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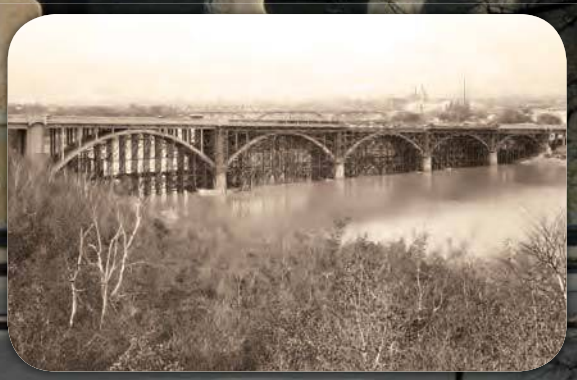
L'INGÉNIEUR CIVIL CANADIEN

- CSCE Conference/Congrès SCGC Montreal
- Financing: an infrastructure bank?
- 40 years of Buckland & Taylor
- Le tracel de Cap-Rouge

2013 | MAY/MAI

Know-how: Past and Present | Savoir-faire: Passé et présent



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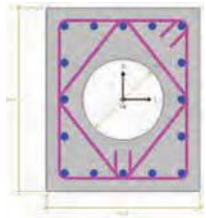

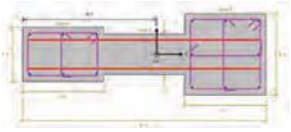

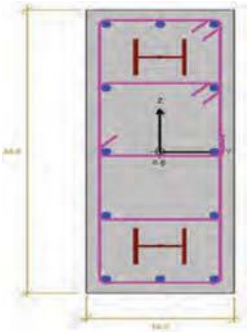

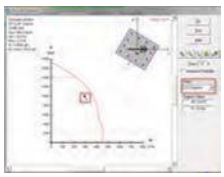

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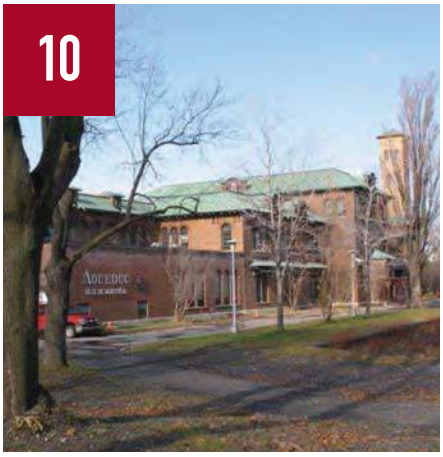

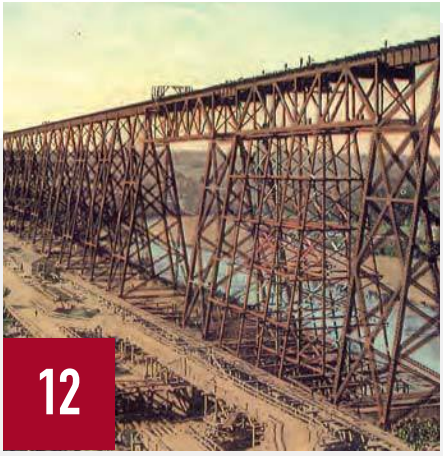

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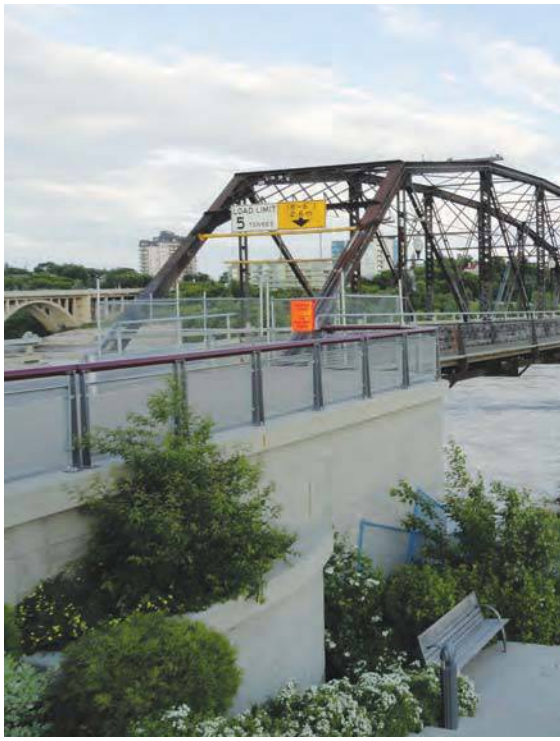
Our Infrastructure Challenge

Infrastructure is at the heart of much of what civil engineering is all about. It includes roads, bridges, pipelines, water treatment and distribution systems, sewage collection and treatment systems, energy supply and distribution systems, communications networks, and so on. Much of it is invisible to most people until such time as it fails to function as intended.

We have increasingly heard about the state of our nation's infrastructure and the need to focus attention on what is now well-established as an infrastructure deficit. Here, deficit refers to the difference in actual annual expenditures on infrastructure (e.g., new construction, maintenance work, etc.) and the expenditures needed to maintain and expand our infrastructure for good service. In the first-ever infrastructure report card for Canada, which focused on municipal roads and water systems, it was estimated that more than $170 billion is needed to bring the infrastructure up to standard. This is staggering!

Failure to address the infrastructure deficit will inevitably result in further deterioration in service, overall increases in long-term expenditures, reduced economic performance and, in turn, a reduced quality of life. The economic impacts have been clearly articulated in two recent reports, one with a Canadian context by the Canada West Foundation (*At the Intersection: The Case for Sustained and Strategic Public Infrastructure Spending*) and the other with an American context by the American Society of Civil



Engineers (*Failure to Act: The Impact of Current Infrastructure Investment on America's Economic Future*). A key finding in both reports is that, in addition to infrastructure condition being important for public safety, there is a strong connection between investments in public infrastructure and economic productivity and prosperity, as expressed by such metrics as levels of employment, gross domestic product and international competitiveness.

So, where do we go from here? While civil engineers have developed tremendous expertise at ensuring that the design and construction of infrastructure is done

right, we have often been silent or not even a part of the decisions related to whether it is the right infrastructure that is being built. Moreover, we have perhaps not been as much a part of an innovation strategy as should be the case. Here, it is suggested that design conservatism has often led us to resort to standard approaches to the problems at hand. With an increasing infrastructure deficit, it is clear that innovative strategies are essential; simply throwing more money at the problem is not a viable option. To this end, it is necessary that the principles of asset management, life cycle analysis and sustainability must be incorporated into all of our work on a go-forward basis. Indeed, we would hope that the next federal infrastructure program, anticipated in 2014, would make a direct link between the funding provided and the principles just noted, so that they are factored into each and every approved project. ■

Photo by Jim Kells.

An example of aging infrastructure: Built in 1907, the Victoria Bridge (Traffic Bridge) in Saskatoon was closed to traffic in 2010 due to safety concerns. The City of Saskatoon is currently examining options for replacing the bridge which range in cost from $26 million to $60 million./ Un exemple de nos infrastructures vieillissantes : inauguré en 1907, le pont Victoria (pont Traffic), à Saskatoon, a été fermé à la circulation en 2010 par souci de sécurité. La ville de Saskatoon étudie présentement les diverses solutions pour remplacer ce pont, dont les coûts vont de 26 millions à 60 millions de dollars.

Notre défi en matière d'infrastructures

Les infrastructures sont au cœur d'une bonne partie de ce qu'est le génie civil. Cela inclut les routes, les ponts, les pipelines, les usines de traitement des eaux, les aqueducs, les réseaux d'égouts, les systèmes de production et de transport d'énergie, les réseaux de communication, etc. Une bonne partie de ces ouvrages passe inaperçu pour la plupart des gens, jusqu'à ce qu'une panne survienne.

Nous avons beaucoup entendu parler de l'état de nos infrastructures et de l'urgence de se préoccuper de notre déficit en matière d'infrastructures. Ce déficit est en fait la différence entre le chiffre de nos dépenses annuelles en infrastructures (ex. : nouvelles constructions, dépenses d'entretien, etc.) et les dépenses qu'exigent le maintien et le développement de nos infrastructures. Dans un premier bulletin publié sur l'état des infrastructures au Canada, qui porte sur les routes et les aqueducs municipaux, on évalue à plus de 170 milliards de dollars le montant nécessaire pour remettre à niveau nos infrastructures. Voilà qui est renversant !

Ne pas régler ce déficit en matière d'infrastructures provoquera inévitablement une détérioration additionnelle des services, une hausse globale des dépenses à long terme, une diminution de la performance économique, et une diminution de notre qualité de vie. Les impacts économiques ont été très bien décrits dans deux rapports récents, dont l'un évoque le contexte canadien et a été fait par la « Canada West Foundation (*At the intersection: the case for sustained and strategic public infrastructure spending*) » et l'autre évoque le contexte américain et a été fait par la « American Society of Civil Engineers (*Failure to act: the impact of current infrastructure investment on America's economic future*). » L'une des principales constatations des deux rapports est le fait qu'en plus de l'importance de l'état des infrastructures pour la sécurité du public, il y a un lien étroit entre les investissements dans les infrastructures publiques et la productivité et la prospérité, en termes d'emplois, de PIB et de capacité concurrentielle internationale.

Où en sommes-nous dans ces circonstances ? Même si les ingénieurs civils ont créé d'impressionnantes compétences en matière de conception et de construction des infrastructures, nous avons souvent omis d'étudier ou même de participer aux décisions relatives à la pertinence des choix en matière d'infrastructures. En outre, nous ne nous sommes peut-être pas assez préoccupé des stratégies d'innovation. Il semblerait ici que le conservatisme dans la conception nous ait souvent porté à conserver des solutions traditionnelles face aux problèmes à régler. Devant un déficit croissant en matière d'infrastructures, il est évident qu'il faut élaborer des stratégies novatrices ; le simple fait de consacrer plus d'argent aux problèmes n'est pas une solution valable. Ici, il faut absolument incorporer dans notre démarche les principes de gestion de l'actif, d'analyse du cycle de vie et de durabilité. En fait, nous souhaiterions que le prochain programme fédéral en matière d'infrastructures, prévu pour 2014, crée un lien direct entre le financement et les principes évoqués ci-dessus, afin qu'ils fassent désormais partie de tout projet approuvé. ■

Rebuilding the Western New Brunswick Section

Susann Hickey, P.Eng., MCSCE, FEC
VICE-PRESIDENT, CSCE ATLANTIC REGION
Susann Hickey, ing., MSCGC, FEC
VICE-PRÉSIDENTE,
RÉGION ATLANTIQUE DE LA SCGC

The Atlantic Region of CSCE covers the geographic area of the four Atlantic provinces: Newfoundland and Labrador, Nova Scotia, New Brunswick and Prince Edward Island. The Western New Brunswick Section, after a period of inactivity, has been making significant effort to rebuild over the last six months. The existing Section executive members are actively looking at bringing new people into the executive committee and have a goal to have a new Section chair in place in 2013.

