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Evolving AISI Design Provisions -- an Overview

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EVOLVING AISI DESIGN PROVISIONS -- AN OVERVIEW

by Albert L. Johnson[1]

INTRODUCTION

The 1986 Edition of AISI's "Specification for the Design of Cold-Formed Steel Structures" (Reference 1) was issued on August 19, 1986. It was the result of six years of intensive effort by the Advisory Group on the Specification, its subcommittees, researchers, consultants, and many users.

We are now more than two years into the cycle leading to a 1992 Edition of the Specification. This paper provides an overview of the revisions and expansions currently (September 1988) under consideration for the 1992 Edition, or possibly the subject of an interim change to the Specification.

The sequence follows that of the Specification -- General Provisions, Elements, Members, Structural Assemblies, Connections and Joints, and Tests for Special Cases.

Mention will also be made of the direction of changes in the Commentary (Reference 2), and the Cold-Formed Steel Design Manual (Reference 3). The status and planning for a load and resistance factor design specification will be reviewed. Finally, the process of evolving change through enhancement of the Advisory Group, liaison with user groups and other specification writing groups, and new approaches to support of the cold-formed steel structures industry will be discussed.

GENERAL PROVISIONS

There is a vigorous debate underway on how members which do not conform to design, whether by material properties or geometry, can be rationally dealt with by provisions in the Specification. The question of thickness in the formed section as delivered to the job site has been covered since 1977. However, there remain unanswered questions on the effects of material understrength in the delivered member, deviation from the dimensions and cross-sectional geometry assumed in design, and other deviations which may occur in manufacture of the member. Some user industries publish tolerances on member geometry. The question for the Specification is if suitable provisions can be developed which will satisfy all users of the Specification. These issues are being addressed by Subcommittee 17 -- Quality in Construction -- of the Advisory Group.

Development of new steels has introduced steels believed to be potentially acceptable for particular applications in construction even though they do not meet current specification requirements. Provisions which would modify ductility requirements are currently being balloted by the Advisory Group. The characteristics of the low-strain-hardening ductile steel which have

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prompted this ballot, tests of members formed from this steel, and the rationale for the proposed changes are discussed in Reference 4.

ELEMENTS

Major changes were made in the 1986 Specification in the interests of unification of the approach used for analysis of the behavior of the elements of members. These changes are well documented by Pekoz in Reference 5. As experience is gained in the application of the 1986 Specification, there will be adjustments in the interest of improving clarity, and there will be some gaps filled.

A potential source for expanding the types of element behavior covered can be found in AISI's Automotive Steel Design Manual (Reference 6), but use for construction applications must be validated.

The behavior of elements and that of the members comprised of these elements are inextricably interwoven. As a result, any changes in the provisions for element design must be studied carefully in the context of the design of members and structural assemblies. A forthcoming document containing decision tables for the 1986 Specification (Reference 7) will be of great assistance to the drafters of the specification revisions, as well as to the user.

MEMBERS

The behavior of compression members has been studied extensively in recent years (References 8-10). The influence of these methodical studies of residual stress in columns on the Specification will be developed for consideration by the Advisory Group.

The behavior of flexural members with laterally unbraced compression flanges is the subject of a research study just initiated at Cornell University. Whether specification provisions will result, or the analytical technique remains part of the Manual is yet to be determined.

STRUCTURAL ASSEMBLIES

The behavior of channel- and Z-sections which are continuously braced on one flange, as found in purlins of pre-engineered buildings, has been a topic of continuous study for over 20 years. Specification improvements have been incremental, with the 1980 edition being an improvement over 1968, and 1986 over 1980. However, there are still loading conditions which are not covered by the Specification, and the design provisions which are developed must properly reflect the benefits of continuous spans over simple spans. LaBoube et al (Reference 11) describe results of a test program intended to provide background and validation of specification provisions. Testing has continued in an attempt to thoroughly dispel any doubts about provisions being balloted by the Advisory Group. When approved, the design provisions are intended for issuance as an interim change, without waiting for the 1992 Specification.

CONNECTIONS AND JOINTS

Design provisions for arc welding in the AISI Specification are related to those published in AWS D1.3 (Reference 12). Recent changes in AWS D1.3 pertain to welding procedures, and not load-carrying capacity. However, there are needs identified by Albrecht in Reference 13. Tension on an arc spot weld, as can occur in roofs subjected to wind load, is one of those needs. There may be sufficient experimental evidence available to provide the basis for formulating Specification provisions to meet that need.

