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CANADIAN CIVIL ENGINEER
L'INGÉNIEUR CIVIL CANADIEN
2017 | MAY/MAI

- Mosquito Creek Bridge
- Toronto joins 100 Resilient Cities
- Evaluating sustainability of public infrastructure
- Life cycle analysis of tall buildings: wood vs. concrete

CSCE Annual Conference – Vancouver

SUSTAINABLE INFRASTRUCTURE | LES INFRASTRUCTURES DURABLES

Congrès annuel de la SCGC – Vancouver

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On the cover: Vancouver skyline (photo: Destination British Columbia)

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We are all an Important Part of the Sustainability Conversation

The pace of civil engineering in Canada continues to increase in a dynamic economic climate. This trend is consistent around the world and in all sectors of the economy. In times like these, it is even more critical to assess our circumstances, focus on priorities, and execute on targeted action plans.

Day-to-day we can become consumed with the details of our work and the pressures of timelines and budgets. It is important that we always keep in the back of our minds the "big picture," and why we do what we do. The reality is that all civil engineers are focused on the same core issue: sustainability.

The challenge for civil engineers is that the sustainability of our built environment depends on many factors and includes all of the disciplines within civil engineering. Each research field and topic plays an important role in addressing a particular sustainability challenge that requires intense and detailed work to resolve. It is easy, therefore, to lose sight of our overarching objective: building sustainable community and infrastructure assets.

The role of the CSCE is to highlight to our members and the public HOW and WHY all aspects of civil engineering play a critical role in the sustainability conversation. This leads back to communication, which was the topic of my previous CCE article. As a technical society, we must be objective in our approach to communication, but this still leaves us with many opportunities to inform all infrastructure, government, and public stakeholders. Case studies and project descriptions are an example of this approach and appeal to a broad audience. The CSCE uses this tool to inform our stakeholders about the role of civil engineering in our communities.

Technical diversity is one of the exciting and challenging aspects of Civil Engineering. During busy times, it is critical to remember the ties that bind our diverse technical interests together. Sustainability is one of these ties. The sustainability conversation presents a fantastic opportunity for all of us to highlight relevant civil engineering accomplishments, new innovations, industry initiatives, and projects that demonstrate leadership in sustainable infrastructure.

I am looking forward to moving the sustainability conversation forward at the 2017 Annual Conference in Vancouver. I hope to see you there! ■

PASSIONATE ABOUT SUSTAINABILITY?
Please consider helping spread the word by volunteering with the CSCE. Please contact me or the National office at your convenience to discuss further.

LA DURABILITÉ EST VOTRE PASSION ?
Venez nous aider à passer notre message en devenant bénévole pour la SCGC.Veuillez me contacter personnellement ou encore le Bureau national pour en discuter plus en détail.

Nous avons tous quelque chose à apporter à la discussion sur la durabilité

Le rythme du génie civil au Canada continue de s'accroître dans un climat économique en pleine évolution. Cette tendance se retrouve partout sur la planète et dans tous les secteurs de l'économie. Dans des périodes comme celle-ci, il est encore plus primordial d'évaluer les circonstances, de mettre l'accent sur les priorités et d'avancer en respectant les plans d'action visés.

Au jour le jour, nous pouvons nous retrouver submergés par les détails de notre travail et la pression des échéances et des budgets. Il est important que nous gardions tous à l'esprit le « portrait global » et que nous ne perdions pas de vue la raison pour laquelle nous faisons ce que nous faisons. La réalité est que tous les ingénieurs civils se concentrent sur le même enjeu central : la durabilité.

Le défi des ingénieurs civils est que la durabilité de notre environnement bâti dépend de plusieurs facteurs et inclut toutes les disciplines du génie civil. Chaque sujet et domaine de recherche joue un rôle important en faisant face à un défi de durabilité particulier nécessitant un travail intense et détaillé pour résoudre le problème. Il est ainsi facile de perdre de vue notre objectif d'ensemble : bâtir une collectivité et des infrastructures durables.

Le rôle de la SCGC est de démontrer à nos membres et au public COMMENT et POURQUOI tous les aspects de l'ingénierie civile jouent un rôle primordial dans la discussion sur la durabilité. Cela nous ramène à la communication, qui était le sujet de mon précédent article de la revue CIVIL. En tant que société technique, nous devons être objectifs dans notre approche à la communication, mais cela nous laisse tout de même plusieurs occasions d'informer tous les intervenants publics, le gouvernement et les infrastructures. Les études de cas et les descriptions de projet sont des exemples de cette approche et font appel à une audience élargie. La SCGC utilise cet outil pour informer nos intervenants sur le rôle de l'ingénierie civile dans nos collectivités.

La diversité technique est l'un des aspects les plus stimulants et complexes du génie civil. Durant les périodes occupées, il est primordial de se rappeler les liens qui unissent nos divers intérêts techniques. La durabilité est l'un de ces liens. La discussion sur la durabilité présente une fantastique occasion pour nous tous de mettre de l'avant les réalisations pertinentes de l'ingénierie civile, les innovations, les initiatives de l'industrie et les projets qui démontrent du leadership en infrastructures durables.

J'ai bien hâte de faire avancer la discussion sur la durabilité au cours du congrès annuel 2017 de Vancouver. J'espère vous y rencontrer ! ■

CSCE LEADERSHIP IN SUSTAINABLE INFRASTRUCTURE: FIVE ADVOCACY POSITIONS

1. Innovative Procurement Practices
2. Long-Term Investment Planning
3. Measure Sustainable Performance
4. Leverage Asset Management Processes
5. Sustainability Education

LEADERSHIP DE LA SCGC EN MATIÈRE D'INFRASTRUCTURES DURABLES : CINQ PLAIDOYERS STRATÉGIQUES

1. Pratiques d'approvisionnement novatrices
2. Planication à long terme des investissements
3. Mesurer le rendement durable
4. Utiliser au mieux des processus de gestion des actifs
5. Enseignement de la durabilité

CSCE TECHNICAL DIVISIONS:

- Environmental
- Engineering mechanics/materials
- Structures
- Cold regions
- Hydrotechnical
- Transportation
- Construction

→ Innovations to Achieve Sustainable Community and Infrastructure Assets

DIVISIONS TECHNIQUES DE LA SCGC :

- Environnement
- Mécanique appliquée et génie des matériaux
- Structures
- Régions froides
- Hydrotechnique
- Transports
- Construction

→ Des innovations pour bâtir une communauté durable et réaliser des infrastructures

Exciting times in the Western Region

Dinu Philip Alex
VP WESTERN REGION, CSCE

The 2017 CSCE Conference in Vancouver will mark the completion of my two terms as Vice President for the Western Region. During the 4 years, I have had the opportunity to visit the sections and see how they have embraced the strategic directions and incorporated them in developing programs, engaging professionals and students, and growing the young professionals.

2016 Highlights and 2017 Outlook

Calgary: The Calgary section has had an exciting past year putting on several mixers, site visits, and hosting presentations. The highlight was a speaker from Parks Canada who provided perspective on how infrastructure in our public parks is very different than urban infrastructure. The section's annual popsicle stick bridge competition is one that engages students and has gained significant interest from several post-secondary institutions. The 2017-2018 season is focusing on streamlining communications and using social media to reach a wider audience, and thereby attracting more members.

Edmonton: If there is one thing this section is not short on, it's the number of events they put on in a given year, ranging from dinner meeting presentations, young professional events, sponsor mixers and contests that involve both the students and the industry. With the great support they get from the industry, the Edmonton section agreeably might be considered one of the stronger sections. Sustainable projects around recycling, transportation, infrastructure, building great neighbourhoods, and the Fort McMurray fire develop a strong program, while events like the curling funspeil, technical tours, billiard tournaments and BBQ mixers help draw the young professionals. The outlook looks bright and only aims to challenge the norm for this section.

Des moments stimulants dans l'Ouest

Dinu Philip Alex
V-P, RÉGION DE L'OUEST, SCGC

Le congrès 2017 de la SCGC à Vancouver marquera la fin de mes deux mandats comme vice-président de la région de l'Ouest. Au cours de ces quatre années, j'ai eu l'opportunité de visiter les sections et de constater comment elles ont adopté les orientations stratégiques et les ont intégrées dans l'élaboration de leurs des programmes, suscitant l'engagement des professionnels et des étudiants et favorisant l'accroissement du nombre des jeunes professionnels.

Faits saillants de 2016 et perspectives pour 2017

Calgary : La section de Calgary vient de vivre une année excitante portée par plusieurs rencontres de réseautage, des visites de sites et la tenue de diverses présentations. Le principal fait saillant fut un conférencier de Parcs Canada qui a fait état des différences entre les infrastructures des parcs publics et l'infrastructure urbaine. Le concours annuel de la section sur les ponts en bâtons de sucettes glacées suscite énormément l'intérêt des étudiants ainsi que celui de plusieurs établissements postsecondaires. La saison 2017-2018 mettra l'accent sur la rationalisation des communications et l'utilisation des médias sociaux afin de rejoindre une plus large audience et ainsi attirer davantage de membres.

Edmonton : S'il y a une chose dont cette section ne manque pas c'est bien le nombre d'événements qu'elle organise au cours d'une année. Ces activités englobent des présentations lors de soupers-rencontres, des activités des jeunes professionnels, du réseautage avec des commanditaires et des concours qui impliquent autant les étudiants que l'industrie. Grâce à l'excellent soutien qu'elle reçoit de la part de l'industrie, la section d'Edmonton peut certainement être considérée comme l'une des sections les plus solides. Des projets durables portant sur le recyclage, les transports, les infrastructures, le développement d'excellents quartiers et l'incendie de Fort McMurray ont permis d'élaborer un programme solide, alors que des événements comme le Curling Funspeil, les tournées techniques, les tournois de billard et les barbecues de réseautage aident à attirer les jeunes professionnels. L'avenir est prometteur, ce qui semble devenir la norme pour cette section.

Victoria / Île de Vancouver : Historiquement, cette section a toujours jumelé ses soupers-rencontres occasionnels avec d'autres organisations et dépend beaucoup des tournées nationales de conférences. La section prévoit plusieurs présentations techniques pour les membres, portant sur des sujets d'intérêt local, incluant le thème potentiel

Victoria/Vancouver Island: Historically, this section has always linked its occassional dinner meeting programs with other organizations and has depended on the National Lecture Tours. The section plans to initiate several technical presentations for members, with topics of local interest, including a potential topic on "Sustainable Cities". With a new Young Professional executive on board as well, the section hopes to further enhance the connection with the UVic student chapter and provide ongoing support to the student chapter.

Vancouver: This section presented four technical presentations with the highlight being the Envision project presented by Stantec. The student chapters have been the bright spot for the section with the BCIT chapter being awarded the best chapter at the CSCE 2016 London Conference. The section is looking forward to providing better services to members through reduced rates for events, enhanced collaboration between student chapters and young professionals through joint social events, and an infrastructure funding debate.