In 2012, this section took on the task of organizing an evening dinner to provide networking opportunities to students at the University of New Brunswick (UNB) Student Chapter and the local business community. The dinner took place in October 2012 at the Wu Centre located on the Fredericton campus of UNB and was attended by 70 people, including approximately 20 from the Fredericton business community. The guest speaker for the event was the CSCE's executive director, Doug Salloum. This event was well received by those who attended and the organizing committee looks forward to hosting similar dinners on an annual basis.

Looking to the future, the Western New Brunswick Section also arranged to send a representative to the CSCE fall board meeting held in December in Montreal. This provided an opportunity for the Section to have direct contact with the CSCE national executive and national office staff and to network with representatives from other sections and bring new ideas home. The Western New Brunswick Section has been quite active in the past and is looking forward to continuing to provide opportunities to the local membership in the coming years. ■

Susann Hickey is Regulatory Manager, St. John's, WorleyParsons Canada.

University of New Brunswick CSCE Student Chapter executive with Doug Salloum, CSCE executive director, at the Fredericton meeting./La direction de la section étudiante de la SCGC de l'Université du Nouveau-Brunswick, en compagnie de Doug Salloum, directeur exécutif de la SCGC, lors de la réunion de Fredericton. From left to right/De gauche à droite: Dr. Trevor Hanson, Garrett Proud, Myran McLaughlin, Jessica Pottier, Rachel Van Wart, Doug Salloum, Kelsey Morrissey, Elizabeth Calvin, Krista Flanagan, Paul Carson. Missing is Dylan Robertson./Dylan Robertson n'apparaît pas sur la photo.

Reconstruire la section de l'Ouest du Nouveau-Brunswick

La région atlantique de la SCGC comprend les quatre provinces atlantiques : Terre-Neuve et Labrador, Nouvelle-Écosse, Nouveau-Brunswick et Île-du-Prince-Édouard. Après une période d'inactivité, la section de l'Ouest du Nouveau-Brunswick s'est lancée dans un important travail de reconstruction depuis six mois. Les membres de l'exécutif de la section cherchent à attirer de nouveaux membres au sein de l'exécutif et comptent bien avoir un nouveau président en 2013.

En 2012, la section a organisé un dîner pour permettre aux étudiants de l'Université du Nouveau-Brunswick de se faire un réseau au sein de la communauté locale des affaires. Le dîner a eu lieu en octobre 2012 au Centre Wu, situé sur le campus de Fredericton de l'UNB et a attiré 70 personnes, dont 20 membres du monde des affaires de Fredericton. Le conférencier invité pour l'occasion était le directeur exécutif de la SCGC, Doug Salloum. Cette initiative a été fort appréciée des participants et devrait se répéter à chaque année.

La section de l'Ouest du Nouveau-Brunswick a également envoyé un représentant à la réunion d'automne du c.a. de la SCGC, à Montréal, en décembre dernier, ce qui a permis à la section d'établir un contact direct avec l'exécutif national et la permanence de la SCGC, de rencontrer des représentants d'autres sections, et de faire le plein d'idées nouvelles. La section de l'Ouest du Nouveau-Brunswick a déjà été très active et compte offrir toutes sortes d'occasions aux membres locaux au cours des prochaines années. ■

Susann Hickey est directrice de la réglementation au bureau de St. John's de WorleyParsons Canada.

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Spirits high at student competitions

Amie Therrien, P. Eng, M. Eng., MCSCE
STUDENT AND YOUNG PROFESSIONALS PROGRAM COORDINATOR, CSCE
Amie Therrien, ing, M. Eng., MSCGC
COORDONNATRICE, PROGRAMME DE LA SCGC POUR ÉTUDIANTS ET JEUNES PROFESSIONNELS

In late January, more than 400 engineering students from across the country came to Vancouver for the Great Northern Concrete Toboggan Race (GNCTR) hosted by the University of British Columbia. They presented their toboggans, the culmination of months of hard work, to the judges, raced them down Mount Seymour, and partied like there was no tomorrow. Congratulations to the team from the University of Western Ontario who took home the CSCE Cup as overall winner. Western will be defending champions as well as the host team for next year's competition (gnctr2014.com).

We also saw students gather in Montreal at the beginning of March for the 29th Annual CSCE Troitsky Bridge Building Competition. As always, Concordia did a wonderful job of organizing and hosting the event, which had more than 25 teams build bridges, present them to judges, then watch as they endured the Crusher. Watch troitsky.ca for information on how to get involved in next year's competition.

Last, but not least, we've got the Canadian National Concrete Canoe Competition (CNCCC), which is being hosted in Montreal by École de technologie supérieure (ETS) from May 17-19. It will be a fun and exciting event. Check out concretecanoe.com for more details.

Another big event on the calendar is the CSCE Annual Conference in Montreal from May 29 to June 1. Each competition discussed above will be sending two members of the winning teams to the conference to receive their awards from CSCE. There will also be a great program of events specifically for students and young professionals this year, in addition to all the great speakers, paper presentations, and activities that make up the conference. Please visit http://www.csce2013.ca/young_professionals for more information. ■

Amie Therrien can be reached at yp@csce.ca

Des concours étudiants qui suscitent l'enthousiasme

À la fin de janvier, plus de 400 étudiants en génie de tous les coins du pays se sont rendus à Vancouver pour la grande course nordique en toboggan de béton (Great Northern Concrete Toboggan Race - GNCTR), sous les auspices de l'Université de la Colombie-Britannique. Ils ont soumis aux juges leurs toboggans, aboutissement de mois de travail intense, ont dévalé la pente du mont Seymour, et célébré dignement l'événement. Félicitations à l'équipe de l'Université Western Ontario qui a remporté la coupe de la SCGC à titre de grand gagnant. Western défendra son championnat et accueillera l'activité en 2014 (gnctr2014.com).

Photo: Amie Therrien

Carsteel Manufacturing Ltd. Team Legacy from University of Calgary pose for a picture while building their bridge./L'équipe Carsteel Manufacturing Ltd. de l'Université de Calgary prend la pose tout en construisant son pont dans le cadre du concours.

© 2013 Hao Yin Photography

CSCE Cup winners, Les Imponderables, from CEGEP de Chicoutimi, cheer on their bridge as it faces the Crusher./ Gagnants de la coupe de la SCGC, Les impondérables, du CEGEP de Chicoutimi, saluent leur chef d'œuvre qui va passer sous l'écraseur.

A group of students from McMaster University show their excitement for GNCTR./Un groupe d'étudiants de l'Université McMaster témoignent de leur enthousiasme pour le concours.

The WETT Vikings from the University of Western Ontario accept the CSCE Cup./Les « WETT Vikings », de l'Université Western Ontario, gagnants de la coupe de la SCGC.

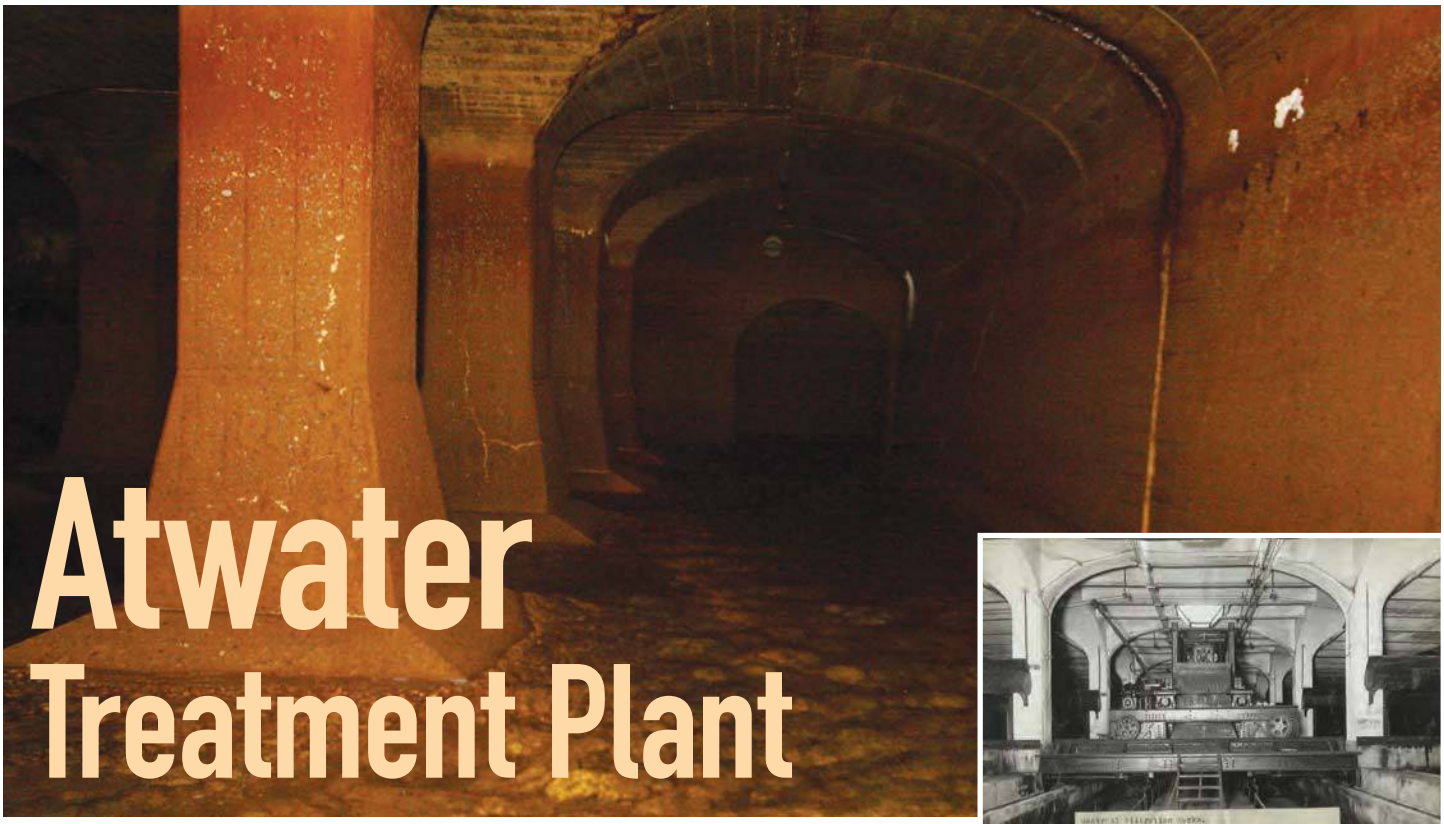
D'autres étudiants se sont aussi réunis à Montréal au début de mars pour le concours de pont Troitsky de la SCGC. Comme d'habitude, Concordia a bien organisé l'événement au cours duquel plus de 25 équipes ont soumis leurs chefs d'œuvre aux juges avant de les voir succomber sous le poids de l'écraseur. Consultez le site troitsky.ca pour savoir comment vous inscrire au concours de l'an prochain.

