INERTIA & ACCELERATION

The inertia of solid steel shafting per inch of shaft length is given in the table below. To calculate for hollow shafts, take the difference between the inertia values for O.D. and I.D. as the value per inch. For shafts of materials other than steel, multiply the value for steel by the factors Material Table below right.

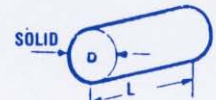
INERTIA OF STEEL SHAFTING
(per inch of length)

Diam. (In.)	WK^2 (= lb. Ft.^{2})	Diam. (In.)	WK^2 (= Ft.^{2})
3/4	.00006	10-1/2	2.35
1	.0002	10-3/4	2.58
1-1/4	.0005	11	2.83
1-1/2	.001	11-1/4	3.09
1-3/4	.002	11-1/2	3.38
2	.003	11-3/4	3.68
2-1/4	.005	12	4.00
2-1/2	.008	12-1/4	4.35
2-3/4	.011	12-1/2	4.72
3	.016	12-3/4	5.11
3-1/2	0.029	13	5.58
3-3/4	0.038	13-1/4	5.96
4	0.049	13-1/2	6.42
4-1/4	0.063	13-3/4	6.91
4-1/2	0.079	14	7.42
5	0.120	14-1/4	7.97
5-1/2	0.177	14-1/2	8.54
6	0.250	14-3/4	9.15
6-1/4	0.296	15	9.75
6-1/2	0.345	16	12.59
6-3/4	0.402	17	16.04
7	0.464	18	20.16
7-1/4	0.535	19	25.03
7-1/2	0.611	20	30.72
7-3/4	0.699	21	37.35
8	0.791	22	44.99
8-1/4	0.895	23	53.74
8-1/2	1.00	24	63.71
8-3/4	1.13	25	75.02
9	1.27	26	87.76
9-1/4	1.41	27	102.06
9-1/2	1.55	28	118.04
9-3/4	1.75	29	135.83
10	1.93	30	155.55
10-1/4	2.13	—	—

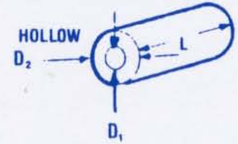
INERTIA (WK^2)

The factor WK^2 is the weight (lbs) of an object multiplied by the square of the radius of gyration (K). The unit measurement of the radius of gyration is expressed in feet.

For solid or hollow cylinders, inertia may be calculated by the equations shown.



$$WK^2 = .000681\ \rho\ LD^4$$



$$WK^2 = .000681\ \rho L\ (D_2^4 - D_1^4)$$

WK^2 = lb. ft^2
D, D_1, D_2 and L = in
ρ = lb. in^3
ρ (aluminum) = .0924
ρ (bronze) = .320
ρ (cast iron) = .260
ρ (steel) = .282

Moment of inertia:
• Solid cylinder rotating about its own axis:

$$WK^2 = 1/2\ WR^2$$

Where:
WK^2 = Moment of inertia (lb-ft^2)
W = Weight of object (lb)
R = Radius of cylinder (ft)

• Material in linear motion with a continuous fixed relation to a rotational speed, such as a conveyor system:

$$WK^2 = W\left(\frac{V}{2\pi N}\right)^2$$

Where:
WK_L^2 = Linear inertia (lb-ft^2)
W = Weight of material (lb)
V = Linear velocity (fpm)
N = Rotational speed of shaft (rpm)

• Reflected inertia of a load through a speed reduction means — gear, chain, or belt system:

$$WK_R^2 = \frac{WK_L^2}{R_r^2}$$

Where:
WK_R^2 = Reflected inertia (lb-ft^2)
WK_L^2 = Load inertia (lb-ft^2)
R_r = Reduction ratio

Accelerating torque and force:
• Of rotating objects:

$$T = \frac{(WK^2)\ \triangle N}{308t}$$

Where:
T = Torque required (lb-ft)
WK^2 = Total inertia of load to be accelerated (lb-ft^2)
$\triangle N$ = Change in speed (rpm)
t = Time to accelerate load (sec)

• Objects in linear motion:

$$F = \frac{W \triangle V}{1933t}$$

Where:
F = Force required (lb)
W = Weight (lb)
$\triangle V$ = Change in velocity (fpm)
t = Time to accelerate load (sec)