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Specification for Structural Steel Buildings

July 7, 2016

Supersedes the *Specification for Structural Steel Buildings* dated June 22, 2010 and all previous versions of this specification

Approved by the AISC Committee on Specifications

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PREFACE

(This Preface is not part of ANSI/AISC 360-16, *Specification for Structural Steel Buildings*, but is included for informational purposes only.)

This Specification is based upon past successful usage, advances in the state of knowledge, and changes in design practice. The 2016 American Institute of Steel Construction's *Specification for Structural Steel Buildings* provides an integrated treatment of allowable strength design (ASD) and load and resistance factor design (LRFD), and replaces earlier Specifications. As indicated in Chapter B of the Specification, designs can be made according to either ASD or LRFD provisions.

This ANSI-approved Specification has been developed as a consensus document using ANSI-accredited procedures to provide a uniform practice in the design of steel-framed buildings and other structures. The intention is to provide design criteria for routine use and not to provide specific criteria for infrequently encountered problems, which occur in the full range of structural design.

This Specification is the result of the consensus deliberations of a committee of structural engineers with wide experience and high professional standing, representing a wide geographical distribution throughout the United States. The committee includes approximately equal numbers of engineers in private practice and code agencies, engineers involved in research and teaching, and engineers employed by steel fabricating and producing companies. The contributions and assistance of more than 50 additional professional volunteers working in task committees are also hereby acknowledged.

The Symbols, Glossary, Abbreviations and Appendices to this Specification are an integral part of the Specification. A nonmandatory Commentary has been prepared to provide background for the Specification provisions and the user is encouraged to consult it. Additionally, nonmandatory User Notes are interspersed throughout the Specification to provide concise and practical guidance in the application of the provisions.

A number of significant technical modifications have also been made since the 2010 edition of the Specification, including the following:

- Adopted an ASTM umbrella bolt specification, ASTM F3125, that includes Grades A325, A325M, A490, A490M, F1852 and F2280
- Adopted new ASTM HSS material specifications, ASTM A1085/A1085M and A1065/A1065M, that permit use of a design thickness equal to the full nominal thickness of the member
- Expanded the structural integrity provisions applicable to connection design
- Added a shear lag factor for welded plates or connected elements with unequal length longitudinal welds
- The available compressive strength for double angles and tees is determined by the general flexural-torsional buckling equation for members without slender elements
- Added a constrained-axis torsional buckling limit state for members with lateral bracing offset from the shear center
- Revised the available compressive strength formulation for members with slender compression elements
- Reformulated the available flexural strength provisions for tees and double angles

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- Revised the shear strength of webs of certain I-shapes and channels without tension field action and when considering tension field action
- Increased the limit on rebar strength to 80 ksi for composite columns
- Incorporated provisions for applying the direct analysis method to composite members
- Inserted general requirements to address minimum composite action in composite beams
- Revised the provisions for bolts in combination with welds
- Increased minimum pretension for $1^1/_8$-in.-diameter and larger bolts
- Increased standard hole sizes and short-slot and long-slot widths for 1-in.-diameter and larger bolts
- Reorganized the HSS connection design provisions in Chapter K, including reference to Chapter J for some limit states
- Expanded provisions in Appendix 1 for direct modeling of member imperfections and inelasticity that may be used with the direct analysis method
- Inserted a table of properties of high-strength bolts at elevated temperatures in Appendix 4

The reader is cautioned that professional judgment must be exercised when data or recommendations in the Specification are applied, as described more fully in the disclaimer notice preceding this Preface.

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The Committee gratefully acknowledges advisory members, Carlos Aguirre, Edward E. Garvin and Alfred F. Wong, for their contributions, and the following task committee members for their involvement in the development of this document.

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SYMBOLS

Some definitions in the list below have been simplified in the interest of brevity. In all cases, the definitions given in the body of this Specification govern. Symbols without text definitions, or used only in one location and defined at that location, are omitted in some cases. The section or table number in the righthand column refers to the Section where the symbol is first defined.

Symbol	Definition	Section
A	Cross-sectional area of angle, in.^{2} (mm^2)	F10.2
A_{BM}	Cross-sectional area of the base metal, in.^{2} (mm^2)	J2.4
A_b	Nominal unthreaded body area of bolt or threaded part, in.^{2} (mm^2)	J3.6
A_c	Area of concrete, in.^{2} (mm^2)	I2.1b
A_c	Area of concrete slab within effective width, in.^{2} (mm^2)	I3.2d
A_e	Effective area, in.^{2} (mm^2)	E7.2
A_e	Effective net area, in.^{2} (mm^2)	D2
A_e	Summation of the effective areas of the cross section based on the reduced effective widths, b_e, d_e or h_e, in.^{2} (mm^2)	E7
A_{fc}	Area of compression flange, in.^{2} (mm^2)	G2.2
A_{fg}	Gross area of tension flange, in.^{2} (mm^2)	F13.1
A_{fn}	Net area of tension flange, in.^{2} (mm^2)	F13.1
A_{ft}	Area of tension flange, in.^{2} (mm^2)	G2.2
A_g	Gross area of member, in.^{2} (mm^2)	B4.3a
A_g	Gross area of composite member, in.^{2} (mm^2)	I2.1
A_{gv}	Gross area subject to shear, in.^{2} (mm^2)	J4.2
A_n	Net area of member, in.^{2} (mm^2)	B4.3b
A_{nt}	Net area subject to tension, in.^{2} (mm^2)	J4.3
A_{nv}	Net area subject to shear, in.^{2} (mm^2)	J4.2
A_{pb}	Projected area in bearing, in.^{2} (mm^2)	J7
A_s	Cross-sectional area of steel section, in.^{2} (mm^2)	I2.1b
A_{sa}	Cross-sectional area of steel headed stud anchor, in.^{2} (mm^2)	I8.2a
A_{sf}	Area on the shear failure path, in.^{2} (mm^2)	D5.1
A_{sr}	Area of continuous reinforcing bars, in.^{2} (mm^2)	I2.1a
A_{sr}	Area of developed longitudinal reinforcing steel within the effective width of the concrete slab, in.^{2} (mm^2)	I3.2d.2
A_t	Net area in tension, in.^{2} (mm^2)	App. 3.4
A_T	Nominal forces and deformations due to the design-basis fire defined in Section 4.2.1	App. 4.1.4
A_w	Area of web, the overall depth times the web thickness, dt_w, in.^{2} (mm^2)	G2.1
A_{we}	Effective area of the weld, in.^{2} (mm^2)	J2.4
A_1	Loaded area of concrete, in.^{2} (mm^2)	I6.3a
A_1	Area of steel concentrically bearing on a concrete support, in.^{2} (mm^2)	J8
A_2	Maximum area of the portion of the supporting surface that is geometrically similar to and concentric with the loaded area, in.^{2} (mm^2)	J8

