Structural Stability Research Council

NEWSLETTER

Volume 2, Issue 1 **April 3, 2012**

Second Year!

We are entering the second year of distribution for the electronic newsletter of the Structural Stability Research Council. The newsletter is released twice a year. In this issue you will find several specialty articles as well as overviews of current research projects and an advanced program for the 2012 Annual Stability Conference in Grapevine, TX, from April 17-20. The SSRC program starts at 2:00pm on Tuesday, April 17. We hope you enjoy the issue!

Copies of all newsletters reside on the SSRC website at http://stabilitycouncil.org. Be sure to use the website as well to keep up-to-date regarding available publications, stability related courses, the next Annual Stability Conference, etc.

Professor Vinnakota is Retiring

Professor Sriramulu Vinnakota graduated with the degree Bachelor of Engineering (Civil) with First Class from Andhra University, India (1957). He earned the degree "Docteures Sciences Techniques" from the Swiss Federal Institute of Technology in Lausanne, Switzerland (EPFL) in 1968 and has held teaching and research positions at Cornell University, University of Waterloo, and the University of Wisconsin at Milwaukee. He is retiring after 30 years of distinguished service to Marquette University and has been Professor of Civil Engineering at Marquette since 1983.

Professor Vinnakota has been teaching courses in the field of structural engineering. He has given invited talks on structural stability in the United States, Canada, West Germany, Switzerland, Yugoslavia, Hungary, and Italy and is an international authority in the field of structural stability and the design of structural steel building systems. He served on numerous task committees within the Structural Stability Research Council (SSRC) from 1973 to present and on European Convention for Constructional Steelworks (ECCS) committees until 1993. He has been serving on specification task committees and on the committees on manuals and textbooks in the American Institute of Steel Construction (AISC) since 1998.

Professor Vinnakota's scholarly activity in the field of structural stability includes contributions to the seminal work: “Guide to Stability Design Criteria for Metal Structures” (edited by T.V. Galambos and now R. Ziemian). Professor Vinnakota authored "Steel Structures: Behavior and LRFD" published by McGraw Hill in 2006 and this first edition was translated into Spanish. As a side note, Professor Vinnakota speaks three languages: English, his East Indian mother tongue, and French.

As many of you may be aware, the SSRC Vinnakota Award was established in 1997 through a financial contribution made by Professor Vinnakota. It is in honor of his parents, Sarada M. and Raju A. Vinnakota, who believed in education and research. It is important to note that this award has significantly increased the number of student-authored papers from 3 or 4 per conference, to over 20 submissions for this past year. All of these papers are prepared by MS or PhD students, and receipt of this award is one of the highest honors for a graduate student focusing their research on a topic related to structural stability.

Professor Vinnakota's service to the profession has been recognized through him being named Fellow of the American Society of Civil Engineers (ASCE) and Life Member of the SSRC.

Inside this issue:

News/Announcements

2012 Beedle Award Winner: Professor Peter Birkemoe

Peter C. Birkemoe, Ph.D., P.Eng., Professor Emeritus Department of Civil Engineering, University of Toronto, has over 45 years in experience in structural engineering involving research, practice, and teaching related to design and behavior of steel structures and is a member of the Canadian Standards Association Committee on Steel Design S16, the Research Council on Structural Connections, the Structural Stability Research Council and served on the Ontario Highway Bridge Design Code Committee (section on Steel Bridges).

Professor Birkemoe's experimental and analytical investigations on the behavior of HSS members, led to the special strength classification for manufactured cold formed, heat-treated tubular members. Extensive large scale testing and analysis of fabricated circular tubular members examined the effects of weld induced residual stresses and geometric imperfections (including damage) on the behavior of beam-columns in offshore applications. Other research on stability conducted by Professor Birkemoe includes the examination of safety of curved bridges during construction and the study of sustained plastic deformation beyond development of full yield properties. With particular expertise in research and design practice for connections employing high strength structural bolts and related structural behavior, he works with various code/specification writing bodies in Canada and the United States. He is currently conducting research on field practices of high strength bolting. Professor Birkemoe will be making his Beedle Presentation, "Experimental Studies of Stability: Have we solved the problem?" on Friday April 20 at 10am.

Beedle Award Details

THE BEEDLE AWARD WAS ESTABLISHED TO HONOR THE LATE LYNN S. BEEDLE, A LEADER AND OUSTANDING CONTRIBUTER TO SSRC

The award has been established in honor of the late Lynn S. Beedle, an international authority on stability and the development of code criteria for steel and composite structures. He was a leader and outstanding contributor to the work of the Structural Stability Research Council for a period of more than 50 years, establishing the council as the preeminent organization worldwide in the area of structural stability. Through Lynn Beedle's dedicated work and leadership in the national and international arenas, the structural engineering profession has seen advanced concepts developed into practical engineering tools. He consistently and successfully endeavored to advance collaboration between researchers, engineers, and code writers worldwide.

Recipients of the Lynn S. Beedle Award must meet the following criteria:

Longtime member of SSRC.

- A worldwide leading stability researcher or designer of structures with significant stability issues.
- A leader in fostering cooperation between professionals worldwide.
- Significant contributions to national and international design code development.

The SSRC Executive Committee serves as the award committee. The award may be presented as frequently as annually. An individual can only receive the award once. The award is presented at the SSRC Annual Stability Conference. It consists of a framed certificate, signed by the SSRC Chair and Vice Chair.

Guide to Stability Design Criteria, Sixth Edition - Buy one today!

