

# COMPARISON OF ANSI/AISC 360-22 TO ANSI/AISC 360-16

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This document summarizes the revisions contained in the 2022 AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360-22) compared to the 2016 AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360-16). Only Sections containing revisions are listed here. See the Commentary to the 2022 *Specification* for background on the revisions.

## CHAPTER A GENERAL PROVISIONS

### A1. SCOPE

Quality has been added to the scope statement for ANSI/AISC 360.

#### A1.1. Seismic Applications

Fabrication, erection, and quality have been added to the scope statement for ANSI/AISC 341.

#### A1.2. Nuclear Applications

Quality has been added to the scope statement for ANSI/AISC N690.

### A2. REFERENCED SPECIFICATIONS, CODES AND STANDARDS

The dates of existing referenced specifications have been updated in this Section, in addition to the following additions and deletions.

#### (a) American Concrete Institute (ACI)

The following reference has been added: ACI 216.1-14.

#### (b) American Institute of Steel Construction (AISC)

The following reference has been deleted:  
ANSI/AISC N690s 1-15

#### (c) American Iron and Steel Institute (AISI) (new Section)

The following new referenced standards have been added:  
AISI S923-20  
AISI S924-20

#### (e) American Society of Mechanical Engineers (ASME) (was Section A2. (d))

The following new referenced standard has been added:  
ASME B1.1-2019

#### (g) ASTM International (ASTM) (was Section A2. (f))

The following references have been deleted:

A216/A216M-14e1

A242/A242M-13

A668/A668M-04(2015)

E165/165M-12

E709-15

The following reference has been added:

F3148-17a

- (h) American Welding Society (AWS) (was Section A2. (g))

The following reference has been deleted:

AWS A5.36/A5.36M:2012

- (i) Gypsum Association (new Section)

The following new reference has been added:

GA-600-2021

- (l) Underwriters Laboratories, Inc. (UL) (new Section)

The following reference has been added:

UL 263, Edition 14m, *Standard for Fire Tests of Building Construction and Materials*, 2018

### **A3. MATERIAL**

#### **A3.1. Structural Steel Materials**

This Section has been edited for clarity

##### **A3.1a. Listed Materials**

The title of this Section has been changed from *ASTM Designations*. A new Table A3.1 has been added listing the permissible grades and strengths and limitations of ASTM standards.

##### **A3.1b. Other Materials** (new Section)

This Section addresses the materials that are not listed in Table A3.1.

#### **A3.3. Bolts, Washers, and Nuts**

Under (a) Bolts, ASTM F3148 has been added. For (b) Nuts, (c) Washers, and (d) Compressible-Washer-Type Direct Tension Indicators, the listed U.S. Customary and SI ASTM standards are now all combined into one standard.

#### **A3.4. Anchor Rods and Threaded Rods**

The paragraph specifying threads has been updated to “conform to Class 2A, Unified Coarse Thread Series of ASMT B1.1, except for anchor rods over 1 in. (25 mm) diameter which are permitted to conform to Class 2A, 8UN Thread Series.”

#### **A3.5. Consumables for Welding**

AWS A5.36/A5.36M has been deleted from this Section.

**A4. STRUCTURAL DESIGN DOCUMENTS AND SPECIFICATIONS**

The title of this Section has been changed from *STRUCTURAL DESIGN DRAWINGS AND SPECIFICATIONS*. The Section has been expanded. This Section addresses what needs to be included on the structural design documents and specifications issued for construction (A4.1), and how they need to be clearly identified as to their purpose when issued (A4.2).

**A5. APPROVALS (new Section)**

This Section addresses the requirements for the submission of approval documents.

## **CHAPTER B DESIGN REQUIREMENTS**

The Chapter preamble clarifies the applicability of the general requirements by changing “all chapters” to “all chapters and appendices”.

### **B1. GENERAL PROVISIONS**

“Framing system” has been revised to “structural system”.

### **B3. DESIGN BASIS**

#### **B3.3. Required Strength**

The third paragraph describing how to determine the required flexural strength using moment redistribution for indeterminate beams composed of compact sections carrying gravity loads has been moved to Appendix 8.

#### **B3.4. Design of Connections and Supports**

##### **B3.4b. Moment Connections**

This Section has been edited for clarity.

##### **B3.10. Design for Ponding**

The reference to Appendix 2 has been removed (Appendix 2 has been replaced with a new appendix on *Design of Filled Composite Members (High Strength)*) and two paragraphs have been added to describe the requirements for ponding.

##### **B3.11. Design for Fatigue**

This Section has been edited for clarity.

##### **B3.12. Design for Fire Conditions**

A new introductory line referring to Appendix 4 has been added and the last paragraph discussing contractual requirements has been removed (and added to the User Note).

### **B4. MEMBER PROPERTIES**

#### **B4.1. Classification of Sections for Local Buckling**

This Section has been edited to clarify that “for all sections addressed in Table B4.1b, flanges must be continuously connected to the web or webs.” A new paragraph addressing sections where the webs and flange are not continuously attached has been added.

##### **B4.1b. Stiffened Elements**

The terminology “diaphragm plate” has been deleted from this Section and in Tables B4.1a and B4.1b.

A new item (g) has been added to address the width and thickness of round HSS.

In Table B4.1a, Cases 1, 2, and 3, and in Table B4.1b, Case 10, the descriptions of elements are broken up into enumerated lists of applicable elements.

**B4.3. Gross and Net Area Determination**

**B4.3b. Net Area**

The term “hole” has been revised to “bolt hole” throughout this Section.

**B5. FABRICATION AND ERECTION**

The term, “shop drawings,” has been removed from this Section.

**B8. DIMENSIONAL TOLERANCES (new Section)**

This Section addresses the consideration of dimensional tolerances assumed in this Specification.

## CHAPTER C DESIGN FOR STABILITY

### C2. CALCULATION OF REQUIRED STRENGTHS

#### C2.1. General Analysis Requirements

In Section C2.1(b), the reference to “Appendix 8” for the approximate method of second-order analysis is revised to “Appendix 8, Section 8.1”, because the approximate method of second-order analysis has been moved.