The preparations for the CSCE 2017 Vancouver conference are in full swing, Every effort is being put towards making this one of the largest conferences that the CSCE has ever done. This will also be the first conference that will be spearheading a new conference model that is primarily hosted through the national office with support locally. The conference is also unique in the sense that the Vancouver and Victoria sections come together as hosts with support from the Western Region.

I look forward to being part of this conference, and I'm excited to see the conference help springboard the two sections in British Columbia to fully develop themselves as sections with a full fledged program and have the industry support.

These are exciting times for the CSCE and in particular the Western Region. There is a lot happening with the CSCE as we play a more significant role as influencers and establishing ourselves as Leaders in Sustainable Infrastructure. ■

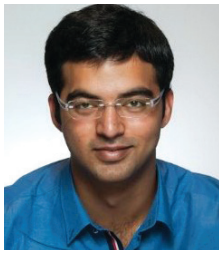
des « Villes durables ». Avec son nouveau responsable des Jeunes professionnel, la section espère améliorer le lien entre le chapitre étudiant de l'UVic et fournir un support continu au chapitre étudiant.

Vancouver : Cette section a organisé quatre présentations techniques, dont le fait saillant fut le projet Envision, présenté par Stantec. Les chapitres étudiants ont été le point fort de la section avec le chapitre de BCIT qui a reçu le prix du meilleur chapitre étudiant lors du congrès 2016 de la SCGC à London. La section cherche à offrir de meilleurs services à ses membres, en réduisant le prix de ses événements, en améliorant la collaboration entre les chapitres étudiants et les jeunes professionnels grâce à des événements sociaux conjoints et en organisant un débat sur le financement des infrastructures.

Les préparatifs du congrès 2017 de la SCGC à Vancouver vont bon train. Chaque effort vise à faire du congrès 2017 l'un des plus importants congrès que la SCGC aura organisés. Ce sera également le premier congrès a être organisé principalement par le Bureau national, avec un soutien local. Le congrès est aussi unique en ce sens que les sections de Vancouver et de Victoria sont les coorganisatrices avec le soutien de la région de l'Ouest.

J'ai bien hâte de prendre part à ce congrès et suis stimulé par le fait qu'il servira de tremplin aux deux sections de la Colombie-Britannique leur permettant de se développer à part entière avec un important programme d'activités avec l'appui de l'industrie.

Nous vivons des moments stimulants pour la SCGC et en particulier pour la région de l'Ouest. Il se passe beaucoup de choses à la SCGC et nous devenons un acteur influent et un leader en infrastructures durables. ■



Annual CSCE 2017 Conference – Student Activities

Raghav Grover, MASc., EIT.
CHAIR STUDENT COMPETITIONS
COMMITTEE CSCE 2017

The student competitions committee for the CSCE Annual Conference 2017 has put together a stimulating program this year giving an opportunity to students to showcase their Capstone projects, research, and a platform to interact and exchange ideas. The events planned for this year are:

Student Papers Competition: This presents an opportunity for students to share the results of their research projects. This year, the competition will be held on a specialty conference basis, meaning each of the four specialty conferences will be recognising the top student papers.

National Civil Engineering Design Capstone Competition: The fifth annual CSCE National Capstone Design Competition will be held on June 2nd between 9 - 11 AM. Accredited Canadian civil engineering programs are invited to submit a nomination for a single entry into the competition in any specialty area of the field for projects completed during the 2016-17 academic year. Two students from each team will present their project in a poster session before a jury.

National Student Chapters Leaders Workshop: This workshop provides a stimulating platform for incoming CSCE Student Chapter leaders from across Canada to interact and exchange ideas. The workshop will address topics such as keys to a dynamic student chapter, member recruitment and retention strategies, finances and fundraising strategies, member and faculty participation, setting SMART chapter goals and action plan, and the roadmap to becoming the best student chapter.

Student Awards Luncheon: Celebrating the achievements of students from across the country, this event also offers an excellent networking opportunity for students. Nearly 400 conference attendees participated in this event in London last year. Some of the awards will include the President's Awards for Outstanding Student Chapters, Best National Capstone Design Awards, Best Student Paper Awards, and Awards for the Canadian National Concrete Canoe, Canadian National Steel Bridge, Great Northern Concrete Toboggan and Troitsky Bridge Building Competitions.

Please visit http://csce2017.ca/young-professionalsstudents/ for more information and registration. ■

Congrès 2017 – Activités étudiantes

Raghav Grover, MASc., EIT
PRÉSIDENT DU COMITÉ DES CONCOURS
ÉTUDIANTS DE LA SCGC - 2017

Le comité des concours étudiants du congrès annuel de la SCGC 2017 a élaboré un programme stimulant cette année, donnant l'opportunité aux étudiants de présenter leurs projets Capstone, d'effectuer de la recherche et d'utiliser une plateforme pour interagir et échanger des idées. Les événements prévus cette année sont :

Le concours de communication étudiante : Ce concours représente l'occasion pour les étudiants de partager les résultats de leurs projets de recherche. Cette année, le concours aura lieu sur la base d'une conférence spécialisée, ce qui signifie que chacun des quatre conférences spécialisées rendra honneur aux meilleures communications étudiantes.

Concours national de conception Capstone en génie civil : Le 5e concours national de conception Capstone de la SCGC se tiendra le 2 juin 2017, de 9h à 11h. Les programmes accrédités de génie civil au Canada sont invités à soumettre une candidature pour une inscription au concours dans n'importe quelle spécialité en ingénierie pour des projets réalisés au cours de l'année universitaire 2016-2017. Deux étudiants/étudiantes de chacune des équipes candidates présenteront leur projet lors d'une séance d'affiche devant jury.

Atelier national des dirigeants des chapitres étudiants : Cet atelier fournit une plateforme stimulante pour les dirigeants des chapitres étudiants de la SCGC de partout au Canada qui seront présents afin d'interagir et de partager des idées. L'atelier traitera de sujets tels que les clés d'un chapitre étudiant dynamique, le recrutement des membres et les stratégies de rétention, les stratégies financières et de collecte de fonds, la participation des membres et du corps professoral, l'établissement d'objectifs et de plans d'action intelligents, ainsi que la feuille de route pour devenir le meilleur chapitre étudiant.

Dîner de remise des prix étudiants : Célébrant les réalisations des étudiants et étudiantes à travers le pays, cet événement offre également une excellente occasion de réseautage. Près de 400 congressistes ont participé à cette activité l'an dernier, lors du congrès de London. Certains des prix incluront le Prix du président pour le meilleur chapitre étudiant, les prix du Concours national de conception Capstone, les Prix des meilleures communications étudiantes, ainsi que les prix du Concours national de canoë de béton, du Concours national de pont en acier, de la Grande course nordique de toboggan de béton et du Concours de construction de ponts Troitsky.

Veuillez visiter http://csce2017.ca/young-professionalsstudents/ pour plus d'informations et pour vous inscrire. ■

CSCE 2017 Vancouver Conference – Young Professional Program at-a-Glance

Stanley A. Chan, M.Eng., EIT
CSCE 2017 VANCOUVER CONFERENCE, YOUNG PROFESSIONALS COORDINATOR

The CSCE 2017 Young Professional Program Subcommittee worked closely with the Student Program Subcommittee in creating a cohesive Young Professional and Student Program. The Young Professional Program focus is on the needs and interests of both practicing young professionals and engineering students, featuring professional development, networking and mentorship opportunities. The Young Professional activities cater to those under the age of 35 or with less than 10 years of engineering experience, but we strongly encourage the participation of all members regardless of age - as long as you are young at heart and are committed to growing with youth!

Wednesday, May 31st

- President's Reception
- The Amazing Race Vancouver & Steamworks Brewing Pub Social (ticket purchase required)

Thursday, June 1st

- Student Paper Competitions (Thursday – Friday)
- YP Session - Career Planning Panel (email RSVP)
- YP Mentorship Workshop (email RSVP)
- Big Rock Brewery Tour & Dinner (ticket purchase required)

Friday, June 2nd

- Student Paper Competitions (Thursday – Friday)
- YP Panel Discussion – 4 Pillars of Sustainability (email RSVP)
- National Civil Engineering Design Capstone Competition
- Student Awards Luncheon
- National Student Chapter Leaders Workshop
- Night out at Gastown Vancouver (email RSVP)

Saturday, June 3rd

- YP Bike Tour (email RSVP)

Please visit the YP/Student page of the conference website for more information and instruction on RSVP and ticket purchase. http://csce2017.ca/young-professionalsstudents/

Be sure to RSVP or purchase tickets soon to secure your spot at the Young Professional Activities. ■

Vancouver – Congrès 2017 de la SCGC – Aperçu du programme des JP

Stanley A. Chan, M.Eng., EIT
COORDONNATEUR DES JEUNES PROFESSIONNELS, CONGRÈS DE LA SCGC, VANCOUVER 2017

Le sous-comité du programme des jeunes professionnels 2017 de la SCGC a travaillé en étroite collaboration avec le sous-comité du programme étudiant en créant un programme homogène pour les étudiants et les jeunes professionnels. Le programme des jeunes professionnels met l'accent sur les besoins et les intérêts autant des jeunes professionnels que des étudiants en génie, mettant ainsi à l'avant-plan des occasions de perfectionnement professionnel, de réseautage et de mentorat. Les activités des jeunes professionnels répondent aux besoins des moins de 35 ans ou ayant moins de 10 années d'expérience en ingénierie, mais nous encourageons fortement la participation de tous les membres, peu importe leur âge, du moment que vous êtes jeune de cœur et avez envie de croître avec les jeunes !

