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L'Association Canadienne du Génie Parasismique (ACGP)

NEWSLETTER

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From the Editor's Desk

by Tuna Onur

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Despite its modest magnitude, the Banff earthquake in February surprised many, raising questions whether it was induced (it wasn't!), reminding us that earthquakes can happen anywhere in Canada, even in regions with relatively low seismic activity. In fact, this earthquake should not have been a surprise, as the Canadian Cordillera had larger magnitude earthquakes in the past. You can find out more in our Earthquake Waves column.

Every felt earthquake brings to mind the earthquake resistance (or lack thereof) of our existing building stock. Code Corner column in this issue discusses the NBC 2015 Commentary L, which provides guidance on seismic upgrading of existing buildings.

We hope everyone is staying healthy, and as always, we encourage you to share short articles, news or other items related to earthquake engineering to be published in our Newsletter. Please send your contributions to secretary@caee-acgp.ca

Earthquake Waves: The "Great Banff Earthquake of 2021"

by John Cassidy

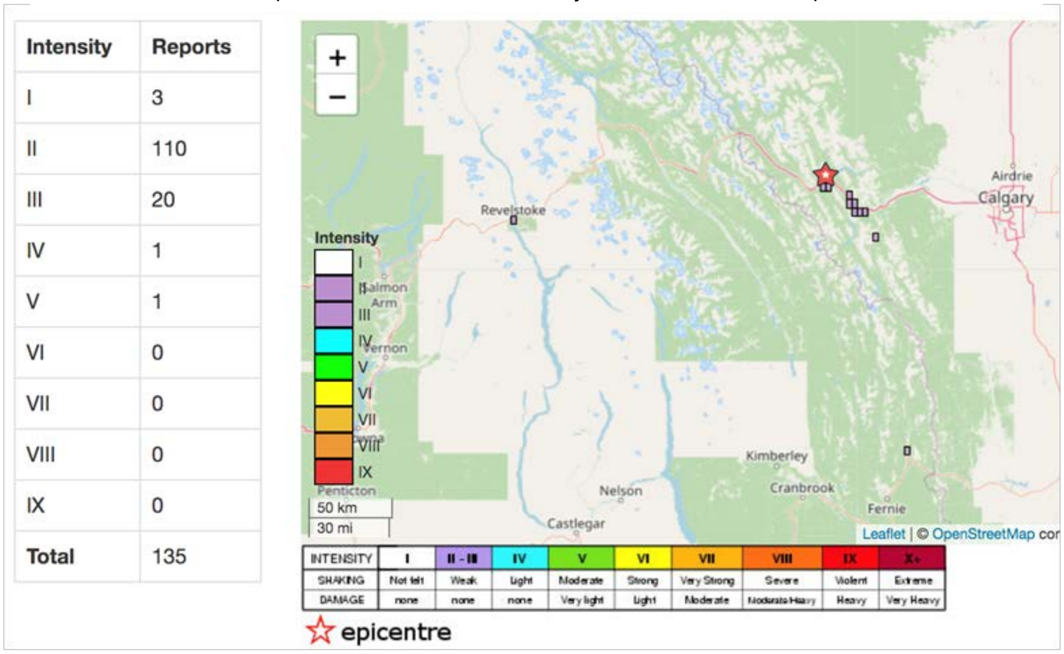
On February 13th, at 6:33 p.m. MST, the residents of Banff, AB and surrounding areas were shaken by a surprise M3.9 earthquake. This was the largest earthquake in the region in more than 100 years. Many described a rumbling noise, and then shaking as if a truck had hit the building. Hundreds of people felt the shaking in Banff, Canmore, as far away as Kananaskis Village, AB (50 km) and one report each from Sparwood, BC (170 km) and Revelstoke, BC (190km). There was no damage reported from this earthquake (although plenty of shattered nerves), but this earthquake serves as a friendly reminder of past, larger earthquakes in the Canadian Cordillera, and also a reminder of rare "surprise" earthquakes that can occur in most parts of Canada.

