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AISI's 1986 cold-formed steel design specification -- an overview

Albert L. Johnson
AISI's 1986 COLD-FORMED STEEL DESIGN SPECIFICATION --

AN OVERVIEW

by Albert L. Johnson

INTRODUCTION

The 1986 Edition of the "Specification for the Design of Cold-Formed Steel Structural Members" (Reference 1), was approved by the Committee on Construction Codes and Standards, American Iron and Steel Institute on August 19, 1986. This new 1986 Specification, which replaces the 1980 Specification, represents six years of intensive effort by the Advisory Group on the Specification, subcommittees of the Advisory Group, researchers, consultants, and many users who offered recommendations for modifications and improvements based upon their experience in practical applications.

This paper reviews major changes found in comparing the 1986 and 1980 Cold-Formed Specifications. It describes procedures followed in deciding upon the changes, it identifies the membership of the Advisory Group and its subcommittees, and it offers a forecast of future activity in codification of design procedures.

SIMPLIFICATION

A complete reformatting of the Specification was one of the major results of an intensive study described in detail by Pinkham (Reference 2). Prompted by user concern that the Specification was difficult to understand, the initial effort was to simplify the 1980 Edition of the Cold-Formed Specification without changing the substance, i.e., without altering load-carrying capacities determined from provisions of the Specification. Once the Advisory Group agreed upon the new format, all of the substantive changes found in the 1986 Specification were introduced into the new arrangement.

In developing the new format, a number of topics were introduced to cover issues of general concern to the designer, such as information on non-conforming shapes and constructions, loads, and design basis.

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Subjects of lesser interest or infrequently used by the designer were relegated to appendices to improve the readability of the main text of the Specification. These included utilization of the cold work of forming, flange curling, and shear lag effects. Although these topics are in appendices, they are part of the Specification and are intended for adoption into building codes.

UNIFIED APPROACH

The most profound changes in design procedure are those related to treatment of post buckling strength and the design of members containing elements which are in the post buckling range. Pekoz (Reference 3) discusses these changes with their theoretical justification and experimental verification in detail. Their presentation in the 1986 Specification represents the culmination of several research projects extending over a decade, and their publication in provisions of the Specification is a major achievement.

Briefly, the unified approach treats post buckling by the effective width method for all elements which exhibit post buckling strength, including stiffened elements which are uniformly compressed, webs of flexural members, stiffened elements with a stress gradient, unstiffened elements, and elements with edge stiffeners.

With all elements thus treated the same, design of flexural members and compression members has been rationalized and simplified. Design provisions for beam strength and deflection, lateral buckling, torsional-flexural behavior, and combined axial load and compression all are made more simple and consistent as a result.

CHANGES HIGHLIGHTED

The Commentary on the 1986 Specification (Reference 4) notes the major differences between the 1986 Specification and the 1980 Specification. The extensive list of references in the Commentary provides the user, researcher, and student with guidance for obtaining detailed background for the provisions of the Specification. The 1986 Commentary, in keeping with the philosophy initiated with the 1980 Commentary, is thus kept reasonably brief with reliance on source documents for amplification in particular areas of interest to the user.

The existence of the text written by Wei-Wen Yu, Cold-Formed Steel Design (Reference 5), has been fundamental in permitting a relatively short commentary as well as being a valuable aid to the practicing engineer and student alike.
Of special significance with introduction of the unified approach is a report by T. B. Pekoz, "Development of a Unified Approach to the Design of Cold-Formed Steel Members" (Reference 6). This thorough and detailed summary of research results leading to the profound changes in the 1986 Specification is a major contribution to the literature on cold-formed steel design.

The following will call attention to changes and additions found in the 1986 Specification besides those of format and simplification mentioned above. There is no attempt made to include here all of the many modifications found in the 1986 Specification.

**General Provisions**

- Attention is called to the non-dimensional character of almost all of the Specification formulation, making its use in any compatible system of units possible.

- Reference to the ASTM specification for zinc-aluminum sheet has been added.

- Provisions for Grade E steels have been clarified, and specific guidance given for design provisions governed by tensile strength.

- Guidance on loading conditions which may need to be considered has been consolidated and expanded.

- A list of reference documents has been added. It includes related design specifications, as well as applications manuals issued by user industries.

**Elements**

- The definition of web depth as the flat portion of the web provides explicit guidance, and eliminates a past ambiguity.

- Alternative methods for calculating effective widths of uniformly compressed stiffened elements for use in deflection calculations are offered.

- Provisions for uniformly compressed stiffened elements with circular holes have been introduced.

- Effective widths under stress gradients are considered for webs and for stiffened elements.
- Allowable stresses for unstiffened elements have been replaced by an effective width approach, in keeping with unification and simplification.

