

## List of Symbol Definitions

- a* long dimension for a section subjected to torsion (in, mm);  
acceleration (ft/sec<sup>2</sup>, m/sec<sup>2</sup>);  
acceleration due to gravity, 32.17 ft/sec<sup>2</sup>, 9.81 m/sec<sup>2</sup> (*also see g*);  
unit area (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>);  
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)
- a* area bounded by the centerline of a thin walled section subjected to torsion (in<sup>2</sup>, mm<sup>2</sup>)
- A* area, often cross-sectional (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- A<sub>b</sub>* nominal cross section bolt area (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- A<sub>e</sub>* net effective area, equal to the total area ignoring any holes and modified by the lag factor, *U*, (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>) (*see A<sub>net</sub>*)
- A<sub>g</sub>* gross area, equal to the total area ignoring any holes (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- A<sub>gv</sub>* gross area in shear, equal to the total area ignoring any holes (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- A<sub>net</sub>* net effective area, equal to the gross area subtracting any holes (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>) (*see A<sub>e</sub>*)
- A<sub>nt</sub>* net area in shear of a bolted connection subject to shear rupture (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- A<sub>nv</sub>* net area in tension of a bolted connection subject to shear rupture (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>);  
net shear area for a masonry member (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- A<sub>p</sub>* bearing area (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- A<sub>throat</sub>* area across the throat of a weld (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- A<sub>s</sub>* area of steel reinforcement in concrete beam design (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- A<sub>s'</sub>* area of compression steel reinforcement in concrete beam design (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- A<sub>v</sub>* area of concrete shear stirrup reinforcement (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>);  
seismic coefficient for acceleration
- A<sub>web</sub>* web area in a steel beam equal to the depth x web thickness (in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- A<sub>1</sub>* area of column in spread footing design ((in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- A<sub>2</sub>* projected bearing area of column load in spread footing design ((in<sup>2</sup>, ft<sup>2</sup>, mm<sup>2</sup>, m<sup>2</sup>)
- 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<sub>E</sub>* effective width of the flange of a concrete T beam cross section (in, mm)
- b<sub>f</sub>* width of the flange of a steel or concrete T beam cross section (in, mm)
- b<sub>o</sub>* perimeter length for two-way shear in concrete footing design (in, ft, mm, m)
- b<sub>w</sub>* 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) ( <i>see x</i> )
$c_1$	coefficient for shear stress for a rectangular bar in torsion
$c_2$	coefficient for shear twist for a rectangular bar in torsion
$CL, \text{¢}$	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 $\delta$ & $\Delta$ )
$d'$	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 $\varepsilon$ ); 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 ( $\text{sec}^{-1}$ , 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 in steel design
$F_{EXX}$	yield strength of weld material (psi, ksi, kPa, MPa)
$F_{horizontal-resist}$	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 ( <i>also see SF</i> )
$g$	acceleration due to gravity, 32.17 ft/sec <sup>2</sup> , 9.81 m/sec <sup>2</sup> ( <i>also see a</i> ) gage spacing of staggered bolt holes (in, mm)