#### C2.3. Adjustments to Stiffness

In Section C2.3(b), the symbol,  $\tau_b$ , is named the “stiffness reduction parameter.” Additionally, in the definition of  $P_{ns}$ , it is clarified that for slender-element sections,  $A_e$  is defined in Section E7 with  $F_n = F_y$ .

## **CHAPTER D**

### **DESIGN OF MEMBERS FOR TENSION**

#### **D3. EFFECTIVE NET AREA**

In Table D3.1, Cases 5 and 6 (round HSS and rectangular HSS with single concentric gusset plate) have been combined into Case 5, and the determination of the shear lag factor has been revised for both. Case 6 is now rectangular HSS with two side gusset plates, and the shear lag factor has been revised.

#### **D5. PIN-CONNECTED MEMBERS**

##### **D5.1. Tensile Strength**

A new reduction factor,  $C_r$ , has been added to Equation D5-2.

##### **D5.2. Dimensional Requirements**

The diameter of pin holes has been revised in (b).

#### **D6. EYEBARS**

##### **D6.1. Tensile Strength**

The definition of  $A_g$  has been clarified as “the gross area of the eyebar body.”

## CHAPTER E DESIGN OF MEMBERS FOR COMPRESSION

Throughout this chapter, the terminology, “critical stress,” and the associated symbol,  $F_{cr}$ , have been revised to “nominal stress,” and the symbol,  $F_n$ .

### **E4. TORSIONAL AND FLEXURAL-TORSIONAL BUCKLING OF SINGLE ANGLES AND MEMBERS WITHOUT SLENDER ELEMENTS**

Two new Sections, E4(d) and E4(e), have been added to address doubly symmetric I-shaped members with major- and minor-axis lateral bracing offset from the shear center. In Section E4(f) (was Section E4(d)), the phrase “For members” has been revised to “For all other members”.

### **E6. BUILT-UP MEMBERS**

#### **E6.2. General Requirements**

The title of this Section has been changed from *Dimensional Requirements*.

In Section E6.2(a), the word “least” has been replaced with the word “minimum.”

In Section E6.2(c), the term, “access holes” has been revised to “access openings”.

## CHAPTER F DESIGN OF MEMBERS FOR FLEXURE

Throughout this chapter, the term “limiting slenderness” has been replaced with “width-to-thickness ratio”.

### F6. I-SHAPED MEMBERS AND CHANNELS BENT ABOUT THEIR MINOR AXIS

#### F6.2. Flange Local Buckling

In (c), Equation F6-4 has been updated by revising the 0.69 multiplier to 0.70.

### F7. SQUARE AND RECTANGULAR HSS AND BOX SECTIONS

#### F7.2. Flange Local Buckling

In (b), Equation F7-2 has been revised to a format more consistent with the flange local buckling equations for the nominal flexural strength of I-shapes.

#### F7.3. Web Local Buckling

In (b), Equation F7-6 has been revised to a format more consistent with the flange local buckling equations for the nominal flexural strength of I-shapes.

Item (c) has been clarified that it applies to sections with slender webs and compact or noncompact flanges. The compression flange local buckling limit state has been deleted.

### F11. RECTANGULAR BARS AND ROUNDS

#### F11.1. Yielding

This Section has been revised and Equation F11-1 applies to rectangular bars bent about their major or minor axis, and a new Equation F11-2 applies to rounds.

#### F11.2. Lateral-Torsional Buckling

Item (a) has been revised to include rectangular bars bent about their minor axis and rounds, which was previously given in (d); therefore, (d) has been removed.

### F13. PROPORTIONS OF BEAMS AND GIRDERS

#### F13.1. Strength Reductions for Members with Bolt Holes in the Tension Flange

This Section has been renamed to replace the term “holes” with “bolt holes”. The first sentence clarifies that “this Section applies to rolled or built-up shapes and cover-plated beams with standard and oversized bolt holes or short- and long-slotted bolt holes parallel to the direction of load”.

#### F13.2. Proportioning Limits for I-shaped Members

This Section has been edited to clarify that “singly and doubly symmetric” I-shaped members with slender webs shall follow the limits given in (a) and (b).

The last paragraph providing limitations on the ratio of the web area in compression to the compression flange area has been updated.

#### F13.5. Unbraced Length for Moment Redistribution

This Section has been moved to Appendix 8, Section 8.2.

## CHAPTER G DESIGN OF MEMBERS FOR SHEAR

### G2. I-SHAPED MEMBERS AND CHANNELS

A new paragraph has been added summarizing the applicability of Sections G2.1, G2.2, and G2.3.

#### G2.1. Shear Strength of Webs

The phrase “without Tension Field Action” has been removed from the title.

#### G2.3. Shear Strength of End Web Panels with $a/h \leq 3$ Considering Tension Field Action (new Section)

This new Section addresses the nominal shear strength for end web panels including the effects of tension field action in members with equal and unequal flanges.

#### G2.4 Transverse Stiffeners (formerly G2.3)

In (a), the limit on  $h/t_w$  has been revised. In (b), the last sentence about the design of stiffeners has been revised.

### G6. DOUBLY SYMMETRIC AND SINGLY SYMMETRIC MEMBERS SUBJECTED TO MINOR-AXIS SHEAR

The title of this Section has been changed from *WEAK-AXIS SHEAR IN DOUBLY SYMMETRIC AND SINGLY SYMMETRIC SHAPES*.

In the first sentence, the terms, “shapes” and “weak,” have been replaced with “members” and “minor,” respectively.

## CHAPTER H

### DESIGN OF MEMBERS FOR COMBINED FORCES AND TORSION

Throughout this chapter, the separate lists of defined symbols for LRFD and ASD have been condensed into one list of definitions for both LRFD and ASD, replacing the terms “design strength” and “allowable strength” with “available strength”.

#### **H1. DOUBLY AND SINGLY SYMMETRIC MEMBERS SUBJECTED TO FLEXURE AND AXIAL FORCE**

##### **H1.1. Doubly and Singly Symmetric Members Subjected to Flexure and Compression**

The definitions of  $P_r$  and  $P_c$  have been revised for clarity, replacing “required axial strength” with “required compressive strength”.

#### **H3. MEMBERS SUBJECTED TO TORSION AND COMBINED TORSION, FLEXURE, SHEAR, AND/OR AXIAL FORCE**

##### **H3.2. HSS Subjected to Combined Torsion, Shear, Flexure and Axial Force**

Equation H3-6 has been revised to include required-to-available flexural strength ratios for both major- and minor-axis bending.

