SEAC GENERAL NOTES
Structural Engineers Association of Colorado Newsletter

SEPTEMBER GENERAL MEETING

Schedule

Mark Your Calendar
(2008)

General Membership Meetings
(Breakfast 7:30 a.m.)
January 17
March 20
May 15
July 17
September 18

Business Practice Committee Meetings
(Breakfast 7:30 a.m.)
February 14
April 10
June 12
August 14
October 9

SEAC Board of Directors Meetings
(7:30 a.m.)
January 10
February 7
April 3
June 5
August 7
October 2

Annual Dinner Banquet
November 20
6 - 9 p.m.

Considerations for Steel Framed Floors

In light of the changing industry, it is the intent of this paper to discuss issues that are typically expressed today by Owners, Architects, Structural Engineers (EOR), General Contractors, Fabricators, Detailers, and Erectors for consideration by the design/construction team that, if sufficiently addressed, can result in a successful steel framed floor system.

Each participant on the design/construction team has responsibilities that affect cost, schedule, quality, and constructability. Often, the participants carry unique perspectives that may not be obvious to other members of the team. If the issues are addressed and coordinated early with the team, an economical and successful steel framed floor can be constructed.

This paper was prepared by the SEAC/ RMSCA Steel Liaison Committee, a coalition of Front Range Fabricators, Detailers, Erectors, General Contractors and Structural Engineers dedicated to improving the steel construction industry.

Jules Van de Pas, P.E., S.E., is Vice President for Computerized Structural Design, SC and is in charge of the Denver, Colorado office. Mr. Van de Pas has been responsible for the design of numerous structures and connections for structures throughout the United States. He has co-authored various articles and papers and frequently lectures on steel design and seismic design issues.

Jules received his B.S. from the University of Wisconsin at Platteville and M.S. from University of Wisconsin at Milwaukee. He is a licensed S.E. in CA, WA, and OR as well as a licensed P.E. in 15 states. Jules is a past Present of the Rocky Mountain Steel Construction Association and former adjust professor at the University of Wisconsin, School of Architecture.

Don't Miss Out - September Meeting

Date: Thurs. Sept 18, 2008
Speaker(s): Jules Van de Pas, P.E., S.E.
Location: Renaissance Denver Hotel
3801 Quebec Street
(South of the I-70 Quebec Intersection)

Please e-mail your reservation to Caryn at: ***seac@martinmartin.com***.
Reservations MUST be made By 12:00 pm - Monday, Sept, 15, 2008

Officers & Board Members

Rodd Merchant, P.E.
President
JE Dunn Construction
303-691-7632
rodd.merchant@jedunn.com

Elizabeth Jones
VP/Treasurer
Martin/Martin Consulting Engineers
303-431-6100
ejones@martinmartin.com

Ron Hedrick
Secretary
Jirsa Hedrick Associates, Inc.
303-839-1963
rhedrick@jirshedrick.com

Stan Neujahr
Past-President
Neujahr & Gorman, Inc.
303-377-2732
stanneujahr@neujahrgorman.com

John Malcom
Director
Peak Engineering, Inc.
303-274-0707
jmalcolm@peakengr.com

Jeannette Torrents
Director
JVA, Inc.
303-444-1951
jtorrents@jvajva.com

Jim Royston
Director
Western Engineering &
Research Corp
303757-4747
jim@werc.com

Submit comments/articles to:
Caryn Bauer
Structural Engineers
Association of Colorado
c/o **Martin/Martin, Inc.**
12499 West Colfax Avenue
P.O. Box 151500
Lakewood, CO 80215
(303) 431-6100 x400
(303) 431-6866 fax
seac@martinmartin.com
WWW.SEAColorado.org
Information for inclusion in the newsletter must be received one month prior to the next general meeting.

