

# **Structural Stability Research Council Annual Stability Conference 2014**

**Toronto, Canada  
25-28 March 2014**

**ISBN: 978-1-63266-710-6**

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2014) by the Structural Stability Research Council (SSRC)  
All rights reserved.

Printed by Curran Associates, Inc. (2014)

For permission requests, please contact the Structural Stability Research Council (SSRC)  
at the address below.

Structural Stability Research Council (SSRC)  
Missouri University of Science & Technology  
301 Butler-Carlton Hall  
Rolla MO 65409-0030

Phone: (573) 341-6610  
Fax: (573) 341-4476

ssrc@umr.edu

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2634  
Email: curran@proceedings.com  
Web: www.proceedings.com

# TABLE OF CONTENTS

---

## SSRC 2014 ANNUAL MEETING

### Session 1 - TECHNICAL PRESENTATIONS: TOPICS in STRUCTURAL STABILITY

|  |    |
|--|----|
| <b>Analysis and Design of Noncompact and Slender Concrete-Filled Steel Tube (CFT) Beam-Columns</b> .....   | 1  |
| Z. Lai and A.H. Varma, Purdue University, West Lafayette, IN   |    |
| <b>Behaviour and Stability of Double-Coped Beam-To-Girder Connections Under Combined Loading</b> .....   | 21 |
| G. Johnston and R.G. Driver, University of Alberta, Edmonton, Canada; L. Callele, Waiward Steel Fabricators, Edmonton, Canada  |    |
| <b>Experimental Study of Hot-Rolled Rectangular Hollow Sections</b> .....  | 33 |
| A. Liew and L. Gardner, Imperial College London, London, UK; N. Boissonnade and J. Nseir, University of Applied Sciences of Western Switzerland, Freiburg, Switzerland |    |
| <b>Design and Analysis of Liner Forms for Shaft Sinking</b> .....  | 52 |
| H.M. Haydl, Cementation Canada, Inc., North Bay, Ontario, Canada   |    |
| <b>A New Analytical Method for Solving Nonlinear Stability Problems of Framed Structures</b> .....   | 68 |
| K.K.F. Wong, National Institute of Standards and Technology, Gaithersburg, MD  |    |

### Session 2 - TECHNICAL PRESENTATIONS: STABILITY OF THIN-WALLED MEMBERS - PART 1

|   |     |
|---|-----|
| <b>Analysis and Design of Thin Metallic Shell Structural Members – Current Practice and Future Research Needs</b> .....   | 88  |
| H. Foroughi, Isfahan University of Technology, Iran; C.D. Moen, Virginia Tech, Blacksburg, VA; A. Myers, Northeastern University, Boston, MA; M. Tootkaboni, University of Massachusetts Dartmouth, North Dartmouth, MA; L. Vieira, Universidade Estadual de Campinas, Campinas, Sao Paulo, Brazil; B.W. Schafer, Johns Hopkins University, Baltimore, MD |     |
| <b>Direct Strength Method for Web Crippling of Cold-Formed Steel C- and Z-Sections Subjected to Two-Flange Loading</b> .....  | 99  |
| M.Y. Choy, X.F. Jia, X. Yuan, J. Zhou and H.S. Wang, Tsinghua University, Beijing, China; C. Yu, University of North Texas, Denton, TX  |     |
| <b>Optimization of Open Cold-Formed Steel Sections Based on Shape Grammar</b> .....   | 112 |
| J.M.S. Franco, E.M. Batista and A. Landesmann, Federal University of Rio de Janeiro, Brazil   |     |
| <b>A Novel DSM-Based Approach for the Rational Design of Fixed-Ended and Pin-Ended Short-to-Intermediate Angle Columns</b> .....  | 129 |
| P.B. Dinis and D. Camotim, Technical University of Lisbon, Lisbon, Portugal; N. Peres, Universidade Nova de Lisboa, Lisbon, Portugal  |     |

