List of Symbol Definitions

a	long dimension for a section subjected to torsion (in, mm); acceleration (ft/sec^2, m/sec^2)
$\mathcal{a}$	area bounded by the centerline of a thin walled section subjected to torsion (in^2, mm^2)
A	area, often cross-sectional (in^2, ft^2, mm^2, m^2)
A_e	net <u>effective</u> area, equal to the total area ignoring any holes (in^2, ft^2, mm^2, m^2) *(see A_{net})*;
A_g	gross area, equal to the total area ignoring any holes (in^2, ft^2, mm^2, m^2)
A_{net}	net <u>effective</u> area, equal to the gross area subtracting any holes (in^2, ft^2, mm^2, m^2) *(see A_e)*
A_p	bearing area (in^2, ft^2, mm^2, m^2)
A_{throat}	area across the throat of a weld (in^2, ft^2, mm^2, m^2)
A_{web}	web area in a steel beam equal to the depth x web thickness (in^2, ft^2, mm^2, m^2)
ASD	Allowable Stress Design
b	width, often cross-sectional (in, ft, mm, m); narrow dimension for a section subjected to torsion (in, mm); number of truss members
b_f	width of the flange of a steel beam cross section (in, mm)
c	distance from the neutral axis to the top or bottom edge of a beam (in, mm, m); distance from the center of a circular shape to the surface under torsional shear strain (in, mm, m)
c_i	distance from the center of a circular shape to the inner surface under torsional shear strain (in, mm, m)
c_o	distance from the center of a circular shape to the outer surface under torsional shear strain (in, mm, m)
c_1	coefficient for shear stress for a rectangular bar in torsion
c_2	coefficient for shear twist for a rectangular bar in torsion
CL, ℄	center line
C	compression label; compression force (lb, kips, N, kN)
C_b	modification factor for moment in ASD & LRFD steel beam design, $C_b = 1$ for simply supported beams (0 moments at the ends)
C_c	column slenderness classification constant for steel column design
C_D	load duration factor for wood design
C_F	size factor for wood design
C_m	modification factor for combined stress in steel design
C_M	wet service factor for wood design
C_p	column stability factor for wood design
C_t	temperature factor for wood design

d depth, often cross-sectional (in, mm, m);
perpendicular distance from a force to a point in a moment calculation (in, mm, m)

d_x difference in the x direction between an area centroid ($\bar{x}$) and the centroid of the composite shape ($\hat{x}$) (in, mm)

d_y difference in the y direction between an area centroid ($\bar{y}$) and the centroid of the composite shape ($\hat{y}$) (in, mm)

D diameter of a circle (in, mm, m);
dead load for LRFD design

DL dead load

e eccentric distance of application of a force (P) from the centroid of a cross section (in, mm)

E modulus of elasticity (psi; ksi, kPa, MPa, GPa);
earthquake load for LRFD design

f symbol for stress (psi, ksi, kPa, MPa)

f_a calculated axial stress (psi, ksi, kPa, MPa)

f_b calculated bending stress (psi, ksi, kPa, MPa)

f_c calculated compressive stress (psi, ksi, kPa, MPa)

f_{cr} calculated column stress based on the critical column load P_{cr} (psi, ksi, kPa, MPa)

f_t calculated tensile stress (psi, ksi, kPa, MPa)

f_p calculated bearing stress (psi, ksi, kPa, MPa)

f_x combined stress in the direction of the major axis of a column (psi, ksi, kPa, MPa)

f_v calculated shearing stress (psi, ksi, kPa, MPa)

f_y yield stress (psi, ksi, kPa, MPa)

F force (lb, kip, N, kN);
capacity of a nail in shear (lb, kip, N, kN);
symbol for allowable stress in design codes (psi, ksi, kPa, MPa)

F_a allowable axial stress (psi, ksi, kPa, MPa)

F_b allowable bending stress (psi, ksi, kPa, MPa)

F'_b allowable bending stress for combined stress for wood design (psi, ksi, kPa, MPa)

F_c allowable compressive stress (psi, ksi, kPa, MPa)

$F_{connector}$ resistance capacity of a connector (lb, kips, N, kN)

F_{cE} intermediate compressive stress for ASD wood column design dependant on material (psi, ksi, kPa, MPa)

F'_c allowable compressive stress for ASD wood column design (psi, ksi, kPa, MPa)

F'^*_c intermediate compressive stress for ASD wood column design dependant on load duration (psi, ksi, kPa, MPa)

F'_e allowable buckling stress for combined bending steel design (psi, ksi, kPa, MPa)

F_t allowable tensile stress (psi, ksi, kPa, MPa)

F_v allowable shear stress (psi, ksi, kPa, MPa);
allowable shear stress in a welded connection

