A Comparison between the 2005 and 2010 AISC Specification

ERIC J. BOLIN, THOMAS J. DEHLIN and LOUIS F. GESCHWINDNER

ABSTRACT

In 2010, the American Institute of Steel Construction published a revised version of its *Specification for Structural Steel Buildings* that replaces the 2005 edition. Changes to the *Specification* were minimal and improved the usability and accuracy of the document. A detailed summary of these changes are contained in this article, providing an extension to the historical reviews of previous AISC specifications presented in Appendix A1 of AISC Design Guide 15.

Keywords: design specifications.

INTRODUCTION

The American Institute of Steel Construction and its Committee on Specifications make great efforts to ensure that the AISC *Specification for Structural Steel Buildings* is presented in a manner that is as clear and simple as possible. Since the first edition was first adopted in 1923, the *Specification* has been revised periodically with the intent to broaden its scope, simplify design procedures, improve the accuracy of some provisions and improve its usability. The 2010 edition continues this advancement of the *Specification* with a few new changes.

To assist users of previous editions of the *Specification* with the newest changes, a cross-reference list has been prepared here, detailing the specific changes made to each provision. This list contains the changes in both content and organization between the 2010 and 2005 editions of the *Specification*. This list expands the historical review found in Appendix A1 of AISC Design Guide 15 (Brockenbrough, 2002) of AISC Specifications and corresponding Supplements from the first edition published in 1923 through the most current 2010 edition. AISC has made the 2010 *Specification* available for free download through the AISC website at www.aisc.org/epubs, but it can also be found in Part 16 of the 14th edition of the AISC *Steel Construction Manual*.

Three major changes that are evident upon using the new *Specification* include a new Chapter N, a major reorganization of Chapters I and K and an increase in the nominal bolt shear strength tabulated in Chapter J.

Eric J. Bolin, Project Engineer, Drucker Zajdel Structural Engineers, Inc., Naperville, IL (corresponding author). E-mail: eric@dzse.com

Thomas Dehlin, Graduate Research Assistant, University of Illinois at Urbana-Champaign, Urbana, IL. E-mail: tdehlin90@gmail.com

Louis F. Geschwindner, Ph.D., P.E., Professor Emeritus of Architectural Engineering, The Pennsylvania State University, University Park, PA. E-mail: lfg@psu.edu

Chapter N, "Quality Control and Quality Assurance," is a compilation of the quality control provisions in Chapter M of the 2005 *Specification* and the quality assurance provisions in various other documents. Chapter N was added to the 2010 *Specification* as a means of tying all of these elements of quality control and assurance together in a consistent, uniform plan. There is little, if anything, in Chapter N that creates a new requirement—rather, this chapter creates an awareness of requirements that have existed elsewhere already, and it generally makes reference to those requirements in "roadmap" form.

Most of Chapter I, "Design of Composite Members," has been reorganized and improved in the newest edition of the *Specification*. Several new topics are covered in this chapter, including design and detailing of composite diaphragms and collector beams, shear and tension interaction strength of steel headed stud anchors (a.k.a., shear stud connectors) and the classification for local buckling of filled composite members.

The provisions within Chapter K, "Design of HSS and Box Member Connections," have been mostly reorganized into a tabular format with figures showing different connection configurations and their respective limit states.

In Chapter J, "Design of Connections," the nominal bolt shear strength for bolts in bearing-type connections has increased by approximately 12.5% for most cases, allowing for a more efficient connection design if bolt shear is the controlling limit state.

The following summarizes the revisions contained in the 2010 AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360-10) compared to the 2005 AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360-05). The organization of the summary parallels the format of the 2010 AISC *Specification*. For full details on the various changes, reference should be made to the 2010 AISC *Specification*.

CHAPTER A
GENERAL PROVISIONS

The major changes to this chapter include:

- Minor editorial changes have been made.
- Several new reference standards, codes and specifications have been added.

A1. SCOPE

The scope statement of the 2010 *Specification* has been expanded by including other structures (through reference to the AISC *Code of Standard Practice for Steel Buildings and Bridges*) and systems with structural steel acting compositely with reinforced concrete. These systems had always been included in the *Specification* but had not been listed separately in this section. Clarification has been added that whenever the *Specification* refers to the applicable building code and there is none, ASCE/SEI 7 is to be used for loads, load combinations, system limitations and general design requirements. This broadens what is already given in Section B2.

A1.1. Seismic Applications (was Sections A1.1 and A1.2)

The *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341) apply for the design of seismic force resisting systems unless exempted by the building code. Thus, the discussion of low-seismic applications and high-seismic applications was deleted. Further, the discussion of the seismic response modification factor, R, has been moved into a new user note.

A1.2. Nuclear Applications (was Section A1.3)

The reference to the *Load and Resistance Factor Design Specification for Steel Safety-Related Structures for Nuclear Facilities* (ANSI/AISC N690L) has been removed from this section because it has been superseded.

A2. REFERENCED SPECIFICATIONS, CODES AND STANDARDS

Several additions and updates have been made to the specifications, codes and standards listed in this section.

A3. MATERIAL

A3.1. Structural Steel Materials

The following statement has been removed from this section, "If requested, the fabricator shall provide an affidavit stating that the structural steel furnished meets the requirements of the grade specified."

A3.1a. ASTM Designations

Several ASTM specifications have been added as approved for use with the 2010 *Specification*. In addition, metric standards for already approved materials have been included. The following materials have been added:

- Hot-rolled shapes—ASTM A1043/A1043M
- Structural tubing—ASTM 618M and A847M
- Plates—ASTM A1043/1043M
- Sheets—ASTM A606M

A3.1b. Unidentified Steel

This section is expanded to clarify the intent of the term "unimportant." It now includes a statement that the use of unidentified steel shall be subject to the approval of the engineer of record.

A3.1c. Rolled Heavy Shapes

The exception has been changed as follows:

- 2005 *Specification*: Charpy V-notch results are not required when a non-heavy shape is welded to the face of a rolled heavy shape with complete joint penetration groove welds.
- 2010 *Specification*: When a rolled heavy shape is welded to the surface of another shape using groove welds, the Charpy V-notch requirement only applies to the shape with the weld metal fused through the cross-section.

A3.1d. Built-Up Heavy Shapes

No changes have been made to this section.

A3.2. Steel Castings and Forgings

No changes have been made to this section.

A3.3. Bolts, Washers and Nuts

The following ASTM specifications have been added for bolts: ASTM A354 and ASTM F2280. For washers, ASTM F844 has been added.

A3.4. Anchor Rods and Threaded Rods

No changes have been made to this section.

A3.5. Consumables for Welding

The title of this section has been changed from "Filler Metal Flux for Welding." The metric-equivalent American Welding Society specifications are now listed for all approved consumables.

A3.6. Headed Stud Anchors

The title of this section has been changed from "Stud Shear Connectors." Steel stud shear connectors are now called steel-headed stud anchors. The metric-equivalent welding code, AWS D1.1M, was added to this section. The user note referencing ASTM A29/A29M-04 for studs made from cold drawn bar has been removed.

A4. STRUCTURAL DESIGN DRAWINGS AND SPECIFICATIONS

The provision requiring that deviations from the *Code of Standard Practice for Steel Buildings and Bridges* be specifically identified in design drawings and/or specifications has been removed. A user note is added to this section stating the information that is to be shown on the design drawings.

CHAPTER B
DESIGN REQUIREMENTS

The major changes to this chapter include:

- Structural integrity requirements for connections in the limit state section have been incorporated.
- The moment redistribution section has been moved to this chapter from Appendix 1.
- A section for the design of diaphragms and collectors has been added.
- The tables for limiting width-to-thickness ratios for flexure and compression elements have been reorganized.
- A new section has been added with changing language for quality control and quality assurance provisions.

B1. GENERAL PROVISIONS

No changes have been made to this section.

B2. LOADS AND LOAD COMBINATIONS

The user note in this section has been reworded for clarity.

B3. DESIGN BASIS

Several new sections have been added. Section B3.12, "Design Wall Thickness for HSS," has been moved to Section B4.2. Section B3.13, "Gross and Net Area Determination," has been moved to Section B4.3.

B3.1. Required Strength

The reference to the provisions in Appendix 1 for moment redistribution in continuous beams has been removed because this topic has been moved into this chapter.

B3.2. Limit States

Treatment of limit states when meeting structural integrity requirements have been added. The limit states intended to limit deformations or yielding are not considered for satisfying structural integrity requirements. Bolt bearing with short-slotted holes parallel to the direction of tension is permitted.

B3.3. Design for Strength Using Load and Resistance Factor Design (LRFD)

No changes have been made to this section.

B3.4. Design for Strength Using Allowable Strength Design (ASD)

No changes have been made to this section.

B3.5. Design for Stability

No changes have been made to this section.

B3.6. Design of Connections

For clarification, the statement that self-limiting inelastic deformations are permitted has been added to this section to apply to all connections. At points of support, beams, girders and trusses must be restrained against rotation about their longitudinal axis unless analysis shows that restraint is not required. This is to clarify the requirements that exist in Chapter F.

B3.6a. Simple Connections

The provision permitting inelastic rotation of a connection has been removed because it is now addressed directly in Section B3.6.

