

# codes & standards

## The 2005 AISC Specification for Structural Steel Buildings

### A Specification for the 21st Century

By Cynthia J. Duncan

The development of the American Institute of Steel Construction's (AISC) new *Specification for Structural Steel Buildings* is on schedule for completion by early 2005. Balloting of this document by the AISC Committee on Specifications is nearing completion, with only one ballot remaining. This new standard will replace two existing AISC Specifications; the 1989 *Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design* and the 1999 *Load and Resistance Factor Design Specification for Structural Steel Buildings*. A new "unified" format will permit the use of either the Allowable Stress Design (ASD) or Load and Resistance Factor Design (LRFD) methods. In addition to the usual historical commentary in the back of the specification, User Notes will be interspersed throughout the text.

*"The roadmap begins with the design basis for the entire document..."*

The *Specification* is organized in a logical fashion, with a "roadmap" at the front that leads you to where specific provisions are located. The roadmap begins with the design

### What are User Notes?

In addition to the traditional commentary that has followed AISC Specifications since 1963, User Notes will appear throughout the text of the 2005 AISC Specification. While not part of the legal document, these helpful suggestions will provide concise and practical guidance in the application of the provisions of the Specification. User Notes may also assist users to quickly determine whether various provisions are applicable or not applicable to common situations, suggest conservative simplifications of complex equations, provide definitions of infrequently used variables, and provide direction to other related requirements in the Specification. *In short, User Notes will be provided throughout the document to make it easier to use in the design office.*

basis for the entire document and then directs you to analysis and stability provisions, member design (including composite members), connection design, serviceability considerations, and ends with fabrication, erection, and quality control. Directions to special topics, such as evaluation and repair and fire design, are also given.

### Design Basis

The new specification employs a "unified" format, meaning the Specification will provide provisions for both ASD and LRFD. There is precedence for this arrangement, as the American Iron and Steel Institute (AISI) used it in the *North American Specification for the Design of Cold-Formed Steel Structural Members*, dated 2001. This direction is also consistent with ASCE 7, which provides load combinations for both "Strength Design," referred to as LRFD in the AISC Specification, and Allowable Stress Design. ASCE 7 is directly referenced for load combinations in the 2005 Specification. This practice of direct reference has been used since 1999 in the LRFD Specification and 2001 in the ASD Specification (when Supplement No. 1 to that document was introduced). Prior to that time, similar ASCE 7 load combinations were directly incorporated into the AISC Specifications.

For LRFD, design will be performed in accordance with the following relation:

$$R_u \leq R_n$$

where

$R_u$  = required strength based on LRFD load combinations

$R_n$  = nominal strength  
= resistance factor

$R_n$  = design strength

For ASD, design will be performed in accordance with the following relation:

$$R_a \leq R_n / \phi$$

where

$R_a$  = required strength based on ASD load combinations

$R_n$  = nominal strength  
= safety factor

$R_n / \phi$  = allowable strength

These formulations allow a single equation for each limit state that may then be used in either LRFD or ASD. It should also be noted that the user can choose to use a strength-based or stress-based approach when using this specification. The overall message conveyed by this format is that steel behaves like steel, and it does not know what method is being used as it is designed. This is especially apparent in the analysis and stability design of steel.

*"...the user can choose to use a strength-based or stress-based approach..."*

### Analysis and Stability

It is important to provide for stability in the design of all structures, at the level of both the individual member and the frame. Stability bracing design provisions were introduced in the 1999 LRFD Specification. These provisions are advanced in the new specification; required brace stiffness and brace strength are given for nodal and relative bracing of columns and lateral and torsional bracing of beams. Frame stability will be handled in a separate chapter, incorporating new analysis provisions, including a direct analysis method using notional loads and  $K=1$ . The effect of individual element buckling is accounted for in the member design provisions in subsequent chapters.

### Member Design

Separate chapters on design for tension, compression, flexure, shear, and combined forces are provided. Chapter F, *Design of Members for Flexure*, may seem more voluminous than in previous specifications. This is due to the incorporation of hollow structural sections (HSS) and single angle provisions into the document, both of which are currently in separate specifications. Although the chapter is longer, the user need not go past Section F2 if designing the typical compact wide flange shape. There is some discussion about moving lesser-used information in this chapter to an Appendix.