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Symbol	Definition	Section
B	Overall width of rectangular HSS main member, measured 90° to the plane of the connection, in. (mm)	Table D3.1
B_b	Overall width of rectangular HSS branch member or plate, measured 90° to the plane of the connection, in. (mm)	K1.1
B_e	Effective width of rectangular HSS branch member or plate, in. (mm)	K1.1
B_1	Multiplier to account for P-δ effects	App. 8.2
B_2	Multiplier to account for P-Δ effects	App. 8.2
C	HSS torsional constant	H3.1
C_b	Lateral-torsional buckling modification factor for nonuniform moment diagrams when both ends of the segment are braced	F1
C_f	Constant from Table A-3.1 for the fatigue category	App. 3.3
C_m	Equivalent uniform moment factor assuming no relative translation of member ends	App. 8.2.1
C_{v1}	Web shear strength coefficient	G2.1
C_{v2}	Web shear buckling coefficient	G2.2
C_w	Warping constant, in.^{6} (mm^6)	E4
C_1	Coefficient for calculation of effective rigidity of encased composite compression member	I2.1b
C_2	Edge distance increment, in. (mm)	Table J3.5
C_3	Coefficient for calculation of effective rigidity of filled composite compression member	I2.2b
D	Outside diameter of round HSS, in. (mm)	E7.2
D	Outside diameter of round HSS main member, in. (mm)	K1.1
D	Nominal dead load, kips (N)	B3.9
D	Nominal dead load rating	App. 5.4.1
D_b	Outside diameter of round HSS branch member, in. (mm)	K1.1
D_u	In slip-critical connections, a multiplier that reflects the ratio of the mean installed bolt pretension to the specified minimum bolt pretension	J3.8
E	Modulus of elasticity of steel = 29,000 ksi (200 000 MPa)	Table B4.1
E_c	Modulus of elasticity of concrete = $w_c^{1.5}\sqrt{f'_c}$, ksi ($0.043w_c^{1.5}\sqrt{f'_c}$, MPa)	I2.1b
E_s	Modulus of elasticity of steel = 29,000 ksi (200 000 MPa)	I2.1b
EI_{eff}	Effective stiffness of composite section, kip-in.^{2} (N-mm^2)	I2.1b
F_c	Available stress in main member, ksi (MPa)	K1.1
F_{ca}	Available axial stress at the point of consideration, ksi (MPa)	H2
F_{cbw}, F_{cbz}	Available flexural stress at the point of consideration, ksi (MPa)	H2
F_{cr}	Buckling stress for the section as determined by analysis, ksi (MPa)	H3.3
F_{cr}	Critical stress, ksi (MPa)	E3
F_{cr}	Lateral-torsional buckling stress for the section as determined by analysis, ksi (MPa)	F12.2
F_{cr}	Local buckling stress for the section as determined by analysis, ksi (MPa)	F12.3
F_e	Elastic buckling stress, ksi (MPa)	E3
F_{el}	Elastic local buckling stress, ksi (MPa)	E7.1
F_{EXX}	Filler metal classification strength, ksi (MPa)	J2.4
F_{in}	Nominal bond stress, ksi (MPa)	I6.2c

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Symbol	Definition	Section
F_L	Nominal compressive strength above which the inelastic buckling limit states apply, ksi (MPa)	F4.2
F_{nBM}	Nominal stress of the base metal, ksi (MPa)	J2.4
F_{nt}	Nominal tensile stress from Table J3.2, ksi (MPa)	J3.6
F'_{nt}	Nominal tensile stress modified to include the effects of shear stress, ksi (MPa)	J3.7
F_{nv}	Nominal shear stress from Table J3.2, ksi (MPa)	J3.6
F_{nw}	Nominal stress of the weld metal, ksi (MPa)	J2.4
F_{nw}	Nominal stress of the weld metal (Chapter J) with no increase in strength due to directionality of load for fillet welds, ksi (MPa)	K5
F_{SR}	Allowable stress range, ksi (MPa)	App. 3.3
F_{TH}	Threshold allowable stress range, maximum stress range for indefinite design life from Table A-3.1, ksi (MPa)	App. 3.3
F_u	Specified minimum tensile strength, ksi (MPa)	D2
F_y	Specified minimum yield stress, ksi (MPa). As used in this Specification, "yield stress" denotes either the specified minimum yield point (for those steels that have a yield point) or specified yield strength (for those steels that do not have a yield point)	B3.3
F_{yb}	Specified minimum yield stress of HSS branch member or plate material, ksi (MPa)	K1.1
F_{yf}	Specified minimum yield stress of the flange, ksi (MPa)	J10.1
F_{ysr}	Specified minimum yield stress of reinforcing steel, ksi (MPa)	I2.1b
F_{yst}	Specified minimum yield stress of the stiffener material, ksi (MPa)	G2.3
F_{yw}	Specified minimum yield stress of the web material, ksi (MPa)	G2.3
G	Shear modulus of elasticity of steel = 11,200 ksi (77 200 MPa)	E4
H	Maximum transverse dimension of rectangular steel member, in. (mm)	16.3c
H	Total story shear, in the direction of translation being considered, produced by the lateral forces used to compute Δ_H, kips (N)	App. 8.2.2
H	Overall height of rectangular HSS member, measured in the plane of the connection, in. (mm)	K1.1
H_b	Overall height of rectangular HSS branch member, measured in the plane of the connection, in. (mm)	K1.1
I	Moment of inertia in the plane of bending, in.^{4} (mm^4)	App. 8.2.1
I_c	Moment of inertia of the concrete section about the elastic neutral axis of the composite section, in.^{4} (mm^4)	I2.1b
I_d	Moment of inertia of the steel deck supported on secondary members, in.^{4} (mm^4)	App. 2.1
I_p	Moment of inertia of primary members, in.^{4} (mm^4)	App. 2.1
I_s	Moment of inertia of secondary members, in.^{4} (mm^4)	App. 2.1
I_s	Moment of inertia of steel shape about the elastic neutral axis of the composite section, in.^{4} (mm^4)	I2.1b
I_{sr}	Moment of inertia of reinforcing bars about the elastic neutral axis of the composite section, in.^{4} (mm^4)	I2.1b
I_{st}	Moment of inertia of transverse stiffeners about an axis in the web center for stiffener pairs, or about the face in contact with the web plate for single stiffeners, in.^{4} (mm^4)	G2.3

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Symbol	Definition	Section
I_{st1}	Minimum moment of inertia of transverse stiffeners required for development of the full shear post buckling resistance of the stiffened web panels, in.^{4} (mm^4)	G2.3
I_{st2}	Minimum moment of inertia of transverse stiffeners required for development of web shear buckling resistance, in.^{4} (mm^4)	G2.3
I_x, I_y	Moment of inertia about the principal axes, in.^{4} (mm^4)	E4
I_{yeff}	Effective out-of-plane moment of inertia, in.^{4} (mm^4)	App. 6.3.2a
I_{yc}	Moment of inertia of the compression flange about the y-axis, in.^{4} (mm^4)	F4.2
I_{yt}	Moment of inertia of the tension flange about the y-axis, in.^{4} (mm^4)	App. 6.3.2a
J	Torsional constant, in.^{4} (mm^4)	E4
K	Effective length factor	E2
K_x	Effective length factor for flexural buckling about x-axis	E4
K_y	Effective length factor for flexural buckling about y-axis	E4
K_z	Effective length factor for torsional buckling about the longitudinal axis	E4
L	Length of member, in. (mm)	H3.1
L	Laterally unbraced length of member, in. (mm)	E2
L	Length of span, in. (mm)	App. 6.3.2a
L	Length of member between work points at truss chord centerlines, in. (mm)	E5
L	Nominal live load	B3.9
L	Nominal live load rating	App. 5.4.1
L	Nominal occupancy live load, kips (N)	App. 4.1.4
L	Height of story, in. (mm)	App. 7.3.2
L_b	Length between points that are either braced against lateral displacement of compression flange or braced against twist of the cross section, in. (mm)	F2.2
L_b	Largest laterally unbraced length along either flange at the point of load, in. (mm)	J10.4
L_{br}	Unbraced length within the panel under consideration, in. (mm)	App. 6.2.1
L_{br}	Unbraced length adjacent to the point brace, in. (mm)	App. 6.2.2
L_c	Effective length of member, in. (mm)	E2
L_{cx}	Effective length of member for buckling about x-axis, in. (mm)	E4
L_{cy}	Effective length of member for buckling about y-axis, in. (mm)	E4
L_{cz}	Effective length of member for buckling about longitudinal axis, in. (mm)	E4
L_{c1}	Effective length in the plane of bending, calculated based on the assumption of no lateral translation at the member ends, set equal to the laterally unbraced length of the member unless analysis justifies a smaller value, in. (mm)	App. 8.2.1
L_{in}	Load introduction length, in. (mm)	I6.3c
L_p	Limiting laterally unbraced length for the limit state of yielding, in. (mm)	F2.2
L_p	Length of primary members, ft (m)	App. 2.1