Enfin, il y a le concours national de canot en béton (Canadian National Concrete Canoe Competition), qui aura lieu à Montréal, à l'École de technologie supérieure (ETS), du 17 au 19 mai prochain. Pour obtenir tous les détails, consultez le site concretecanoe.com.

Even superheroes make time for GNCTR! Team Batmoboggan from UBC makes their way down the hill./Même les superhéros participent ! L'équipe « Batmoboggan » de UBC en pleine descente.

Autre activité importante au calendrier : le congrès annuel de la SCGC, qui aura lieu à Montréal, du 29 mai au 1er juin. Tous les concours mentionnés ci-dessus enverront deux membres de l'équipe gagnante au congrès pour recevoir leurs prix. Également au programme : diverses activités pour les étudiants et les jeunes professionnels, en plus des conférenciers éméritas, des communications et des activités qui constituent l'essentiel du congrès. Visitez le site http://www.csce2013.ca/young_professionals pour avoir plus de renseignements. ■

Vous pouvez rejoindre Amie Therrien à l'adresse yp@csce.ca



Atwater Treatment Plant

Above left: water reservoir constructed in 1911. Inset: filtration gallery.

The City of Montreal's first water treatment plant is over a century old, but thanks to many upgrades it still provides good quality water to a population of 1.8 million.

The Atwater Treatment Plant in the City of Montreal has been recognized this year as a Civil Engineering Historic Site by the CSCE.

The Atwater treatment plant combined with the Charles J. des Baillets plant represents 88% of the City of Montreal's water treatment capacity serving a population of 1.8 million. The Atwater plant is the work of Mr. Charles J. des Baillets who was chief engineer of the City of Montreal Aqueduct Commission between 1921 and 1941.

Established at the beginning of the last century, the plant has undergone expansion and modernization. However, several of its original engineering works are still in operation and the plant continues to produce high quality drinking water for Montreal.

History of the plant

Due to an outbreak of typhoid fever in 1910, Montreal city council decided to build its first water treatment plant. The Atwater plant, which was completed in 1918, provided an initial capacity of 200,000 m^3/day and has since been upgraded to a capacity of 1.36 million m^3/day, making it the largest in Quebec. The plant was also the largest in Canada until the construction of a new treatment plant in Vancouver.

Even before the construction of the plant, it was Thomas Coltrin Keefer (one of the founding members of the Canadian Society of Civil Engineers, the predecessor of the modern CSCE), who in 1853 proposed the construction at the end of the aqueduct canal of a pumping station powered by two water wheels driven by the current in the canal. From this point the water was to be pumped to a reservoir on Mount Royal and redistributed by gravity to the city. This distribution system concept is the one still in use, beginning at the site of the existing Atwater plant.

Construction of the Atwater plant began in 1911. Most of the additions have been related

HISTORIC CIVIL ENGINEERING SITES

Each year, the CSCE's National History Committee selects sites or projects to be commemorated as national Historic Civil Engineering Sites. This year, the Atwater Water Treatment Plant in Montreal and the trestle at Cap-Rouge near Quebec City are being honored.

to process equipment, pumping expansions and electrical upgrades. All buildings that house pumping and filtration activities are classified as "Buildings of Exceptional Heritage Value" by the City of Montreal and their restoration must meet strict criteria.

In the late 1970s the Charles J. des Baillets plant was added to meet growing demands.

Current upgrades

Following regulatory changes, upgrades to the processing chain were started in 2005 to ensure compliance with the new standards. The original process was limited to sand filtration and chlorination. Ozonation and UV disinfection have since been added. For security purposes, disinfection with chlorine gas will be replaced by sodium hypochlorite generated on site. Parallel to these changes, upgrades are being made to pumping, mechanical, electrical and control systems, and to the building envelope.

By the time the upgrades are complete in 2015 the Atwater plant will exceed regulatory standards both in terms of quality and capacity. These improvements, worth $300 million, will give the city a plant on the cutting edge of technology at a cost below that of a new plant.

By opting for the renovation of this century old plant, the city will meet the highest standards of water supply while optimizing investments, ensuring sustainability and preserving a unique civil engineering site.

MAJOR MILESTONES IN THE CONSTRUCTION OF THE ATWATER PLANT:

1911	Construction of the first part of the plant (now converted to a reservoir). This first gallery remains intact and includes the structural level (see photo).
1918-1921	Construction of the first wing (north) of the central pumping station.
1927-1947	Successive additions of filter galleries 2, 3 and 4.
1932	Construction of the south wing of the central pumping station.
1951	Addition of a new intake.
1958-1967	Addition of filter galleries 5, 6 and 7.

Pumping station interior.

The Atwater plant is a tribute to engineering works that were designed and built to meet both the needs of their time and into the future. All work undertaken hereafter is with a view to ensuring sustainability.

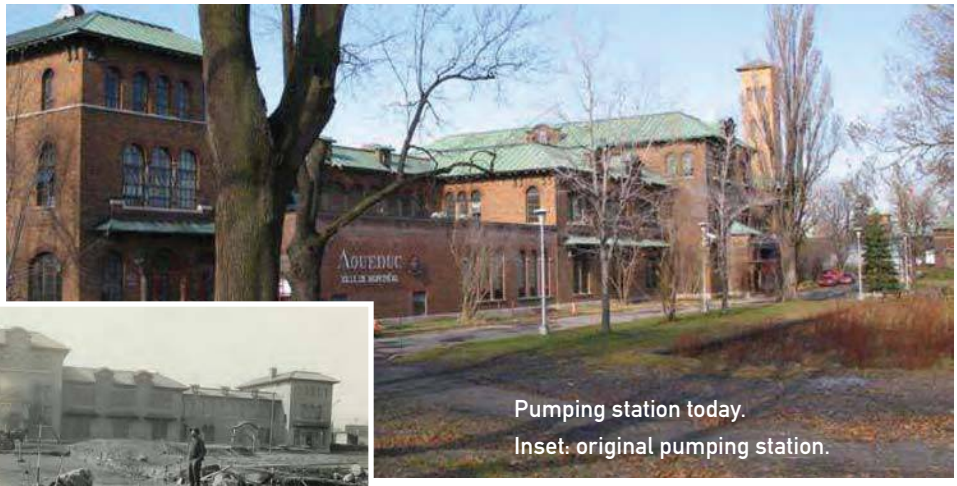
For almost a century the Atwater plant has represented a fertile skills development venue for civil engineering. The current (2005-2015) major upgrading project has enabled many to gain professional experience in the most recent innovations in water treatment.

In addition to the administrative staff, the plant has an operating staff of 69 and an engineering team of 20 engineers, technicians and telecommunications specialists. ■

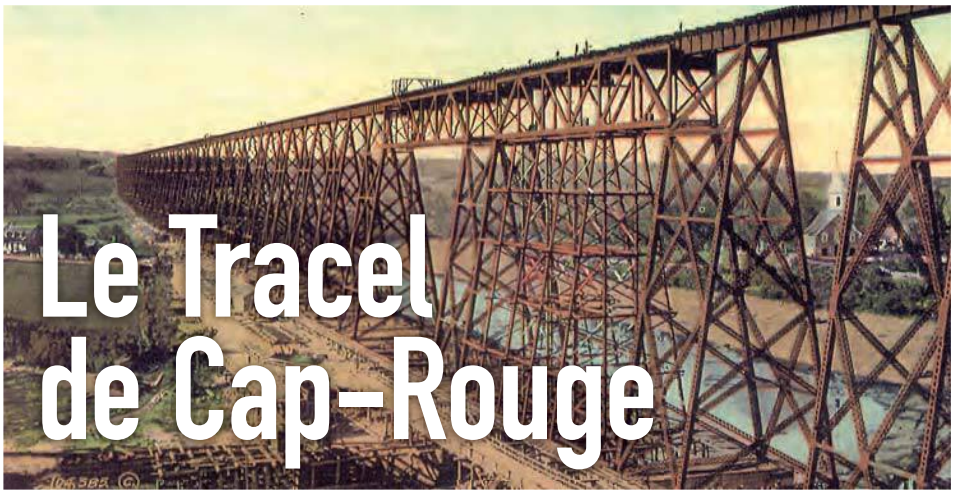
This article is adapted from a submission by the City of Montreal to CSCE. The nominating committee members from the City of Montreal are: Chantal Morissette, Babak Herischi, Yves Bernier, André Marsan, Robert Millette, with support from Michèle Prévost (NSERC), Dinu Bumbaru (Heritage Montreal).

The Atwater Plant in its current and projected state is equipped with the following:

- Raw Water Pumps: 5 pumps of 225,000 m^3/day (500 hp); 5 pumps of 160,000 m^3/day (350 hp)
- 96 filters in 6 galleries with a capacity of 576 m^3/hr
- Ozonation (under construction). A filter gallery is being converted into a contact tank for pre-ozonation and for adding coagulation chemicals to about 210,000 m^3 of filtered water and almost 75,000 m^3 of water filtered and disinfected.
- Addition of an ultraviolet disinfection system replacing the current chlorine gas system and addition of a system to produce sodium hypochlorite on site.
- 14 high pressure pumps of 135,000 m^3/day (2000 hp)
- 3 – 1800-mm diameter steel outlet headers and 1 – 1500-mm diameter outlet.



Pumping station today.
Inset: original pumping station.



Le Tracel de Cap-Rouge

Source: The Valentine and Sons Publishing Co Ltd, collection Magella Bureau, vers 1910 (carte postale)

Par Yolande Perron
(recherche et rédaction)

Cap-Rouge se situe à l'ouest de la ville de Québec sur le fleuve Saint-Laurent à 2,5km du pont de Québec.

Au début du XXe siècle, le patrimoine carougeois s'est enrichi d'une construction monumentale en acier désignée dans le langage populaire sous le nom de « Tracel » de l'anglais trestle. Il a été construit pour franchir une vallée profonde, sans devoir la contourner au nord par un long détour, et surtout respecter les normes prescrites des pentes et des virages.