Caryn L. Bauer
SEAC Executive Assistant
seac@martinmartin.com

President's Message

I'd like to lead off with a topic that I am personally very passionate about – Virtual Design & Construction, or as it's sometimes more commonly referred to - BIM. If you received the August issue of Structural Engineer, you undoubtedly saw the cover article "BIM: Changing the Way We Deliver Stadiums". If you're an ENR reader, you may also have read the April article titled, "$1-Billion Jigsaw Puzzle Has Builder Modeling Supply Chains", which highlighted how the General Contractor utilized the Building Information Model in concert with precast concrete units embedded with individual Radio-Frequency Identification (RFID) tags to track, monitor, and plan construction of more than 3,200 pieces. These two stories and countless others leave little room for doubt that VDC & BIM are changing the way we do business. This is especially true for Structural Engineers. For many of our members, it has spawned new internal production processes as well as new business opportunities, many with non-traditional customers. But the innovation highway is not without its obstacles and pitfalls, which is why I'm so excited about this year's Fall Seminar. I hope you will plan to spend the day with us on ***Thursday, October 16, 2008*** to hear from industry experts, as well as fellow SEAC members as they share their lessons learned, risk considerations, and vision for the future of BIM in our industry. Whether you're a BIM novice or experienced expert, the session is sure to have something for everyone! Please see the seminar flyer and registration form for more information.

As we work to finalize event plans and activities for this year, my fellow board members suggested I take a moment and update you on board activities and discussion items from our August board meeting. So, here are the highlights: Per our bylaws, the President shall appoint a Nominating Committee consisting of three voting members of SEAC to find candidates for the board Treasurer and Director positions. To that end, **Jerry Maly** has been appointed chair of the Nominating Committee and will be assisted by **Dave Houdeshell** and **Brent Norris**. Our national organization (NCSEA) has put forth a proposed Code of Ethics for Structural Engineers asking Member Organizations (MO) to consider adopting. To that end, the board discussed the process to put forth the proposed code to the membership, solicit member comment, and vote as a MO whether or not to adopt the code. The formal process will be detailed in a forthcoming letter to all SEAC members. The board also discussed desired improvements to the SEAC website as well as suggested topics for 2009 general breakfast meetings. If you have suggestions for meeting topics, please forward them to me or another board member.

So what's coming up? Besides the Fall Seminar, this month's breakfast meeting will be a joint meeting of both SEAC and the Rocky Mountain Steel Construction Association (RMSCA) and will feature a presentation by the Steel Liaison Committee on the subject of steel framed floors. The committee, comprised of members from both SEAC and RMSCA, has worked diligently over the past several months to author a paper summarizing the many issues and suggested best practices for the successful design and construction of steel framed floors. Please plan to attend as this is one not to be missed!

And finally, I hope you will mark your calendars and come help us close out the year at the annual dinner celebration, scheduled for ***Thursday, November 20, 2008***. This year, the event will take place at the recently completed Museum of Contemporary Art in downtown Denver and will include a wrap-up of activities, special awards and a few surprises. Please watch your email in-box for additional information and registration form. So, as the second half of this year continues to race by, I encourage you take advantage of the outstanding learning and networking opportunities available at our upcoming events. As always, I encourage all of you to provide your input and feedback on how we can improve your member organization. Good luck and continued success.

Thank You!

July Speaker's

David Morrill, P.E.

The content of his Seminar focused on the design and construction of cost effective and efficient CIP Concrete structures.

July Sponsor

Restruction Corporation®

Restruction Corporation is a contractor that specializes in structural concrete repair and structural strengthening. Established in Colorado in 1975, the company has grown to include offices in Salt Lake City, Utah, and Phoenix, Arizona. The company serves and has completed projects throughout the Rocky Mountain region and in selected mid-west and western states.

September Sponsor

ROCKY MOUNTAIN PRESTRESS STRESSCON CORPORATION
COLORADO PRESTRESSERS ASSOCIATION

While today the Colorado Prestressers Association (CPA) is heralded as one of the most prestigious and influential Associations in the precast prestressed concrete industry, it might be surprising to know that it had quiet and humble beginning. It is our hope that the reader will find the following history recap of interest.

In 1953 the very first Precast Prestress concrete plant in the United States was created at 5801 N. Pecos St. in Denver. By the time 1969 rolled around Colorado had four prestress plants, ranging from Pueblo in the south to Boulder in the north. The time also arrived when these four plants felt a common need to get together and investigate how to advance this new found industry as well as discuss mutual problems and solutions. At that time the group met in the downtown Denver office of the Portland Cement Association, and this somewhat casual relationship continued until 1971 when the industry flourished to a point that signaled the need to organize on a more professional level, eventually leading to hiring an Executive Director, and becoming a strong leader in the field of prestressed concrete. For the next several years mergers and acquisitions took place, absorbing some of the original founders and resulting in the current membership of two producers. The current CPA, as most of you know it now, consists of producer members Rocky Mountain Prestress in Denver, and Stresscon Corporation in Colorado Springs. The Executive Director, taken on in 1971, is Wally Prebis, P.E. (mail: wallycpa@aol.com).