31 mai

- Réception du président
- Course Amazing Race Vancouver et soirée sociale au Steamworks Brewing Pub (achat de billets obligatoire)

1er juin

- Concours de communications papier étudiantes (jeudi et vendredi)
- Session JP - Panel de planification de carrière (RSVP par courriel)
- Atelier de mentorat JP (RSVP par courriel)
- Tournée et souper BigRock Brewery (achat de billets obligatoire)

2 juin

- Concours de communications papier étudiantes (jeudi et vendredi)
- Panel de discussion JP - Les 4 piliers de la durabilité (RSVP par courriel)
- Concours national de conception Capstone en génie civil
- Dîner de remise des prix étudiants
- Atelier national des dirigeants des chapitres étudiants
- Soirée à Gastown Vancouver (RSVP par courriel)

3 juin

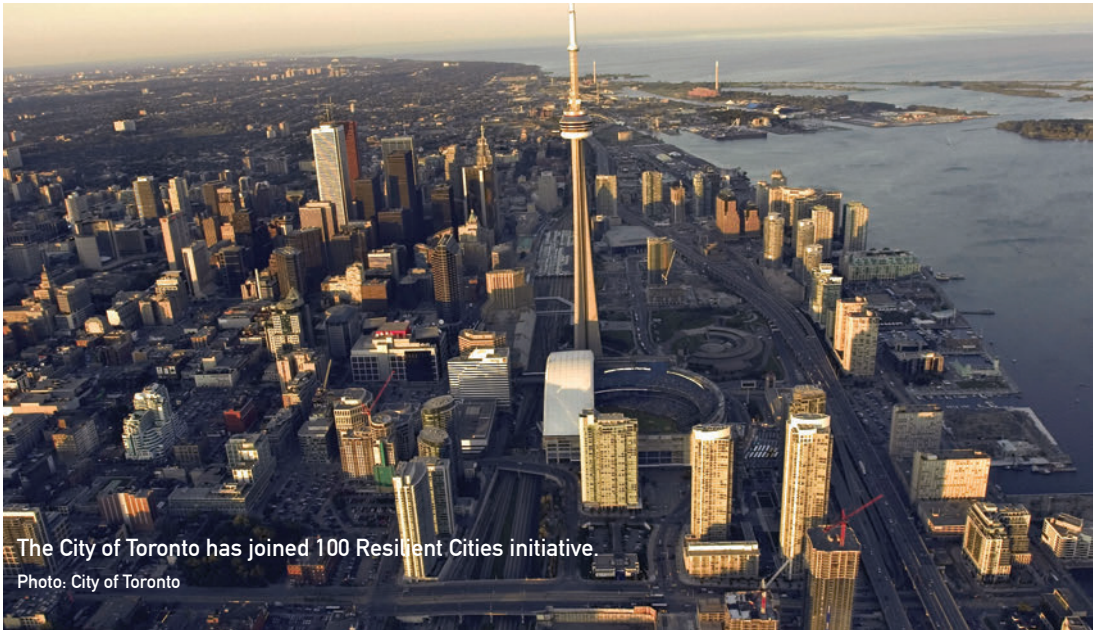
- Promenade à vélo des JP (RSVP par courriel)

Veuillez visiter la page des JP/étudiants du site Web du congrès pour davantage d'informations et de directives sur les réservations et l'achat de billets. http://csce2017.ca/young-professionalsstudents/

Assurez-vous de réserver ou d'acheter vos billets le plus tôt possible afin de ne pas manquer les activités des jeunes professionnels. ■

Toronto to lead Global City Innovation by developing and implementing a World-Class Integrated Resilience Strategy

By Peter Hall and Shawn Allen, Amec Foster Wheeler



The City of Toronto has joined 100 Resilient Cities initiative.
Photo: City of Toronto

Toronto is the latest Canadian city to join 100 Resilient Cities, an initiative pioneered by the Rockefeller Foundation, dedicated to building "urban resilience" in cities around the world.

In doing so, Toronto joins ranks with Calgary, Vancouver and Montreal in a firm commitment to finding innovative solutions to some of its biggest challenges. The city needs this level of commitment to prepare for the shocks and stresses of the twenty-first century – threats that impact the economic viability and standard of living in all our cities. An integrated and collaborative resilience strategy led by 100 Resilient Cities will provide Toronto with the tools, resources, and network required to be at the forefront of city resilience, leverage other city best-practices and embed a resilience lens to future city projects.

Part of preparing for urban stresses means finally tackling infrastructure and public transportation challenges Toronto has been facing for years. This is an item that Toronto Mayor John Tory is grappling with and has tried to address through a planned toll regime on the Don Valley Parkway and the Gardiner Expressway. However, since Ontario's Premier blocked the mayor's plan to toll the city's two main expressways, Mayor Tory has now requested financial support from the province for both expressways, as well as the city's massive transit system and its crumbling public housing.

Funding failing infrastructure and underdeveloped public transportation is just one of the myriad challenges Toronto faces as a thriving metropolis. By joining 100 Resilient Cities, the city is taking major steps towards getting in front of these challenges. The original target for the network is 100 cities around the world, but the ultimate goal is to use proven models to help 10,000 cities make effective resilience planning a part of their DNA.

Chief Resiliency Officer

A required component of the 100 Resilient Cities model is the Rockefeller Foundation funded Chief Resiliency Officer – a public official dedicated to developing a defined process tailored to the needs of the city. In Toronto's case, this means building on the city's existing resilience-related efforts to address economic inequality, aging infrastructure, building transit to encourage all modes of transportation, and preparing for potential impacts of extreme weather such as ice storms and flooding. These are stresses that add up over time to erode a city's economic viability, and lead to bigger problems. The Chief Resiliency Officer may be a relatively new concept to a lot of cities, but in a decade it will be just as common as hiring a Chief of Police.

When it comes to resilience planning there's a lot to keep track of, particularly when our cities are run by dozens of departments, each with its own priorities. A significant aspect of the Chief Resiliency Officer's job is about connectivity and helping siloed government agencies to work and plan together, and scaling up existing disaster

planning to meet a city's actual needs.

In additional to institutionalizing resilience into the fabric of city operations, it's also about connecting Toronto to other cities that deal with similar shocks and stresses, and learning from best practices developed in other parts of the world. Atlanta, Georgia, for example, has a strained transportation system which has led to excessive traffic congestion and introduced new challenges such as poor air quality and social cohesion. In November, Atlanta voters approved two transportation funding tax increases to expand and enhance the city's Beltline and Metropolitan Atlanta Rapid Transit Authority (MARTA) bus and rail lines in an attempt to mitigate infrastructure challenges.

There are a number of advantages to having a dedicated person responsible for integrating resilience into the planning process for different city departments thereby saving costs and increasing effectiveness. With a Chief Resilience Officer at the helm, his or her efforts can reduce excess spending caused by redundancy, create the opportunity to apply for grants and lead to an increase in overall productivity among other things.

Planning

The case for resilience planning is well laid-out and once strategies and plans are identified, these projects can be implemented by various stakeholders in both the public and private sector. For example, in Los Angeles, engineering firm Amec Foster Wheeler is working on a feasibility study that will develop an infrastructure vulnerability framework to support a component of the city's resilience strategy.

In New York City, the firm is also developing a materials management dashboard tool that will integrate several NYC agencies and support infrastructure projects that are part of that city's resilience strategy. Projects like these demonstrate the full value of having an integrated approach to sustainability and resilience.

Cities are extremely complex ecosystems which are faced with political, social and economic challenges. But they are also increasingly the preferred way to organize our societies and drive our economies. The reality is that, like Toronto, Atlanta and New York City (along with other leading cities), we're seeing more municipalities worldwide opting for new ways to fund important resilience strategies.

Right now, more than 50 per cent of the global population lives in cities, and by 2050 this is expected to increase to 70 per cent. By planning to protect our cities, we will protect our livelihoods, and ultimately ourselves. By establishing international networks, cities can share best practices, support each other and collaborate where possible. Ensuring that resiliency is taken into consideration every step of the way, we give ourselves a better chance to deal with whatever comes our way. ■

When it comes to resilience planning there's a lot to keep track of, particularly when our cities are run by dozens of departments, each with its own priorities.

Peter Hall is a global sustainability and climate change resiliency lead for Amec Foster Wheeler and director of the firm's partnership with 100 Resilient Cities. He is an Alliance for Water Stewardship and Environmental Management Systems certified professional.

Shawn Allan is currently the manager of the Met-Ocean Services group at Amec Foster Wheeler, overseeing teams in met-ocean weather forecasting, climate consulting, oceanography, and information management. He has a Master's Degree in Atmospheric Science.

National Historic Civil Engineering Sites

Each year at the CSCE annual conference the Society's National History Committee selects a site or project from the region in which the conference is being held as a National Historic Civil Engineering Site. Through this program the committee aims to make the general public and engineers themselves more aware of the rich history and heritage of Civil Engineering in Canada.

A commemoration ceremony is held during the CSCE conference, and a plaque is placed on the chosen site in a place that is readily visible to the public. Since the program began in 1983, 66 national, international and regional sites have been designated.

The National Historic Site to be commemorated at this year's conference is the Mosquito Creek Bridge in North Vancouver. The following history of the bridge is by one of our most distinguished CSCE Fellows, who was closely involved in both the design and construction of the bridge.

MOSQUITO CREEK BRIDGE

History of the design, construction, and impact of Mosquito Creek Bridge – North Vancouver.

By Ramsay Murray, P.Eng. FCSCE

In 1951, A.B. Sanderson P. Eng., Assistant Chief Bridge Engineer of B.C. Highways Department, was considering the design of a new bridge over Mosquito Creek. The crossing was located just downstream from the point where the steep profile down the side of the mountain flattened to cross the delta to the shoreline.

The bridge site was located on Marine Drive in a well-developed residential and business area which made it very difficult to raise the grade of the street. The width of the waterway was also restricted. Any attempt to deepen the creek would only result in deposition of the gravels which were continually washed down in storm conditions. It called for a very shallow bridge and an overhead truss was undesirable.

At that time, the B.C. Department of Public Works decided to install some prestressed girders in some of their schools using the services of C. L. van der Brandeler, a Dutch engineer, who had worked with Eugène De Fressinet on prestressed design in Europe. [De Fressinet, the French structural and civil engineer was a major pioneer of prestressed concrete.]. He was, at the time, designing the roof for the power chamber tunnelled into the mountain at Kemano for the generating station to power Alcan's (now Rio Tinto Alcan's) Kitimat aluminum smelter.

Sanderson was a brilliant mathematician and set up 20 simultaneous equations – one for each of the twenty stringers – in order to determine the load sharing under AASHO design loads so that he might design the prestress for the lateral diaphragms at the third points. This was before the wide spread use of computers when a finite element analysis would have easily solved his problem.

Later in 1956, he brought the first computer to Vancouver, a Bendix G15, and used it to design the 805 feet fixed arch for the Alexandra Bridge in the Fraser Canyon. The programming had to be entered in machine language. He saved 10 per cent of the steel he would have used had he re-used the design methods for the Niagara Gorge Bridge.

One of his concerns on the Mosquito Creek Bridge stringers was that the stringers should have ultimate design strengths similar to the time tested steel wide-flange beams.

He calculated that the ultimate capacity should be 1.1 Dead Load + 4.4 Live Load. It is interesting to note that AASHO later adopted a criterion very close to this. It is little wonder that there is an annual award for excellence in structural analysis in the name of A. B. Sanderson.

It was this ultimate strength concern that led to a full scale test to destruction of one stringer. The test was carried out at the yard of the B. C. Concrete Company, the fabricator, under the direction of Keith Douglas, P. Eng., their engineer.

The test was instrumented and observed by Jim Asser, P. Eng. of the B.C. Research Council, who installed instrumentation including the then new SR 4 strain gauges together with

Mosquito Creek Bridge, North Vancouver

a hydraulic jack system.

In the event, the stringer deflected 9 inches at mid-span with no visible signs of distress and to 21 inches before failure in shear. The stringer met the ultimate strength criteria.