$G$	shear modulus (psi; ksi, kPa, MPa, GPa); gigaPascals (10 <sup>9</sup> Pa or 1 kN/mm <sup>2</sup> ); relative stiffness of columns to beams in a rigid connection ( <i>see <math>\Psi</math></i> )
$h$	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, ( <i>see <math>\ell_e</math></i> )
$h_c$	height of the web in a wide flange section (in, ft, mm, m) ( <i>also see <math>t_w</math></i> )
$h_f$	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 <sup>4</sup> , mm <sup>4</sup> , m <sup>4</sup> ); seismic importance factor based on building occupancy
$\bar{I}$	moment of inertia about the centroid (in <sup>4</sup> , mm <sup>4</sup> , m <sup>4</sup> )
$\bar{I}_T$	moment of inertia about the centroid of a composite shape (in <sup>4</sup> , mm <sup>4</sup> , m <sup>4</sup> ) ( <i>also see <math>\hat{I}</math></i> )
$\hat{I}$	moment of inertia about the centroid of a composite shape (in <sup>4</sup> , mm <sup>4</sup> , m <sup>4</sup> ) ( <i>also see <math>I_c</math></i> )
$I_c$	moment of inertia about the centroid of a composite shape (in <sup>4</sup> , mm <sup>4</sup> , m <sup>4</sup> )
$I_{min}$	minimum moment of inertia of $I_x$ and $I_y$ (in <sup>4</sup> , mm <sup>4</sup> , m <sup>4</sup> )
$I_{net}$	moment of inertia of plate area excluding bolt holes (in <sup>3</sup> , mm <sup>3</sup> , m <sup>3</sup> )
$I_o$	moment of inertia about the centroid (in <sup>4</sup> , mm <sup>4</sup> , m <sup>4</sup> )
$I_{transformed}$	moment of inertia of a multi-material section transformed to one material (in <sup>4</sup> , mm <sup>4</sup> , m <sup>4</sup> )
$I_x$	moment of inertia with respect to an x-axis (in <sup>4</sup> , mm <sup>4</sup> , m <sup>4</sup> )
$I_y$	moment of inertia with respect to a y-axis (in <sup>4</sup> , mm <sup>4</sup> , m <sup>4</sup> )
$j$	number of connections in a truss ( <i>also see n</i> ); multiplier by effective depth of concrete or masonry section for moment arm, $jd$ ( <i>see d</i> )
$J, J_o$	polar moment of inertia (in <sup>4</sup> , mm <sup>4</sup> , m <sup>4</sup> )

$k$	kips (1000 lb); shape factor for plastic design of steel beams, $M_p/M_y$ ; effective length factor for columns ( <i>also</i> $K$ ); 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 <sup>2</sup> )
$ksf$	kips per square foot (k/ft <sup>2</sup> )
$kN$	kiloNewtons (10 <sup>3</sup> N)
$kPa$	kiloPascals (10 <sup>3</sup> Pa)
$K$	effective length factor with respect to column end conditions ( <i>also</i> $k$ ); masonry mortar strength designation
$K_A$	empirically derived coefficient based on soil properties
$K_{cE}$	material factor for wood column design
$\ell$	length (in, ft, mm, m); cable span (ft, m)
$\ell_d$	development length of concrete reinforcement (in, ft, mm, m)
$\ell_{dc}$	development length of compression reinforcement in concrete footing design (in, ft, mm, m)
$\ell_{dh}$	development length for hooks (in, ft, mm, m)
$\ell_e$	effective length that can buckle for wood column design (in, ft, mm, m)
$\ell_n$	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); effective length of a steel member (in, ft, mm, m) ( <i>see</i> $L_e$ )
$L_{c1}$	effective length of a steel member in the plane of bending (in, ft, mm, m)
$L_d$	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 ( $\rho_b$ ) for limiting strains in both concrete and steel (lb-ft, kip-ft, N-m, kN-m)
$M_c$	allowable or design flexural strength for steel beam-columns (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)
$M_{nt}$	moment (ASD or LRFD) with the structure restrained against lateral translation for steel beam-columns (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) ( <i>also see</i> $M_{ult}$ )
$M_r$	required flexural strength for steel beam-columns (lb-ft, kip-ft, N-m, kN-m)
$M_{resist}$	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) ( <i>also see</i> $M_p$ )