A requirement is added that “ $V_r/V_c$  shall be taken as the larger value for the x- or y-axis.”

##### **H3.3. Non-HSS Members Subjected to Torsion and Combined Stress**

The statement, “Constrained local yielding is permitted adjacent to areas that remain elastic” has been deleted.

#### **H4. RUPTURE OF FLANGES WITH BOLT HOLES AND SUBJECTED TO TENSION**

Consistent with the first sentence in this Section, the title has been revised from *RUPTURE OF FLANGES WITH HOLES SUBJECTED TO TENSION*, replacing the term “HOLES” with “BOLT HOLES”.

# CHAPTER I

## DESIGN OF COMPOSITE MEMBERS

The preamble is edited to include concrete filled composite shear walls in the scope.

The following terminology has been revised throughout Chapter I:

- “slenderness ratio” revised to “width-to-thickness ratio”
- “compact,” “noncompact,” and “slender” have been updated to “compact composite,” “noncompact composite,” and “slender-element composite,” respectively.

### **I1. GENERAL PROVISIONS**

#### **I1.1. Concrete and Steel Reinforcement**

Item (a), “ACI 318 provisions specifically intended for composite columns shall be excluded in their entirety” has been deleted. Note that composite column provisions are no longer provided in ACI 318-19.

#### **I1.2. Nominal Strength of Composite Sections**

The third paragraph in this Section is edited to state that buckling effects for composite plate shear walls need not be evaluated.

##### **I1.2d. Effective Stress-Strain Method**

The term “steel” has been clarified to include “structural steel” and “reinforcing steel” for the computation of nominal strength using the effective stress-strain method.

#### **I1.3. Material Limitations**

The first paragraph has been revised to state that the limitations in this Section must be met unless Appendix 2 is employed. Charging language for Appendix 2 is incorporated at the end of this Section.

#### **I1.4. Classification of Filled Composite Sections for Local Buckling**

In this Section, in Tables I1.1a and b, and throughout Chapter I, the terminology is revised such that “compact”, “noncompact,” and “slender” have been updated to “compact composite”, “noncompact composite” and “slender-element composite,” respectively.

#### **I1.5. Stiffness for Calculation of Required Strengths**

Composite plate shear walls have been added to the first paragraph. Requirements in (1), (2), (3), and (4) have been updated to (a), (b), (c), and (d); they have been updated to specifically apply to encased and composite members. Requirements (e) and (f) have been added for composite plate shear walls.

#### **I1.6. Requirements for Composite Plate Shear Walls (new Section)**

This is the new Section that has been added to address the slenderness and tie bar requirements of composite plate shear walls. In Section I1.6a, plate slenderness

requirements are provided and in Section I1.6b, tie bar spacing requirements are provided.

## **I2. AXIAL FORCE**

Composite plate shear walls have been added to the introduction.

### **I2.1. Encased Composite Members**

#### **I2.1a. Limitations**

In (b), the first paragraph, the phrase “lateral ties or spirals” has been revised to “transverse reinforcement consisting of ties, hoops, and/or spirals”. Additionally, a new paragraph referring to ACI 318 for detailing and placement requirements for longitudinal reinforcement has been added. The term “lateral ties” has been replaced by “ties or hoops” in the remainder of this Section.

In (c), the definition of  $A_{sr}$  is revised to “area of continuous longitudinal reinforcing bars”.

A new item (d) has been added about maximum reinforcement requirements.

#### **I2.1b. Compressive Strength**

A text definition of  $P_{no}$  has been added.

#### **I2.1e. Detailing Requirements**

Requirement (a) has been edited for clarity.

### **I2.2. Filled Composite Members**

#### **I2.2a. Limitations**

The term “steel” has been replaced by “structural steel” in (a).

In (c), provisions for transverse reinforcement have been added.

A new item (d) addressing maximum reinforcement requirements has been added.

#### **I2.2b. Compressive Strength**

In (a), the text definition of  $P_p$  has been added.

In (c),  $F_{cr}$  has been replaced with  $F_n$  in Equation I2-9e.

#### **I2.2e. Detailing Requirements (new Section)**

This is a new Section added to provide requirements for spacing between the inside of the structural steel section and the longitudinal reinforcing steel.

### **I2.3. Composite Plate Shear Walls (new Section)**

This Section addresses the compressive and tensile strength requirements of composite plate shear walls.

### **I3. FLEXURE**

#### **I3.2 Composite Beams with Steel Headed Stud or Steel Channel Anchors**

##### **I3.2b. Negative Flexural Strength**

The term steel has been revised as structural steel in the first paragraph.

Limitation I is updated for clarity.

##### **I3.2c. Composite Beams with Formed Steel Deck**

###### **I3.2c.1. General**

In (d), “contract documents” has been revised to “design documents and specifications issued for construction”.

##### **I3.2d. Load Transfer Between Steel Beam and Concrete Slab**

###### **I3.2d.2. Load Transfer for Negative Flexural Strength**

In (a), the term “reinforcement” has been revised to “longitudinal reinforcement”.

#### **I3.3. Encased Composite Members**

##### **I3.3a. Limitations (new Section)**

The existing information about the limitations of encased composite members has been retained and incorporated into this Section as (a). Items (a), (b), and (c) have been updated to sublist Items (1), (2), and (3). Limitations (b), (c), (d), and (e) have been added, including requirements for cross-sectional area of structural steel and longitudinal and transverse reinforcement.

##### **I3.3b. Detailing Requirements (new Section)**

This new Section addresses clear spacing between the steel core and longitudinal reinforcing steel in encased composite members.

#### **I3.4. Filled Composite Members**

##### **I3.4a. Limitations**

This Section has been revised to both retain the limitation for local buckling and add new requirements for filled composite members.

##### **I3.4b. Flexural Strength**

In (c), the symbol,  $F_{cr}$ , has been updated to  $F_r$ .

##### **I3.4c. Detailing Requirements (new Section)**

This new Section provides clear spacing requirements for filled composite members.

#### **I3.5. Composite Plate Shear Walls (new Section)**

This new Section provides the available flexural strength requirements for composite plate shear walls.