The strength of the Association lies in its three working Committees: Marketing, Technical, and Fire and Codes. Through our Technical and Marketing Committees the Association has not only been able to penetrate every conceivable building category, but also been able to develop new and innovative structural systems to satisfy specific market needs. Our Fire and Code Committee has been at the forefront of code development, making it possible to properly interpret the building codes and offer assistance when needed. And, in many instances the CPA has written design procedures making it possible to follow code requirements and result in efficient and economic design.

In conclusion it must be stated that it is an honor and one of our finest achievements to have become a part of SEAC and be associated with the caliber of engineering talent this organization has as its membership.

Bowstring Trusses Fail to Meet Current Code Requirements

Paul C. Gilham, P.E., Chief Engineer, Western Wood Structures, Inc.
Terry D. McKee, P.E., VP Field Services, Western Wood Structures, Inc.

Introduction

The timber bowstring trusses found in many local buildings have been affected by a series of changes that have rendered them as "dangerous members" as defined by the International Existing Building Code (IEBC). These trusses have been in use for more than seventy years to provide economical unobstructed spaces in commercial and industrial buildings, gymnasiums, airplane hangers, etc. From the 1940's through the 1960's they were a dominant roof structural type. There are many buildings still in use today that use this type of roof structure.

Bowstring trusses are made with a curved top chord and a straight bottom chord. The top chords were originally made with multiple leaf chords where the curvature was cut into the solid sawn chord members. A second style of bowstring truss used glued-laminated chords. The top chord in these trusses was curved in the laminating process.

While these trusses have carried the roof load for decades, it is not uncommon to receive calls regarding broken trusses following a heavy snow event. Fortunately, the breaks seldom lead to a total roof collapse if the trusses can be properly shored and repaired quickly.

Three factors, including a series of code changes, refinements in analysis methods and revisions to allowable timber stresses, have resulted in these trusses now being significantly overstressed. The IEBC defines a dangerous member as one where, "the stress in a member or portion thereof due to all factored dead and live loads is more than one and one third the nominal strength allowed in the *International Building Code*…" Increases in loading and decreases in allowable stresses alone render most of these trusses dangerous.

The application of unbalanced snow loads as prescribed in ASCE 7 results in a localized increase in forces for many truss members and is significantly more severe than the original design loading. The use of computer-assisted frame analysis identifies secondary moments that the original classical determinate truss analysis ignored. Finally the allowable timber stresses were reduced in the late 1980s.

However, these trusses can be retrofitted to remedy these problems and to increase the load capacity to meet the current code requirements. This is accomplished by first analyzing the trusses using frame analysis software with the current code-required loading and then upgrading each member and connection as required to meet the design requirements.

Bowstring Truss Configurations

The trusses existing in most buildings today have one of two dominant configurations. The first configuration is referred to as a TECO truss. TECO trusses were fabricated using multiple leaf chords and single webs. The top chords were made by using wide solid sawn members where the roof curvature was cut into the top of each piece of wood. The members are lapped from side to side so that the splices in the top chord members do not occur at the same location from one side to another. These splices are also located so that they fall in between truss panel points.

The bottom chords were made of two solid sawn members and were spliced between web members using wood splice blocks between the chord members and on the outside of the chords. The splices were usually made up of multiple split ring connections.

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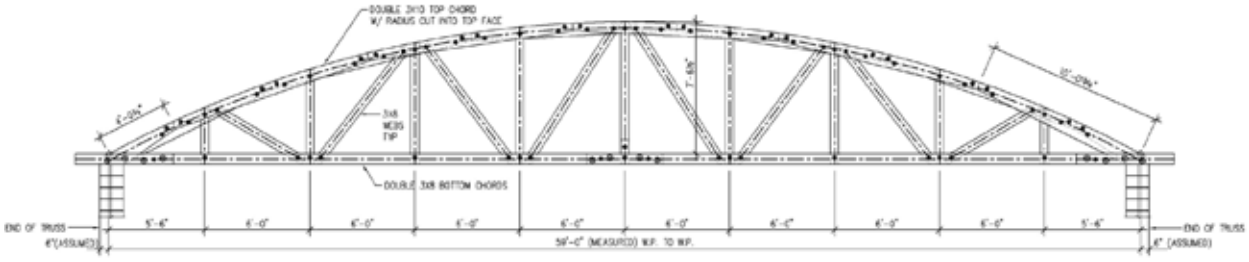
Bowstring Trusses Fail, From Page 4