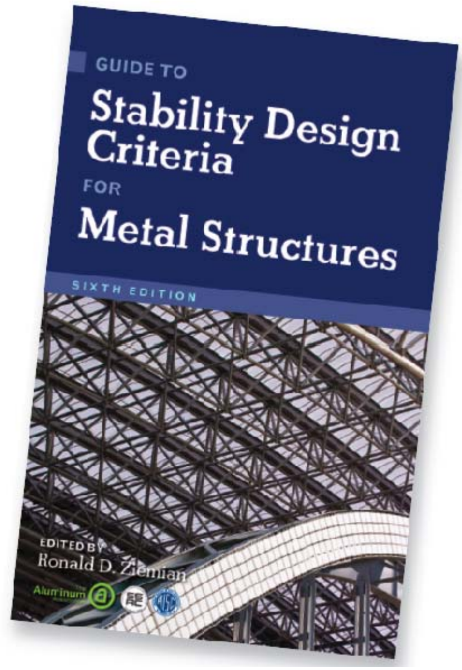
In the Spring of 2010, the sixth edition of SSRC's definitive publication *Guide to Stability Design Criteria for Metal Structures* became available. Often described as an invaluable reference for designing metal structures, the Guide is written by SSRC task group members who are leading experts in a wide range of structural stability topics. In fact, the book is heavily referenced in the commentaries to the latest editions of the AISC, AISI, AASHTO, and Aluminum design specifications.

In addition to providing updated chapters on beams, beam-columns, bracing, and plates, the Guide provides significantly revised chapters on columns, plates, box girders, curved girders, composite columns as well as structural systems, frame stability, and arches. Of particular note are two chapters, one on thin-walled (cold-formed) metal structural members and the other on stability under seismic loading, which include unprecedented coverage and easily justify the purchase of this 1100 page book.

From topics of the direct analysis method to the direct strength member design, the Guide provides comprehensive coverage of many state-of-the-art topics. Complete with over 350 illustrations, plus references and technical memoranda, the *Guide to Stability Design Criteria for Metal Structures, Sixth Edition* offers detailed guidance and background on design specifications, codes, and standards worldwide.

Be sure to purchase your copy today! The best way to purchase the Guide is via the SSRC website at

PURCHASE THE GUIDE AT HTTP://STABILITY COUNCIL.ORG



SSRC Continuing Education Opportunity

A four-hour short course titled "Cold-Formed Steel Design for Secondary Building Framing Members" will be presented by SSRC at the 2012 NASCC. The course will be offered from 8am-12pm on Wednesday, April 18. Due to the success of last year's short course, this is an encore presentation by Roger LaBoube and Mike Seek.

For many years cold-formed steel products have been used by the pre-engineered building manufacturers for roof and wall framing. Although engineers are versed in the use and design of hot-rolled steel members, they often lack an understanding of the behavior and design requirements for cold-formed steel members. Mixed structural framing systems, consisting of hot-rolled main frame members and cold-formed purlins and/or girts, can translate into a highly competitive framing solution. However, to properly combine hot-rolled and cold-formed members requires a clear understanding of the design requirements for the different components of the system. Using an example problem Roger LaBoube will provide an overview of the behavior and the design of cold-formed steel members. Mike Seek presents an in-depth discussion of bracing requirements for cold-formed steel purlin roof systems. Available resources that may be useful for the design of cold-formed steel members will be discussed.

AN ENCORE SHORT COURSE ("COLD-FORMED STEEL DESIGN FOR SECONDARY BUILDING FRAMING MEMBERS") PRESENTATION TO BE PRESENTED AT THE 2012 NASCC

Ongoing Stability Research

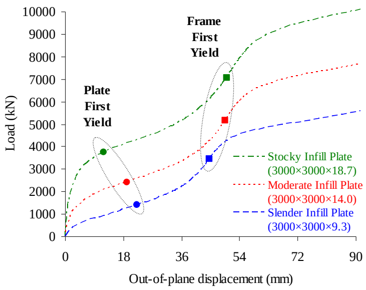


Fig. 1. Buckling and yielding behavior of SPSWs with LYP steel infill plates of various slenderness ratios

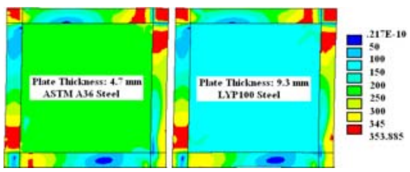
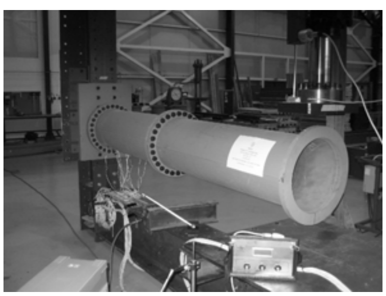


Fig. 2. vo Mises contour plots at 0.02 drift ratio (*frame members are similarly stressed*)

On the Improvement of Buckling Stability & Performance of SPSW Systems

Tadeh Zirakian & Jian Zhang
University of California, Los Angeles (UCLA); Sponsored by Graduate Division Fellowship at UCLA

Steel plates are the primary lateral force-resisting and energy dissipating components in Steel Plate Shear Wall (SPSW) systems. Structural stability and performance of steel plates are characterized by geometrical buckling and material yielding. Based on their slenderness parameter and geometrical-material bifurcation characteristics, steel plates may be divided into slender, moderate, and stocky categories. Slender plates undergo early elastic buckling and subsequently yielding during the post-buckling stage. Moderate plates, on the other hand, undergo simultaneous buckling and yielding, while stocky plates yield first and then undergo inelastic buckling. Current practice in North America is to use unstiffened and slender-web SPSWs, which buckle at very low loads and the resistance of the panel is dominated by tension field action during the post-buckling stage. However, premature buckling of slender plates may pose serviceability problems and also result in reduced structural and seismic performance. Use of Low Yield Point (LYP) steel with extremely low yield stress and high elongation capacity in shear walls allows the practical employment of moderate and/or stocky infill plates with low yielding and high buckling capacities (Fig. 1), which can result in enhanced buckling stability, serviceability, and energy dissipation capacity of such systems. In fact, application of LYP steel infill plates ensures early yielding of these thin-walled elements, and reduces forces imposed on frame members (Fig. 2). Current research at UCLA focuses on various aspects of application of SPSWs with preferably unstiffened LYP steel infill plates by addressing plate-frame interaction, seismic design requirements, and other structural and economical considerations.



