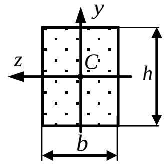
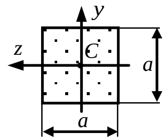
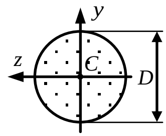
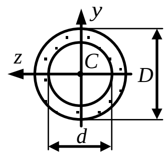
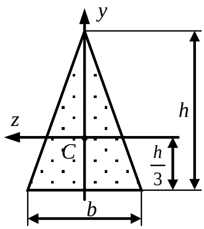
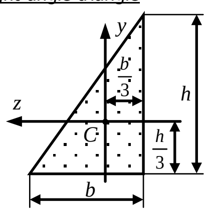
Geometrical properties of simple planar shapes

Figure	Area	Inertial properties	Section modulus properties
Rectangle 	$A = bh$	$I_y = \frac{b^3 h}{12}$ $I_z = \frac{bh^3}{12}$	$S_y = \frac{b^2 h}{6}$ $S_z = \frac{bh^2}{6}$
Square 	$A = a^2$	$I_y = I_z = \frac{a^4}{12}$ $I_t = 0{,}1406\, a^4$	$S_y = S_z = \frac{a^3}{6}$ $S_t = 0{,}208\, a^3$
Circle 	$A = \frac{\pi D^2}{4}$	$I_y = I_z = \frac{\pi D^4}{64}$ $I_C = \frac{\pi D^4}{32}$	$S_y = S_z = \frac{\pi D^3}{32}$ $S_C = \frac{\pi D^3}{16}$
Ring 	$A = \frac{\pi}{4}(D^2 - d^2)$	$I_y = I_z = \frac{\pi D^4}{64}(1-\alpha^4)$ $I_C = \frac{\pi D^4}{32}(1-\alpha^4)$ $\alpha = \frac{d}{D}$	$S_y = S_z = \frac{\pi D^3}{32}(1-\alpha^4)$ $S_C = \frac{\pi D^3}{16}(1-\alpha^4)$ $\alpha = \frac{d}{D}$
Isosceles triangle 	$A = \frac{bh}{2}$	$I_y = \frac{b^3 h}{36}$ $I_z = \frac{bh^3}{48}$	$S_y = \frac{b^2 h}{24}$ $S_z = \frac{bh^2}{24}$
Right-angle triangle 	$A = \frac{bh}{2}$	$I_y = \frac{b^3 h}{36}$ $I_z = \frac{bh^3}{36}$ $I_{yz} = -\frac{b^2 h^2}{72}$	not applicable

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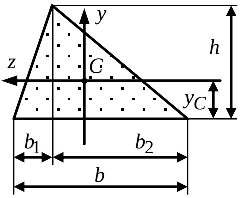
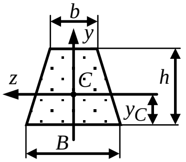
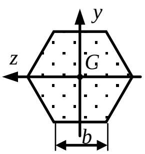
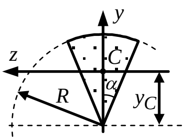
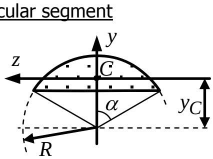
Triangle  $y_C = h/3$	$A = \frac{bh}{2}$	$I_y = \frac{bh}{36}(b^2 - b_1 b_2)$ $I_z = \frac{bh^3}{36}$ $I_{yz} = \frac{bh^2}{72}(b_1 - b_2)$	not applicable
Isosceles trapezoid  $y_C = \frac{B+2b}{3(B+b)}h$	$A = \frac{(B+b)h}{2}$	$I_y = \frac{h(B+b)(B^2+b^2)}{48}$ $I_z = \frac{h^3(B^2+4Bb+b^2)}{36(B+b)}$	$S_y = \frac{h(B+b)(B^2+b^2)}{24B}$ $S_z = \frac{h^2(B^2+4Bb+b^2)}{12(2B+b)}$
Hexagon  	$A = \frac{3\sqrt{3}}{2}b^2$	$I_y = I_z = \frac{5\sqrt{3}}{16}b^4$ $I_t = 1{,}0306 b^4$	$S_y = \frac{5\sqrt{3}}{16}b^3$ $S_z = \frac{5}{8}b^3$ $S_t = 0{,}981 b^3$
Circular sector  $y_C = \frac{2}{3}\frac{\sin\alpha}{\alpha}R$	$A = R^2\alpha$ α is in radians!	$I_y = \frac{\alpha R^4}{4}(1 - \frac{\sin 2\alpha}{2\alpha})$ $I_z = \frac{\alpha R^4}{4}(1 + \frac{\sin 2\alpha}{2\alpha} -$ $- \frac{16}{9}\frac{\sin^2\alpha}{\alpha^2})$	$S_y = \frac{\alpha R^3}{4\sin\alpha}(1 - \frac{\sin 2\alpha}{2\alpha})$ $S_z = \frac{3\alpha}{2R\sin\alpha}I_z$
Circular segment  $y_C = \frac{4}{3}R\frac{\sin^3\alpha}{2\alpha - \sin 2\alpha}$	$A = \frac{R^2}{2}(2\alpha -$ $- \sin 2\alpha)$ α is in radians!	$I_y = \frac{R^4}{48}(12\alpha - 8\sin 2\alpha +$ $+ \sin 4\alpha)$ $I_z = \frac{R^4}{16}(4\alpha - \sin 4\alpha) -$ $- \frac{8}{9}R^4\frac{\sin^6\alpha}{2\alpha - \sin 2\alpha}$	$S_y = \frac{I_z}{R\sin\alpha}$ $S_z = \frac{I_y}{R - z_C}$

