List of Symbol Definitions

a long dimension for a section subjected to torsion (in, mm);
acceleration (ft/sec^2, m/sec^2);
acceleration due to gravity, 32.17 ft/sec^2, 9.81 m/sec^2 (*also see g*)
unit area (in^2, ft^2, mm^2, m^2);
distance used in beam formulas (ft, m);
depth of the effective compression block in a concrete beam (in, mm);
equivalent square column size in spread footing design (in, ft, mm, m)

$\mathcal{a}$ 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_b nominal cross section bolt area (in^2, ft^2, mm^2, m^2)

A_e net effective area, equal to the total area ignoring any holes and modified by the lag factor, U, (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_{gv} gross area in shear, equal to the total area ignoring any holes (in^2, ft^2, mm^2, m^2)

A_{net} net effective area, equal to the gross area subtracting any holes (in^2, ft^2, mm^2, m^2) *(see A_e)*

A_{nt} net area in shear of a bolted connection subject to shear rupture (in^2, ft^2, mm^2, m^2)

A_{nv} net area in tension of a bolted connection subject to shear rupture (in^2, ft^2, mm^2, m^2);
net shear area for a masonry member (in^2, ft^2, mm^2, m^2)

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_s area of steel reinforcement in concrete beam design (in^2, ft^2, mm^2, m^2)

$A_{s'}$ area of compression steel reinforcement in concrete beam design (in^2, ft^2, mm^2, m^2)

A_v area of concrete shear stirrup reinforcement (in^2, ft^2, mm^2, m^2);
seismic coefficient for acceleration

A_{web} web area in a steel beam equal to the depth x web thickness (in^2, ft^2, mm^2, m^2)

A_1 area of column in spread footing design ((in^2, ft^2, mm^2, m^2)

A_2 projected bearing area of column load in spread footing design ((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 (*also see n)*;
rectangular column dimension in concrete footing design (in, mm, m);
distance used in beam formulas (ft, m)

b_E effective width of the flange of a concrete T beam cross section (in, mm)

b_f width of the flange of a steel or concrete T beam cross section (in, mm)

b_o perimeter length for two-way shear in concrete footing design (in, ft, mm, m)

b_w width of the stem of a concrete T beam cross section (in, mm)

B spread footing dimension in concrete design (ft, m);
dimension of a steel base plate (in, mm, m)

B_s width within the longer dimension of a rectangular spread footing that reinforcement must be concentrated within for concrete design (ft, m)

B_1 factor for determining M_u for combined bending and compression

c distance from the neutral axis to the top or bottom edge of a beam (in, mm, m);
rectangular column dimension in concrete footing design (in, mm, m);
the distance from the top of a masonry or concrete beam to the neutral axis (in, mm, m) (*see x*)

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);
dimension of a steel base plate for concrete footing design (in, mm, m);
seismic design coefficient dependent on the building period of vibration;
constant for moment calculation of plates with respect to boundary conditions;
coefficient for eccentrically loaded bolt groups

C_a constant for moment calculation of plates with respect to boundary conditions

C_b modification factor for LRFD steel beam design;
constant for moment calculation of plates with respect to boundary conditions

C_d pressure coefficient for wind force calculation

C_D load duration factor for wood design

C_F size factor for wood design

C_{fu} flat use factor for wood design

C_H shear stress factor for wood design

C_i incising factor for wood design

C_L beam stability 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_r repetitive member factor for wood design

C_s seismic design coefficient based on soil, response and acceleration

C_t temperature factor for wood design

C_T buckling stiffness factor for wood truss design

C_v web shear coefficient for steel design

C_V glulam volume factor for wood design

C_t temperature factor for wood design;
seismic coefficient based on structural system and number of stories to determine building period

d diameter of a circle (in, mm, m);
depth, often cross-sectional (in, mm, m);
perpendicular distance from a force to a point in a moment calculation (in, mm, m) ;
effective depth from the top of a reinforced concrete beam to the centroid of the steel (in, mm);
effective depth from the top of a reinforced masonry member to the centroid of the steel (in, mm);
critical cross section dimension of a rectangular timber column cross section related to the profile (axis) for buckling (in, mm, m);
symbol in calculus to represent a very small change (like the greek letters for d, *see* δ & Δ)

d' effective depth from the top of a reinforced concrete beam to the centroid of the compression steel (in, mm)

d_b depth of a steel wide flange section (in, mm);
bar diameter of concrete reinforcement (in, mm)

d_f depth of a steel column flange (wide flange section) (in, mm)

d_x difference in the x direction between an area centroid and the centroid of the composite shape (in, mm)

d_y difference in the y direction between an area centroid and the centroid of the composite shape (in, mm)