I may say that while everybody was observing the stringer behaviour I was watching the test rig closely, as I had designed it.

I was also able to do a bit of international knowledge transfer. The concrete mix had been supplied by the BC Highways Test Laboratory, and the first test was coming up just over 3000psi, standard for the concrete of the day, but we required strengths of over 5000psi.

I had trained with the City of Birmingham and part of my training included a time in their testing laboratory. Their mix design was based on the gradation system of the British Department of Scientific and Industrial Research. When I applied this method I discovered that the sand content was too high and, with little change in cement content, we regularly achieved over 5000psi.

In 1956, B.C. Concrete supplied the prestressed stringers for the 1077 feet long, six lane north approach to the Second Narrows Bridge. An important factor in the transport of prestressed stringers is to ensure that they are always supported at the ends. While the last stringer at Second Narrows was being transported from the area where it had been cast on site, the supporting wheels at one end ran into soft ground and the dolly twisted sideways, causing the stringer to explode. The whole casting bed had to be reassembled to cast one stringer. Many stringers have been fabricated for bridges and buildings across British Columbia and Canada. ■

(Photos: Evan Huang)

Sustainable Infrastructure | Les Infrastructures durables

May 31–June 3, 2017 | 31 mai – 3 juin 2017 | Vancouver, BC.

Kenedee Ludwar, P.Eng.
DIRECTOR, TRAFFIC AND HIGHWAY SAFETY ENGINEERING

Welcome to CSCE 2017 Vancouver

If you haven't already, register today for what is sure to be one of the best conferences of the year. Set in beautiful Vancouver, British Columbia, the Local Organising Committee is pleased to invite you to the CSCE Annual Conference taking place from May 31 to June 3, 2017.

The city of Vancouver, located between English Bay and the Fraser River, is the hub of the Lower Mainland of British Columbia. The metropolitan area offers a vibrant cultural and entertainment scene in a beautiful natural setting, including the world famous Stanley Park. And located near Vancouver are tourist destinations such as Victoria, Whistler and the Gulf Islands.

This year's conference theme, 'Leadership in Sustainable Infrastructure' aligns with the CSCE strategic direction and includes specialty conferences in Mechanics and Materials, Environmental, Hydrotechnical, and Construction.

This year's program includes technical presentations, tours, social events, and an incredible Young Professional and Student program. For the first time, we are proud to present a new First Nations Speaker Series. This event will provide a forum for interaction between First Nation community leaders, civil engineers and other infrastructure professionals.

The 2017 CSCE Annual Conference will be hosted at the Westin Bayshore Hotel. Accommodations are available at the Westin Bayshore where we have negotiated special rates for attendees. A variety of activities are being planned to entertain conference delegates and their guests. Early June is a lovely season to explore our beautiful and diverse city and the surrounding communities.

Don't forget to check us out online:
Twitter: https://twitter.com/csce2017
Facebook: https://www.facebook.com/events/708198586008808/
Instagram: https://www.instagram.com/csce2k17/

Bienvenue au Congrès SCGC 2017

Le congrès, dont le thème est ''Leadership en infrastructures durables", comprend : conférences spécialisées en mécanique technique et matériaux, environnement, hydrotechnique et construction, présentations et visites techniques, activités sociales et un super programme Jeunes professionnels/Étudiants. Pour la première fois, nous présentons des conférenciers des Premières Nations et un forum pour une interaction entre les dirigeants des Premières Nations, les ingénieurs civils et les professionnels des infrastructures. Le congrès se tiendra à l'hôtel Westin Bayshore.

Des chambres sont disponibles à des tarifs spéciaux. Suivez-nous en ligne: www.csce17.ca, Twitter: https://twitter.com/csce2017 Facebook: https://www.facebook.com/events/708198586008808/ Instagram: https://www.instagram.com/csce2k17/.

Photo: City of Vancouver

Technical Tour UBC Tall Wood Building

The structure of UBC's tall wood building, Brock Commons now complete!

The mass wood structure and façade has been completed for UBC's Brock Commons student residence—the world's tallest wood building at 18 storeys (53 metres, about 174 feet)—four months ahead of schedule, showcasing the advantages of building with wood.

The structure was completed less than 70 days after the prefabricated components were first delivered to the site. Construction will now focus on interior elements, with completion expected in early May 2017—18 per cent (or four months) faster than a typical project. The building is expected to welcome more than 400 students in September 2017.

"This remarkable building, the first of its kind in the world, is another shining example of Canadian ingenuity and innovation, an apt demonstration of how Canada's forest industry is finding new opportunities through technology and innovation — opening up a world of possibilities for our forest and construction industries," said Jim Carr, Canada's Minister of Natural Resources. ■

Photo: naturally:wood: KK Law

UBC's Brock Commons under construction

Social Event

Photo: magicyachtcharters

The Magic Spirit

We are very excited about this year's social evening! We will be embarking on a gorgeous 3 hour cruise on Vancouver's pride, The Magic Spirit!

Come join us on this wonderful evening! Connect with old friends and make some new ones!

The Magic Spirit is the largest and most newly renovated vessel in False Creek with 3 decks, including an amazing 3000 sq ft sundeck. It boasts a wrap around balcony, dining rooms with panoramic windows and beautiful bars on each level. This stunning vessel provides unobstructed views for taking in Vancouver from the water. The evening includes a buffet dinner and 2 premium drinks (specialty drinks not included) of your choice. This will certainly be a highlight of your conference experience! ■

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The CSCE is a volunteer organization with limited financial resources so we need your support to make an impact. Sponsorship opportunities still available. We have options to fit every budget. http://csce2017.ca/partnershiptrade-booths/

Conference Schedule Overview

Tuesday, May 30, 2017
(Pre Conference)
- Envision Training

Wednesday, May 31, 2017
- Registration Opens
- Student Construction Colloquium
- Paper and Case Study Presentations
- Welcome Cocktail Reception

Thursday, June 1, 2017
- Opening Ceremonies and Keynote
- Trade Show
- Opening Lunch and First Nations Keynote
- First Nations Speaker Series
- Paper and Case Study Presentations
- Historic Site Tour
- Social Event

Friday, June 2, 2017
- Breakfast and Keynote
- Trade Show
- Paper and Case Study Presentation
- Student Awards and Luncheon
- Technical Tour
- Awards Ceremony and Banquet

Saturday, June 3, 2017
- Breakfast and Keynote
- Paper and Case Study Presentations
- Annual General Meeting Luncheon

TRADEBOOTHS

S-Frame Software Inc.
Newforma, Inc.
Reinforced Earth
Computational Hydraulics Int. (CHI)
Langley Corporate Group
Vector Corrosion Technologies
V-Rod Canada
Simpson Strong Tie
Skyline Steel
CSIC
Fibrewrap Construction Services Ltd.
Canadian Precast Prestress Concrete Inst.
Atlantic Industries Limited
GMK Consultants Inc.
National Research Council Canada
ADS Canada
City of Vancouver
Basalite Concrete Products
Armetc
T2 Utilities

First Nations Speaker Series

This year's conference will include the inaugural First Nations Speaker series to bring together First Nations Community leaders, industry professionals and civil engineers.

The First Nations Infrastructure Speaker Series will provide presentations on engaging in meaningful consultation and the infrastructure needs of First Nations Communities. First Nations community leaders, industry experts and government officials will be invited to present material and lead discussions on the social and environmental challenges technical professionals must understand to be effective in the improvement of First Nation infrastructure in Canada.

This speaker series includes a special keynote delivered by Kim Baird, a celebrated First Nations Leader in Canada. ■

Envision Training

This year's conference will also provide an opportunity for members to participate in Envision training.

Today, infrastructure must perform in an increasingly challenging environment, as demands for energy, water resources and ecosystem services climb; access to natural resources of all types are increasingly limited; financial and political constraints mount; environmental, ecological and climate change perils escalate; and global population is surging. The owners and professionals who design and build these projects face a tall order of satisfying ever-growing demand, while at the same time responsibly addressing requirements for resiliency and sustainability through progressive techniques in infrastructure design and construction in ways that simultaneously meet high standards for economic performance. The works that best meet those challenges, and can serve as an example to others, are justifiably receiving considerable positive recognition.

Envision provides a holistic framework for planning, evaluating and rating the community, environmental, and economic benefits of all types and sizes of infrastructure projects. It encourages, evaluates, grades, and gives recognition to infrastructure projects that use transformational, collaborative approaches to assess the sustainability indicators over the course of the project's life cycle.

Training will be provided at an additional cost on May 30, 2017. ■

Deborah Goodings, P.Eng.

Keynote
Deborah Goodings:

Deborah J. Goodings is director of the division of civil, mechanical, and manufacturing innovation in the engineering directorate at the U.S. National Science Foundation. With an annual research investment budget of over $200M, the division supports research that advances knowledge to enable manufacturing, design and use of engineering materials, and building technologies across scales from nanometers to kilometers; to improve the resilience and sustainability of the nation's civil infrastructure, including reduction of risk and damage from natural and human-induced disasters; and to expand theory in engineering mathematics, engineering decision-making, and systems control and engineering.

Goodings is on leave from her position as Dewberry Chair Professor of Civil Engineering at George Mason University where she chaired the Department of Civil, Environmental, and Infrastructure Engineering during a five year period of realignment, and expansion of both personnel and resources. Before joining George Mason, Goodings held a faculty appointment in the Department of Civil and Environmental Engineering at the University of Maryland for nearly 30 years. In addition to her geotechnical engineering research and teaching, she co-founded and co-directed the University of Maryland Master of Engineering and Public Policy program with the School of Public Policy; and was the founding faculty advisor of the university's highly successful chapter of Engineers Without Borders-USA. An endowed chair in Engineering for Global Sustainability was established in her honour upon her departure from the University of Maryland.

