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Introduction

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Continuing Education

Nineteenth International Specialty Conference on
Cold-Formed Steel Structures

RECENT RESEARCH AND DEVELOPMENTS IN COLD-FORMED STEEL DESIGN AND CONSTRUCTION

Held in St. Louis, Missouri
October 14 & 15, 2008

Edited by
Roger A. LaBoube and Wei-Wen Yu

Department of Civil, Architectural & Environmental Engineering
Missouri University of Science & Technology
Rolla, Missouri

Presented by

Department of Civil, Architectural & Environmental Engineering
Wei-Wen Yu Center for Cold-Formed Steel Structures
Missouri University of Science & Technology

Sponsored by

American Iron and Steel Institute
Cold-Formed Steel Engineers Institute of Framing Alliance
Metal Building Manufacturers Association
Metal Construction Association
Rack Manufacturers Institute
Steel Deck Institute
Steel Stud Manufacturers Association
Missouri University of Science & Technology

In Cooperation with

ASCE Committee on Cold-Formed Members
Canadian Sheet Steel Building Institute, Canada
SSRC Task Group on Thin-Walled Metal Construction
University of Strathclyde, Scotland, UK
Centre for Advanced Structural Engineering
of the University of Sydney, Australia

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Wei-Wen Yu, Founding Director
of the Wei-Wen Yu Center for Cold-Formed Steel Structures,
Missouri University of Science & Technology

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W.W. Yu – Missouri S&T; Conference Co-Director; Representative of the Wei-Wen Yu
Center for Cold-Formed Steel Structures

CONTENTS

PREFACE

Cold-formed steel members are used in virtually every area of construction. In order to review the research findings and the design methods developed in this field, 18 International Specialty Conferences on Cold-Formed Steel Structures have been held since 1971.

In recent years, significant progress has been made in the development of design standards and in research studies of cold-formed steel members and structural systems throughout the world. The Nineteenth International Specialty Conference on Cold-Formed Steel Structures was held in St. Louis, Missouri on October 14 & 15, 2008. It was sponsored by the American Iron and Steel Institute (AISI), Cold-Formed Steel Engineers Institute of the Steel Framing Alliance (CFSEI), Metal Building Manufacturers Association (MBMA), Metal Construction Association (MCA), Rack Manufacturers Institute (RMI), Steel Deck Institute (SDI), Steel Stud Manufacturers Association (SSMA), and the Missouri University of Science & Technology (formerly University of Missouri-Rolla) in cooperation with the American Society of Civil Engineers Committee on Cold-Formed Members, Canadian Sheet Steel Building Institute, Structural Stability Research Council Task Group on Thin-Walled Metal Construction, the University of Strathclyde in Scotland and the Centre for Advanced Structural Engineering of the University of Sydney in Australia.

This publication contains 43 papers that were presented at the conference. These papers not only report the results of recent research but also discuss the technical developments in cold-formed steel design and construction.

As Directors of the Conference, we are very grateful to all the sponsors and supporting organizations for their financial and technical support and to all authors for their contributions in the field of cold-formed steel structures. Appreciation is also due to members of the Planning Committee (D. Allen. R.L. Brockenbrough, H.H. Chen, J. Crews, W.S. Easterling, S.R. Fox, G.J. Hancock, R.B. Haws, D.L. Johnson, R.A. LaBoube, J.W. Larson, J.A. Mattingly, T.B. Pekoz, J. Rhodes, B.W. Schafer, W.E. Schultz, P.A. Seaburg, W.L. Shoemaker, T. Sputo and W.W. Yu) for review and selection of papers and their advice in preparation of the conference. We would also like to thank all of the session chairpersons listed in the program for their time and effort.

Special thanks are extended to Mrs. Christina Stratman and Ms. Kristin Imm for their assistance in preparing this publication.