Experimental setup

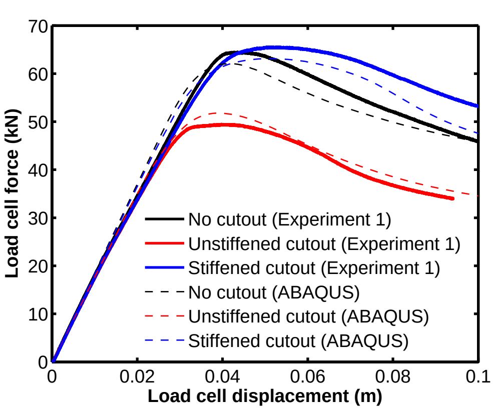
Stiffening of Manholes in Tubular Wind Turbine Towers

Christoforos Dimopoulos & Charis J. Gantes
National Technical University of Athens, Greece
Sponsored by National Technical University of Athens

In tubular wind turbine towers, it is common practice to use a cut-out near the base, serving as a manhole, to provide access to the interior of the tower for maintenance purposes. The size of the manhole is such that stress concentrations occur that may lead to local buckling, thus reducing significantly the tower strength. In order to compensate for this strength reduction, a stiffening scheme around the opening is introduced.

The effect of the opening and stiffening on the shell strength has been studied experimentally. Six shells were tested: two without openings, two with openings, and two with a stiffened opening, employing a frame welded around the cut-out. The slenderness of the shells and the size of opening and stiffeners were chosen to correspond to modern wind turbine towers at a 1:10 scale. The specimens consisted of parts connected together by means of bolted flanges. The reduction of tower strength due to the manhole was found to be in the order of 25%, while the chosen stiffener was adequate to compensate this strength loss.

The experimental results were then considered as a reference point for the validation of numerical results obtained from finite element analyses using ABAQUS, accounting for geometrical and material nonlinearities as well as contact effects. The numerical results exhibited excellent correspondence to the experimental ones in terms of characteristic load-displacement curves and strength. Further parametric numerical analyses provided data for a wide range of cases, enabling the formulation of design rules.



Load-displacement curves from experimental and numerical analyses

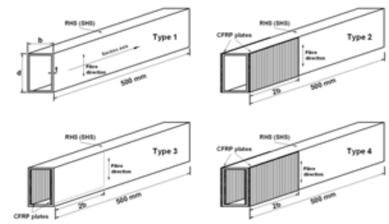
Improving Web Crippling Capacity of Aluminum Tubular Sections with CFRP Strengthening

Chao Wu, Xiao Ling Zhao, & Wen Hui Duan
Monash University; Sponsored by Australia Research Council

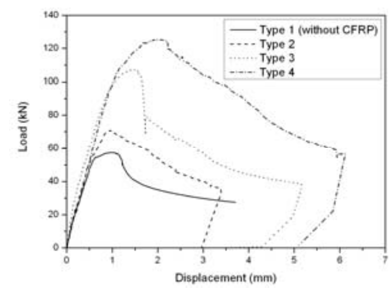
Web crippling is the major failure mode of thin-walled members when they are subjected to concentrated loading. Carbon Fibre Reinforced Polymer (CFRP), with its advanced structural properties, is a promising strengthening material for metallic structural members . Comparing with research on improving web crippling capacity of steel sections with CFRP strengthening, limited studies have been conducted on the aluminium counterparts. Aluminium tubular sections are becoming common structural elements in modern constructions. And they are more prone to web crippling failure due to their lower web stiffness, because of which CFRP strengthening can be more efficient for aluminium sections. Our research project aims to investigate how to improve the web crippling capacity of aluminium tubular sections with CFRP strengthening.

In order to study the effect of height to thickness ratio of the web on the web crippling capacity, aluminium Rectangular Hollow Sections (RHS) and Square Hollow Sections (SHS) with various sectional dimensions are selected. CFRP plates with a nominal modulus of 165 GPa are selected and two-part structural adhesive Aradite 420 is used as bonding material. Four different CFRP strengthening methods are adopted with CFRP plates attached to the interior and/or exterior webs of aluminium sections. All specimens have a length of 500 mm and the CFRP strengthening length is twice the width of the section being reinforced. All tests are performed in a 500kN capacity Baldwin Universal testing machine. During testing, the aluminium section is placed on a fixed rigid steel base. The load is then applied through a rigid bearing steel plate.

It is found that aluminium sections with Type 2 and Type 3 strengthening fail by web buckling, in which all Type 2 sections buckle outward and Type 3 sections buckle inward. Aluminium sections with Type 4 strengthening are subjected to web yielding failure. The load carrying capacity of aluminium RHS and SHS is significantly increased by CFRP strengthening on the web. Type 2, Type 3, and Type 4 strengthening produced an average of 50%, 100% and 245% increase, respectively, comparing with sections without CFRP strengthening.