Goodings has held leadership positions in professional societies, and served on U.S. and Canadian university and agency visiting committees that draw on her research and education expertise, including U.S. National Research Council committees and boards. She has been recognized by the Transportation Research Board with the Fred Burggraf Award, and by the Department of the Army with the Outstanding Civilian Service Medal. Goodings earned her B.A.Sc. in civil engineering from the University of Toronto, and her Ph.D. in geotechnical engineering from Cambridge University. She is a Fellow of the American Society of Civil Engineers; a Diplomat, Geotechnical Engineering; and a registered professional engineer. ■

(Photo: Stephanie Holden, George Mason University)

Kim Baird

First Nations Keynote
Kim Baird

Kim Baird was the elected Chief of the Tsawwassen First Nation (TFN) for six terms, from 1999-2012. She had the honour of negotiating and implementing British Columbia's first urban treaty on April 3, 2009 and has since overseen numerous economic and institutional development projects for TFN. Kim has a deep knowledge of consultation and engagement management for First Nation communities in relation to governance development, economic development and major project impacts to First Nation communities. Currently some of Kim's clients include industry, government and First Nations. She served on BC Hydro's Board of Directors for six years. She is on several boards including the Smithsonian's National Museum of the American Indian, Canada Public Policy Forum and Clear Seas, and holds an Institute of Corporate Director's designation. Kim has been appointed to the British Columbia Premier's Aboriginal Business Investment Council. Kim has received a number of prestigious awards recognizing her contributions to her community and beyond, including an Indspire Award, being appointed to both the Orders of Canada and British Columbia, an honourary doctorate degree from Simon Fraser University, Kwantlen Polytechnic University Distinguished Alumni Award, Canada's Top 40 Under 40 Award, the National Aboriginal Women in Leadership Distinction Award, Vancouver Magazine's Power 50 Award, and Canada's Most Powerful Women Top 100 Award. Kim is a proud mother of three daughters and her ancestral name is Kwuntiltunaat. ■

Jerry W. Dobrovolny

Keynote
Jerry W. Dobrovolny, P.Eng., MBA

Jerry is the General Manager of Engineering Services for the City of Vancouver. With annual budgets totaling over $500 million and 1,900 staff, he is responsible for the design, construction, operation and maintenance of this world class city's public works infrastructure. Engineering Services is also mandated with a variety of planning and regulatory functions and plays a central role in the day-to-day functioning of the city. As the largest city department, Engineering delivers a complex array of essential public services while implementing an ambitious policy agenda to become the greenest City in the world by 2020.

Jerry received his civil engineering degree from the University of British Columbia, a Masters of Business Administration from Simon Fraser University, and has worked at the city for 28 years. Jerry also served as a City Councillor for the City of New Westminster for nine years and played professional football in the CFL for five years. ■

Sustainability in public infrastructure and residential building applications

Markus R. Dann, PhD
ASSISTANT PROFESSOR, DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY OF CALGARY.

This special issue of CIVIL Magazine is devoted to the CSCE Annual Conference held in Vancouver, British Columbia, May 31 – June 3, 2017. The conference, which is promoted by the Canadian Society for Civil Engineering, includes the General Conference and the following four Specialty Conferences:

- 6th CSCE/CRC International Construction Specialty Conference
- 6th International Conference on Engineering Mechanics and Materials
- 23rd Canadian Hydrotechnical Conference
- 15th International Conference on Environmental Engineering

The theme of the 2017 Conference is Leadership in Sustainable Infrastructure. The conference will cover a number of topics within sustainability and provide a forum for presentations and discussions of scientific papers and case studies covering theory, methods and applications to a wide range of sectors and problem areas.

The two articles presented in this issue are shortened versions of presentations selected for the conference. They have been individually reviewed and revised for this issue. The paper by Benson and Rankin focuses on public infrastructure projects where 18 sustainability criteria are combined into a single decision support model to evaluate the sustainability performance of such projects. The approach is demonstrated on a major traffic intersection upgrade project in Fredericton, New Brunswick. The paper by Therani and Froese investigates the sustainability of residential buildings using a life cycle approach to make tradeoff decisions between a project's environmental impact and cost based on nine impact categories. Two 18-storey residential buildings in Vancouver are considered in the example, a traditional cast-in-place concrete frame building and a mass timber design using glulam.

Please enjoy these topical articles. ■

La durabilité dans les infrastructures publiques et les applications dans les constructions résidentielles

Markus R. Dann, PhD
PROFESSEUR ADJOINT AU DÉPARTEMENT DE GÉNIE CIVIL
UNIVERSITÉ DE CALGARY.

Cette édition spéciale de la revue CIVIL est dédiée au congrès annuel de la SCGC qui se tiendra à Vancouver (Colombie-Britannique), du 31 mai au 3 juin 2017. Le congrès, organisé par la Société canadienne de génie civil, inclut un congrès général, ainsi que les quatre conférences spécialisées suivantes :

6e Conférence internationale spécialisée sur la construction de la SCGC/CRC

6e Conférence internationale sur la mécanique appliquée et le génie des matériaux

23e Conférence canadienne sur l'hydrotechnique

15e Conférence internationale sur l'ingénierie environnementale

Le thème du congrès 2017 est le leadership en infrastructures durables. Le congrès traitera d'un certain nombre de sujets relatifs à la durabilité et procurera un forum pour des présentations et des discussions d'exposés scientifiques et d'études de cas couvrant la théorie, les méthodes et les applications associées à une panoplie de secteurs et de zones problématiques.

Les deux articles présentés dans cette édition sont des versions abrégées de présentations sélectionnées pour le congrès. Ils ont été tous deux révisés pour les besoins de cette édition. L'article de Benson et Rankin met l'accent sur les projets d'infrastructures publiques où 18 critères de durabilité sont combinés au sein d'un seul modèle de soutien décisionnel afin d'évaluer la performance de durabilité de tels projets. L'approche est démontrée par un projet de modernisation d'une intersection de circulation majeure à Fredericton, au Nouveau-Brunswick. L'article de Therani et Froese examine la durabilité des constructions résidentielles en utilisant une approche de cycle de vie pour prendre des décisions de compromis entre l'impact environnemental d'un projet et les coûts, selon neuf catégories d'impact. Deux bâtiments résidentiels de 18 étages de Vancouver sont considérés dans l'exemple présenté : un bâtiment comportant une armature traditionnelle en béton coulée sur place et une conception en panneaux de bois massifs, en utilisant du bois lamellé-collé (glulam).

Nous espérons que vous apprécierez ces deux articles. ■

Evaluating the Sustainable Performance of Public Infrastructure Projects

Michael Benson[1], MCSCE and Jeff Rankin[2], FCSCE
[1] R.V. ANDERSON ASSOCIATES LIMITED
[2] UNIVERSITY OF NEW BRUNSWICK, DEPARTMENT OF CIVIL ENGINEERING

The Canadian Society for Civil Engineering (CSCE) has embraced sustainable infrastructure as a key strategic goal (CSCE 2015), and public owners are increasingly including sustainability in their decision making. Despite the concern and attention to this topic, decision makers still have questions; "What exactly constitutes sustainability?" "How can I measure my infrastructure's sustainable performance?" "What makes one project more sustainable than another?"

The idea of "measuring" the sustainability or sustainable performance of public infrastructure has existed for some time. Generally viewed as a multi-objective optimization problem, the ability to objectively measure the sustainability of infrastructure has proved difficult (Sahely et al 2005), but is recognized as an important goal towards realizing sustainable development. Within North America, the Envision (ISI 2017) infrastructure sustainability rating system is gaining momentum. While these tools are a great guide to building a single piece of sustainable infrastructure, they often are not as well-suited as a decision-making tool to compare multiple infrastructure projects of dissimilar typologies within a universal framework.

The Sustainable Efficiency Model (SEM) has been developed to support the sustainability decision making process for public infrastructure. The SEM is a stochastic decision support system which combines cost-benefit and multi-criteria methodologies into a single quantitative indicator to demonstrate a public infrastructure project's sustainable performance. The SEM includes a total of 18 sustainability criteria as defined by ISO 21929-2 "Framework for the development of sustainability indicators for civil engineering works" (ISO2015). What follows is a description of the SEM methodology, with a case study to demonstrate the model's application as a project prioritization tool.

Existing Methods

Existing methods to evaluate the sustainable performance of infrastructure projects can be categorized as: monetary, and non-monetary. Monetary methods identify criteria which can be monetized using economic valuation methods such as the derived demand functions, hedonic price, contingent valuation, or damage costs avoided. Non-monetary methods typically assign points-based values to criteria and impacts.

The most common monetary method for evaluating the sustainable performance of infrastructure is the social cost-benefit analysis (CBA). Given an investment or policy decision, all known impacts over the life-cycle of this decision are identified, measured, assigned dollar values based on economic valuation methods and discounted back to the present using time-value-of-money principles. Despite the objective rigor that can be applied with a social cost-benefit analysis, not all criteria and impacts relevant to sustainability can be included in the analysis. Criteria such as aesthetic value or cultural heritage have little to no valuation evidence. In addition, CBAs are typically calculated with deterministic values, while a more complete assessment will include a degree of uncertainty (Williams et al 2012).

Non-monetary methods typically assign "points" to criteria based on project performance. The most popular method identified is the multi-criteria analysis (MCA). In its basic form an MCA is a three-step process of: indicator identification and development; indicator evaluation and measurement; and weighting and ranking. The ability to include criteria which do not have inherent quantitative results (e.g. aesthetic value) overcomes a disadvantage of a CBA.

The Sustainable Efficiency Model (SEM)

The SEM integrates monetary and non-monetary results using efficiency indicators. Additionally, consideration is given for a stochastic analysis at all levels, to allow decision makers to make objective decisions given uncertain results and information. The model works very similarly to a MCA, whereby criteria and indicators are determined and then combined with relevant weighting factors to determine sustainable efficiency "points". The SEM is defined in eq. 1.

$$(1) \quad SES_a = \sum_{i=1}^{I} w_i \, mBCR_{ia} + \sum_{j=1}^{J} w_j \, QTEI_{ja} + \sum_{k=1}^{K} w_k \, QLEI_{ka}$$

Table 1: Efficiency indicator categorization for the SEM.

Monetary	Non-Monetary Quantitative	Non-Monetary Qualitative
Life-Cycle Costs	Material Use	Cultural Heritage
Other External Costs	Water Use	Access to Nature
GHG Emissions	Energy Use	Urban Sprawl
Health and Safety	Waste Production	Public Acceptability
	Eutrophication Potential	Aesthetic Value
	Acidification Potential	
	Ozone Depletion Potential	
	Land Use Changes	
	Job Creation	

Figure 1: Case study intersection upgrade project.