- Stress gradients are considered for unstiffened elements and for edge stiffeners.

- Behavior of elements with less than "adequate" edge stiffeners is described.

**Members**

- Member strengths are given in terms of force or moment, rather than stress.

- Safety factors are given explicitly.

- The unified approach permits numerous simplifications in formulation of design provisions.

- A rational method of analysis is permitted for C- and Z-section beams which have laterally unbraced compression flanges.

- The presentation of web crippling strength is simplified.

- Cylindrical tubular member design has been clarified and expanded, with separate treatment of bending and compression.

**Structural Assemblies**

- The purpose and requirements for bracing performance are clearly defined.

- Detailed provisions for anchorage of bracing for roof systems under gravity load with the compression flange braced have been added, with guidance for conditions encountered in design of purlins for pre-engineered buildings.

- Wall stud design provisions have been improved.

- A test alternative for determination of wall sheathing parameters is permitted in addition to use of tabulated values.

- Design provisions for the interaction of bending and axial load in wall studs have been liberalized.
Connections and Joints

- Thickness definitions for calculation of fillet weld strength have been clarified.
- Resistance spot weld allowable shear strengths have been increased for thinner sheets.
- Provisions for oversize and slotted holes have been added.
- Allowable tension stresses for bolts have been added.
- Provisions are introduced for bolts subject to a combination of shear and tension.
- Shear rupture is considered at beam-end connections.
- Connections to other materials are considered, with specific guidance for bearing stresses.
- Attention is called to the need for consideration of pull-over of sheet around fastener heads, as well as pull-out of fasteners.

Tests for Special Cases

- Potential misinterpretation of the test provisions is avoided through rewording definitions and requirements.

REVIEW AND APPROVAL OF SPECIFICATION CHANGES

A public review period, in which comments were solicited from any interested parties, resulted in several significant suggestions about proposed changes in the Specification as well as recommendations for future consideration by the Advisory Group.

Approval of each change in the Specification followed rigorous procedures with full consideration of all negative ballots and review of all comments offered with affirmative votes.
FUTURE REVISIONS

Studies continue on many aspects of the Specification. Although complete revisions are planned on six-year intervals, interim changes can be made when the Specification is found to be out-of-keeping with the needs of the users.

Among continuing projects are:

- Development of design procedures for C- and Z-sections braced on the tension flange (purlin uplift)
- Tension on the net section in bolted connections
- Wall stud design
- Cold-formed columns
- Load and resistance factor design.

CONCLUSIONS

The 1986 "Specification for the Design of Cold-Formed Steel Structural Members" is a major improvement over previous Specifications in terms of organization, presentation, and discussion. Since the First Edition of the Specification in 1946, the level of activity and the number of participants in developing recommendations for revision have continued to increase. The dedication of the members of the Advisory Group on the Specification and of its subcommittees, under the leadership of Advisory Group Chairman S. J. Errera, and the many long days of meetings and significant hours of personal time spent on Advisory Group work outside of meetings have made the changes described above possible.

Special credit has to be given to the late George Winter in recognition of his many contributions and achievements to the enhancements of cold-formed steel design. It was through his efforts that many of the recommendations for change were initiated.

A complete listing of the membership of the Advisory Group and its subcommittees is given in Appendix A of this paper. Users of the Specification are invited to contact any member with their suggestions for further improvement; however, they are cautioned that any official interpretations of the Specification are a matter for full Advisory Group action.
REFERENCES

1. "Specification for the Design of Cold-Formed Steel Structural Members", American Iron and Steel Institute, Washington, DC, August 19, 1986

2. C. W. Pinkham, "Reformatting the AISI Cold-Formed Steel Design Specification", Proceedings, Eighth International Specialty Conference on Cold-Formed Steel Structures, November 11-12, 1986, University of Missouri-Rolla

3. T. B. Pekoz, "Development of a Unified Approach to the Design of Cold-Formed Steel Members", Proceedings, Eighth International Specialty Conference on Cold-Formed Steel Structures, November 11-12, 1986, University of Missouri-Rolla

4. "Commentary on the Specification for the Design of Cold-Formed Steel Structural Members", American Iron and Steel Institute, Washington, DC, August 1986

5. Wei-Wen Yu, Cold-Formed Steel Design, Wiley-Interscience, New York, 1985

## APPENDIX A -- MEMBERSHIP OF COLD-FORMED ADVISORY GROUP AND SUBCOMMITTEES

**Advisory Group (as of August 19, 1986)**

<table>
<thead>
<tr>
<th>Name</th>
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<td>A. S. Zakrzewski</td>
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