Next Generation

Louis F. Geschwindner, P.E., Ph.D., and Cynthia J. Lanz

AISC is currently working on the next generation of steel design standards.

In 1923, the American Institute of Steel Construction introduced a specification for the design and construction of structural steel buildings in order to create a standard for the steel industry. The document provided information on allowable stresses and assumed that the materials of the day behaved elastically. Over time the approach became known as allowable stress design (ASD). ASD established a factor of safety that provided a desired margin against some perceived measure of failure. This failure could be seen as simple as the material reaching its yield stress or as complex as reaching some critical buckling capacity. The ASD approach was the foundation for structural design in all materials for many years.

Simplification and standardization still are the driving principles for the development of all AISC specifications. The original *Specification* was approved by a five-person committee and was only nine pages. It has since undergone numerous revisions based on analytical and physical experience and research. Today, the AISC Committee on Specifications (COS), a consensus body consisting of 40 industry representatives, educators and consulting engineers, develops the AISC *Specification for Structural Steel Buildings*. Since 2000, the committee has been accredited by the American National Standards Institute (ANSI) as a standards-writing body. The committee works with a much larger group of task committee members to assess information and formulate new and revised provisions before approving a new specification.

In 1986, the AISC COS introduced its first load and resistance factor design specification (LRFD). This specification provided an approach to steel design that was consistent with other specifications being developed worldwide, as well as that already used for the design of reinforced concrete. The LRFD approach requires the calculation of member nominal strength based on all possible limit states. This nominal strength is then multiplied by a resistance factor to determine the design member capacity.

As with any design approach, member capacities must be compared to the required capacity established through application of the appropriate building code. The ANSI-approved standard for loads on buildings is ASCE 7, *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2002). This standard provides the load magnitudes and load combinations that must be met for both ASD and LRFD design approaches. AISC continues to provide design standards to be used with both the ASD and LRFD load combinations of ASCE 7.

The premier edition of the *LRFD Specification* was followed by the revision of the *ASD Specification* in 1989. Subsequent to 1989, the COS focused on continued development of the LRFD specification and published revisions to that standard in 1993 and 1999.

THE NEXT GENERATION

After careful consideration of the needs of the design community and observing how other standards developers have handled the dilemma of promulgating two design philosophies, AISC COS has embarked on the development of a "unified" or single specification, incorporating both the ASD and LRFD methods. The overriding principal of this unified standard is that "steel is steel and it does not know the method by which it has been designed." This leads to the fundamental formulation of the unified specification, where a single resistance is calculated for a given limit state; and that resistance is then further cast either into LRFD, with the use of a resistance factor, or into ASD, with the use of a safety factor.

Although the current *ASD Specification* is dated 1989, its fundamentals are based on the 1961 edition. Thus, over 40 years of research and knowledge are potentially missing from its provisions. Some of the provisions that have been more succinctly included in the *LRFD Specification* appear to be missing in the *ASD Specification*. Some users of the *ASD Specification* ignore "leaning columns" and others do not address second-order effects. Ignoring either of these topics is as unreasonable as ignoring lateral-torsional buckling in unbraced beams. They are behavioral aspects of steel structures and are not design-approach specific.

The new generation of the AISC standard will incorporate the most up-to-date knowledge of steel structures behavior. The provisions from the current ASD and LRFD specifications are being combined with the goal of providing the best of both standards. The final product will be available in 2005. In addition to the change in format, some reorganization of the specification will occur, as well as the inclusion of new and revised provisions throughout. Simultaneously, the entire commentary will be evaluated and rewritten as necessary for clarification and conciseness. User notes will be interspersed throughout the specification

text to give brief and helpful tips where they can best be put to use.

All of the efforts of the COS are undertaken with the committee's mission in mind: to develop a practice-oriented specification for structural steel buildings that provides for life safety, economical building systems, predictable behavior and response, and efficient use.

NEW FORMAT

As much as possible, the chapter organization of the current ASD and LRFD specifications is being retained in the new specification. Design can be carried out according to the provisions for LRFD or for ASD.

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

$$R_u \le \phi R_n$$

where

R_u = required strength (LRFD)
R_n = nominal strength
ϕ = resistance factor
ϕR_n = design strength

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

$$R_a \le R_n/\Omega$$

where

R_a = required strength (ASD)
R_n = nominal strength
Ω = safety factor
R_n/Ω = allowable strength

These formulations are consistent with the principle that a single resistance is calculated and that resistance can then be cast into either LRFD or ASD. It should also be noted that the specification is not a strength or stress specification but rather a resistance specification. This means that any provisions can be cast in the strength or stress format, at the discretion of the designer.

Within the member-oriented chapters, nominal capacity will be specified and the resistance factor and safety factor will be given in a "side-by-side" format. For example, for calculating tensile yield strength, the new specification will read:

$$P_n = F_y A_g$$

$\phi_t = 0.90$ (LRFD) $\Omega_t = 1.67$ (ASD)

where the design tensile strength is $\phi_t P_n$ and the allowable tensile strength is P_n/Ω_t.