Cette importante structure fait partie du troisième transcontinental qui relie le Canada d'une côte à l'autre. Le Tracel, après 100 ans de loyaux services, est toujours fonctionnel. Aujourd'hui deux ou trois trains de marchandise le parcourent quotidiennement à vitesse réduite.

La venue de la technologie de l'acier pour les ponts ferroviaires

La fin du XIXe et le commencement du XXe siècle marquent le début de la technologie de l'acier pour les ponts ferroviaires dû à sa solidité et sa durabilité, nonobstant le coût plus élevé. L'ère de cette nouvelle technologie d'acier et de fer succédait aux grosses structures en bois des ponts ferroviaires qui déclinaient en vertu de nos rigoureux hivers canadiens.

Le Tracel de Cap-Rouge appartient à cette génération de monumentales structures en acier : 4 288 000kg ont été utilisé. La compagnie Dominion Bridge de Lachine, Montréal, est le maître d'œuvre des plans de la superstructure. Mandatée par la Commission du chemin de fer National Transcontinental, elle s'emploiera à l'édification et au rivetage des structures métalliques. Dans le paysage de Cap-Rouge, le Tracel est un témoin de l'architecture industrielle de son époque.

La construction du pont de Québec, indissociable du Tracel

En 1906 on débutera la construction du viaduc ferroviaire pour rejoindre le pont de Québec conçu et construit principalement pour servir de pont ferroviaire. Ce sont deux projets intimement liés, ils seront ainsi plus faciles à réaliser. Par le Tracel, on viendra traverser le pont de Québec pour se rendre sur la rive sud du Saint-Laurent jusqu'au Nouveau-Brunswick. Les Maritimes sont importantes en raison de leur accès direct à l'Atlantique par leurs ports où affluent marchandises et immigrants.

En effet ce nouveau projet ferroviaire d'un océan à l'autre a grandement contribué à la croissance économique du Canada par l'exploitation des ressources naturelles, l'immigration, l'agriculture, les ressources minières, le transport efficace des marchandises et des passagers, ce qui a fait du Canada une force économique concurrentielle. Et en raison de ce lien avec le Tracel, ce gigantesque projet a aussi largement collaboré au développement du Nord de l'Ontario et du Québec -- dans ce dernier cas surtout l'Abitibi et la Mauricie. C'était la belle époque d'importants chantiers ferroviaires.

La chronologie de la construction du Tracel

La Commission du chemin de fer National Transcontinental approuve le tracé général fin 1905 ou début 1906. Ce viaduc s'étendra sur 1017m de longueur et d'une hauteur de 52,4m à marée basse.

À l'été de 1906, les entrepreneurs M.P. et J.T. Davis commencent les travaux de fondations. Se joindront à eux d'autres ingénieurs comme E.A. Hoare, pour une courte durée et de qui relèvent d'ailleurs les emprises du pont de Québec, et surtout A.E. Doucet, ingénieur responsable du district B de la Eastern Division.

Rapidement, on se rend compte que la tâche sera plus ardue qu'envisagée. À Cap-Rouge, les marées hautes peuvent atteindre de 5 à 7m. Ainsi elles pourraient emporter les piliers ou une érosion pourrait avoir le même résultat. Par conséquent, on décide d'adopter la technique des caissons pneumatiques bien que cette technique soit plus coûteuse que le contrat le permet.

Les premiers plans du viaduc comprennent 32 chevalets. L'approbation de les modifier a été confirmée le 19 mars 1907, dans une lettre adressée à la Commission du National Transcontinental Railway signée par M. Hugh D. Lumsden, ingénieur en chef (Sgd). Pour éviter la construction de piliers en plein dans la rivière, on a résolu d'enjamber la rivière avec des piliers de formes différentes voisinant la rivière. Les piliers prévus d'avant sont remplacés par des piliers rectangulaires plus volumineux à cause de la profondeur des

assises solides. Seul le tiers de la hauteur de ces piliers sont apparents. Mais ce travail a toutefois impliqué 1735,6m3 de béton chacun et de nombreuses heures additionnelles. D'ailleurs, la justification de l'emploi de cette technique plus longue et par le fait même plus coûteuse fera l'objet d'une commission d'enquête.

La construction des trois caissons pneumatiques et des fondations perdure bien que la livraison du viaduc soit prévue pour l'ouverture du pont de Québec en 1909. Parallèlement la Dominion Bridge commence les travaux de la superstructure en juin 1907 sur les piliers déjà en place, à partir de l'extrémité sud-ouest de la vallée et se dirigeant vers le nord-est.

Par ailleurs, à cause du premier effondrement du pont de Québec en août 1907, il n'y a moins de hâte à compléter le viaduc. Les rails seront posés entre 1908 et 1911 et les autres travaux nécessaires seront graduellement échelonnés jusqu'en septembre 1913. Mis à part le pont de Québec, la ligne Winnipeg-Moncton était complétée le 17 novembre 1913.

Le viaduc de Cap-Rouge fut la première structure importante de son genre à être réalisée au Canada. Toutefois en importance au Canada il vient en second lieu après le viaduc de Lethbridge en Alberta.

Le rivetage à chaud

Le travail de rivetage à chaud était exécuté dans des conditions dangereuses. Il demandait beaucoup d'adresse et de force. Comme l'acier refroidissait rapidement il fallait se presser.

Selon nos sources l'équipe de rivetage se compose de quatre hommes. Henri Bertrand, porteur-d'eau, avait relaté à sa famille le processus d'exécution pour la pose des rivets. À partir d'une forge mobile, il y a celui qui lance les rivets chauffés à blanc, celui qui les attrape au vol avec un cornet pour les passer avec de grandes pinces d'acier à un troisième qui les met en place dans les trous préparés à cet effet. Le dernier homme de l'équipe, à l'aide de son marteau à riveter, écrase les deux extrémités du rivet chauffé à blanc. (Déry, 2000).

Le fonçage à air comprimé

Ces caissons de béton étaient coulés à l'intérieur d'un batardeau construit en pièces de bois jusqu'à la nappe d'eau. A l'intérieur de ce batardeau, un caisson était coulé et enfoncé au fur et à mesure que les ouvriers, travaillant dans une pièce pressurisée sous le caisson, extirpaient la glaise pour la placer dans une benne remontant le matériel à la surface par un cylindre de 1,9m de diamètre. Il faudra creuser profondément à travers la boue et la glaise pour atteindre le roc ce qui aura comme fonction de bien asseoir les piliers.

Les ouvriers ne pouvaient travailler que quelques heures consécutives vu la pression constante qui empêchait l'eau d'entrer dans le caisson. Un deuxième tube d'acier avec échelle et écoutille permettait l'accès et la sortie des ouvriers le tout étanche à 35 livres au pouce carré de pression (Simard, 1920; Ouellet, 1948).

Source: collection Société historique du Cap-Rouge, vers 1908

La poutre à treillis

Une poutre à treillis, appelée également poutre Eiffel ou poutre rivetée, est un ensemble de barres en acier reliées entre elles en formant des triangles.

Très présente durant la période de la construction du Tracel cette technique, comparativement à d'autres, a comme principal avantage d'être un élément porteur plus efficace, solide et rigide tout en permettant un assemblage solide avec un minimum d'acier. Conséquemment on obtient une structure moins lourde.

Cette particularité de poutre comprend généralement deux membrures parallèles reliées par un mélange de « diagonales » et de « montants » disposés à angle droit par rapport aux membrures. Construit selon cette technique, le Tracel est assez solide pour porter une charge quatre fois plus lourde que prescrite par les normes (Nicole, 1983).

La main-d'œuvre

À la construction du viaduc, le contremaître du chantier, Jos Brousseau de Cap-Rouge, a signalé qu'entre 1908 et 1909 il se trouvait sur le chantier jusqu'à 500 travailleurs qui venaient de Québec, Sainte-Foy, Cap-Rouge, St-Augustin, etc. (Lessard, 2008).

Les coûts

Une commission royale d'enquête justifia les coûts supplémentaires apportés au contrat original, dans l'esprit du grand défi de stabiliser les piliers qui demandaient les fondations améliorées par des caissons pneumatiques. Les trois chevalets jouxtant la rivière coûteront à eux seuls 329 429,18$ sur un coût total des fondations de 454 133,51$. Quant à la superstructure, elle ne coûtera guère plus cher que le contrat ne le prévoyait, soit un grand total de 817 462, 73$.

Selon l'évaluation foncière en vigueur pour les trois prochaines années d'exercice, la valeur du terrain et du Tracel est de 8 425 000$, soit environ dix fois le coût d'origine.

Conclusion

Le viaduc de Cap-Rouge reste un témoin d'une époque de bâtisseurs de pays et de nouvelles techniques. Le Tracel est de construction notable par ses dimensions. Il l'est aussi par la méthode à caisson pneumatique utilisée. Ce pont ferroviaire sur 30 chevalets est très imposant. Malgré cette masse métallique, la finesse de l'ensemble de son treillis est clairement perceptible sous différents angles. ■

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CONFERENCE ORGANIZATION

The Annual General Conference is being held in conjunction with four specialty conferences and a forum on professional practice and career development. The conference theme of *Know-How* will be covered throughout.

The Annual General Conference provides researchers and practitioners with a wide variety of topics including:

- geotechnical engineering
- structural engineering
- environmental engineering
- transportation engineering and policy making
- sustainable development and practices
- case studies
- civil engineering history
- codes of practice and their change to encourage greater sustainability
- cold and arctic regions engineering
- emerging technologies
- geomatics and remote sensing
- municipal engineering
- information technologies & computer applications

4TH SPECIALTY CONFERENCE ON COASTAL, ESTUARY AND OFFSHORE ENGINEERING:

- Storms and hurricane: impacts and mitigation
- Tidal inlet: morphodynamics and modeling
- Tsunamis: risk and mitigation
- Structures côtières : modélisation physique et numérique
- Coastal structures: physical andnumerical modeling wave and tidal energy
- Ports andnavigation waterways: design and retrofitting
- The Great Lakes: challenges and problems
- Impacts of global warming on coastal structure design and coastal erosion.

3RD SPECIALTY CONFERENCE ON DISASTER PREVENTION AND MITIGATION:

- Wind storms
- Winter storms: snow and atmospheric icing
- Earthquakes
- Emergency-preparedness planning and post-disaster management
- GIS in emergency management
- Disaster response for lifeline systems
- Rapid damage assessment
- Vulnerability assessment at local and urban scales
- Seismic retrofit and advanced technologies
- Advances in monitoring technologies and alert systems
- And public participation in emergency response.