B3.6b. Moment Connections

No changes have been made to this section.

B3.7. Moment Redistribution in Beams (new section, was Appendix 1, Section 1.3)

A limitation has been added that does not permit moment redistribution when using partially restrained moment connections.

B3.8. Diaphragms and Collectors (new section)

This section is used to remind designers that these elements must be designed.

B3.9. Design for Serviceability (was Section B3.7)

This section was edited for clarity.

B3.10. Design for Ponding (was Section B3.8)

No changes have been made to this section.

B3.11. Design for Fatigue (was Section B3.9)

No changes have been made to this section.

B3.12. Design for Fire Conditions (was Section B3.10)

This section was edited for clarity.

B3.13. Design for Corrosion Effects (was Section B3.11)

No changes have been made to this section.

B3.14. Anchorage to Concrete (new section)

This section includes charging language for design of anchorage between steel and concrete acting compositely and for design of column bases and anchor rods.

B4. MEMBER PROPERTIES

The title of this section has been changed from "Classification of Sections for Local Buckling" due to the expanded coverage of this section. Several subsections have been moved here including, B4.2, "Design Wall Thickness for HSS," and B4.3, "Gross and Net Area Determination."

B4.1. Classification of Sections for Local Buckling (was Section B4)

To clarify the distinction between columns and beams and to eliminate the notation "NA" for λ_p (which is not applicable to columns), the local buckling classifications have been separated for flexure and compression. The classification for flexure remains compact/noncompact/slender, while compression members are now classified as nonslender/slender. Table B4.1 has been divided into two parts, Tables B4.1a for members subject to axial compression and B4.1b for members subject to flexure.

B4.1a. Unstiffened Elements (was Section B4.1)

No changes have been made to this section.

B4.1b. Stiffened Elements (was Section B4.2)

Section (e) has been added, defining *b*, the width of perforated cover plates.

TABLE B4.1a
Width-to-Thickness Ratios: Compression Elements Members Subject to Axial Compression

This table contains the cases from Table B4.1 in the 2005 *Specification* that apply to compression. New figures are included in the "Examples column," which now illustrate a larger number of possibilities. Because compression elements in members subject to axial compression are either nonslender or slender, only the limiting width-to-thickness ratio, λ_r, is provided in Table B4.1a. The following table shows the changes that have been made to the element descriptions and the case numbering in this table.

Case (2010)	Case (2005)	Change in Description
1	3	Flanges of tees have been added to this case.
2	4	*
3	5	*
4	8	*
5	10	Channels have been added to this case.
6	12	Flanges have been changed to walls and bending moved to Table B4.1b.
7	12	Bending moved to Table B4.1b.
8	14	*
9	15	Circular hollow sections have been changed to round HSS and bending moved to Table B4.1b.

* No changes have been made.

TABLE B4.1b
Width-to-Thickness Ratios: Compression Elements Members Subject to Flexure

This table contains the cases from Table B4.1 in the 2005 *Specification* that apply to flexure. New figures are included in the "Examples" column, which now illustrate a larger number of possibilities. The following table shows the changes that have been made to the element descriptions and case numbering in Table B4.1b.

Case (2010)	Case (2005)	Change in Description
10	1,7	*
11	2	*
12	6	*
13	1	Clarification for weak axis flexure.
14	New	New provisions for the stems of tees in flexure.
15	9	*
16	11	*
17	12	Compression moved to Table B4.1a.
18	12	Compression moved to Table B4.1a.
19	13	Webs of boxes added.
20	15	Circular hollow sections has been changed to round HSS and compression moved to Table B4.1a.

* No changes have been made.

B4.2. Design Wall Thickness for HSS (was Section B3.12)
No changes have been made to this section.

B4.3. Gross and Net Area Determination (was Section B3.13)

B4.3a. Gross Area (was Section B3.13a)
No changes have been made to this section.

B4.3b. Net Area (was Section B3.13b)
The reference to Section J3.2 for determining hole and slot dimensions was removed because it was unnecessary. For clarity, the following statement has been added: "For members without holes, the net area, A_n, is equal to the gross area, A_g."

B5. FABRICATION AND ERECTION
Quality control was moved to Section B6.

B6. QUALITY CONTROL AND QUALITY ASSURANCE (new section)
This new section contains the charging language for the new Chapter N, "Quality Control and Quality Assurance."

B7. EVALUATION OF EXISTING STRUCTURES (was Section B6)
This section has been reworded for clarity.

CHAPTER C
DESIGN FOR STABILITY

The major changes to this chapter include:

- The title of this chapter has been changed from "Stability Analysis and Design."
- This chapter now contains the direct analysis method, which has been moved from Appendix.7
- The effective length method and the first-order analysis method have been moved to Appendix 7.
- The approximate second-order analysis method (B_1-B_2 method) has been moved to Appendix 8.
- A new section, C3, titled "Calculation of Available Strengths," has been added to this chapter.

C1. GENERAL STABILITY REQUIREMENTS (was Section C1.1)
The content of this section has been reorganized for clarity. A numbered list is now provided for effects that must be considered when assessing the stability of a structure. Consideration of residual

stresses has been expanded to include stiffness reduction due to inelasticity. Uncertainty in stiffness and strength has been added as a consideration. The LRFD and ASD load levels used for analysis are added to this section. A user note is included in this section defining the term "design," which is the combination of analysis to determine required strength and proportioning components to have adequate available strength.

C1.1. Direct Analysis Method of Design (new section)

This section permits the use of the direct analysis method for all structures.

C1.2. Alternative Methods of Design (new section)

This section permits the use of the effective length method and the first-order analysis method, defined in Appendix 7, when meeting the constraints specified. Appendix 7 contains the material on these methods that had been in Chapter C.

C2. CALCULATION OF REQUIRED STRENGTHS

This section now contains the required strength calculations using the direct analysis method. The content of this section has been moved from Appendix 7 in the 2005 *Specification* so all sections are new; however, the material is generally not new.

C2.1. General Analysis Requirements (new section)

The conditions under which the influence of P-δ effects on the response of the structure may be neglected have been expanded. Two user notes have been added; one states the that P-δ effects evaluated for individual members can be satisfied by applying the B_1 multiplier, and the other states that all gravity loads should be included in the analysis.

C2.2. Consideration of Initial Imperfections (new section)

A user note has been added stating that the imperfections considered are the locations of points of intersection of members caused by the out-of-plumbness of columns and that initial out-of-straightness of members is addressed in Chapter E for compression members and is not considered explicitly in analysis.

C2.2a. Direct Modeling of Imperfections (new section)

A user note has been added stating the initial displacements should be similar in configuration to displacements caused by loading and buckling with magnitudes based on permissible construction tolerances given in the AISC *Code of Standard Practice*.

C2.2b. Use of Notional Loads to Represent Imperfections

The requirement that use of notional loads are permitted only for structures that support gravity loads primarily through nominally vertical members has been added. A user note has been added stating that using notional loads can create additional fictitious base shears and overturning moments. The correct horizontal reaction at the base is found using a force equal to but opposite in direction to the notional loads applied at the base.

C2.3. Adjustments to Stiffness (new section)

The reduced flexural stiffness and reduced axial stiffness equations have been deleted, and the requirements have been reformatted into a text description in order to clarify that the reduction applies to all stiffness contributing to the lateral load resistance of the structure. A paragraph has been added for the stability analysis of a structure using materials other than structural steel.

C3. CALCULATION OF AVAILABLE STRENGTHS (new section)

This section clarifies that Chapters D through K are used for determination of available strengths. It also includes the requirement, moved from Appendix 7.1, that the effective length factor, K, will be taken as unity unless a smaller value can be justified by analysis. A statement has been included reiterating the requirements of Appendix 6 that bracing that defines the unbraced length must have sufficient strength and stiffness. In addition, it is pointed out that bracing included in the second-order analysis, as required by the direct analysis method, need not meet the requirements of Appendix 6.

CHAPTER D
DESIGN OF MEMBERS FOR TENSION

The major changes to this chapter include:

- The gross and net area sections have been moved to Chapter B.
- A new minimum shear lag factor is given for open cross-section shapes.
- Modifications have been made to several of the descriptions of elements in Table D3.1.

D1. SLENDERNESS LIMITATIONS

No changes have been made to this section.

D2. TENSILE STRENGTH

No changes have been made to this section.

D3. EFFECTIVE NET AREA

The title of this section has been changed to reflect that gross area and net area provisions have been moved to Sections B4.3a and B4.3b, respectively. For open cross-sections, a minimum shear lag factor has been added. The requirement that connections be proportioned so that the shear lag factor need not be less than 0.60 unless eccentricity is included in the design has been removed.

TABLE D3.1
Shear Lag Factors for Connections to Tension Members

This table remains the same with the following exceptions: Case 2 has been expanded to include tension members that transmit tensile load with longitudinal welds in combination with transverse welds. Two new figures have been added for Case 2 examples. Case 8 is expanded to include double angles. In the 2005 *Specification,* the single-angle condition with two or three fasteners per line in the direction of loading, with $U = 0.60$, has been changed to only three fasteners and directs the user to Case 2 for fewer fasteners.