# SSRC 2014 ANNUAL STABILITY CONFERENCE

## Session 1 - STABILITY UNDER FIRE CONDITIONS – PART 1

|  |     |
|--|-----|
| <b>Stability of Continuous Steel Column Members at Elevated Temperatures</b> ..... | 166 |
| C. St. Aubin and A.H. Varma, Purdue University, West Lafayette, IN                 |     |

|   |     |
|---|-----|
| <b>Cold-Formed Steel Lipped Channel Beams Under Fire Conditions: Distortional Response, Failure and DSM Design</b> .....  | 182 |
| A. Landesmann, Federal University of Rio de Janeiro, Brazil; D. Camotim, Technical University of Lisbon, Lisbon, Portugal |     |

|   |     |
|---|-----|
| <b>Stability and Load-Carrying Capacity of Cold-Formed Steel Compression Members at Elevated Temperatures</b> ..... | 213 |
| J.C. Batista Abreu and B.W. Schafer, Johns Hopkins University, Baltimore, MD  |     |

## Session 2 - STABILITY BRACING

|   |     |
|---|-----|
| <b>Stiffness and Strength of Shear Diaphragms Used for Stability Bracing of Slender Beams</b> .....                                   | 230 |
| O.O. Egilmez, Izmir University of Economics, Izmir, Turkey; A. Akbaba and M. Vardaroglu, Izmir Institute of Technology, Izmir, Turkey |     |

|  |     |
|--|-----|
| <b>Application of Diaphragm Stiffness and Strength Equations to Bridge Metal Deck Forms</b> .....          | 246 |
| O.O. Egilmez, Izmir University of Economics, Izmir, Turkey; T. Helwig, The University of Texas, Austin, TX |     |

|   |     |
|---|-----|
| <b>The Interaction of Stability and Fatigue Related Brace Forces in Cross Frame Members of Steel I Girder Bridge Systems</b> .....                | 264 |
| A. Battistini, S. Donahue, W. Wang, T. Helwig and M. Engelhardt, The University of Texas, Austin, TX; K. Frank, Hirschfeld Industries, Austin, TX |     |

|   |     |
|---|-----|
| <b>Lateral Bracing Requirements for H-Section Beams with Supports Attached to Top Flange Subjected to Cyclic Antisymmetric Moment</b> ..... | 278 |
| R. Matsui and T. Takeuchi, Tokyo Institute of Technology, Tokyo, Japan; Y. Yamaura, Yamashita Sekkei Inc., Japan                            |     |

## Session 3 - ADVANCES in ANALYSIS and DESIGN for STABILITY

|  |     |
|--|-----|
| <b>Stiffness Reduction Method for the Design of Steel Columns and Beam-Columns</b> ..... | 297 |
| M. Kucukler, L. Gardner and L. Macorini, Imperial College London, London, UK             |     |

|  |     |
|--|-----|
| <b>An Alternative Approach for the Prediction of Hollow Structural Shapes Cross-Sectional Resistance: the Overall Interaction Concept</b> .....                                    | 315 |
| J. Nseir, E. Saloumi, M. Hayeck and N. Boissonnade, University of Applied Sciences of Western Switzerland, Freiburg, Switzerland; A. Taras, Graz University of Technology, Austria |     |

|  |     |
|--|-----|
| <b>Determining Unbraced Lengths in Continuous Girders Subjected to Warping Restraint</b> ..... | 335 |
| C.E. Quadrato and K.P. Arnett, United States Military Academy, West Point, NY                  |     |

|   |     |
|---|-----|
| <b>Experimental and Computational Analysis of Direct Torsion in Cold-Formed Steel Lipped Channels</b> ..... | 346 |
| K.D. Peterman, G. Bian and B.W. Schafer, Johns Hopkins University, Baltimore, MD                            |     |