Roger A. LaBoube

Wei-Wen Yu

PROGRAM

Monday, October 13, 2008

6-9 p.m. Registration

Tuesday, October 14, 2008

7 a.m. – 4 p.m. Registration

8:00 a.m. Welcoming Remarks
R.A. LaBoube, Missouri University of Science & Technology

Presentation of 2008 AISI Market Development Industry Leadership Award to Dr. J.M. Fisher, Computerized Structural Design, Milwaukee, WI,

8:10 a.m. Technical Session No. 1
Elements and Cross-Section Behavior

Chairpersons:
W.S. Easterling, Virginia Tech, Blacksburg, VA, USA
D.L. Johnson, Maus Engineering, Wolfeboro, NH, USA

"Floor System Design for Distortional Buckling Including Sheathing Restraint;"
B.W. Schafer, R.H. Sangree, Y. Guan, Johns Hopkins University, Baltimore, MD, USA

"Simplified Methods for Predicting Elastic Buckling of Cold-Formed Steel Structural Members with Holes;"
C.D. Moen, Virginia Tech, Blacksburg, VA, USA, and B.W. Schafer, Johns Hopkins University, Baltimore, MD, USA

"Generalized Beam Theory Formulation Able to Capture Load Application and Localized Web Buckling Effects;"
N.M.F. Silva, D. Camotim, N. Silvestre, Technical University of Lisbon, Lisbon, Portugal

"GBTUL – A Code for the Buckling Analysis of Cold-Formed Steel Members,"
R. Bebiano, N. Silvestre, D. Camotim, Technical University of Lisbon, Lisbon, Portugal

9:30 a.m. Break

9:50 a.m. Technical Session No. 2
Compression Members

Chairpersons:
J. Rhodes, University of Stratclyde, Glasgow, Scotland
W.L. Shoemaker, Metal Building Manufacturers Association, Cleveland, OH, USA

"Impact of Global Flexural Imperfections on the Cold-Formed Steel Column Curve;"
B.W. Schafer, V. M. Zeinoddini, Johns Hopkins University, Baltimore, MD, USA

"Computed Flexural Buckling Stress for Cold-Formed Stainless Steel Columns;"
S.H. Lin, Minghsin University of Science & Technology, Taiwan, R.O.C., C.L. Pan and C.P. Yu, Chaoyang University of Technology, Taiwan, R.O.C.

"Stability of Cold-Formed Steel Simple and Lipped Angles under Compression;"
W.R. Maia, J.M. Neto and M. Malite, University of Sao Paulo, Sao Carlos, Brazil

"Structural Analysis of Scaffolding with Plank and Anchor Rod during Construction;"
J.L. Peng, Yunlin University of Science & Technology, Taiwan, R.O.C., C.L. Pan, Chaoyang University of Technology, Taiwan, R.O.C., K.H. Chen, National Science Council, Taiwan, R.O.C., S.L. Chan, Hong Kong polytechnic University, Hong Kong, China

11:10 a.m. Technical Session No. 3
Design Standards and Guides Development

Chairpersons:
R.L. Brockenbrough, R.L. Brockenbrough and Associates, Pittsburgh, PA, USA
W.W. Yu, Missouri University of Science & Technology, Rolla, MO, USA

"What's New in the 2007 Edition of the North American Cold-Formed Steel Specification?;"
R. Brockenbrough, R.L. Brockenbrough and Associates, Pittsburg, PA, R. Schuster, University of Waterloo, Waterloo, Ontario, Canada, R. LaBoube, Missouri University of Science & Technology, Rolla, MO, H. Chen, American Iron and Steel Institute, Washington, D.C.

"An Update on AISI Standards for Cold-Formed Steel Framing;"
J. Larson, American Iron and Steel Institute, Washington, D.C.

"Overview of the Standard for Seismic Design of Cold-Formed Steel Structural Systems - Special Bolted Moment Frames;"
H. Chen, American Iron and Steel Institute, Washington, D.C., C.M. Uang, University of California – San Diego, La Jolla, CA, R. Bjorhovde, The Bjorhovde Group, Tucson, AZ, B. Manley, American Iron and Steel Institute, Washington, D.C.

12:10 p.m. Lunch

1:10 p.m. Technical Session No. 4
Flexural Members

Chairpersons:
R.M. Schuster, University of Waterloo, Ontario, Canada
T. Sputo, Steel Deck Institute, Gainsville, FL USA

"Buckling Studies of Thin-Walled Channel Sections under Combined Bending and Shear;"
C.H. Pham, G.J. Hancock, University of Sydney, Sydney, Australia

"Experimental Study on Web Crippling of Lapped Cold-Formed Steel Channels Subjected to Interior Two-Flange Loading;"
Q. Rahman, Ryerson University, Toronto, Ontario, Canada, K. Sennah, Ryerson University, Toronto, Ontario, Canada, S. Fox, Canadian Sheet Steel Building Institute, Cambridge, Ontario, Canada

