Canadian Association for Earthquake Engineering and Seismology (CAEES)
L'Association Canadienne du Génie Parasismique et de la Sismologie (ACGPS)

NEWSLETTER

July 2024
Volume 8, Issue 3

http://caee.ca/

From the Editor's Desk

by Tuna Onur

INSIDE THIS ISSUE

The new national Earthquake Early Warning system in Canada became operational in BC in May and will be operational in Ontario and Québec later this year. You can read more about this exciting development in our feature article.

The CAEES earthquake reconnaissance team has released its report on the February 2023 earthquakes in Turkey. It is now posted on the CAEES website.

The CAEES Distinguished Webinar Series continue to cover important topics in earthquake engineering and seismology. The latest in the series was in June by Dr. Perry Adebar titled "Seismic Design of High-Rise Concrete Buildings in Canada: A State-of-the-Art Review". You can find links to the webinars you missed on the CAEES website's "Members" section.

Finally, the upcoming changes to the National Building Code (NBC) of Canada are out for public review. See the News section for more.

Our Newsletter is a great way to share short articles, news or other items related to earthquake engineering with your colleagues. Please send your contributions to secretary@caee-acgp.ca

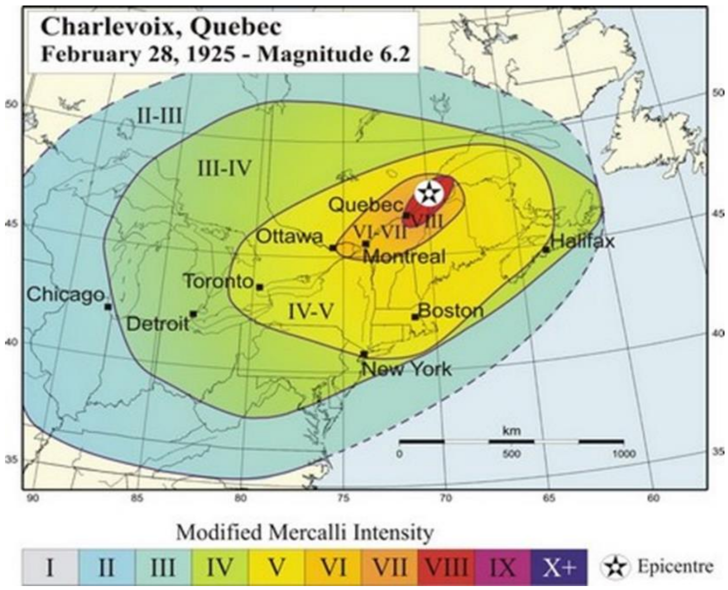
Earthquake Waves: The Damaging Charlevoix, Québec Earthquake of 1925

by John Cassidy

Canada has remained quiet in terms of significant earthquakes during the past few months. As a result, this column highlights a significant Canadian earthquake of the past – the 1925 M6.2 earthquake in the Charlevoix region of Québec.

At 9:19 p.m. (Eastern time) on February 28, 1925, a damaging M6.2 earthquake occurred beneath the St. Lawrence River in the Charlevoix-Kamouraska region of Québec. Shaking was felt across much of northeastern North America – to distances of more than 1,000 km (from the island of Newfoundland in the east, to Sault St. Marie, Ontario in the west, and south to Virginia. Damage was reported as far away as Québec City (~150 km distance) and Shawinigan Falls (~250 km distance) where stone and brick walls were damaged. The most significant damage occurred in a narrow belt (~30-km-long) on both sides of the St. Lawrence River near the epicentre. Here chimneys collapsed, and many masonry homes and churches were damaged. The soft soils ("Leda clays") amplified ground shaking and played an important role in damage patterns throughout the region. There were some reports of liquefaction and ground cracking (despite the ground being completely frozen) in the epicentral region.

Earthquake Waves… *Continued from Page 1*



Estimated ground shaking intensity (using the Modified Mercalli Intensity scale) for the 1925 M6.2 Charlevoix earthquake, based on questionnaire responses collected by the Geological Survey of Canada

The earthquake was followed by a series of aftershocks, including 9 of magnitudes 3.7 to 5.0 within the first month. These aftershocks were all felt in Charlevoix and Kamouraska, causing anxiety and fear amongst the population. The mainshock (one of five earthquakes of Mw>5.5 since 1663 in the Charlevoix region) was the first to be recorded at seismographs around the world. This allowed for (many years later) detailed analysis of the seismograms using modern techniques. Bent (1992) determined that the rupture of this earthquake was shallow (~10 km depth) and primarily thrust, along a northeast-striking (and southeast-dipping) fault plane.

This earthquake is a clear and important reminder of the importance of understanding and mitigating earthquake hazards and risk in eastern Canada. For more details and publications on this earthquake, see: www.earthquakescanada.nrcan.gc.ca/historic-historique/events/19250301-ref-en.php

Or use Natural Resources Canada “Geoscan” publication database (search using 1925 Charlevoix) at: geoscan.nrcan.gc.ca/starweb/geoscan/servlet.starweb?path=geoscan/geoscan_e.web

Code Corner

by Don Kennedy and Marc Gerin

Access to the sixth-generation seismic hazard model results have been available for structural and geotechnical design of buildings since 2022. The hazard was posted on the NRCan website, but the timing of its implementation depended on the owner’s or jurisdiction’s regulations or policy. The sixth-generation seismic hazard has also been available for bridge design or retrofit since that time. It has been adopted for the next update to the Canadian Highways Bridge Design code (CHBDC, formally known as CSA S6:25) when published in 2025. Provinces and territories across Canada will specify its use through regulation (Ontario) or contractually.

