Canadian Association for Earthquake Engineering (CAEE)
L'Association Canadienne du Génie Parasismique (ACGP)

# NEWSLETTER

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## From the Editor's Desk

by Tuna Onur

The American design loads standard included a new chapter, "Tsunami Loads and Effects" in its latest edition, ASCE 7-16 (*Minimum Design Loads and Associated Criteria for Buildings & Other Structures*). This is the first time a national, consensus-based standard for tsunami resilience is being introduced in the US. The new chapter benefited from post-tsunami surveys conducted over more than a decade. In this issue, we highlight such a post-tsunami forensic engineering survey that was carried out after the 2011 Tohoku earthquake and tsunami.

On the home front, in its 2015 Edition, National Building Code (NBC) of Canada included, for the first time, design provisions for seismic isolation and supplementary energy dissipation systems, which we also highlight in this issue.

### Inside This Issue



The CCEE in Québec was a huge success with record number of attendees and CAEE has a new Board! You can find the election results in the following pages, along with a short report on the conference.

Also, starting with this issue, we are pleased to reinstate the "Earthquake Waves" column. Check it out to learn about a little-known yet remarkable Canadian earthquake!

## Report from the CAEE AGM and Board Elections

by Lydell Wiebe

The Annual General Meeting (AGM) of the Canadian Association for Earthquake Engineering (CAEE) was held as part of the 12th Canadian Conference on Earthquake Engineering (CCEE 2019) at the Château Frontenac, Québec City, on June 18th. The meeting was well attended by 40 of the 187 confirmed CAEE members, plus 18 other conference attendees.

Outgoing President Carlos Ventura highlighted numerous activities of the CAEE over the last four years, including improving the process for applications and emails to members, restarting the CAEE newsletter, sending a reconnaissance team to Mexico after the 2017 earthquake (a report is now available on the CAEE website), updating policies for reconnaissance teams and copyright, providing partial funding for students attending the 2017

World Conference on Earthquake Engineering (WCEE), and initiating committees on Student Activities and Research & Design. A major upcoming activity includes plans to host the next CCEE jointly with the Pacific Conference on Earthquake Engineering (PCEE), in Vancouver in 2023.

Ghasan Doudak (Treasurer) presented financial statements from 2018, showing approximately $330,600 in net assets, of which about 5% have been spent annually in recent years. In 2018, the main expenses were seed funding for the CCEE 2019 and expenses from the 2017 reconnaissance trip. A full audit is currently being conducted.

**Report from the CAEE AGM and Board Elections…** *Continued from Page 1*

Based on electronic voting conducted prior to the AGM, Carlos Ventura presented the newly elected President, Board of Directors, and Treasurer:

- President: Sharlie Huffman
- 4-year Term Director (Secretary): Martin Lawrence
- 4-year Term Director (Education Chair): Voula Pantazopoulou
- 4-year Term Director (Research): Nathalie Roy
- 4-year Term Director (Vice-President): Lydell Wiebe
- 2-year Term Director (Membership Services Chair): Jeff Erochko
- 2-year Term Director (Code Corner): Don Kennedy
- 2-year Term Director (Education): Sheri Molnar
- 2-year Term Director (Policy Chair / Code Corner): John Sherstobitoff
- Treasurer: Ghasan Doudak

Finally, Marie-José Nollet (École de Technologie Supérieure, Montréal) and Marc-André Gemme (Palais des Congrès, Montréal) presented a bid to host the 2024 WCEE in Montréal. This proposal was very well received by those in attendance.

The meeting ended with expressions of appreciation and thanks to Carlos Ventura for his years of service as President, and a sense of excitement in the room for the continually increasing activity of the CAEE!