The web members are connected to the chords with a single bolt with split rings. The centerlines of the webs do not intersect at the centerline of the chords so there is some eccentricity to the connections. This eccentricity induces shear forces and bending moments into the chord members but these were not accounted for in the original design. Shown below is a typical layout of a TECO bowstring truss.



TRUSS PROFILE

The second configuration used single glue-laminated chords. The top chord was curved in the manufacturing process. This type of bowstring truss (as manufactured by Timber Structures, Inc.) was known as a Tim Truss. The webs were often solid sawn members. The web to chord connections were made with steel plates and angles, bolted to the timber members, and arranged so that the web centerlines intersected at the chord centerline.

In both configurations, the most economical truss was obtained by using a top chord radius equal to the truss span. This relationship yields a 30° spring angle at the truss heel.

Changes in Loading Considerations

The basic roof snow load has increased in many jurisdictions since the time the trusses were designed and installed. For example, the snow load was increased from 20 psf to 25 psf in the Portland, Oregon area following a large snowstorm in the late 1960s that caused many roofs to collapse. Additionally, the building codes in effect during the design of these trusses required a dead load plus ½ snow load plus wind load combination. Recognizing that some of the truss members experienced a reversal of forces under unbalanced loading, it was common to apply the ½ snow load to one side of the truss and leave the other side unloaded. While this may have changed the force in some web members from compression to tension or from tension to compression, it seldom changed the absolute value of the member force and therefore did not change the member size or the connection.

In ASCE 7, section 7.6.2, the unbalanced snow load varies from ½ at the crown to 2 times the roof snow load at a slope of 30°. (This is located at the eave for common bowstring trusses.) The application of this loading condition greatly increases the load in the web members and drives more of the members into stress reversal. It is not uncommon for this loading condition to cause the longer web members to become compression members with very high L/d ratios resulting in the members being significantly overstressed.

Changes in Structural Analysis Methodology

The design of both of these types of trusses was accomplished using a graphical force diagram. This analysis method provides an accurate means of determining the member axial forces. In the TECO truss analysis, the eccentricity of the web connections and the continuity of the members at the joints were ignored.

In the Tim Truss analysis, the continuity of the top chords was accounted for by treating the member as a three-span beam to determine the primary bending moments. An additional bending moment was determined by multiplying the axial load by the offset due to the curvature of the member.

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Bowstring Trusses Fail, From Page 5

The shortcoming of these methods is that the secondary moments produced by the continuity of the members at the joints were not accounted for. These secondary moments can be quite large. The graphical methods also do not account for the shears and moments introduced by the joint eccentricity of the TECO trusses. Additionally, these methods cannot account for the effects of the relative stiffness of the members. Since the trusses are statically indeterminate, the relative stiffness of the members must be accounted for to accurately determine the internal forces.

Today, with the use of general-purpose frame analysis methods, it is easy to account for the actual geometry of the truss configurations, the continuity, and the relative stiffness of the truss members.

Changes in Allowable Timber Stresses

In the 1980s, the timber industry completed an extensive testing program to evaluate the allowable stresses of full-size timber members. This program was referred to as the "In-grade Testing Program." Before this program, allowable stresses for timber members were determined by multiplying the stresses obtained by testing small clear samples with a series of factors that accounted for naturally-occurring, strength-reducing defects, duration of load, drying, safety factors, etc. The In-grade Testing Program demonstrated that the testing of these small clear samples failed to accurately determine the appropriate allowable stresses for full-size members.

With the In-grade Testing Program, full-size members for each grade of each species were tested to failure. This extensive testing program resulted in the reduction of the allowable stresses for timber members for many grades and load conditions. This reduction affects the capacity of TECO bowstring trusses because the tension values for the bottom chord members were significantly reduced for many sizes. For example, prior to 1982, the NDS supplement listed the allowable tensile stress of a 3 x 10, Douglas Fir-Larch #1 bottom chord member as 1000 psi. In 1982, the application of footnote 3 reduced this value to 600 psi. In the current NDS, the value is 675*1.1 = 742.5 psi.