## **I4. SHEAR**

### **I4.1. Encased Composite Members**

The title of this section has been changed from *Filled and Encased Composite Members*. The introduction has been edited to clarify the scope. The available shear strength of filled composite members has been moved to Section I4.2.

In (a), the term “steel” has been revised as “structural steel.”

In (b), the term “steel” has been replaced with the term “transverse.”

In (c), the term “steel” has been replaced with “structural steel” and “reinforcing steel” has been replaced with the term “transverse reinforcement”.

### **I4.2. Filled Composite Members (new Section)**

This new Section addresses the shear strength requirements of filled composite members, previously addressed in I4.1.

### **I4.3. Composite Beams with Formed Steel Deck (was Section I4.2)**

No changes have been made to this Section.

### **I4.4. Composite Plate Shear Walls (new Section)**

This Section addresses the shear strength requirements of composite plate shear walls.

## **I5. COMBINED FLEXURE AND AXIAL FORCE**

A new item (c) has been added for composite plate shear walls.

## **I6. LOAD TRANSFER**

### **I6.1 General Requirements**

The terminology, “design strength” and “allowable strength,” has been replaced by “available strength”.

### **I6.2 Force Allocation**

#### **I6.2b. External Force Applied to Concrete**

In (a), “compact” and “noncompact” have been updated to “compact composite” and “noncompact composite,” respectively.

In Equation I6-2b, the symbol,  $F_{cr}$ , has been updated to  $F_n$ .

The definition of  $P_{no}$  has been revised to read, “nominal compressive strength without consideration of length effects, determined by Equation I2-7 for encased composite members, and Equation I2-9a, Equation I2-9c, or Equation I2-9e for filled composite members”.

### **I6.3 Force Transfer Mechanisms**

The second paragraph has been edited to address filled composite members in addition to encased composite members, stating that “The force transfer mechanism of direct

bond interaction shall not be used for...filled composite members where bond failure would result in uncontrolled slip.”

**I6.4. Detailing Requirements**

**I6.4a. Encased Composite Members**

In the second sentence, the term “longitudinal shear” has been revised to “shear” and the term “steel shape” has been revised to “structural steel shape”.

**I6.4b. Filled Composite Members**

In the second sentence, the term “reinforcement” has been revised to “longitudinal reinforcement”.

**I8. STEEL ANCHORS**

**I8.2. Steel Anchors in Composite Beams**

**I8.2d. Detailing Requirements**

In (a), “contract documents” has been updated as “design documents and specifications issued for construction”

**I8.3. Steel Anchors in Composite Components**

**I8.3c. Strength of Steel Headed Stud Anchors for Interaction of Shear and Tension in Composite Components**

The separate lists of defined symbols for LRFD and ASD have been condensed into one list of definitions for both LRFD and ASD, replacing the terms “design strength” and “allowable strength” with “available strength”.

**I8.4. Performance-Based Alternative for the Design of Shear Connection (new Section)**

This Section addresses an alternative design approach for shear connection design in composite members.

## CHAPTER J DESIGN OF CONNECTIONS

AWS D1.1/D1.1M references to specific clauses have been updated to the 2020 edition of AWS D1.1/D1.1M throughout Chapter J.

### J1. GENERAL PROVISIONS

#### J1.8 Bolts in Combination with Welds

In (b), the “combined method” of installation has been added for pretensioned high-strength bolts.

#### J1.10. High-Strength Bolts in Combination with Existing Rivets

This title of this Section has been changed from *High-Strength Bolts in Combination with Rivets*. This Section has been edited for clarity.

### J2. WELDS AND WELDED JOINTS

This title of this Section has been changed from *WELDS*. The paragraph and list of AWS D1.1/D1.1M clauses that are replaced by the Specification requirements at the beginning of the Section have been removed and replaced with a new paragraph that more generally addresses differences between the Specification and AWS D1.1/D1.1M. (A list similar to the one formerly found in this section is provided in the Commentary.)

#### J2.1. Groove Welds

##### J2.1a Effective Area

The last paragraph has been revised relative to the allowance of larger partial-joint-penetration groove and flare groove welds.

#### J2.2. Fillet Welds

##### J2.2a Effective Area

The first paragraph has been expanded to provide more details on testing required if the effective throat is to be increased.

##### J2.2b Limitations

This Section has been edited for clarity. In Table J2.4, the requirement to use single pass welds in footnote [a] has been clarified. In limitation (c), the last sentence has been removed.

#### J2.3. Plug and Slot Welds

##### J2.3a Effective Area

This Section has been edited for clarity.

**J2.4. Strength**

Item (a) has been edited for clarity. A new Equation J2-4 has been added for the strength of fillet welds. Definitions for  $k_{ds}$  and  $\theta$  have been added. A new Equation J2-5 is part of the  $k_{ds}$  definition.

Item (b) has been edited for clarity. Equation J2-6a was removed as it is adequately covered in (a).

In Table J2.5, in the PJP Groove Weld section, the first and third compression cases have been renamed and the second compression case has been removed. Footnote [c] has been edited to clarify that it applies to CJP groove welds.

**J3. BOLTS, THREADED PARTS, AND BOLTED CONNECTIONS**

This title of this Section has been changed from *BOLTS AND THREADED PARTS*. The introductory paragraph has been moved.

**J3.1. Common Bolts** (new Section)

The introduction removed from above has been moved to this Section.

**J3.2. High-Strength Bolts** (was Section J3.1)

This Section has been edited for clarity. Group A, Group B, and Group C have been renamed to Group 120, Group 150, and Group 200, respectively. A new Group 144 has been added to incorporate ASTM F3148 Grade 144. A new paragraph is also added to address the use of Group 144 bolting assemblies. The Section is edited throughout to update for consistency with the new nomenclature.

In Table J3.1, The table headings have been updated to Group 120, Group 144 and 150, and Group 200, respectively. The footnotes have been edited for clarity. A new footnote [b], (applying to Group 144 and 150) has been added. The original footnote [b] has been relabeled as footnote [c].

In Table J3.1M, the table headings have been renamed to Group 120 and Group 150, respectively. A new row has been added for M12 bolts. Footnote [a] has been edited for clarity. A new Footnote [b] has been added.

Table J3.2 has been revised as indicated in the following.