*"CAEE expresses appreciation and thanks to Carlos Ventura for his years of service as President and welcomes Sharlie Huffman as the new President."*

# Message from the New CAEE President

by Sharlie Huffman

It is a great honour and pleasure to be serving as the CAEE's new President. I would like to thank every candidate who ran for the Board providing us with an impressive slate of candidates. Thanks also to everyone for updating their profiles in our database and for voting. Your participation has provided us, after some close voting, with an excellent new Board.

We moved to electronic voting this year and we will be moving also to on-line options for registering & paying for future events. Look for seminars and workshops to come, the continuation of our Newsletter with regular columnists and interesting articles, the formation of student chapters and a forum for showcasing your research. We have a lot of enthusiasm and great ideas going forward, and we can use more ideas and feedback from the membership. So please contact any one of the Board members directly or send us a note at secretary@caee-acgp.ca

Thank you all again and have a great summer.

# CCEE 2019 – Summary Report

by Patrick Paultre and Olivier Gauron


*Improving Seismic Infrastructure Performance and Community Resilience*

*Améliorer la performance sismique de nos infrastructures et la résilience de la communauté*

The 12th Canadian Conference on Earthquake Engineering (CCEE 2019) was held in Québec City from June 17 to June 20 at the Hotel Château Fairmont Frontenac. The four-day conference was a great success with 454 registered attendees from 18 countries – the largest attendance of any previous CCEE – and the exceptional venue of the patrimonial Château Frontenac along with the European ambiance of the old town of Québec City, registered by UNESCO as a World Heritage Site.

The conference started with a one-day workshop titled "Performance Based Design and seismic updates in the Canadian Highway Bridge Design Code 2019 (CHBDC)". The workshop was much appreciated by the 70 registered attendees for the knowledge and experience of the five lecturers in seismic structural and geotechnical engineering, and in seismology: Don Kennedy (workshop main organizer), Denis Mitchell, John Adams, Paul Wilson and Robert Tremblay.

The main program of the conference started with the welcoming words of the CCEE 2019 Chair, Patrick Paultre, and of the CAEE president, Carlos Ventura. During the conference, four plenary sessions took place. Three were dedicated to the invited speakers: Gian Michele Calvi (IUSS Pavia, Italy, "Re-Visiting Earthquake Resistant Design"), Gregory MacRae (U. of Canterbury, New Zealand, "Recovery after the Canterbury Earthquakes") and Carlos Ventura (U. of British Columbia, "Subduction Ground Motions Characterization and Their Relation to Potential Structural Damage"). The last plenary session was about "The New Champlain Bridge Seismic Hazard, Analysis, and Design" (by Tim Ingham and Guy Mailhot).

Overall 240 technical presentations were given by the participants during the plenary sessions running in parallel in six different rooms, and 30 technical posters were presented by the Centre d'études interuniversitaires des structures sous charges extremes (CEISCE) students.

The three social events organized during the conference provided memorable moments. The first day of the conference ended with the traditional Welcome Reception that around 120 attendees participated in. The second day ended with the CEISCE poster session with votes from all attendees to rate the best three posters. Congratulations to Rocio Lilen Segura (U. of Sherbrooke, 1st position), Mohammad Sohayeb Akiel (McGill, 2nd position) and David Gauthier (U. Sherbrooke, 3rd position) for the awards they received during the closing ceremony. The evening of Wednesday, June 19 was the summit of CCEE 2019 with the traditional Banquet Reception held in the Ballroom of the Château Frontenac with 270 attendees and the exceptional musical theater show, *Masques et Bergamasques*, performed by opera singers and musicians from Québec. The newly elected CAEE board was also presented during the banquet, lead by the new President, Sharlie Huffman.

Finally, an interesting technical tour was offered to the attendees the day after the conference closure. Attendees were taken by bus to Montreal to visit the recently completed Samuel de Champlain Bridge, an impressive bridge made of several continuous girder spans with a limited number of joints and with a cable-stayed central span, which was intended to open to public a few days later.