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Symbol	Definition	Section
L_r	Limiting laterally unbraced length for the limit state of inelastic lateral-torsional buckling, in. (mm)	F2.2
L_r	Nominal roof live load	App. 5.4.1
L_s	Length of secondary members, ft (m)	App. 2.1
L_v	Distance from maximum to zero shear force, in. (mm)	G5
L_x, L_y, L_z	Laterally unbraced length of the member for each axis, in. (mm)	E4
M_A	Absolute value of moment at quarter point of the unbraced segment, kip-in. (N-mm)	F1
M_a	Required flexural strength using ASD load combinations, kip-in. (N-mm)	J10.4
M_B	Absolute value of moment at centerline of the unbraced segment, kip-in. (N-mm)	F1
M_C	Absolute value of moment at three-quarter point of the unbraced segment, kip-in. (N-mm)	F1
M_c	Available flexural strength, kip-in. (N-mm)	H1.1
M_{cr}	Elastic lateral-torsional buckling moment, kip-in. (N-mm)	F10.2
M_{cx}, M_{cy}	Available flexural strength determined in accordance with Chapter F, kip-in. (N-mm)	H1.1
M_{cx}	Available lateral-torsional strength for major axis flexure determined in accordance with Chapter F using $C_b = 1.0$, kip-in. (N-mm)	H1.3
M_{cx}	Available flexural strength about x-axis for the limit state of tensile rupture of the flange, determined according to Section F13.1, kip-in. (N-mm)	H4
M_{lt}	First-order moment using LRFD or ASD load combinations, due to lateral translation of the structure only, kip-in. (N-mm)	App. 8.2
M_{max}	Absolute value of maximum moment in the unbraced segment, kip-in. (N-mm)	F1
M_n	Nominal flexural strength, kip-in. (N-mm)	F1
M_{nt}	First-order moment using LRFD or ASD load combinations, with the structure restrained against lateral translation, kip-in. (N-mm)	App. 8.2
M_p	Plastic bending moment, kip-in. (N-mm)	Table B4.1
M_p	Moment corresponding to plastic stress distribution over the composite cross section, kip-in. (N-mm)	I3.4b
M_r	Required second-order flexural strength using LRFD or ASD load combinations, kip-in. (N-mm)	App. 8.2
M_r	Required flexural strength, determined in accordance with Chapter C, using LRFD or ASD load combinations, kip-in. (N-mm)	H1.1
M_r	Required flexural strength of the beam within the panel under consideration using LRFD or ASD load combinations, kip-in. (N-mm)	App. 6.3.1a
M_r	Largest of the required flexural strengths of the beam within the unbraced lengths adjacent to the point brace using LRFD or ASD load combinations, kip-in. (N-mm)	App. 6.3.1b

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Symbol	Definition	Section
M_{br}	Required flexural strength of the brace, kip-in. (N-mm)	App. 6.3.2a
M_{ro}	Required flexural strength in chord at a joint, on the side of joint with lower compression stress, kips (N)	Table K2.1
$M_{r\text{-}ip}$	Required in-plane flexural strength in branch using LRFD or ASD load combinations, kip-in. (N-mm)	Table K4.1
$M_{r\text{-}op}$	Required out-of-plane flexural strength in branch using LRFD or ASD load combinations, kip-in. (N-mm)	Table K4.1
M_{rx}, M_{ry}	Required flexural strength, kip-in. (N-mm)	H1.1
M_{rx}	Required flexural strength at the location of the bolt holes, determined in accordance with Chapter C, positive for tension in the flange under consideration, negative for compression, kip-in. (N-mm)	H4
M_u	Required flexural strength using LRFD load combinations, kip-in. (N-mm)	J10.4
M_y	Moment at yielding of the extreme fiber, kip-in. (N-mm)	Table B4.1
M_y	Yield moment corresponding to yielding of the tension flange and first yield of the compression flange, kip-in. (N-mm)	I3.4b
M_y	Yield moment about the axis of bending, kip-in. (N-mm)	F9.1
M_{yc}	Yield moment in the compression flange, kip-in. (N-mm)	F4.1
M_{yt}	Yield moment in the tension flange, kip-in. (N-mm)	F4.4
M_1'	Effective moment at the end of the unbraced length opposite from M_2, kip-in. (N-mm)	App. 1.3.2c
M_1	Smaller moment at end of unbraced length, kip-in. (N-mm)	F13.5
M_2	Larger moment at end of unbraced length, kip-in. (N-mm)	F13.5
N_i	Notional load applied at level i, kips (N)	C2.2b
N_i	Additional lateral load, kips (N)	App. 7.3.2
O_v	Overlap connection coefficient	K3.1
P_a	Required axial strength in chord using ASD load combinations, kips (N)	Table K2.1
P_{br}	Required end and intermediate point brace strength using LRFD or ASD load combinations, kips (N)	App. 6.2.2
P_c	Available axial strength, kips (N)	H1.1
P_c	Available axial strength for the limit state of tensile rupture of the net section at the location of bolt holes, kips (N)	H4
P_{cy}	Available axial compressive strength out of the plane of bending, kips (N)	H1.3
P_e	Elastic critical buckling load determined in accordance with Chapter C or Appendix 7, kips (N)	I2.1b
$P_{e\ story}$	Elastic critical buckling strength for the story in the direction of translation being considered, kips (N)	App 8.2.2
P_{e1}	Elastic critical buckling strength of the member in the plane of bending, kips (N)	App. 8.2.1
P_{lt}	First-order axial force using LRFD or ASD load combinations, due to lateral translation of the structure only, kips (N)	App. 8.2
P_{mf}	Total vertical load in columns in the story that are part of moment frames, if any, in the direction of translation being considered, kips (N)	App. 8.2.2

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Symbol	Definition	Section
P_n	Nominal axial strength, kips (N)	D2
P_n	Nominal compressive strength, kips (N)	E1
P_{no}	Nominal axial compressive strength of zero length, doubly symmetric, axially loaded composite member, kips (N)	I2.1b
P_{no}	Available compressive strength of axially loaded doubly symmetric filled composite members, kips (N)	I2.2b
P_{ns}	Cross-section compressive strength, kips (N)	C2.3
P_{nt}	First-order axial force using LRFD and ASD load combinations, with the structure restrained against lateral translation, kips (N)	App. 8.2
P_p	Nominal bearing strength, kips (N)	J8
P_r	Largest of the required axial strengths of the column within the unbraced lengths adjacent to the point brace, using LRFD or ASD load combinations, kips (N)	App. 6.2.2
P_r	Required axial compressive strength using LRFD or ASD load combinations, kips (N)	C2.3
P_r	Required axial strength of the column within the panel under consideration, using LRFD or ASD load combinations, kips (N)	App. 6.2.1
P_r	Required second-order axial strength using LRFD or ASD load combinations, kips (N)	App. 8.2
P_r	Required axial strength, determined in accordance with Chapter C, using LRFD or ASD load combinations, kips (N)	H1.1
P_r	Required axial strength of the member at the location of the bolt holes; positive in tension, negative in compression, kips (N)	H4
P_r	Required external force applied to the composite member, kips (N)	I6.2a
P_{ro}	Required axial strength in chord at a joint, on the side of joint with lower compression stress, kips (N)	Table K2.1
P_{story}	Total vertical load supported by the story using LRFD or ASD load combinations, as applicable, including loads in columns that are not part of the lateral force-resisting system, kips (N)	App. 8.2.2
P_u	Required axial strength in chord using LRFD load combinations, kips (N)	Table K2.1
P_u	Required axial strength in compression using LRFD load combinations, kips (N)	App. 1.3.2b
P_y	Axial yield strength of the column, kips (N)	J10.6
Q_{ct}	Available tensile strength, kips (N)	I8.3c
Q_{cv}	Available shear strength, kips (N)	I8.3c
Q_f	Chord-stress interaction parameter	J10.3
Q_g	Gapped truss joint parameter accounting for geometric effects	Table K3.1
Q_n	Nominal strength of one steel headed stud or steel channel anchors, kips (N)	I3.2d.1
Q_{nt}	Nominal tensile strength of steel headed stud anchor, kips (N)	I8.3b
Q_{nv}	Nominal shear strength of steel headed stud anchor, kips (N)	I8.3a
Q_{rt}	Required tensile strength, kips (N)	I8.3b
Q_{rv}	Required shear strength, kips (N)	I8.3c
R	Radius of joint surface, in. (mm)	Table J2.2
R_a	Required strength using ASD load combinations	B3.2