$M_y$	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 $1 \text{ N/mm}^2$ )
$n$	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 ( $\text{kg}\cdot\text{m}/\text{sec}^2$ ); 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
$N_\phi$	meridional in-plane internal force per unit length in a shell (lb/ft, N/m, kN/m)
$N_\theta$	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) ( <i>also see s</i> ); pressure ( $\text{lb}/\text{in}^2$ , $\text{lb}/\text{ft}^2$ , $\text{kip}/\text{in}^2$ , $\text{kip}/\text{ft}^2$ , Pa, MPa); unit weight of soil for determining active lateral pressure ( $\text{lb}/\text{ft}^3$ , $\text{kN}/\text{m}^3$ )
$p_A$	active soil pressure ( $\text{lb}/\text{ft}^3$ , $\text{kN}/\text{m}^3$ )
$p_r$	internal pressure ( $\text{lb}/\text{in}^2$ , $\text{lb}/\text{ft}^2$ , $\text{kip}/\text{in}^2$ , $\text{kip}/\text{ft}^2$ , Pa, MPa)
$plf$	pounds per linear foot (lb/ft)
$psf$	pounds per square inch ( $\text{lb}/\text{ft}^2$ )
$psi$	pounds per square inch ( $\text{lb}/\text{in}^2$ )
$P$	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)
$P_a$	Pascals (N/m <sup>2</sup> )
$q$	shear flow (lb/in, kips/ft, N/m, kN/m) ); soil bearing pressure (lb/ft <sup>2</sup> , kips/ft <sup>2</sup> , N/m <sup>2</sup> , Pa, MPa)
$q_{allowed}$	allowable soil bearing pressure (lb/ft <sup>2</sup> , kips/ft <sup>2</sup> , N/m <sup>2</sup> , Pa, MPa)
$q_h$	static wind velocity pressure for wind force calculation (lb/ft <sup>2</sup> , kips/ft <sup>2</sup> , N/m, Pa, MPa)
$q_{net}$	net allowed soil bearing pressure (lb/ft <sup>2</sup> , kips/ft <sup>2</sup> , N/m, Pa, MPa)
$q_u$	factored soil bearing pressure in concrete design from load factors (lb/ft <sup>2</sup> , kips/ft <sup>2</sup> , N/m, Pa, MPa)
$Q$	first moment area used in shearing stress calculations (in <sup>3</sup> , mm <sup>3</sup> , m <sup>3</sup> )
$Q_{connected}$	first moment area used in shear calculations for built-up beams (in <sup>3</sup> , mm <sup>3</sup> , m <sup>3</sup> )
$Q_x$	first moment area about an x axis (using y distances) (in <sup>3</sup> , mm <sup>3</sup> , m <sup>3</sup> )
$Q_y$	first moment area about an y axis (using x distances) (in <sup>3</sup> , mm <sup>3</sup> , m <sup>3</sup> )
$r$	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) ( <i>also see</i> $V_a$ , $M_a$ )
$R_n$	concrete beam design ratio = $M_u/bd^2$ (lb/in <sup>2</sup> , MPa) nominal value for LRFD design to be multiplied by $\phi$ ( <i>also see</i> $P_n$ , $M_n$ ) nominal value for ASD design to be divided by the safety factor $\Omega$
$R_u$	design value for LRFD design based on load factors ( <i>also see</i> $P_u$ , $M_u$ )
$R_w$	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) ( <i>also see</i> $p$ ); 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 ( $\text{in}^3, \text{mm}^3, \text{m}^3$ ); 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 ( $\text{in}^3, \text{mm}^3, \text{m}^3$ )
$S_{required}$	section modulus required to not exceed allowable bending stress ( $\text{in}^3, \text{mm}^3, \text{m}^3$ )
$S_x$	section modulus with respect to the x-centroidal axis ( $\text{in}^3, \text{mm}^3, \text{m}^3$ )
$S_y$	section modulus with respect to the y-centroidal axis ( $\text{in}^3, \text{mm}^3, \text{m}^3$ )
$SC$	slip critical bolted connection
$SF$	safety factor ( <i>see F.S.</i> )
$S4S$	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 ( <i>see <math>A_e</math> and <math>A_{net}</math></i> )
$U_{bs}$	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) ( <i>see <math>q</math></i> )
$V$	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 <sup>2</sup> , kip/ft <sup>2</sup> , N/m <sup>2</sup> , kN/m <sup>2</sup> ) ( <i>see <math>w'</math></i> ); width dimension (in, ft, mm, m)
$w_c$	weight of reinforced concrete per unit volume (lb/ft <sup>3</sup> , N/m <sup>3</sup> )