Ongoing studies may provide answers to questions about design of bolted connections, particularly related to tension on the net section of the connected part. LaBoube discusses the present situation in Reference 14, revealing the interrelationships between tension on net section and bearing.

Screw connections, although extensively used, do not now have the benefit of design provisions. It is hoped that the 1992 Specification will contain information on screw connections, although it is not known now what form those provisions may take.

TESTS FOR SPECIAL CASES

The usefulness of testing provisions is greatly enhanced by the availability of generally agreed upon procedures for conducting particular types of tests. Klippstein (Reference 15) describes current activities intended to expand on Part VII of the Manual. Procedures for testing mechanically fastened connections will be balloted soon.

Good interpretation of test results is essential. Pekoz (Reference 16) describes probabilistic evaluation of test results, which may have validity in testing in accordance with the Specification, as well as in applied research programs.

COMMENTARY ON THE SPECIFICATION

The 1986 Commentary relies heavily on the existence of documents such as Yu (Reference 17), and Pekoz (Reference 5), in addition to many references to the technical literature. Consideration is being given to expanding the Commentary beyond that which would explain changes in the Specification provisions.

DESIGN MANUAL

Advisory Group Subcommittee 20 on Simplification is continuing its thorough study of all aspects of the Manual, as well as the Specification and Commentary. Its recommendations range from including more figures to a preliminary design guide -- all intended to make the entire Manual easier to use.

Computer aids are an integral part of the Manual. Seaburg's review (Reference 18) includes the decision tables mentioned above.

LOAD AND RESISTANCE FACTOR DESIGN

A load and resistance factor design format for cold-formed steel has been in development for several years (Reference 19). The Advisory Group will be balloted soon. Plans call for a public review period following Advisory Group approval, with publication in 1989, three years out-of-phase with the current allowable stress design approach. There is no present intention of load and resistance factor design being phased in and allowable stress design phased out. There appears to be demand for both.

COLD-FORMED ADVISORY GROUP

The Advisory Group and its 21 active subcommittees are made up of active, concerned engineers who devote a significant amount of time and effort in development of the Specification and related documents. They also function as research panels in identifying research needs, and supervising research projects to satisfactory conclusion.

Readers are invited to express their views on the Specification, Commentary, and Manual to any member of the Advisory Group. Contact the author for up-to-date rosters.

LIAISON

Informal liaison with other cold-formed steel specification writing groups, research councils, user associations, and consensus standard writing groups is maintained through cross-memberships of individuals on the Advisory Group. The long list of liaison includes the Canadian Standards Association, the European Convention for Constructional Steelwork, the Structural Stability Research Council, the Research Council on Structural Connections, the American Welding Society, the American Society for Testing and Materials, the Metal Building Manufacturers Association, the Steel Deck Institute, and the Rack Manufacturers Institute -- to mention only a few.

This liaison is an essential part of the activity, maintaining user acceptable approaches, and taking advantage of world-wide developments.

Efforts are underway to identify and study areas of overlap and conflict between the Cold-Formed Specification and other structural design specifications used in the United States. The approach will be to identify the conflict, and to determine if the conflict is realistic and desirable, or if steps should be taken to bring them into concurrence.

CENTER FOR COLD-FORMED STEEL STRUCTURES

The concept of an organization particularly devoted to cold-formed steel structures is being developed. In addition to providing strong support to

the extensive activities of the Advisory Group, a center for cold-formed steel structures could respond to requests for technical information or refer the inquiry to recognized specialists; maintain a library of published documents; provide listings of sources of cold-formed products; maintain a data bank on past and current research; be a clearing house for educational activities; and have inhouse capability of performing specific research tasks.

A center would broaden the base of support for all involved in the cold-formed steel industry, whether as users, suppliers, consultants, or code writers.

CONCLUSIONS

Development and maintenance of a modern structural design specification, responsive to the needs of the design engineer and consuming industry, and making the best possible use of the steel supplied to that industry is an activity made possible only through the coordinated effort of many.

On behalf of the steel producers, thanks is expressed to all involved.

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