D4. BUILT-UP MEMBERS

No changes have been made to this section.

D5. PIN-CONNECTED MEMBERS

D5.1. Tensile Strength

No changes have been made to this section.

D5.2. Dimensional Requirements

No changes have been made to this section.

D6. EYEBARS

D6.1. Tensile Strength

No changes have been made to this section.

D6.2. Dimensional Requirements

No changes have been made to this section.

CHAPTER E
DESIGN OF MEMBERS FOR COMPRESSION

The major changes to this chapter include:

- A new user note table has been added to assist in determining the applicable sections in this chapter.

- Changes have been made to the provisions for single-angle compression members.
- A new modified slenderness ratio is given for built-up members.

E1. GENERAL PROVISIONS

Sections E1(a) and E1(b) have been removed from this section and new text is used throughout the chapter to clarify the applicability of the various limit states.

TABLE USER NOTE E1.1

Selection Table for the Application of Chapter E Sections

This new table shows the applicable limit states with chapter section references.

E2. EFFECTIVE LENGTH

The title of this section has been changed from "Slenderness Limitations and Effective Length" to reflect that it just defines the effective length factor. This section now references Appendix 7 (in addition to Chapter C) for the determination of the effective length factor, K.

E3. FLEXURAL BUCKLING OF MEMBERS WITHOUT SLENDER ELEMENTS

The title of this section has been changed from "Compressive Strength for Flexural Buckling of Members without Slender Elements." The flexural buckling stress, F_{cr}, is now referred to as the critical stress. In Section E3(a), the alternate slenderness check, $F_e \geq 0.44F_y$, is now shown as $F_y/F_e \leq 2.25$, and in Section E3(b), $F_e < 0.44F_y$, is now shown as $F_y/F_e > 2.25$ to eliminate the truncation of the coefficient. The definition of the elastic buckling stress, F_e, now references Appendix 7 instead of Section C2 because that material was moved.

E4. TORSIONAL AND FLEXURAL-TORSIONAL BUCKLING OF MEMBERS WITHOUT SLENDER ELEMENTS

The title of this section has been changed from "Compressive Strength for Torsional and Flexural-Torsional Buckling of Members without Slender Elements." This section now clearly states that it applies to all doubly symmetric members without slender elements when the torsional unbraced length exceeds the lateral unbraced length and for single angles with $b/t > 20$ as a clarification for what was removed from Sections E1(a) and E1(b). In Section E4(a), the definition of member slenderness for double-angle compression members is clarified. With the exception of their organization, the equations in this section remain unchanged.

E5. SINGLE-ANGLE COMPRESSION MEMBERS

This section now stipulates that the provisions in Section E4 apply to single angles with $b/t > 20$. The material in Section E5(c) has been moved to Section E5, with the exception of the specific examples of different end conditions requiring the use of Chapter H provisions, which have been removed.

E6. BUILT-UP MEMBERS

E6.1. Compressive Strength

This section has been reorganized for clarity. The requirement that the end connection of built-up members be welded or connected by means of pretensioned bolts with Class A or B faying surfaces has been moved here from Section E6.2. The user note from Section E6.2 has also been moved into this section. This user note has added that the end connection should be designed to resist slip. Section E6.1(i) has been changed to E6.1(a), and Section E6.1(ii) has been changed to E6.1(b). In Section E6.1(b), the modified column slenderness equation for built-up shapes with intermediate connectors that are welded or connected with pretensioned bolts has been replaced with two new equations.

E6.2. Dimensional Requirements

Parts of this section have been reworded for clarity.

E7. MEMBERS WITH SLENDER ELEMENTS

A statement that it is conservative to use the smaller Q_s for cross-sections composed of multiple unstiffened slender elements has been added to the user note.

E7.1. Slender Unstiffened Elements, Q_s

In Section E7.1(b), the referenced member was changed from built-up to built-up I-shaped.

E7.2. Slender Stiffened Elements, Q_a

No changes have been made to this section.

CHAPTER F
DESIGN OF MEMBERS FOR FLEXURE

The major changes to this chapter include:

- The equation for the lateral-torsional buckling modification factor, C_b, has been modified.
- The equations for flange local buckling of tees have been modified.
- A new section for the limit state of local buckling of tee stems has been added.
- New proportioning limits are now given for I-shaped members.
- This chapter now contains the unbraced length requirement to permit moment redistribution.

TABLE USER NOTE F1.1
Selection Table for the Application of Chapter F Sections

The portion of this table referring to Section F12 for unsymmetrical shapes now excludes single angles.

F1. GENERAL PROVISIONS

The material addressing the lateral-torsional buckling modification factor has been separated into a new subsection. Application of the lateral-torsional buckling modification factor, C_b, as given is now limited to singly symmetric members in single curvature and all doubly symmetric members. In Equation F1-1, the cross-section monosymmetry parameter, R_m, has been removed along with the upper limit. The statement that C_b is permitted to be conservatively taken as 1.0 has been removed. The user note has been expanded to include a reference to the commentary for detailed analysis for singly symmetric members.

F2. DOUBLY SYMMETRIC COMPACT I-SHAPED MEMBERS AND CHANNELS BENT ABOUT THEIR MAJOR AXIS

F2.1. Yielding

No changes have been made to this section.

F2.2. Lateral-Torsional Buckling

A user note has been added stating that Equations F2-3 and F2-4 in the 2010 *Specification* produce results identical to the equations used in past editions of the LRFD *Specification*. Equation F2-6 has been reformatted to eliminate the issue when $J = 0$; otherwise, the equation produces identical results.

F3. DOUBLY SYMMETRIC I-SHAPED MEMBERS WITH COMPACT WEBS AND NONCOMPACT OR SLENDER FLANGES BENT ABOUT THEIR MAJOR AXIS

F3.1. Lateral-Torsional Buckling

No changes have been made in this section.

F3.2. Compression Flange Local Buckling

The definition of h has been clarified.

F4. OTHER I-SHAPED MEMBERS WITH COMPACT OR NONCOMPACT WEBS BENT ABOUT THEIR MAJOR AXIS

F4.1. Compression Flange Yielding
The definition of M_{yc} has been clarified.

F4.2. Lateral-Torsional Buckling
The web plastification factor, R_{pc}, for extreme singly symmetric members has been set to 1.0. The definitions for I_{yc} and h_c have been clarified.

F4.3. Compression Flange Local Buckling
No changes have been made to this section.

F4.4. Tension Flange Yielding
No changes have been made to this section.

F5. DOUBLY SYMMETRIC AND SINGLY SYMMETRIC I-SHAPED MEMBERS WITH SLENDER WEBS BENT ABOUT THEIR MAJOR AXIS

F5.1. Compression Flange Yielding
No changes have been made to this section.

F5.2. Lateral-Torsional Buckling
No changes have been made to this section.

F5.3. Compression Flange Local Buckling
No changes have been made to this section.

F5.4. Tension Flange Yielding
No changes have been made to this section.

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

F6.1. Yielding
No changes have been made to this section.

F6.2. Flange Local Buckling
The definition of b has been clarified.

F7. SQUARE AND RECTANGULAR HSS AND BOX-SHAPED MEMBERS

A user note has been added to this section stating that a lateral-torsional buckling equation is not provided in this section because the limit state of beam deflection will control for reasonable cases.

F7.1. Yielding
No changes have been made to this section.

F7.2. Flange Local Buckling
No changes have been made to this section.

F7.3. Web Local Buckling
No changes have been made to this section.

F8. ROUND HSS

F8.1. Yielding
No changes have been made to this section.

F8.2. Local Buckling
No changes have been made to this section.

F9. TEES AND DOUBLE ANGLES LOADED IN THE PLANE OF SYMMETRY

A new section, F9.4, has been added to address the limit state of local buckling for tee stems in flexural compression.

F9.1. Yielding

New subsections have been added to improve clarity.

F9.2. Lateral-Torsional Buckling

No changes have been made to this section.

F9.3. Flange Local Buckling of Tees

The strength equations have been changed from stress to nominal moment and presented in a format similar to that for other shapes. A new user note has been added directing the user to Section F10.3 for double angles with flange legs in compression.

F9.4. Local Buckling of Tee Stems in Flexural Compression (new section)

The nominal moment strength of a tee stem in flexural compression is presented. This new approach replaces the past approach of relying on lateral-torsional buckling as the upper limit for flange local buckling. A user note has been included in this section for double angles with web legs in compression directing the user to Section F10.3.

F10. SINGLE ANGLES

For clarity, a requirement has been added stating that if there is moment about both principle axes with or without axial load, or if there is moment along one principle axis with axial load, the combined stress ratio shall be determined using Section H2. A user note has been added stating that if bending is about the minor axis, only the limit states of yielding and leg local buckling apply.

F10.1. Yielding

No changes have been made in this section.

F10.2. Lateral-Torsional Buckling

Several parts within this section have been relocated to improve organization, and Section F10.2(b)(iii) now indicates that no axial compression can be present.

F10.3. Leg Local Buckling

No changes have been made to this section.

F11. RECTANGULAR BARS AND ROUNDS

F11.1. Yielding

No changes have been made to this section.

F11.2. Lateral-Torsional Buckling

No changes have been made to this section.