The CCEE 2019 Organizing Committee wishes to warmly acknowledge the 10 partners of the conference, including the Gold partner MTS, the nine additional exhibitors, and the cooperating organizations CEISCE, FRQNT, and of course the CAEE. The 12th Canadian Conference on Earthquake Engineering would not have been such a successful event without these organizations and without the high professionalism of the staff of the organizing partner Conferium in Québec City.

# Bridging the Faults

by Paul Steneker

The CAEE Outreach Committee hosted a networking session with some young professionals and aspiring graduate students during the Canadian Conference on Earthquake Engineering (CCEE) in Québec City in June. The event was hosted in conjunction with the corresponding group from the Centre d'études interuniversitaire des structures sous charges extreme (CEISCE).

During the networking event, discussions surrounding the content of the presentations took place, but perhaps more importantly, the topic of current and future research goals was discussed and new insights regarding potential future endeavors were explored in detail. Undoubtedly, these events will spur the creation of new collaborations for the future!

The Outreach Committee would like to recognize the support of the CAEE board, the organizational efforts of the CEISCE committee, as well as all the attendees of the networking event for an enjoyable evening. If you missed the event but would like to be informed of future events, please reach out to the chair of the Outreach Committee, Paul Steneker, at stenekpr@mcmaster.ca to be added to the contact list. We look forward to the next opportunity for such an event!

# Engineering Significance of & Lessons from the 2011 Tohoku Tsunami – Impact on Structures

by Ioan Nistor

On March 11, 2011, a magnitude 9.0 earthquake occurred offshore along the Sanriku Coast, northeast Japan, at 3:46 p.m. local time. The earthquake caused several massive tsunami waves that hit the Japanese coast, often reaching run-up wave heights of up to 10 metres to 30 metres, and even in excess of 45 metres locally in some areas.

The first international forensic engineering research team surveyed the affected area approximately four weeks after the tsunami to conduct reconnaissance work on behalf of the American Society of Civil Engineers (ASCE). A number of critical engineering lessons with direct application to buildings subjected to tsunami impact were drawn from the forensic engineering survey as follows:

- While recorded history from past tsunamis provides valuable information with respect to the magnitude of possible future events, it may not always provide a good measure of the potential inundation and run-up heights generated inland due to extreme tsunami events. The experience from the 2011 Tohoku Tsunami demonstrated that historical events need to be carefully reassessed.

- Probabilistic Tsunami Hazard Analysis should be implemented as a method to determine the maximum considered tsunami event for a particular location in an area prone to tsunami impact. Numerous scenarios for the specific geographic location and tsunamigenic sources should be considered for a scientifically justified probability of exceedance or return period.

**Engineering Significance of the 2011 Tohoku Tsunami...** *Continued from Page 3*

- In addition to the development of evacuation strategies, losses to buildings and critical infrastructure should be mitigated.

- Coastal dikes designed to protect against storm waves generally performed poorly against the high loading generated by the overtopping tsunami waves, which resulted in scour either to the front or at the back of these structures, leading to failure of many of the sections of the dikes.

- Future tsunami breakwater design should avoid potential catastrophic failures and provide some degree of resilience. However, considering the present experience with such structures, it is not clear what level of protection these structures can successfully provide.

- Damaging tsunamis can travel far inland due to the long period of the tsunami surge, and sites should be studied for unfavourable topographical conditions that can generate high outflow velocities.

- Flow diversion and acceleration around large buildings significantly focus flow on downstream buildings.

- Foundation systems should consider uplift and scour effects, particularly at the corners.

- Structures of all construction and material types can be subject to general and progressive collapse during tsunamis.

- Overturning should be considered as a tsunami design condition for the foundation and the superstructure.

- Wood-frame construction in nearly all cases and locations were quickly destroyed, down to the foundation.

- High seismic design may not ensure sufficient tsunami resistance, particularly for low-rise buildings.

- Debris accumulation in tsunami inflow occurs rapidly and debris loads on structures must consider debris damming and blockage.