4TH CONSTRUCTION SPECIALTY CONFERENCE:

- Construction engineering and management
- Modeling and simulation
- Planning and scheduling
- Management and optimization of construction operations and processes: procurement, Resources, quality assurance, health and safety and risk assessment
- Integrated cost and time control
- Productivity and benchmarking
- Sustainable infrastructure management
- Computer and web-based applications
- Automated and realtime systems
- building information modeling (BIM)
- Decision-making system
- Artificial intelligence and information technology

3RD SPECIALTY CONFERENCE ON ENGINEERING MECHANICS AND MATERIALS:

- Novel experimental and numerical methods
- Nonlinear behavior and structural stability
- Computer-aided engineering; probabilistic methods
- High-performance and innovative materials
- Aging effects and long-term durability of materials
- Elasticity, plasticity, and fracture mechanics
- Application of recycled materials in road and construction industry
- Bituminous and pavement materials
- Soil-structure and fluid-structure interactions
- Soil reinforcement
- Improvement of loadbearing capacity
- Underpinning and foundation repairs
- Properties of structural and geotechnical materials

2ND FORUM ON PROFESSIONAL PRACTICE AND CAREER DEVELOPMENT:

EMPLOYMENT OF CIVIL ENGINEERS IN THE 21ST CENTURY

- Canadian Engineering Competiveness in Foreign Markets
- Outsourcing and foreign competition
- Employment, unemployment, and underemployment
- Recruitment and retention of engineers, their remuneration and unionization
- Difficulty in establishing new engineering enterprises
- Supply and demand of engineering graduates
- Erosion of the scope of civil engineering practice

EDUCATION AND CONTINUING EDUCATION

- Teaching future civil engineers
- Perspectives on professional development
- Pedagogical challenges in technical upgrading and advancement of civil engineers
- Recognizing emerging technologies

CIVIL ENGINEERS IN THE WORKPLACE

- Ethics, liability and insurance in a changing world
- Professional image and career advancement
- Challenges of working in multidisciplinary, diverse workplaces
- Professional licensing and learned societies: allies or competitors?

CIVIL ENGINEERS IN THE WORLD

- International development
- Disaster relief
- Third world issues in engineering practice (corruption, receiving payment, building effective partnerships)

ORGANISATION DU CONGRÈS

La conférence générale se tiendra conjointement avec quatre conférences spécialisées et un forum sur la pratique professionnelle et le développement de carrière.

Le thème du congrès « *Savoir-faire* » se veut rassembleur, il propose aux chercheurs et aux ingénieurs praticiens une grande variété de sujets incluant :

- ingénierie géotechnique
- ingénierie des structures
- ingénierie de l'environnement
- ingénierie des transports, et l'élaboration des politiques
- développement durable et les pratiques
- études de cas
- l'histoire du génie civil
- les codes de pratique et leur changement afin d'encourager une plus grande durabilité
- le génie des régions froides et arctiques
- les technologies émergentes
- géomatique et la télédétection
- génie municipal

4E CONFÉRENCE SPÉCIALISÉE SUR L'INGÉNIERIE CÔTIÈRE ET EN MILIEU MARITIME:

- Tempêtes et ouragans : impacts et mesures d'atténuation
- Goulet de marée : morphodynamique et modélisation
- Tsunamis : risques et atténuation
- Structures côtières : modélisation physique et numérique
- Énergie des vagues et des marées
- Ports et voies navigables : conception et rénovation
- Les Grands lacs : les défis et les problèmes
- Impacts du réchauffement climatique sur la conception de structures côtières et l'érosion côtière

3E CONFÉRENCE SPÉCIALISÉE SUR LA PRÉVENTION ET LA MITIGATION DES DÉSASTRES NATURELS:

- Vents extrêmes
- Tempêtes hivernales: neige et verglas
- Séismes
- Gestion des désastres et planification des mesures d'urgence
- Systèmes SIG en gestion de désastres
- Réponse des infrastructures essentielles
- Évaluation rapide des dommages
- Évaluation des vulnérabilités à l'échelle locale et à l'échelle urbaine
- Technologies de surveillance et systèmes d'alerte
- Participation des citoyens dans la réponse post-désastre

4E CONFÉRENCE SPÉCIALISÉE SUR LA CONSTRUCTION:

- Gestion de l'ingénierie et de la construction
- Modélisation et simulation
- Planification et ordonnancement
- Gestion et optimisation des opérations de construction et des processus : approvisionnement, ressources, assurance qualité, santé et sécurité et risques
- Contrôle intégré des coûts et du temps
- Productivité et analyse comparative
- Gestion durable des infrastructures
- Applications informatiques et Web
- Systèmes automatisés en temps réel
- Modélisation des informations du bâtiment (BIM)
- Systèmes d'aide à la décision
- Intelligence artificielle et technologie de l'information

3E CONFÉRENCE SPÉCIALISÉE SUR LA MÉCANIQUE APPLIQUÉE ET LES MATÉRIAUX:

- Nouvelles méthodes expérimentales et numériques
- Comportement non-linéaire et stabilité des structures
- Ingénierie assistée par ordinateur
- Méthodes probabilistes
- Matériaux novateurs et de haute performance
- Effets du vieillissement et durabilité à long terme des matériaux
- Élasticité, plasticité, et mécanique de la rupture
- Application des matériaux recyclés dans l'industrie de la construction et des routes
- Matériaux bitumineux et enrobés de chaussées
- Interactions sol-structure et fluide-structure
- Renforcement des sols
- Amélioration de la capacité portante
- Reprise en sous-œuvre et réparation des fondations
- Propriétés des matériaux structurels et géotechniques

2E FORUM SUR LA PRATIQUE PROFESSIONNELLE ET LE DÉVELOPPEMENT DE CARRIÈRE:

EMPLOIS POUR LES INGÉNIEURS CIVILS AU 2IE SIÈCLE

- Compétitivité du génie canadien dans les marchés étrangers
- L'externalisation et la concurrence étrangère
- L'emploi, le chômage, et la sous-utilisation des capacités
- Le recrutement et la rétention des ingénieurs, leurs rémunérations et la syndicalisation
- Difficulté à établir de nouvelles entreprises d'ingénierie
- Offre et demande de diplômés en génie
- L'érosion de la portée de la pratique du génie civil

EDUCATION ET FORMATION CONTINUE

- Enseigner aux futurs ingénieurs civils
- Perspectives sur le développement professionnel
- Les défis pédagogiques dans les mises à niveau techniques et dans l'avancement des ingénieurs civils
- Reconnaître les technologies émergentes

INGÉNIEURS CIVILS DANS LE MILIEU DE TRAVAIL

- L'éthique, responsabilité et assurance dans un monde en mutation
- L'image professionnelle et l'avancement professionnel
- Les défis de travailler dans les lieux de travail multidisciplinaires
- Les professionnels des sociétés d'octroi de licences et brevets: des alliés ou concurrents?

INGÉNIEURS CIVILS DANS LE MONDE

- Développement à l'international
- Les opérations de secours
- Les questions du Tiers-Monde dans la pratique du génie (la corruption, la réception du paiement, l'établissement de partenariats efficaces)

SOCIAL EVENING

Montreal's 2013 social evening event will be like none other! This year's theme is "*Moulin Rouge/Cabaret*". This will be a fun filled exciting night indeed. Walking distance from the Centre Sheraton, the first part of your evening will be a typical Montreal happening on Crescent St. In Montreal's famous Sir Winston Churchill pub, you will experience a true Montreal cocktail hour. A *Cinq à Sept* in the speak of the town. Drinks (2) and appetizers will welcome you. Reconnect with old CSCE friends and make new ones at this landmark Montreal watering hole.

Later we will all make our way upstairs to Karina's Club Lounge. You will be welcomed to our "*Moulin Rouge/Cabaret*"! This night promises to be one of excitement and surprises. A feast for your sight, taste and all your senses! You will enjoy a 4 course meal which also includes 2 glasses of wine. This tantellizing evening is one you won't want to miss!

Dress: Any way you feel good. Dress down or up to the nines. It's "MOULIN ROUGE" and Montreal after all. A little naughty, a little nice, it's all up to you.

SOIRÉE SOCIALE

La soirée mondaine du congrès 2013 sera tout un événement. Cette soirée aura pour thème « *Cabaret/Moulin Rouge* ». Et ce sera toute une soirée, qui commencera par une petite marche depuis le Centre Sheraton jusqu'à la rue Crescent, haut lieu des soirées montréalaises. Au « Sir Winston Churchill pub », vous apprécierez le traditionnel *cinq à sept* montréalais. Belle occasion pour revoir de vieux amis de la SCGC !

Après l'apéro, vous monterez au Club Karina, au « *Cabaret/Moulin Rouge* » ! Une soirée pleine de surprises, avec un spectacle qui vous en mettra plein la vue ! Sans parler du repas de quatre services bien arrosé. Une soirée à ne pas rater !

Tenue vestimentaire : selon votre bon goût. Tenue relax ou plus élaborée, selon vos préférences.

COMPANION'S PROGRAM

We are very proud to present our Companion's Program for the Montreal 2013 Conference!

We have put together 3 exciting days of Montreal touring. Accompanying you for the entire 3 days will be Kate Puxley, a young , talented Quebec artist who will be there with you every step of the way to show you our beautiful and exciting city.

For more information on the Program, please click on the links below. You are not required to attend all three days of activities, however as a special gift to you, if you attend all three days, you will be invited to a very special cocktail in the President's suite where you will be pampered by having your hair and makeup done just for you so you will look your very best at the Awards Banquet!

Please know that we've worked very hard to ensure you have the very best prices possible and are at cost to the Montreal 2013 Conference.

- Cuisine/Opera and Old Montreal Walking Tour
- Olympic Stadium-Biodome-Botanical Gardens
- Shopping tour – Holt Renfrew, Ogilvy and Ste. Catherine Street

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Nous sommes fiers de vous présenter notre programme des compagnes et compagnons pour le congrès de 2013 à Montréal ! Nous avons organisé trois journées absolument fascinantes de visites à Montréal. Kate Puxley, une jeune artiste du Québec, vous accompagnera en tout temps, pendant ces trois jours, pour vous faire découvrir notre belle ville.

Pour plus de renseignements sur le programme, cliquez sur les liens ci-dessous. Vous n'êtes pas tenu de participer aux activités tous les jours. Toutefois, si vous participez à tous les jours, vous serez invité à un cocktail spécial dans la suite du président, pendant lequel vous aurez droit à une séance de coiffure et de maquillage qui vous permettra de vous présenter en beauté au banquet des lauréats !

