frac{R+r}{2}$; $R = \frac{S^2}{8H} + \frac{H}{2}$; $r = \frac{s^2}{8h} + \frac{h}{2}$ $B = \pi R\frac{\varphi°}{180°}$; $b = \pi r\frac{\varphi°}{180°}$ $S = 2R\,\mathrm{sen}\frac{\varphi}{2}$; $s = 2r\,\mathrm{sen}\frac{\varphi}{2}$; $H = R - R\cos\frac{\varphi}{2}$; $h = r - r\cos\frac{\varphi}{2}$	
		$F = \frac{\pi}{360°}(R^2\Phi° - r^2\varphi°) - \frac{1}{2}mS$	$e_1 = \frac{120(SR^2 - sr^2) - 60Sm(R+m-H) - \pi\varphi m r^2}{360°\,F}$ $e_2 = e_1 - m - r + h$
		en donde	
		$R = \frac{S^2}{8H} + \frac{H}{2}$; $r = \frac{s^2}{8h} + \frac{h}{2}$; $S = s + 2t\cos\alpha = 2\sqrt{H(2R-H)}$ $\mathrm{sen}\frac{\Phi}{2} = \frac{S}{2R}$; $\mathrm{sen}\frac{\varphi}{2} = \frac{s}{2r}$; $s = 2r\,\mathrm{sen}\frac{\varphi}{2} = 2\sqrt{h(2r-h)}$ $m = R - d - r$; $\cos\alpha = \frac{S}{2r}$; $H = h + d - t\,\mathrm{sen}\,\alpha = R - R\cos\frac{\Phi}{2}$; $h = r - r\cos\frac{\varphi}{2}$	
		$F = s(d+h) - \frac{r^2}{2}\left(\frac{\varphi°\pi}{180°} - \mathrm{sen}\,\varphi\right)$	$e = \frac{s(d+h)^2 - 2F_1e_1}{2F}$
		en donde	
		$s = 2r\,\mathrm{sen}\frac{\varphi}{2} = 2\sqrt{h(2r-h)}$; $h = r - r\cos\frac{\varphi}{2}$; $r = \frac{s^2}{8h} + \frac{h}{2}$; $\mathrm{sen}\frac{\varphi}{2} = \frac{s}{2r}$ $F_1 = \frac{r^2}{2}\left(\frac{\varphi°\pi}{180°} - \mathrm{sen}\,\varphi\right)$; $e_1 = \frac{2}{3}\frac{r^3\,\mathrm{sen}\frac{\varphi}{2}}{F_1} - r + h$; F = Superficie de la sección	