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

DL dead load

e dimensional change to determine strain (in, mm) *(see s or* ε*)*;
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

E_c modulus of elasticity of concrete (psi; ksi, kPa, MPa, GPa)

E_s modulus of elasticity of steel (psi; ksi, kPa, MPa, GPa)

f symbol for stress (psi, ksi, kPa, MPa);
symbol for function with respect to some variable, ie. f(t)

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'_c concrete design compressive stress (psi, ksi, kPa, MPa)

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

f_m calculated compressive stress in masonry (psi, ksi, kPa, MPa)

f'_m masonry design compressive stress (psi, ksi, kPa, MPa)

f_n natural frequency of a suspended cable (sec^{-1}, Hz)

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

f_r calculated radial stress for a glulam timber (psi, ksi, kPa, MPa)

f_s calculated steel stress for reinforced masonry (psi, ksi, kPa, MPa)

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

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

f_x combined stress in the direction of the major axis of a column (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);
hydraulic fluid load for LRFD design

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)
critical unfactored compressive stress for LRFD steel design

F_{cr} flexural buckling (column) stress in ASD and LRFD (psi, ksi, kPa, MPa)

$F_{c\perp}$ allowable compressive stress perpendicular to the wood grain (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_{cr} critical column stress due to buckling (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 elastic critical buckling stress is steel design

F_{EXX} yield strength of weld material (psi, ksi, kPa, MPa)

$F_{horizontal\text{-}resist}$ resultant frictional force resisting sliding in a footing or retaining wall (lb, kip, N, kN)

F_n nominal stress (psi, ksi, kPa, MPa)

F_{nv} nominal shear stress (psi, ksi, kPa, MPa)

F_{nt} nominal tensile stress (psi, ksi, kPa, MPa)

F_p allowable bearing stress parallel to the wood grain (psi, ksi, kPa, MPa)

F_r allowable radial stress for a curved glulam (psi, ksi, kPa, MPa)

$F_{sliding}$ resultant force causing sliding in a footing or retaining wall (lb, kip, N, kN)

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 (psi, ksi, kPa, MPa)

F_{vm} allowable shear stress in the reinforced masonry (psi, ksi, kPa, MPa)

F_{vs} allowable shear stress in the reinforcement for masonry (psi, ksi, kPa, MPa)

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_{yw} yield stress in the web of a steel wide flange section (psi, ksi, kPa, MPa)

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

F.S. factor of safety *(also see SF)*

g acceleration due to gravity, 32.17 ft/sec^2, 9.81 m/sec^2 *(also see a)*
gage spacing of staggered bolt holes (in, mm)

G shear modulus (psi; ksi, kPa, MPa, GPa);
gigaPascals (10^9 Pa or 1 kN/mm^2);
relative stiffness of columns to beams in a rigid connection *(see Ψ)*

h depth, often cross-sectional (in, ft, mm, m);
sag of a cable structure (ft, m);
height (in, ft, mm, m);
effective height of a wall or column, (*see* ℓ_e)

h_c height of the web in a wide flange section (in, ft, mm, m) (*also see* t_w)

h_f depth of a flange in a T section (in, ft, mm, m);
height of a concrete spread footing (in, ft, mm, m)

h_n building height for determination of period for seismic design

H hydraulic soil load for LRFD design;
height of retaining wall (ft, m)

H_A horizontal load from active soil or water pressure (lb, k, N, kN)

I moment of inertia (in^4, mm^4, m^4);
seismic importance factor based on building occupancy