Types of CFRP strengthening methods (schematic view, not to scale)

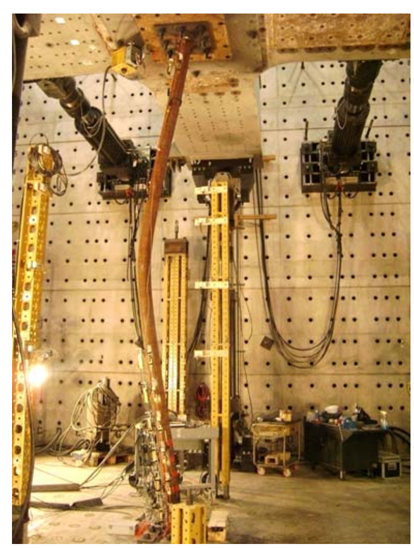


Typical load-displacement curves of aluminium section with various CFRP strengthening methods

System Behavior Factors for Composite & Mixed Structural Systems

Roberto Leon[a], Jerome Hajjar[b], Tiziano Perea[c], & Mark Denavit[d]
[a]Virginia Polytechnic Institute and State University; [b]Northeastern University, [c]Universidad Autónoma Metroplitana, & [d]University of Illinois at Urbana-Champaign (UIUC); Sponsored by National Science Foundation, American Institute of Steel Construction, Georgia Institute of Technology, and UIUC

Steel-concrete composite frames have been shown to be a sensible option for use as the primary lateral resistance system of building structures; and in many cases offer significant advantages over traditional alternatives. However, there is a notable lack of quantitatively justified guidance for the design of these structures. This NEES research project includes both experimental and analytical work to build core knowledge on the behavior of composite systems and to develop rational design recommendations. A series of full scale tests were conducted, subjecting slender concrete-filled steel tube beam-columns to complex three-dimensional loading. The specimens were heavily instrumented and the evolution of strength and stiffness of the composite members was documented in detail. A mixed beam finite element formulation for composite members was developed and validated against the experimental results from this project and other projects worldwide. The formulation is currently being utilized in large parametric studies to develop design recommendations for composite systems, including the elastic flexural stiffness, direct analysis method, and the seismic performance factors (i.e., R, C_d, and Ω_o).



Improved Cross Frame Details

Anthony Battistini, Wei Wang, & Todd Helwig
The University of Texas at Austin; Sponsored by Texas Department of Transportation

Standard X-type angle cross frame at ultimate failure

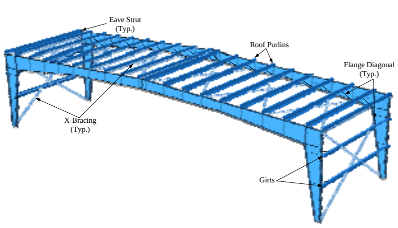
Z-type tube cross frame with knife-plate connections

Cross frames are critical to the stability of straight and curved steel bridges. The cross frames provide lateral stability to the bridge system and increase the individual girder buckling capacity. Conventional cross frames are often fabricated from angle members to make an X-type brace. Preliminary analysis and experimental tests have shown the current analytic equations for the torsional stiffness of the X-type brace do not accurately capture the behavior of the cross frame. The goal of the research project is to develop new cross frame details that improve performance and increase efficiency. By using members with substantial compression capacity, a single diagonal cross frame (Z-type) can provide an effective brace. In addition, the Z orientation better correlates with the tension-only model for brace stiffness.

One detail under investigation at the Ferguson Structural Engineering Laboratory is utilizing a knife-plate connection with square tubular HSS members. By providing a concentric connection, the out-of-plane displacement of the cross frame is reduced. Other possible details include using a double angle member along the diagonal or using cast steel connections in conjunction with round HSS members. Each of these details was tested in an MTS Universal Testing Machine to determine the stiffness and fatigue behavior. In addition, full-scale cross frame tests are being conducted to compare the actual torsional brace stiffness to the analytical formulas.

Combinations of Bracing Types in Metal Building Frames

Cliff Bishop & Don White
Georgia Institute of Technology; Sponsored by Metal Building Manufacturers Association



Various Types of Bracing on a Two-Frame, One-Bay System

Metal building frames are structures that aim for extreme weight efficiency through the extensive use of web-tapered members. By tailoring each cross-section to the moment envelope of the frame, extraneous steel can be removed to allow for an optimized and safe structure. Along with complicated geometry, metal building frames also utilize complex bracing systems. These frames incorporate many different types of bracing, including: 1) torsional bracing of the rafter and columns through flange diagonals connected to purlins or girts, 2) relative bracing provided by rod or cable X-bracing in the plane of the roof or the wall, 3) relative bracing provided by roof or wall panels between purlin or girt locations, and 4) lean-on bracing by the purlins or girts connected axially between adjacent frames. The figure illustrates one such frame system and the various bracing types that are utilized.

In the 2010 edition of the Specification for Structural Steel Buildings (AISC), there is little guidance to suggest how one should assess bracing stiffness and strength requirements when multiple bracing types are employed. Current research at Georgia Tech, through sponsorship from the Metal Building Manufacturers Association, aims at determining said requirements when multiple types of bracing are used on the same member. For example, in one scenario, a finite element simulation is created to model the requirements for bracing when torsional bracing (through the use of flange diagonals) and relative bracing (through the use of wall panels between purlin/girt locations) are used in tandem. Initially, the member has only rigid torsional bracing applied and a second-order analysis with material and geometric nonlinearities is performed. Iteratively, various amounts of torsional stiffness are applied to the member to determine at what value of bracing stiffness the strength of the frame reaches 90% of the strength predicted when the torsional bracing was rigid. Next, 10% of the AISC requirement for relative nodal bracing is applied to the member. From the results, the member supports up to around 94% of the rigidly braced strength. Thus, with a mere 10% of the required bracing stiffness from relative nodal bracing, the frame is able to support almost 4.5% more load. Ongoing studies are focusing on what proportions of each bracing type as well as how the framing properties (e.g., brace spacing, non-uniform brace stiffness, or slenderness classification of the member's flanges or webs) affect the level of stiffness required to achieve safe, adequate bracing while still remaining economical.

