TABLE OF SPRING STIFFNESS   Revision B

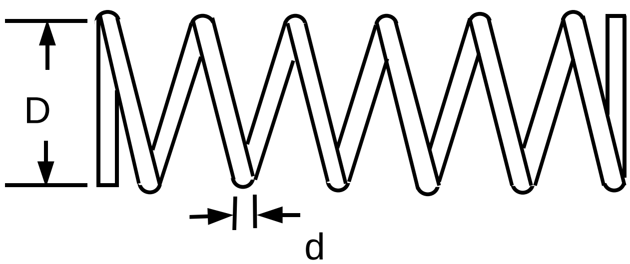
By Tom Irvine
Email: tomirvine@aol.com

October 5, 1999

Common Variables

k = spring stiffness.
G = shear modulus.
E = elastic modulus.

Circular Wire Helical Spring in Tension or Compression



$$k = \frac{d^4 G}{8 D^3 N}$$

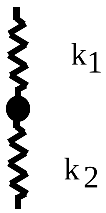
D = mean diameter.
d = wire diameter of spring material.
N = number of active turns of wire.

Circular Wire Helical Spring in Torsion

$$k = \frac{d^4 E}{64 D N}$$

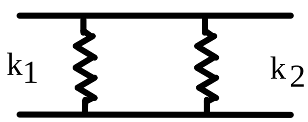
Dimensions: [length-force/radian]

Springs in Series



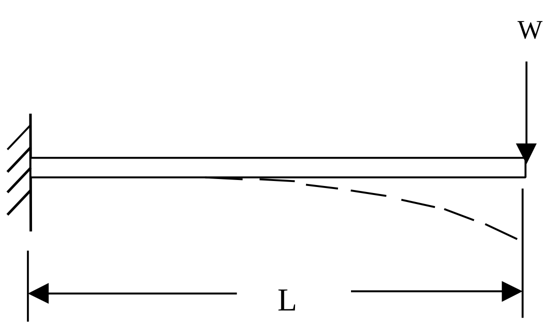
$$k = \frac{1}{\left[\frac{1}{k_1} + \frac{1}{k_2}\right]}$$

Springs in Parallel



$$k = k_1 + k_2$$

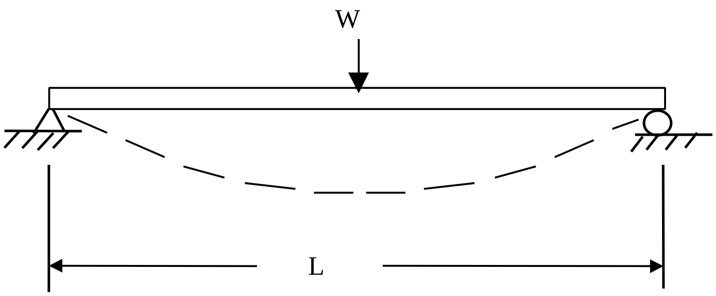
Bending of Fixed-Free Beam with Concentrated Load



$$k = \frac{3EI}{L^3}$$

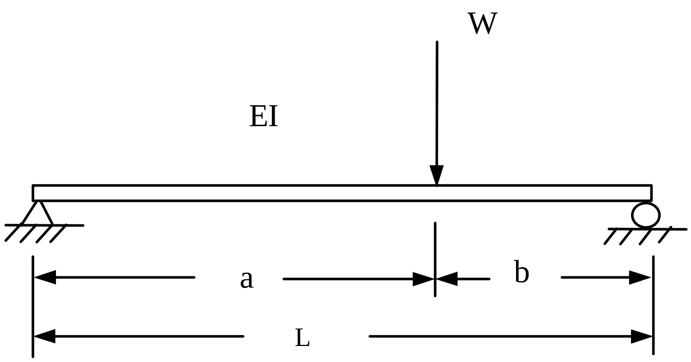
I = the area moment of inertia.

