



Newsletter

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Message from the President



Cameron Kemp, P.Eng.
SEABC President

Think Globally (and get used to the chaos)

As I read the newspaper and other publications, watch TV, or go about my regular business day I'm continually struck by how global our world has become. Information exchange is instantaneous, events on the other side of the world ripple around the globe within minutes, the economies of the world are highly interconnected and competition is coming from companies, until a few short years ago, most of us had never even heard of.

We also seem to live in a state of constant turmoil whether it's being driven by the economy, technology, politics, religious ideologies, climate change or any of a number of other factors.

After the global economic meltdown of 2007/2008 and our slow recovery since I thought (and hoped) that by now, things would have settled back down to a steadier and more predictable state but that does not appear to be happening. I think what we are currently experiencing is going to be the rule rather than the exception.

As tumultuous as it appears, I think that North America is one of the most stable places we could possibly be; however, globalization has almost made borders and geographies irrelevant. For example Euro-Zone companies, as they look within their own borders and see limited opportunities, are looking globally for new markets, customers and opportunities. Canada, and Western Canada in particular (alright maybe not including Alberta as of recently) is seen as a bright spot on the world economic horizon. These companies, as well as many others from other regions of the world, are bringing money, people, intellectual property and drive to our part of the world.

Whereas previously we used to just compete amongst ourselves in our local market, we now find ourselves competing against firms with a global reach on a daily basis.

To succeed in this new environment we are going to have to think more globally:

- Perhaps firms arriving on our doorstep present collaborative opportunities as opposed to competition.
- We need to continually adopt technologies and tools to our advantage.
- We need to be much more aware of global factors and how they affect our local economies and markets.
- We need to adapt to the ever-increasing pace of change.
- We need to be cognizant of the fact that history has told us that work will go to people or places where it can be done less expensively.
- We need to foster innovation and leadership in creating new systems/technologies.
- We need to continue to develop engineers that have a holistic understanding of how they influence society – they need to be integrators and collaborative leaders.
- Before it's too late, we need to acknowledge that we live in a fragile ecosphere that can't continually absorb the abuse it receives without major consequences. I just heard on the radio that a highly respected and major scientific body believes that we should begin research on pumping sulphur into the atmosphere to simulate the global cooling effect of major volcanic eruptions as a means of getting global warming under control. If that isn't sobering I don't know what is.

We need to not only learn how to stay afloat in turbulent waters but swim strongly through them. Just staying afloat won't get us anywhere.

Whenever I speak with people from firms from around the world I'm often quite pleased to hear that they see Canadian engineers in a very positive light as being competent, well-trained, technologically savvy and collaborative.

We need to keep pushing on all of these fronts so that we can continue to survive and, in fact,

thrive in a highly competitive, turbulent and global economy. To quote one of the most memorable lines from the movie Apollo 13 "Failure is Not an Option".

We've got too much going for us already to fall behind and fail. We need the perspective to see the world clearly, the wisdom to know how to adapt to it and the courage to act decisively.

Engineering Images

We would like to start including some engineering images in our newsletter. Please submit your project images for future issues to newletter@seabc.ca

The image selected for this edition is of the Burrard Bridge Rehabilitation in Vancouver BC. (Associated Engineering)



Mission Bridge – Retrofit of Pier S4 with Ultra High Performance Fibre Reinforced Concrete (UHPFRC)



Katrin Habel P.Eng
Associated Engineering

Background

The Mission Bridge is a major bridge across the Fraser River connecting the District of Mission and the City of Abbotsford in the Lower Mainland (Figure 1). The 1125 m long bridge was built in 1973 and consists of 22 spans, including 11 post-tensioned concrete approach spans, eight steel I-girder approach spans, and a 310 m long three-span trapezoidal steel box-girder with an orthotropic-deck. All spans are supported on inclined-column concrete piers designed for foundation cost savings and appearance.



Figure 1: Mission Bridge.

Associated Engineering, with Klohn Crippen Berger, carried out a detailed seismic assessment in the early 2000's using evolving displacement-based methods. This confirmed that the bridge contained significant seismic deficiencies and was unable to withstand large earthquakes. Structural retrofitting and ground improvement were required to address seismically-inadequate detailing, liquefiable soils and lateral spreading, loss-of-span risk, and other seismic deficiencies. We used a displacement-based approach for seismic assessment. The resulting retrofit design included extensive ductility-enhancing pier retrofits, bearing replacement or elimination, restrainers and

seat extensions, expansion-joint elimination, and bridge re-articulation, as well as ground improvements near end fills and river banks. Extensive structural rehabilitation of the bridge was also carried out in conjunction with the seismic upgrades.

Liquefaction at Pier S4 at the south river bank

We recently addressed one of the remaining seismic retrofit issues. Geotechnical modelling had predicted significant lateral-spreading movement of the river bank of approximately 400 mm towards the river. Located at the south river bank, Pier S4 had been structurally retrofitted previously with Fibre-Reinforced Polymer (FRP) composite jackets and concrete dowels to increase shear capacity within plastic hinge regions and to address seismically-deficient column and pier cap reinforcing details (Figure 2).



Figure 2: Pier S4 (looking north-east) prior to retrofit with UHPFRC jackets.

Originally, the predicted liquefaction-induced movements were intended to be addressed with ground improvements to reduce the peak displacement, and this had been successfully done at the north river bank. However, a trial contract showed that ground improvements were less effective at the south bank due to loose soils extending to a deeper level than at the north bank. Therefore, structural solutions were re-considered for this pier. Possible solutions were to add piles to the foundation of Pier S4

or to increase the deformation capacity of the columns, beyond that achieved with the previously installed FRP jackets, to enable the pier to withstand the large ground deformation without causing collapse of the bridge. The design criterion adopted was to obtain longitudinal deformation capacity of the pier of about 800 mm, corresponding to twice the predicted displacement due to liquefaction. This option, which would require jacketing of the pier, was found to be the most cost-effective solution. This is a good example of a displacement-based approach to achieving a performance-based design specification.