Effect of These Changes on Existing Bowstring Trusses

The combination of the three factors (changes to loading, analysis methods, and timber stresses) results in an over-stressed condition for most bowstring trusses. In a recent example, the maintenance personnel at an Oregon School District noticed that the pilasters of a gymnasium were cracking. The district called Youngman Locke Engineers of Salem to inspect the building. The inspection uncovered several broken chord members in the trusses. Youngman Locke Engineers prepared a design-build specification for the analysis, design, and repair of the trusses on this building and three other buildings. One of these buildings was the district's Technical and Information Services Building. Western Wood Structures, Inc. of Tualatin, Oregon was awarded the contract to complete this work. The TECO trusses on this building are 78 feet long and are spaced at 17 feet on center. The top chords were made using two 3 x 14 members with the roof curvature saw cut into the top of the members. The bottom chords were made using two 3 x 10 members and the webs were single 3 x 6 and 4 x 6 members.

The analysis using current code load requirements and allowable timber stresses resulted in the top chords being overstressed in combined bending and compression by 36 percent. The bottom chords were overstressed on combined bending and tension by 94 percent. Several of the web members originally designed as tension members became compression members and violated the limit of 50 for L/d ratio. Other web members were overstressed by 63 percent.

Upgrade Techniques

The good news is that these trusses can be upgraded to meet the current code requirements for lower cost than replacing the roof structure. The trusses at the Oregon School District were retrofitted to increase their load-carrying capacity. To accomplish this, the trusses were first fully shored to remove the dead load stresses from the members.

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Bowstring Trusses Fail, From Page 6

The compression members in the top chord and webs were upgraded by epoxying and screwing timber side members to the existing member. The addition of the side members reduces the L/d ratio and increases the section size. The upgraded members are analyzed using a transformed section of the new member to account for differences in stiffness.

The bottom chord was upgraded by adding post-tensioning elements. The addition of these post-tensioning elements applies an initial compressive stress to the bottom chord. The trusses on this building had an applied ceiling installed that provided lateral support for the bottom chord along its length. The initial compressive force is calculated so that the total tensile force in the bottom chord is less than the allowable load after the roof load is applied.

Conclusions

Bowstring trusses in existing buildings built before 1980 most likely will not meet current code requirements for load capacity. Recognizing this, the city of Portland, Oregon requires existing bowstring trusses to be upgraded to current code when a change to the building occupancy occurs. Using modern frame analysis methods, these trusses can be accurately analyzed, and by applying specific repair techniques, the members can be upgraded to meet the current code requirements.

New AISC Seismic Connections Seminar coming to Denver!

Coming **September 17th** to the Red Lion Hotel, this new seminar explores practical applications of the 2005 AISC Seismic Provisions. With recent advances in code requirements and options, it can be a challenge to design cost-effective connections to resist seismic demands. This new seminar demystifies seismic connection design. You will learn how to design connections for moment frames, braced frames, and other seismic load resisting elements. For more information and to register, go to www.aisc.org/seminars.

In The Spotlight

Coming Soon

SEAC Annual Dinner will be held at the Museum of Contemporary Art on Thursday evening, November 20, 2008. Please Mark your calendar!!!! Watch for more details and reservation form.

Nominating Committee

The SEAC BOD has established a "Nominating Committee". Jerry Maly (Chair) along with Brent Norris, and David Houdeshell will be working hard to find Members to fill the BOD Treasurer Position and Director Position. Please contact Jerry Maly at jmaly@wje.com if you are interested in serving on the Board of Directors for SEAC.

GENERAL NOTES - *Keep them CLASSIFIED!*

Structural Engineers Association of Colorado Classified Section
& Other General Announcements

CH2M HILL

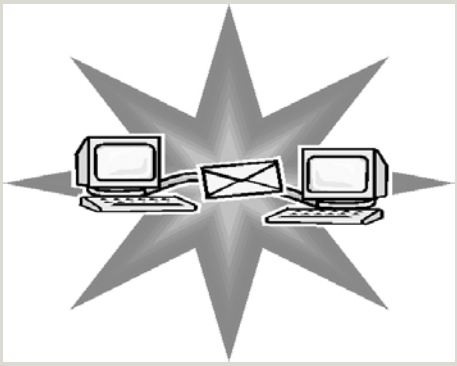
CH2MHILL is looking for a dynamic person to join the firm as a Structural Engineer in our Denver office. In this position, you will have the opportunity to work with our water resources engineering staff to support our existing and future work in the water and wastewater treatment market. Your work will include planning, study, and design of water/wastewater treatment plant projects. You should have some experience with working on proposals, contributing to client relationships, and understand the basics behind developing new business. In this role, you may serve as a task leader and/or supervise the work of less-experienced engineers and support staff.