<b>TABLE J3.2</b>			
<b>Nominal Stress of Fasteners and Threaded Parts, ksi (MPa)<sup>†</sup></b>			
Description of Fasteners	Nominal Tensile Stress, $F_t$ , ksi (MPa) <sup>[a][b] ‡</sup>	Nominal Shear Stress in Bearing-Type Connections, $F_m$ , ksi (Mpa) <sup>[c] †*</sup>	
		Threads Not Excluded from Shear Planes- (N) <sup>[c] ‡</sup>	Threads Excluded from Shear Planes-(X)

**	**	27 (186) <sup>[c][d]</sup> has been changed to 27(190) <sup>[d]</sup>	27 (190) <sup>[d]</sup> has been added
Group A has been updated to Group 120	**	54 (372) has been changed to 54(370)	68 (470) has been added
This row for Group A has been deleted.			
Group 144 has been added	108 (750) has been added	65 (450) has been added	81 (570) has been added
Group B has been updated to Group 150	**	68 (469) has been changed to 68 (470)	84 (580) has been added
This row about Group B has been deleted			
Group C has been updated to Group 200	150(1040) has been changed to 150(1000)	Subscript [f] has been added	113(780) <sup>[f]</sup> has been added
This row about Group C has been deleted			
Description has been edited for clarity	**	**	0.563 $F_u$ has been added
This row has been deleted			
New definitions for [b] and [f] have been added [b] and [c] have been updated to [c] and [d], respectively [d] has been updated to [e] and edited for clarity			

† The title has been changed.

‡ The title has been changed and a footnote has been added.

\* The information has been separated into two columns.

\*\* No change

**J3.3. Size and Use of Holes** (was Section J3.2)

Requirement (a) has been revised.

In Table J3.3M, a new row has been added for M12 bolts.

**J3.4. Minimum Spacing** (was Section J3.3)

No changes have been made to this Section.

**J3.5. Minimum Edge Distance** (was Section J3.4)

A new row has been added for M12 bolts in Table J3.4M.

**J3.6. Maximum Spacing and Edge Distance** (was Section J3.5)

This Section has been edited for clarity.

**J3.7. Tensile and Shear Strength of Bolts and Threaded Parts** (was Section J3.6)

No changes have been made to this Section.

**J3.8. Combined Tension and Shear in Bearing-Type Connections** (was Section J3.7)

No changes have been made to this Section.

**J3.9. High-Strength Bolts in Slip-Critical Connections** (was Section J3.8)

Class A surfaces that are hot-dipped galvanized have been updated to be as-galvanized or hand roughened.

**J3.10. Combined Tension and Shear in Slip-Critical Connections** (was Section J3.9)  
No changes have been made to this Section.

**J3.11. Bearing and Tearout Strength at Bolt Holes** (was Section J3.10)  
A new Section J3.11a, Snug-Tightened or Pretensioned High-Strength Bolted Connections, has been added. All requirements formerly in Sections J3.10(a) and J3.10(b) have been added to this new subsection. The requirements formerly in Section J3.10(c) have been removed and a new Section has been added: Section J3.11b, Connections Made Using Bolts or Rods that Pass Completely Through an Unstiffened Box Member or HSS. The requirements for bolts or rods passing completely through an unstiffened box member or HSS have been expanded. The section has been edited for clarity throughout.

**J3.12. Special Fasteners** (was Section J3.11)  
No changes have been made to this Section.

**J3.13. Wall Strength at Tension Fasteners** (was Section J3.12)  
No changes have been made to this Section.

#### **J4. AFFECTED ELEMENTS OF MEMBERS AND CONNECTING ELEMENTS**

**J4.4. Strength of Elements in Compression**  
The definition of  $L$  has been clarified, replacing “member” with “element”.

#### **J5. FILLERS**

##### **J5.1. Fillers in Welded Connections**

###### **J5.1b Thick Fillers**

This Section has been edited for clarity in the second sentence, replacing “area” with the term “region”.

#### **J6. SPLICES**

References to “plate girders” have been removed from this Section.

#### **J7. BEARING STRENGTH**

Requirement (a) has been to include bolts or rods that pass completely through an unstiffened box or HSS member.

## **J10. FLANGES AND WEBS WITH CONCENTRATED FORCES**

### **J10.2. Web Local Yielding**

The definition for  $l_b$  has been edited by removing the limitation on length of bearing at end beam reactions.

### **J10.3. Web Local Crippling**

The definition for  $Q_f$  has been edited for clarity giving it a name, “chord-stress interaction parameter.” It has been updated to be equal to 1.0 for channels and box sections. The reference for all other HSS conditions has been revised from Table K3.2 to Section K1.3.

### **J10.4. Web Sidesway Buckling**

The definition for  $C_r$  has been edited to delete  $1.5M_a$  and  $M_u$ , replacing them with  $\alpha_s M_r$ .

### **J10.5. Web Compression Buckling**

The definition for  $Q_f$  has been updated to be equal to 1.0 for channels and box sections. The reference for all other HSS conditions has been revised from Table K3.2 to Section K1.3.

### **J10.6. Web Panel-Zone Shear**

The definition of  $A_g$  has been edited for clarity.

### **J10.8. Additional Stiffener Requirements for Concentrated Forces**

The term “plate girders” has been removed from this Section.

**CHAPTER K**  
**ADDITIONAL REQUIREMENTS FOR HSS AND**  
**BOX-SECTIONS CONNECTIONS**

**K1. GENERAL PROVISIONS AND PARAMETERS FOR HSS CONNECTIONS**

**K1.1. Definitions of Parameters**

The term “main member” from the definitions of  $B$ ,  $D$ ,  $F_c$ ,  $F_u$ ,  $F_y$ ,  $H$ , and  $t$  has been changed to “chord member”. The definition of  $B_e$  has been updated. All symbols used in the chapter have been added to this Section for ease of reference.

**K1.2. Rectangular HSS**

**K1.2a. Effective Width for Connections to Rectangular HSS**

The existing Equation K1-1 has been clarified to apply for local yielding of transverse elements. A new Equation K1-2 has been added for shear yielding (punching).

**K1.3. Chord-Stress Interaction parameter (new Section)**

This new Section defines the chord stress interaction parameter,  $Q_f$ , for various connections. The limits of applicability of the provisions in this chapter are also given in this Section.