While the FRP jacket and dowel retrofit applied in earlier phases had addressed shear enhancement in hinge zones, it did not provide significant additional confinement or sufficient deformation capacity to be able to sustain the predicted liquefaction movements. The cross-section of the rectangular pier columns was about 2.1 m by 2.5 m. FRP jackets are ineffective for confining columns of this size and an elliptical steel jacket or reinforced concrete jacket would have been needed to obtain adequate confinement. Column-jacketing philosophy is based on work by Priestley in the late 1980's and early 1990's. A gap is created between jacket base and pile cap to allow the column to hinge plastically. The jacket above confines the column above the localized hinge. Testing of such jackets, including half-scale tests done on the Oak Street Bridge pier columns, demonstrated that reliable, repeatable displacement-ductility capacities in the range of 10 to 12 were achieved – considerably greater than is assumed for the design of new columns. However, awareness of the visual obtrusiveness of elliptical steel or reinforced-concrete jackets at Pier S4 provided the incentive to develop a substantially thinner, more aesthetically pleasing jacket design. Accordingly, we proposed and designed an ultra-high performance fibre-reinforced concrete (UHPFRC) jacket, capable of providing sufficient confinement pressure and internal stiffness. Subsequently, the UHPFRC jacket design was tendered and constructed.

UHPFRC

UHPFRC is a fairly recent class of advanced cementitious materials with improved strength and durability properties when compared to normal strength concrete. UHPFRC typically exhibit elastic-plastic or strain-hardening characteristics under uniaxial tension and have a very low permeability due to their dense matrix. UHPFRC traditionally consist of cement,

silica fume, fine quartz sand, superplasticizers and steel fibres with water/binder-ratios ranging between 0.15 and 0.25. UHPFRC mixes that are site-cast without heat or pressure treatment typically have a compressive strength of about 150 MPa to 170 MPa; a secant modulus of 45 to 50 GPa; and a tensile strength in the range of 6 to 10 MPa. The tensile behaviour of the material is strongly influenced by the amount and type of steel fibres used. UHPFRC is typically self-compacting. The advantageous tensile behaviour of UHPFRC allows for large energy-dissipation capacities within the material, which is further increased by the embedded reinforcing bars. Moreover, the fibres embedded in the UHPFRC significantly reduce spalling under dynamic or cyclic loading.

UHPFRC Jacket for Pier S4

For the Mission Bridge pier, the project team designed a 225 mm thick UHPFRC jacket. We detailed 15M reinforcing bars, spaced at roughly 230 mm in both directions in the UHPFRC to increase column-core confinement and energy-dissipation capacity. The addition of reinforcing bars improves crack localization, leads to the formation of a larger number of closely-spaced cracks, and increases the post-cracking stiffness of the jacket. The reinforcing bars also prevent premature failure of the jacket by formation of a single localized crack. To the project team's knowledge, this application of UHPFRC for a seismically-confining jacket of a large rectangular column was the first worldwide.

There are currently no test results or research data available for using UHPFRC for seismically retrofitting columns of this size. Accordingly, we adopted a cautious approach to the design, which did not fully rely on the tensile capacity of the UHPFRC. The UHPFRC used for the project was Ductal, supplied by Lafarge, and incorporated 12 mm long thin and straight steel fibres at 2% by mass. The addition of fibres resulted in a marginally strain-hardening material under bending. Since this was the first application of UHPFRC for the BC Ministry of Transportation and Infrastructure, a UHPFRC trial was successfully carried out to simulate placement at the bridge site and to obtain material specimens for compression, bending and shrinkage tests.

Jacket Construction

The first construction step was to remove the existing FRP wrap, and roughen the surfaces of the existing concrete where new concrete or UHPFRC was to be

installed. Following the preparatory work, the pier pedestal was strengthened with traditional reinforced concrete in order to force hinge formation under a seismic event to occur in the gap left at the bottom of the columns. The cross-section at the bottom of the column was also weakened by creating a notch and cutting selected longitudinal bars to capacity-protect the column and pedestal. Dowels were embedded into the existing column and into the UHPFRC jacket to tie the UHPFRC jacket to the column, and to increase and stiffen the confinement (Figure 3). Reinforcing bars were installed, and finally the UHPFRC was cast into the formwork.



Figure 3: Pier S4: Column preparation with sandblasting and installation of dowels.



Figure 4: Casting of UHPFRC jacket.

The UHPFRC was mixed at the Lafarge plant in Abbotsford and transported to site in a traditional concrete truck. Casting of the self-compacting UHPFRC was carried out with traditional means with a bucket as shown in Figure 4. Quality control tests for fresh UHPFRC flow and for compressive tests were carried out for the UHPFRC for each truck load.

Conclusion

The installation of the UHPFRC jacket was carried out smoothly without any construction issues on site. The UHPFRC for both columns was cast in one day. This innovative solution provided a relatively unobtrusive retrofit for Pier S4 (Figure 5), which is aesthetically pleasing and cost-effective when compared to other alternatives. The UHPFRC jacket design reliably addresses the large pier movement expected due to be caused by liquefaction-induced ground displacement. This retrofit was the final phase of the \$20M seismic safety retrofit of the Mission Bridge and brought the project to a successful conclusion.

The project team for the Pier S4 UHPFRC jacket retrofit consisted of Don Kennedy, Katrin Habel, Mingyu Li and Grant Fraser from Associated Engineering.



Figure 5: Finished UHPFRC retrofit of Pier S4.

Committee Reports

Communications Committee



David Harvey, P.Eng.,
Struct.Eng.
Director SEABC

We much appreciate our members contributing articles or photographs to the newsletter describing their professional activities or interests. Working to inform readers about our engineering designs or research helps raise our professional profile, and may help inspire others to follow suit. Contributions from structural engineers are always interesting and we want to see more. Please keep sending in your submissions- we look forward to hearing from you. Kindly send information for publication to:

newsletter@seabc.ca

– We'll definitely try to include as many submissions as we can!