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Symbol	Definition	Section
R_{FIL}	Reduction factor for joints using a pair of transverse fillet welds only	App. 3.3
R_g	Coefficient to account for group effect	I8.2a
R_M	Coefficient to account for influence of P-δ on P-Δ	App. 8.2.2
R_n	Nominal strength, specified in this Specification	B3.1
R_n	Nominal slip resistance, kips (N)	J1.8
R_n	Nominal strength of the applicable force transfer mechanism, kips (N)	I6.3
R_{nwl}	Total nominal strength of longitudinally loaded fillet welds, as determined in accordance with Table J2.5, kips (N)	J2.4
R_{nwt}	Total nominal strength of transversely loaded fillet welds, as determined in accordance with Table J2.5 without the alternate in Section J2.4(a), kips (N)	J2.4
R_p	Position effect factor for shear studs	I8.2a
R_{pc}	Web plastification factor	F4.1
R_{pg}	Bending strength reduction factor	F5.2
R_{PJP}	Reduction factor for reinforced or nonreinforced transverse partial-joint-penetration (PJP) groove welds	App. 3.3
R_{pt}	Web plastification factor corresponding to the tension flange yielding limit state	F4.4
R_u	Required strength using LRFD load combinations	B3.1
S	Elastic section modulus about the axis of bending, in.^{3} (mm^3)	F7.2
S	Nominal snow load, kips (N)	App. 4.1.4
S	Spacing of secondary members, ft (m)	App. 2.1
S_c	Elastic section modulus to the toe in compression relative to the axis of bending, in.^{3} (mm^3).	F10.3
S_e	Effective section modulus determined with the effective width of the compression flange, in.^{3} (mm^3)	F7.2
S_{ip}	Effective elastic section modulus of welds for in-plane bending, in.^{3} (mm^3)	K5
S_{min}	Minimum elastic section modulus relative to the axis of bending, in.^{3} (mm^3)	F12
S_{op}	Effective elastic section modulus of welds for out-of-plane bending, in.^{3} (mm^3)	K5
S_{xc}, S_{xt}	Elastic section modulus referred to compression and tension flanges, respectively, in.^{3} (mm^3)	Table B4.1
S_x	Elastic section modulus taken about the x-axis, in.^{3} (mm^3)	F2.2
S_x	Minimum elastic section modulus taken about the x-axis, in.^{3} (mm^3)	F13.1
S_y	Elastic section modulus taken about the y-axis, in.^{3} (mm^3)	F6.1
T	Elevated temperature of steel due to unintended fire exposure, °F (°C)	App. 4.2.4d
T_a	Required tension force using ASD load combinations, kips (kN)	J3.9
T_b	Minimum fastener tension given in Table J3.1 or J3.1M, kips (kN)	J3.8
T_c	Available torsional strength, kip-in. (N-mm)	H3.2

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Symbol	Definition	Section
T_n	Nominal torsional strength, kip-in. (N-mm)	H3.1
T_r	Required torsional strength, determined in accordance with Chapter C, using LRFD or ASD load combinations, kip-in. (N-mm)	H3.2
T_u	Required tension force using LRFD load combinations, kips (kN)	J3.9
U	Shear lag factor	D3
U	Utilization ratio	Table K2.1
U_{bs}	Reduction coefficient, used in calculating block shear rupture strength	J4.3
U_p	Stress index for primary members	App. 2.2
U_s	Stress index for secondary members	App. 2.2
V'	Nominal shear force between the steel beam and the concrete slab transferred by steel anchors, kips (N)	I3.2d
V_{br}	Required shear strength of the bracing system in the direction perpendicular to the longitudinal axis of the column, kips (N)	App. 6.2.1
V_c	Available shear strength, kips (N)	H3.2
V_{c1}	Available shear strength calculated with V_n as defined in Section G2.1 or G2.2. as applicable, kips (N)	G2.3
V_{c2}	Available shear buckling strength, kips (N)	G2.3
V_n	Nominal shear strength, kips (N)	G1
V_r	Required shear strength in the panel being considered, kips (N)	G2.3
V_r	Required shear strength determined in accordance with Chapter C, using LRFD or ASD load combinations, kips (N)	H3.2
V_r'	Required longitudinal shear force to be transferred to the steel or concrete, kips (N)	I6.1
Y_i	Gravity load applied at level i from the LRFD load combination or ASD load combination, as applicable, kips (N)	C2.2b
Z	Plastic section modulus taken about the axis of bending, in.^{3} (mm^3)	F7.1
Z_b	Plastic section modulus of branch taken about the axis of bending, in.^{3} (mm^3)	K4.1
Z_x	Plastic section modulus about the x-axis, in.^{3} (mm^3)	Table B4.1
Z_y	Plastic section modulus about the y-axis, in.^{3} (mm^3)	F6.1
a	Clear distance between transverse stiffeners, in. (mm)	F13.2
a	Distance between connectors, in. (mm)	E6.1
a	Shortest distance from edge of pin hole to edge of member measured parallel to the direction of force, in. (mm)	D5.1
a	Half the length of the nonwelded root face in the direction of the thickness of the tension-loaded plate, in. (mm)	App. 3.3
a'	Weld length along both edges of the cover plate termination to the beam or girder, in. (mm)	F13.3
a_w	Ratio of two times the web area in compression due to application of major axis bending moment alone to the area of the compression flange components	F4.2
b	Full width of leg in compression, in. (mm)	F10.3
b	For flanges of I-shaped members, half the full-flange width, in. (mm)	B4.1a

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Symbol	Definition	Section
b	For legs of angles and flanges of channels and zees, full leg or flange width, in. (mm)	B4.1a
b	For plates, the distance from the free edge to the first row of fasteners or line of welds, in. (mm)	B4.1a
b	Width of the element, in. (mm)	E7.1
b	Width of unstiffened compression element; width of stiffened compression element, in. (mm)	B4.1
b	Width of the leg resisting the shear force or depth of tee stem, in. (mm)	G3
b	Width of leg, in. (mm)	F10.2
b_{cf}	Width of column flange, in. (mm)	J10.6
b_e	Reduced effective width, in. (mm)	E7.1
b_e	Effective edge distance for calculation of tensile rupture strength of pin-connected member, in. (mm)	D5.1
b_f	Width of flange, in. (mm)	B4.1
b_{fc}	Width of compression flange, in. (mm)	F4.2
b_{ft}	Width of tension flange, in. (mm)	G2.2
b_l	Length of longer leg of angle, in. (mm)	E5
b_p	Smaller of the dimension a and h, in. (mm)	G2.3
b_s	Length of shorter leg of angle, in. (mm)	E5
b_s	Stiffener width for one-sided stiffeners; twice the individual stiffener width for pairs of stiffeners, in. (mm)	App. 6.3.2a
c	Distance from the neutral axis to the extreme compressive fibers, in. (mm)	App. 6.3.2a
c_1	Effective width imperfection adjustment factor determined from Table E7.1	E7.1
d	Depth of section from which the tee was cut, in. (mm)	Table D3.1
d	Depth of tee or width of web leg in compression, in. (mm)	F9.2
d	Nominal fastener diameter, in. (mm)	J3.3
d	Full nominal depth of the member, in. (mm)	B4.1
d	Depth of rectangular bar, in. (mm)	F11.1
d	Diameter, in. (mm)	J7
d	Diameter of pin, in. (mm)	D5.1
d_b	Depth of beam, in. (mm)	J10.6
d_b	Nominal diameter (body or shank diameter), in. (mm)	App. 3.4
d_c	Depth of column, in. (mm)	J10.6
d_e	Effective width for tees, in. (mm)	E7.1
d_{sa}	Diameter of steel headed stud anchor, in. (mm)	I8.1
e	Eccentricity in a truss connection, positive being away from the branches, in. (mm)	K3.1
$e_{mid\text{-}ht}$	Distance from the edge of steel headed stud anchor shank to the steel deck web, in. (mm)	I8.2a
f_c'	Specified compressive strength of concrete, ksi (MPa)	I1.2b
f_o	Stress due to impounded water due to either nominal rain or snow loads (exclusive of the ponding contribution), and other loads acting concurrently as specified in Section B2, ksi (MPa)	App. 2.2