F12. UNSYMMETRICAL SHAPES

No changes have been made to this section.

F12.1. Yielding

No changes have been made to this section.

F12.2. Lateral-Torsional Buckling

No changes have been made to this section.

F12.3. Local Buckling

No changes have been made to this section.

F13. PROPORTIONS OF BEAMS AND GIRDERS

F13.1. Strength Reductions for Members with Holes in the Tension Flange
This section has been renamed from "Hole Reductions." The references for area calculations have been changed appropriately.

F13.2. Proportioning Limits for I-Shaped Members
The maximum web slenderness ratio for I-shaped members with stiffened slender webs has been slightly revised.

F13.3. Cover Plates
No changes have been made to this section.

F13.4. Built-Up Beams
No changes have been made to this section.

F13.5. Unbraced Length for Moment Redistribution (new section)
The contents of this section have been moved here from Appendix 1, Section 1.7 in the 2005 *Specification*.

CHAPTER G
DESIGN OF MEMBERS FOR SHEAR

The major change to this chapter includes:

- A minimum moment of inertia of stiffeners for use with tension field action has been established.

G1. GENERAL PROVISIONS
No changes have been made to this section.

G2. MEMBERS WITH UNSTIFFENED OR STIFFENED WEBS

G2.1. Shear Strength
The title of this section has been changed from "Nominal Shear Strength," and the material has been edited for clarity.

G2.2. Transverse Stiffeners
A new variable, I_{st}, has been defined as the moment of inertia of transverse stiffeners, and the equation is now a function of the least dimension of the stiffened panel.

G3. TENSION FIELD ACTION

G3.1. Limits on the Use of Tension Field Action
No changes have been made to this section.

G3.2. Shear Strength with Tension Field Action
The title of this section has been changed from "Nominal Shear Strength with Tension Field Action."

G3.3. Transverse Stiffeners
The second limiting condition for stiffeners in tension field action has been changed from a basis on area to one on moment of inertia.

G4. SINGLE ANGLES
This section has been reorganized for clarity. The given, $C_v = 1.0$, has been removed, and for clarity, the web slenderness has been defined.

G5. RECTANGULAR HSS AND BOX-SHAPED MEMBERS

This section has been reorganized for clarity. The definition of the design wall thickness, t, has been added to this section.

G6. ROUND HSS

The definition of, A_g, has been changed from the gross area based on design wall thickness to the gross cross-sectional area of the member.

G7. WEAK AXIS SHEAR IN DOUBLY SYMMETRIC AND SINGLY SYMMETRIC SHAPES

Definitions have been added for clarity.

G8. BEAMS AND GIRDERS WITH WEB OPENINGS

No changes have been made to this section.

CHAPTER H
DESIGN OF MEMBERS FOR COMBINED FORCES AND TORSION

The major changes to this chapter include:

- A new section for the rupture of flanges with holes subject to tension has been added.
- For members subject to tension and flexure, the multiplier has been revised to be given in one equation for ASD and LRFD and the ASD constant changed from 1.5 to $\alpha = 1.6$.
- The interaction equation in Section H1.3 has been revised.

H1. DOUBLY AND SINGLY SYMMETRIC MEMBERS SUBJECT TO FLEXURE AND AXIAL FORCE

H1.1. Doubly and Singly Symmetric Members Subject to Flexure and Compression

No changes have been made to this section.

H1.2. Doubly and Singly Symmetric Members Subject to Flexure and Tension

The equation for the multiplier of C_b with doubly symmetric members using LRFD and ASD has been combined into a single equation. The use of α in this equation for ASD means that the constant has been changed from 1.5 to 1.6.

H1.3. Doubly Symmetric Rolled Compact Members Subject to Single Axis Flexure and Compression

The title of this section has been changed from "Doubly Symmetric Members in Single Axis Flexure and Compression." $(KL)_z \le (KL)_y$ has been added as a limit on applicability to ensure that flexural buckling is the controlling limit state. The limit state of flexural-torsional buckling has been corrected to lateral-torsional buckling. The interaction equation for out-of-plane buckling has been revised. The statement that the moment ratio in Equation H1-2 shall be neglected if bending is only about the weak axis has been removed because this section only applies to bending about the major axis.

H2. UNSYMMETRIC AND OTHER MEMBERS SUBJECT TO FLEXURE AND AXIAL FORCE

Subscripts have been added for clarity.

H3. MEMBERS SUBJECT TO TORSION AND COMBINED TORSION, FLEXURE, SHEAR AND/OR AXIAL FORCE

The title of this section has been changed from "Members Under Torsion and Combined Torsion, Flexure, Shear and/or Axial Force."

H3.1. Round and Rectangular HSS Subject to Torsion
The title of this section has been changed from "Torsional Strength of Round and Rectangular HSS." This section has been reorganized, and definitions have been added for clarity.

H3.2. HSS Subject to Combined Torsion, Shear, Flexure and Axial Force
No changes have been made to this section.

H3.3. Non-HSS Members Subject to Torsion and Combined Stress
The title of this section has been changed from "Strength of Non-HSS Members Under Torsion and Combined Stress."

H4. RUPTURE OF FLANGES WITH HOLES SUBJECT TO TENSION (new section)
This new section has been added to address strength of flanges with holes subject to tension under combined axial force and major axis flexure.

CHAPTER I
DESIGN OF COMPOSITE MEMBERS

The major changes to this chapter include:

- The chapter has been extensively reorganized for clarity.
- The term "shear connector" has been changed to "steel-headed stud anchor."
- Limits on width-to-thickness ratios for filled composite members subject to compression and flexure have been expanded.
- Additional strength equations have been provided for filled composite members based on the new limiting width-to-thickness ratios.
- A single set of resistance and safety factors are now given for encased and filled composite members subject to flexure.
- Provisions for determining shear strength of filled and encased composite members are provided.
- New equations along with a set of resistance and safety factors are now given for direct bond interaction.
- Modifications have been made to the steel anchor detailing requirements for composite beams, and requirements for composite components have been added.
- A new section has been added for composite diaphragms and collector beams.
- The strength of steel-headed stud anchors in flat soffit slabs has been reduced.

I1. GENERAL PROVISIONS
The reference to the applicable building code and ACI 318 for the design, details and material properties of concrete and reinforcing steel have been moved to Section I1.1.

I1.1. Concrete and Steel Reinforcement (new section)
This section clarifies when ACI 318 is to be applied. A user note is included that indicates the intent of the *Specification* that the reinforced concrete portion of a composite section be detailed using the noncomposite provisions of ACI 318.

I1.2. Nominal Strength of Composite Sections (was Section I1.1)
A statement that local buckling effects need not be considered for encased members has been added.

I1.2a. Plastic Stress Distribution Method (was Section I1.1a)
Specific mention of concrete strength to be used in calculations has been removed and located in appropriate member design provisions.

I1.2b. Strain Compatibility Method (was Section I1.1b)

No changes have been made to this section.

I1.3. Material Limitations (was Section I1.2)

This section has been edited for clarity. The provision that higher strength materials are permitted when justified by testing or analysis has been removed, but it remains in the Commentary and is permitted by Section I9.

I1.4. Classification of Filled Composite Sections for Local Buckling (new section)

This section addresses the limiting width-to-thickness ratios for filled composite sections. The ratios and limits for filled composite members are presented in Tables I1.1a and I1.1b.

TABLE I1.1A
Limiting Width-to-Thickness Ratios for Compression Steel Elements in Composite Members Subject to Axial Compression for Use with Section I2.2 (new table)

Filled HSS and boxes in compression are defined as compact, noncompact or slender and a maximum permitted width-to-thickness ratio is established.

TABLE I1.1B
Limiting Width-to-Thickness Ratios for Compression Steel Elements in Composite Members Subject to Flexure for Use with Section I3.4 (new table)

Filled HSS and boxes in flexure are defined as compact, noncompact or slender and a maximum permitted width-to-thickness ratio is established.

I2. AXIAL FORCE

The title of this section has been changed from "Axial Members."

I2.1. Encased Composite Members

I2.1a. Limitations

A minimum size of lateral tie reinforcement has been added along with the maximum spacing based on reinforcement size and least column dimension. A user note is added clarifying that ACI 318 is to be used for additional tie and spiral reinforcement requirements.

I2.1b. Compressive Strength

For clarity, the provisions of this section have been revised to specifically apply to doubly symmetric encased composite members. Additionally, a statement has been added that the available compressive strength of the composite member need not be less than that of the bare steel member. The limits on the use of specific strength equations have been changed to be consistent with Section E3.

I2.1c. Tensile Strength

No changes have been made to this section.

I2.1d. Load Transfer (was Section I2.1e)

This section now refers to Section I6 for load transfer requirements for encased composite members.

I2.1e. Detailing Requirements (was Section I2.1f)

The requirement for total number of longitudinal reinforcing bars has been removed. The transverse reinforcement spacing requirement has been moved to Section I2.1a, and the requirements for shear connectors have been moved to Section I6. A provision for clear distance between reinforcing and the steel core has been added.

I2.2 Filled Composite Members

The title of this section has been changed from "Filled Composite Columns." Noncompact and slender members are now permitted by the provisions.