Young Members Group



Grant Fraser, P.Eng.
YMG Chair

The YMG is pleased to announce that Grant Fraser has been elected as the YMG organizing committee chair. Grant is a bridge engineer with Associated Engineering, and has been a member of the committee in various capacities since 2010. He is excited to take on more responsibility, and continue to work with the other committee members to build upon the success of the YMG in 2015.

Kate Thibert will be stepping down from her role on the committee to pursue other exciting opportunities in the community. Kate is currently a member of the EERI Housner Fellows Program, and

sits on the board of directors for the EERI BC Chapter. Kate was one of the founding members of the YMG, and has volunteered countless hours of her time to help shape the group and enable us to reach our current level of success. We would like to sincerely thank Kate for her contributions and leadership, and wish her every success in her future endeavours. Kate, you are always welcome at YMG events, particularly those where you can show off your bowling skills!

Vancouver Island Branch



Thor Tandy, P.Eng Struct.Eng
Branch Chair

Mission

To provide a focal point for SEABC members on the Island to meet, discuss SEABC issues and to take benefit in the form of exchange items of technical interest.

2015 Branch Delegates

Branch Exec: Thor Tandy, Leon Plett, Ima Rahmanian (currently on maternity leave), Martin Turek (when available.)

Inter-Branch Liaison as best we can: Meagan Harvey, Lee Rowley

Branch Demographic

- Members in the local Victoria, Gulf Islands area.
- A central Island group centred on the Nanaimo, Port Alberni area.
- A small North Island group.
- Demographic to be reviewed and references with respect to events etc.

Events

No events of significance for this period.

Proposed Events

- Maintain communications with Education Committee to review convenience of mirror events on the island.
- Relevant webinars, lecture tours. We intend to ensure that the local membership receive general notification.

Member Participation

- We plan to encourage members to submit comment and suggestions to the VI Branch.
- The membership would then have better ownership of Branch affairs and begin to guide executive considerations and decisions.

Contacts

Victoria/Gulf Islands:	Executive
Central Island:	Lee Rowley
North Island:	Ralph Watts
Okanagan:	Meagan Harvey

On the Web



Stephen Pienaar, P.Eng.
Webmaster

The Communications Committee aims to provide members with relevant and up-to-date content through our website, newsletter and email broadcasts. None of this would be possible without the efforts of many volunteers. We are especially grateful to the Education Committee (who works tirelessly to provide monthly seminars and workshops), the Professional Practice and Technical Committees (who offer up their personal time to research and compile reports on current issues) and

the Young Members Group (who empowers young engineers to make their mark). These volunteers make the Communications Committee look good!

A few highlights of 2014

- The year closed with a total of 884 active members.
- The online library of seminar and workshop material is growing steadily. We now have 24 have video recording of evening seminars and workshops. Members-only access to video recordings and seminar handouts is available at www.seabc.ca/seminar-downloads.
- The Directory of Structural Engineering Firms has grown to 65 listings. If your firm is not yet listed, you are missing out. Add it at www.seabc.ca/corporate.

Looking ahead at 2015 – SEABC website refresh

Work on a new SEABC website started in spring of 2014. The purpose of the website refresh is more than a mere face-lift: it is a significant upgrade of the back-end that will enable more volunteer involvement (enable stakeholders to maintain website sections and events directly) and improve members' experience. The upgrade proved to be more complex than anticipated and we missed our initial target implementation date in September. If all goes to plan, we will complete work on the new website during the quieter summer month and go live in August.

Staying in touch

- Bookmark the SEABC home page for a quick glance at what is happening: www.seabc.ca
- Follow us on Twitter: www.twitter.com/SEABC
- Encourage non-member colleagues to join our mailing list: www.seabc.ca/maillinglist

IStructE News



Bill Alcock, P.Eng. Struct.Eng.
MISTructE.

Director SEABC

As the SEABC Representative on the IStructE Council, and Chair of the Institution's International Interest Group, I am very pleased to report on the meetings held at the Institution of Structural Engineers in London on January 23, 2015, in its newly renovated headquarters at 47-58 Bastwick Street, London.

International Interest Group (IIG)

Education and Membership Director, Darren Byrne, reported that, over the next year, the Institution plans on reviewing all countries worldwide with the intention of establishing more Regional Groups and encouraging the use of the Chartered Membership exam as a basis for qualification. The Institution currently offers membership in China and Singapore using existing exams from those countries as the base, and providing a supplementary IStructE exam and interview. The supplementary exams are different in both countries. The Institution is expecting to establish a similar supplementary exam route in Malaysia in 2015.

Darren reported that, in Hong Kong, an ongoing dispute between HKIE and IStructE over recognition of qualifications is moving towards resolution. In India there are a number of pockets of IStructE members; however, there is no single Regional Group. The Institution is hoping to resolve this situation during an upcoming presidential visit to India in 2015. The Institution will be also holding a major International Conference in Singapore on Sept 3 & 4, 2015 and welcomes all visitors. Because it is the only body of engineers that has representation from all over the world, a unique opportunity has been identified for the Institution. We believe there is a significant opportunity to act in a coordinating role, worldwide, to ensure that seismic design codes, research and post-event evaluation of structures are consistent, relevant and that there is not duplication of effort. Similar opportunities exist in wind and

climate change engineering. More discussion on these topics will follow at our next meeting.

Council Meeting Highlights

At the beginning of the Council meeting, the incoming President, Dr. Tim Ibell, thanked outgoing President, Nick Russell, for an outstanding year in which, amongst other things, Nick presided over the move into the Institution's newly renovated building. The new building will greatly enhance the Institution's operations and, with its state-of-the-art IT system, international participation in conference calls will be much improved. Nick then handed over the "green baton" to the new President, Dr. Tim Ibell, symbolizing that Tim has now taken over the reins.

CEO Martin Powell followed with a couple of announcements:

- A new quarterly "Structures" magazine on structural research will soon be launched.
- A new booklet, entitled "Building Confidence", explaining the role of structural engineers to clients with small structural projects (such as home renovations) will be launched in May 2015. This information will also be available on the Institution's website.

