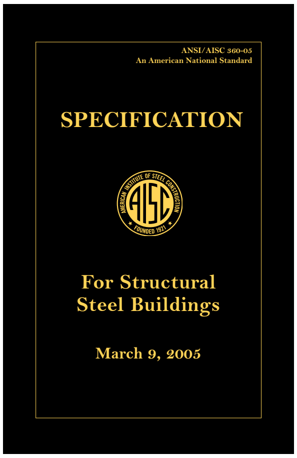

A Comparative Look at the 2010 AISC Specification

BY ERIC BOLIN AND THOMAS DEHLIN

The changes between the 2005 and 2010 editions are small in number, but contribute significantly to usability.

THE NEWEST EDITION OF THE AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360-10) was released early in 2011 and immediately made available as a free PDF download on the AISC website, **www.aisc.org/2010specification**. On July 1, 2011, a printed version of the *Specification* became available as an integral part of the 14th Edition of the AISC *Steel Construction Manual*.

Changes to the 2005 *Specification* were kept to a minimum, but those that are reflected in the 2010 *Specification* simplify design procedures, improve the accuracy of some provisions, or improve its usability. Additionally, AISC and its Committee on Specifications have made great efforts to ensure that the *Specification* continues to be presented as clearly and simply as possible.

The changes discussed herein provide a brief synopsis of the revisions incorporated into the 2010 *Specification*. A complete list of changes between the 2005 and 2010 AISC *Specification* is available as a free download at **www.aisc.org/2010speccomp**.

Newest Additions

One of the first things you may notice in the new *Specification* is the addition of Chapter N, "Quality Control and Quality Assurance." In the 2005 *Specification*, Chapter M contained quality control provisions, and many other documents had quality assurance; some also had criteria for non-destructive testing. Chapter N was added to the 2010 *Specification* as a means of tying all of these elements of quality 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 generally makes reference to those requirements in roadmap form.

Some provisions included in this chapter foster involvement of the fabricator's and erector's personnel in the quality process: material identification procedures to be monitored by the fabricator's quality control inspector (a similar list is provided for the erector's quality control inspector as well); qualifications for quality control inspectors, quality assurance inspectors, and nondestructive testing personnel; and specific tasks to be completed before, during, and after the work is performed. A similar list of requirements for independent inspection and the personnel performing those inspections also is included.

Chapter N has been adopted by the International Code Council for the 2012 Edition of the *International Building Code (IBC)* as the basis in Chapter 17 for quality requirements for steel buildings in wind and low-seismic applications (SDC A systems and R=3 systems, for example). In addition, the 2012 *IBC* uses Chapter J of the 2010 AISC *Seismic Provisions for Structural Steel Buildings* for quality requirements in high-seismic applications.

Eric Bolin is a graduate student at University of Illinois, and Thomas Dehlin is an undergraduate student at the University of Illinois at Urbana-Champaign. Both were summer interns at AISC in 2011.

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. Many of the sections from the 2005 *Specification* have been expanded to include items such as new methods for calculating interaction of shear and tension for steel headed stud anchors in composite beams, new methods for calculating the load transfer in filled and composite members, a new resistance and safety factor for direct bond interaction, and new methods for calculating the shear strength of both filled and encased composite members. Additionally, ACI 318 provisions are now incorporated by reference for the design of reinforced concrete portions of composite members. In the previous *Specification*, ACI 318 was referenced only in the absence of an applicable building code. A change also was made to the strength calculation of steel headed stud anchors based on the decrease from 1.0 to 0.75 for the position factor, R_p, of composite beams with no decking.

In Chapter B, "Design Requirements," new requirements for connections have been added related to structural integrity. The intent of Section B3.2 is to clarify the application of the requirements now given in the *IBC*. The AISC *Specification* states that "design for structural integrity requirements shall be based on nominal strength rather than design strength (LRFD) or allowable strength (ASD), unless specifically stated otherwise in the applicable building code." The *IBC* stipulates that the nominal axial tension strength of a beam end connection must equal or exceed the required vertical shear strength for ASD or $^{2}/_{3}$ the required vertical shear strength for LRFD, but not less than 10 kips. Additionally, the *Specification* notes that limit states based on limiting deformations or yielding can be ignored when making the structural integrity check. That is, the intent is to preclude rupture limit states and accept ductile deformations when considering structural integrity requirements. Accordingly, bearing bolts are permitted in short slots parallel to the direction of the beam end tension force; the bolt is assumed to be at the end of the slot in such a design. Note that most typical steel construction already satisfies these new requirements.

Simplifying Design Provisions

Several of the changes in the 2010 *Specification* have been made to simplify design procedures. The design of composite flexural members in Chapter I, for example, has been given a single resistance factor ϕ and safety factor Ω for all conditions, allowing for easier calculation of available strength. In Chapter J, a change has been made in the design provisions for high-strength bolts in slip-critical connections: the provisions have been streamlined so that the designer no longer must decide whether to check slip at service loads or at the strength level. Even simple changes have been made, such as a change to the calculation of L_{pd} in Appendix 1, "Design by Inelastic Analysis," that eliminates the need to check for double curvature or single curvature.

Simplifications were made in Chapter F for calculating the local buckling strength of tee stems in flexural compression. The procedure in the 2005 *Specification* required using the lateral-torsional buckling equations with L_b = 0. The use of this method resulted in a mathematically indeterminate solution with M_{cr} = 0 / 0 (who wants to have to differentiate and solve using L'Hospital's rule, anyway?). In the 2010 *Specification* a new section includes new critical stress equations that do not require additional mathematical operations to calculate the nominal flexural strength of tee stems in compression.

