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ENGINEERING EDUCATION ON COLD-FORMED STEEL DESIGN

Paul A. Seaburg⁽¹⁾

Consider the problem of structural member which must:

1. Serve as a platform for construction.
2. Act as formwork for poured concrete
3. Serve as positive reinforcing steel for the concrete
4. In combination with the concrete support floor loads of 200 psf (or more)
5. Act as a diaphragm to resist the wind and seismic loads on high rise buildings.
6. Be part of a composite steel beam/concrete slab assembly
7. Contain electrical and communication distribution systems
8. Be economically manufactured, shipped and erected

A creative design problem? Definitely! Covered in civil engineering courses? Usually not! This was the general conclusion of a recent survey on teaching practices related to cold-formed steel design.

In the Spring of 1980 the ASCE Committee on Cold-Formed Steel Design and Civil Engineering - ASCE conducted a survey on current teaching practices for cold-formed steel design. The survey was conducted through a questionnaire mailed to 210 Civil Engineering Departments in the United States. The questionnaire was distributed by Kneeland, Godfrey, Editor of Civil Engineering, replies were returned directly to the author. Ninety-one questionnaires (43%) were returned. The replies represented 37 States. The total yearly civil engineering graduates in those schools responding are 6,185 at the BS level, 1,430 at the MS level and 197 at the Ph.D. level. Compared to the June, 1979, reported civil engineering graduates, these figures account for respectively 62%, 51% and 66% of the BS, MS and Ph.D, graduating classes. Based on this analysis, the survey is considered to be a reliable representation of the overall teaching trends.

Let's look at the results. A complete summary is given in Table 1. It may be noted that 59 schools (65%) of the responding Civil Engineering Departments do not teach cold-formed steel design in any way. Thirty-two Departments (35%) stated they do teach the subject. Fourteen Departments indicated the subject is taught in undergraduate courses. The replies indicated an average of 3.8 hours is devoted to the topic. Twenty-one Departments teach cold-formed steel design in graduate courses, devoting an average of 13.9 hours to the subject.

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A breakdown of the class hour coverage of cold-formed steel design is given in the illustration of Figure 1. Only 4 schools provide more than four hours of coverage at the undergraduate level. Only 6 schools provide more than 10 hours of instruction at the graduate level. Is there a message in this data? Yes, it is clear that cold-formed steel design receives far less than "honorable mention" in the civil engineering curriculum.

By far, the most frequent reason for neglect of cold-formed steel design is lack of time. (This was specifically stated in 46 of the replies.) Structural engineering courses are filled by coverage of the more traditional material related to design with hot-rolled shapes. Cold-formed steel design is not perceived as an important topic. The claim is often made that a student with a good background in engineering mechanics and basic steel design can readily understand and apply the somewhat unique concepts used in the AISI Specifications. Among the other reasons stated were (1) no faculty interest, (2) little student interest, (3) subject is not covered in the steel design textbook and (4) a concise reference is not available.

On the more positive side, five schools described extensive coverage of cold-formed steel design in several graduate level courses;

1. University of Missouri - Columbia, Dr. Richard Douty reported on the course Design of Special Structural Systems. It is offered each Spring to about 10 to 12 graduate students. Twenty-five class hours concern cold-formed steel design.
2. University of Missouri - Rolla, Dr. J. H. Senne described the course Advanced Design in Steel and Lightweight Structures. An average of 10 graduate students take this class offered once each year. Thirty-six class hours are devoted to cold-formed steel design.
3. Georgia Institute of Technology, Dr. Paul Sanders supplied information on the 30 hour course, Cold-Formed Steel, offered every other year for about 10 to 15 graduate students.
4. University of Texas at Arlington. A 45 hour course on Light Gage Steel Design was described by Professor John Mattnys. It has been offered twice to approximately 24 graduate students.
5. Cleveland State University, Dr. John Hemann reported on a 40 hour course, Structural Design Light Gage Metals. This graduate level course is not scheduled in the foreseeable future.

A course outline for item 2 above is included with this paper.

As a former educator, the author is sympathetic with faculty members who state that available class time does not permit coverage of anything but high priority topics. It is also agreed that a well trained engineering graduate can readily adapt to the unique aspects of cold-formed steel design. On the other hand, as a practicing engineer, he would like to see

more specialized training in this area. A better introduction to this subject within the engineering curriculum would yield worthwhile results. Cold-formed steel products are indeed important to today's construction industry. In a typical pre-engineered metal building, at least 70% of the steel by weight consists of cold-formed steel members. Cold-formed products are equally important in high rise construction, bridges, drainage structures, tunnels - virtually all areas of construction. Insulated sandwich panels can be effectively used in frigid arctic outposts or arid desert oil fields. Inadequate design or improper use of cold-formed products can lead to numerous problems.