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

$\bar{I}_T$ moment of inertia about the centroid of a composite shape (in^4, mm^4, m^4) *(also see* $\hat{I}$)

$\hat{I}$ moment of inertia about the centroid of a composite shape (in^4, mm^4, m^4) *(also see* I_c*)*

I_c moment of inertia about the centroid of a composite shape (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_{net} moment of inertia of plate area excluding bolt holes (in^3, mm^3, m^3)

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

$I_{transformed}$ moment of inertia of a multi-material section transformed to one material (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 number of connections in a truss (*also see n)*;
multiplier by effective depth of concrete or masonry section for moment arm, jd (*see d)*

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;
effective length factor for columns (*also K);*
distance from outer face of flange to the web toe of fillet of a wide flange section (in, mm);
spring constant (lb/in, N/mm);
multiplier by effective depth of masonry section for neutral axis, kd

kg kilograms

klf kips per linear foot (k/ft)

ksi kips per square inch (k/in^2)

ksf kips per square foot (k/ft^2)

kN kiloNewtons (10^3 N)

kPa kiloPascals (10^3 Pa)

K effective length factor with respect to column end conditions *(also k)*;
masonry mortar strength designation

K_A empirically derived coefficient based on soil properties

K_{cE} material factor for wood column design

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

ℓ_d development length of concrete reinforcement (in, ft, mm, m)

ℓ_{dc} development length of compression reinforcement in concrete footing design (in, ft, mm, m)

l_{dh} development length for hooks (in, ft, mm, m)

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

ℓ_n effective clear span for concrete one-way slab design (ft, m)

lb pound force

L length (in, ft, mm, m);
live load for LRFD design;
spread footing dimension in concrete design (ft, m)

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

L_c clear distance between the edge of a bolt hole and the edge of the next hole or edge of the connected steel plate in the direction of the load (in, mm)

L_d development length of reinforcement in concrete (ft, m)

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

L_m projected length for bending in concrete footing design (ft, m)

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

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

L' length of the one-way shear area in concrete footing design (ft, m)

LL live load

LRFD Load and Resistance Factor Design

m mass (lb-mass, g, kg);
meters;
moment per unit width (lb-ft/ft, kN-m/m);
edge dimension in a steel base plate (in, mm)

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);
masonry mortar strength designation

M_a required bending moment in steel ASD beam design (unified) (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);
nominal moment capacity of a reinforced concrete beam at the balanced steel ratio (ρ_b) for limiting strains in both concrete and steel (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_m moment capacity of a reinforced masonry beam (lb-ft, kip-ft, N-m, kN-m)

M_n nominal moment capacity of a reinforced concrete beam based on steel yielding and concrete design strength (lb-ft, kip-ft, N-m, kN-m)

M_o total factored design moment for a two –way slab (lb-ft, kip-ft, N-m, kN-m)

$M_{overturning}$ resulting moment from all forces on a footing or retaining wall causing overturning (lb-ft, kip-ft, N-m, kN-m)

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

M_{resist} resulting moment from all forces on a footing or retaining wall resisting overturning (lb-ft, kip-ft, N-m, kN-m)

M_u factored moment calculated in concrete design from load factors (lb-ft, kip-ft, N-m, kN-m)

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

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 or members, nails or bolts;
modulus of elasticity transformation coefficient for steel to concrete;
edge dimension in a steel base plate (in, mm)

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

n' equivalent edge dimension in a steel base plate for design (in, mm)

N Newtons (kg-m/sec^2);
bearing-type connection with bolt threads included in shear plane;
normal load (lb, kip, N, kN);
bearing length on a wide flange steel section (in, mm);
dimension of a steel base plate (in, mm, m);
masonry mortar strength designation

N_ϕ meridional in-plane internal force per unit length in a shell (lb/ft, N/m, kN/m)