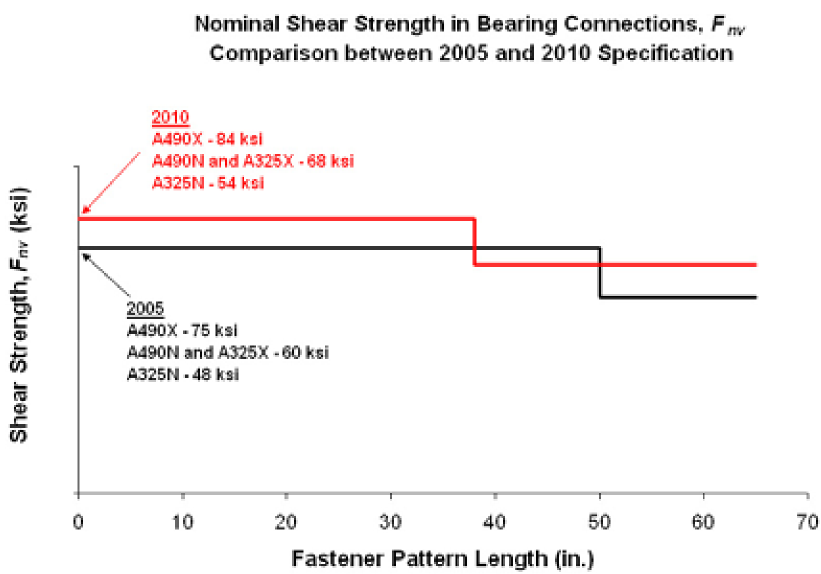

Fig. 1. Comparison between nominal shear strength of bolts in bearing connections in the 2010 and 2005 editions of the AISC *Specification* for end-loaded connections.

Improving Accuracy

Changes have been made in Chapter J, "Design of Connections," to improve the accuracy of the *Specification*. Quantities tabulated in Table J3.2 for the nominal shear strength of bolts in bearing-type connections, F_{nv}, have been increased, which allows for a more efficient connection design if bolt shear is the controlling limit state. The magnitude of this increase is shown in Figure 1, which also shows a parallel change in the reduction required for end loaded connections with fastener pattern exceeding a certain length (50 in. in the 2005 *Specification* has been changed to 38 in. in the 2010 *Specification* to better align with the strength increase).

Additional changes in Chapter J that improve the accuracy of the *Specification* involve provisions for both connections to concrete bases and weld strength. More efficient designs may be possible for columns connected to concrete bases because the resistance factor and the safety factor associated with the limit state of concrete crushing have been increased and decreased, respectively. New research showed that the "in-plane" loading limitation was no longer necessary for welds, and that the alternative strength provisions given in Section J2.4 could be used in all cases. In addition, the base metal strength for partial-joint-penetration groove welds in tension was revised to be based on rupture strength rather than yield strength.

The accuracy of some provisions in Appendix 4, "Structural Design for Fire Conditions," has also been improved in the 2010 *Specification*. When using simple methods of analysis as defined by Section 4.2.4.3b, for example, the design strength of flexural members is no longer determined using equations from Chapter F. A flexural member's design strength is now determined using two new equations, Equations A-4-3 and A-4-4, which are more consistent with existing test data.

Making the *Specification* Easier to Use

Several changes have been made to enhance the usability of the *Specification*. One such change has occurred in Chapter K, "Design of HSS and Box Member Connections;" the design provisions in this chapter are now listed in tabular form with figures depicting each connection for convenience. In Chapter J, high-strength bolts of similar strength level have been sorted into two groups (Group A for A325 and similar bolts and Group B for A490 and similar bolts), making the provisions more readable in the chapter.

The user notes dispersed throughout the *Specification* are intended to provide practical guidance in the application of the provisions, and serve the sole purpose of enhancing the usability of the *Specification*. In Chapter E, "Design of Members for Compression," a new user note selection table similar to the existing selection table in Chapter F, has been added to assist in determining the appropriate limit states for a variety of cross sections. It directs the user to the applicable chapter section for appropriate limit state checks. In Chapter I a new user note table is included for determining the provisions for the minimum stud head to shank diameter ratio, h/d, for steel anchors in composite components. This table allows the user to quickly find the steel headed stud anchor h/d ratio for shear, tension and combined shear and tension loading conditions for both normal and lightweight concrete.

Improved Organization

Some changes in the new *Specification* can be considered editorial. One such change is the reorganization of the analysis methods in Chapter C and its appendices. The direct analysis method has been moved from Appendix 7 to Chapter C and is now the primary approach upon which stability requirements are presented. The first-order and effective length methods remain permitted and are contained in Appendix 7. The B1-B2 method of calculating second-order effects is now provided in Appendix 8.

Another editorial change found in the *Specification* is the reorganization of the width-thickness tables in Chapter B. Flexural and compression elements have been separated, and several new cross section examples have been included. The local buckling classifications for compression members have been changed to nonslender or slender. In Chapter I the provisions for load transfer and shear of filled and encased composite members have been condensed and reorganized into their own sections.

Additional Changes

The 2010 AISC *Specification* has not seen a great amount of change over the previous edition. The preceding summarizes the major changes found in the new *Specification*. The few minor changes not discussed here were also based on the criteria of expanding the scope of the document, improving its accuracy, simplifying design procedures, and improving its usability. The 2010 *Specification* is available in the new 14th Edition *Manual* and as a free download at **www.aisc.org/epubs**. MSC