I2.2a. Limitations

The provisions now specifically apply to box members of uniform wall thickness as well as HSS. The width-to-thickness ratios for local buckling are contained in Table I1.1A. The maximum permitted *b/t* ratio for rectangular HSS and the maximum permitted *D/t* ratio for round HSS have been increased.

I2.2b. Compressive Strength

The strength equations have been revised to reflect the new provisions based on wall slenderness. For clarity, a statement has been added that the available compressive strength of the composite member need not be less that that of the bare steel member.

I2.2c. Tensile Strength

No changes have been made to this section.

I2.2d. Load Transfer

This section now refers to Section I6 for load transfer requirements for filled composite members.

I3. FLEXURE

The title of this section has been changed from "Flexural Members."

I3.1. General

I3.1a. Effective Width

No changes have been made to this section.

I3.1b. Strength During Construction (was Section I3.1c)

No changes have been made to this section.

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

The title of this section has been changed from "Strength of Composite Beams with Shear Connectors."

I3.2a. Positive Flexural Strength

No changes have been made to this section.

I3.2b. Negative Flexural Strength

No changes have been made to this section.

I3.2c. Composite Beams with Formed Steel Deck

The title of this section has been changed from "Strength of Composite Beams with Formed Steel Deck."

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

The title of this section has been changed from "Shear Connectors." The subsections addressing strength of connectors have been moved to Section I8.

I3.3. Encased Composite Members

The title of this section has been changed from "Flexural Strength of Concrete-Encased and Filled Members." The provisions for filled members have been moved to Section I3.4. The resistance factor and safety factor is now the same regardless of the approach taken to calculating strength.

I3.4. Filled Composite Members (new section)

This topic has been moved from Section I3.3 and significantly expanded.

I3.4a. Limitations (new section)

Filled composite sections are now classified for local buckling using the limiting width-to-thickness ratios in Table I1.1B.

I3.4b. Flexural Strength (new section)
New equations have been provided for the calculation of the nominal flexural strength for compact, noncompact and slender filled composite members.

I4. SHEAR (new section)

I4.1. Filled and Encased Composite Members (was Sections I2.1d and I3.1b)
This section has combined the requirements for filled and encased beams and columns that had previously been presented separately. New resistance and safety factors are provided.

I4.2. Composite Beams with Formed Steel Deck (was Section I3.1b)
No changes have been made in these provisions.

I5. COMBINED FLEXURE AND AXIAL FORCE (was Section I4)
Provisions for composite beam-columns have been clarified and expanded.

I6. LOAD TRANSFER (new section)

I6.1. General Requirements (new section)
This section now combines the requirements for introduction and transfer of forces for both encased and filled axially loaded composite members.

I6.2. Force Allocation (was Section I2.1e)
These provisions now also apply to filled members.

I6.2a. External Force Applied to Steel Section (was Section I2.1e)
This section has been edited for clarity.

I6.2b. External Force Applied to Concrete (was Section I2.1e)
This section has been edited for clarity.

I6.2c. External Force Applied Concurrently to Steel and Concrete (new section)
This new section provides requirements for encased and filled composite members with force applied concurrently to the concrete and steel sections.

I6.3. Force Transfer Mechanisms (was Section I2.2e)
This section has been edited for clarity, and force transfer through direct bond interaction has been limited to filled composite members.

I6.3a. Direct Bearing (was Section I2.2e)
This section has been edited for clarity.

I6.3b. Shear Connection (new section)
This new section provides requirements for determination of strength of shear connectors in filled and encased composite members.

I6.3c. Direct Bond Interaction (new section)
This new section provides requirements for determination of strength for force transfer by direct bond interaction in filled rectangular and round composite members.

I6.4. Detailing Requirements (new section)

I6.4a. Encased Composite Members (was Section I2.1f)
The requirements for distribution of shear connectors has been changed from along the length of the member over a length of at least 2.5 times the depth of the member to within the load introduction length no greater than 2 times the minimum transverse dimension of the member.

I6.4b. Filled Composite Members (was Section I2.2f)

The requirements for distribution of the shear connectors has changed from along the length of the member at least 2.5 times the width or diameter of the HSS to within the load introduction length that shall not exceed 2 times the width of a rectangular steel member or 2 times the diameter of a round steel member. The provision for the maximum connector spacing of 16 in. has been moved to Section I8.3e and revised.

I7. COMPOSITE DIAPHRAGMS AND COLLECTOR BEAMS (new section)

This section requires that composite slab diaphragms and collector beams be designed.

I8. STEEL ANCHORS (was Section I3.2d)

The provisions in this section have been gathered from the previous provisions for composite beams and provisions for composite components have been added.

I8.1. General (was Section I3.2d(6))

This section has been edited for clarity.

I8.2. Steel Anchors in Composite Beams (was Section I1.3)

The title of this section has been changed from "Shear Connectors," and the section has been edited for clarity.

I8.2a. Strength of Steel-Headed Stud Anchors (was Section I3.2d(3))

The title of this section has been changed from "Strength of Stud Shear Connectors." For steel-headed stud anchors welded directly to the steel shape, the position effect factor, R_p, has been changed from 1.0 to 0.75.

I8.2b. Strength of Steel Channel Anchors (was Section I3.2d(4))

The title of this section has been changed from "Strength of Channel Shear Connectors," and the section has been edited for clarity.

I8.2c. Required Number of Steel Anchors (was Sections I3.2d(5) and (6))

This section has been edited for clarity.

I8.2d. Detailing Requirements (was Section I3.2d(6))

A provision for the minimum distance from the center of an anchor to a free edge in the direction of the shear force has been added.

I8.3. Steel Anchors in Composite Components (new section)

This new section provides requirements for all types of composite construction other than composite beams.

I8.3a. Shear Strength of Steel-Headed Stud Anchors in Composite Components (new section)

This section covers the shear strength of a steel headed stud anchor when concrete breakout is not an applicable limit state.

I8.3b. Tensile Strength of Steel-Headed Stud Anchors in Composite Components (new section)

This section covers the tensile strength of a steel-headed stud anchor based on the distance from the anchor to a free edge and the center-to-center anchor spacing.

I8.3c. Strength of Steel-Headed Stud Anchors for Interaction of Shear and Tension in Composite Components (new section)

This section covers the nominal strength for interaction between shear and tension for a steel-headed stud anchor.

I8.3d. Shear Strength of Steel Channel Anchors in Composite Components (new section)

This section refers to Section I8.2b for strength of steel channel anchors and provides the resistance factor and safety factor for the steel channel anchors in composite components.

I8.3e. Detailing Requirements in Composite Components (new section)

This section establishes the minimum cover, minimum and maximum spacing of steel-headed stud anchors and maximum spacing of steel channel anchors for composite components.

I9. SPECIAL CASES (was Section I5)

No changes have been made to this section.

CHAPTER J
DESIGN OF CONNECTIONS

The major changes to this chapter include:

- Weld requirements have been revised where necessary to be consistent with AWS D1.1-2010.
- The base metal strength for partial-joint-penetration (PJP) groove welds in tension has been revised to use rupture strength rather than yield strength.
- To use provisions in Section J2.4 welds no longer need to be loaded in-plane.
- Bolt groups A and B have been established to simplify presentation of requirements for high-strength bolts.
- Nominal shear strength in bearing-type connections has been increased by approximately 12.5% for most cases.
- The resistance and safety factors for column bases and bearing on concrete have been changed.

J1. GENERAL PROVISIONS

J1.1. Design Basis

No changes have been made to this section.

J1.2. Simple Connections

No changes have been made to this section.

J1.3. Moment Connections

No changes have been made to this section.

J1.4. Compression Members with Bearing Joints

This section has been edited for clarity.

J1.5. Splices in Heavy Sections

A fourth provision, filler metal requirements as given in Section J2.6, has been added.

J1.6. Weld Access Holes

The title of this section has been changed from "Beam Copes and Weld Access Holes." Beam cope provisions have been removed from this section.

A minimum length of 1½ in. has been added for access holes, and the minimum height has been changed from 1 in. to ¾ in.

J1.7. Placement of Welds and Bolts

No changes have been made to this section.

J1.8. Bolts in Combination with Welds

No changes have been made to this section.

J1.9. High-Strength Bolts in Combination with Rivets

No changes have been made to this section.

J1.10. Limitations on Bolted and Welded Connections

Slip-critical joints have been removed from the list of joints to which this section applies.

J2. WELDS

Many of the revisions to the weld requirements in this section have been made to be consistent with AWS D1.1/D1.1M-2010.

J2.1. Groove Welds

J2.1a. Effective Area

No changes have been made to this section.

TABLE J2.1
Effective Throat of Partial-Joint-Penetration Groove Welds

No changes have been made to this table.

TABLE J2.2
Effective Weld Throats of Flare Groove Welds

No changes have been made to this table.

TABLE J2.3
Minimum Effective Throat of Partial-Joint-Penetration Groove Welds

No changes have been made to this table.

J2.1b. Limitations

No changes have been made to this section.

J2.2. Fillet Welds

J2.2a. Effective Area

No changes have been made to this section.

J2.2b. Limitations

The actual length of the weld is now used instead of the effective length when establishing minimum length requirements for fillet welds designed on the basis of strength.