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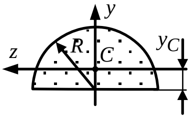
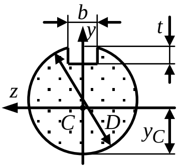
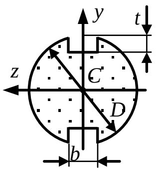
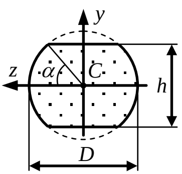
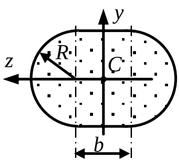
Semicircle  $y_C = \frac{4}{3\pi}R$	$A = \frac{\pi R^2}{2}$	$I_y = R^4\frac{\pi}{8} \approx 0{,}3927R^4$ $I_z = R^4(\frac{\pi}{8} - \frac{8}{9\pi}) \approx 0{,}1098R^4$	$S_y = R^3\frac{\pi}{8} \approx 0{,}3927R^3$ $S_z = \frac{R^3(9\pi^2 - 64)}{24(3\pi - 4)} \approx$ $\approx 0{,}1908R^3$
Circle with parallel key  $y_C \approx \frac{D}{2} - \frac{2Dbt - 2bt^2}{\pi D^2 - 4bt}$	$A = \frac{\pi D^2}{4} - bt$	$I_y \approx \frac{\pi D^4}{64} - \frac{b^3t}{12}$ $I_z \approx \frac{\pi D^4}{64} - \frac{bt(D-t)^2}{4}$ $I_t \approx \frac{\pi D^4}{32} - \frac{bt(D-t)^2}{4}$	$S_y \approx \frac{\pi D^3}{32} - \frac{b^3t}{6D}$ $S_z \approx \frac{\pi D^3}{32} - \frac{bt(D-t)^2}{2D}$ $S_t \approx \frac{\pi D^3}{16} - \frac{bt(D-t)^2}{2D}$
Circle with two parallel keys  	$A = \frac{\pi D^2}{4} - 2bt$	$I_y \approx \frac{\pi D^4}{64} - \frac{b^3t}{6}$ $I_z \approx \frac{\pi D^4}{64} - \frac{bt(D-t)^2}{2}$ $I_t \approx \frac{\pi D^4}{32} - \frac{bt(D-t)^2}{2}$	$S_y \approx \frac{\pi D^3}{32} - \frac{b^3t}{3D}$ $S_z \approx \frac{\pi D^3}{32} - \frac{bt(D-t)^2}{D}$ $S_t \approx \frac{\pi D^3}{16} - \frac{bt(D-t)^2}{D}$
Double oblique circle  	$A = \frac{D^2}{4}(\pi -$ $-2\alpha + \sin 2\alpha)$ α is in radians!	$I_y = \frac{D^4}{32}(\alpha + \frac{\sin 2\alpha}{2} +$ $+ \frac{\sin 2\alpha \cos^2\alpha}{3})$ $I_z = \frac{D^4}{32}(\alpha - \frac{\sin 4\alpha}{4})$	$S_y = \frac{D^3}{16}(\alpha + \frac{\sin 2\alpha}{2} +$ $+ \frac{\sin 2\alpha \cos^2\alpha}{3})$ $S_z = \frac{D^3}{16\sin\alpha}(\alpha - \frac{\sin 4\alpha}{4})$
Oval  	$A = 2Rb + \pi R^2$	$I_y = \frac{b^3R}{6} + \frac{9\pi^2 - 64}{36\pi}R^4 +$ $+ \pi R^2(\frac{b}{2} + \frac{4}{3\pi}R)^2$ $I_z = \frac{R^3}{4}(\pi R + \frac{8b}{3})$	$S_y = \frac{I_z}{R + 0{,}5b}$ $S_z = \frac{R^2}{4}(\pi R + \frac{8b}{3})$

** Symbols are given in page 4.*

LIST OF SYMBOLS

h - height;
b - width;
A - area;
$\mathbf{I_y}$, $\mathbf{I_z}$ - second moments of inertia;
$\mathbf{I_{yz}}$ - product of inertia;
$\mathbf{S_y}$, $\mathbf{S_z}$ - section modulus;