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Preface, Introduction and Keynote Address

George Winter

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First Specialty Conference on
COLD-FORMED STEEL STRUCTURES

August 19-20, 1971

Second Printing, April 1973

CIVIL ENGINEERING DEPARTMENT
UNIVERSITY OF MISSOURI-ROLLA

THE FIRST SPECIALTY CONFERENCE

ON

COLD FORMED STEEL STRUCTURES

August 19-20, 1971

Presented by:

CIVIL ENGINEERING DEPARTMENT

UNIVERSITY OF MISSOURI-ROLLA

Sponsored by:

American Iron and Steel Institute
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In Cooperation with:

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PREFACE

During recent years, numerous research projects on thin-walled, cold-formed steel structures have been conducted in various institutions and individual steel companies in the United States and foreign countries. Even though technical papers and research reports have been presented at some meetings of professional societies and a number of short courses have been conducted at several universities since 1966, no specialty conference on cold-formed steel structures has been held in the United States prior to 1971 to discuss research findings and various engineering problems.

In view of the fact that cold-formed steel structures have been widely used in building construction and other areas, and that the scope of short courses has been limited to the design feature of cold-formed steel structures, the First Specialty Conference on Cold-Formed Steel Structures was held at the University of Missouri - Rolla, Rolla, Missouri on August 19-20, 1971. The objective of this Conference was to bring together leading scientists, researchers, educators and engineers who have been engaged in the field of cold-formed steel structures for detailed discussion of research findings and design problems.

The Conference was sponsored by American Iron and Steel Institute, National Science Foundation and the University of Missouri - Rolla, in cooperation with ASCE Task Committee on Cold-Formed Members and the Column Research Council Task Group on Thin-Walled Metal Construction.

This publication contains the technical papers presented at the Conference. They represent the major part of the results of recent research and technical developments related to cold-formed steel structures conducted at various institutions and individual companies located in several nations.

The success of this type of conference would not have been possible without the support and cooperation of many individuals and organizations. Appreciation should be expressed to all sponsors for their financial and technical supports and all speakers and authors of papers

for their contribution to the technical developments in the field of cold-formed steel structures. Thanks are due to Chancellor Merl Baker for the welcoming remarks, Dr. George Winter of Cornell University for the keynote address, Mr. L. A. Barron of AISI for the banquet speech, and all chairmen for technical sessions including Mr. D. S. Wolford, Chairman of the ASCE Task Committee on Cold-Formed Members; Dr. J. B. Scalzi of the United States Steel Corporation; Dr. S. J. Errera, Chairman of the CRC Task Group on Thin-Walled Metal Construction; Dr. A. L. Johnson of AISI; Dr. G. Winter of Cornell University; Dr. J. H. Senne and Dr. W. A. Andrews of the University of Missouri - Rolla.

Appreciation is also due to many faculty and staff members of the University of Missouri - Rolla. These include Dean J. Stuart Johnson, Dean G. E. Lorey, Dean S. A. Douglass, Dean J. K. Roberts, Dr. J. H. Senne, Dr. D. E. Day, Prof. J. B. Heagler, Mr. John Short and many others. Their advice, encouragement and contributions have been of great value to the Conference.

Rolla, Missouri

Wei-Wen Yu

PERSPECTIVES

Keynote Address

by

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In this year 1971 it may be truly said that cold-formed steel construction has come of age. For it is exactly 25 years since the first design specification has been published in this country, or anywhere in the world for that matter, after six years of intensive research sponsored at Cornell University by the American Iron and Steel Institute. Research has gone on ever since, at Cornell and also elsewhere, and the specification has been repeatedly improved, enlarged, and also translated and followed, in whole or in part, in many other countries. Cold-formed construction is being used for the main load-carrying elements from small utility structures to large industrial storage racks, from moderate-size industrial and commercial buildings, schools, and churches, to the largest hangars for jumbo-jets with roofs cantilevering out some 250 ft. Maybe this is the time to take stock on where we are, and to try defining where we should be going.

As always, there is much to be done in research. However, not all research that can be thought of is equally worthwhile. Minor adjustments in effective width equations, in column formulas, in allowable stresses for unbraced beams may be interesting exercises, but they have only limited effect on the economy, and none at all on the versatility of this type of construction. The researcher must be sensitive to the feedback from application, to the needs experienced in practice for new or modified design information. Then one learns that not enough is known regarding connections in thin, cold-formed members, not enough regarding torsional-flexural behavior under all types of loading of the typically asymmetrical or singly-symmetrical cold-formed shapes, not enough regarding the behavior of the unlimited variety of cross-sectional shapes which can be produced by cold-forming, in contrast to almost any other type of construction, be it in metal, concrete, timber or some other material. These and other matters of detail need to be worked on in the traditional path from research to specification to practice.

There are, however, larger issues to be addressed. And none of these affect only cold-formed construction. One of them is the problem of the increasing complexity of design specifications. This increasing complexity is an inevitable consequence of more refined and economical ways of using material structurally, of utilizing the full benefits of higher strength material, and of maximizing the effects of our more sophisticated knowledge of structural mechanics and materials science. It is odd that there should be a problem in this increased complexity at the very time when ever more efficient computer methods enable one routinely to carry out calculations of previously undreamed of length and complication.