The designer using hot rolled shapes usually thinks of wide flange or perhaps box cross sections. To the designer of cold-formed products any cross section is possible as long as it serves its multi-function purpose and is structurally adequate. Design is more than selecting an available section - it requires creating a unique shape.

The solution to the problem posed at the beginning of this paper exists - cellular composite floor deck. But more and greater design challenges lie ahead. Let's educate our young engineers for these opportunities.

Conclusion:

Of 91 Civil Engineering Departments responding to a questionnaire on teaching practices related to cold-formed steel design 59 (65%) indicated they do not include the subject. In 32 Departments (35%) an average of 3.8 class hours at the undergraduate level and 13.9 class hours at the graduate level are devoted to instruction on cold-formed steel design. These results are believed to be representative of the current practice in the United States engineering schools.

FIFTH SPECIALTY CONFERENCE

QUESTIONNAIRE

1. Name and Address of Institution:

2. Name of Respondent:

Title:

Address:

Telephone Number:

3. Approximately how many civil engineering students does your institution graduate each year at the following levels:

BS _____ MS _____ PhD _____

4. What courses in structural design are taught at your institution?

Course Title	Required or Elective	Texts or References	Undergraduate or Graduate
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5. (a) Is cold-formed steel design taught in any of these courses? _____

(b) If yes, approximately how many class hours?

Course Title	Class Hours on Cold-Formed Steel Design
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6. Is the AISI Cold-Formed Steel Design Manual used in any of the above courses?

7. Is there any other information or teaching aid related to cold-formed steel design that would be useful to you and your students?

8. What factors limit the amount of coverage given to cold-formed steel design? (i.e. lack of time, no faculty interest, etc.)

Thank you for your assistance.

Subcommittee on Design Criteria
ASCE Committee on Cold-Formed Members

Table 1 Summary of Survey on Current Teaching
Practices for Cold-Formed Steel Design
 Spring, 1980

Total questionnaires mailed - 210

Total questionnaires returned - 91

Number of States represented in replies - 37

Civil Engineering Departments replying that they do not teach cold-formed steel design:

Number of schools - 59

Total yearly civil engineering graduates:

BS degree - 3,825

MS degree - 811

PhD degree - 131

Civil Engineering Departments replying that they do teach cold-formed steel design:

Number of schools - 32

Total yearly civil engineering graduates:

BS degree - 2,360

MS degree - 619

PhD degree - 66

Departments teaching subject at undergraduate level

Total - 14

Average hours of coverage - 3.8

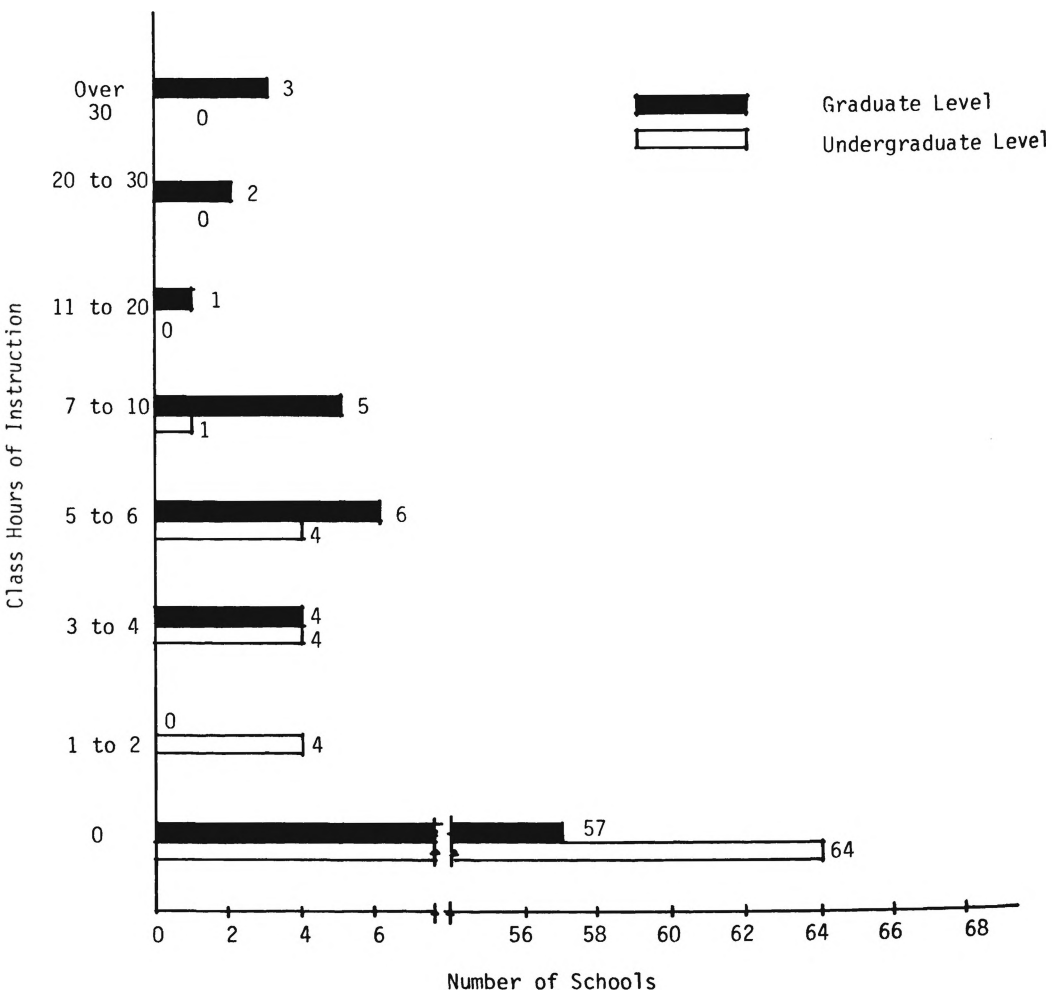
Departments teaching subject at graduate level