**K1.4. End Distance (new Section)**

This new Section defines the end distance,  $l_{end}$ , for rectangular and round sections.

**K2. CONCENTRATED FORCES ON HSS**

**K2.2. Round HSS**

In Table K2.1, Y-connections have been added in the first connection type. The notes in the footer (Functions) have been deleted as they are now defined in Section K1.

In Table K2.1A, the limits on  $D/t$  for branch plate shear loading and cap plate connections in compression have been deleted and the limitation on the end distance has been deleted because it is now included in new Section K1.4.

**K3. HSS-HSS TRUSS CONNECTIONS**

The introduction is edited for clarity. In (b), the statement that “An N-connection can be considered as a type of K-connection” has been deleted.

**K3.1. Definition of Parameters**

The definitions of  $\beta$ ,  $\beta_{eff}$ ,  $\gamma$ ,  $\eta$ , and  $\theta$  have been removed as they were already defined in Section K1.1.

**K3.2. Round HSS**

In Table K3.1, the notes in the footer (Functions) for  $Q_f$  and  $U$  have been deleted as they are now defined in Section K1. In Table K3.1A, the definition of end distance has been removed because it is now included in new Section K1.4.

### **K3.3. Rectangular HSS**

In Table K3.2, Equations K3-10, K3-11, and K3-12, the symbols,  $B_{ei}$  and  $B_{ej}$  have been replaced with  $B_{eoi}$  and  $B_{eov}$ , respectively, and two new equations, K3-13 and K3-14 have been added to determine these. The former Equation K3-13 has been updated to K3-15. The notes in the footer (Functions) for  $Q_f$  and  $U$  have been deleted as they are now defined in Section K1. The Equation K3-17 for  $B_{ep}$  has been revised.

In Table K3.2A, “branch wall slenderness” has been aligned correctly and the definition of end distance has been removed because it is now included in new Section K1.4.

## **K4. HSS-HSS MOMENT CONNECTIONS**

### **K4.1. Definition of Parameters**

The definitions of  $\beta$ ,  $\gamma$ ,  $\eta$ , and  $\theta$  have been removed as they were already defined in Section K1.1.

### **K4.2. Round HSS**

In Table K4.1, the Equation K4-1 has been edited by moving  $\sin\theta$  into the denominator on the right side, consistent with Equations K4-2, K4-3, and K4-4. In the footer, the two equations for combined loading have been combined into one Equation K4-5, in a more generic format, similar to Chapter H, and definitions of applicable symbols have been updated.

### **K4.3. Rectangular HSS**

In Table K4.2, the limit state of chord sidewall local yielding has been added for branches under out-of-plane bending (T- and cross-connections) and the limit state of sidewall yielding has been added for branches under in-plane bending (T- and cross-connections). In the footer, the two equations for combined loading are combined into one Equation K4-5, in a more generic format, similar to Chapter H, and definitions of applicable symbols are updated.

## **K5. WELDS OF PLATES AND BRANCHES TO HSS**

The title of this Section has been changed from *WELDS OF PLATES AND BRANCHES TO RECTANGULAR HSS*.

The definition of  $F_{nw}$  has been revised for consistency with changes in Chapter J related to the directional strength increase for fillet welds.

In Table K5.1, from the Equations K5-10, K5-11, and K5-12, the symbols  $B_{ei}$  and  $B_{ej}$  have been replaced with  $B_{eoi}$  and  $B_{eov}$ , respectively, and two new equations, K3-13 and K3-14, have been added to determine these. Equation K5-14 has been added to define  $B_{ej}$ . The former Equation K5-14 has been updated to K5-15.

Table K5.2 has been added to provide the effective weld properties for connections to round HSS.

**CHAPTER L**  
**DESIGN FOR SERVICEABILITY**

No changes have been made to this chapter.

## CHAPTER M FABRICATION AND ERECTION

In the introduction, the term “shop drawings” has been replaced with “fabrication and erection documents.”

### M1. FABRICATION AND ERECTION DOCUMENTS

The title of this Section has been changed from *SHOP AND ERECTION DRAWINGS*.

#### M1.1. Fabrication Documents for Steel Construction (new Section)

This new Section specifies the items required by the applicable building code and the Specification for work to be performed and included in the fabrication documents.

#### M1.2. Erection Documents for Steel Construction (new Section)

This new Section specifies the items required by the applicable building code and the Specification for work to be performed and included in the erection documents.

### M2. FABRICATION

#### M2.1. Cambering, Curving, and straightening

The provisions have been expanded to address limitations on heating the following materials to correct camber, curvature, and straightness: ASTM A709/A709M, ASTM A913/A913M, and ASTM A1066/A1066M. The Section also now allows alternative temperature limitations if approved by the engineer of record.

#### M2.2. Thermal Cutting

This Section is revised to be consistent with updates to referenced clauses in AWS D1.1/D1.1M.

#### M2.5. Bolted Construction

The language referring to holes is editorially revised, and the term “bolt holes” is consistently used.

#### M2.9. Holes for Anchor Rods

This Section is revised to clarify that mechanical or manual thermal cutting is permitted for cutting anchor rod holes, and specifically the “quality” requirements in Section M2.2 must be satisfied.

**CHAPTER N**  
**QUALITY CONTROL AND QUALITY ASSURANCE**

**N1. GENERAL PROVISIONS**

This Section has been edited to stipulate that responsibilities for quality assurance shall be specified in the contract documents, when required.

**N3. FABRICATOR AND ERECTOR DOCUMENTS**

**N3.1. Submittals for Steel Construction**

In this Section, all occurrences of “shop drawings” and “erection drawings” have been replaced with “fabrication documents” and “erection documents,” respectively.

**N4. INSPECTION AND NONDESTRUCTIVE TESTING PERSONNEL**

**N4.1. Quality Control Inspector Qualifications**

A new paragraph has been added to provide requirements for quality control coating inspection.

**N4.2. Quality Assurance Inspector Qualifications**

A new paragraph has been added to provide requirements for quality assurance coating inspection.

**N5. MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS**

**N5.1. Quality Control**

In this Section, all occurrences of “shop drawings” and “erection drawings” have been replaced with “fabrication documents” and “erection documents,” respectively.

