2.2   AMERICAN INSTITUTE OF STEEL CONSTRUCTION SPECIFICATION

Because the emphasis of this book is on the design of structural steel building members and their connections, the Specification of the American Institute of Steel Construction is the design specification of most importance here. It is written and kept current by an AISC committee comprising structural engineering practitioners, educators, steel producers, and fabricators. New editions are published periodically, and supplements are issued when interim revisions are needed. Allowable stress design has been the primary method used for structural steel buildings since the first AISC Specification was issued in 1923, although plastic design was made part of the Specification in 1963. In 1986, AISC issued the first specification for load and resistance factor design along with a companion *Manual of Steel Construction.* The purpose of these two documents was to provide an alternative to allowable stress design, much as plastic design is an alternative. The current specification (AISC, 2010a) incorporates both LRFD and ASD.

The LRFD provisions are based on research reported in eight papers published in 1978 in the *Structural Journal of the American Society of Civil Engineers* (Ravindra and Galambos; Yura, Galambos, and Ravindra; Bjorhovde, Galambos, and Ravindra; Cooper, Galambos, and Ravindra; Hansell et al.; Fisher et al.; Ravindra, Cornell, and Galambos; Galambos and Ravindra, 1978).

Although load and resistance factor design was not introduced into the AISC Specification until 1986, it is not a recent concept; since 1974, it has been used in Canada, where it is known as *limit states design.* It is also the basis of most European building codes. In the United States, LRFD has been an accepted method of design for reinforced concrete for years and is the primary method authorized in the American Concrete Institute•s Building Code, where it is known as *strength design* (ACI, 2008). Current highway bridge design standards also use load and resistance factor design (AASHTO, 2010).

The AISC Specification is published as a stand-alone document, but it is also part of the *Steel Construction Manual,* which we discuss in the next section. Except for such specialized steel products as cold-formed steel, which is covered by a different specification (AISI, 2007), the AISC Specification is the standard by which virtually all structural steel buildings in this country are designed and constructed. Hence the student of structural steel design must have ready access to his document. The details of the Specification will be covered in the chapters that follow, but we discuss the overall organization here.

The Specification consists of three parts: the main body, the appendixes, and the Commentary. The body is alphabetically organized into Chapters A through N. Within each chapter, major headings are labeled with the chapter designation followed by a number. Furthermore, subdivisions are numerically labeled. For example, the types of structural steel authorized are listed in Chapter A, •General Provisions,Žunder Section A3, •Material,Žand, under it, Section 1, •Structural Steel Materials.ŽThe main body of the Specification is followed by appendixes 1.8. The Appendix section is followed by the Commentary, which gives background and elaboration on many of the provisions of

the Specification. Its organizational scheme is the same as that of the Specification, so material applicable to a particular section can be easily located.

The Specification incorporates both U.S. customary and metric (SI) units. Where possible, equations and expressions are expressed in non-dimensional form by leaving quantities such as yield stress and modulus of elasticity in symbolic form, thereby avoiding giving units. When this is not possible, U.S. customary units are given, followed by SI units in parentheses. Although there is a strong move to metrication in the steel industry, most structural design in the United States is still done in U.S. customary units, and this textbook uses only U.S. customary units.

2.3 LOAD FACTORS, RESISTANCE FACTORS, AND LOAD COMBINATIONS FOR LRFD

Equation 2.4 can be written more precisely as

$$\gamma_i Q_i \le \phi R_n \tag{2.5}$$

where

Q_i = a load effect (a force or a moment)
γ_i = a load factor
R_n = the nominal resistance, or strength, of the component under consideration
ϕ = resistance factor

The factored resistance ϕR_n is called the *design strength*. The summation on the left side of Equation 2.5 is over the total number of load effects (including, but not limited to, dead load and live load), where each load effect can be associated with a different load factor. Not only can each load effect have a different load factor but also the value of the load factor for a particular load effect will depend on the combination of loads under consideration. Equation 2.5 can also be written in the form

$$R_u \le \phi R_n \tag{2.6}$$

where

R_u = required strength = sum of factored load effects (forces or moments)

Section B2 of the AISC Specification says to use the load factors and load combinations prescribed by the governing building code. If the building code does not give them, then ASCE 7 (ASCE, 2010) should be used. The load factors and load combinations in this standard are based on extensive statistical studies and are prescribed by most building codes.

ASCE 7 presents the basic load combinations in the following form:

Combination 1: $1.4D$
Combination 2: $1.2D + 1.6L + 0.5(L_r$ or S or $R)$
Combination 3: $1.2D + 1.6(L_r$ or S or $R) + (L$ or $0.5W)$
Combination 4: $1.2D + 1.0W + L + 0.5(L_r$ or S or $R)$