Total - 21

Average hours of coverage - 13.9

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Figure 1 - Class Hours Devoted to Teaching Cold-Formed Steel Design in 91 U.S. Departments of Civil Engineering



University of Missouri - Rolla
CE-426

ADVANCED DESIGN IN STEEL AND LIGHTWEIGHT STRUCTURES

References:

1. "Cold-Formed Steel Structures," Wei-Wen Yu, McGraw-Hill Book Company, 1973.
2. "Structural Members and Frames," T.V. Galambos, Prentice-Hall, 1968.
3. "Guide to Stability Design Criteria for Metal Structures," edited by B. G. Johnston, John Wiley & Sons, 1976.

1. Introduction
 - (a) Hot-rolled shapes and built-up members
 - (b) General discussion of cold-formed steel structures (Ch.1 of Ref.1)
2. Materials
 - (a) Mechanical Properties
 - (b) Residual Stress in hot-rolled and welded shapes (Ch.1 of Ref.2)
 - (c) Effect of cold work on cold-formed sections (Ch.2 of Ref.1)
3. Elastic Behavior of Members (Ch.2 of Ref.2)
 - (a) Studies of stresses and deformations for members subjected to axial load, shear force, bending moment and torsion
 - (b) First-order and second-order analyses
4. Beams
 - (a) Differential equations for in-plane bending and lateral buckling (Ch.3 of Ref.2)
 - (b) Critical moment for lateral buckling and the development of the AISC and AISI design criteria (Ch.3 of Ref.2 and Ch.4 of Ref.1)
 - (c) Local buckling and post-buckling strength (Ch.3 of Ref.1)
 - (d) Design of cold-formed steel beams (Ch.4 of Ref.1)
5. Columns
 - (a) Differential equations (Ch.4 of Ref.2)
 - (b) Elastic and inelastic column buckling (flexural, torsional, torsional-flexural) (Ch.5 of Ref.1 and Ch.4 of Ref.2)
 - (c) AISC and AISI design criteria (Ch.5 of Ref.1 and Ch.4 of Ref.2)
6. Beam-Columns
 - (a) Differential equations (Ch.5 of Ref.2)
 - (b) AISC design criteria (Ch.5 of Ref.2)
 - (c) AISI design criteria (Ch.6 of Ref.1)
7. Cylindrical Tubular Members (Ch.7 of Ref.1)
 - (a) Column buckling and local buckling
 - (b) Design criteria
8. Connections (Ch.8 of Ref.1)

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9. Structural Systems
 - (a) Shear diaphragms (Ch.9 of Ref.1)
 - (b) Shell roof structures (Ch.9 of Ref.1)
 - (c) Composite design (Ch.11 of Ref.1)
10. Other Topics
 - (a) Stainless steel design (Ch.12 of Ref.1)
 - (b) Computer-aided design (Ch.13 of Ref.1)