For all welds whose length exceeds 300 times its leg size, the effective length is now taken as 180 times its leg size instead of the former 0.6 times its length.

The clause "when the required strength is less than that developed by a continuous fillet weld of the smallest permitted size" has been removed from the paragraph outlining the conditions under which intermittent fillet welds may be used.

In addition to being used to transmit shear in lap joints, fillet welds in holes or slots are now permitted to be used to resist loads perpendicular to the faying surface in lap joints.

TABLE J2.4
Minimum Size of Fillet Welds

No changes have been made to this table.

J2.3. Plug and Slot Welds

J2.3a. Effective Area

No changes have been made to this section.

J2.3b. Limitations

No changes have been made to this section.

J2.4. Strength

The limit state of yielding has been removed as an applicable limit state. This deletion relates to tension strength of the base metal.

Welds are no longer required to be loaded in-plane to use the alternative provisions given in Sections J2.4(a), J2.4(b) and J2.4(c).

Sections J2.4(a) and J2.4(c) now require that the weld group has a uniform leg size.

A new equation, J2-7, has been provided for use in determining the nominal moment capacity of weld elements within a weld group when analyzed using the instantaneous center of rotation method.

TABLE J2.5
Available Strength of Welded Joints, ksi (MPa)

For PJP groove weld connections subjected to tension normal to the weld axis, the nominal strength of the base material has been altered in Table J2.5 to account for the removal of yielding as an applicable limit state and the corresponding resistance and safety factors have been changed.

J2.5. Combination of Welds

No changes have been made to this section.

J2.6. Filler Metal Requirements

No changes have been made to this section.

J2.7. Mixed Weld Metal

No changes have been made to this section.

J3. BOLTS AND THREADED PARTS

J3.1. High-Strength Bolts

High-strength bolts have been grouped according to material strength. Group A bolts are equivalent to A325 bolts, and Group B bolts are equivalent to A490 bolts. This grouping permits a simplification in the presentation of the provisions throughout Section J3.

For clarity, the exceptions to use of bolts in snug-tight connections are now presented. The definition of the snug-tight condition has been simplified, and a requirement that any bolts to be tightened to other than snug-tight be identified on the design drawings has replaced a requirement that all snug-tight bolts be identified.

A user note has been added to this section stating that there are no specific minimum or maximum tension requirements for snug-tight bolts and that fully pretensioned bolts such as ASTM F1852 or F2280 are permitted unless specifically prohibited on design drawings.

For clarity, the requirements relating to bolt geometry, such as for length and diameter, now refer to the 2009 RCSC *Specification*.

The conditions under which a single, hardened washer conforming to ASTM F436 shall be used in lieu of the standard washer and its associated user note have been moved to Section J3.2 in the 2010 *Specification*.

The paragraph referencing Section J3.10 for the provisions for adequate available bearing strength in slip-critical connections has been removed.

TABLE J3.1 and J3.1M
Minimum Bolt Pretension

No changes have been made in these tables.

TABLE J3.2
Nominal Strength of Fasteners and Threaded Parts, ksi (MPa)

The strength values for shear have been increased approximately 12.5%.

Several of the footnotes have been changed.

- For clarity, footnote [a] now applies to the entire "Nominal Tensile Strength" column.
- Footnote [b] addresses the influence of connection length effects and has been changed to correspond to the increase in shear strength values provided in the table. This had been footnote [f].
- Footnote [c] was footnote [b]. It now applies only when determining nominal shear strength.
- Footnote [d] was footnote [c].
- Footnote [d] in the 2005 *Specification* has been removed.
- Footnote [e] in the 2005 *Specification* has been incorporated into footnote [a].

J3.2. Size and Use of Holes

This section has been expanded to include the conditions under which a single, hardened washer is to be used, and its associated user note has been moved to this section from Section J3.1.

TABLE J3.3
Nominal Hole Dimensions

No changes have been made in this table.

J3.3. Minimum Spacing

A user note has been added to this section stating that ASTM F1554 anchor rods may be furnished in accordance to product specifications with a body diameter less than the nominal diameter.

J3.4. Minimum Edge Distance

No changes have been made to this section.

TABLE J3.4 and TABLE J3.4M
Minimum Edge Distance from Center of Standard Hole to Edge of Connected Part

Footnotes [c] and [d] have been removed because these limits are simply workmanship standards.

TABLE J3.5 and J3.5M
Values of Edge Distance Increment C_2

No changes have been made in these tables.

J3.5. Maximum Spacing and Edge Distance

A user note has been added to this section indicating that the requirements do not apply to elements consisting of two shapes in continuous contact.

J3.6. Tensile and Shear Strength of Bolts and Threaded Parts

The reference to footnote [d] of Table J3.2 has been removed from the definition of A_b because the footnote has been removed from the table.

A user note has been added to provide a conservative interpretation for determining the strength of a bolt group.

J3.7. Combined Tension and Shear in Bearing-Type Connections

This section was edited for clarity.

In the user note, the upper limit for when the provisions need not apply was corrected from 20% to 30% to be consistent with the equations provided.

J3.8. High-Strength Bolts in Slip-Critical Connections

The provisions for slip-critical connections have been completely revised. There is no longer a requirement that they be assessed under a serviceability limit.

- The equation for determining strength of bolts in slip-critical connections has been revised.

- The factor for hole type has been replaced by resistance and safety factors that vary depending on hole type.
- The mean slip coefficient for Class A surfaces has been reduced to 0.30.
- A fill factor has been added to account for the presence of more than one filler in a slip plane.

J3.9. Combined Tension and Shear in Slip-Critical Connections
This section has been edited for clarity.

J3.10. Bearing Strength at Bolt Holes
This section has been edited for clarity.

A user note has been added to provide a conservative interpretation for determining the strength of a bolt group.

J3.11. Special Fasteners
No changes have been made to this section.

J3.12. Tension Fasteners
No changes have been made to this section.

J4. AFFECTED ELEMENTS OF MEMBERS AND CONNECTING ELEMENTS

J4.1. Strength of Elements in Tension
A user note has been added to this section stating that the effective net area of the connection plate may be limited due to stress distribution as calculated by methods such as the Whitmore Section.

J4.2. Strength of Elements in Shear
No changes have been made to this section.

J4.3. Block Shear Strength
No changes have been made to this section.

J4.4. Strength of Elements in Compression
No changes have been made to this section.

J4.5. Strength of Elements in Flexure (new section)
This section identifies the limit states that must be checked for elements in flexure.

J5. FILLERS

For clarity, this section has been reorganized into four subsections.

J5.1. Fillers in Welded Connections (new section)
The requirements to which fillers and their connecting welds must conform have been established.

J5.1a. Thin Fillers (new section)
It has been clarified that thin fillers are not to be used to transfer stress; otherwise, no changes have been made in these requirements.

J5.1b. Thick Fillers (new section)
No changes have been made to these requirements.

J5.2. Fillers in Bolted Connections (new section)
A minimum reduction of 0.85 has been established for bolt shear strength with thick fills.

J6. SPLICES

No changes have been made to this section.

J7. BEARING STRENGTH

No changes have been made to this section.

J8. COLUMN BASES AND BEARING ON CONCRETE

The resistance and safety factors have been changed to be consistent with ACI 318.

J9. ANCHOR RODS AND EMBEDMENTS

For clarity, ACI 318 and 349 are now specified for the design of column bases and anchor rods when the transfer of forces to a concrete foundation is through bearing.

A user note has been added that recommends consideration of bearing on concrete for the transfer of horizontal forces at a base plate.

J10. FLANGES AND WEBS WITH CONCENTRATED FORCES

J10.1. Flange Local Buckling

No changes have been made to this section.

J10.2. Web Local Buckling

No changes have been made to this section.

J10.3. Web Local Crippling

No changes have been made to this section.

J10.4. Web Sidesway Buckling

No changes have been made to this section.

J10.5. Web Compression Buckling

No changes have been made to this section.

J10.6. Web Panel Zone Shear

This section has been edited for clarity.

J10.7. Unframed Ends of Beams and Girders

No changes have been made to this section.

J10.8. Additional Stiffener Requirements for Concentrated Forces

For clarity, references to the appropriate sections in J4 have been made for tension and compression stiffeners.

The requirement for the minimum stiffener thickness has been slightly modified.

J10.9. Additional Doubler Plate Requirements for Concentrated Forces

No changes have been made to this section.

CHAPTER K
DESIGN OF HSS AND BOX MEMBER CONNECTIONS

The major changes to this chapter include:

- The entire chapter is reorganized so that the requirements are presented in tabular form.
- Illustrations are included for the connection types associated with the specific requirements.
- The preamble has been edited for clarity, and user notes have been added.
- Section K4, “Welds of Plates and Branches to Rectangular HSS,” has been added.

K1. CONCENTRATED FORCES ON HSS

The limits of applicability that were listed in Section K1.2 in the 2005 *Specification* are now tabulated in Table K1.1A for round HSS and Table K1.2A for rectangular HSS.

All user notes from the 2005 *Specification* have been removed from this section.

K1.1. Definitions of Parameters

Variables A_g, F_c, S and l_b were added; variable N was removed; and some definitions were edited for clarity.