The eastern Canadian Cordillera is relatively quiet – especially in central and southern British Columbia. The largest known earthquake in this area, a M6 event, occurred on February 4, 1918 roughly 140 km to the north of Revelstoke, and about 200 km to the northwest of the 2021 Banff earthquake. It caused some damage in Revelstoke, including broken chimneys.

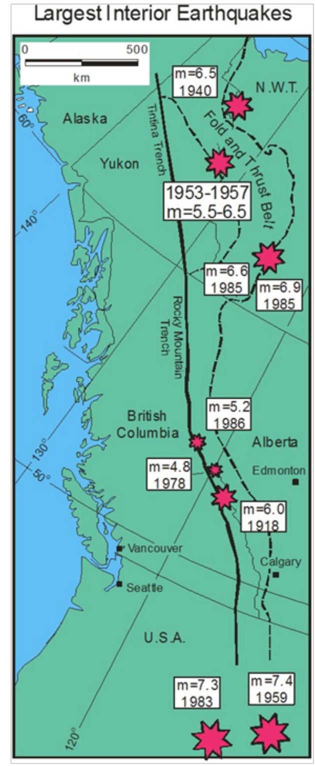
Overall, the largest known earthquakes in the eastern Canadian Cordillera are the October 5 (M6.6) and December 23, 1985 (M6.9) earthquake sequences. Shaking was felt in the Northwest Territories, Yukon, southeastern Alaska, British Columbia, Alberta and Saskatchewan. These shallow, thrust earthquakes (followed by thousands of aftershocks) were a surprise – as no earthquakes larger than M5 had ever been recorded in this region.

Earthquake Waves… *Continued from Page 2*

Felt Reports from the M3.9 February 13, 2021 Banff Earthquake



Intensity	Reports
I	3
II	110
III	20
IV	1
V	1
VI	0
VII	0
VIII	0
IX	0
Total	135



Finally, this recent Banff earthquake reminds us of "surprise earthquakes" in the Canadian Cordillera that shouldn't come as a complete surprise. We still have much to learn, and preparedness is key.

Code Corner

by Andy Metten, Ron DeVall, John Sherstobitoff

More detailed information on NBC 2015 Commentary L can be found in a paper by the authors in the Proceedings of the 12th Canadian Conference on Earthquake Engineering (2019), accessible on the CAEE website: *https://www.caee.ca/conferenceproceedings/*

Although the National Building Code (NBC) is primarily intended for new buildings, it can also be used for the alteration, reconstruction and evaluation of the seismic adequacy of existing buildings as the concepts and methods of analysis and design presented therein are often applicable for upgrading of existing buildings. Commentary L contains general considerations for the structural evaluation and upgrading of existing buildings, including earthquake considerations.

In this column, we describe the NBC 2015 Commentary L guidance for existing buildings. For upgrading of existing buildings, it is necessary to examine both the force level that the building can resist as well as the expected drift. Many heritage buildings have brittle gravity load systems and it is necessary to limit the drift that the building is experiencing so these brittle gravity load elements can continue to do their work in supporting the weight of the building. Some buildings, particularly heritage buildings built of non-ductile materials, can have very low resistance to seismic forces or the drift that is imposed by those seismic forces. Renovations that add mass to the building or increase the irregularity or height of the building will increase the risk of collapse and should be mitigated. Similarly, renovations that extend the life of the building increase the risk to occupants and should have at least part of the project budget spent on seismic mitigation.