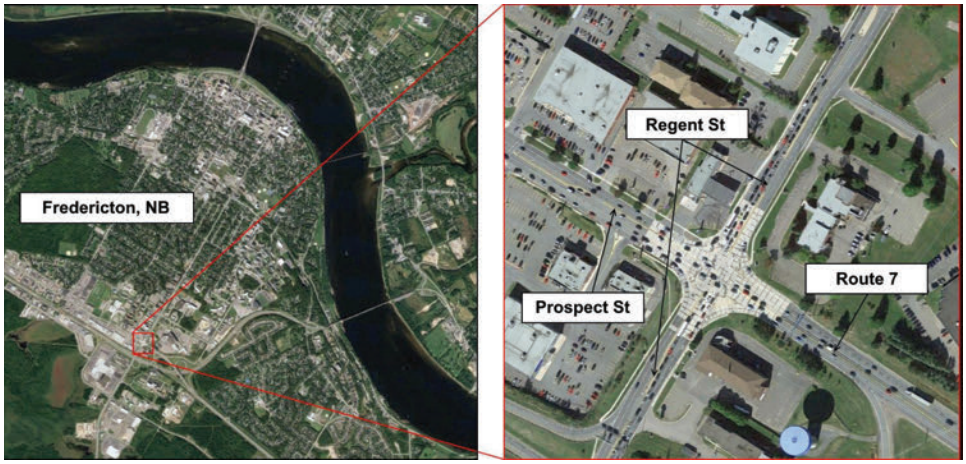
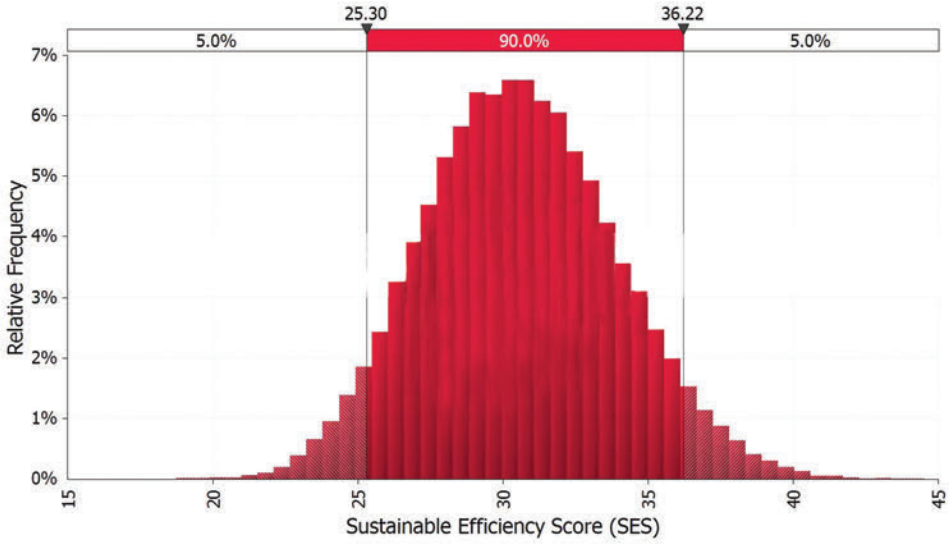


Figure 2



where SES_a is the sustainable efficiency score of project a; w_i, w_j, and wk are the weighting factors for criteria i, j, and k respectively; $mBCR_{ia}$ is the "modified" benefit-cost ratio for monetary criteria i; $QTEI_{ja}$ is the efficiency indicator for non-monetary quantitative criteria j; and $QLEI_{ka}$ is the efficiency indicator for non-monetary qualitative criteria k.

Sustainability Criteria Identified:

A consistent and holistic set of criteria that comprise "sustainable infrastructure" is required. Regional differences and personal biases can all influence what an individual or evaluator deems as to be inclusive in the breadth of sustainability. The ISO 21929-2 is used to generate a set of criteria to form the basis of an evaluation. To evaluate each of the criteria, efficiency indicators are developed. The purpose of an efficiency indicator is to quantify how efficiently a project has met the goals and objectives defined by the criteria. Criteria are grouped into three distinct categories: monetary, non-monetary quantitative, and non-monetary qualitative (Table 1).

Case Study

To demonstrate the Sustainable Efficiency Model's application as a project prioritization tool, a case study was completed of a major traffic intersection upgrade project in Fredericton, New Brunswick. The Regent Street and Prospect Street Intersection (Figure 1) currently functions under fully-actuated control, with two thru lanes and an exclusive left turn lane on each approach. The intersection is Fredericton's busiest, with roughly 65,000 vehicles entering per day (Lewis 2014).

The intersection upgrades include implementation of protected left-turn phasing, construction of new right-turn island design, construction of dual left turn lanes on Regent Street and Vanier Highway, reconstruction of an existing concrete roadway intersection, replacement of various underground services (sewer, storm, and water), and increased lighting and visibility.

After evaluating all 18 criteria in the SEM, it was determined that the project earned a

Table 2: - Summary of results for the case study.

Category	Criteria	Sustainable Efficiency Indicator	Result	W_i	SES_i
Economic (18.9%)	Life-Cycle Costs	$= PVB_{LCC}/C_a$	0.14	11%	1.47
	Travel Time	$= PVB_{TT}/C_a$	0.15	7%	1.05
Environmental (29%)	GHG Emissions	$= PVB_{GHG}/C_a$	0.00	6%	0.03
	Land Use Changes	None	0.00	4%	0.00
	Material Use	$= RM_i/RM_{max}$	0.03	3%	0.07
	Energy Use	$= \Delta EU/EU_o$	0.59	2%	1.01
	Water Use	$= \Delta WU/WUo$	0.91	4%	3.35
	Waste Reduction	$= WR/WG$	0.00	4%	0.00
	Eutrophication Potential	None	0.00	3%	0.00
	Acidification Potential	None	0.00	2%	0.00
	Ozone Depletion Potential	None	0.00	2%	0.00
Social (53.1%)	Health and Safety	$= PVB_{H\&S}/C_a$	0.69	35%	24.22
	Access to Nature	Contribution to Nature Access (out of 1)*	0.20	2%	0.42
	Urban Sprawl	Contribution to Urban Sprawl (out of 1)*	-0.20	3%	-0.54
	Public Acceptance	Degree of Public Acceptance (out of 1)*	0.40	2%	0.72
	Aesthetic Value	Contribution to Aesthetic Value (out of 1)*	0.40	2%	0.84
	Job Creation	$= LR_i/LR_l$	-0.43	5%	-1.98
	Cultural Heritage	None	0.00	5%	0.00
				Total	31

sustainable efficiency score (SES) of +31 (Table 2). Additionally, the results of a Monte Carlo simulation indicate a 90% confidence that the project had a SES between +25.3 and +36.2 (Figure 2).

A significant portion of the benefits realised by the project are from the health and safety criterion. Other benefits such as reduced life-cycle costs from infrastructure asset upgrades, reduced congestion and travel time for users, and reduced quantity of freshwater lost due to water main leaks and bursts are realized.

To demonstrate the calculation of efficiency indicators, an example for each category from each efficiency indicator category is provided. It should be noted that due to space limitations, the details of the weighting and uncertainty values for this case study project are not included in this article.

Monetary – Other External Costs (Travel Time): For monetary criteria, a modified benefit-cost-ratio is used as an efficiency indicator. Each criterion's impacts are isolated individually and their respective benefits are valued. The modified benefit-cost ratio (mBCR) differs from a traditional BCR in that the numerator is the present-value benefit (both positive and negative) of the criterion in question, and the denominator is the initial construction or investment cost of the project. The mBCR is governed by eq. 2.

$$mBCR_{ia} = \frac{PVB_i}{C_a} \quad (2)$$

Where PVBi is the present-value benefit of criterion i and Ca is the initial construction or investment cost of project a.

For the case study, additional left turning lanes will reduce the amount of congestion experienced at the intersection during peak traffic volumes. The intersection upgrades will reduce traffic delays by 3,873 hours annually in the first year, decreasing down to 3,522 hours annually in year 10, and climb back to 4,561 hours annually in 20 years. Given these results, the total delay hours reduced per year over a 20-year period can be linearly interpolated.

To determine the social cost of congestion or travel time (TT), guidance is sought from Litman (2009). The social cost of personal travel time has been estimated to be 47.5% of the average local wages. Assuming an average wage of roughly $21.15 per hour (Statistics Canada 2015), the social cost of travel time is estimated to be $10.04 per hour. Given the total travel time delay hours reduced by the intersection upgrades, a total present-value benefit of $614,101 is determined (assuming a 3% discount rate). Additionally, the project's initial construction cost was estimated to be $4.2 million, resulting in a modified benefit-cost ratio for TT of 0.15 (eq. 3).

$$mBCR_{TT} = \frac{PVB_{TT}}{C_{R\&P}} = \frac{\$614{,}101}{\$4{,}200{,}000} = 0.15 \quad (3)$$

Non-Monetary Quantitative – Material Use (Recycled Material): Non-monetary efficiency indicators have been split into two distinct categories: quantitative and qualitative. Quantitative indicators can rely on actual and estimated results from infrastructure projects. The efficiency indicators determined must reflect how efficiently a project has achieved a certain goal or objective, with a result of 1 indicating 100% or complete efficiency. These indicators can vary depending on the criterion in question and as such there is no standardized formula

available.

For the case study, the material use (MU) criterion, a non-monetary quantitative efficiency indicator was developed to reflect how efficiently the project has used recycled material in the design of asphalt pavement (eq. 4).

$$QTEI_{MU} = \frac{\%RAP_{R\&P}}{\%RAP_{max}} \quad (4)$$

Where $\%RAP_{R\&P}$ is the percentage of reclaimed asphalt pavement used in the project, and %RAPmax is the maximum functional percentage of reclaimed asphalt pavement.

It is possible to use recycled material in asphalt through reclaimed asphalt pavements (RAP), however there is a functional limit to its use. The US Federal Highway Administration (US FWHA) widely considers 50 percent RAP to be the maximum limit (US FHWA 2008). This value forms the basis for the maximum allowable quantity of recycled material used (%RAPmax). The expected quantity of RAP used in the project is 2.5%. Therefore, the efficiency indicator for MU is 0.05 (eq. 5).

$$QTEI_{MU} = \frac{\%RAP_{R\&P}}{\%RAP_{max}} = \frac{2.5\%}{50\%} = 0.05 \quad (5)$$

Non-Monetary Qualitative – Public Acceptance: A non-monetary qualitative efficiency indicator relies on subject matter experts to evaluate the given criteria. As a subjective result, qualitative and descriptive terms are required. A standardized subjective linear scale has been developed for non-monetary qualitative efficiency indicators shown in Table 3.

For the public acceptance (PA) criterion, a subjective scale is rated by a subject matter expert. The linear scale is used to determine the degree to which the project has the public acceptance. A traffic engineer who had consulted with local businesses and key stakeholder in the construction area was asked to rate the project. From the consultation period, the traffic engineer ranked the project as -0.8 in the short-term and a +0.8 in the long-term, therefore giving the project a total ranking of +0.4.

Moving Forward

The SEM does not prescribe to be the perfect or ideal set of criteria to represent sustainability, and it is expected that this is an area that continues to evolve. The SEM also does not prescribe specific indicators to be used for each criterion as every project will be unique and may have varying degrees of functional limits. While specific indicators are not prescribed, the SEM does define the purpose of an indicator – to determine how efficiently a project has met the stated goals or objectives. This notion of determining efficiency ratios is key to integrating monetary and non-monetary criteria into a single quantitative indicator. The main purpose of the SEM is to evaluate public infrastructure projects of dissimilar typology and size.

The case study project shown above, with a result of 31, can then be compared to another potential infrastructure investment such as a wastewater treatment plant upgrade. This will allow decision-makers and asset managers the ability to compare "apples" to "apples" in efforts to prioritize public infrastructure projects. ■

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Table 3: Non-monetary qualitative indicator evaluation scale.