Staff Directors Darren Byrne and Tina Cardy then led a discussion over the need to develop further diversity and inclusion within the Institution.

Currently there are:

- More than 16% retired members (and growing)
- 10% female
- 25% Graduates and Young Members

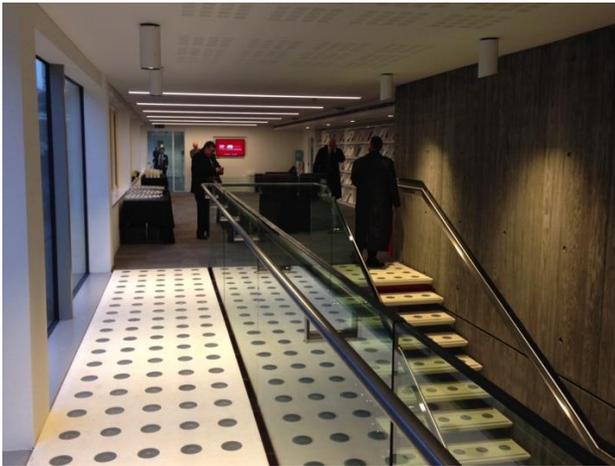
A lively discussion ensued largely around the need to encourage more retiring members to take an active role in the Institution or as mentors, and the need to encourage more Young Members to participate in IStructE activities. A survey of recently retired members and their willingness to participate was recommended.

President's Inaugural Address:

Dr. Tim Ibell gave a very enthusiastic presentation on his academic life and passion for teaching:

Dr. Ibell's recent research at the University of Bath has focused on the use of fabric formwork to provide concrete where it is most needed, and not where in areas concrete stresses are low. As a result, fabric formwork permits the development of highly efficient concrete structures resulting in unique, beautiful and economical shapes.

Academically, Tim is very passionate about the need for engineering students to develop their creative side, something that he is deeply concerned is missing from most engineering educations. Tim believes many engineers enter university with curious minds and find that their thought processes are channelled into solving boring, unexciting problems. He firmly believes there is much more we could be doing to develop the curiosity and excitement so necessary to encourage the future structural engineers of this world.



Stylish Interior of new Institution Headquarters Building



Presidential Handover Ceremony: L-R: Vice President Alan Crossman; President Tim Ibell; Past President Nick Russell; Vice President Ian Firth; and Vice President Mike Cook.



International Connections: President Tim Ibell relaxes after his inaugural address with Council Member Bill Alcock from Canada to the left, and Council Member Glenn Bell from the US to the right.

2015 Executive Board – Candidates for Elections

	<p>Perry Adebar, Ph.D. P.Eng. University of British Columbia.</p> <p>Professor in the Department of Civil Engineering at the University of British Columbia, Perry has served as a Director of SEABC for two years. If elected, he will continue to serve in that capacity.</p>
	<p>Bill Alcock, P.Eng. Struct.Eng.</p> <p>Bill is Vice President, Engineering and Quality Management for Sacré-Davey Engineering, and a former director and chair of the Division of Structural Engineers. Bill has served as a Director of SEABC for four years and if elected, will continue to serve in that capacity.</p>
	<p>David Davey, P.Eng. SE (Past President)</p> <p>Formerly with the company he founded, Sacre-Davey Engineering, David was the founding President of the SEABC, and served in that position for two years. He is the current Past President and if elected, will continue to serve in that capacity.</p>
	<p>Paul Fast, P.Eng. Struct.Eng.</p> <p>Managing Partner with the firm he founded, Fast + Epp Structural Engineers, Paul has served as a Director of SEABC for five years and if elected, will continue to serve in that capacity.</p>
	<p>Grant Fraser, P.Eng</p> <p>A bridge engineer with Associated Engineering, Grant is the incoming chair of SEABC’s Young Members Group. He has been involved with the Young Members Group since 2010. If elected, Grant will serve as a Director.</p>
	<p>Tejas Goshalia, P.Eng. SE</p> <p>A Senior Associate with Stantec, Tejas has served as a Director of SEABC for two years and currently chairs its Education Committee. If elected, he will continue to serve as a Director.</p>
	<p>Adrian Gygax, P.Eng. Struct.Eng.</p> <p>A Principal with with his own firm, Gygax Engineering Associates Ltd., Adrian has served as a Director of SEABC for five years and if elected, will continue to serve in that capacity.</p>

	<p>David Harvey, P.Eng. Struct.Eng.</p> <p>A Principal with Associated Engineering, David was a founding Director of the SEABC and currently chairs its Communications Committee. If elected, he will continue to serve as a Director.</p>
	<p>Cameron Kemp, P.Eng. LEED AP (Serving President)</p> <p>A Principal and Chairman of Omicron Canada Inc. Cameron was a founding Director of the SEABC. Currently serving as President, Cameron has served in that position for four years and if elected, will continue to serve in that capacity.</p>
	<p>Kitty Leung, P.Eng. Struct.Eng.</p> <p>Manager, Structural Engineering, with WSP Canada Inc's Vancouver office, Kitty is an incoming member of the SEABC Board. If elected, she will serve as a Director.</p>
	<p>Surinder Parmar, P.Eng. PMP</p> <p>Manager- Portfolio Capital Projects with BC Hydro, Surinder was a founding Director of the SEABC and has served as Secretary/Treasurer since its inception. If elected, he will continue to serve as a Director.</p>
	<p>Kevin Riederer, P.Eng.</p> <p>Project Structural Engineer with Read Jones Christoffersen Ltd., Kevin is an incoming member of the SEABC Board. If elected, he will serve as a Director.</p>
	<p>Andrew Seeton, P.Eng.</p> <p>A senior structural engineer with Glotman Simpson Consulting Engineers, Andrew was a founding Director of the SEABC and former chair of its Education Committee. If elected, he will continue to serve as a Director.</p>
	<p>John Sherstobitoff, M.Sc., P.Eng.</p> <p>A Principal with Ausenco, John has served as a Director of the SEABC for one year. If elected, he will continue to serve as a Director.</p>

Recent Seminars and Events

So You Think You Can Give a Seminar?