Code Corner… *Continued from Page 2*

Buildings constructed when seismic codes were essentially nonexistent or just being developed frequently used a variety of brittle materials such as stone, brick, or lightly reinforced concrete that are both weak and brittle when exposed to the impacts of seismic loading. These buildings often have weak and soft storeys and incomplete load paths. To fully upgrade them to meet the full requirements of current seismic codes would be very costly. Thus, building authorities have often permitted the seismic upgrading of buildings to less than full code levels. Over time, upgrade requirements have evolved from a simple "bolts-plus" approach, where only floors are bolted to walls and falling objects such as parapets are addressed by stating that a certain percentage of code be met. This percentage will often vary depending on the authority having jurisdiction and the extent or cost of the renovation. The upgrading levels recommended by Commentary L are risk-based and based on using ground motion levels with a lower return period for each upgrading level. The levels were chosen to align with return periods that are easily available from the Earthquakes Canada website.

Establishing the Upgrade Levels

The desire in having a risk-based seismic upgrading system is to choose selected return periods and upgrading design targets for the analysis. The result is a more consistent upgrading level than is achieved by assigning a set percentage of base code. The following return periods are used in determining upgrade levels in NBC 2015 Commentary L:

- 2% in 50 years (full code 1:2475 years)
- 5% in 50 years (1:1000 years)
- 10% in 50 years (1 in 475 years)

And the upgrade levels are described below. Each of these can be obtained from the Earthquakes Canada "Hazard Calculator."

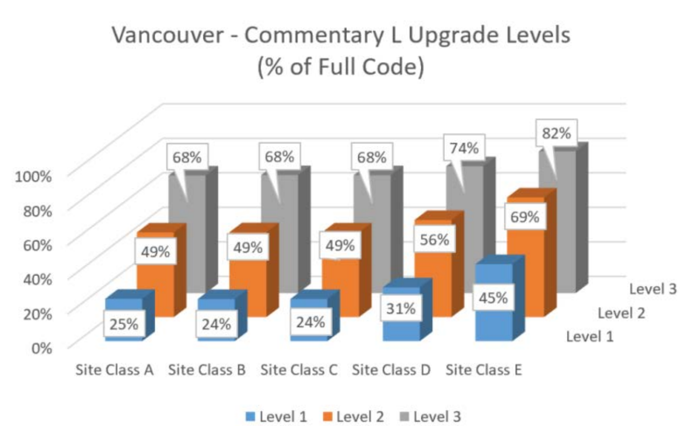
Level 1: Use response spectrum values that correspond to one-half (0.5) of those for 5% in 50 years (5% in 50 years is equivalent to 1/1000 per annum) probability.

Level 2: Use response spectrum values that correspond to those for 10% in 50 years (1/475 per annum) probability.

Level 3: Use response spectrum values that correspond to those for 5% in 50 years (1/1000 per annum) probability.

There are several advantages to using a risk-based approach to seismic upgrading, but one of the most obvious is the necessity to increase the seismic upgrading requirements for buildings located on soft soil sites relative to those located on firm soil sites. This effect is due to non-linearity in the foundation factors, where smaller earthquakes with a higher probability of occurrence are more magnified on soft sites than are large earthquakes with a lower probability of occurrence.

Traditionally in Canada, if a building is upgraded to a level less than full code levels, then it is upgraded to a percentage of full code. This percentage is usually defined by the authority having jurisdiction without consideration of risk levels or site conditions. Due to the non-linearity of the site factors, the percentage code compliance for the upgrading levels using NBC Commentary L vary both with what is being done and with the site conditions. This is illustrated in the Figure below.



Code Corner... *Continued from Page 3*

Useful Definitions

To help users determine the difference between a minor and major renovation definitions were added to NBC 2015 Commentary L. Samples from these definitions are as follows:

Vertical addition: A vertical addition is an addition that increases both the area and the height of the building with or without increasing its footprint. Vertical additions are usually built at least in part on the existing building. However, a structurally connected addition that is taller than the original building without being on the footprint of the original building is also considered a vertical addition.

Horizontal addition: A horizontal addition is an addition that increases the area of the building without increasing its height and that may or may not increase the footprint of the building.

Major renovation: A major renovation is an extensive renovation to the architectural, structural, mechanical and electrical components in a major portion of the building that extends the useful life of the building. The renovation may or may not involve removal of the wall and ceiling finishes in the project area. A change of use is also considered a major renovation.