Negative					Positive			
Significant	Major	Moderate	Minor	Neutral	Minor	Moderate	Major	Significant
-1.0	-0.75	-0.50	-0.25	0.00	0.25	0.50	0.75	1.00

A Comparative Life Cycle Assessment of Tall Buildings with Alternative Structural Systems: Wood Vs. Concrete

By Maryam Abolghassem Tehrani and Thomas M. Froese
UNIVERSITY OF BRITISH COLUMBIA

As the world's population continues to grow, the need for buildings and infrastructure increases, and this growth in construction has negative impacts on the environment. In Canada, the construction industry is estimated to account for 33% of energy production, 50% of the extracted natural resources, 25% of landfill wastes, 10% of airborne particulates and 35% of greenhouse gases (Lucuik 2005). Despite the traditions of using concrete and steel as the primary building material for tall buildings, there has been an increased interest in using wood and wood-based materials for large-scale construction. This growth is driven by technical advances in the design, manufac-

Figure 1 Brock Commons Tallwood House under construction at the University of British Columbia

(Photos: T. Froese)

ture, and construction of engineered wood structural systems, as well by recognition of the environmental advantages of wood as a renewable resource (CIRS 2016). With the application of wood in low-rise buildings considered to be environmentally positive, interest in using mass-timber for mid-rise and high-rise buildings is increasing. Research was conducted to compare the environmental impacts of two high-rise buildings—a mass-timber hybrid building and a reinforced concrete frame building—by conducting a life cycle assessment (LCA) on two case study buildings located on the University of British Columbia's Point Grey campus. The aim of this and similar researches is to provide reliable and accurate impact assessment data to officials, policy makers, designers, contractors, stakeholders and other decision makers to support informed material selection and decision making in future projects.

Previous Work

Previous research has analyzed the effect of alternative structural systems on the environment.

In 2011, the environmental impact of two green buildings in Europe, an innovative wood structure and a reinforced concrete structure were analyzed. Overall, the wood building consumed less energy compared to the concrete alternative, in particular, fossil fuel usage was 45% less. (Gaurdigli, Monari and Bragadin 2011). Similarly, in 2011, a comparative LCA on two mid-rise laminated timber and reinforced concrete buildings was conducted. The assessment found that the heavy timber design showed a lower environmental impact in ten out of the eleven impact categories. Most significantly, global warming potential was 71% less in the timber design building. Fossil fuel depletion was the only category in which the concrete design was superior by 6%. (A. B. Robertson 2011).

Case Study Buildings

At the time of this study, the tallest mass timber hybrid building in the world (Brock Commons Phase 1) was under construction at the University of British Columbia's Point Grey Campus (CIRS 2016). The motivation behind this research was to evaluate how the tallest timber building compares environmentally to a similar building with a concrete frame. Brock Commons is an 18-storey (53 meters) mass-timber hybrid student residence with a gross floor area of 15,120 m2. The building's foundation, ground floor, stairs, and elevator cores are reinforced concrete, while the superstructure is composed of cross-laminated timber (CLT) floor panels supported on Parallel Strand Lumber (PSL) and glue-laminated timber (GLT) columns with steel connections (CIRS 2016). Ponderosa Commons phase 2 consists of an L-shaped wing connected to a residential wing. Ponderosa's building is also an 18-storey (53 meters) student residence with a gross floor area of 15,574 m2. The building is a typical tall reinforced concrete structure where the foundation, floors, columns, stairs and elevator walls are all reinforced concrete. The case study buildings' proximity, similar height and gross floor area along with their residential occupancy type ensured the validity of the building selection process (in fact, the floor plan for the Brock Commons building was based, in part, from the Ponderosa Commons building).

Life Cycle Assessment

LCA was used to determine which structural system alternative produced lower environmental impacts throughout its life-cycle. Athena Sustainable Materials Institute's Life Cycle Inventory (LCI) database and Athena's Impact Estimator for Buildings version 5 (IE4B) was used to translate input flows into outputs. (Athena Sustainable Materials Institute 2014). To obtain material quantity data to input into IE4B, material take-off was performed for each building from their respective floor plans and elevation plans. The software then reported footprint data for the following environmental impact measures for both buildings: global warming potential, acidification potential, human health particulate, ozone depletion potential, smog potential, eutrophication potential, and fossil fuel consumption. The software also calculates total primary energy and non-renewable energy.

Results and Discussion

As shown in Figure 2, Brock Commons (mass timber) has a lower environmental impact in 8 of the 9 impact categories (global warming potential, acidification potential, HH particulate, eutrophication potential, ozone depletion potential, smog potential, non-renewable energy, and fossil fuel depletion), while Ponderosa Commons (concrete) has a lower impact in 1 of the impact categories (total primary energy). At a maximum, the HH particulate of Brock Commons was 38% less than Ponderosa, followed by ozone depletion potential with a reduction of 35%, global warming potential by 24%, acidification potential by 20%, smog potential by 17%, eutrophication potential by 12%, non-renewable energy by 8%, and fossil fuel consumption by 4%. Ponderosa Commons' total primary energy was 11% less than Brock Commons.

The results were normalized as a percentage in Figure 2, which also indicates which phase of the buildings' lifecycle has the largest overall contribution to each category. Phase A includes product manufacturing, product transportation, construction installation processes, and associated transportation. Phase B includes replacement manufacturing and transportation. Operational Energy use is excluded from this phase, as energy data were not available. Phase C includes deconstruction, demolition, disposal and waste processing and associated transportation.

Global warming potential is a worldwide concern and perhaps one of the main reasons that the construction industry is shifting from concrete to wood as a primary structural material. Therefore, it is not surprising that the Brock project has a lower global warming potential than Ponderosa. Wood is a renewable resource, with a neutral carbon balance. Carbon released into the atmosphere when wood is burnt will eventually be re absorbed by new tree growth, reducing the overall carbon emission in the life cycle of Brock Commons. Energy can also be recovered from

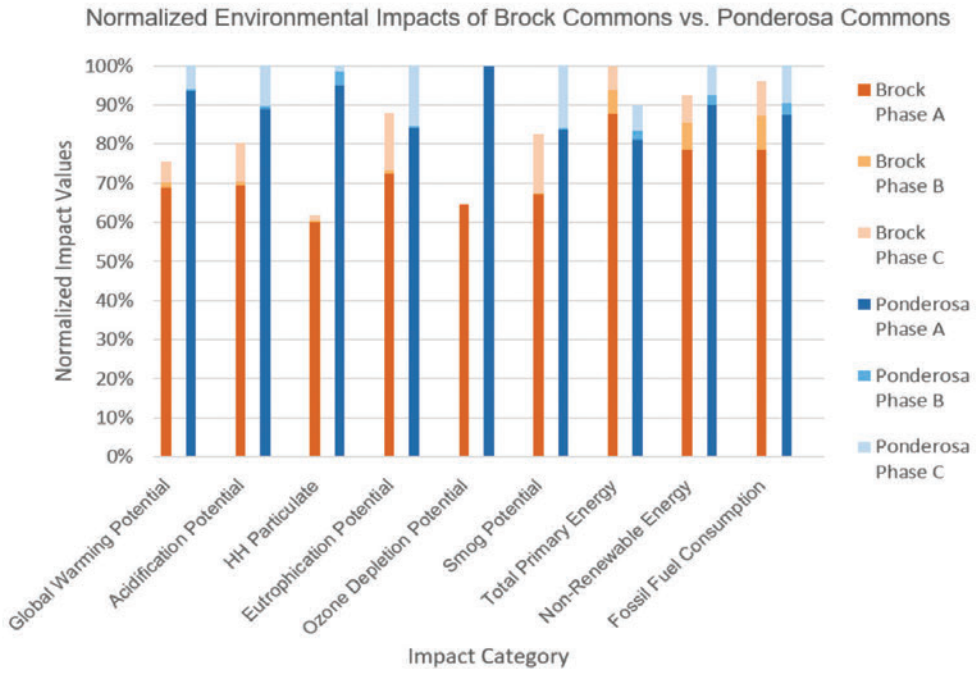

Figure 2 Normalized Environmental Impacts. Brock is a mass-timber hybrid high-rise while Ponderosa is a similar concrete building. Phase A includes product manufacturing, transportation, and installation. Phase B includes replacement manufacturing. Phase C includes demolition, disposal and waste processing. Operational Energy was not included.

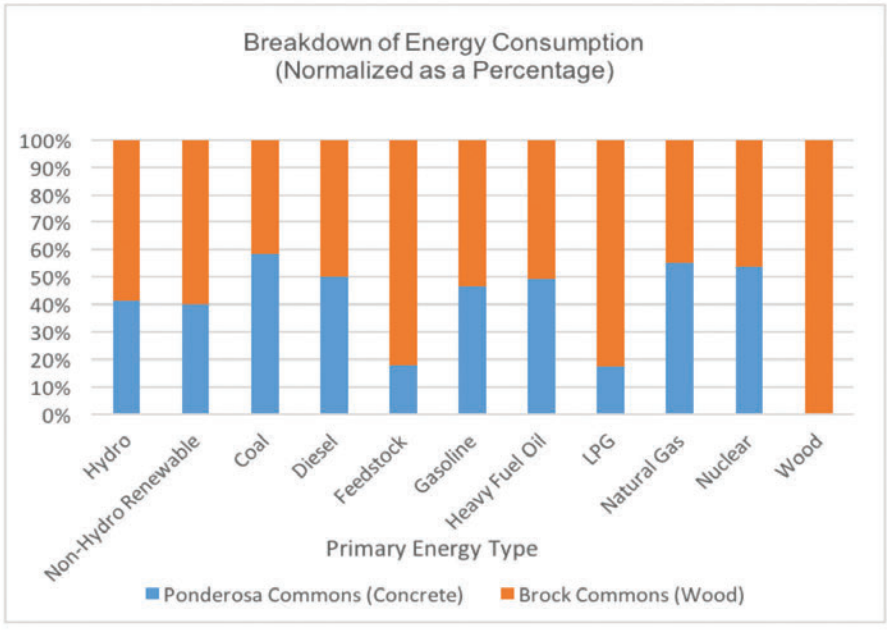

Figure 3 Energy Consumption Breakdown

This growth is driven by technical advances in the design, manufacture, and construction of engineered wood structural systems, as well by recognition of the environmental advantages of wood as a renewable resource (CIRS 2016).

demolition wood waste by the way of incineration. Moreover, wood and engineered wood material have a lower weight of shipping in both delivering the material to site and removing demolition waste from the site. Glulam columns and CLT panels are prefabricated offsite and therefore installation time is significantly less than traditional cast-in-place concrete and they consume less water and less electrical energy. In the demolition phase, wood buildings not only produce less waste, but they require less electrical energy as well (Pajchrowski, et al. 2014).