F_x force component in the x coordinate direction (lb, kip, N, kN)

F_y force component in the y coordinate direction (lb, kip, N, kN);
yield stress (psi, ksi, kPa, MPa)

F_u ultimate stress a material can sustain prior to failure (psi, ksi, kPa, MPa)

F.S. factor of safety

g acceleration due to gravity, 32.17 ft/sec^2, 9.807 m/sec^2

G shear modulus (psi; ksi, kPa, MPa, GPa)

h depth, often cross-sectional (in, ft, mm, m);
sag of a cable structure (ft, m)

I moment of inertia (in^4, mm^4, m^4)

$\bar{I}$ moment of inertia about the centroid (in^4, mm^4, m^4)

I_c moment of inertia about the centroid (in^4, mm^4, m^4)

I_{min} minimum moment of inertia of I_x and I_y (in^4, mm^4, m^4)

I_x moment of inertia with respect to an x-axis (in^4, mm^4, m^4)

I_y moment of inertia with respect to a y-axis (in^4, mm^4, m^4)

J, J_o polar moment of inertia (in^4, mm^4, m^4)

k kips (1000 lb);
shape factor for plastic design of steel beams, M_p/M_y

kg kilograms

kN kiloNewtons (10^3 N)

kPa kiloPascals (10^3 Pa)

K effective length factor with respect to column end conditions

K_{cE} material factor for wood column design

ℓ length (in, ft, mm, m);
cable span (ft, m)

lb pound force

L length (in, ft, mm, m);
live load for LRFD design

L_b unbraced length of a steel beam in LRFD design (in, ft, mm, m)

L_c maximum unbraced length of a steel beam in ASD design for maximum allowed bending stress (in, ft, mm, m)

L_e effective length that can buckle for column design (in, ft, mm, m)

L_r roof live load in LRFD design

L_p maximum unbraced length of a steel beam in LRFD design for full plastic flexural strength (in, ft, mm, m)

L_r maximum unbraced length of a steel beam in LRFD design for inelastic lateral-torsional buckling (in, ft, mm, m)

L_u maximum unbraced length of a steel beam in ASD design for reduced allowed bending stress (in, ft, mm, m)

LL live load

LRFD Load and Resistance Factor Design

m mass (lb-mass, g, kg);
meters

mm millimeters

M moment of a force or couple (lb-ft, kip-ft, N-m, kN-m);
bending moment (lb-ft, kip-ft, N-m, kN-m)

M_A moment value at quarter point of unbraced beam length for LRFD beam design (lb-ft, kip-ft, N-m, kN-m)

M_B moment value at half point of unbraced beam length for LRFD beam design (lb-ft, kip-ft, N-m, kN-m)

M_C moment value at three quarter point of unbraced beam length for LRFD beam design (lb-ft, kip-ft, N-m, kN-m)

M_n nominal flexure strength with the full section at the yield stress for LRFD beam design (lb-ft, kip-ft, N-m, kN-m)

M_p (also M_{ult}) internal bending moment when all fibers in a cross section reach the yield stress (lb-ft, kip-ft, N-m, kN-m)

M_u maximum moment from factored loads for LRFD beam design (lb-ft, kip-ft, N-m, kN-m)

M_{ult} (also M_p)internal bending moment when all fibers in a cross section reach the yield stress (lb-ft, kip-ft, N-m, kN-m)

M_y internal bending moment when the extreme fibers in a cross section reach the yield stress (lb-ft, kip-ft, N-m, kN-m)

M_1 smaller end moment used to calculate C_m for combined stresses in a beam-column (lb-ft, kip-ft, N-m, kN-m)

M_2 larger end moment used to calculate C_m for combined stresses in a beam-column (lb-ft, kip-ft, N-m, kN-m)

MPa megaPascals (10^6 Pa or 1 N/mm^2)

n number of truss joints, nails or bolts

n.a. neutral axis (axis connecting beam cross-section centroids)

N Newtons (kg-m/sec^2);
bearing-type connection with bolt threads included in shear plane

O point of origin

p pitch of nail spacing (in, ft, mm, m)

P force, concentrated (point) load (lb, kip, N, kN);
axial load in a column or beam-column (lb, kip, N, kN)

P_{cr} critical (failure) load in column calculations (lb, kip, N, kN)

P_n nominal load strength capacity for LRFD design (lb, kip, N, kN)

P_u maximum load from factored loads for LRFD design (lb, kip, N, kN)

Pa Pascals (N/m^2)

q shear flow (lb/in, kips/ft, N/m, kN/m)

Q first moment area used in shearing stress calculations (in^3, mm^3, m^3)

$Q_{connected}$ first moment area used in shearing stress calculations for built-up beams (in^3, mm^3, m^3)

Q_x first moment area about an x axis (using y distances) (in^3, mm^3, m^3)