Tyler Best EIT
Young Members Group
Committee

On the evening of Wednesday, February 18th, the SEABC Young Members Group welcomed a modest group of attendees to UBC Robson Square for the fourth installment of our popular "So You Think You Can Give A Seminar?" Presentation Competition. Four young engineers, one P.Eng., one E.I.T., one Ph.D. student and one undergrad, each took to the stage to give a short presentation on a topic of their choosing. In addition, our 'Distinguished Guest', John Sherstobitoff of Ausenco, took us through an amusing and inspiring reflection of his career and the plethora of lessons he has learned along the way. A big thank you to everyone who was able to attend and help make for another successful evening, particularly our competitors, guest speaker and judges!

Roxanne Duigou, an undergrad student at Camosun College, came out on top with her enlightening presentation "Polystyrene Building Blocks: A Triple Bottom Line Approach to Addressing Several of Haiti's Most Pressing Challenges". As our first participant from outside of the Lower Mainland, we are excited to see interest brewing abroad as the event continues to gain traction! Roxanne is looking forward to returning to Vancouver to attend the SEABC Annual General Meeting on the evening of March 4th, where she will accept her \$1000 grand prize and give her winning presentation once again for those who were unable to attend the Competition.

The Call for Applicants for next year's competition is set to go out in late fall of this year so keep your ear

to the ground if you're interested in participating. We strongly encourage any young engineers to apply – not only does it allow you to present something that you are passionate about and work on your public speaking skills, but it is also a great opportunity to gain some exposure for yourself and your affiliates. If that doesn't quite do it for you, there's also the enticing cash prize...

The main event of our next installment will take place in late February 2016, so mark your calendars and we hope to see you there!



Competition winner, Roxanne Duigou, Camosun College



2015 Competition participants and judges

The Great Northern Concrete Toboggan Race



Tim Abbott, P.Eng.
TGCTR Organiser

The 41st annual Great Northern Concrete Toboggan Race (GNCTR) descended upon Kelowna from January 21 to 25th, 2015 and saw over 430 Engineering students from across Canada complete for sledding glory. Students on teams from 17 Universities and Colleges from across Canada (and one from the US) competed during this four day competition which included judging and a Technical Exposition at UBC Okanagan, and the downhill portion of the competition at Big White Ski resort. The University of Calgary was the winner of race day and the overall competition, while UBC Okanagan placed second overall.



U of C Team at the hill (Photo Credit Ryan Mandau)



UBC Okanagan Team (Photo Credit Ryan Mandau)



Winning University of Calgary Team – (Photo Credit John Roxas)



UBC Vancouver Team at the Start Line (Photo Credit Ryan Mandau)

A Practical Guide to Wood-Frame Design: Lumber Beams



Joel A. Hampson, M.A.Sc., P.Eng., LEED AP

This article focuses on the practical flexural and shear capacities of dimension lumber beams. Since the dawn of construction lumber has been used to span horizontal distances (such as beams, headers, stingers, joists and rafters) and lumber remains ubiquitous on construction sites today. Recent innovations in engineered wood products (EWP) have introduced stronger and stiffer beams (such as parallel strand lumber, laminated veneer lumber and laminated strand lumber) though solid-sawn lumber remains readily available and commonly used.

Shown below in Table 1 are the specified bending and shear strengths for lumber. These are taken from a worst-case combination of Doug-Fir, Hem-Fir & S-P-F species for grade No. 2—as discussed in “A Practical Guide to Wood-Frame Design: Lumber Properties”.

Table 1 - Strengths for No. 2 Grade lumber¹

System	Bending at extreme fibre, f_b	Longitudinal shear, f_v
SI, MPa	10.0	1.5
Imperial, psi	1450	220

To calculate flexural and shear capacities, “O86-09: Engineering design in wood” specifies modification factors to account for wood properties and lumber applications. Most factors are unity for most day-to-day designs:

- Load duration, K_D , is usually “Standard term”²
- Service condition, K_S , is usually “Dry”³
- Preservative & fire treatment, K_T , is usually “Untreated”⁴

The system factor, K_H , accounts for the capacity to distribute local failures to neighbouring members; it can be greater than one and is considered below in the tabulated capacities.

$$F_b = f_b(K_D K_H K_S K_T)$$

$$F_v = f_v(K_D K_H K_S K_T)$$

¹ “A Practical Guide to Wood-Frame Design: Lumber Properties” by J.A. Hampson, SEABC Newsletter, August 2014, Volume 27,

² “O86-09: Engineering design in wood” by the Canadian Standards Association, 2010, Table 4.3.2.2

³ Ibid, Table 5.4.2

⁴ Ibid, Table 5.4.3

These factored strengths are used with the elastic analysis equations for rectangular cross-sections in order to find the factored bending-moment and shear capacities. The bending and shear calculations also require modification factors; again some factors are unity for most day-to-day designs. The lateral stability factor, K_L , is taken as unity⁵; the rationale for this is that the maximum aspect ratio (for 2X12) is 7.5, member ends should be restrained (by blocking or nailing) and bridging /blocking should be provided at 82" on-centre⁶. "O86-09: Engineering design in wood" specifies a net area, A_n , to account for notches, but it is not practical to allow for notches on site: they propagate splitting, will inevitably be over-cut and be taken as licence to notch where not specified; therefore, the un-notched cross-sectional area, A , is used to determine the factored shear resistance. The size factor for bending, K_{zb} , and shear, K_{zv} , account for the higher probability of natural defect occurrence (like knots, wane, shake, slope of grain, etc.) in larger sections; they are the same factor, K_z , for these equations and are shown in Table 2.

$$M_r = \Phi F_b S K_z K_L$$

$$V_r = \Phi F_v \frac{2A}{3} K_z$$

Table 2 - Size factor for visually stress-graded lumber⁷

Name	Size factor, K_z
2X4	1.7
2X6	1.4
2X8	1.2
2X10	1.1
2X12	1.0

Table 3 shows the capacities for single-ply lumber beams. All factors are taken as unity except for the Size Factor.