## Session 4 - STABILITY OF THIN-WALLED MEMBERS - PART 2

|   |     |
|---|-----|
| <b>Constrained Finite Strip Method Stability Analysis of Thin-Walled Members with Arbitrary Cross-Section</b> .....   | 360 |
| S. Ádány, Budapest University of Technology and Economics, Budapest, Hungary; B.W. Schafer, Johns Hopkins University, Baltimore, MD   |     |
| <b>Experimental Study and Modeling of Cold-Formed Steel Lipped Channel Stub Beam-Columns</b> .....  | 380 |
| S. Torabian, B. Zheng and B.W. Schafer, Johns Hopkins University, Baltimore, MD   |     |
| <b>On the Relevance of Local-Distortional Interaction Effects in the Behavior and Design of Cold-Formed Steel Columns</b> .....   | 402 |
| A.D. Martins, P.B. Dinis and D. Camotim, Technical University of Lisbon, Lisbon, Portugal; P. Providência, University of Coimbra, Coimbra, Portugal   |     |
| <b>Cylindrical Shell Buckling Strength According to the "Overall Method" of Eurocode 3 - Background and Applicability to the Design of High Strength Steel Circular Hollow Sections</b> ..... | 446 |
| A. Taras, Graz University of Technology, Austria; J. Nseir and N. Boissonnade, University of Applied Sciences of Western Switzerland, Switzerland   |     |

## Session 5 - STABILITY of JOISTS and TRUSS SYSTEMS

|   |     |
|---|-----|
| <b>Effective Length K-Factors for Flexural Buckling Strengths of Web Members in Open Web Steel Joists</b> .....   | 466 |
| S.G. Lee, University of Texas-Arlington, Arlington, TX; R.D. Ziemian, Bucknell University, Lewisburg, PA          |     |
| <b>Analytical Investigation of the Stability and Post-Buckling Behavior of Large-Scale Truss Assemblies</b> ..... | 482 |
| H.J. Brown, P.S. Green, J.L. Ryan and D.G. Reigles, Bechtel Power Corporation, Frederick, MD                      |     |
| <b>Behaviour of LSF Floor Systems with Improved Joist Sections Under Fire Conditions</b> .....                    | 497 |
| V. Jatheeshan and M. Mahendran, Queensland University of Technology, Brisbane, Australia                          |     |

## Session 6 - STUDIES on POST BUCKLING STRENGTH

|  |     |
|--|-----|
| <b>Influence of the Cross-Section Geometry on the Distortional Post-Buckling Strength of Cold-Formed Steel Columns</b> .....   | 515 |
| C. Basaglia, University of Campinas, Brazil; A. Landesmann, Federal University of Rio de Janeiro, Brazil; D. Camotim, Technical University of Lisbon, Lisbon, Portugal |     |
| <b>Web Post Buckling Resistance of Longitudinally Stiffened Plate Girders</b> .....  | 531 |
| L.P. Subramanian and D.W. White, Georgia Institute of Technology, Atlanta, GA  |     |
| <b>Experimental Investigation on Shear Strength of Elastic End-Web Panels Strengthened with CFRP Strips</b> .....  | 548 |
| S.S. Safar and M.N. Abou-Zeid, American University in Cairo, Cairo, Egypt  |     |

## Session 7 - MEASUREMENT and IMPACT of IMPERFECTIONS on MEMBER STABILITY

|   |     |
|---|-----|
| <b>Initial Geometric Imperfection Measurement and Characterization of Cold-Formed Steel C-Section Structural Members with 3D Non-Contact Measurement Techniques</b> ..... | 566 |
| L.E. McAnallen, D.A. Padilla-Llano, C.D. Moen and M.R. Eatherton, Virginia Tech, Blacksburg, VA; X. Zhao and B.W. Schafer, Johns Hopkins University, Baltimore, MD        |     |
| <b>Effect of Imperfections on the Ultimate Shear Strength of Tapered Girders</b> .....  | 591 |
| M. Abu-Hamd and B. El Samman, Cairo University, Giza, Egypt   |     |

