

Design aids for composite columns, consisting of hollow structural sections or pipe filled with plain (unreinforced) concrete, are also included. Composite columns are covered in Chapter 9 of this textbook.

Part 5. Design of Tension Members. This part includes design aids for tension members and a summary of the Specification requirements for tension members.

Part 6. Design of Members Subject to Combined Loading. Part 6 covers members subject to combined axial tension and flexure, combined axial compression and flexure, and combined torsion, flexure, shear, and/or axial force. Of particular interest is the material on combined axial compression and flexure, which is the subject of Chapter 6 of this textbook, •Beam. Columns.Ž

Parts 7 through 15 cover connections:

Part 7. Design Considerations for Bolts.

Part 8. Design Considerations for Welds.

Part 9. Design of Connecting Elements.

Part 10. Design of Simple Shear Connections.

Part 11. Design of Partially Restrained Moment Connections.

Part 12. Design of Fully Restrained (FR) Moment Connections.

Part 13. Design of Bracing Connections and Truss Connections.

Part 14. Design of Beam Bearing Plates, Column Base Plates, Anchor Rods, and Column Splices.

Part 15. Design of Hanger Connections, Bracket Plates, and Crane–Rail Connections.

Part 16. Specifications and Codes. This part contains the AISC Specification and Commentary, a specification for high-strength bolts (RCSC, 2009), and the AISC Code of Standard Practice (AISC, 2010b).

Part 17. Miscellaneous Data and Mathematical Information. This part includes properties of standard steel shapes in SI units, conversion factors and other information on SI units, weights and other properties of building materials, mathematical formulas, and properties of geometric shapes.

All design aids in the *Manual* give values for both allowable strength design (ASD) and load and resistance factor design (LRFD). The *Manual* uses a color-coding scheme for these values: ASD allowable strength values (R_n/Ω) are shown as black numbers on a green background, and LRFD design strength values (ϕR_n) are shown as blue numbers on a white background.

The AISC Specification is only a small part of the *Manual*. Many of the terms and constants used in other parts of the *Manual* are presented to facilitate the design process and are not necessarily part of the Specification. In some instances, the recommendations are only guidelines based on common practice, not requirements of the Specification. Although such information is not in conflict with the Specification, it is important to recognize what is a *requirement* (a *specification* that is adopted by a building code) and what is not.

As a companion document to the *Manual*, a set of design examples is available at the AISC web site (AISC, 2011b). These examples illustrate the application of the Specification and the *Manual*. A comprehensive building design example is also included. Both LRFD and ASD solutions are presented in a side-by-side format.

2.7 DESIGN COMPUTATIONS AND PRECISION

The computations required in engineering design and analysis are done with either a digital computer or an electronic calculator. When doing manual computations with the aid of an electronic calculator, an engineer must make a decision regarding the degree of precision needed. The problem of how many significant figures to use in engineering computations has no simple solution. Recording too many significant digits is misleading and can imply an unrealistic degree of precision. Conversely, recording too few figures can lead to meaningless results. The question of precision was mostly academic before the early 1970s, when the chief calculating tool was the slide rule. The guiding principle at that time was to read and record numbers as accurately as possible, which meant three or four significant figures.

There are many inherent inaccuracies and uncertainties in structural design, including variations in material properties and loads; load estimates sometimes border on educated guesses. It hardly makes sense to perform computations with 12 significant figures and record the answer to that degree of precision when the yield stress is known only to the nearest 10 kips per square inch (two significant figures). Furthermore, data given in the *Steel Construction Manual* has been rounded to three significant figures. To avoid results that are even less precise, however, it is reasonable to assume that the given parameters of a problem, such as the yield stress, are exact and then decide on the degree of precision required in subsequent calculations.

A further complication arises when electronic calculators are used. If all of the computations for a problem are done in one continuous series of operations on a calculator, the number of significant figures used is whatever the calculator uses, perhaps 10 or 12. But if intermediate values are rounded, recorded, and used in subsequent computations, then a consistent number of significant figures will not have been used. Furthermore, the manner in which the computations are grouped will influence the final result. In general, the result will be no more accurate than the least accurate number used in the computation and sometimes less because of round-off error. For example, consider a number calculated on a 12-digit calculator and recorded to four significant figures. If this number is multiplied by a number expressed to five significant figures, the product will be precise to four significant figures at most, regardless of the number of digits displayed on the calculator. Consequently, it is not reasonable to record this number to more than four significant figures.

It is also unreasonable to record the results of every calculator multiplication or division to a predetermined number of significant figures in order to have a consistent degree of precision throughout. A reasonable approach is to perform operations on the calculator in any convenient manner and record intermediate values