Q_y first moment area about an y axis (using x distances) (in^3, mm^3, m^3)

r radius of a circle (in, mm, m);
radius of gyration (in, mm, m)

r_o polar radius of gyration (in, mm, m)

r_x radius of gyration with respect to an x-axis (in, mm, m)

r_y radius of gyration with respect to a y-axis(in, mm, m)

R force, reaction or resultant (lb, kip, N, kN);
radius of curvature of a beam (ft, m);
rainwater or ice load for LRFD design;
generic design quantity (force, shear, moment, etc.) for LRFD design

R_n generic nominal capacity (force, shear, moment, etc.) for LRFD design

R_u generic maximum quantity (force, shear, moment, etc.) from factored loads for LRFD design

R_x reaction or resultant component in the x coordinate direction (lb, kip, N, kN)

R_y reaction or resultant component in the y coordinate direction (lb, kip, N, kN)

s length of a segment of a thin walled section (in, mm)

s.w. self-weight

S section modulus (in^3, mm^3, m^3);
snow load for LRFD design;
allowable strength per length of a weld for a given size (lb/in, kips/in, N/mm, kN/m)

$S_{required}$ section modulus required to not exceed allowable bending stress (in^3, mm^3, m^3)

S_x section modulus with respect to the x-centroidal axis (in^3, mm^3, m^3)

S_y section modulus with respect to the y-centroidal axis (in^3, mm^3, m^3)

SC slip critical bolted connection

S4S surface-four-sided

t thickness (in, mm, m)

t_f thickness of the flange of a steel beam cross section (in, mm, m)

t_w thickness of the web of a steel beam cross section (in, mm, m)

T tension label;
tensile force (lb, kip, N, kN);
torque (lb-ft, kip-ft, N-m, kN-m);
throat size of a weld (in, mm)

V shearing force (lb, kip, N, kN)

V_n nominal shear strength capacity for LRFD beam design (lb, kip, N, kN)

V_u maximum shear from factored loads for LRFD beam design (lb, kip, N, kN)

w (also ω) load per unit length on a beam (lb/ft, kip/ft, N/m, kN/m)

W weight (lb, kip, N, kN);
total load from a uniform distribution (lb, kip, N, kN);
wind load for LRFD design

x a distance in the x direction (in, ft, mm, m)

$\bar{x}$ the distance in the x direction from a reference axis to the centroid of a shape (in, mm)

$\hat{x}$ the distance in the x direction from a reference axis to the centroid of a composite shape (in, mm)

X bearing-type connection with bolt threads excluded from shear plane

y a distance in the y direction (in, ft, mm, m);
distance from the neutral axis to the y-level of a beam cross section (in, mm)

$\bar{y}$ the distance in the y direction from a reference axis to the centroid of a shape (in, mm)

$\hat{y}$ the distance in the y direction from a reference axis to the centroid of a composite shape (in, mm)

Z plastic section modulus of a steel beam (in^3, mm^3)

' symbol for feet

" symbol for inches

symbol for pounds

α coefficient of thermal expansion (/°C, /°F);
angle, in a math equation (degrees, radians)

β angle, in a math equation (degrees, radians)

δ elongation (in, mm)

δ_P elongation due to axial load (in, mm)

δ_s shear deformation (in, mm)

δ_T elongation due to change in temperature (in, mm)

Δ beam deflection (in, mm);
an increment

Δ_{LL} beam deflection due to live load (in, mm)

Δ_{max} maximum calculated beam deflection (in, mm)

Δ_{TL} beam deflection due to total load (in, mm)

ΔT change in temperature (°C, °F)

ε strain (no units)

ε_t thermal strain (no units)

ϕ diameter symbol;
angle of twist (degrees, radians);
resistance factor in LRFD steel design

ϕ_b resistance factor for flexure in LRFD steel design

ϕ_c resistance factor for compression in LRFD steel design

ϕ_t resistance factor for tension in LRFD steel design

ϕ_v resistance factor for shear in LRFD steel design

λ_c design constant for slenderness evaluation for steel columns in LRFD design

μ Poisson's ratio

γ specific gravity of a material (lb/in^3, lb/ft^3, N/m^3,kN/m^3);
angle, in a math equation (degrees, radians);
shearing strain;
load factor in LRFD design

γ_D dead load factor in LRFD steel design

γ_L live load factor in LRFD steel design

θ angle, in a trig equation (degrees, radians);
slope of the deflection of a beam at a point (degrees, radians)

π pi

ρ radial distance (in, mm)

σ engineering symbol for normal stress (axial or bending)

τ engineering symbol for shearing stress

Σ summation symbol

ω (also w) load per unit length on a beam (lb/ft, kip/ft, N/m, kN/m)