**N5.4. Inspection of Welding**

In Table N5.4-1, two tasks have been added under “Welder identification system” incorporating the provision that formerly appeared in a footnote regarding die stamping of members.

In Table N5.4-3, a footnote has been added relative to die stamping of members subjected to fatigue.

**N5.6. Inspection of High Strength Bolting**

Items (b) and (c) have been revised to include the combined method of installation for bolts.

**N5.8. Other Inspection Tasks**

In this Section, all occurrences of “shop drawings” and “erection drawings” have been replaced with “fabrication documents” and “erection documents,” respectively.

**N6. APPROVED FABRICATORS AND ERECTORS**

This Section has been revised to address requirements if the fabricator or erector is approved by the authority having jurisdiction to perform and document quality assurance inspections.

**N8. MINIMUM REQUIREMENTS FOR SHOP OR FIELD APPLIED COATINGS (new Section)**

This new Section addresses the quality control requirements for coatings applied by the fabricator or erector.

**APPENDIX 1**  
**DESIGN BY ADVANCED ANALYSIS**

**1.3. DESIGN BY INELASTIC ANALYSIS**

**1.3.2. Ductility Requirements**

**1.3.2b Cross Section**

In (b), “diaphragm plates” have been removed from the list.

**APPENDIX 2**  
**DESIGN OF FILLED COMPOSITE MEMBERS**  
**(HIGH STRENGTH)**

The title of this appendix has been changed from *Design for Ponding*. Guidance for ponding has been added to Section B3.10 and a new appendix on *Design of Filled Composite Members (High Strength)* has been added, with the limitations of the appendix given in Section 2.1.1.

## APPENDIX 3 FATIGUE

### 3.6 NONDESTRUCTIVE EXAMINATION REQUIREMENTS FOR FATIGUE

The clauses from AWS D1.1/D1.1M referenced in this Section, 6.12.2 and 6.13.2, have been updated to 8.12.2 and 8.13.2, respectively.

The following Case descriptions were revised in Table A-3.1.

- Case 1.3: For  $R \geq 1$  in. (25 mm), water-jet cutting has been added as an acceptable method for cutting, copes, cuts, block-outs, or other geometrical discontinuities. For  $R \geq 3/8$  in. (10 mm), provisions for cutting copes, cuts, block-outs, or punching bolt holes are provided.
- Case 2.1: Footnote [a] has been added to require the use of slip-critical connections when joints are subjected to reversal of the loading direction, and also address hole preparation.
- Case 2.2: Revised to address lap joints connected by pretensioned bolts. The new footnote provides additional requirements, including preparation of bolt holes.
- Case 2.3: Revised to clarify the description applies to existing riveted joints. The Stress Category changed from C to D. The Constant,  $C_f$ , changed from 4.4 to 2.2. The Threshold,  $F_{TH}$ , changed from 10 ksi (69 MPa) to 7 ksi (48 MPa).
- Case 2.4: Revised to clarify that the description applies to eye bar or pin plate “connections.”
- Case 7.1: Revised.
- Production methods for small radius cuts have been added.

## APPENDIX 4 STRUCTURAL DESIGN FOR FIRE CONDITIONS

### 4.1. GENERAL PROVISIONS

#### 4.1.2. Design by Engineering Analysis

Provisions for using a design based on advanced analysis has been added. Also, clarification has been added to use ambient resistance factors with the LRFD method.

#### 4.1.4. Load Combinations and Required Strength

The last paragraph related to the application of a notional load has been removed.

### 4.2. STRUCTURAL DESIGN FOR FIRE CONDITIONS BY ANALYSIS

#### 4.2.1. Design-Basis Fire

In this Section, all mentions of “heating conditions” have been replaced with “heating and cooling conditions.”

ANSI/UL 263 is now included as an alternate standard to determine the design-basis fire.

#### 4.2.3. Material Properties at Elevated Temperatures

The title of this Section has been changed from *Material Strengths at Elevated Temperatures*.

The preamble to this Section has been revised to be more general with reference to Section 4.2.3a and 4.2.3b to determine material properties at elevated temperatures.

#### 4.2.3b. Mechanical Properties of Structural Steel, Hot-Rolled Reinforcing Steel, and Concrete at Elevated Temperatures

The title of this Section has been changed from *Mechanical Properties at Elevated Temperatures*. This Section has been revised with provisions from CEN (2005b) and CEN (2005d). (Note that these full references are given at the end of this appendix in this document. Refer to the Commentary Appendix 4, Table C-A-4.1 for a summary of the references that the new provisions come from.)

##### Table A-4.2.1 Properties of Steel at Elevated Temperatures

The fourth column that listed  $k_t$  has been removed.

##### Table A-4.2.3 Properties of Group 120 and Group 150 High-Strength Bolts at Elevated Temperatures

The title of this table has been changed from *Properties of Group A and Group B High-Strength Bolts at Elevated Temperatures* to be consistent with new labels for bolts in Section J3. The heading for the second column in the Table is revised to  $k_b$ .

#### 4.2.4. Structural Design Requirements

##### 4.2.4a. General Requirements

The title of this Section has been changed from *General Structural Integrity*. A new paragraph on vent holes has been added.

##### 4.2.4b. Strength Requirements and Deformation Limits

This Section has been edited for clarity.

##### 4.2.4c. Design by Advanced Methods of Analysis

This Section has been edited for clarity.

##### 4.2.4d. Design by Simple Methods of Analysis

This Section has been edited throughout for clarity. Additionally, new provisions for the design compressive strength in gravity-only columns, filled composite columns, and filled composite plate shear walls at elevated temperature have been added.

##### Table A-4.2.4 Retention Factor for Flexure in Composite Beams

The title of this Table has been changed from *Retention Factor for Composite Flexural Members*. The heading of the second column is revised to  $k_{cb}$  to reflect a change in terminology.

##### 4.2.4e. Design by Critical Temperature Method (new Section)

Critical temperature is introduced in this Section, which is the temperature at which the demand on the member exceeds its capacity under fire conditions. This Section addresses the critical temperature requirements of tension members, compression members, and continuously braced beams not supporting a concrete slab, which are permitted to be used instead of Section 4.2.4d.

