COLD-FORMED STEEL DESIGN

THIRD EDITION

Wei-Wen Yu, Ph.D., P.E.
Curators’ Professor Emeritus of Civil Engineering
Director, Center for Cold-Formed Steel Structures
University of Missouri-Rolla
PREFACE

This third edition of the book has been prepared to provide readers with a better understanding of the analysis and design of the thin-walled, cold-formed steel structures that have been so widely used in building construction and other areas in recent years. It is a revised version of my book, *Cold-Formed Steel Design*, published by John Wiley & Sons, Inc. in 1991. All the revisions are based on the 1996 edition of the AISI Specification with the Supplement No. 1 which combines the Allowable Stress Design (ASD) and the Load and Resistance Factor Design (LRFD) methods.

The material was originally developed for graduate courses and short courses in the analysis and design of cold-formed steel structures and is based on experience in design, research, and development of American Iron and Steel Institute (AISI) design criteria.

Throughout the book, descriptions of the structural behavior of cold-formed steel members and connections are given from both the theoretical and the experimental points of view. The reasons and justification for the various design provisions of the AISI Specification are discussed at length. Consequently the text will not only be instructive for students but can serve as a major source of reference for structural engineers and researchers.

Of the published book’s 14 chapters, Chapters 2 through 9 have been completely revised according to the combined ASD/LRFD Specification. Other chapters have been updated on the basis of available information. Chapter 14 is a new chapter on residential construction.

Chapter 1 includes a general discussion of the application of cold-formed steel structures and a review of previous research. It also discusses the development of design specifications, and the major differences between the design of cold-formed and hot-rolled steel structural members. Because of the many research projects in the field that have been conducted worldwide during the past 25 years, numerous papers have been presented at various conferences and published in a number of engineering journals. At the same time, new design criteria have been developed in various countries. These new developments are reviewed in this chapter.

Since material properties play an important role in the performance of structural members, the types of steels and their most important mechanical properties are described in Chapter 2. In addition to the revision of Table 2.1, new information on the use of low-ductility steel has been included in Article 2.4. Article 2.10 includes additional information on test methods.
In Chapter 3, the strength of thin elements and design criteria are discussed to acquaint the reader with the fundamentals of local buckling and postbuckling strength of thin plates and with the basic concepts used in design. This chapter has been completely revised to include detailed information on design basis with a revised Table 3.1 for safety factors and resistance factors.

Chapter 4 deals with the design of flexural members. Because the AISI design provisions were revised extensively during 1996–1999, this chapter has been completely rewritten to cover the design of beams using both ASD and LRFD methods. It also includes new information on perforated elements, distortional buckling, and beams having one flange fastened to a standing seam roof system.

The design procedures for compression members are discussed in Chapter 5. This chapter has been brought up to date by using the newly revised equations for computing the nominal buckling stress with the revised factor of safety. Design information on compression members having one flange through-fastened to deck or sheathing has also been added.

In 1996, the AISI Specification included new design provisions on combined tensile load and bending, as discussed in Chapter 6. Revisions have also been made on the design of beam-columns using ASD and LRFD methods.

Chapter 7 covers the design of cylindrical tubes. This revised chapter reflects the minor changes made in the 1996 edition of the AISI Specification and Supplement No. 1.

Like the member design, the design of connections has been updated in Chapter 8 for using the ASD and LRFD methods with additional provisions for shear lag and staggered holes. New design information on screw connections and press joints have been added.

Because various types of structural systems, such as shear diaphragms and shell roof structures, have become increasingly popular in building construction, Chapter 9 contains design information on these types of structural systems. It also contains the current design procedure for wall studs on the basis of the 1996 Specification.

The sectional properties of standard corrugated sheets are discussed in Chapter 10 because they have long been used in buildings for roofing, siding, and other applications.

Steel decks are widely used in building construction. Consequently the updated information in Chapter 11 on their use in steel-deck-reinforced composite slabs and composite beams is timely.

Chapter 12 contains an introduction to the design of cold-formed stainless steel structural members supplementing the information on cold-formed carbon steel structural members in other chapters. This chapter is based on the ASCE Standard for the design of cold-formed stainless steel structural members.

The increasing use of computers for design work warrants the brief introduction that is given in Chapter 13 for the computer-aided design of cold-formed steel structures.
During recent years, cold-formed steel members have been used increasingly for residential construction. The new Chapter 14 includes recently developed design information on residential steel framing.

It is obvious that a book of this nature would not have been possible without the cooperation and assistance of many individuals, organizations, and institutions. It is based primarily on the results of continuing research programs on cold-formed steel structures that have been sponsored by the American Iron and Steel Institute (AISI), the American Society of Civil Engineers (ASCE), the Metal Building Manufacturers Association (MBMA), the Metal Construction Association (MCA), the National Science Foundation (NSF), the Rack Manufacturers Institute (RMI), the Steel Deck Institute (SDI), the Steel Stud Manufacturers Association (SSMA), and others at various universities. The publications related to cold-formed steel structures issued by AISI and other establishments have been very helpful for the preparation of this book.

I am especially indebted to the late Professor George Winter of Cornell University, who made contributions of pronounced significance to the building profession in his outstanding research on cold-formed steel structures and in the development of AISI design criteria. A considerable amount of material used in this book is based on Dr. Winter’s publications.

My sincere thanks go to Mr. David Jeanes, Senior Vice President of the American Iron and Steel Institute, for permission to quote freely from the AISI Specification and the Commentary thereon. An expression of appreciation is also due to the many organizations and individuals that granted permission for the reproduction of quotations, graphs, tables, and photographs. Credits for the use of such materials are given in the text.

I also wish to express my sincere thanks to Mr. Roger L. Brockenbrough, Dr. Helen Chen, Dr. Samuel J. Errera, Dr. James M. Fisher, Mr. Richard B. Heagler, Professor Gregory J. Hancock, Professor Roger A. LaBoube, Mr. Jay W. Larson, Professor Teoman B. Pekoz, and Dr. Benjamin W. Schafer for their individual reviews of various parts of the manuscript. Their suggestions and encouragement have been of great value to the improvement of this book.

I am very grateful to Mrs. Laura Richardson for her careful typing and kind assistance. The financial assistance provided by the University of Missouri-Rolla through the Curators’ Professorship and the Center for Cold-Formed Steel Structures is appreciated.

This book could not have been completed without the help and encouragement of my wife, Yueh-Hsin. I am most grateful for her patience, understanding, and assistance.

Wei-Wen Yu

Rolla, Missouri
March 2000