Ultimate Capacity of Laced Built-up Columns

Konstantinos Kalochairetis & Charis Gantes
National Technical University of Athens, Greece; Sponsored by National Technical University of Athens

Laced built-up columns (Fig. 1a,b) are often used in steel buildings and bridges, providing economical solutions in cases of large spans and heavy loads. In the design of such columns the detrimental effects of shear deformations and interaction between global and local buckling modes (Fig. 1c,d) should be accounted for.

The objective of the research is to propose an analytical methodology to obtain the ultimate capacity of such columns with arbitrary boundary conditions subjected to combined axial and lateral loads. It has been concluded numerically that collapse may be either due to elastic failure of the whole column or due to local inelastic failure of a part between joints of connectors, with the second mechanism prevailing for the majority of laced built-up columns in practice. Therefore, the approach for obtaining the capacity is based on this concept.

Initially, laced built-up columns have been modeled as equivalent Timoshenko members. Analytical solutions for imperfect Timoshenko members with arbitrary boundary conditions under combined axial and lateral loading have been presented using Engesser's approach to account for shear deformation. A general interaction equation has then been derived and used for calculation of the collapse loads. Results obtained analytically based on the proposed method, as well as from 1st and 2nd order analysis with commercial software have been compared with the ones found from Geometrically and Materially Nonlinear Imperfection Analyses (GMNIA) of laced built-up columns modelled using either beam or shell elements. The accuracy of the proposed procedure has been found to be very satisfactory (Fig. 2).

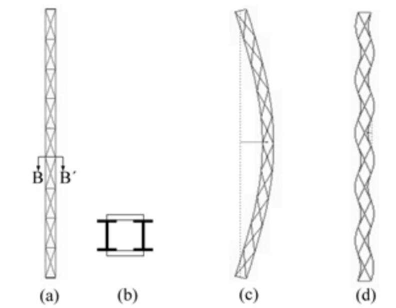


Fig. 1 (a) Typical simply-supported laced built-up column, (b) its cross-section B-B', (c) its global buckling mode and (d) its local buckling mode.

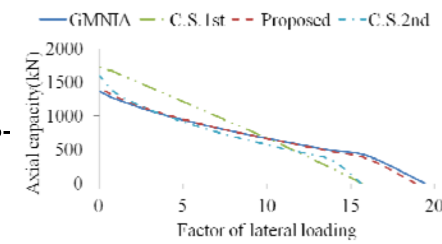


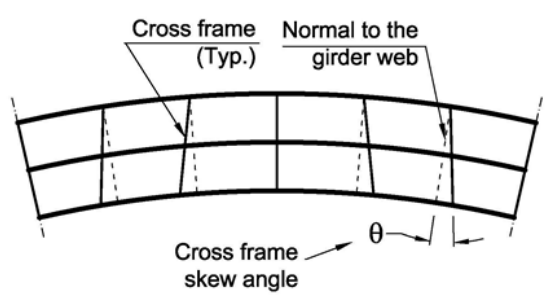
Fig. 2 Interaction diagram for imperfect laced built-up column under combined axial and lateral load

Optimizing Cross Frame Plan Orientation in a Horizontally-Curved Steel Bridge

Mohammad Sharafbayani & Dan Linzell
Pennsylvania State University

In horizontally-curved bridges, braces are commonly placed between girders in the radial direction and normal to the girder webs. This pattern results in smaller brace spacings for interior girders, which generally experience smaller deformations and rotations, and larger brace spacing for exterior girders that have larger deformations and rotations. In fact, selecting an adequate cross frame spacing for a horizontally-curved bridge to limit the effect of curvature on girder deformations and stresses (e.g. out of plane rotations and flange lateral stresses) is mainly governed by the behavior of exterior girders. Therefore, using a radial arrangement for the cross frames could result in unnecessarily stiffened interior girders and a less than optimal design. If the same braces were effectively "skewed" relative to the girder webs, such that they are not oriented perpendicular to the web plate, it may be possible to have similar unbraced lengths for all girders or to even produce larger unbraced lengths for interior girders and smaller lengths for exterior girders at critical locations along the bridge (see figure).

This research examines the optimized skewed bracing pattern in horizontally-curved, I-girder, bridges. The main objective of the research is to reduce the number of required intermediate braces for interior girders while concurrently maintaining stable geometric control and acceptable stress levels in the bridge members. Construction stages are considered for the examinations of bridge behavior, since, in many instances, the most critical phase with respect to girder stability and stiffness occurs during construction of these structures due to a lack of a large, hardened, concrete deck that helps to stiffen and stabilize the entire system.



Skewed bracing schematic in horizontally-curved bridges

Girder End Twist Prediction for Straight Skewed Steel Girder Bridges

Craig Quadrato[a], Wei Wang[b], & Todd Helwig[b]
[a] United States Military Academy, [b]The University of Texas at Austin; Sponsored by Texas Department of Transportation

Girder test specimen

Girder end twist in straight skewed steel girder bridges presents significant challenges during bridge erection. The amount of twist at the end of a girder in a skewed bridge is difficult to predict yet must be accounted for in erection planning to facilitate end cross frame fit-up and to achieve a vertical web under the specified loading condition. Currently girder end twist is predicted solely by the vertical deflection of the girders. However, at least two other parameters may have a significant impact on girder end twist and its elastic buckling strength-(1) the tip and (2) the warping restraint provided by the bearing.