#### 4.3. DESIGN BY QUALIFICATION TESTING

##### 4.3.1. Qualification Standards

The UL 263 standard has been added as an alternative to the ASTM E119 standard. The option to use advanced analysis methods is also added in the first paragraph of this Section. A new Table A-4.3.1, *Minimum Fire Protection and Fire Resistance Ratings of Steel Assemblies*, taken from ICC (2018) has been added.

##### 4.3.2. Structural Steel Assemblies (new Section)

This Section addresses the procedures for establishing standard fire resistance ratings of structural steel assemblies by calculations. The Provisions are based on ASCE (2005) and ICC (2018). Under Steel Columns, there are provisions for gypsum wallboard protection, sprayed and intumescent or mastic fire-resistant materials, noncomposite columns encased in concrete, and noncomposite columns encased in masonry units of concrete or clay. Under composite steel-concrete columns, there are provisions for filled columns and composite columns encased in concrete. There are also provisions for composite and noncomposite steel I-shaped beams and girders, concrete-encased steel beams and girders, trusses, concrete floor slabs on steel deck,

and composite plate shear walls. New Table A-4.3.2, Ambient Properties of Concrete Encasement for Steel Column Fire Resistance, and new Table A-4.3.3, Thermal Conductivity of Masonry Units for Steel Column Encasement, are provided, as well as several other new tables required to implement the new provisions.

- 4.3.3. Restrained Construction** (was Section 4.3.2.)  
The list of assemblies that are considered restrained construction has been updated.
- 4.3.4. Unrestrained Construction** (was Section 4.3.3.)  
No Changes have been made to this Section.

## **Appendix 4 References**

ASCE (2005), *Standard Calculation Methods for Structural Fire Protection*, ASCE/SEI/SFPE 29-05, American Society of Civil Engineers, Reston, VA.

CEN (2005b), *Eurocode 3: Design of Steel Structures*, Part 1-2: General Rules, Structural Fire Design, Comité Européen de Normalisation, Brussels, Belgium.

CEN (2005d), *Eurocode 4: Design of Composite Steel and Concrete Structures*: Part 1-2: General Rules, Structural Fire Design, Comité Européen de Normalisation, Brussels, Belgium.

ICC (2018), *International Building Code*, International Code Council, Country Club Hills, Ill.

## **APPENDIX 5 EVALUATION OF EXISTING STRUCTURES**

The introduction has been edited for clarity.

### **5.1. GENERAL PROVISIONS**

The provisions related to load tests have been moved to Section 5.4.1, under evaluation by load tests.

### **5.2. MATERIAL PROPERTIES**

An introduction has been added that clarifies that steel grades outside those listed in Section A3.1 are permitted.

#### **5.2.2. Tensile Properties**

This Section has been revised editorially for clarity.

#### **5.2.6. Bolts and Rivets**

This Section has been revised editorially for clarity.

### **5.3. EVALUATION BY STRUCTURAL ANALYSIS**

#### **5.3.1. Dimensional Data**

The term “shop drawings” has been replaced with “fabrication documents.”

#### **5.3.2. Strength Evaluation**

It has been clarified that applicable provisions for determining available strength of members and connections are also found in Appendix 5.

##### **5.3.2a Rivets (new Section)**

This Section addresses the design strength of rivets.

### **5.4. EVALUATION BY LOAD TESTS**

#### **5.4.1. General Requirements (new Section)**

The requirements of this Section were moved from Section 5.1.

#### **5.4.2. Determination of Load Rating by Testing (was Section 5.4.1.)**

This Section has been revised editorially for clarity. In the fifth paragraph, the discussion of permanent deformation has been deleted as it provided information more consistent with commentary.

#### **5.4.3. Serviceability Evaluation (was Section 5.4.2.)**

No changes have been made to this Section.

### **5.5. EVALUATION REPORT**

This Section has editorially revised for clarity and the term “drawings” has been replaced with “documents” to include digital models.

## **APPENDIX 6 MEMBER STABILITY BRACING**

The introduction has been edited for clarity.

### **6.1. GENERAL PROVISIONS**

The requirement that flexibility of all components in a system must be considered has been added.

### **6.3. BEAM BRACING**

#### **6.3.2. Torsional Bracing**

##### **6.3.2a Point Bracing**

Equations A-6-9, A-6-11a, and A-6-11b have been updated, a definition for  $L_{br}$  has been added, and additional provisions relating to these equations have also been added.

**APPENDIX 7**  
**ALTERNATIVE METHODS OF DESIGN FOR STABILITY**

**7.2. EFFECTIVE LENGTH METHOD**

**7.2.1. Limitations**

The introduction has been editorially revised for clarity.

**7.2.3. Available Strengths**

The term “control” in the final paragraph has been editorially replaced with “limit.”

**7.3. FIRST-ORDER ANALYSIS METHOD**

**7.3.1. Limitations**

A new limitation (b) has been added for the required axial compressive strength in nominally horizontal members in moment frames. Additionally, the definitions for  $\alpha$  and  $P_r$  have been moved to (b) and the definition for  $P_{ns}$  has been edited to clarify that  $A_e$  should be calculated using Section E7, where  $F_n = F_y$ .

## **APPENDIX 8 APPROXIMATE ANALYSIS**

The title of this appendix has been changed from *APPROXIMATE SECOND-ORDER ANALYSIS*.

The introductory remarks have been edited to expand the scope of this appendix from only approximate second-order analysis to approximate analysis methods in general.

### **8.1. APPROXIMATE SECOND-ORDER ELASTIC ANALYSIS**

The title of this Section has been changed from *LIMITATIONS*.

The existing language is enhanced with additional requirements related to approximating second-order effects by amplifying the required strengths determined by two first-order elastic analyses. The added sentence says that this method is not permitted for design by advanced analysis.

**8.1.1 Calculation Procedure** (was Section 8.2)  
No changes have been made to this Section.

**8.1.2 Multiplier  $B_1$  and  $P-\delta$  Effects** (was Section 8.2.1)  
No changes have been made to this Section.

**8.1.3 Multiplier  $B_2$  and  $P-\Delta$  Effects** (was Section 8.2.2)  
No changes have been made to this Section.

### **8.2. APPROXIMATE INELASTIC MOMENT REDISTRIBUTION**

This is a new Section that consists of provisions moved from Section B3.3 (moment redistribution) and former Section F13.5 (unbraced length for moment redistribution).