Table 3 - Single ply

Name	Breadth, in (mm)	Depth, in (mm)	Moment of inertia, in ⁴	Unit weight, plf	Aspect ratio	Factored moment resistance, lb-ft	Factored shear resistance, lb
2X4	1.5 (38)	3.5 (89)	5.4	1.1	2.3	566	1165
2X6	1.5 (38)	5.5 (140)	21	1.7	3.7	1152	1508
2X8	1.5 (38)	7.25 (184)	47	2.3	4.8	1715	1703
2X10	1.5 (38)	9.25 (235)	99	2.9	6.2	2560	1992
2X12	1.5 (38)	11.25 (286)	178	3.6	7.5	3442	2203

⁵ Ibid, Clause 5.5.4.2

⁶ "National Building Code of Canada" by the National Research Council of Canada, 2010, Division B, Clause 9.23.9.4

⁷ "O86-09: Engineering design in wood" by the Canadian Standards Association, 2010, Table 5.4.5

Table 4 shows beams as part of a system. The wood-frame floor—joist—and roof—rafter—systems often meet the following minimum criteria thus qualify for a Case 2 system factor⁸: members at less than 24” on centre sheathed with at least 3/8” plywood that is connected with 2” COMMON nails at 6” on centre. Vibration of floor joists should be checked, but that is beyond the scope of this article.

Table 4 - Joist or rafters with sheathing ($K_H = 1.40$)

Name	Breadth, in (mm)	Depth, in (mm)	Moment of inertia, in ⁴	Unit weight, plf	Aspect ratio	Factored moment resistance, lb·ft	Factored shear resistance, lb
2X4	1.5 (38)	3.5 (89)	5.4	1.1	2.3	793	1631
2X6	1.5 (38)	5.5 (140)	21	1.7	3.7	1612	2111
2X8	1.5 (38)	7.25 (184)	47	2.3	4.8	2401	2385
2X10	1.5 (38)	9.25 (235)	99	2.9	6.2	3583	2789
2X12	1.5 (38)	11.25 (286)	178	3.6	7.5	4819	3084

Tables 6 & 7 show the capacity or built-up (multiply) beams. Built-up plies should be nailed together for better lateral restraint⁹ and to improve their ability to share loads; it is sufficient to specify all built-up lumber be connected with two 3” nails at 6” on-centre for each ply. Additional fasteners should be added where built-up beams support other flush transfer-beams, and for this reason it is not practical to use more than triple-ply beams; if more is required then consider specifying an EWP. Built-up beams have their own system factor¹⁰.

Table 5 - Double ply ($K_H = 1.10$)

Name	Breadth, in (mm)	Depth, in (mm)	Moment of inertia, in ⁴	Unit weight, plf	Aspect ratio	Factored moment resistance, lb·ft	Factored shear resistance, lb
2·2X4	3.0 (76)	3.5 (89)	11	2.2	1.2	1246	2563
2·2X6	3.0 (76)	5.5 (140)	42	3.5	1.8	2534	3317
2·2X8	3.0 (76)	7.25 (184)	95	4.6	2.4	3774	3748
2·2X10	3.0 (76)	9.25 (235)	197	5.9	3.1	5631	4383
2·2X12	3.0 (76)	11.25 (286)	355	7.1	3.8	7572	4846

⁸ Ibid, Table 5.4.4

⁹ Ibid, Clause 5.5.4.2.2

¹⁰ Ibid, Table 5.4.4

Table 6. Triple ply ($K_H = 1.10$)

Name	Breadth, in (mm)	Depth, in (mm)	Moment of inertia, in ⁴	Unit weight, plf	Aspect ratio	Factored moment resistance, lb·ft	Factored shear resistance, lb
3·2X4	4.5 (114)	3.5 (89)	16	3.3	0.8	1869	3845
3·2X6	4.5 (114)	5.5 (140)	63	5.2	1.2	3801	4975
3·2X8	4.5 (114)	7.25 (184)	142	6.9	1.6	5660	5621
3·2X10	4.5 (114)	9.25 (235)	296	8.8	2.1	8446	6575
3·2X12	4.5 (114)	11.25 (286)	533	10.7	2.5	11,358	7269

Joel A. Hampson, MAsc, PEng, LEED AP, practices structural engineer in Vancouver. Scott Ash-Anderson, BSc, EIT, helped him prepare this article.

While the authors have tried to be as accurate as possible, they cannot be held responsible for the designs of others that might be based on the material presented in this article. The material covered in this article is intended for the use of professional personnel who are competent to evaluate the significance & limitations of its content & recommendations and who will accept the responsibility for its application. The authors and the sponsoring organizations disclaim any and all responsibility for the applications of the stated principles & values and for the accuracy of any of the material presented in the article.



Court Decision Increases Design Duty to Third Parties



Rob McLeod, CIP, CAIB
Metrix Professional Liability
Insurance Broker

On July 3, 2014, the California Supreme Court issued its highly anticipated decision that has opened the door for design professional liability to third parties for purely economic damages, even where there is no contractual relationship and no property damage or bodily injuries. The Court did so even though the design firm's agreement expressly disclaimed the existence of any "third-party beneficiary of the obligations contained in the Agreement". The Supreme Court observed that despite this clause, the architects provided services "knowing that the finished product would be sold as condominiums".

The underlying claim involved a 595-unit condominium project. The developer treated the project as for-rent apartments for two years before selling units to the public. After the units were sold, the condo owner's association complained of water infiltration, cracked drywall, inadequate firewall separation and-- most importantly-- solar heat gain, which made some units periodically uninhabitable. At its core, this issue arose from multiple programming and "value engineering" modifications that ultimately created a problematic condition in some units.

Cameron B. Elder, a lawyer with Harper Grey LLP who chairs the firm's construction and engineering practice group in Vancouver, BC, discussed with us the recovery of economic loss in Canada and commented on a six step strategy to prevent assuming a design duty to third parties:

- Using the intended beneficiary clause
- Drafting a closed and limited scope of services
- Assuming limited & allocated construction roles
- Warning the client of value engineering modifications

- Seeking contractual separation
- Recommending outside review.