The current research focus has been to validate a relatively simple finite element model of a standard elastomeric bearing pad to account for the tipping restraint as well as the warping restraint provided by an elastomeric bearing pad using tension and compression elements. Through element birth and death, the impacts of tip-up is also being incorporated into the model. Full scale laboratory testing and the University of Texas at Austin has shown that these two sources of end restraint can have a significant impact on elastic buckling strength during girder erection and deck placement. The laboratory test results, which included shimmed and unshimmed elastomeric bearings, are currently being used to validate the finite element model.

Finite element model with bearing pad detail

Lateral Stability of Discretely-Braced Steel Beams

Finian McCann, Leroy Gardner, & Ahmer Wadee
Imperial College London; Sponsored by Engineering and Physical Sciences Research Council & Department of Civil & Environmental Engineering at Imperial College

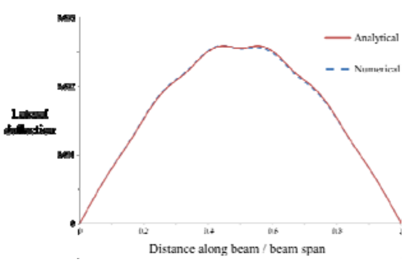


Fig. 1 Typical lateral deflection of a beam (numerical and analytical)

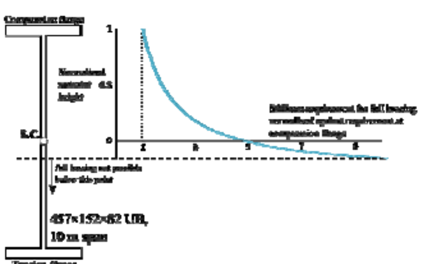


Fig. 2 Stiffness required to achieve full bracing

When treating beams with discrete lateral restraints, design codes often do not specify the stiffness required to ensure the effectiveness of bracing members. Similarly, the strength requirements for bracing members are often simplistic and based on analogous column behaviour. A Rayleigh-Ritz analysis of an imperfect simply-supported beam with a number of linearly elastic lateral restraints is conducted, with the displacement components modelled by Fourier series - it is shown that a single harmonic representation of the displacement components has numerous shortcomings. Linear eigenvalue analysis reveals that the system possesses two classes of buckling modes: a finite number, equal to the number of braces, of modes involving displacement of the restraint nodes, and an infinite number of modes where the beam buckles in between the restraints. Analytical results for the critical moment and the deflected shape are validated by comparison with numerical studies (see Fig. 1). Analysis of the progression of critical modes with increasing restraint stiffness provides a closed-form expression for the stiffness required to ensure full bracing. It is shown that full bracing is only achievable if the restraints are located closer to the compression flange than a limiting point, which lies on the tension side of the cross-section (see Fig. 2). If located below this point, the beam cannot achieve full bracing, regardless of the restraint stiffness. Design formulae are derived based on the analytical results for the critical moment, the stiffness required for full bracing and the restraint forces; when existing rules are compared to the analytical results, it is found that the existing rules are overly conservative for compression flange restraints, but significantly unsafe when the restraints are positioned closer to the shear centre.

SS1: Tu 2:00-3:00 Technical Presentations: Topics in Stability Research (Moderator: Benjamin Schafer)

Flexural and Axial Behaviour of CFRP Strengthened Steel Circular Hollow Section Beams and Short Columns

Jimmy Haedir, Xiao-Ling Zhao, Monash University, Clayton, VIC, Australia

Effects of Splice Configuration on Web Crippling of Lapped Cold-Formed Steel Channels Subjected to Interior Two-Flange Loading*

R. Quzzafi, K. Sennah, Ryerson University, Toronto, ON, Canada; S. Fox, Canadian Sheet Steel Institute, Cambridge, Canada

3D Second-Order Analysis of Industrial Buildings

Zacarias Martin Chamberlain Pravia, Ricardo A. Ficanha, University of Passo Fundo, Passo Fundo, Brazil

SS2: Tu 3:25-4:25 Technical Presentations: Angle & Cruciform Columns (Moderator: Ronald Ziemian)

Flexural Buckling of Simply Supported Columns with "Rigid End Links" - the Key to Interpret Simply Supported Angle Column Test Results?

Enio Mesacasa, Jr., University of Sao Paulo, Sao Paulo, Brazil; Dinar Camotim, Pedro Borges Dinis, Technical University of Lisbon, Lisbon, Portugal; Maximiliano Malite, University of Sao Paulo, Sao Paulo, Brazil

Buckling, Post-Buckling, Strength and Design of Angle Columns

Pedro Borges Dinis, Dinar Camotim, Nuno Silvestre, Technical University of Lisbon, Lisbon, Portugal

Behavior of HPS Cruciform Columns

Perry S. Green, Consultant, Bechtel Power Corporation, Frederick, MD, USA

SS3: Tu 4:30-5:40 Task Group Meetings: Parallel Breakout Sessions for Task Groups

Table 1: TG02 Members: stability of steel members

Chair: Don White

Table2: TG03 Systems: stability of steel systems, especially frames

Chair: Chris Foley

TG Chairs Report at ~ 5:30

SS4: Tu 5:50-7:00 Task Group Meetings: Parallel Breakout Sessions for Task Groups