The total primary energy of the Brock Commons is more than the total primary energy of Ponderosa Commons. Figure 3 breaks down the constituents of each building's embodied energy. From Figure 3, it can be seen that Brock Commons has a higher primary energy in Hydro, non-hydro renewable, feedstock, gasoline, LPG, and wood energy categories, resulting its total energy that surpasses Ponderosa's primary energy. From the primary energy types, wood, feedstock, and LPG have the most significant contribution. Since wood is not a primary material used in Ponderosa Commons, higher level of wood in Brock Commons' primary energy calculations is justified. However, it is important to understand the significance of feedstock energy. Feedstock energy is the easily accessible potential energy contained in fuel resources that are extracted from earth. More specifically, they are the potential energy contained in engineered wood products (A. B. Robertson 2011).

Comparing the feedstock energy of Brock Commons and Ponderosa Commons, it is apparent that Brock Commons has roughly 4.5 times of feedstock energy than Ponderosa Commons. This is due to the fact that the wood material, specifically the glulam and CLT panels, store potential energy within the wood fibers and within the fossil fuel-derived adhesive resins. This potential energy can be readily combusted and used as an energy source at the end of Brock Commons' service life. For Ponderosa Commons, it is not practical to obtain useful energy from concrete at the end of the building's service life (Robertson, Lam and Cole 2011).

Comparing the results of different LCA studies is often challenging. Most of the previous studies examined light-wood framing technique, whereas in this study, glulam and CLT panels are the main components of the framing system. The size, location, height, functional use, scope, and system boundary of buildings are different. Also, different studies use different LCA tools to measure the embodied energy in a building, whereas in some tools, the total primary energy is calculated based on different energy types than IE4B. These variations could all account towards the challenging nature of comparing different LCA study results.

The University of British Columbia's Center for Interactive Research on Sustainability is also currently conducting a detailed and comprehensive LCA and life cycle costing (LCC) on the two buildings. Future results will provide more in-depth information regarding environmental impacts of alternative structural systems.

Conclusion

This study compared two 18-storey residential buildings with mass timber and concrete structural systems by means of LCA. The results of the study indicated that, considering the system boundary and assemblies studied, it causes less environmental impact to use wood (specifically glulam and CLT) as the primary building material in 8 of the 9 impact categories. Moreover, the LCA results indicated that the Ponderosa Commons building has a lower embodied energy compared to the Brock Commons building, a difference of 11%. ■

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REPORT OF THE NOMINATING COMMITTEE (2017–2018)

The Nominating Committee of the Board of Directors of the Canadian Society for Civil Engineering has provided, for approval by the members, the following nominations to the Board of Directors.

Position	Incumbent	Proposed	Term
President	Jim Gilliland, end of term	Susan Tighe	1 yr
President-Elect	Susan Tighe, end of term	Glenn Hewus	1 yr
Senior Vice-President and Chair, Regional Coordinating Committee	Glenn Hewus, end of term	Michel Khouday	1 yr
Past President	Tony Bégin, end of term	Jim Gilliland	1 yr
Honorary Treasurer	Glen Hewus, end of term	Brad Smid	2 yrs
Vice-President, Administration Coordinating Committee	Wade Zwicker, finishing 2nd yr	Wade Zwicker	2 yrs
Vice-President, Technical Divisions and Committees	Gopal Achari, finishing 2ndt yr	Gopal Achari	2 yrs
Vice-President Technical Programs	John Newhook, finishing 1st yr	John Newhook	1 yr
Vice-President, Atlantic Region	Jeff Rankin, finishing 2nd yr	Samuel Richard	2 yrs
Vice-President, Quebec Region	Michel Khouday, finishing 1st yr	Frédéric Brunet	2 yrs
Vice-President, Ontario Region	Adrian Munteanu, finishing 3rd yr	Adrian Munteanu	1 yr
Vice-President, Prairie Region	Mike Hnatiuk, finishing 2nd yr	Mike Hnatiuk	2 yrs
Vice-President, Western Region	Philip Alex, end of term	To be determined	2 yrs
Vice-President, International Region	Brian Burrell, finishing 3rd yr	Brian Burrell	1 yr
Member at Large representing Corporate Members	Peter Langan, finishing 1st yr	Peter Langan	1 yr
Member at Large representing Heads and Chairs	Ashraf El Damatty, end of term	Jeff Rankin	1 yr

In addition to the above Director positions, which are voting positions on the Board, there are two non-voting positions on the Board appointed by others:

Position	Incumbent	Proposed	Term
Representative – Canadian Geotechnical Society (non-voting)	Catharine Mulligan, end of term	Dharma Wijewickreme	1 yr
Representative – Hong Kong Branch (non-voting)	Kelvin Cheung, finishing 2nd yr	Kelvin Cheung	1 yr

RAPPORT DU COMITÉ DES CANDIDATURES (2017–2018)

Le Comité des candidatures du conseil d'administration de la Société canadienne de génie civil a soumis les candidatures suivantes au conseil d'administration pour approbation par ses membres.

Poste	Titulaire	Candidat	Durée
Président	Jim Gilliland, fin de mandat	Susan Tighe	1 an
Président désigné	Susan Tighe, fin de mandat	Glenn Hewus	1 an
Premier vice-président et Président, Comité des régions	Glenn Hewus, fin de mandat	Michel Khouday	1 an
Ancien président	Tony Bégin, fin de mandat	Jim Gilliland	1 an
Trésorier honoraire	Glenn Hewus, fin de mandat	Brad Smid	2 ans
Vice-président, Comité de coordination de l'administration	Wade Zwicker, fin de la 2 e année	Wade Zwicker	2 an
Vice-président, Divisions techniques et comités	Gopal Achari, fin de la 2 e année	Gopal Achari	2 an
Vice-président, Programmes techniques	John Newhook, fin de la 1 ère année	John Newhook	1 an
Vice-président, Atlantique	Jeff Rankin, fin de la 2 e année	Samuel Richard	2 ans
Vice-président, Québec	Michel Khouday, fin de la 1 ère année	Frédéric Brunet	2 ans
Vice-président, Ontario	Adrian Munteanu, fin de la 3e année	Adrian Munteanu	1 an
Vice-président, Prairies	Mike Hnatiuk, fin de la 2 e année	Mike Hnatiuk	2 ans
Vice-président, Ouest	Philip Alex, fin de mandat	À déterminer	2 ans
Vice-président, International	Brian Burrell, fin de la 3e année	Brian Burrell	1 an
Représentant les entreprises membres	Peter Langan, fin de 1 ère année	Peter Langan	1 an
Représentant le Conseil des chefs de départements de génie civil canadiens	Ashraf El Damatty, fin de mandat	Jeff Rankin	1 an

En plus des administrateurs proposés ci-dessus, avec droit de vote, des candidats sans droit de vote sont nommés par d'autres organisations pour les deux postes suivants:

Poste	Titulaire	Candidat	Durée
Représentant la Société canadienne de géotechnique (sans vote)	Catharine Mulligan, fin de mandat	Dharma Wijewickreme	1 an
Représentant la succursale de Hong Kong (sans vote)	Kelvin Cheung, fin de la 2 e année	Kelvin Cheung	1 an

Reader Feedback

A letter to the Editor regarding the "New Champlain Bridge" article in the Spring 2017 issue.

The article "The New Champlain Bridge: Technical Requirements and Delivery Status Report" states that an important aspect of the project was "architectural quality", which I understand to mean the visual impression that will be created by the bridge.

Two aspects of the design that appear to have been significantly influenced by visual considerations are the unusually shaped approach span piers (shown on the cover of the Canadian Civil Engineer) and the structural system for the main span, which consists of a single-tower cable-stayed bridge.

Both features appear to have considerable structural inefficiencies. The approach span piers incorporate inclined legs, which carry vertical load less efficiently than vertical members. Assuming the outer two girders of the superstructure, which carry highway traffic, are significantly heaver than the central girder, which carries light rail traffic, it would appear that there will be significant bending in the main legs of the piers under permanent load, a condition that is also inefficient.

The 240 m main cable-stayed span is supported by a single tower. From the perspective of forces and stresses, this system holds much in common with half of a 480 m span. It is likely that a system supported by two towers, one at each end of the main span, would have resulted in lower forces and stresses, and hence greater efficiency.

There is no doubt that the shape of the approach piers and the single-tower main span contribute significantly to the visual impression created by this bridge. Given that these aspects of the bridge appear to be associated with structural inefficiency, it is likely that the bridge will cost more than one that had efficient structural systems.

I would therefore like to know, not so much as an engineer but rather as a citizen and a taxpayer, what was the premium that was paid for these and other measures incorporated into the design to create the visual impression, over and above the cost of a design that satisfied all of the functional requirements of the project efficiently and economically?

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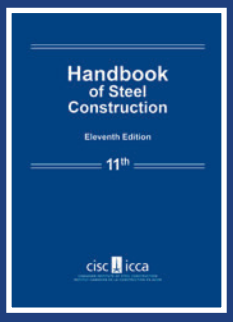

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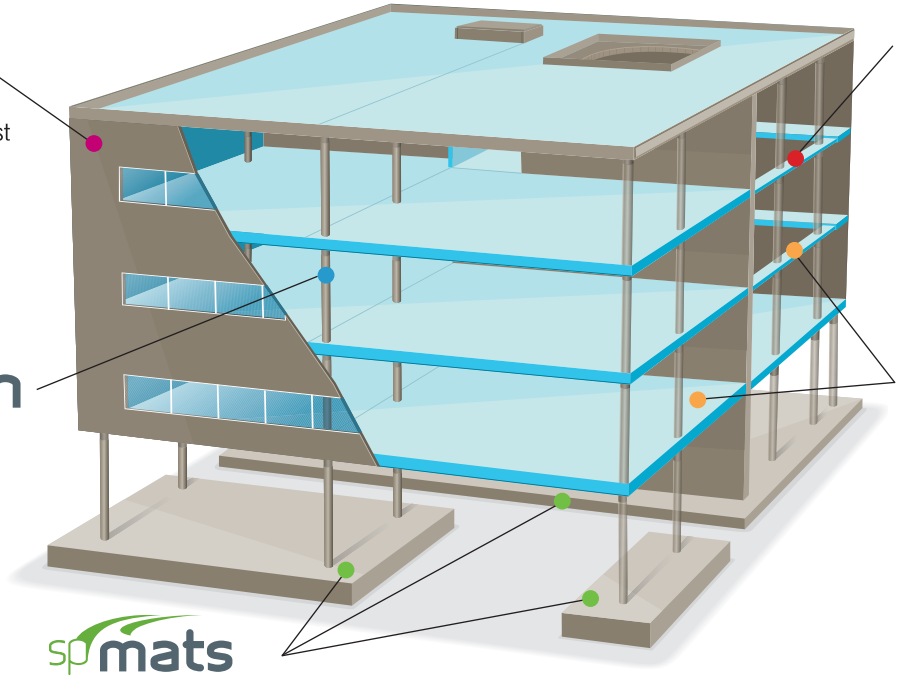

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