N_θ hoop in-plane internal force per unit length in a shell (lb/ft, N/m, kN/m)

o.c. on-center

O point of origin;
masonry mortar strength designation

p pitch of nail spacing (in, mm) (*also see s)*;
pressure (lb/in^2, lb/ft^2, kip/in^2, kip/ft^2, Pa, MPa):
unit weight of soil for determining active lateral pressure (lb/ft^3, kN/m^3)

p_A active soil pressure (lb/ft^3, kN/m^3)

p_r internal pressure (lb/in^2, lb/ft^2, kip/in^2, kip/ft^2, Pa, MPa)

plf pounds per linear foot (lb/ft)

psf pounds per square inch (lb/ft^2)

psi pounds per square inch (lb/in^2)

P force, concentrated (point) load (lb, kip, N, kN)

P_a required axial force in ASD steel design (unified) (lb, kip, N, kN)

P_c available axial strength for steel unified design (lb, kip, N, kN)

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

P_{el} Euler buckling strength in steel unified design (lb, kip, N, kN)

P_n maximum column load capacity in LRFD steel and concrete design (lb, kip, N, kN);
nominal axial load for a tensile member or connection in LRFD steel (lb, kip, N, kN)

P_o maximum axial force with no concurrent bending moment in a reinforced concrete column (lb, kip, N, kN)

P_r required axial force in steel unified design (lb, kip, N, kN)

P_u factored column load calculated from load factors in LRFD steel and concrete design (lb, kip, N, kN);
factored axial load for a tensile member or connection in LRFD steel (lb, kip, N, kN)

Pa Pascals (N/m^2)

q shear flow (lb/in, kips/ft, N/m, kN/m));
soil bearing pressure (lb/ft^2, kips/ft^2, N/m^2, Pa, MPa)

$q_{allowed}$ allowable soil bearing pressure (lb/ft^2, kips/ft^2, N/m^2, Pa, MPa)

q_h static wind velocity pressure for wind force calculation (lb/ft^2, kips/ft^2, N/m, Pa, MPa)

q_{net} net allowed soil bearing pressure (lb/ft^2, kips/ft^2, N/m, Pa, MPa)

q_u factored soil bearing pressure in concrete design from load factors (lb/ft^2, kips/ft^2, N/m, Pa, MPa)

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

$Q_{connected}$ first moment area used in shear 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 or arc (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 or radius of a shell (ft, m);
rainwater or ice load for LRFD design;
seismic response modification based on structural type;
calculated reduction in live load limited to 60% (in percent);
generic load quantity (force, shear, moment, etc.) for LRFD design

R_a required strength (ASD-unified) *(also see V_a, M_a)*

R_n concrete beam design ratio = M_u/bd^2 (lb/in^2, MPa)
nominal value for LRFD design to be multiplied by ϕ *(also see P_n, M_n)*
nominal value for ASD design to be divided by the safety factor Ω

R_u design value for LRFD design based on load factors *(also see P_u, M_u)*

R_w seismic response modification based on structural type

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 strain (=change in length divided by length) (no units);
displacement with respect to time (ft, m);
length of a segment of a thin walled section (in, mm);
pitch of nail spacing (in, mm) (*also see p);*
longitudinal center-to-center spacing of any two consecutive holes (in, mm);
spacing of stirrups in reinforced concrete beams (in, mm)

s.w. self-weight

S section modulus (in^3, mm^3, m^3);
snow load for LRFD design;
allowable strength of a weld for a given size (lb/in, kips/in, N/mm, kN/m)
seismic soil profile;
masonry mortar strength designation

S_{net} section modulus of plate area excluding bolt holes (in^3, mm^3, m^3)

$S_{required}$ 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

SF safety factor *(see F.S.)*

S4S surface-four-sided

t thickness (in, mm, m);
time (sec, hrs)

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);
effect of thermal load for LRFD design;
seismic building period (sec);
depth in web of wide flange section from fillet to fillet (in, mm)

U shear lag factor for steel tension member design *(see A_e and A_{net})*

U_{bs} reduction coefficient for block shear rupture

v velocity (ft/sec, m/sec, mi/h);
shear force per unit length (lb/ft, k/ft, N/m, kN/m) *(see q)*

V shearing force (lb, kip, N, kN);
seismic base shear force (lb, kip, N, kN)

V_a required shear in steel ASD design (unified) (lb, kip, N, kN)

V_c shear force capacity in concrete (lb, kip, N, kN)