Table 1: TG04: Stability of metal bridges and bridge components

Chair: Dan Linzell Vice-Chair: Qiuhong Zhao

Table 2: TG05 Thin-walled: Stability of thin-walled metal structures

Chair: Cris Moen, Vice-Chair: Cheng Yu

Table 3: TG06 Extreme Loads: stability under extreme loads, seismic, fire,

Co-Chairs: Amit Varma, Robert Tremblay

TG Chairs Report at ~ 6:50

SS5: Tu 7:00-7:15 SSRC Annual Business Meeting

SS6: Tu 7:15-8:00 SSRC Social Hour

2012 Conference Program Tuesday, April 17 (annual meeting) through Friday, April 20

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ANNUAL MEETING (4/17/2012) FROM 2PM TO 8PM, INCLUDES PRESENTATION, GROUP MEETINGS, AND SSRC SOCIAL HOUR

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SSRC SESSIONS S1-S11 ARE PART OF THE NASCC

S1: W 3:15-4:15 Advances in Stability Analysis & Design (Moderator: Ronald Ziemian)

Welcome to the 2012 SSRC Annual Stability Conference

R. Ziemian, Bucknell University, Lewisburg, PA, USA

Stability Analysis and Design of Steel-Concrete Composite Columns*

Mark D. Denavit, University of Illinois at Urbana-Champaign, Urbana, IL, Jerome F. Hajjar, Northeastern University, Boston, MA

On the Behavior, Failure, and DSM Design of Thin-Walled Steel Frames

Cilmar Basaglia, Dinar Camotim, Technical University of Lisbon, Lisbon, Portugal

S2: W 4:30-6:00 Stability of Purlins and Joists (Moderator: Clarence Miller)

Flexural Strength of Exterior Metal Building Wall Assemblies with Rigid Insulation

Tian Gao, Cristopher D. Moen, Virginia Tech, Blacksburg, VA

GBT-Based Assessment of the Buckling Behavior of Cold-Formed Steel Purlins Partially Restrained by Sheeting*

Andre Graca, Cilmar Basaglia, Dinar Camotim, Technical University of Lisbon, Lisbon, Portugal; Rodrigo Goncalves, Universidade Nova de Lisboa, Lisbon, Portugal

Computational Studies Aimed at Defining Bridging Requirements for Steel Joists During Erection*

Jonathan Eberle, Virginia Tech, Blacksburg, VA; Ronald D. Ziemian, Bucknell University, Lewisburg, PA; Drew R. Potts, Pennsylvania College of Technology, Williamsport, PA

Capacity Prediction of Open-Web Steel Joists Partially Braced by a Standing-Seam Roof*

Cristopher D. Moen, Luke Cronin, Ryan Fehr, Virginia Tech, Blacksburg, VA

Characterization of the Moment-Rotation Response of Cold-Formed Steel Beams

D. Ayhan, B.W. Shafer, Johns Hopkins University, Baltimore, MD

S3: TH 8:00-9:30 Bridge Stability & Bracing (Moderator: Donald White)

Curvature Limitations of Non-Composite Girder Bridges at Construction Stage*

Imad Eldin Khalafalla, Khaled Sennah, Ryerson University, Toronto, ON, Canada

Optimizing Cross Frame Plan Orientation in a Horizontally Curved Steel Bridge - Is it Worth it?*

M. Sharafbayani, D.G. Linzell, Pennsylania State University, University Park, PA

Comparison of the Stiffness Properties for Various Cross Frame Members and Connections*

Anthony Battistini, Weihua Wang, Todd Helwig, Michael Engelhardt, University of Texas at Austin, Austin, TX; Karl Frank, Hirschfeld Industries, Austin, TX

Cross Frame Stiffness Study by Using Full-Size Laboratory Test and Computer Models*

Weihua Wang, Anthony Battistini, Todd Helwig, Michael Engelhardt, University of Texas at Austin, Austin, TX; Karl Frank, Hirschfeld Industries, Austin, TX

S4: Th 10:00-11:30 Stability of Steel Shear Walls (Moderator: LeRoy Lutz)

The Elastic and Inelastic Post-Buckling Behavior of Steel Plate Shear Wall Web Plates and Their Interaction with Vertical Boundary Elements

David J. Webster, J. Berman, L.N. Lowes, University of Washington, Seattle, WA

Modified PFI Method for SPSWs with Moderate LYP Steel Infill Plates*

Tadeh Zirakian, Jian Zhang, University of California, Los Angeles, Los Angeles, CA

Cold-Formed Steel Sheet Sheathed Shear Walls in Mid-Rise Construction

C. Yu, N. Yanagi, University of North Texas, Denton, TX

Cold-Formed Steel Shear Walls in Ledger-Framed Buildings*

P. Liu, Northeastern University, China, C. Yu, University of North Texas, Denton, TX; B.W. Schafer, Johns Hopkins University, Baltimore, MD

S5: Th 1:15-2:15 Cold Formed Steel Member Stability (Moderator: Roger LaBoube)

Cross-Section Optimization using Simulated Annealing of Cold-Formed Steel Channel Columns

Zacarias Martin Chamberlain Pravia, Moacir Kripka, University of Passo Fundo, Passo Fundo, Brazil

Post-Buckling, Strength and Design of Cold-Formed Steel-Lipped Channel, Zed and Hat-Section Columns Affected by Local-Distortional Interaction*

Rui Fena, Pedro Borges Dinis, Dinar Camotim, Technical University of Lisbon, Lisbon, Portugal,

Stability of Sheathed Cold-Formed Steel Studs under Axial Load and Bending*

K.D. Peterman, B.W. Schafer, Johns Hopkins University, Baltimore, MD

S6: Th 3:00-4:00 Member Stability (Moderator: Dinar Camotim)