Bending of Beam Simply-Supported at Both Ends with Concentrated Load at Center Location



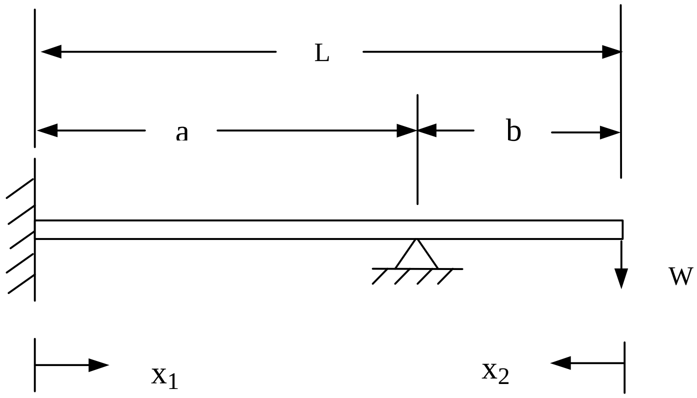
$$k = \frac{48\,EI}{L^3}$$

Beam with Simply-Supported at Both Ends with Concentrated Load at an Arbitrary Location



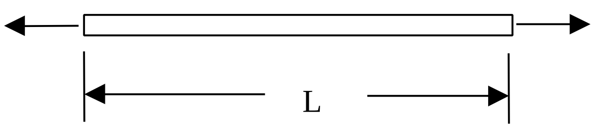
The stiffness at the load point is $k = \left\{ \frac{3\,EI\,L}{a^2 b^2} \right\}$.

Clamped-Pinned-Free Beam



The stiffness at the free end is $k = \frac{12\,EI}{\left\{b^2\,[4\,b + 3a]\right\}}$.

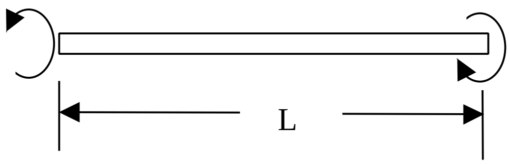
Rod or Bar Longitudinal Stiffness



$$k = \frac{EA}{L}$$

A is the cross-sectional area.

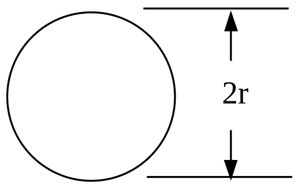
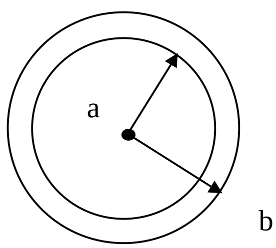
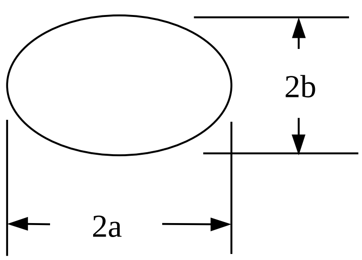
Rod or Bar Torsional Stiffness

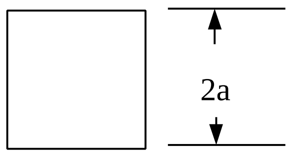
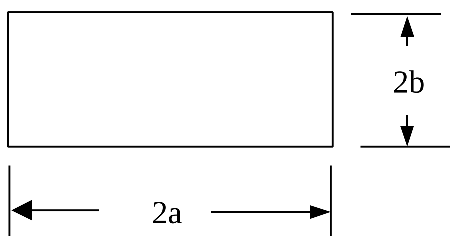


$$k = \frac{G\,J}{L}$$

J is the torsion constant of the cross-section. Examples are shown in Table 1.

Table 1. Torsion Constants for Torsional Stiffness

Cross-section Shape	Torsion Constant J
Solid Circular Section 	$J = \frac{1}{2}\pi r^4$
Hollow Concentric Circular Section 	$J = \frac{1}{2}\pi\left[b^4 - a^4\right]$
Solid Elliptical Section 	$J = \frac{\pi a^3 b^3}{a^2 + b^2}$

Cross-section Shape	Torsion Constant J
Solid Square Section 	$J = 2.25a^4$
Solid Rectangular Section 	$J = ab^3\left[\frac{16}{3} - 3.36\frac{b}{a}\left(1 - \frac{b^4}{12a^4}\right)\right], \quad a \geq b$

1. W. Thomson, Theory of Vibration with Applications, 2nd edition, Prentice-Hall, Englewood Cliffs, N.J., 1981.
2. W. Young, Roark's Formulas for Stress & Strain, 6th edition, McGraw-Hill, New York, 1989.
3. Vibration and Shock Mount Handbook, Product Catalog A-816, Stock Drive Products, New York, 1990.