|  |     |
|--|-----|
| <b>Imperfection Analysis and Optimized Design of Tapered Spirally-Welded Wind Turbine Towers</b> .....   | 607 |
| A. Jay and A. Myers, Northeastern University, Boston, MA   |     |
| <b>Session 8 - STABILITY UNDER FIRE CONDITIONS – PART 2</b>  |     |
| <b>Axial Compression Resistance of Cold-Formed Steel Lipped Channel at Elevated Temperatures</b> .....   | 617 |
| A.A.S.C. Neto, P.D.A. Neto, A.A.R. Costa, R.B. Caldas and F.C. Rodrigues, Universidade Federal de Minas Gerais, Brazil   |     |
| <b>Modeling of Moment Connections for Structural Fire Analyses</b> .....   | 626 |
| M. Seif, T. McAllister, J. Main and W. Luecke, National Institute of Standards and Technology, Gaithersburg, MD  |     |
| <b>Effect of Shear on Stability of Steel Girders Under Fire Conditions</b> .....   | 643 |
| V.K.R. Kodur and M.Z. Naser, Michigan State University, East Lansing, MI   |     |
| <b>Experimental Studies of Cold-Formed Steel Hollow Section Columns at Elevated Temperatures</b> .....   | 654 |
| M. Balarupan and M. Mahendran, Queensland University of Technology, Brisbane, Australia  |     |
| <b>Session 9 - BEEDLE PRESENTATION SESSION: PROFESSOR SRIRAMULU VINNAKOTA</b>  |     |
| <b>Beedle Presentation: Inelastic Stability of Steel Members and Frames Using Computers with Vacuum Tubes in the '60s to Supercomputers in the '90s</b> .....  | 672 |
| S. Vinnakota, Marquette University, Milwaukee, WI  |     |
| <b>A Comparison of Stability Design Requirements: A Work in Progress of SSRC Task Committees on Systems and Extreme Loads and the ASCE/SEI Methods of Design Committee</b> .....                       | 57  |
| A.E. Surovek, South Dakota School of Mines and Technology, Rapid City, SD; L.A. Fahnestock, University of Illinois at Urbana-Champaign, Champaign, IL  |     |
| <b>Session 10 - TOPICS in STRUCTURAL STABILITY</b>   |     |
| <b>New Proposal for Classification of Steel Flexural Members Based on Member Ductility</b> .....   | 60  |
| M. Shokouhian and Y.J. Shi, Tsinghua University, Beijing, China  |     |
| <b>Analysis and Design of Steel Plate Shear Walls with Column Restrainers</b> .....  | 779 |
| M.A. Amer and B.E. Machaly, Cairo University, Giza, Egypt; S.S. Safar, American University in Cairo, Cairo, Egypt  |     |
| <b>Stability and Service Consideration for Steel Bridge Orthotropic Deck Panels</b> .....  | 797 |
| M.W. Jen, Parsons Transportation Group, New York, NY; B.T. Yen, Lehigh University, Bethlehem, PA   |     |
| <b>Session 11 - STABILITY of FRAMES AND SYSTEMS</b>  |     |
| <b>Stability of Energy-Dissipating Steel Fuses in an Innovative Seismic System for Cold-Formed Steel Structures</b> .....  | 811 |
| R. Comini and B.W. Schafer, Johns Hopkins University, Baltimore, MD  |     |
| <b>Stability Behavior of Full-Scale Cold-Formed Steel Buildings Under Seismic Excitations</b> .....  | 828 |
| K.D. Peterman, M.J.J. Stehman, N. Nakata and B.W. Schafer, Johns Hopkins University, Baltimore, MD; S.G. Buonopane, Bucknell University, Lewisburg, PA; R.L. Madsen, Devco Engineering, Enterprise, OR |     |
| <b>Calculation-Based Design of Through-Fastened Metal Building Wall and Roof Systems for Wind</b> .....  | *   |
| L.S. Cotterell and C.D. Moen, Virginia Tech, Blacksburg, VA  |     |