Responsible for working with design teams to perform detailed design work including concept development, detailed design calculations, and the generation of bid drawings and technical specifications primarily for water and wastewater treatment plant projects.

Required Qualifications: A Bachelors Degree in Civil/Structural Engineering and PE is required, a minimum of 9 years relevant work experience in design of water and wastewater facilities.

Preferred Qualifications:
M.S. Degree in Structural Engineering desired
Experience in construction phase engineering services and shop drawings
Experience designing water holding structures
Experience working with multiple tasks
Experience working in a multi-discipline team environment

For more information, or to apply for this position, please send an email to Julie.Marr@ch2m.com.



If you have a change of address, phone, fax, or e-mail. Please e-mail Caryn Bauer at ***seac@martinmartin.com***

Fall Seminar

Thursday, October 16, 2008

Topic:
Building Information Modeling

RSVP with Payment BY: October 10, 2008 to cbauer@martinmartin.com

This is a full day seminar. Breakfast and Lunch will be served. CEU Certificate will be available at the Seminar.

SEE ATTTACHED FLYER AND REGISTRATION FORM

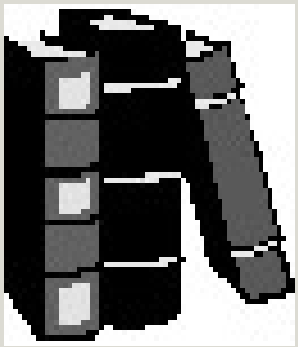
Publications for sale

2007 Colorado ground snow load report & map
Price: $75 (members)

A Guide For Consulting Structural Engineering Services: A Recommended Standard Of Practice
Price: $25 (members) and $50 (non-members)

2006 Survey of Colorado Building Departments
Unit Price: $50.00
CD: $100.00

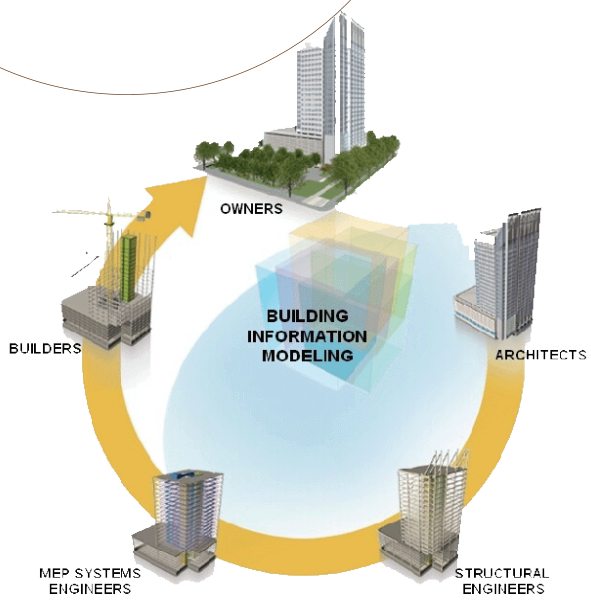
Contact Caryn Bauer at seac@martinmartin.com for order forms.



STRUCTURAL ENGINEERS ASSOCIATION OF COLORADO

BUILDING INFORMATION MODELING

2008—SEAC FALL SEMINAR



OCTOBER 16, 2008
RENAISSANCE DENVER HOTEL
3801 QUEBEC ST. (SOUTH OF THE I-70& QUEBEC INTERSENTION)
7:30AM TO 5:00PM

SEAC
c/o Martin/Martin, Inc.
12499 West Colfax Avenue
Lakewood, Colorado 80215
Phone: 303.431.6100x403
E-mail: seac@martinmartin.com