- Cuisine/Opéra et visite à pied du Vieux Montréal
- Stade olympique – Biodôme – Jardin botanique
- Visite de magasinage – Holt Renfrew, Ogilvy et la rue Ste-Catherine

Photo: Thinkstock

A National Infrastructure Bank for Canada

By M. Saeed Mirza, P.Eng, Ph.D., FCSCE
PRESIDENT CSCE, 1985/86

Canada's severely deteriorated infrastructure requires an investment of $123 billion to upgrade the deteriorated municipal facilities to a minimum acceptable level of performance, along with another $115 billion for new or expanded assets to fulfill the changing community needs for demographic, socio-economic, environmental and other reasons (FCM-McGill 1996, 2007). Along with the infrastructure under the jurisdictions of the federal and provincial government, and their continued neglect and ongoing accelerated deterioration over the next 10-15 years, the total infrastructure deficit could easily reach $500 billion dollars.

Presently, Canada's energy infrastructure needs an investment of about $300 billion in electrical power generation and transmission infrastructure, along with another $200 billion in oil and gas extraction and transportation infrastructure (basically, the pipeline system).

In summary, the total infrastructure investment needs in Canada are approximately $1 trillion, which could easily compound (at an assumed rate of 5%) and escalate to well over $3 trillion in another 25 years, if no remedial actions are taken urgently. Innovative sources of sustainable financing and sound management of infrastructure are needed to combat this urgent crisis, which could seriously harm Canada's productivity, international competitiveness and the overall quality of life of all Canadians (Mirza 2005, 2012).

A new institution: an infrastructure bank

A new financing institution to overcome the current shortcomings of the present mix of financing arrangements should provide a stable, long-term financing source to offset the instability of both the federal and provincial aid through grants and subsidies, and the bond market uncertainties. It should also use the available sources to institutionalize new management practices, since new investment would be wasteful if the infrastructure facilities are turned back to the same "old" ineffective arrangements that resulted in their deterioration (Peterson, 1984).

This institution must optimally use the available financial resources, or leverage, to encourage the authorities to establish long-term user-fees based on total costs for financing of capital assets, wherever possible. The needed long-term investments should be linked to long range (50 to 100 years) planning by requiring the recipients to generate their own assessments of infrastructure needs, and maintenance requirements, and immediate investment priorities. In the process, the provincial and local governments should be allowed flexibility in deciding on the local priorities for "catch-up" investment, since they cannot be established uniformly at the federal level.

Innovative sources of sustainable financing and sound management of infrastructure are needed to combat this urgent crisis.

A federal infrastructure bank would meet these requirements, and help alleviate the crisis by making variable interest loans for infrastructure investments. Also, as the loans are repaid, they can be recycled to other capital projects.

Role of elected politicians and public officials

Presently, the different levels of Canadian government do not have the financial means and have only a partial political will to finance upgrading, or maintenance and development of new infrastructure. Significant cutbacks in transfers from the federal and provincial governments have put a tremendous burden on local or municipal governments. These cutbacks combined with the strong need for infrastructure renewal have forced all levels of government, including the municipalities, to seek new and innovative ways to finance infrastructure. Their challenge is to ensure that infrastructure needs are met in the least costly and sustainable manner and to find additional financial resources.

Besides municipal taxes, alternative meth-

ods of financing infrastructure renewal are available and some have already been practiced by several municipalities, while some major federal and provincial/territorial projects are normally debt-financed with significant interest rates.

Both politicians and senior administrative officials (decisions makers) in the public sector typically do not have adequate information about the advantages and disadvantages of the various infrastructure financing alternatives which have been successfully proven in other comparable jurisdictions (domestically or internationally). Thus, the impact of trying something new is often ignored or viewed with suspicion, or is considered risky.

Municipal officials and others responsible for financing infrastructure no longer have a choice but to consider the available alternative financing techniques. In addition, public officials should focus on infrastructure renewal, rather than on the development of new infrastructure, unless it is absolutely necessary. Rehabilitation of infrastructure offers no "photo ops" for politicians, as for new infrastructure assets. However, remediation is at least as big a challenge as constructing new infrastructure, regardless of its public appeal. Public education by the various levels of government could mitigate some of these issues.

Where do we go from here?

The Government of Canada must immediately acknowledge the serious infrastructure crisis facing all levels of government, and initiate a national conference of all stakeholders and interested professionals to develop a national infrastructure policy (Mirza 1998, 2005, 2012). It should also examine the creation of an infrastructure bank as this type of structure is working well for infrastructure financing in some of the states in the U.S. at both the state and the federal level, and in Europe. Because of the current financial constraints with all levels of government, it is recommended that the proposed infrastructure bank be established jointly by both the public and private sectors. A recent Australian study showed that about 15% of all major business costs are infrastructure-related (Reeder 1997).

Some preliminary recommendations are presented by Mirza (2012) for the needed legislation, structure, eligibility of projects for financing and their selection criteria. The infrastructure bank represents a long-term commitment to dealing with the infrastructure crisis, since it guarantees long-term attention to infrastructure needs; however, the current practice of "design, build and forget" must be changed to ensure that maintenance is never deferred (The Gazette, June 16, 2007). This must be the essential basis for making any loans to projects. A second round of lending activities can be ensured if the initial legislation establishes a revolving fund, so that the repaid loans are recycled to new infrastructure projects.

An infrastructure bank should make loans to facilities, such as a water or sewer system, only on the condition that all transactions will be based on full-cost pricing including all environmental and social costs.

An infrastructure bank should make loans to facilities, such as a water or sewer system, only on the condition that all transactions will be based on full-cost pricing including all environmental and social costs. These must also include the recovery of depreciation of the asset and its decommissioning and final sustainable disposal after its useful service life. The user fees must include amounts needed to sustain long-term repayment of the capital with low interest, and an appropriate repair, rehabilitation, depreciation and replacement strategy. The bank may also impose certain conditions for the issuance of loans stipulating that the local governments must implement a system of capital assessment and capital budgeting that meets professional standards set by the bank. These conditions will help ensure that the loan can be repaid and the public funds used to subsidize the loan rates will serve their intended purposes. ■

If you would like to add you voice to the discussion of CSCE's Vision 2020 Strategic Direction – Leadership in Sustainable Infrastructure, contact Nick Larson at nlarson@rvanderson.com with your idea for an article.

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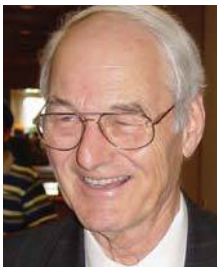
Dr. Mirza is an emeritus professor with the Department of Civil Engineering and Applied Mechanics, McGill University, Montreal.

Alistair D. MacKenzie, FCSCE
PRESIDENT, CSCE, 2005/06



Peter M. Wright, LF.CSCE
PRESIDENT, CSCE, 1981/82

Recognizing the Legacy of Civil Engineers

Thirty years ago, the Canadian Society for Civil Engineering recognized Thomas Keefer's Hamilton Pumping Station as its first National Historic Civil Engineering Site. Since then the Society through the efforts of its National History Committee has designated more than 60 such sites located from coast to coast to coast. Wherever possible the individuals most responsible for the project are also identified on the plaques. The Society's history program has led the industry in recognizing Canada's engineering history and heritage, and its work has resulted in the receipt of the Parks Canada Award in 1996 and of the Pierre Berton History Award in 2002.

The Society is fully aware of Canada's long and rich history of civil engineering achievement. Indeed, Canada may be the only country in the world whose very existence depended on the successful and speedy completion of two major civil engineering projects. These two projects, the Intercolonial Railway in the Maritimes and the very challenging Canadian Pacific Railway to the west coast, are included in the Society's National Historic Civil Engineering Sites.

In this conference issue of CIVIL we further celebrate our history. At the conference in Montreal, the Society will commemorate two more significant historic civil engineering projects: Montreal's Atwater Water Treatment Facility and the Tracel Cap-Rouge in Quebec City, as National Historic Civil Engineering Sites. Both are described in this issue of CIVIL.

In the History Notes section we profile two outstanding Canadian civil engineers from relatively recent times. The first is bridge engineer Peter Buckland, who describes the founding and development of the firm of Buckland & Taylor which recently celebrated the 40th anniversary of its founding. The second engineer is C.J. Mackenzie. Peter Wright's article pays tribute to this distinguished Canadian. In a third article, CSCE National History Committee Chair Cal Sexsmith sketches Mackenzie's vital contributions to the construction of the Broadway Bridge in Saskatoon, one of CSCE's earliest National Historic Civil Engineering Sites. ■

L'héritage des ingénieurs

Alistair D. MacKenzie, FSCGC
PRÉSIDENT, SCGC, 2005/2006

Peter M. Wright, LF.SCGC
Président, SCGC, 1981/1982

Il y a trente ans, la Société canadienne de génie civil faisait de la station de pompage de Hamilton, créée par Thomas Keefer, son premier lieu historique national du génie civil. Depuis, la SCGC, par le truchement de son comité d'histoire nationale, a commémoré plus de 60 lieux du genre situés d'un océan à l'autre. Dans la mesure du possible, les principaux responsables des projets sont aussi identifiés sur les plaques. Le programme d'histoire de la SCGC a été le premier du genre à célébrer l'histoire du génie canadien, et ses travaux lui ont valu le prix de Parcs Canada de 1996 et le prix d'histoire Pierre Berton, en 2002.

La SCGC est consciente de la richesse de l'histoire du génie canadien. En fait, le Canada est peut-être le seul pays au monde dont l'existence a dépendu de la réussite de deux grands projets de génie. Ces deux projets furent le chemin de fer intercontinental (Intercolonial Railway), dans les provinces maritimes, et le chemin de fer du Canadien Pacifique, sur la côte du Pacifique, qui font partie des lieux historiques commémorés par la SCGC.

Ce numéro de « CIVIL » porte sur notre histoire. Au congrès de Montréal, la SCGC commémorera deux autres importantes réalisations du génie civil : l'usine de traitement des eaux Atwater, et le viaduc (le tracel) de Cap Rouge, près de Québec. Ces deux lieux sont décrits dans ce numéro de « CIVIL ».

Dans la section réservée aux affaires historiques, nous soulignons la contribution de deux ingénieurs plus contemporains. Le premier est Peter Buckland, spécialiste en ponts, qui décrit

la fondation et la croissance de la firme « Buckland and Taylor », qui vient de célébrer son 40e anniversaire. Le deuxième ingénieur est C.J. Mackenzie. L'article de Peter Wright rend hommage à ces deux grands canadiens. Dans un troisième article, le président du comité des affaires historiques nationales de la SCGC, Cal Sexsmith, évoque les contributions essentielles de Mackenzie à la construction de « Broadway Bridge », à Saskatoon, l'un des premiers ouvrages commémorés par la SCGC à titre de lieu historique national du génie civil. ■

Buckland & Taylor Ltd. — 40 years

BY PETER BUCKLAND, FCSCE

Last year marked the 40th anniversary of the founding of Buckland & Taylor Ltd. This article is a brief summary of those first 40 years, with some observations on the road to success.

