Appendix 3 Properties of Area

A-3-1. Useful equations

Area: $A = \int y\,dx = \int x\,dy$

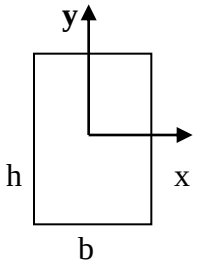
Second moment of area $I_x = \int y^2 dA \quad I_y = \int x^2 dA$

Polar second moment of area $J = \int r^2 dA = I_x + I_y$

Section modulus $W_x = \frac{I_x}{c};\ W_y = \frac{I_y}{c} \qquad W = \frac{J}{c}$

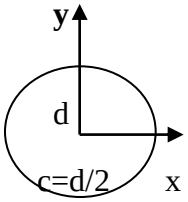
A-2-2. Useful formulas

Rectangular cross section



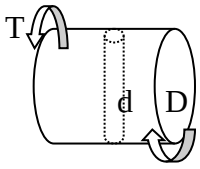
$I_x = \frac{bh^3}{12} \qquad I_y = \frac{b^3 h}{12}$

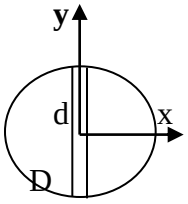
Circular cross section



$I_x = \frac{\pi d^4}{64} = I_y \quad W_x = \frac{I_x}{c} = \frac{\pi d^3}{32} \qquad J = \frac{\pi d^4}{32} \qquad \frac{J}{c} = \frac{\pi d^3}{16}$

Cylinder with a through hole

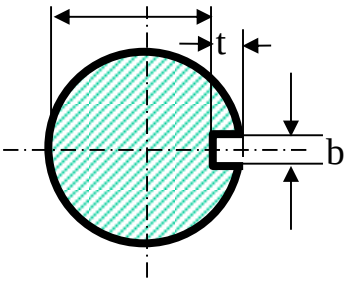




$M_x \approx \frac{\pi D^3}{32} - \frac{dD^2}{6} \qquad \frac{J}{c} \approx \frac{\pi D^3}{16} - \frac{dD^2}{6}$

Cylinder with a keyway

For drawing



Diameter: D

$$W_x = \frac{\pi D^3}{32} - \frac{bt(D-t)^2}{2D} \qquad \frac{J}{c} \approx \frac{\pi D^3}{16} - \frac{bt(D-t)^2}{2D}$$

$$A \approx \frac{\pi D^2}{4} - bt$$