Partner Organizations
HGC, DBIA, ACEC, RMSCA, RMMI

Seminar Sponsors
Tekla Corporation, Colorado Prestressers Association

STRUCTURAL ENGINEERS ASSOCIATION OF COLORADO

SEMINAR AGENDA

2008—SEAC FALL SEMINAR

Seminar Agenda

7:30 – 8:30	**Breakfast**
8:00 – 9:00	**Vendor meet and greet**
9:00 – 9:45	**Key note address - Kristine Fallon, FAIA** ***Noted Author, AEC Technologies Expert***
10:00 – 10:45	**Rodd Merchant, P.E., SEAC President, Innovations in Construction** **Wayne Muir, P.E., Former SEAC President, Innovations in Design** **Topic:** Process Transformation Through Technology Adoption & Integrated Project Delivery This session will highlight how today's' project challenges are being solved through new and creative collaboration between structural engineers and contractors. Find out how structural engineers are utilizing BIM and alternative contracting methods to deliver superior project results. Also learn what to expect and what information contractors need and want. The session will wrap-up with a discussion about how technology will facilitate future collaboration between engineers and contractors.
11:00 – 12:00	**Legal Speaker - Tim Shulte, Attorney with Jackson Kelly, Innovations in Legal Concepts** **Topic:** Contract, Intellectual Property and Liability Issues That Arise With The Use of BIM.
12:00 – 1:00	**Lunch with Vendor**
1:00 – 1:45	**Stacy Scopano, Global Business Development Manager, Tekla Corporation** **Topic:** The 5 year Future of BIM - Stacy will address the 5 year outlook of working in the BIM environment. He will discuss the on-going developments in the software Indus try along with industry planning for further interoperability. This session is intended to provide insight to the engineering community for developing their current office practices and policies while looking ahead to upcoming advancements in the Indus-try.
2:00 – 2:45	**Vendor demonstration hour**
3:00 – 4:00	**Architect and Engineering panels** **Topic:** BIM in an Architectural Led Project - This session will be a panel discussion on the practical applications of BIM in an architectural led project. The panel will consist of Jeff Ambrose, Partner with H+L Architecture, Robert Alson, Manager of Design Engineering with H+L Architecture, J.R. Barker, Principal with Structural Consult ants Inc. and Ben Nelson, Principal with Martin/Martin Consulting Engineers. The discussion will be a brief presentation on the interactive BIM process with the Architect as the client and time for questions and answers with the participating audience.
4:00 – 5:00	**Social hour and vendor specials with beverages**

STRUCTURAL ENGINEERS ASSOCIATION OF COLORADO

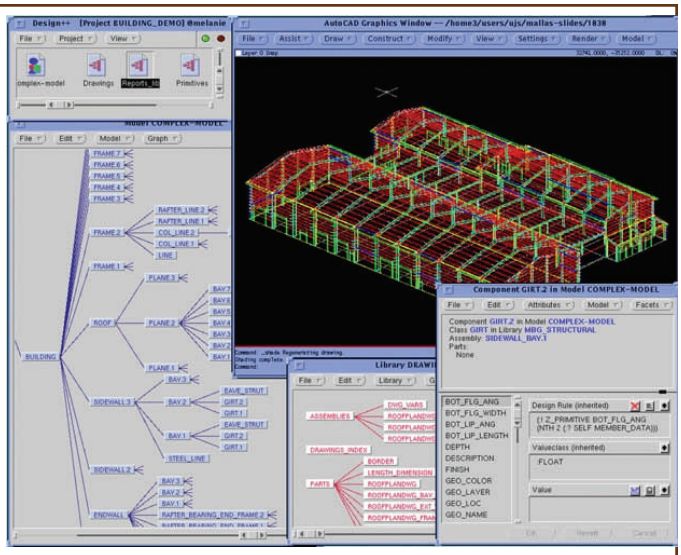
REGISTRATION FORM

2008 – SEAC FALL SEMINAR

COST:
$250.00/Members
$300.00/Non-Members

Send This form with PAYMENT To :
Attention: Caryn Bauer
SEAC
c/o Martin/Martin, Inc.
12499 West Colfax Avenue
Lakewood Co 80215

***Registration Form With Payment Must Be Received By:*
OCTOBER 10, 2008**



Company Name:			
Address:			
City, Zip:			
Phone No:			
Names of Attendees:		Fee Amount	Total

Equals to 0.7 CEUs or 7.0 PDH– CEU Certificate available at the Seminar