Variables (Alphbetical By Variable)

a	Constant; distance
A, B, C, . . .	Forces; reactions
$A, B, C, \ldots$	Points
$A, \mathcal{A}$	Area
b	Distance; width
c	Constant; distance; radius
C	Centroid
$C_1, C_2, \ldots$	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
F	Force
$F.S.$	Factor of safety
G	Modulus of rigidity; shear modulus
h	Distance; height
H	Force
H, J, K	Points
$I, I_x, \ldots$	Moment of inertia
$I_{xy}, \ldots$	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
M	Couple
$M, M_x, \ldots$	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
P	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
Q	Force
Q	First moment of area
r	Radius; radius of gyration
R	Force; reaction
R	Radius; modulus of rupture
s	Length
S	Elastic section modulus
t	Thickness; distance; tangential deviation
T	Torque
T	Temperature
u, v	Rectangular coordinates
u	Strain-energy density
U	Strain energy; work
v	Velocity
V	Shearing force
V	Volume; shear
w	Width; distance; load per unit length
W, W	Weight, load

V	Shearing force
V	Volume; shear
w	Width; distance; load per unit length
W, W	Weight, load
x, y, z	Rectangular coordinates; distance; displacements; deflections
$\bar{x}, \bar{y}, \bar{z}$	Coordinates of centroid
Z	Plastic section modulus
α, β, γ	Angles
α	Coefficient of thermal expansion; influence coefficient
γ	Shearing strain; specific weight
γ_D	Load factor, dead load (LRFD)
γ_L	Load factor, live load (LRFD)
δ	Deformation; displacement
ϵ	Normal strain
θ	Angle; slope
λ	Direction cosine
ν	Poisson's ratio
ρ	Radius of curvature; distance; density
σ	Normal stress
τ	Shearing stress
ϕ	Angle; angle of twist; resistance factor
ω	Angular velocity

Conversion Factors

$$1hp = 550ft*lb/s = 6600\ in*lb/s \tag{1}$$

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	μ
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

$$\gamma = \frac{\rho\phi}{L} \tag{2}$$

$$\gamma_{max} = \frac{c\phi}{L} \tag{3}$$

$$\gamma = \frac{\rho}{c} * \gamma_{max} \tag{4}$$

Shearing Stresses in Elastic Range

$$\tau = \frac{\rho}{c}\tau_{max} \tag{5}$$

$$\tau_{max} = \frac{Tc}{J} \tag{6}$$

$$\tau = \frac{T\rho}{J} \tag{7}$$

Polar Moment of Inertia Solid Shaft

$$J = \frac{1}{2}\pi c^4 \tag{8}$$

c = radius

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

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

Angle of Twist

$$\phi = \frac{TL}{JG} \tag{10}$$

$$\phi = \Sigma \frac{TL}{JG} \tag{11}$$

Statically Indeterminante Shafts

Transmission Shafts

Power P is transmitted as:

$$P = 2\pi f T \tag{12}$$

T is the torque exerted at each end of the shaft
f the frequency (hz or s^{-1})

Stress Concentrations

$$\tau_{\max} = K\frac{Tc}{J} \tag{13}$$

K = Stress concentration factor
stress $\frac{Tc}{J}$ is computed for the smaller-diameter shaft

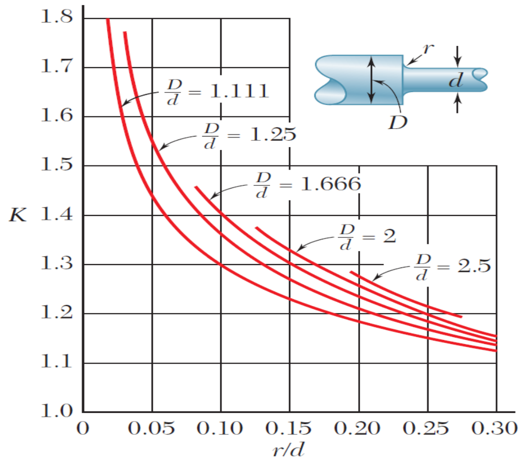

Fig. 3.28 Plot of stress concentration factors for fillets in circular shafts. (Source: W. D. Pilkey and D. F. Pilkey, *Peterson's Stress Concentration Factors*, 3rd ed., John Wiley & Sons, New York, 2008.)

Plastic Deformations

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

Modulus of Rupture

This is a ficticious value.

$$R_t = \frac{T_u c}{j} \tag{15}$$

Solid Shaft of Elastoplastic Material

Maximum Elastic Torque; Solid Circular Shaft, Radius c

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

Torque Related to ρ_y

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

Plastic Torque

$$T_p = \frac{4}{3}T_y \tag{18}$$

Plastic Torque Vs. Angle of Twist

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

Torsional Loading or Shaft Cross-Section Changes Along Length

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

Thin-Walled Hollow Shafts

Shear Flow

$$q = \tau t \tag{21}$$

Average Shearing Stress τ at any given point in cross section

$$\tau = \frac{T}{2tA} \tag{22}$$