Computed Strength of Uni-Axially Loaded Battened Columns Composed of Four Cold Formed Angles

Mohamed A. El Aghoury, Adel H. Salem, Ain Shams University, Cairo, Egypt; Maged T. Hanna, National Housing and Building Research Center, Cairo, Egypt; Essam A. Amoush, Higher Technological Institute, Cairo Egypt

Influence of Imperfections in FEM Modeling of Lateral Torsional Buckling

N. Boissonnade, College of Engineering and Architecture of Fribourg, Fribourg, Switzerland; H. Somja, National Institute of Applied Sciences of Rennes, Rennes, France

Influence of Weak-Axis Flexural Yielding on Strong-Axis Buckling Strength of Wide Flange Columns

Christopher D. Stoakes, University of Iowa, Iowa City, Iowa; Larry A. Fahnestock, University of Illinois at Urbana-Champaign, Urbana, IL

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S7: Th 4:15-5:15 Member Stability Under Fire (Moderator: Amit Varma)

Enhancing the Fire Performance of Concrete Filled Steel Columns through System Level Analysis

R.S. Fike, Dematic Corporation, Grand Rapids, MI, V.K.R. Kodur, Michigan State University, Lansing, MI

DSM Design of Cold-Formed Steel Columns Failing Distortionally Exposed to Fire: How Relevant is the Temperature Dependence of the Material Behavior?

Alexandre Landesmann, COPPE, Federal University of Rio de Janeiro, Brazil; Dinar Camotim, Technical University of Lisbon, Lisbon, Portugal

Cross-Sectional Stability of Structural Steel at Elevated Temperatures

M. Seif, T. McAllister, National Institute of Standards and Technology, Gaithersburg, MD

S8: F 8:00-9:30 Castellated/Cellular & Corrugated Web Beams (Moderator: Andrea Surovek)

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Lateral Torsional Buckling of Cellular Steel Beams*

J. Nseir, College of Engineering and Architecture of Fribourg, Fribourg, Switzerland; M. Lo, National Institute of Applied Sciences of Rennes, Rennes, France; D. Sonck, Ghent University, Ghent, Belgium; H. Somja, College of Engineering and Architecture of Friboug, Fribourg, Switzerland; O. Vassart, ArcelorMittal Commercial Sections, Esch-sur-Alzette, Luxembourg; N. Boissonnade, College of Engineering and Architecture of Fribourg, Fribourg, Switzerland

Assessment of Buckling Stability of Elastically-Braced Castellated Beams

Hossein Showkati, Urmia University, Iran; Tohid Ghanbari Ghazijahani, Islamic Azad University, Iran; Amir Noori, Bu-Ali Sina University, Iran; Tadeh Zirakian, University of California, Los Angeles, CA

Instabilities of Cellular Members Loaded in Bending or Compression*

D. Sonck, Ghent University, Zwijnaarde, Belgium; N. Boissonnade, College of Engineering and Architecture of Fribourg, Fribourg, Switzerland; R. Van Impe, Ghent University, Zwijnaarde, Belgium

Ultimate Capacity of Slender Section Beam-columns with Corrugated Webs

M. El Aghoury, Sherif A. Ibrahim, Ain Shams University, Cairo, Egypt; M.M. Nader, Senior Structural Engineer, Cairo, Egypt

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S9: F 10:00-11:30 Beedle Presentation Session (Moderator: Benjamin Schafer)

Beedle Presentation:

Experimental Studies of Stability: Have we solved the problem?

P. Birkemoe, University of Toronto, Toronto, ON, Canada

Session talks

Experimental Study of Residual Stresses in Thick Steel Plates

R. Thiebaud, J.P. Lebet, Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland

S10: F 2:15-3:15 HSS & Panel Stability (Moderator: Donald Sherman)

Effect of Width-Thickness and Depth-Thickness on the Cyclic Bending Behavior of Hollow Structural Sections*

Matthew Fadden, Jason McCormick, University of Michigan, Ann Arbor, MI

Material Characterization and Microstructural Simulation of Hollow Sphere Steel Foam*

B. Smith, University of Massachusetts Amherst, Amherst, MA; S. Szyniszewski, Johns Hopkins University, Baltimore, MD; J. Hajjar, Northeastern University, Boston, MA; B.W. Schafer, Johns Hopkins University, Baltimore, MD; S. Arwade, University of Massachusetts Amherst, Amherst, MA

Local Buckling Strength of Steel Foam Sandwich Panels

S. Szyniszewski, Johns Hopkins University, Baltimore, MD; B. Smith, University of Massachusetts Amherst, Amherst, MA; J. Hajjar, Northeastern University, Boston, MA; S. Arwade, University of Massachusetts Amherst, Amherst, MA; B.W. Schafer, Johns Hopkins University, Baltimore, MD

S11: F 3:30-5:00 Vinnakota Award Session & Plate Girders (Moderator: Todd Helwig)

Presentation of the Vinnakota Award

Ronald Ziemian, Bucknell University, Chair SSRC

New Shear Design Criteria for Plate Girders

Sung C. Lee, Doo S. Lee, Dongguk University, Seoul, Korea; Chai H. Yoo, Auburn University, Auburn, AL

Moment-Shear Interaction in Plate Girders

Sung C. Lee, , Doo S. Lee, Dongguk University, Seoul, Korea; Chai H. Yoo, Auburn University, Auburn, AL

Moment-Shear Interaction of Longitudinally Stiffened Plate Girders

Darko Beg, Franc Sinur, University of Ljubljana, Ljubljana, Slovakia

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