

## Variables (Alphabetical By Variable)

$a$	Constant; distance
<b>A, B, C, ...</b>	Forces; reactions
$A, B, C, \dots$	Points
$A, \mathcal{A}$	Area
$b$	Distance; width
$c$	Constant; distance; radius
$C$	Centroid
$C_1, C_2, \dots$	Constants of integration
$C_p$	Column stability factor
$d$	Distance; diameter; depth
$D$	Diameter
$e$	Distance; eccentricity; dilatation
$E$	Modulus of elasticity
$f$	Frequency; function
<b>F</b>	Force
$F.S.$	Factor of safety
$G$	Modulus of rigidity; shear modulus
$h$	Distance; height
<b>H</b>	Force
$H, J, K$	Points
$I, I_x, \dots$	Moment of inertia
$I_{xy}, \dots$	Product of inertia
$J$	Polar moment of inertia
$k$	Spring constant; shape factor; bulk modulus; constant
$K$	Stress concentration factor; torsional spring constant
$l$	Length; span
$L$	Length; span
$L_e$	Effective length
$m$	Mass
<b>M</b>	Couple
$M, M_x, \dots$	Bending moment
$M_D$	Bending moment, dead load (LRFD)
$M_L$	Bending moment, live load (LRFD)
$M_U$	Bending moment, ultimate load (LRFD)
$n$	Number; ratio of moduli of elasticity; normal direction
$p$	Pressure
<b>P</b>	Force; concentrated load
$P_D$	Dead load (LRFD)
$P_L$	Live load (LRFD)

$P_U$	Ultimate load (LRFD)
$q$	Shearing force per unit length; shear flow
<b>Q</b>	Force
$Q$	First moment of area
$r$	Radius; radius of gyration
<b>R</b>	Force; reaction
$R$	Radius; modulus of rupture
$s$	Length
$S$	Elastic section modulus
$t$	Thickness; distance; tangential deviation
<b>T</b>	Torque
$T$	Temperature
$u, v$	Rectangular coordinates
$u$	Strain-energy density
$U$	Strain energy; work
<b>v</b>	Velocity
<b>V</b>	Shearing force
$V$	Volume; shear
$w$	Width; distance; load per unit length
<b>W, W</b>	Weight, load
<b>V</b>	Shearing force
$V$	Volume; shear
$w$	Width; distance; load per unit length
<b>W, W</b>	Weight, load
$x, y, z$	Rectangular coordinates; distance; displacements; deflections
$\bar{x}, \bar{y}, \bar{z}$	Coordinates of centroid
$Z$	Plastic section modulus
$\alpha, \beta, \gamma$	Angles
$\alpha$	Coefficient of thermal expansion; influence coefficient
$\gamma$	Shearing strain; specific weight
$\gamma_D$	Load factor, dead load (LRFD)
$\gamma_L$	Load factor, live load (LRFD)
$\delta$	Deformation; displacement
$\epsilon$	Normal strain
$\theta$	Angle; slope
$\lambda$	Direction cosine
$\nu$	Poisson's ratio
$\rho$	Radius of curvature; distance; density
$\sigma$	Normal stress
$\tau$	Shearing stress
$\phi$	Angle; angle of twist; resistance factor
$\omega$	Angular velocity

## Conversion Factors

$$1\text{hp} = 550\text{ft}\cdot\text{lb/s} = 6600\text{ in}\cdot\text{lb/s} \quad (1)$$

## General

## SI Prefixes

Multiplication Factor	Prefix†	Symbol
1 000 000 000 000 = $10^{12}$	tera	T
1 000 000 000 = $10^9$	giga	G
1 000 000 = $10^6$	mega	M
1 000 = $10^3$	kilo	k
100 = $10^2$	hecto‡	h
10 = $10^1$	deka‡	da
0.1 = $10^{-1}$	deci‡	d
0.01 = $10^{-2}$	centi‡	c
0.001 = $10^{-3}$	milli	m
0.000 001 = $10^{-6}$	micro	$\mu$
0.000 000 001 = $10^{-9}$	nano	n
0.000 000 000 001 = $10^{-12}$	pico	p
0.000 000 000 000 001 = $10^{-15}$	femto	f
0.000 000 000 000 000 001 = $10^{-18}$	atto	a

## Chapter 1 - Concept of stress

## Chapter 2 - Stress and Strain - Axial Loading

## Chapter 3 - Torsion

## General

## Deformation in Circular Shafts

$$\gamma = \frac{\rho\phi}{L} \quad (2)$$

$$\gamma_{max} = \frac{c\phi}{L} \quad (3)$$

$$\gamma = \frac{\rho}{c} * \gamma_{max} \quad (4)$$

## Shearing Stresses in Elastic Range

$$\tau = \frac{\rho}{c} \tau_{max} \quad (5)$$

$$\tau_{max} = \frac{Tc}{J} \quad (6)$$

$$\tau = \frac{T\rho}{J} \quad (7)$$

Polar Moment of Inertia Solid Shaft

$$J = \frac{1}{2}\pi^4$$
(8)

Polar Moment of Inertia of a Hollow Shaft inner radius c1, outer radius c2

$$J = \frac{1}{2}\pi(c_2^4 - c_2^4)$$
(9)

Angle of Twist

$$\phi = \frac{TL}{JG}$$
(10)

$$\phi = \Sigma \frac{TL}{JG}$$
(11)

Statically Indeterminante Shafts

Transmission Shafts

Poswer P is transmitted as:

$$P = 2\pi fT$$
(12)

Stress Concentrations

$$\tau_{\max} = K \frac{Tc}{J} K = \text{Stress concentration factor}$$
(13)

Plastic Deformations

$$T = \int_0^c \rho \tau (2\pi d\rho) = 2\pi \int_0^c \rho^2 \tau d\rho$$
(14)

Modulus of Rupture

This is a ficticious value.

$$R_t = \frac{T_u c}{j}$$
(15)

Solid Shaft of Elastoplastic Material

Maximum Elastic Torque; Solid Circular Shaft, Radius c

$$\tau_y = \frac{1}{2}\pi c^3 \tau Y$$
(16)

Torque Related to  $\rho_y$

$$T = \frac{4}{3}T_y(1 - \frac{1}{4}\rho\rho^3yc^3)$$
(17)

Plastic Torque

$$T_p = \frac{4}{3}T_y$$
(18)

Plastic Torque Vs. Angle of Twist

$$T = \frac{4}{3}T_y(1 - \frac{1}{4}\frac{\phi^3y}{\phi^3})$$
(19)

Torsional Loading or Shaft Cross-Section Changes Along Length

$$\phi = \Sigma_i \frac{T_i L_i}{J_i G_i}$$
(20)

Thin-Walled Hollow Shafts  
Shear Flow

$$q = \tau t$$
(21)

Average Shearing Stress  $\tau$  at any given point in cross section

$$\tau = \frac{T}{2tA}$$
(22)