The existing *LRFD Specification* was originally calibrated so that LRFD and ASD provided the same member strength for a live- to dead-load ratio of 3 using a load combination of 1.2D + 1.6L. This results in a target effective load factor of 1.5. Therefore, in most cases, the ASD safety factor is calculated as $1.5/\phi$ and it is given to three significant figures. In many cases, use of the current LRFD resistance factors results in safety factors that are the same as currently in use in ASD. The COS believes that this arrangement satisfies its mission and will result in greater clarity, uniformity and efficiency when applying AISC specifications. In the final analysis, the only difference between the LRFD and ASD methods of design is on the required strength side of the equation where ASCE 7 provides two different sets of load combinations for design.

REORGANIZATION

In an effort to attain the goal of design efficiency, a limited amount of reorganization will occur. The plate girder and slender compression element provisions, currently located in the appendices, will be incorporated in the appropriate chapters in the main body. The new appendices will include only provisions that experience limited use, such as fatigue, evaluation and repair, and temperature effects—a new section to be discussed below. Also, the hollow structural section and single angle provisions will be assimilated into the main specification, rather than maintaining them as separate documents.

NEW PROVISIONS

Several other technical revisions are under development and will be proposed for inclusion in the specification. These include:

- Increasing the calculated column capacity for short columns
- Increasing the resistance factor for compression member design
- Addressing the relationship between stability and analysis issues
- Providing for the use of sophisticated analysis software, as well as simplified analysis procedures
- Clarifying and revising the definitions of types of construction.
- Adding new temperature effects provisions.

The new temperature effects provisions will focus on structural design and evaluation of structural steel components and systems for fire conditions using a performance-based design approach. Compliance with the performance objective in this appendix can be demonstrated by either structural analysis or component qualification testing. The provisions provide for the determination of the heat input, and thermal expansion and degradation in mechanical properties of materials at elevated temperatures that cause progressive decrease in strength and stiffness of structural components and systems. The introduction of these criteria in the AISC specification fulfills the need for a procedure to evaluate and design steel structures that potentially can be exposed to elevated temperatures.

USER NOTES

With the goal of making this a more user-friendly specification, user notes will be interspersed throughout the text. The purpose of these notes is to relate helpful hints or simplified equations as applicable to the provision at hand. Unlike the existing "Commentary" located in the back of the specification, (which will be significantly updated in the final document), user notes are not intended to provide historical context or detailed clarifying descriptions of a specification provision. Rather they are intended to present brief, direct, and clear guidance for the implementation of the specification, often highlighting issues relevant to the most common situations addressed. User notes will be most useful to:

- Highlight the implications and applicability of a provision, particularly if the provision is clearly *not* relevant to the majority of common cases.
- Present simplifying concepts of a provision.
- Present a simplification of a complex formula that is appropriate for use in a wide range of common cases.

An example of a user note that is expected to be included in the "Design of Members for Flexure" chapter is:

User note: All current ASTM A6 W, S, M, C and MC shapes except W21x48, W14x99, W14x90, W12x65, W10X12, W8x31, W8x10, W6x15, W6x9, W6x8.5, and M4x6 have compact flanges at $F_y \le$ 50 ksi (345 MPa); all current ASTM A6 W, S, M, HP, C and MC shapes have compact webs at $F_y <$ 65 ksi (450 MPa).

THE JOURNEY

The topics mentioned above and others may be discussed more succinctly after balloting on this document begins in early 2003. The individual task committees under the COS are assigned responsibility for various portions of the specification, and they will submit their proposed sections for balloting. Time has been allotted for several ballot cycles in order to have the document in print by mid-2005. The COS must follow specific ANSI-approved procedures that require all negative votes and comments to be addressed. Concurrent with the balloting of the COS, the public review period will begin in early 2004, when the draft document will be available for review and comment by the entire design community. The timeline for completion of the standard continues to be largely dictated by building code adoption schedules. The ballot process must be completed by November 2004 in order for the new specification to be adopted by the 2005 NFPA (National Fire Protection Association) Building Code and subsequently the 2006 IBC (International Building Code).

CONCLUSION

Careful forethought and planning have gone into the preliminary preparation of the next generation of the *AISC Specification: the Standard for the Design of Structural Steel Buildings*. The needs of the design engineer are reflected in the new format that allows design using ASD or LRFD. Design efficiency will be improved with the reorganization of the text and with new user notes. AISC continues to maintain life safety, economical building systems, and predictable behavior and response through revisions of old provisions and the addition of new provisions, such as the structural design and evaluation of steel structures under fire conditions. ★

Louis F. Geschwindner, P.E., Ph.D. is Vice President of Engineering and Research at AISC. Cynthia J. Lanz is AISC's Director of Specifications.

Louis F. Geschwindner will deliver a keynote address on the future of AISC specifications at the 2003 NASCC in Baltimore, MD, on Wednesday, April 2.