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Symbol	Definition	Section
f_{ra}	Required axial stress at the point of consideration, determined in accordance with Chapter C, using LRFD or ASD load combinations, ksi (MPa)	H2
f_{rbw}, f_{rbz}	Required flexural stress at the point of consideration, determined in accordance with Chapter C, using LRFD or ASD load combinations, ksi (MPa)	H2
f_{rv}	Required shear stress using LRFD or ASD load combinations, ksi (MPa)	J3.7
g	Transverse center-to-center spacing (gage) between fastener gage lines, in. (mm)	B4.3
g	Gap between toes of branch members in a gapped K-connection, neglecting the welds, in. (mm)	K3.1
h	For webs of rolled or formed sections, the clear distance between flanges less the fillet or corner radius at each flange; for webs of built-up sections, the distance between adjacent lines of fasteners or the clear distance between flanges when welds are used; for webs of rectangular HSS, the clear distance between the flanges less the inside corner radius on each side, in. (mm)	B4.1b
h	Width resisting the shear force, taken as the clear distance between the flanges less the inside corner radius on each side for HSS or the clear distance between flanges for box sections, in. (mm)	G4
h_c	Twice the distance from the center of gravity to the following: the inside face of the compression flange less the fillet or corner radius, for rolled shapes; the nearest line of fasteners at the compression flange or the inside faces of the compression flange when welds are used, for built-up sections, in. (mm)	B4.1
h_e	Effective width for webs, in. (mm)	F7.1
h_f	Factor for fillers	E3.8
h_o	Distance between flange centroids, in. (mm)	F2.2
h_p	Twice the distance from the plastic neutral axis to the nearest line of fasteners at the compression flange or the inside face of the compression flange when welds are used, in. (mm)	B4.1b
k	Distance from outer face of flange to the web toe of fillet, in. (mm)	J10.2
k_c	Coefficient for slender unstiffened elements	Table B4.1
k_{sc}	Slip-critical combined tension and shear coefficient	J3.9
k_v	Web plate shear buckling coefficient	G2.1
l	Actual length of end-loaded weld, in. (mm)	J2.2
l	Length of connection, in. (mm)	Table D3.1
l_a	Length of channel anchor, in. (mm)	I8.2b
l_b	Bearing length of the load, measured parallel to the axis of the HSS member (or measured across the width of the HSS in the case of loaded cap plates), in. (mm)	K2.1
l_b	Length of bearing, in. (mm)	J7
l_c	Clear distance, in the direction of the force, between the edge of the hole and the edge of the adjacent hole or edge of the material, in. (mm)	J3.10

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Symbol	Definition	Section
l_e	Total effective weld length of groove and fillet welds to rectangular HSS for weld strength calculations, in. (mm)	K5
l_{end}	Distance from the near side of the connecting branch or plate to end of chord, in. (mm)	K1.1
l_{ov}	Overlap length measured along the connecting face of the chord beneath the two branches, in. (mm)	K3.1
l_p	Projected length of the overlapping branch on the chord, in. (mm)	K3.1
l_1, l_2	Connection weld length, in. (mm)	Table D3.1
n	Number of braced points within the span	App. 6.3.2a
n	Threads per inch (per mm)	App. 3.4
n_b	Number of bolts carrying the applied tension	J3.9
n_s	Number of slip planes required to permit the connection to slip	J3.8
n_{SR}	Number of stress range fluctuations in design life	App. 3.3
p	Pitch, in. per thread (mm per thread)	App. 3.4
p_b	Perimeter of the steel-concrete bond interface within the composite cross section, in. (mm)	I6.3c
r	Radius of gyration, in. (mm)	E2
r	Retention factor depending on bottom flange temperature	App. 4.2.4d
r_a	Radius of gyration about the geometric axis parallel to the connected leg, in. (mm)	E5
r_i	Minimum radius of gyration of individual component, in. (mm)	E6.1
$\overline{r_o}$	Polar radius of gyration about the shear center, in. (mm)	E4
r_t	Effective radius of gyration for lateral-torsional buckling. For I-shapes with a channel cap or a cover plate attached to the compression flange, radius of gyration of the flange components in flexural compression plus one-third of the web area in compression due to application of major axis bending moment alone, in. (mm)	F4.2
r_x	Radius of gyration about the x-axis, in. (mm)	E4
r_y	Radius of gyration about y-axis, in. (mm)	E4
r_z	Radius of gyration about the minor principal axis, in. (mm)	E5
s	Longitudinal center-to-center spacing (pitch) of any two consecutive holes, in. (mm)	B4.3b
t	Distance from the neutral axis to the extreme tensile fibers, in. (mm)	App. 6.3.2a
t	Thickness of wall, in. (mm)	E7.2
t	Thickness of angle leg, in. (mm)	F10.2
t	Width of rectangular bar parallel to axis of bending, in. (mm)	F11.1
t	Thickness of connected material, in. (mm)	J3.10
t	Thickness of plate, in. (mm)	D5.1
t	Total thickness of fillers, in. (mm)	J5.2
t	Design wall thickness of HSS member, in. (mm)	B4.2
t	Design wall thickness of HSS main member, in. (mm)	K1.1
t	Thickness of angle leg or of tee stem, in. (mm)	G3
t_b	Design wall thickness of HSS branch member or thickness of plate, in. (mm)	K1.1
t_{bi}	Thickness of overlapping branch, in. (mm)	Table K3.2

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Symbol	Definition	Section
t_{bj}	Thickness of overlapped branch, in. (mm)	Table K3.2
t_{cf}	Thickness of column flange, in. (mm)	J10.6
t_f	Thickness of flange, in. (mm)	F3.2
t_f	Thickness of the loaded flange, in. (mm)	J10.1
t_f	Thickness of flange of channel anchor, in. (mm)	I8.2b
t_{fc}	Thickness of compression flange, in. (mm)	F4.2
t_p	Thickness of tension loaded plate, in. (mm)	App. 3.3
t_{st}	Thickness of web stiffener, in. (mm)	App. 6.3.2a
t_w	Thickness of web, in. (mm)	F4.2
t_w	Smallest effective weld throat thickness around the perimeter of branch or plate, in. (mm)	K5
t_w	Thickness of channel anchor web, in. (mm)	I8.2b
w	Width of cover plate, in. (mm)	F13.3
w	Size of weld leg, in. (mm)	J2.2b
w	Subscript relating symbol to major principal axis bending	H2
w	Width of plate, in. (mm)	Table D3.1
w	Leg size of the reinforcing or contouring fillet, if any, in the direction of the thickness of the tension-loaded plate, in. (mm)	App. 3.3
w_c	Weight of concrete per unit volume ($90 \le w_c \le 155$ lb/ft^3 or $1\,500 \le w_c \le 2\,500$ kg/m^3)	I2.1b
w_r	Average width of concrete rib or haunch, in. (mm)	I3.2c
x	Subscript relating symbol to major axis bending	H1.1
x_o, y_o	Coordinates of the shear center with respect to the centroid, in. (mm)	E4
$\bar{x}$	Eccentricity of connection, in. (mm)	Table D3.1
y	Subscript relating symbol to minor axis bending	H1.1
z	Subscript relating symbol to minor principal axis bending	H2
α	ASD/LRFD force level adjustment factor	C2.3
β	Length reduction factor given by Equation J2-1	J2.2b
β	Width ratio; the ratio of branch diameter to chord diameter for round HSS; the ratio of overall branch width to chord width for rectangular HSS	K3.1
β_T	Overall brace system required stiffness, kip-in./rad (N-mm/rad)	App. 6.3.2a
β_{br}	Required shear stiffness of the bracing system, kip/in. (N/mm)	App. 6.2.1a
β_{br}	Required flexural stiffness of the brace, kip/in. (N/mm)	App. 6.3.2a
β_{eff}	Effective width ratio; the sum of the perimeters of the two branch members in a K-connection divided by eight times the chord width	K3.1
β_{eop}	Effective outside punching parameter	K3.2
β_{sec}	Web distortional stiffness, including the effect of web transverse stiffeners, if any, kip-in./rad (N-mm/rad)	App. 6.3.2a
β_w	Section property for single angles about major principal axis, in. (mm)	F10.2
Δ	First-order interstory drift due to the LRFD or ASD load combinations, in. (mm)	App. 7.3.2