$w_u$	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 <sup>2</sup> , kip/ft <sup>2</sup> , N/m <sup>2</sup> , kN/m <sup>2</sup> )
$w'$	load per unit area on a surface (lb/ft <sup>2</sup> , kip/ft <sup>2</sup> , N/m <sup>2</sup> , kN/m <sup>2</sup> ) ( <i>see w</i> );
$W$	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) ( <i>see c</i> )
$\bar{x}$	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) ( <i>also see <math>\hat{y}</math></i> )
$\hat{y}$	the distance in the y direction from a reference axis to the centroid of a composite shape (in, mm) ( <i>also see <math>\bar{y}_T</math></i> )
$z$	the distance from a unit area to a reference axis (in, ft, mm, m) ( <i>also see <math>d_x</math> and <math>d_y</math></i> )
$Z$	plastic section modulus of a steel beam (in <sup>3</sup> , mm <sup>3</sup> ); 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
$\alpha$	coefficient of thermal expansion (/°C, /°F); angle, in a math equation (degrees, radians)
$\beta$	angle, in a math equation (degrees, radians)
$\beta_c$	ratio of long side to short side of the column in concrete footing design
$\beta_1$	coefficient for determining stress block height, $a$ , based on concrete strength, $f'_c$
$\delta$	elongation (in, mm) ( <i>see e</i> )

$\delta_P$	elongation due to axial load (in, mm)
$\delta_s$	shear deformation (in, mm)
$\delta_T$	elongation due to change in temperature (in, mm)
$\Delta$	beam deflection (in, mm); story drift (in, mm); an increment
$\Delta_{LL}$	beam deflection due to live load (in, mm)
$\Delta_{max}$	maximum calculated beam deflection (in, mm)
$\Delta_T$	beam deflection due to total load (in, mm)
$\Delta T$	change in temperature (°C, °F)
$\varepsilon$	strain (no units)
$\varepsilon_t$	thermal strain (no units): strain in the steel
$\varepsilon_y$	= strain at the yield stress
$\phi$	diameter symbol; angle of twist (degrees, radians); resistance factor in LRFD steel design and reinforced concrete design; angle defining the shell cutoff (degrees, radians)
$\kappa$	limit of timber slenderness for intermediate length columns (no units)
$\lambda$	design constant for steel base plate design; modification factor for reinforced concrete shear for lightweight materials
$\mu$	Poisson's ratio ( <i>also see</i> $\nu$ ); coefficient of static friction
$\nu$	Poisson's ratio ( <i>also see</i> $\mu$ )
$\gamma$	specific gravity of a material (lb/in <sup>3</sup> , lb/ft <sup>3</sup> , N/m <sup>3</sup> , kN/m <sup>3</sup> ); angle, in a math equation (degrees, radians); shearing strain (no units); load factor in LRFD design; ratio of reinforcement width to width of column
$\gamma_D$	dead load factor in LRFD steel design
$\gamma_L$	live load factor in LRFD steel design
$\theta$	angle, in a trig equation, ex. $\sin \theta$ (degrees, radians); slope of the deflection of a beam at a point (degrees, radians)
$\pi$	pi (180°)
$\rho$	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)
$\rho_b$	balanced reinforcement ratio in concrete beam design

$\rho_g$	reinforcement ratio in concrete column design = $A_{st}/A_g$
$\rho_{max}$	maximum reinforcement ratio allowed in concrete beam design for ductile behavior
$\sigma$	engineering symbol for normal stress (axial or bending)
$\tau$	engineering symbol for shearing stress
$\nu_c$	shearing stress capacity in concrete design (psi; ksi, kPa, MPa);
$\omega$	load per unit length on a beam (lb/ft, kip/ft, N/m, kN/m) ( <i>see w</i> ); load per unit area (lb/ft <sup>2</sup> , kips/ft <sup>2</sup> , N/m <sup>2</sup> , Pa, MPa)
$\omega'$	load per unit volume (lb/ft, kip/ft, N/m, kN/m) ( <i>see <math>\gamma</math></i> )
$\Sigma$	summation symbol
$\Omega$	safety factor for ASD of steel (unified)
$\Psi$	relative stiffness of columns to beams in a rigid connection ( <i>see G</i> )