The founders

While at the University of Cambridge, Peter Buckland discovered his lifelong passion: bridge engineering. In 1960 he joined Freeman Fox and Partners, eminent UK bridge engineers, and in 1963 he emigrated to Canada where he worked for a steel fabricator for five years and a consultant for three. The shock of being laid off in 1970 dissolved into his lucky moment as, out of a job, he started Buckland & Associates.

Peter Taylor graduated from Birmingham University in the UK in 1960, then earned his Master's degree from the University of British Columbia and his Ph.D. from Bristol University in the UK, before emigrating in 1965 to work for Dominion Bridge Company in Lachine, Que. Eventually he moved to Vancouver and worked as an independent structural engineer.

In 1969 Buckland and Taylor were both working on major bridges when Bob Wardlaw of the National Research Council of Canada suggested that they should meet. Little did they realize how momentous this meeting would be, not only for themselves but also for hundreds of future engineers.

Origin of the company

While working independently, Buckland and Taylor occasionally collaborated on projects. In 1972 they were asked to study how to replace the roadway deck of the approach viaduct of the Lions' Gate Bridge, without interrupting daytime traffic. This was the impetus needed to create what would one day be a world-leading bridge engineering company: Buckland & Taylor Ltd. (B&T).

Photos: Buckland & Taylor Ltd

Trikoupis Bridge, Greece: independent engineer

Lions' Gate Bridge, Vancouver: renovation

Pivotal moments

The Lions' Gate viaduct posed a challenging question: how to remove the concrete deck, and form, pour and cure a new one while keeping all lanes open during the daytime? B&T's solution was to replace the concrete deck with prepaved steel orthotropic deck panels, during full closures of the bridge at night. Finished in 1975, and believed to be a world's first, the technique was later copied on the Golden Gate and other major bridges.

The success of this project led to a study of how to replace the deck on the suspended spans of the bridge. The selected option was to completely replace the suspended structure, 30 m at a time, during full weekend closures. However, the project was delayed until 1999, by which time weekend closures were no longer tolerated, so the work was

Photo: Buckland & Taylor Ltd

Bangkok, Thailand: design

done at night in 20-m lengths. It was another world's first (to be repeated soon on the Macdonald Bridge in Halifax,).

In 1982, the B.C. government planned a cable-stayed bridge with a world-record span. CBA Engineering, who had done the initial study, approached B&T to form a 50-50 joint venture to pursue the project. The joint venture was selected to design a steel alternative, with a rival group designing a concrete alternative. Both alternatives were tendered, and the CBA-B&T design won. The Alex Fraser Bridge was opened to traffic in 1986.

This launched the company into the big league of major bridges, and many cable-stayed and suspension bridge projects followed, some of them being design assignments, and some the difficult erection engineering. Working for contractors helped to improve the company's skills in practical design.

In the 1980s the company made the decision to focus on bridges only. This was a risky decision because it meant refusing all non-bridge work that had been a large part of its revenue.

A longer-term pivotal change for B&T has been the swing by governments to the design-build process. This has allowed B&T to compete on its position of strength: the design of durable, buildable, economical bridges.

Projects

Over the years one successful project has led to another, with almost 1000 bridge projects completed. These include: the design of the three longest-span cable-stayed bridges in Canada and the U.S.; independent engineer for Confederation Bridge in Canada and Harilaos Trikoupis Bridge in Greece; erection engineering for the Ting Kau Bridge in Hong Kong and Sheikh Zayed Bridge in Abu Dhabi; renovation of Macdonald and MacKay suspension bridges in Halifax; and seismic retrofit of California's historic arch bridges.

The list includes more than 20 cable-stayed bridges, 15 arches, 15 suspension bridges, many girder and truss bridges, and one of the world's few floating bridges.

Innovation

One of the most satisfying aspects for B&T has been the opportunity to find original ways to improve what has gone before. For example, for a cable-stayed bridge, Alex Fraser Bridge incorporated the first use of long lay cables, the first concrete deck acting compositely with the girders, the first use of precast deck panels, the first "tuning fork" towers, and was the first to be designed to modern North American earthquake standards.

The Lions' Gate Project spurred research into traffic loading of long span bridges, wind tunnel testing in turbulent flow, dynamics and structural damping. Arras, Beaver, Parsnip, Peace River, Murray and Wolverine Bridges were all launched from the bank using various innovative techniques. Other bridges were floated, cantilevered and erected by high-line. Ease of construction is central to all B&T designs.

Another fascinating aspect has been serving on national design codes, particularly Canadian Standard CAN/CSA-S6, where B&T's staff contributed to going metric, adopting limit states format, improved evaluation of existing bridges, seismic design, and extension of the code to include long spans, including design loading and load factors.

B&T's philosophy has always been to share knowledge, and well over 100 technical papers have been published by B&T engineers in journals and refereed proceedings. Eight of the company's engineers have gone on to be professors.

Innovation occurred in management, too. From the beginning, staff worked an eight-hour day, but were given every second Friday off, on the grounds that loss of time (36 h/week average instead of 37.5 h/week) is more than compensated by improved productivity. Overtime is not paid, but is taken as time off in lieu. In busy times extra hours are worked; while during quiet times, employees can take time off. This avoids the "hire-and-fire" syndrome and provides job security for the staff, continuity of contacts for clients, and the ability of the company to retain good people. There is also a profit-sharing incentive bonus for all staff.

The people

It would be impossible to name all those who have contributed so much, but a few must be mentioned.

Brian Morgenstern, a brilliant engineer and an astute financial officer, joined the company in 1974, became a "partner" (shareholder) in 1984, and an equal partner with Buckland and Taylor in 1991.

Aegide van Selst joined the company in 1972 and wrote B&T's workhorse program CAMIL for the analysis of cable-supported and other structures. Updated, it is still in use today. For many years he ran the company's computer system. Robert (Bob)

Harris brought his encyclopaedic knowledge, reputation and dry humour from Dominion Bridge Company. Roger Dorton, following a distinguished career as a consultant and later with the government of Ontario, joined B&T in 1993 as project manager of the new international Blue Water Bridge at Sarnia, Ont.

Other contributors include Robert Sexsmith, co-author of a book on structural behaviour, who was a partner from 1982 to 1991, and the late Ole Simonsen, partner from 1984 to 1991.

At last count, one third of the engineers had doctorates, and another third had master's degrees. And one third had graduated in the top 2% of their class. In 1975 B&T had nine employees; six of them are still with the company, working with later generations of bright young engineers, drafters and support staff.

Awards

B&T has won 86 awards, most notably the Order of Canada for Dorton, Buckland and Taylor.

Transition

In the late 1990s Buckland, Taylor and Morgenstern thought about succession. There were three basic options: continue working until carried out in a casket, sell the company to staff, or sell to a third party. The third option was selected, and on September 1, 1998, ownership of the company passed to COWI A/S of Denmark. Jorge Torrejon took over the presidency in 2001, with Don Bergman and Darryl Matson as vice-presidents. Torrejon was succeeded in 2009 by Steve Hunt, who was new to the company.

Since then the company has flourished, and now has 175 employees and branch offices in Seattle, Edmonton, Halifax and New York. The company is currently designing a major bridge over the Ohio River in Louisville, KY, the new Tappan Zee Bridge in New York, an extradosed bridge from Minnesota to Wisconsin, and redecking of the Macdonald Bridge in Halifax. A host of other bridges are being designed, checked, renovated or erected.

Photo: Buckland & Taylor Ltd

Blue Water Bridges, Canada/USA: design of the new bridge and renovation of the old (with Modjeski & Masters).

What has contributed to B&T's success?

The answer is probably in the company's mission statement, which emphasizes value, integrity and the quality of employees:

"Buckland & Taylor Ltd. is a world leading bridge engineering company. Our business is bridges of all types and sizes.

"We provide the greatest possible value to our clients, regard integrity as central to our business, and employ the best staff to stay at the forefront of our profession."

Peter Buckland co-founded Buckland & Taylor in 1972. He resigned as president in 2001 and is now a principal of the company.

Remembering Dean C.J. Mackenzie

By Peter M. Wright, LF.CSCE
PRESIDENT, CSCE, 1981/82

In September 2012, the College of Engineering, University of Saskatchewan, celebrated its 100th anniversary. So much has happened since 1912 when the first lectures were given by young Chalmers Jack (C.J.) Mackenzie and A. R. Greig. I enrolled in the College in 1950. Dean Mackenzie had moved on to Ottawa more than a decade earlier but he was still a revered figure in the College. Now more than 60 years later I am rediscovering him.

Chalmers Jack Mackenzie, born in 1888 in St. Stephen, N.B., was the youngest of the six children of James and Janet Mackenzie. His father was a master mason and builder and thus it is not surprising that C.J. Mackenzie would go on to study civil engineering at Dalhousie University, graduating in 1909. Following graduation, Mackenzie headed west to practice his profession. In 1912 the University of Saskatchewan began a degree program in engineering and its president, Walter Murray, who had been a faculty member at Dalhousie University, engaged Mackenzie to take on the teaching of descriptive geometry and drafting. Thus began his long association with the College of Engineering.

Mackenzie returned for the 1913-14 year but then concluded that he needed further training so he completed a master's degree at Harvard University. He returned for the 1915-16 year and was named head of the School of Engineering, which was in the College of Arts and Science. In the spring of 1916 the first three graduates in engineering completed their degrees, although two of them were exempt from the final examinations because they had already enlisted in the army. There was also a Department of Agricultural Engineering within the College of Agriculture.

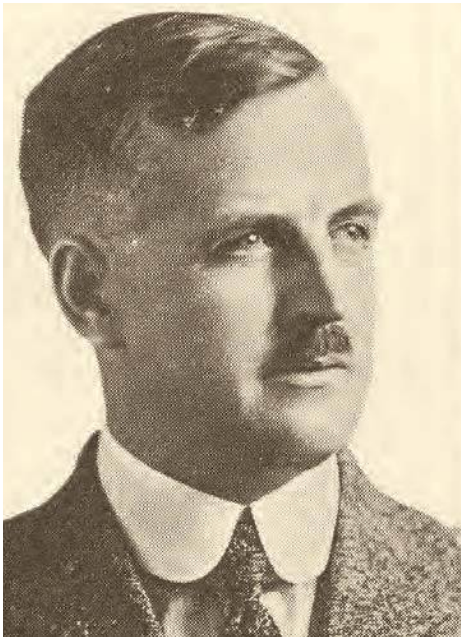


Figure 1: C.J. Mackenzie, 1921.