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Symbol	Definition	Section
Δ_H	First-order interstory drift, in the direction of translation being considered, due to lateral forces, in. (mm)	App. 8.2.2
γ	Chord slenderness ratio; the ratio of one-half the diameter to the wall thickness for round HSS; the ratio of one-half the width to wall thickness for rectangular HSS	K3.1
ζ	Gap ratio; the ratio of the gap between the branches of a gapped K-connection to the width of the chord for rectangular HSS	K3.1
η	Load length parameter, applicable only to rectangular HSS; the ratio of the length of contact of the branch with the chord in the plane of the connection to the chord width	K3.1
λ	Width-to-thickness ratio for the element as defined in Section B4.1	E7.1
λ_p	Limiting width-to-thickness parameter for compact element	B4.1
λ_{pd}	Limiting width-to-thickness parameter for plastic design	App. 1.2.2b
λ_{pf}	Limiting width-to-thickness parameter for compact flange	F3.2
λ_{pw}	Limiting width-to-thickness parameter for compact web	F4.2
λ_r	Limiting width-to-thickness parameter for noncompact element	B4.1
λ_{rf}	Limiting width-to-thickness parameter for noncompact flange	F3.2
λ_{rw}	Limiting width-to-thickness parameter for noncompact web	F4.2
μ	Mean slip coefficient for Class A or B surfaces, as applicable, or as established by tests	J3.8
ϕ	Resistance factor	B3.1
ϕ_B	Resistance factor for bearing on concrete	I6.3a
ϕ_b	Resistance factor for flexure	H1.1
ϕ_c	Resistance factor for compression	H1.1
ϕ_c	Resistance factor for axially loaded composite columns	I2.1b
ϕ_{sf}	Resistance factor for shear on the failure path	D5.1
ϕ_T	Resistance factor for torsion	H3.1
ϕ_t	Resistance factor for tension	H1.2
ϕ_t	Resistance factor for tensile rupture	H4
ϕ_t	Resistance factor for steel headed stud anchor in tension	I8.3b
ϕ_v	Resistance factor for shear	G1
ϕ_v	Resistance factor for steel headed stud anchor in shear	I8.3a
Ω	Safety factor	B3.2
Ω_B	Safety factor for bearing on concrete	I6.3a
Ω_b	Safety factor for flexure	H1.1
Ω_c	Safety factor for compression	H1.1
Ω_c	Safety factor for axially loaded composite columns	I2.1b
Ω_t	Safety factor for steel headed stud anchor in tension	I8.3b
Ω_{sf}	Safety factor for shear on the failure path	D5.1
Ω_T	Safety factor for torsion	H3.1
Ω_t	Safety factor for tension	H1.2
Ω_t	Safety factor for tensile rupture	H4
Ω_v	Safety factor for shear	G1
Ω_v	Safety factor for steel headed stud anchor in shear	I8.3a
ρ_w	Maximum shear ratio within the web panels on each side of the transverse stiffener	G2.3

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Symbol	Definition	Section
ρ_{sr}	Minimum reinforcement ratio for longitudinal reinforcing	I2.1
θ	Angle between the line of action of the required force and the weld longitudinal axis, degrees	J2.4
θ	Acute angle between the branch and chord, degrees	K3.1
τ_b	Stiffness reduction parameter	C2.3

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GLOSSARY

Notes:
(1) Terms designated with † are common AISI-AISC terms that are coordinated between the two standards development organizations.
(2) Terms designated with * are usually qualified by the type of load effect, for example, nominal tensile strength, available compressive strength, and design flexural strength.
(3) Terms designated with ** are usually qualified by the type of component, for example, web local buckling, and flange local bending.

Active fire protection. Building materials and systems that are activated by a fire to mitigate adverse effects or to notify people to take action to mitigate adverse effects.

*Allowable strength**†. Nominal strength divided by the safety factor, R_n/Ω.

*Allowable stress**. Allowable strength divided by the applicable section property, such as section modulus or cross-sectional area.

Applicable building code†. Building code under which the structure is designed.

ASD (allowable strength design)†. Method of proportioning structural components such that the allowable strength equals or exceeds the required strength of the component under the action of the ASD load combinations.

ASD load combination†. Load combination in the applicable building code intended for allowable strength design (allowable stress design).

Authority having jurisdiction (AHJ). Organization, political subdivision, office or individual charged with the responsibility of administering and enforcing the provisions of this *Specification*.

*Available strength**†. Design strength or allowable strength, as applicable.

*Available stress**. Design stress or allowable stress, as applicable.

Average rib width. In a formed steel deck, average width of the rib of a corrugation.

Beam. Nominally horizontal structural member that has the primary function of resisting bending moments.

Beam-column. Structural member that resists both axial force and bending moment.

Bearing†. In a connection, limit state of shear forces transmitted by the mechanical fastener to the connection elements.

Bearing (local compressive yielding)†. Limit state of local compressive yielding due to the action of a member bearing against another member or surface.

Bearing-type connection. Bolted connection where shear forces are transmitted by the bolt bearing against the connection elements.

Block shear rupture†. In a connection, limit state of tension rupture along one path and shear yielding or shear rupture along another path.

Box section. Square or rectangular doubly symmetric member made with four plates welded together at the corners such that it behaves as a single member.

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Braced frame†. Essentially vertical truss system that provides resistance to lateral forces and provides stability for the structural system.

Bracing. Member or system that provides stiffness and strength to limit the out-of-plane movement of another member at a brace point.

Branch member. In an HSS connection, member that terminates at a chord member or main member.

Buckling†. Limit state of sudden change in the geometry of a structure or any of its elements under a critical loading condition.

Buckling strength. Strength for instability limit states.

Built-up member, cross section, section, shape. Member, cross section, section or shape fabricated from structural steel elements that are welded or bolted together.

Camber. Curvature fabricated into a beam or truss so as to compensate for deflection induced by loads.

Charpy V-notch impact test. Standard dynamic test measuring notch toughness of a specimen.

Chord member. In an HSS connection, primary member that extends through a truss connection.

Cladding. Exterior covering of structure.

Cold-formed steel structural member†. Shape manufactured by press-braking blanks sheared from sheets, cut lengths of coils or plates, or by roll forming cold- or hot-rolled coils or sheets; both forming operations being performed at ambient room temperature, that is, without manifest addition of heat such as would be required for hot forming.

Collector. Also known as drag strut; member that serves to transfer loads between floor diaphragms and the members of the lateral force-resisting system.

Column. Nominally vertical structural member that has the primary function of resisting axial compressive force.

Column base. Assemblage of structural shapes, plates, connectors, bolts and rods at the base of a column used to transmit forces between the steel superstructure and the foundation.

Compact section. Section capable of developing a fully plastic stress distribution and possessing a rotation capacity of approximately three before the onset of local buckling.

Compartmentation. Enclosure of a building space with elements that have a specific fire endurance.

Complete-joint-penetration (CJP) groove weld. Groove weld in which weld metal extends through the joint thickness, except as permitted for HSS connections.

Composite. Condition in which steel and concrete elements and members work as a unit in the distribution of internal forces.

Composite beam. Structural steel beam in contact with and acting compositely with a reinforced concrete slab.

Composite component. Member, connecting element or assemblage in which steel and concrete elements work as a unit in the distribution of internal forces, with the exception of the special case of composite beams where steel anchors are embedded in a solid concrete slab or in a slab cast on formed steel deck.

Concrete breakout surface. The surface delineating a volume of concrete surrounding a steel headed stud anchor that separates from the remaining concrete.

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Concrete crushing. Limit state of compressive failure in concrete having reached the ultimate strain.

Concrete haunch. In a composite floor system constructed using a formed steel deck, the section of solid concrete that results from stopping the deck on each side of the girder.

Concrete-encased beam. Beam totally encased in concrete cast integrally with the slab.

Connection†. Combination of structural elements and joints used to transmit forces between two or more members.

Construction documents. Written, graphic and pictorial documents prepared or assembled for describing the design (including the structural system), location and physical characteristics of the elements of a building necessary to obtain a building permit and construct a building.

Cope. Cutout made in a structural member to remove a flange and conform to the shape of an intersecting member.

Cover plate. Plate welded or bolted to the flange of a member to increase cross-sectional area, section modulus or moment of inertia.

Cross connection. HSS connection in which forces in branch members or connecting elements transverse to the main member are primarily equilibrated by forces in other branch members or connecting elements on the opposite side of the main member.

Design. The process of establishing the physical and other properties of a structure for the purpose of achieving the desired strength, serviceability, durability, constructability, economy and other desired characteristics. Design for strength, as used in this *Specification*, includes analysis to determine required strength and proportioning to have adequate available strength.

Design-basis fire. Set of conditions that define the development of a fire and the spread of combustion products throughout a building or portion thereof.

Design drawings. Graphic and pictorial documents showing the design, location and dimensions of the work. These documents generally include plans, elevations, sections, details, schedules, diagrams and notes.

Design load†. Applied load determined in accordance with either LRFD load combinations or ASD load combinations, as applicable.

*Design strength**†. Resistance factor multiplied by the nominal strength, ϕR_n.