K1.2. Round HSS

The provisions are now presented in Tables K1.1 and K1.1A.

K1.3. Rectangular HSS

The provisions are now presented in Tables K1.2 and K1.2A.

K2. HSS-TO-HSS TRUSS CONNECTIONS

K2.1. Definitions of Parameters

Symbols have been edited for clarity.

K2.2. Round HSS

The provisions are now presented in Tables K2.1 and K2.1A.

K2.3. Rectangular HSS

The provisions are now presented in Tables K2.2 and K2.2A.

K3. HSS-TO-HSS MOMENT CONNECTIONS

K3.1. Definitions of Parameters

No changes have been made to this section.

K3.2. Round HSS

The provisions are now presented in Tables K3.1 and K3.1A.

K3.3. Rectangular HSS

The provisions are now presented in Tables K3.2 and K3.2A.

K4. WELDS OF PLATES AND BRANCHES TO RECTANGULAR HSS (new section)

Effective weld properties are established for use in determination of weld strength accounting for nonuniformity of load transfer along the weld length.

CHAPTER L
DESIGN FOR SERVICEABILITY

No major changes have been made to this chapter.

L1. GENERAL PROVISIONS

The user note has been edited for clarity.

L2. CAMBER

The user note has been removed.

L3. DEFLECTIONS

No changes have been made to this section.

L4. DRIFT

No changes have been made to this section.

L5. VIBRATION

No changes have been made to this section.

L6. WIND-INDUCED MOTION

No changes have been made to this section.

L7. EXPANSION AND CONTRACTION

No changes have been made to this section.

L8. CONNECTION SLIP

This section has been edited for clarity.

CHAPTER M
FABRICATION AND ERECTION

The major changes to this chapter include:

- Section M5, "Quality Control," has been relocated to new Chapter N, where it has been expanded.

M1. SHOP AND ERECTION DRAWINGS

This section has been edited for clarity to indicate that shop and erection drawings may be prepared in stages.

M2. FABRICATION

M2.1. Cambering, Curving and Straightening

No changes have been made to this section.

M2.2. Thermal Cutting

Requirements for reentrant corners have been expanded, and a user note has been added.

The requirement for crack inspections in accordance with ASTM E709 has been removed.

The user note has been revised to change the sample reference.

M2.3. Planing of Edges

No changes have been made to this section.

M2.4. Welded Construction

No changes have been made to this section.

M2.5. Bolted Construction

Water-jet cut holes are now permitted.

A user note has been added that provides a guide for evaluating the surface roughness of thermally cut holes.

M2.6. Compression Joints

No changes have been made to this section.

M2.7. Dimensional Tolerances

This section has been edited for clarity.

M2.8. Finish of Column Bases

No changes have been made to this section.

M2.9. Holes for Anchor Rods
No changes have been made to this section.

M2.10. Drain Holes
No changes have been made to this section.

M2.11. Requirements for Galvanized Members
This user note has been edited for clarity.

M3. SHOP PAINTING

M3.1. General Requirements
This section has been edited for clarity.

M3.2. Inaccessible Surfaces
No changes have been made to this section.

M3.3. Contact Surfaces
No changes have been made to this section.

M3.4. Finished Surfaces
No changes have been made to this section.

M3.5. Surfaces Adjacent to Field Welds
No changes have been made to this section.

M4. ERECTION

M4.1. Column Base Setting
This section has been edited for clarity.

M4.2. Stability and Connections
The title of this section has been changed from "Bracing." The requirement that the structure be secured to support dead, erection and other loads anticipated to occur as erection progresses has been moved here from Section M4.7, and that section has been deleted.

M4.3. Alignment
No changes have been made to this section.

M4.4. Fit of Column Compression Joints and Base Plates
No changes have been made to this section.

M4.5. Field Welding
This section has been edited for clarity and simplified.

M4.6. Field Painting
No changes have been made to this section.

CHAPTER N (new chapter)
QUALITY CONTROL AND QUALITY ASSURANCE

This chapter is new to the 2010 *Specification*. It addresses minimum requirements for quality control, quality assurance and nondestructive testing for structural steel systems and steel elements of composite members for buildings and other structures.

This chapter replaces Section M5 of the 2005 *Specification*.

N1. SCOPE (new section)

Quality control and quality assurance are defined.

N2. FABRICATOR AND ERECTOR QUALITY CONTROL PROGRAM (was Section M5)

The first sentence of the preamble to Section M5 of the 2005 *Specification* has been moved to this section, and it has been expanded to include minimum requirements for what the quality control inspector must inspect.

N3. FABRICATOR AND ERECTOR DOCUMENTS (new section)

N3.1. Submittals for Steel Construction

Documents to be submitted by the fabricator or erector are identified.

N3.2. Available Documents for Steel Construction

Documents to be available in electronic or printed form are identified.

N4. INSPECTION AND NONDESTRUCTIVE TESTING PERSONNEL (new section)

N4.1. Quality Control Inspector Qualifications

Qualifications are established for quality control welding inspection personnel.

N4.2. Quality Assurance Inspector Qualifications

Qualifications are established for quality assurance welding inspectors.

N4.3. NDT Personnel Qualifications

Qualifications are established for nondestructive testing personnel.

N5. MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS (new section)

N5.1. Quality Control

This new section identifies the quality control inspection tasks to be performed by the fabricator's or erector's quality control inspector.

N5.2. Quality Assurance

This new section identifies the quality assurance inspection tasks.

N5.3. Coordinated Inspection

This new section permits coordinated inspection between the quality control inspector and the quality assurance inspector.

N5.4. Inspection of Welding

Section M5.3 of the 2005 *Specification* has been moved to this section, and it has been expanded.

The first paragraph of Section M5.3 of the 2005 *Specification* is now a user note in this section.

N5.5. Nondestructive Testing of Welded Joints

N5.5a. Procedures

This new section identifies tests to be performed by quality assurance in accordance with AWS D1.1/D1.1M.

N5.5b. CJP Groove Weld NDT

This new section defines ultrasonic testing procedures for CJP groove welds.

N5.5c. Access Hole NDT

This new section specifies requirements for testing of weld access holes.

N5.5d. Welded Joints Subjected to Fatigue
This new section specifies requirements for weld soundness inspection.

N5.5e. Reduction of Rate of Ultrasonic Testing
This new section identifies when the rate of ultrasonic testing may be reduced.

N5.5f. Increase in Rate of Ultrasonic Testing
This new section identifies when the rate of ultrasonic testing must be increased.

N5.5g. Documentation
This new section specifies that all NDT performed shall be documented.

N5.6. Inspection of High-Strength Bolting
Section M5.4 of the 2005 *Specification* has been moved to this section, and it has been expanded.

N5.7. Other Inspection Tasks
This new section identifies what the fabricator's and erector's quality control personnel shall inspect and the documents to be used to verify compliance.

N6. MINIMUM REQUIREMENTS FOR INSPECTION OF COMPOSITE CONSTRUCTION (new section)
This new section identifies the tasks associated with inspection of structural steel and steel deck used in composite construction.

N7. APPROVED FABRICATORS AND ERECTORS (new section)
This new section specifies when quality assurance inspections may be waived for approved fabricators and erectors.

N8. NONCOMFORMING MATERIAL AND WORKMANSHIP (new section)
Section M5.2 of the 2005 *Specification* has been moved to this section, and it has been expanded to include instructions on dealing with nonconforming material.

APPENDIX 1
DESIGN BY INELASTIC ANALYSIS

The major changes to this appendix include:

- How to design using inelastic analysis has been clarified.
- The negative moment redistribution provisions have been relocated to Sections B3.7 and F13.5.
- The appendix has been reorganized into three new sections.

1.1 GENERAL REQUIREMENTS (new section)
Sections 1.8 and 1.9 of the 2005 *Specification* have been moved here and expanded. The requirements for inelastic analysis have been defined, and the basic procedure for performing an inelastic analysis have been outlined.

1.2 DUCTILITY REQUIREMENTS (new section)

1.2.1. Material
Section 1.2 of the 2005 *Specification* has been moved to this section and edited for clarity.

1.2.2. Cross Section
Section 1.4 of the 2005 *Specification* has been moved to this section. The controlling width-to-thickness ratio, λ_{pd}, is defined.

1.2.3. Unbraced Length

Section 1.7 of the 2005 *Specification* has been moved to this section, and the equations have been modified.

A third case, tension only, has been defined where there is no L_{pd} limit.

1.2.4. Axial Force

This section is based on Section 1.5.2 of the 2005 *Specification* and requires that the compressive design strength for compression members with plastic hinges not exceed $0.75F_yA_g$.

1.3 ANALYSIS REQUIREMENTS (new section)

1.3.1. Material Properties and Yield Criteria

This section provides requirements previously specified in Sections 1.5, 1.6, 1.7 and 1.8 of the 2005 *Specification*.

1.3.2. Geometric Imperfections

This section requires that initial geometric imperfections be taken into account during an inelastic analysis.

1.3.3. Residual Stress and Partial Yielding Effects

This section requires that the effect of residual stresses and partial yielding be part of the inelastic analysis.

APPENDIX 2
DESIGN FOR PONDING

No major changes have been made in this appendix.