For additional information on this or other matter related to liability insurance, you can contact me at:

rmcleod@mpib.com

Nominate a Colleague



David Harvey, P.Eng.
Struct.Eng
Director SEABC

Do you have a deserving colleague that has contributed strongly to the profession and/or the community? Is that person serving as a role model and inspiring others? If so, consider nominating him/her for the 2015 President's Awards, recently announced by APEGBC – B.C.'s premier awards for professional engineers. To nominate an individual, you will need to prepare a letter of nomination, or support for a nomination, outlining that person's outstanding achievements.

The President's Awards include awards for meritorious achievement; community service; professional service; young professionals; and the R.A. McLachlan Memorial Award – BC's top award for professional engineers. Nominations must be received by Friday April 10th 2015.

Full details of the awards and the nomination procedures are available at:-

www.apeg.bc.ca/Awards-Nomination

Nomination packages should be submitted to:

www.awards@apeg.bc.ca

For further information or assistance on any aspect of the APEGBC President's Awards, contact Laurel Buss at:- lbuss@apeg.bc.ca

Mark Your Calendar

Upcoming Seminars and Courses

Risk Drivers, Professional Liability Education Seminar/AGM

Date: March 6th 2015

Presenter: Rob McLeod & Mike Russell, Metrix Professional Insurance Brokers

Venue: Charles Room, 11th Floor, 555 Burrard Street, Vancouver, BC, V7X 1M9

Time: 9:15 am

Sponsor: Metrix Professional Insurance Brokers

Registration: Rob McLeod 604-629-2680 or rmcleod@mpib.com

CSCE One-Day Course: CSA-S-06 Canadian Highway Bridge Design Code (New Edition)

Date: Spring 2015

Venue: Vancouver

Registration: Please email: csce.vancouver@gmail.com to be informed as soon as event date and registration becomes available

ACI Spring Seminar: Extending the Service Life of Concrete Structures

Dates: May 29th 2015

Venue: Italian Cultural Centre

Time: 8:30-4:00pm

More Information: See flyer at end of newsletter

SEA Northwest Conference

Date: July 16th-18th 2015

Venue: Boise, Idaho

More information: See flyer at end of newsletter

Upcoming Industry Events

2015 SEAOC Convention

Date: September 9th – 12th 2015

Venue: Hyatt Regency, Bellevue, Washington

Abstracts Deadline: March 9th 2015

Call for Papers: www.informationandsubmission

More information: www.conventionwebsite

2015 Wood Design Awards

Date: March 2nd 2015

Venue: Vancouver Convention Centre-West

More Information: www.conferenceabstracts

Engineering Essentials for Timber Design Workshop

Dates: March 26th 2015 (Victoria) March 27th 2015 (Vancouver)

Venues: Delta Ocean Pointe, 45 Songhees Road, Victoria and Pacific Gateway Hotel, Vancouver Airport, 3500 Cessna Drive.

More Information: www.conferenceabstracts

Final Words

Editorial Information

The SEABC Newsletter is published by the Structural Engineers Association of British Columbia. The current and past issues are available on the SEABC website at www.seabc.ca.

The Newsletter is edited and managed by the SEABC Communications Committee.

- Committee Chair: David Harvey
- Newsletter Editor: Catherine Porter
- Webmaster: Stephen Pienaar

Submissions are welcomed and all SEABC members are encouraged to actively contribute to the Newsletter. Submissions, letters to the Editor, questions and comments can be sent to: newsletter@seabc.ca.

The Committee reserves the right to include or exclude submitted material and in some cases edit submitted material to suit overall space requirements. If content is not to be edited, please advise so at submission time.

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Advertising

Pre-paid rates per edition:

- \$270 (quarter page), \$360 (half page) or \$450 (full page) plus GST. Rates include a banner advert on the Events page of the SEABC website.
- 50-word "Available for Employment" ads are free.

Please address advertising enquiries to: newsletter@seabc.ca.

Please support our advertisers!

SEABC Annual General Meeting, Dinner & Presentation



Date:	Wednesday March 4, 2015
Venue:	Sutton Place Hotel, 845 Burrard Street, Vancouver
Time:	5:30pm
Cost:	\$40+GST (SEABC Members), \$100+GST (Non-Members)
AGM:	Address from SEABC President and 3-course dinner
Keynote:	Chris Wise, RDI, FEng, FICE, HonFRIBA, MStructE Director, Structural Engineer at Expedition Engineering, London, UK
Registration:	www.seabc.ca/agm or use attached mail-in form

Keynote Presentation:

“They took a dead heap of stones.....”

*Jacob Bronowski in The Ascent of Man
Describes Gothic cathedrals as,
“Man’s superb synthesis arising out of an analysis of nature”.*

*His words lift the spirits
Cue up something about the way engineers design,
Our motivations and emotions involved,
From anger through despair,
Heading off to joy – always our Hope!*

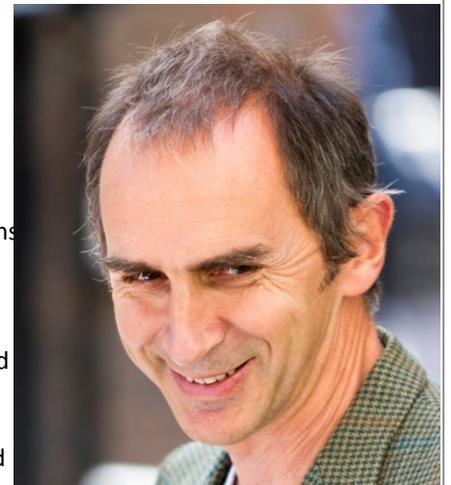
*If at first you don’t succeed -
The engineer’s interaction to this day
With the natural world and the humans within,
An ancient tale, that today’s engineers hold in Trust.*

*Let’s amble down that beaten path,
Together with **Chris Wise**,
And rekindle the core roots of –
Our world we call - Structural Engineering.*

Chris Wise is the Director and Structural Engineer at Expedition Engineering in London, UK. He co-founded Expedition in 1999, after a successful career with Arup - becoming their youngest director. Expedition has a trail-blazing ethos and runs as part of the Useful Simple Trust, an employee-benefit trust without human shareholders, which Chris chairs.