Design wall thickness. HSS wall thickness assumed in the determination of section properties.

Diagonal stiffener. Web stiffener at column panel zone oriented diagonally to the flanges, on one or both sides of the web.

Diaphragm†. Roof, floor or other membrane or bracing system that transfers in-plane forces to the lateral force-resisting system.

Diaphragm plate. Plate possessing in-plane shear stiffness and strength, used to transfer forces to the supporting elements.

Direct bond interaction. In a composite section, mechanism by which force is transferred between steel and concrete by bond stress.

Distortional failure. Limit state of an HSS truss connection based on distortion of a rectangular HSS chord member into a rhomboidal shape.

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Distortional stiffness. Out-of-plane flexural stiffness of web.

Double curvature. Deformed shape of a beam with one or more inflection points within the span.

*Double-concentrated force*s. Two equal and opposite forces applied normal to the same flange, forming a couple.

Doubler. Plate added to, and parallel with, a beam or column web to increase strength at locations of concentrated forces.

Drift. Lateral deflection of structure.

Effective length factor, K. Ratio between the effective length and the unbraced length of the member.

Effective length. Length of an otherwise identical compression member with the same strength when analyzed with simple end conditions.

Effective net area. Net area modified to account for the effect of shear lag.

Effective section modulus. Section modulus reduced to account for buckling of slender compression elements.

Effective width. Reduced width of a plate or slab with an assumed uniform stress distribution which produces the same effect on the behavior of a structural member as the actual plate or slab width with its nonuniform stress distribution.

Elastic analysis. Structural analysis based on the assumption that the structure returns to its original geometry on removal of the load.

Elevated temperatures. Heating conditions experienced by building elements or structures as a result of fire which are in excess of the anticipated ambient conditions.

Encased composite member. Composite member consisting of a structural concrete member and one or more embedded steel shapes.

End panel. Web panel with an adjacent panel on one side only.

End return. Length of fillet weld that continues around a corner in the same plane.

Engineer of record. Licensed professional responsible for sealing the design drawings and specifications.

Expansion rocker. Support with curved surface on which a member bears that is able to tilt to accommodate expansion.

Expansion roller. Round steel bar on which a member bears that is able to roll to accommodate expansion.

Eyebar. Pin-connected tension member of uniform thickness, with forged or thermally cut head of greater width than the body, proportioned to provide approximately equal strength in the head and body.

Factored load†. Product of a load factor and the nominal load.

Fastener. Generic term for bolts, rivets or other connecting devices.

Fatigue†. Limit state of crack initiation and growth resulting from repeated application of live loads.

Faying surface. Contact surface of connection elements transmitting a shear force.

Filled composite member. Composite member consisting of an HSS or box section filled with structural concrete.

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Filler metal. Metal or alloy added in making a welded joint.

Filler. Plate used to build up the thickness of one component.

Fillet weld reinforcement. Fillet welds added to groove welds.

Fillet weld. Weld of generally triangular cross section made between intersecting surfaces of elements.

Finished surface. Surfaces fabricated with a roughness height value measured in accordance with ANSI/ASME B46.1 that is equal to or less than 500.

Fire. Destructive burning, as manifested by any or all of the following: light, flame, heat or smoke.

Fire barrier. Element of construction formed of fire-resisting materials and tested in accordance with an approved standard fire resistance test, to demonstrate compliance with the applicable building code.

Fire resistance. Property of assemblies that prevents or retards the passage of excessive heat, hot gases or flames under conditions of use and enables the assemblies to continue to perform a stipulated function.

First-order analysis. Structural analysis in which equilibrium conditions are formulated on the undeformed structure; second-order effects are neglected.

Fitted bearing stiffener. Stiffener used at a support or concentrated load that fits tightly against one or both flanges of a beam so as to transmit load through bearing.

Flare bevel groove weld. Weld in a groove formed by a member with a curved surface in contact with a planar member.

Flare V-groove weld. Weld in a groove formed by two members with curved surfaces.

Flashover. Transition to a state of total surface involvement in a fire of combustible materials within an enclosure.

Flat width. Nominal width of rectangular HSS minus twice the outside corner radius. In the absence of knowledge of the corner radius, the flat width is permitted to be taken as the total section width minus three times the thickness.

Flexural buckling†. Buckling mode in which a compression member deflects laterally without twist or change in cross-sectional shape.

Flexural-torsional buckling†. Buckling mode in which a compression member bends and twists simultaneously without change in cross-sectional shape.

Force. Resultant of distribution of stress over a prescribed area.

Formed steel deck. In composite construction, steel cold formed into a decking profile used as a permanent concrete form.

Fully-restrained moment connection. Connection capable of transferring moment with negligible rotation between connected members.

Gage. Transverse center-to-center spacing of fasteners.

Gapped connection. HSS truss connection with a gap or space on the chord face between intersecting branch members.

Geometric axis. Axis parallel to web, flange or angle leg.

Girder filler. In a composite floor system constructed using a formed steel deck, narrow piece of sheet steel used as a fill between the edge of a deck sheet and the flange of a girder.

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Girder. See *Beam*.

Gouge. Relatively smooth surface groove or cavity resulting from plastic deformation or removal of material.

Gravity load. Load acting in the downward direction, such as dead and live loads.

Grip (of bolt). Thickness of material through which a bolt passes.

Groove weld. Weld in a groove between connection elements. See also AWS D1.1/D1.1M.

Gusset plate. Plate element connecting truss members or a strut or brace to a beam or column.

Heat flux. Radiant energy per unit surface area.

Heat release rate. Rate at which thermal energy is generated by a burning material.

Horizontal shear. In a composite beam, force at the interface between steel and concrete surfaces.

HSS (hollow structural section). Square, rectangular or round hollow structural steel section produced in accordance with one of the product specifications in Section A3.1a(b).

Inelastic analysis. Structural analysis that takes into account inelastic material behavior, including plastic analysis.

In-plane instability†. Limit state involving buckling in the plane of the frame or the member.

Instability†. Limit state reached in the loading of a structural component, frame or structure in which a slight disturbance in the loads or geometry produces large displacements.

Introduction length. The length along which the required longitudinal shear force is assumed to be transferred into or out of the steel shape in an encased or filled composite column.

Joint†. Area where two or more ends, surfaces, or edges are attached. Categorized by type of fastener or weld used and method of force transfer.

Joint eccentricity. In an HSS truss connection, perpendicular distance from chord member center-of-gravity to intersection of branch member work points.

k-area. The region of the web that extends from the tangent point of the web and the flange-web fillet (AISC k dimension) a distance 12 in. (38 mm) into the web beyond the k dimension.

K-connection. HSS connection in which forces in branch members or connecting elements transverse to the main member are primarily equilibriated by forces in other branch members or connecting elements on the same side of the main member.

Lacing. Plate, angle or other steel shape, in a lattice configuration, that connects two steel shapes together.

Lap joint. Joint between two overlapping connection elements in parallel planes.

Lateral bracing. Member or system that is designed to inhibit lateral buckling or lateral-torsional buckling of structural members.

Lateral force-resisting system. Structural system designed to resist lateral loads and provide stability for the structure as a whole.

Lateral load. Load acting in a lateral direction, such as wind or earthquake effects.

Lateral-torsional buckling†. Buckling mode of a flexural member involving deflection out of the plane of bending occurring simultaneously with twist about the shear center of the cross section.

Leaning column. Column designed to carry gravity loads only, with connections that are not intended to provide resistance to lateral loads.

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Length effects. Consideration of the reduction in strength of a member based on its unbraced length.

Lightweight concrete. Structural concrete with an equilibrium density of 115 lb/ft^3 (1 840 kg/m^3) or less, as determined by ASTM C567.

Limit state†. Condition in which a structure or component becomes unfit for service and is judged either to be no longer useful for its intended function (serviceability limit state) or to have reached its ultimate load-carrying capacity (strength limit state).

Load†. Force or other action that results from the weight of building materials, occupants and their possessions, environmental effects, differential movement, or restrained dimensional changes.

Load effect†. Forces, stresses and deformations produced in a structural component by the applied loads.

Load factor. Factor that accounts for deviations of the nominal load from the actual load, for uncertainties in the analysis that transforms the load into a load effect and for the probability that more than one extreme load will occur simultaneously.