There is typically a period of evaluation by the authorities of the latest S6 code before formal adoption. Important disclaimer first - CSA S6:25 currently in final editing and is scheduled for balloting in Q2-2024. As always for Code Corner articles, this content is provided for guidance only.

The seismic hazard has typically increased across Canada with this generation of ground motion models and earthquake hazard models. In parts of Ontario and Quebec where seismic hazard previously was relatively low, ground and spectral accelerations have increased by substantial amounts, between 40% and 100%. With these significant increases, particularly in eastern Canada, how can CSA and owners implement this increased seismic hazard?

In both CSA S6:19 and S6:25, the seismic design of bridges and related geotechnical systems starts with the selection of the seismic hazard for the project location. The next step is to determine the Seismic Performance Category (SPC). This

Code Corner… *Continued from Page 2*

influences the site information needed (soils), the design steps and the minimum design requirements for the bridge.

In CSA S6:19, the SPC was a function of:

- Seismic hazard through spectral accelerations at 0.2 or 1.0 seconds;
- the structure's natural period of vibration and whether it was a 'stiff' or more massive / flexible structure (first mode period below or above 0.5 seconds);
- bridge importance classification (lifeline, major route or other).

SPC values were either 1, 2 or 3. Higher SPC values require higher levels of investigation, seismic analysis and design, and more stringent detailing requirements. To determine SPC, the period of vibration in each direction was needed, which required some of level of dynamic analysis. In regions of low hazard and SPC 1, only minimal prescribed detailing was required and no further dynamic analysis outcomes were needed; despite having completed at least a simplified analysis. It was possible also that analyses could target a structural period above or below 0.5 seconds by adopting modelling assumptions that would produce a lower SPC value.

Seismic-related details for SPC 1 were limited to minimum support lengths or bearing lateral forces, and minimum column tie volumes. Minimum seat lengths are long, and bearing forces are significant and sometimes required supplemental components for seismic load paths. These seismic requirements were contained in several clauses of Section 4 (seismic design), which required a careful perusal of Section 4 for all bridges in all regions of Canada.

In the CSA S6:25 latest draft, the SPC determination has been simplified. SPC is proposed to be a function of spectral acceleration value only at T = 1.0 seconds. No structural analysis is therefore required for this purpose. Bridge performance was judged to be better related to this structural period than to spectral values at a period of 0.2 or 0.5 seconds as used in S6:19.

An SPC = 0 (zero) classification has been introduced for sites with Sa(1.0) < 0.05g. For such sites, the intent is that there will be no seismic design requirements. Designers would need not refer further to Section 4 nor to Section 6.14 (geotechnical). Requirements for column ties or spirals, or other details affecting lateral load resistance, are as covered in other sections of S6:25.

Bridge importance in the draft S6:25 does not factor into SPC values, however, SPC values (for SPC 1, 2 and 3) influences the seismic analysis, design steps and some details.

For SPC 0 cases, the various requirements for all bridges, such as design for lateral loads for wind, vehicle impact, unbalanced traffic loads or other demands are deemed sufficient and in most cases provide a level of intrinsic seismic resilience in case future seismic hazard increase at low-hazard sites.

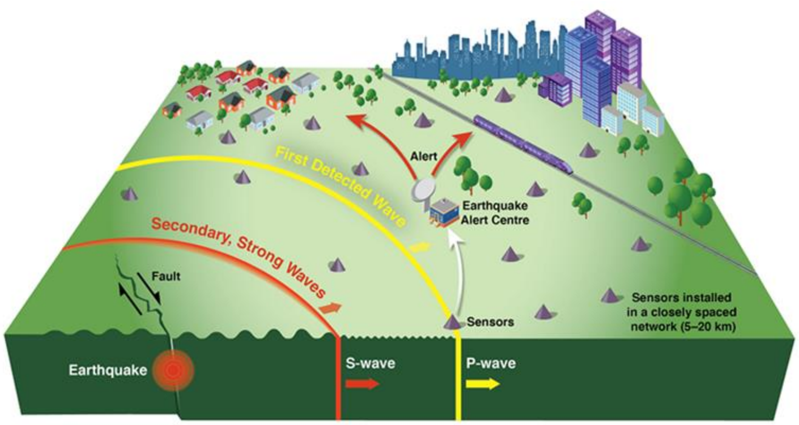
As part of the diligence process for these potential changes to SPC values and impacts, a review of other standards, including National Building Code of Canada and the AASHTO LRFD code, was performed. Further, a cross-Canada study was undertaken using sixth-generation hazard and proposed SPC values to compare old and new seismic design implications. A short white paper and/or table that illustrates these checks may be provided after balloting for CSA S6:25 on the CAEES website.