2.1. SIMPLIFIED DESIGN FOR PONDING

This section has been edited for clarity.

2.2. IMPROVED DESIGN FOR PONDING

This section has been edited for clarity.

APPENDIX 3
DESIGN FOR FATIGUE

No major changes have been made in this appendix.

3.1. GENERAL PROVISIONS

The conditions under which evaluation of fatigue resistance is not required have been expanded.

3.2. CALCULATION OF MAXIMUM STRESSES AND ALLOWABLE STRESS RANGES

No changes have been made to this section.

3.3. PLAIN MATERIAL AND WELDED JOINTS

This section has been edited for clarity.

3.4. BOLTS AND THREADED PARTS

The factors C_f and F_{TH} are now provided in Table A-3.1.

3.5. SPECIAL FABRICATION AND ERECTION REQUIREMENTS

This section requires that longitudinal backing, if left in place, be attached with continuous fillet welds.

A user note has been added indicating that AWS C4.1 Sample 3 may be used to evaluate compliance with these requirements.

TABLE A-3.1
Fatigue Design Parameters

The table has been edited and additional figures included for clarity. Additional changes include:

- The thickness criteria for determining C_f and F_{TH} have been changed.
- Weld soundness must be established by radiographic or ultrasonic inspection in accordance with the requirements of subclauses 6.12 or 6.13 of AWS D1.1/D1.1M.
- The provisions for selecting stress categories E and E′ have changed.

APPENDIX 4
STRUCTURAL DESIGN FOR FIRE CONDITIONS

The major change in this appendix includes:

- The strength equations for compression and flexure when using the "Simple Methods of Analysis" have been revised.

4.1. GENERAL PROVISIONS

Terms that were defined in this section in the 2005 *Specification* have been moved to the Glossary.

4.1.1. Performance Objective

No changes have been made to this section.

4.1.2. Design by Engineering Analysis

It is now required that load and resistance factor design be used for structural design for fire conditions.

4.1.3. Design by Qualification Testing

No changes have been made to this section.

4.1.4. Load Combinations and Required Strength

This section has been edited for clarity.

4.2. STRUCTURAL DESIGN FOR FIRE CONDITIONS BY ANALYSIS

4.2.1. Design-Basis Fire

No changes have been made to this section.

4.2.1.1. Localized Fire

No changes have been made to this section.

4.2.1.2. Post-Flashover Compartment Fires

Section 4.2.1.4, "Fire Duration," from the 2005 *Specification* has been moved to this section.

4.2.1.3. Exterior Fires

No changes have been made to this section.

4.2.1.4. Active Fire Protection System (was Appendix 4, Section 2.1.5)

No changes have been made to this section.

4.2.2. Temperatures in Structural Systems Under Fire Conditions

No changes have been made to this section.

4.2.3. Material Strengths at Elevated Temperatures

No changes have been made to this section.

4.2.3.1. Thermal Elongation

No changes have been made to this section.

4.2.3.2. Mechanical Properties at Elevated Temperatures

The proportional limit at elevated temperatures, $F_p(T)$, and the shear modulus, G, are now defined.

TABLE A-4.2.1
Properties of Steel at Elevated Temperatures

The proportional limit coefficient and the relationship for shear modulus at elevated temperatures are now given in this table.

TABLE A-4.2.2
Properties of Concrete at Elevated Temperatures

The subheading for $\varepsilon_{cu}(T)$ has been corrected to normal-weight concrete.

4.2.4. Structural Design Requirements

4.2.4.1. General Structural Integrity

No changes have been made to this section.

4.2.4.2. Strength Requirements and Deformation Limits

No changes have been made to this section.

4.2.4.3. Methods of Analysis

4.2.4.3a. Advanced Methods of Analysis

No changes have been made to this section.

4.2.4.3b. Simple Methods of Analysis

It is now stated that temperature effects for steel temperatures less than or equal to 400 °F need not be considered in calculating member strengths.

(1) Tension Members

No changes have been made to this section.

(2) Compression Members

A new compression strength equation has been provided.

(3) Flexural Members

New flexural strength equations have been provided.

(4) Composite Floor Members

No changes have been made to this section.

4.2.4.4. Design Strength

No changes have been made to this section.

4.3. DESIGN BY QUALIFICATION TESTING

4.3.1. Qualification Standards

No changes have been made to this section.

4.3.2. Restrained Construction

No changes have been made to this section.

4.3.3. Unrestrained Construction

No changes have been made to this section.

APPENDIX 5
EVALUATION OF EXISTING STRUCTURES

No changes have been made to this appendix.

APPENDIX 6
STABILITY BRACING FOR COLUMNS AND BEAMS

The major changes to this appendix include:

- The addition of Section 6.4, with provisions for beam-column bracing.
- The addition of a user note to provide definitions for relative and nodal braces.

6.1. GENERAL PROVISIONS

This section has been edited for clarity and expanded.

The definitions of "relative brace" and "nodal brace" have been moved to a new user note.

6.2. COLUMN BRACING

6.2.1. Relative Bracing

No changes have been made to this section.

6.2.2. Nodal Bracing

This section has been edited for clarity.

6.3. BEAM BRACING

This section has been edited for clarity.

6.3.1. Lateral Bracing

This section has been edited for clarity.

6.3.1a. Relative Bracing

This section has been edited for clarity.

6.3.1b. Nodal Bracing

No changes have been made to this section.

6.3.2. Torsional Bracing

This section has been edited for clarity.

6.3.2a. Nodal Bracing

This section has been edited for clarity.

6.3.2b. Continuous Bracing

This section has been edited for clarity.

6.4. BEAM-COLUMN BRACING (new section)

This section provides the requirements for combining strength and stiffness for beam-columns.

APPENDIX 7
ALTERNATIVE METHODS OF DESIGN FOR STABILITY

This appendix has been renamed and reorganized as follows:

- The title of this appendix has been changed from "Direct Analysis Method to Alternative Methods of Design for Stability." This reflects the fact that the direct analysis method has been moved to Chapter C, and the effective length method and first-order analysis method have been moved from Chapter C to this appendix.
- The titles of Sections 7.2 and 7.3 have been changed from "Notional Loads and Design-Analysis Constraints to Effective Length Method" and "First-Order Analysis Method," respectively.
- The presentation of these two alternative methods has been reorganized for clarity.

7.1. GENERAL STABILITY REQUIREMENTS

Sections C1 and C2 are incorporated by reference, and the effective length method and first-order analysis method are introduced. The effective length method was formerly called the second-order analysis method.

7.2. EFFECTIVE LENGTH METHOD

7.2.1. Limitations

The parts of Section C2.2 of the 2005 *Specification* that reference the effective length method have been moved here and edited for clarity.

The 1.6 factor for ASD load combinations has been removed from the user note and has been placed in a list of conditions in this section.

7.2.2. Required Strengths

The parts of Section C2.2 of the 2005 *Specification* that reference the effective length method have been moved here and edited for clarity.

A user note has been added that explains why the notional load need only be applied in gravity-only load cases.

7.2.3. Available Strengths

Sections C1.3a, C1.3b and C1.3c of the 2005 *Specification* have been moved to this section and represent the provisions for determining the effective length factor, K.

7.3. FIRST-ORDER ANALYSIS METHOD

7.3.1. Limitations

The limitations in this section have been moved from Section C2.2 and Section C2.2b of the 2005 *Specification*.

7.3.2. Required Strengths

Section C2.2b of the 2005 *Specification* has been moved to this section.

The equation for notional load has been slightly modified for clarity.

7.3.3. Available Strengths

The first two paragraphs of Section C1.2 of the 2005 *Specification* have been moved to this section.

A user note referencing Appendix 6 for methods of satisfying bracing requirements has been added.

APPENDIX 8 (new appendix)
APPROXIMATE SECOND-ORDER ANALYSIS

This appendix is new to the 2010 *Specification*. The approximate second-order analysis method (the B_1-B_2 method) has been moved from Chapter C.

8.1. LIMITATIONS (new section)
This section states the limitations of the procedure.

8.2. CALCULATION PROCEDURE (was Section C2.1b)
This section has been edited for clarity.

8.2.1. Multiplier B_1 for P-δ Effects
This section has been edited for clarity.

8.2.2. Multiplier B_2 for P-Δ Effects
This section has been edited for clarity. In addition, a new equation has been provided to address distribution of load on moment frame and gravity-only columns.

REFERENCES

AISC (2005), *Specification for Structural Steel Buildings*, March 9, American Institute of Steel Construction, Chicago, IL.

AISC (2010), *Code of Standard Practice for Steel Buildings and Bridges*, April 14, American Institute of Steel Construction, Chicago, IL.

AISC (2010), *Seismic Provisions for Structural Steel Buildings*, AISC 341-10, American Institute of Steel Construction, Chicago, IL.

AISC (2010), *Specification for Structural Steel Buildings*, June 22, American Institute of Steel Construction, Chicago, IL.

AISC (2011), *Steel Construction Manual*, 14th ed., American Institute of Steel Construction, Chicago, IL.

Brockenbrough, R.L. (2002), *AISC Rehabilitation and Retrofit Guide—A Reference for Historical Shapes and Specifications*, Design Guide 15, AISC, Chicago, IL.