Load transfer region. Region of a composite member over which force is directly applied to the member, such as the depth of a connection plate.

*Local bending***†. Limit state of large deformation of a flange under a concentrated transverse force.

*Local buckling***. Limit state of buckling of a compression element within a cross section.

*Local yielding***†. Yielding that occurs in a local area of an element.

LRFD (load and resistance factor design)†. Method of proportioning structural components such that the design strength equals or exceeds the required strength of the component under the action of the LRFD load combinations.

LRFD load combination†. Load combination in the applicable building code intended for strength design (load and resistance factor design).

Main member. In an HSS connection, chord member, column or other HSS member to which branch members or other connecting elements are attached.

Member imperfection. Initial displacement of points along the length of individual members (between points of intersection of members) from their nominal locations, such as the out-of-straightness of members due to manufacturing and fabrication.

Mill scale. Oxide surface coating on steel formed by the hot rolling process.

Moment connection. Connection that transmits bending moment between connected members.

Moment frame†. Framing system that provides resistance to lateral loads and provides stability to the structural system, primarily by shear and flexure of the framing members and their connections.

Negative flexural strength. Flexural strength of a composite beam in regions with tension due to flexure on the top surface.

Net area. Gross area reduced to account for removed material.

Nominal dimension. Designated or theoretical dimension, as in tables of section properties.

Nominal load†. Magnitude of the load specified by the applicable building code.

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Nominal rib height. In a formed steel deck, height of deck measured from the underside of the lowest point to the top of the highest point.

*Nominal strength**†. Strength of a structure or component (without the resistance factor or safety factor applied) to resist load effects, as determined in accordance with this Specification.

Noncompact section. Section that is able to develop the yield stress in its compression elements before local buckling occurs, but is unable to develop a rotation capacity of three.

Nondestructive testing. Inspection procedure wherein no material is destroyed and the integrity of the material or component is not affected.

Notch toughness. Energy absorbed at a specified temperature as measured in the Charpy V-notch impact test.

Notional load. Virtual load applied in a structural analysis to account for destabilizing effects that are not otherwise accounted for in the design provisions.

Out-of-plane buckling†. Limit state of a beam, column or beam-column involving lateral or lateral-torsional buckling.

Overlapped connection. HSS truss connection in which intersecting branch members overlap.

Panel brace. Brace that controls the relative movement of two adjacent brace points along the length of a beam or column or the relative lateral displacement of two stories in a frame (see *point brace*).

Panel zone. Web area of beam-to-column connection delineated by the extension of beam and column flanges through the connection, transmitting moment through a shear panel.

Partial-joint-penetration (PJP) groove weld. Groove weld in which the penetration is intentionally less than the complete thickness of the connected element.

Partially restrained moment connection. Connection capable of transferring moment with rotation between connected members that is not negligible.

Percent elongation. Measure of ductility, determined in a tensile test as the maximum elongation of the gage length divided by the original gage length expressed as a percentage.

Pipe. See *HSS*.

Pitch. Longitudinal center-to-center spacing of fasteners. Center-to-center spacing of bolt threads along axis of bolt.

Plastic analysis. Structural analysis based on the assumption of rigid-plastic behavior, that is, that equilibrium is satisfied and the stress is at or below the yield stress throughout the structure.

Plastic hinge. Fully yielded zone that forms in a structural member when the plastic moment is attained.

Plastic moment. Theoretical resisting moment developed within a fully yielded cross section.

Plastic stress distribution method. In a composite member, method for determining stresses assuming that the steel section and the concrete in the cross section are fully plastic.

Plastification. In an HSS connection, limit state based on an out-of-plane flexural yield line mechanism in the chord at a branch member connection.

Plate girder. Built-up beam.

Plug weld. Weld made in a circular hole in one element of a joint fusing that element to another element.

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Point brace. Brace that prevents lateral movement or twist independently of other braces at adjacent brace points (see *panel brace*).

Ponding. Retention of water due solely to the deflection of flat roof framing.

Positive flexural strength. Flexural strength of a composite beam in regions with compression due to flexure on the top surface.

Pretensioned bolt. Bolt tightened to the specified minimum pretension.

Pretensioned joint. Joint with high-strength bolts tightened to the specified minimum pretension.

Properly developed. Reinforcing bars detailed to yield in a ductile manner before crushing of the concrete occurs. Bars meeting the provisions of ACI 318, insofar as development length, spacing and cover are deemed to be properly developed.

Prying action. Amplification of the tension force in a bolt caused by leverage between the point of applied load, the bolt, and the reaction of the connected elements.

Punching load. In an HSS connection, component of branch member force perpendicular to a chord.

P-δ effect. Effect of loads acting on the deflected shape of a member between joints or nodes.

P-Δ effect. Effect of loads acting on the displaced location of joints or nodes in a structure. In tiered building structures, this is the effect of loads acting on the laterally displaced location of floors and roofs.

Quality assurance. Monitoring and inspection tasks to ensure that the material provided and work performed by the fabricator and erector meet the requirements of the approved construction documents and referenced standards. Quality assurance includes those tasks designated "special inspection" by the applicable building code.

Quality assurance inspector (QAI). Individual designated to provide quality assurance inspection for the work being performed.

Quality assurance plan (QAP). Program in which the agency or firm responsible for quality assurance maintains detailed monitoring and inspection procedures to ensure conformance with the approved construction documents and referenced standards.

Quality control. Controls and inspections implemented by the fabricator or erector, as applicable, to ensure that the material provided and work performed meet the requirements of the approved construction documents and referenced standards.

Quality control inspector (QCI). Individual designated to perform quality control inspection tasks for the work being performed.

Quality control program (QCP). Program in which the fabricator or erector, as applicable, maintains detailed fabrication or erection and inspection procedures to ensure conformance with the approved design drawings, specifications, and referenced standards.

Reentrant. In a cope or weld access hole, a cut at an abrupt change in direction in which the exposed surface is concave.

*Required strength**†. Forces, stresses and deformations acting on a structural component, determined by either structural analysis, for the LRFD or ASD load combinations, as applicable, or as specified by this Specification or Standard.

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Resistance factor, ϕ†. Factor that accounts for unavoidable deviations of the nominal strength from the actual strength and for the manner and consequences of failure.

Restrained construction. Floor and roof assemblies and individual beams in buildings where the surrounding or supporting structure is capable of resisting significant thermal expansion throughout the range of anticipated elevated temperatures.

Reverse curvature. See *double curvature*.

Root of joint. Portion of a joint to be welded where the members are closest to each other.

Rotation capacity. Incremental angular rotation defined as the ratio of the inelastic rotation attained to the idealized elastic rotation at first yield prior to significant load shedding.

Rupture strength†. Strength limited by breaking or tearing of members or connecting elements.

Safety factor, Ω†. Factor that accounts for deviations of the actual strength from the nominal strength, deviations of the actual load from the nominal load, uncertainties in the analysis that transforms the load into a load effect, and for the manner and consequences of failure.

Second-order effect. Effect of loads acting on the deformed configuration of a structure; includes P-δ effect and P-Δ effect.

Seismic force-resisting system. That part of the structural system that has been considered in the design to provide the required resistance to the seismic forces prescribed in ASCE/SEI 7.

Seismic response modification factor. Factor that reduces seismic load effects to strength level.

Service load combination. Load combination under which serviceability limit states are evaluated.

Service load†. Load under which serviceability limit states are evaluated.

Serviceability limit state†. Limiting condition affecting the ability of a structure to preserve its appearance, maintainability, durability, comfort of its occupants, or function of machinery, under typical usage.

Shear buckling†. Buckling mode in which a plate element, such as the web of a beam, deforms under pure shear applied in the plane of the plate.

Shear lag. Nonuniform tensile stress distribution in a member or connecting element in the vicinity of a connection.

Shear wall†. Wall that provides resistance to lateral loads in the plane of the wall and provides stability for the structural system.

Shear yielding (punching). In an HSS connection, limit state based on out-of-plane shear strength of the chord wall to which branch members are attached.

Sheet steel. In a composite floor system, steel used for closure plates or miscellaneous trimming in a formed steel deck.

Shim. Thin layer of material used to fill a space between faying or bearing surfaces.

Sidesway buckling (frame). Stability limit state involving lateral sidesway instability of a frame.

Simple connection. Connection that transmits negligible bending moment between connected members.

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