Either as design lead or with many of the world’s leading architects including Rogers, Foster, Hopkins and Renzo Piano, Chris is the guiding hand on the engineering of many projects including the 2012 Olympic Velodrome (IStructE Supreme Award-2012); American Air Museum, Duxford; Barcelona Bullring; London Millennium Bridge; Barcelona Communications Tower; Channel 4 HQ, London, Las Arenas Barcelona. According to Richard Rogers, “Chris thinks like an artist and acts like an engineer”.

In academia, Chris has been design professor first at Imperial College, London, then Yale, and since September 2012, at UCL, London. He served for 9 years as a Trustee for the Design Council. He was Master (President) of the RSA’s Royal Designers from 2007 to 2009, a position once held by Barnes Wallis. He is a Fellow of the Royal Academy of Engineering, and of the Institution of Civil Engineers, and an Honorary Fellow of the RIBA. In October 2012 he was awarded an unprecedented double, winning Gold Medals for outstanding contribution to engineering profession from both the IStructE and the ICE.





Structural Engineers Association of British Columbia

Mail-in Registration Form:
AGM, Dinner, & Presentation
March 4, 2015

You can also register online!
www.seabc.ca/agm
(secure credit card payment via PayPal)

Contact Information:

Name of Company or Individual _____
(Receipt will be issued in this name to email provided below)

Street Address _____ City, Province _____ Postal Code _____

Telephone _____ Email (receipt will be issued to this email address) _____

Registration Fees:

REGISTRATION DEADLINE February 28, 2015

Name(s) of Attendee(s)	SEABC Membership Number (Required for Member discount)	SEABC Member \$40	Non-Member \$100	Fees
1. _____	_____	<input type="checkbox"/>	<input type="checkbox"/>	\$ _____
2. _____	_____	<input type="checkbox"/>	<input type="checkbox"/>	\$ _____
3. _____	_____	<input type="checkbox"/>	<input type="checkbox"/>	\$ _____
4. _____	_____	<input type="checkbox"/>	<input type="checkbox"/>	\$ _____
5. _____	_____	<input type="checkbox"/>	<input type="checkbox"/>	\$ _____
6. _____	_____	<input type="checkbox"/>	<input type="checkbox"/>	\$ _____

Check one box per attendee

Three-course plated dinner is included.
Please indicate any special dietary requirements.

SUBTOTAL: \$ _____

ADD 5% GST \$ _____

TOTAL (PAYMENT ENCLOSED) \$ _____
Cheque payable to SEABC

Please make cheque payable to SEABC
Mail this form and cheque to:
SEABC
#201-288 West 8th Avenue
Vancouver, BC V5Y 1N5
[Contact: agm@seabc.ca](mailto:agm@seabc.ca)

Registration will be confirmed via e-mail. Registration cannot be guaranteed if received after February 27, 2015.
An administration fee of \$25 will apply to any cancellations received by February 27, 2015. No refunds given after February 27, 2015.

Save the Date!



- ✓ **Up to 12 PDH's**
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- ✓ **Happy Hour!**
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- ✓ **Gifts!**
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- ✓ Water Event

✓ **Fun for the Entire Family!!**

Now accepting Exhibitor applications and Sponsors!
For more information go to SEAlIdaho.org



2015 Spring Seminar

“Extending the Service Life of Concrete Structures”

Date of Seminar – Friday, May 29, 2015

Time - 8:30 am – 4:00 pm

Location = Italian Cultural Center

Prices: Members- \$325 + GST
Non Members - \$365 + GST
Students - \$145 + GST

6 sessions are approximately 50 min per presentation. Planned Topics include:

- Common Causes of Concrete Cracking – Repair Techniques and Materials
- What Every Structural Engineer Should Know about Concrete
- Differences between Service Life Models
- Current Lab Testing Methods

Day also includes a small trade show with 10 – 12 vendors on site

Lunch, Coffee and Snacks and all presentations on a memory stick is included.

**The Vancouver Geotechnical Society
A Local Section of**

**The Canadian
Geotechnical Society**



**La Société canadienne
de géotechnique**

CALL FOR ABSTRACTS

**23rd Symposium of the Vancouver Geotechnical Society
Marriott Pinnacle Vancouver, June 12, 2015
Topic: Soil Structure Interaction**

The 23rd Symposium of the Vancouver Geotechnical Society (VGS) will focus on the topic of Soil Structure Interaction and be held at the Marriott Pinnacle Hotel, on Friday, June 12, 2015. The organizing committee believes it is timely to address the behavior of structures in response to various soil conditions and improve collaboration between structural and geotechnical engineers.

Abstracts are called for papers which draw attention to the particular challenges associated with design where the interaction of the structural and geotechnical elements are of significant importance. As such, we encourage the submission of papers addressing recent case-histories, construction challenges, design, modeling, and/or any submission which may be thought relevant to the topic of Soil Structure Interaction. We also invite submissions concerning any engineering activity of particular note in the Lower Mainland.

The symposium is anticipated to consist of the following events:

1. A Keynote Lecture by Dr. Ahmed Elgamal of UC San Diego presenting on pile group interaction;
2. Technical sessions that would allow the presentation of 6 to 8 papers;
3. Panel discussion;
4. Exhibitors displays;
5. A hosted lunch, and coffee breaks.

Abstracts should not exceed 500 words and be sent to the Symposium Chair by February 27, 2015.

Contact Information:

Marc Bosse – Symposium Chair
c/o Thurber Engineering Ltd.
900 – 1281 West Georgia Street
Vancouver, B.C. V6E 3J7

Tel. 604-684-4384
Fax. 604-684-5124
email: mbosse@thurber.ca