- Buildings should have sufficient openings to alleviate buoyancy. The advantages of breakaway cladding may be more beneficial to prevent buoyancy rather than to drastically reduce hydrodynamic forces (due to debris accumulation).

*"High seismic design may not ensure sufficient tsunami resistance, particularly for low-rise buildings."*

- Structurally boxed-in areas should be avoided in the design of structures since they would be subject to hydrodynamic pressurization.

- Mid-to-high-rise reinforced concrete buildings with robust shear walls appear to survive structurally, even for cases where a number of walls are located at the perimeter. These buildings can be used for successful vertical evacuation, if tall enough.

- Protection structures can be designed to mitigate damaging effects for the case of small to medium size tsunamis, but are difficult to design and implement for regions affected by large tsunamis.

# Code Corner

by John Sherstobitoff

In the 2015 Edition of the National Building Code (NBC) of Canada, new provisions were introduced regarding seismic isolation and supplementary energy dissipation systems.

In seismically isolated structures, forces are significantly reduced compared to conventional structures; the large deformations occur across the isolators at the isolation plane rather than in the superstructure; and both the contents and the structure are "protected" from the effects of strong shaking. Seismic isolation reduces seismic response of the building by "decoupling" the structure from the ground. In many applications isolators are installed beneath the structure and thus referred to as base isolation.

Design with the new provisions requires a 3-D non-linear time-history analysis with a suite of ground motion records suitable for the project site. And it is recommended (in the Commentary) to have a peer-reviewed special study of all aspects of the analysis and design.

*"NBC 2015, for the first time, includes provisions (Sentences 4.1.8.19 – 4.1.8.22) on seismic isolation and supplementary energy dissipation systems."*

Article 4.1.8.19 defines "seismic isolation" and provides analysis and modeling criteria. It also directs designers to the Commentary which recommends how selection and scaling of ground motion time-histories should be done, and how the target spectrum should be derived.

Article 4.1.8.20 provides the design provisions for seismic isolation including:

- Period of the isolated structure
- Configuration to ensure a specified restoring force
- Values of storey shears, storey forces, member forces, and deflections used in the design of all structural framing elements and components of the isolation system
- Validation, by testing, of force-deformation and damping characteristics of the isolation system
- Continuity of diaphragm above the isolators and the superstructure
- Drift limit for wind load
- Relaxation of height restrictions

Supplementary energy dissipation devices are typically "dampers" installed in parts of a 'conventional' structure where there is appreciable relative motion. Most structures have inherent damping of 1%-5% of critical. Supplemental energy dissipation devices increase damping and reduce base shear. Many structures realize a significant reduction of both forces and drifts with the addition of 10-20% critical damping for earthquake input. More damping is typically better, but with diminishing return.

Article 4.1.8.21 defines a supplemental energy dissipation "device" and "system", and provides analysis (3-D non-linear time-history analysis as for seismic isolation) and modeling criteria. In addition, it directs designers to the Commentary regarding criteria related to ground motion time-histories.

Article 4.1.8.22 provides design considerations for supplemental energy dissipation systems including:

- Values of storey shears, storey forces, member forces, and deflections for design of all structural framing elements and all supplemental energy dissipation devices
- Validation, by testing, of force-deformation and force-velocity characteristics of the supplemental energy dissipation devices
- Means of access for inspection and removal for replacement of all supplemental energy dissipation devices

# Earthquake Waves

by John Cassidy

Welcome to the new (well… revived) "Earthquake Waves" column of the CAEE Newsletter. I thank the Editor for the invitation and opportunity to contribute this column on a regular basis. My intent is to provide a short summary of recent, significant earthquakes that are of engineering or seismological interest. If no significant events have occurred during the past few months, then I plan to highlight significant historical Canadian earthquakes.