Also following balloting, future Code Corner articles will discuss other updates to seismic design in Sections 4 and 6 of CSA S6:25. Technical sub-committees have endeavoured to streamline the seismic design process in Canada. Performance-based design was maintained and its application clarified. Force-based design was maintained for some bridges and sites. Seismic isolation design was updated to encourage its use as a proven low-damage system in more bridges, and to reflect improvements in testing, procuring and risk that arose during discussions with suppliers.

National Earthquake Early Warning System to Mitigate Impacts of Earthquakes in Canada

by Alison L. Bird

Natural Resources Canada (NRCan) has developed a national Earthquake Early Warning (EEW) system for regions of moderate-to-high earthquake risk in Canada. The EEW coverage is focussed in western British Columbia, eastern Ontario, and southern Quebec; as strong earthquakes expected within these zones will cause significant damage and other impacts to structures, systems, humans, and the environment. Canada's EEW system will mitigate earthquake impacts through timely notification to and appropriate response actions by emergency measures organizations, critical infrastructure (CI) operators, other industrial facilities, and the public.

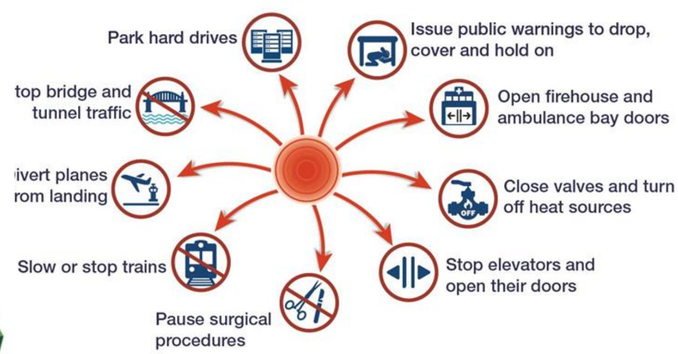


Principles of an Earthquake Early Warning (EEW) system

The system is composed of dense networks of specialized sensors, multiple modes of high-speed communications equipment, computer centres capable of rapid data processing, and alert dissemination (see Figure on the left above). NRCan's EEW system employs the [U.S. EEW system's software], adapted for use in Canada; this facilitates the sharing of data between the two countries and helps ensure consistent alerting in border regions.

Dissemination of alerts to people in Canada is through the [National Public Alerting System], via cellular telephone, radio, and television – encouraging people to protect themselves (Drop, Cover & Hold on). In addition, the alerting system will provide detailed EEW messages, by subscription and in xml format, to Technical Partners. Such messages can be used to trigger automatic protective actions, including: stop trains, put industrial equipment into safe mode, sound alarms, open doors, close valves, shut access to tunnels and bridges, and secure hard-drives in data centres (see Figure on the right below).

Warning times can be extremely short (a few seconds). Additionally, sites close to an earthquake's epicentre could be within a "late alert zone", where alerting prior to the onset of shaking is not possible.



Typical safe response actions that can be taken upon receipt of an EEW alert

For the EEW system to be effective, people and systems must respond appropriately. An effective EEW system therefore requires a culture of awareness, achieved through substantial, coordinated campaigns for public education and technical engagement. NRCan is working with federal and provincial public safety organizations, private and international collaborative partners, and Non-Governmental Organizations (ShakeOutBC; GrandeSecousse), to ensure that authoritative, consistent, and accessible EEW messaging is available to the public and technical users. Finally, NRCan encourages potential Technical Partners to contact EEWinfo-infoASP@nrcan-rncan.gc.ca for more information.

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News

Public Review of the Proposed Changes to NBC Now Open

The Canadian Board for Harmonized Construction Codes (CBHCC) is inviting code users and the public to participate in the spring 2024 public review of the proposed changes to the 2020 edition of the National Building Code (NBC) of Canada (along with other National Model Codes).

The national public review opened on May 27th and will run until July 29th.

Follow the link below to see the proposed changes and provide feedback:

cbhcc-cchcc.ca/en/public-review-of-proposed-changes-to-the-2020-national-model-codes/

News and Upcoming Events

Below, we provide some information on upcoming events related to earthquake engineering and seismology. Please send us any events you would like highlighted here.

Upcoming events

18th World Conference on Earthquake Engineering
30 June – 5 July 2024
Milan, Italy
www.wcee2024.it/

4th International Bridge Seismic Workshop
11 – 14 August 2024
Ottawa, ON
carleton.ca/4ibsw/

2024 SEAOC Convention
3 – 7 September 2024
Portland, OR
site.pheedloop.com/event/SEAOC2024/home

GeoMontréal 2024
15 – 18 September 2024
Montréal, QC
www.geomontreal2024.ca/

National Insurance Conference of Canada
22 – 24 September 2024
Vancouver, BC
www.niccanada.com/

Photonic Seismology (Seismological Society of America)
7 – 10 October 2024
Vancouver, BC
www.seismosoc.org/photonic/

American Geophysical Union (AGU) Annual Meeting
9 – 13 December 2024
Washington, DC
www.agu.org/annual-meeting