"Simplified Models for Cross-section Stress Demands on C-Section Purlins in Uplift;"
L.C.M. Vieira, Johns Hopkins University, Baltimore, MD, USA, M. Malite, University of Sao Paulo, Sa Carlos, Brazil, B.W. Schafer, Johns Hopkins University, Baltimore, MD, USA

"Flexural Resistance of Cold-Formed Steel Built-Up Box Sections Subjected to Eccentric Loading;"
L. Xu, P. Sultana, University of Waterloo, Waterloo, Ontario, Canada

"Web Crippling Behaviour of Thin-Walled Lipped Channel Beams Subjected to EOF and ETF Loading;"
M. Macdonald, Glasgow Caledonian University, Glasgow, Scotland, M.A. Heiyantuduwa, Glasgow Caledonian University, Glasgow, Scotland, J. Rhodes, University of Strathclyde, Glasgow, Scotland

2:50 p.m.Break

3:10 p.m.Technical Session No. 5
Rack Systems and Panel and Deck Assemblies

Chairpersons:
B.W. Schafer, Johns Hopkins University, Baltimore, MD
J. Crews, Unarco Material Handling, Springfield, TN USA

"Simplified Consideration of Down-isle Stability in Pallet Racking,"
J. Rhodes, University of Strathclyde, Glasgow, Scotland and M. Macdonald, Glasgow Caledonian University, Glasgow, Scotland

"Response of Metal Roofs to Uniform Static and True Hurricane Wind Loads;"
R. R. Sinno, Mississippi State University, Mississippi

"State of the Art Report on Thin-walled Cold-formed Profiled Steel Decking;"
N.A. Hedaoo, College of Engineering, Pune, India, L.M. Gupta, Viseesearaya National Institute of Technology, Nagpur, India, G.N. Ronghe, Viseesearaya National Institute of Technology, Nagpur, India, S.K. Parikh, College of Engineering, Pune, India

4:10 p.m.Technical Session No. 6
Floor Joists and Floor Joist Assemblies

Chairpersons:
M. Macdonald, Glasgow Caledonian University, Glasgow, Scotland
R.B. Haws, NUCONSTEEL, Denton, TX, USA

"Vibration Performance of Lightweight Floor Systems Supported by Cold-Formed Steel Joists;"
B.W. Davis, R. Parnell, L. Xu, University of Waterloo, Waterloo, Ontario, Canada

"Innovative Composite Cold-Formed Steel Floor Joist System;"
D.M. Fox, iSPAN Technologies, Richmond Hill, Ontario, Canada, R.M. Schuster, University of Waterloo, Waterloo, Ontario, Canada, M. Strickland, iSPAN Technologies, Richmond Hill, Ontario, Canada

"Flexural Behaviour and Design of the New Built-up LiteSteel Beams;"
S. Jeyaragan, M. Mahendran, Queensland University of Technology, Brisbane, Australia

"Experimental and Numerical Studies of the Shear Behaviour of LiteSteel Beams;"
P. Keerthan, M. Mahendran, Queensland University of Technology, Brisbane, Australia

5:30 p.m.Adjourn

6:00-7:00 pm. Reception

Sponsored by:
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Cold-Formed Steel Engineers Institute of Steel Framing Alliance
Metal Building Manufacturers Association
Metal Construction Association
Rack Manufacturers Institute
Steel Deck Institute
Steel Stud Manufacturers Association

Wednesday, October 15, 2008

8:00 a.m Technical Session No. 7
Shear Wall Assemblies

Chairpersons:
S.R. Fox, Canadian Sheet Steel Building Institute, Cambridge, Ontario, Canada
J.W. Larson, American Iron and Steel Institute, Washington, D.C., USA

"Inelastic Performance and Design of CFS Walls Braced with Straps Having Reduced Width Fuses;"
K. Velchev, G. Comeau, N. Balh, C.A. Rogers, McGill University, Montreal, Canada

"Pilot Research on Cold-Formed Steel Framed Shear Wall Assemblies with Corrugated Sheet Steel Sheathing;"
H. Vora, C. Yu, University of North Texas, Denton, TX

"Structural Testing of Corrugated Sheet Steel Shear Walls,"
B. Stojadinovic, University of California at Berkeley, CA, USA, S. Tipping, Tipping Mar + Associates, Berkeley, CA, USA

"Shear Resistance of Cold-Formed Steel Framed Shear Wall Assemblies with 0.027-, 0.030-, 0.033-inch Sheet Steel Sheathing;"
C. Yu, University of North Texas, Denton, TX, USA