In this issue, I will introduce a little-known, yet critically important Canadian earthquake – the 25 December 1989 Ms 6.3 Ungava earthquake that occurred in the Superior Province (> 2.6 b.y. old) of the Canadian Shield. Why is this very remote (no damage, and felt by very few people) and relatively small earthquake important? This shallow earthquake produced the first known surface faulting from a historical intraplate earthquake in North America. At the time (1989), only 10 historical intraplate earthquakes worldwide were known to have produced surface faulting. Therefore, this remote Ungava earthquake provided a unique opportunity to better understand rare, but potentially very damaging, North American intraplate ruptures.

The surface faulting produced by the M 6.3 Ungava earthquake was first discovered during an aftershock survey in July, 1990 (see *earthquakescanada.nrcan.gc.ca/historic-historique/events/19891225-en.php* ). The epicentral area is north of the tree line, in an area of continuous permafrost and with numerous lakes. It produced thrust and strike-slip faulting along the Lac Turquoise Fault. The 1989 Ungava produced up to 1.8 m of reverse faulting along a 10-km-long curvilinear fault segment. The thrust faulting uplifted lake shorelines and boulders, tore the muskeg above the fault trace, caused sand and mud volcanoes, discoloured adjacent lakes (silt disturbance), partially drained a lake, and created a new lake through uplift.


*Flying over the surface rupture of the Ungava earthquake. Thrusting on the fault has uplifted lake shorelines, showing the extent and pattern of the vertical deformation. Photo credit: Maurice Lamontagne.*

Detailed fieldwork concluded that faulting was controlled by geology at scales ranging from regional to outcrop. Although this work helps to guide the type of evidence to be sought from prehistoric ruptures, it also revealed that this particular fault had not ruptured (prior to the 1989 event) during Phanerozoic time (past 541 m.y.) – suggesting that these are very rare events and making it difficult to predict which faults (in similar tectonic settings) may be activated in the future.

A detailed seismological study of this earthquake found source complexity (both thrust and strike slip movement at a depth of ~3 km) and concluded that this earthquake shares a number of characteristics with other global intraplate events, including shallow depth, source complexity, and, most troublesome – unexpected locations on faults that could not have been recognised as active faults, prior to the earthquakes. An important engineering aspect of this earthquake is that, like other shallow complex-source intraplate earthquakes, it has an unusual spectral shape; and finally an interesting seismological aspect is that there was a M5.1 foreshock 10 hours before the mainshock.

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## News

### Important Dates for the 17th WCEE (2020) in Sendai, Japan

The 17th World Conference on Earthquake Engineering will be held in Sendai, Japan on 13-18 September 2020. While the conference is a year away, abstract submission deadline is already coming up and we would like to take this opportunity to bring to your attention some key dates:

Deadline for Abstract Submission: 30 August 2019

Deadline for Organized Session Submission: 31 August 2019

Deadline for Full Paper Submission: 31 January 2020

Deadline for Sponsorship/Exhibition Application: 31 January 2020

*www.17wcee.jp/*

# News and Upcoming Events

We are soliciting earthquake engineering related news and events that you would like to bring to the attention of your colleagues. Please send your contributions by September 15 to secretary@caee-acgp.ca to get them included in the October Newsletter.

## Upcoming events

**IABEE Third International Bridge Seismic Workshop**
1-4 October 2019
Seattle, WA
www.iabee.org/iii-ibsw

**5th International Conference on Earthquake Engineering and Seismology**
8-11 October 2019
Ankara, Turkey
www.5icees.com/

**2020 National Earthquake Conference and 72nd EERI Annual Meeting**
3-6 March 2020
San Diego, CA
earthquakeconference.org/

**Seismological Society of America (SSA) Annual Meeting**
27-30 April 2020
Albuquerque, NM
www.seismosoc.org/annual-meeting/

**2020 Understanding Risk Forum**
18-22 May 2020
Singapore
understandrisk.org/event/ur2020/

**International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics**
13-16 July 2020
Bangalore, India
7icragee.org/