V_n nominal shear force capacity for concrete design (lb, kip, N, kN)

V_s shear force capacity in steel (lb, kip, N, kN)

V_u factored shear calculated in concrete design from load factors (lb, kip, N, kN)

V_{u1} factored one-way shear calculated in concrete footing design from load factors (lb, kip, N, kN)

V_{u2} factored two-way shear calculated in concrete footing design from load factors (lb, kip, N, kN)

w load per unit length on a beam (lb/ft, kip/ft, N/m, kN/m);
load per unit area on a surface (lb/ft^2, kip/ft^2, N/m^2, kN/m^2) *(see w')*;
width dimension (in, ft, mm, m)

w_c weight of reinforced concrete per unit volume (lb/ft^3, N/m^3)

w_u factored load per unit length on a beam from load factors (lb/ft, kip/ft, N/m, kN/m);
factored load per unit area on a surface from load factors (lb/ft^2, kip/ft^2, N/m^2, kN/m^2)

w' load per unit area on a surface (lb/ft^2, kip/ft^2, N/m^2, kN/m^2) *(see w)*;

W weight (lb, kip, N, kN);
total load from a uniform distribution (lb, kip, N, kN);
wind load for LRFD design;
seismic building weight (lb, kip, N, kN);
wide flange shape designation (i.e. W 21 x 68)

x a distance in the x direction (in, ft, mm, m);
the distance from the top of a masonry or concrete beam to the neutral axis (in, mm, m) (*see c*)

$\bar{x}$ 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;
design constant for steel base plate design based on concrete bearing capacity

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)

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

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

z the distance from a unit area to a reference axis (in, ft, mm, m) *(also see d_x and d_y)*

Z plastic section modulus of a steel beam (in^3, mm^3);
seismic geographic factor based on zone

′ symbol for feet

″ symbol for inches

symbol for pounds

= symbol for equal to

≈ symbol for approximately equal to

∝ symbol for proportional to

≤ symbol for less than or equal to

∫ symbol for integration

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

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

β_c ratio of long side to short side of the column in concrete footing design

β_1 coefficient for determining stress block height, *a,* based on concrete strength, f'_c

δ elongation (in, mm) *(see e)*

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);
story drift (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):
strain in the steel

ε_y = strain at the yield stress

ϕ diameter symbol;
angle of twist (degrees, radians);
resistance factor in LRFD steel design and reinforced concrete design;
angle defining the shell cutoff (degrees, radians)

κ limit of timber slenderness for intermediate length columns (no units)

λ design constant for steel base plate design;
modification factor for reinforced concrete shear for lightweight materials

μ Poisson's ratio (*also see* ν*);*
coefficient of static friction

ν Poisson's ratio (*also see* μ*)*

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 (no units);
load factor in LRFD design;
ratio of reinforcement width to width of column

γ_D dead load factor in LRFD steel design

γ_L live load factor in LRFD steel design

θ angle, in a trig equation, ex. $\sin\theta$ (degrees, radians);
slope of the deflection of a beam at a point (degrees, radians)

π pi (180°)

ρ radial distance (in, mm);
radius of curvature in beam deflection relationships (ft, m);
reinforcement ratio in concrete beam design = A_s/bd (or possibly A_s/bt, A_s/bh) (no units)

ρ_b balanced reinforcement ratio in concrete beam design

ρ_g reinforcement ratio in concrete column design = A_{st}/A_g

ρ_{max} maximum reinforcement ratio allowed in concrete beam design for ductile behavior

σ engineering symbol for normal stress (axial or bending)

τ engineering symbol for shearing stress

υ_c shearing stress capacity in concrete design (psi; ksi, kPa, MPa);

ω load per unit length on a beam (lb/ft, kip/ft, N/m, kN/m) (*see w*);
load per unit area (lb/ft^2, kips/ft^2, N/m^2, Pa, MPa)

ω' load per unit volume (lb/ft, kip/ft, N/m, kN/m) (*see* γ)

Σ summation symbol

Ω safety factor for ASD of steel (unified)

Ψ relative stiffness of columns to beams in a rigid connection *(see G)*