"Estimating the Effective Yield Strength of Cold-Formed Steel Light-Frame Shear Walls;"
R.Serrette, Santa Clara University, Santa Clara, CA, USA

9:40 a.m.Break

10:00 a.m. Technical Session No. 8
Wall Stud and Wall Stud Assemblies

Chairpersons:
D. Allen, Steel Stud Manufacturers Association, Washington, D.C., USA
P.A. Seaburg, Consultant, Edwardsville, IL, USA

"Effect of Varied Imperfections on Bracing Demand of Cold-Formed Steel Stud Walls;"
T. Sputo, K. Beery, E. Wong, University of Florida, Gainesville, FL, USA

"Finite Element Analytical Investigation of Torsional Bracing Requirements for Cold-Formed Steel C-Shaped Studs;"
J. Tovar, Schwab Structural Engineering, New Braunfels, TX, T. Helwig, University of Texas, Austin, TX, T. Sputo, University of Florida, Gainesville, TX, USA

"Strength of Cold-Formed Steel Jamb Stud-to-Track Connections;"
A.V. Lewis, University of Waterloo, Waterloo, Ontario, Canada, S.R. Fox, Canadian Sheet Steel Building Institute, Cambridge, Ontario, Canada, R.M. Schuster, University of Waterloo, Waterloo, Ontario, Canada

"Thermal Performance of Plasterboard Lined Steel Stud Walls;"
P. Kolarkar, M. Mahendran, Queensland University of Technology, Brisbane, Australia

"Testing and Evaluation of CFS L-Headers;"
J. Pauls, University of Waterloo, Waterloo, Ontario, Canada, L.Xu, University of Waterloo, Waterloo, Ontario, Canada, S. Fox, Canadian Sheet Steel Building Institute, Cambridge, Ontario, Canada

11:40 a.m. Lunch

1:00 p.m. Technical Session No. 9
Connections

Chairpersons:
J. Mattingly, CMC Joist & Deck, Summit, NJ, USA
H. Chen, American Iron and Steel Institute, Washington, D.C., USA

"Effects of Elevated Temperatures on Ultimate Moment Capacity of Bolted Moment-Connections between Cold-formed Steel Members;"
J. B.P. Lim, University of Strathclyde, Glasgow, Scotland, Ben Young, University of Hong Kong, Hong Kong

"Cold-Formed Steel Special Bolted Moment Frames: Cyclic Testing and Numerical Modeling of Moment Connections;"
C.M. Uang, University of California, San Diego, La Jolla, CA, USA, J.K. Hong, Myers, Houghton & Partners, Long Beach, CA, USA, A. Sato, Kyoto University, Kyoto, Japan, K. Wood, KL Wood Engineering, Colorado Springs, CO, USA

"Cold-Formed Steel Special Bolted Moment Frames: Capacity Designed Requirements;"
A. Sato, Kyoto University, Kyoto, Japan, C.M. Uang, University of California, San Diego, La Jolla, CA, USA

"Cold-Formed Steel Portal Frame Joints: A Review;"
A. Wrzesien, J.B.P. Lim, University of Strathclyde, Glasgow, Scotland

2:20 p.m. Break

2:30 p.m.Technical Session No. 9 (cont.)

"Strength of Arc-Spot Welds Made in Single and Multiple Steel Sheets;"
G. Snow, W.S. Easterling, Virginia Tech, Blacksburg, VA, USA

"Cold-Formed Steel Bolted Connections Without Washers on Oversized Holes: Shear and Bearing Failures in Sheets,"
C. Yu and I. Sheerah, University of North Texas, Denton, TX

"Experimental response of connections between cold-formed steel profile and cement-based panel;"
L. Fiorino, O. Iuorio, R. Landolfo, University of Naples "FedericoII", Naples, Italy

"Test Standard for Joist Hangers and Similar Devices Attached to Cold-Formed Steel Framing;"
G. Greenlee, USP Structural Connectors, Burnsville, MN, USA

"New Test Standard for Hold-downs Attached to Cold-Formed Steel Structural Framing"
J. Ellis, Simpson-Strong Tie, Pleasanton, CA, USA

"Behavior of Arc Spot Weld Connections Subjected to Combined Shear and Tension Forces;"
L.K. Stirneman, R.A. LaBoube, Missouri University of Science & Technology, Rolla, MO, USA

4:30 p.m. Closing Remarks and Adjournment