During World War I Canada organized more than 250 battalions, one of which was the 196th (Western Universities) battalion formed in 1916 mainly from students in the four western universities. In the summer of 1916, the remaining students in the School of Engineering and two lecturers, Mackenzie and J.P. Oliver, enlisted in the 196th and the School of Engineering was closed. The 196th did not become a frontline unit as expected but instead was used to provide reinforcements to other units. Mackenzie, as a member of the 54th battalion, was awarded the Military Cross in 1917.

Post-war expansion

The School of Engineering re-opened in the fall of 1919 and became the College of Engineering in 1922 with Mackenzie as the dean. Figure 1 is a photo of C. J. Mackenzie taken in 1921. The 1920s were busy times for the dean and for the College. New staff members were engaged, the building was enlarged, and programs were expanded. Figure 2 shows the Engineering Building in 1921.

Early in the 1920s Mackenzie became involved in the planning for the new provincial associations which would be responsible for the licensing of engineers. In 1925, he became the first president of the Association of Professional Engineers of Saskatchewan. Later in the decade he began work on his best-known civil engineering achievement, the design and construction of the Broadway Bridge in Saskatoon. (More information on the Broadway Bridge is provided in the article by Cal Sexsmith on pages 28-29.)

In 1935 Mackenzie was appointed to the Advisory Council of the National Research Council of Canada. His contributions were so significant that in 1939 Mackenzie became the acting president to succeed General Andrew McNaughton, who had been selected to command the Canadian army in Great Britain. Dr. Gerhard Herzberg, in his tribute to Mackenzie, written after his death in Ottawa on February 26, 1984, had these words: "Fully aware of what needed to be done, Mackenzie entered this, the most important period of his life, with determination, hard work, and wise decisions; the result was a complete transformation of NRC, and a superb contribution of Canadian science and technology to the war effort."

Following World War II, Mackenzie was the president of Atomic Energy of Canada for two

Photos: University of Saskatchewan archives

Figure 2: Engineering Building, University of Saskatchewan, 1921.

years, then from 1948 to 1961 he was the president of the Atomic Energy Control Board and its successor. Mackenzie also found the time to be a very effective chancellor of Carleton University from 1954 to 1968.

During his life, Mackenzie was well recognized for his achievements by many institutions and universities. It must have been a special pleasure to him to be made Companion of the Order of Canada at its inauguration in 1967.

Acknowledgement

The author thanks Shawna Jardine, alumni relations coordinator, College of Engineering, University of Saskatchewan, for her valuable assistance in obtaining photographs for this article and Mr. Sexsmith's article about the Broadway Bridge. ■

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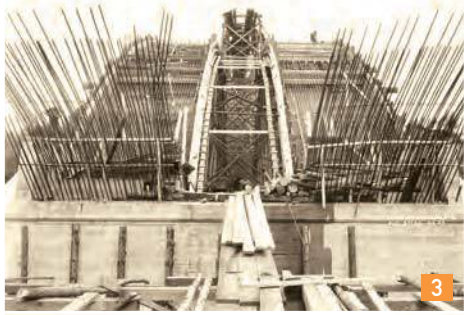
Peter M. Wright graduated from the College of Engineering, University of Saskatchewan, in 1954 and in 1957 joined the academic staff of the Department of Civil Engineering. He moved to Toronto in 1968 to join the staff of the Department of Civil Engineering, University of Toronto. Since 1970 he has been an active member of the Canadian Society for Civil Engineering serving as president in 1981/82.

Photo: University of Saskatchewan

Saskatoon's Broadway Bridge



Photos: University of Saskatchewan archives

By Calvin Sexsmith, FCSCE
CHAIR OF THE CSCE NATIONAL HISTORY COMMITTEE

The City of Saskatoon for good reason has often been called the "City of Bridges" or "The Bridge City," as there are seven bridges (soon to be eight) crossing the South Saskatchewan River within the city limits. But of these, one bridge has come to symbolize the city; that is the Broadway Bridge, a graceful multi-span reinforced concrete arch bridge. Figure 1 shows the Broadway Bridge as it appears today.

Prior to the construction of the Broadway Bridge the movement of people and vehicles between the two sides of the river was awkward to say the least. This situation would have been evident to many, but one person, the civil engineer C.J. Mackenzie, is properly given the credit for solving the problem. Mackenzie, who was the dean of the College of Engineering, University of Saskatchewan, became fully aware of the need while chair of the city planning board. His next step was to be elected to the city council in 1928 and from there he was persuasive in obtaining the necessary approvals.

But there was no funding. Like an ill wind, the Great Depression ensured that there would be federal government funding for the project as a relief project. Construction began on December 12, 1931, and the Broadway Bridge was opened on Remembrance Day, 1932. Mackenzie himself took a leave of absence from the university in order to supervise the construction. Several of the engineers involved in the construction, including Howard Douglas and Clarence Forsberg, went on to become members of the academic staff of the College of Engineering.

Figure 2 shows the piers prior to the building of the arches, with the Traffic Bridge shown to the left, Figure 3 shows the form-

Figure 1: Broadway Bridge today.
Figure 2: Broadway Bridge piers, prior to building of arches.
Figure 3: The formwork and reinforcing steel for one of the arches.
Figure 4: The mostly completed bridge on September 29, 1932.

work and reinforcing steel for one of the arches, and Figure 4 shows the mostly completed bridge on September 29, 1932.

After the completion of the bridge, streetcars were re-routed from the Traffic Bridge. Although the grade on the bridge itself is the steepest in Saskatoon at 4%, the approaches to the bridge were significantly less steep than the south approach to the Traffic Bridge. In 1985 the Broadway Bridge was named a National Historical Civil Engineering Site by the CSCE.

During the celebrations in September 2012 marking the 100th anniversary of the College of Engineering, University of Saskatchewan, a commemorative plaque was mounted on the bridge as a tribute to Dean C. J. Mackenzie, a remarkable civil engineer.

Acknowledgments

The author would like to thank Jeff O'Brien, city archivist, City of Saskatoon, for his invaluable assistance in preparing this article. ■

Calvin Sexsmith is future growth engineering manager, Infrastructure Services, City of Saskatoon.

Learning opportunities at the Montreal 2013 Annual Conference

Les occasions de perfectionnement au congrès annuel de 2013, à Montréal

Mahmoud Lardjane
CSCE PROGRAMS MANAGER / DIRECTEUR DES PROGRAMMES MAHMOUD@CSCE.CA

Gestion des désastres / Disaster Management

Séminaire – discussion programme/Seminar - Discussion Agenda: Disaster management during the last decade in Canada – The insurer's perspective

Présentation en anglais

Paul Kovacs, executive director, Institute for Catastrophic Loss Reduction (ICLR), Toronto, www.iclr.org

Restoration of New York's infrastructure services following Hurricane Sandy

Présentation en anglais

Mathew Francis, PE, Infrastructure Resilience Department Manager, URS Corporation, Germantown, MD, www.urscorp.com

Assessment of the war disasters in Afghanistan

Présentation en anglais

Eric Cook, PE, Buchart Horn, VA, www.bh-ba.com

Gestion des sinistres majeures à Montréal

Presented in French

Madame Louise Bradette, chef de division, Centre de sécurité civile de Montréal, www.ville.montreal.qc.ca

Réduction du risque sismique des composants fonctionnels (non-structuraux) des bâtiments

This course is presented in French.

Certains bâtiments dont ceux désignés comme installations de protection civile (post critiques) sont soumis à des normes sévères de fonctionnalité post-sismique, laquelle dépend de plusieurs facteurs dont les dominants sont :

1) l'aléa sismique et les effets de site;
2) la performance de l'ossature du bâtment; ainsi que
3) la performance des composants fonctionnels et opérationnels (CFO) du bâtiment.

Le cours vise à apporter un éclairage global sur l'ensemble du problème de la fonctionnalité post-sismique des bâtiments, dans les bâtiments neufs et existants. La méthodologie d'évaluation du risque sismique des CFO selon la norme CSA S832-06(R2011) est présentée en détail avec des exemples de la pratique pour l'installation de restreintes parasismiques.

Programme:

Microzonage sismique et effets de site

Prof. Luc Chouinard, Université McGill

Évaluation des bâtiments et CFO

Prof. Ghyslaine McClure, Université McGill

Exemples de la pratique

MAJOR PARTNERS / ASSOCIÉS PRINCIPAUX

LAFARGE NORTH AMERICA

SNC·LAVALIN

PARTNERS / ASSOCIÉS

The Federal Bridge Corporation Limited / La Société des ponts fédéraux Limitée

CH2MHILL

WorleyParsons resources & energy

CANAM Solutions + Service

MORRISON HERSHFIELD

Schöck Innovative Building Solutions

AFFILIATES / AFFILIÉS

Underground Engineering Services

BUCKLAND & TAYLOR LTD. a COWI company

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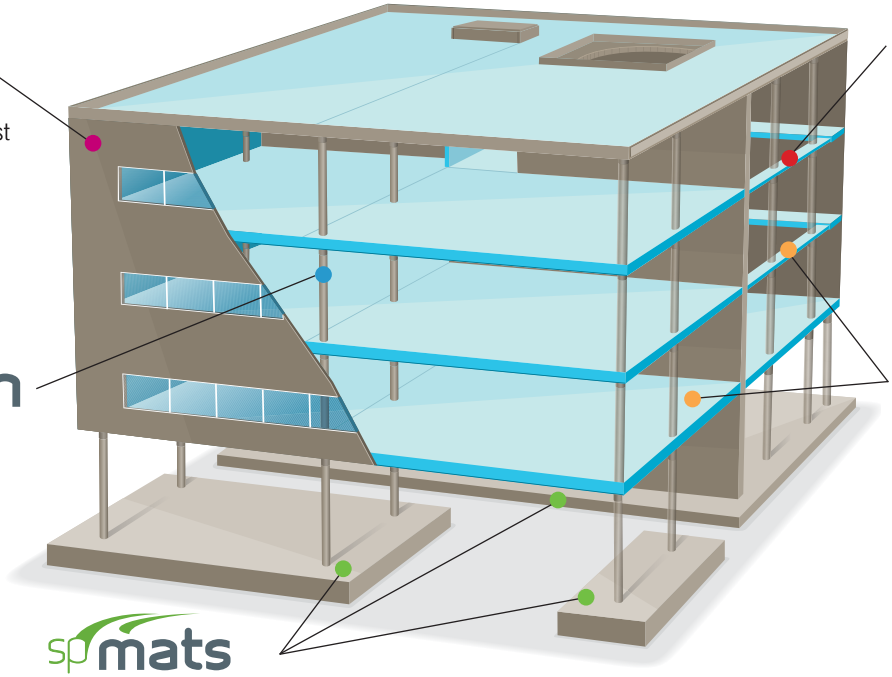

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