The reason for this is the following: Design codes and specifications are, in effect, legal documents; at the same time they are a set of technical directions to the designer. The manner in which to write these dual-character documents has gradually established itself in the pre-computer era. But this way of writing specifications in relatively simple sets of directions, of closed-form equations, preferably explicit, algebraic and of first degree, is the very anti-thesis of the mathematical complexity which can routinely be handled by computer. The result is a bizarre situation in which codified specification provisions, while still written in the accustomed form, have become so complex that they can hardly be used without computer. The irony in this is that many of these complex provisions are themselves the result of elaborate and highly accurate computer studies. In order to write code provisions, the results of these studies, by a variety of approximations and straight-jacket manipulations (all on "the conservative side") are then cast into excessively simplified code provisions of the accustomed, but by now excessively complex kind. Yet, if computer methods could be directly specified in design codes, not only would much of the present apparent complexity disappear, but the need for many of the present approximations, most of them on the uneconomical side, would also cease. How this can be done I don't know. It is difficult to see how matters which have to stand up in court can be formulated in terms appropriate for computer methods. It is also difficult to see how computer formulations can convey that understanding of structural behavior which is so inescapably necessary and which becomes apparent when matters are formulated in explicit mathematical terms.

Yet, something must be done about this or else the complexity of specifications will get out of hand while at the same time the opportunities of computerization will remain under-exploited. Codes and specifications are mostly written by people like myself, part of a generation older than that which grew up in computer-language, if the term be permitted. Maybe it remains for that generation to develop modified forms of design codes in order to overcome this problem. If so, let them go at it now.

Another problem, again not unique, but particularly pronounced in cold-formed steel structures is this: Structural engineering, especially as formulated in design codes, comes in almost airtight compartments. Cold-formed construction is a particularly relevant example of this because it has suffered under this compartmentalization from its very beginning. In fact, this type of construction was for a long time regarded by the practitioners and specification writers of conventional hot-rolled steel structures as a competing, rather than a complementing way of using steel. Hence research in the two areas was sponsored, and specifications for them were written, by two different organizations hardly cognizant of each other. It has taken about twenty years, in fact until the latest editions of the two documents, that this separation was at least partially overcome. Yet, in spite of this institutional difficulty, practice has long used the two methods concurrently and intermixed, utilizing in otherwise heavy steel framing cold-formed steel for floors, roofs, walls, for bracing against wind and seismic forces, in long-span roofs of truss, shell and folded plate construction, and otherwise. Much more would be done in imaginatively using steel to greater economic advantage if design engineers were made more aware not only of the individual features and merits of the presumably separate methods, but of their mutually supplementary and complementary character.

The same goes for combined use of concrete and steel in construction. Here again practice was ahead of code writing and even of research. Thus, light gage steel deck has been used for some three decades not only as formwork but also as reinforcement of concrete floor and roof slabs, in ways not recognized by any design code, nor designed by any established method. Parallel to this, concrete slabs have been used to act as a composite with steel girders long before the subsequent recognition and code formulation of composite construction. While such recognition now exists, the two specification writing bodies, in concrete and in steel, are still not really on speaking terms with each other, thus preventing the optimal combined use of the two materials. The next step, the use of composite, deck-reinforced slabs to act compositely with steel girders, is now underway, both in research and in practice. However, the alternative combination of using such composite slabs to act compositely with concrete girders, precast or otherwise, has not even been looked into. These are just examples of the few areas in which the compartmentalization of structural engineering has at least partly been overcome by the designing profession.

To be sure, industry has now come around to a recognition of this structural interactions. Research is being sponsored on various aspects of composite construction of concrete with light-gage and with conventional steel shapes, of interaction of light-gage steel diaphragms with heavy structural framing, in multi-story buildings as well as in shell roofs, of combining plastics, gypsum and steel in sandwiches, etc., etc. It is to be hoped that more of this will be undertaken, and that more of it will shortly be reflected in design codes, specifications, manuals and similar documents, so that broader practical use can be made of all these possibilities.

It seems to this writer, presumably an academic person who, however, has been in close touch for most of his professional life with both the steel and the concrete industry and also with the designing profession, that what is needed in the context of the urban problem and of the housing problem is radically more economical construction. This cannot be achieved without substantial industrialization of the construction process. Cold-formed steel construction lends itself unusually well to industrialization. But in order to reap the full benefits of industrialization and of design innovations of all kinds, short-sighted compartmentalization of structural engineering will have to be replaced by positive stimulation toward taking maximum advantage of all promising materials, of all promising combinations of materials and of the widest possible freedom of using new or improved structural shapes and configurations. The increased construction volume which should follow such a development would more than make up for the presumed competitive advantages provided by present compartmentalization.

Tendencies in this direction, while slow, are now clearly discernible and one is justified in hoping that in this direction will lie a real and badly needed renaissance in building.