The chapter on Design of Composite Members has been updated extensively to reflect recent research and higher strength materials, as well as for consistency with ACI 318. This has resulted in the allowance of higher values for material limitations. Also, shear stud strength is now dependent on the location of the stud in the flute of the metal deck, the number of studs welded within one flute, as well as the orientation of the metal deck with respect to the beam. Composite column design will be based on new interaction formulas that better reflect behavior and strength.

## Connection Design

The usual specification sections on bolts and welds are included, as well as a new chapter on HSS and box member connections. The specific topics included are concentrated forces on HSS, HSS-to-HSS truss connections, and HSS-to-HSS moment connections. The latter subject is new to the AISC Specification. The other topics are updated from the 2000 *Load and Resistance Factor Design Specification for Steel Hollow Structural Sections*.

There will be several revisions to bolt and weld criteria with respect to previous specifications: simplified block shear rupture calculations, broadened coverage

“...several revisions to bolt and weld criteria...”

of shear lag, improved details for weld access holes, reduced height limitation where the use of slip-critical joints in column splices is required, types of bolts permitted when large diameters and long lengths are required, and slip strength and combined tension and shear strength for slip-critical connections.

## Other Topics

Other important topics follow the member design chapters or are located in the Appendix, where the most infrequently used design provisions now reside. The chapters on Serviceability and Fabrication, Erection, and Quality Control immediately follow member design. The *Specification* continues to give only limited and general recommendations with regards to serviceability. The Fabrication, Erection, and Quality Control chapter is essentially unchanged, and continues to reference the AISC *Code of Standard Practice* as an important resource on such topics as shop

painting and erection tolerances. AWS D1.1, *Structural Welding Code – Steel* and the RCSC *Specification for Structural Steel Joints Using ASTM A325 or A490 Bolts* are also referenced with respect to welding and bolting.

One new topic to be included in the AISC Specification is Structural Design for Fire Conditions. This will be located in the Appendix, and “provides criteria for the design and evaluation of structural steel components, systems and frames for fire conditions,” when the client wishes to pay for an approach that is more performance oriented than the traditional prescriptive methods in the building code. That is, the performance objectives of this new specification section are stated and then one of two methods may be employed to meet those objectives: design by engineering analysis or design by qualification testing. The latter is based on qualification for the rating period in conformance with ASTM Standard E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*.

## A New Specification

The dual method format, its expanded scope to include single angles and HSS, and the new and updated provisions throughout the 2005 Specification will make it a specification for the 21st century. With this new *Specification*, the AISC Committee on Specifications is dedicated to fulfilling its mission statement:

*To develop the practice-oriented specification for structural steel buildings that provides for*

- life safety
- economical building systems
- predictable behavior and response
- efficient use

User notes will provide concise and practical guidance in the application of the provisions of the *Specification* by:

- Helping users quickly determine whether various provisions are applicable or not applicable to common situations.
- Suggesting conservative simplifications of complex equations.
- Providing definition of infrequently used section properties (e.g.,  $C_w$ ).
- Providing direction to other related requirements in the Specification.
- Aiding users in understanding concepts and applying provisions of the Specification.

The significant work associated with these revisions will be accomplished through the dedication and contributions of the 10 task committees assigned to various portions of the specification, and extensive balloting of

the Committee, which is an ANSI-accredited consensus body with 40 members. The membership is equally balanced among the three categories: Industry, Consultants, and Research/Academia. In addition, the document is expected to undergo two public review periods – the first one began in March and ended in April. After its completion, early next year, the AISC *Manual*

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of *Steel Construction* will follow in late 2005. It is expected to include tables giving values for both ASD and LRFD.

The 2005 Specification will reflect the needs of the design engineer, in a new format that allows design using ASD or LRFD. Design efficiency will be improved with the reorganization, as well as a rewritten commentary and user notes located within the body of the document. And, it will continue to maintain life safety, economical building systems, and predictable behavior and response through revisions and the addition of new provisions. The 2005 AISC Specification is well on its way to being a specification we can all use. ■

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## Public Review of the 2005 AISC Specification

The first public review of the AISC 2005 *Specification for Structural Steel Buildings* was held March 5 through April 19, 2004. There will be a second public review later this summer. Look for it to be announced on the AISC web site ([www.aisc.org](http://www.aisc.org)) or in the ANSI Standards Action publication.

The review document will be downloadable from the AISC web site.