Minor renovation: A minor renovation is a limited renovation to the architectural, mechanical and electrical components in a portion of the building. The renovation may or may not involve some structural work but does not increase the occupied area of the building. A minor renovation is limited to one floor in a building with three or more storeys and to a part of one floor in a one- or two-storey building. Minor renovations must not reduce the capacity of the Seismic Force Resisting System (SFRS).

Voluntary seismic upgrade: A voluntary seismic upgrade is a non-mandatory upgrade of the SFRS. Upgrading to Level 1, the minimum assessment / upgrading level, is recommended. Non-structural upgrading is also recommended.

Evaluating the Building Capacity

In evaluating the capacity of an existing building, appropriate R_dR_o values to be used in the analysis need to be determined. Buildings that possess structural systems with little ductility should use $R_dR_o = 1.0$. The percentage of code is a measure of the degree of compliance of the building when compared to current code values considering both drift capability and existing strength as measures of compliance. Determine the existing strength (lateral load resisting capacity for earthquake loading) of the building using appropriate R_dR_o values and using appropriate material factors in accordance with current material standards. Determine the existing strength as a percentage of current code lateral force requirements. If the building has a seismic system that substantially complies with present systems with a defined R_dR_o then use the R_dR_o appropriate for that system. For systems including unreinforced masonry that do not have a defined system in the current code, use $R_dR_o=1.0$ when looking at force compliance. When evaluating deflections, use $R_dR_o=1.0$ forces to determine the deflections. Drift compliance is determined by establishing the drift where failure of the vertical load carrying system occurs, usually from the brittle failure of a column or short wall segment. Use the lower of percentage drift compliance and percentage force compliance to define the percentage of code compliance.

Conclusions

The NBC 2015 Commentary L provides guidance for the renovation of existing buildings built to previous codes that often had only rudimentary or nonexistent seismic provisions and are deficient from a seismic standpoint. These include: a) force levels that the building should be capable of resisting; b) consideration of drift levels that will often govern the design; and c) consideration of non-structural falling hazards such as parapets.

The Commentary L does not constitute a complete seismic upgrading protocol; rather guidance as to the philosophy and extent of seismic upgrading.

CAEE
Dept. of Civil Engineering
Univ. of British Columbia
2324 Main Mall
Vancouver, BC,
Canada V6T 1Z4
Fax:
604-822-6901
E-mail:
secretary@caee-acgp.ca

We're on the Web!

Visit us at:

http://caee.ca

News

Free Access to NBC 2015 Structural Commentaries!

The *Structural Commentaries (User's Guide – NBC 2015: Part 4 of Division B)* document is intended to help the Code users understand and apply the design requirements provided in Part 4 of Division B of the National Building Code of Canada 2015 (NBC).

Following an earlier announcement that the NBC was made available free of charge, the National Research Council (NRC) recently announced that the *Structural Commentaries* for NBC 2015 is also being made available, free of charge, on the NRC web site:

https://nrc-publications.canada.ca/eng/view/ft/?id=a23153d5-ad9d-46f9-9a29-3f76aa09dd7c

News and Upcoming Events

Due to COVID-19 pandemic, many conferences and workshops have been cancelled, postponed or converted to online events globally. We provide information on events available this quarter.

Upcoming events

Kinematrics Webinar
The Importance of Force Balance Accelerometers to Constrain Future and Near Real-Time Ground Motion Scenarios
2 Jun 2021
Online
https://kinemetrics.zoom.us/webinar/register/3316215446801/WN_Lkk0sYAIQ4ScOtJsxVNugg

37th General Assembly of the European Seismological Commission
19-24 September 2021
Online
www.escgreece2020.eu/

17th World Conference on Earthquake Engineering
27 September – 2 October 2021
Sendai, Japan
Hybrid format
www.17wcee.jp/

3rd European Conference on Earthquake Engineering and Seismology
19 – 24 June 2022
Bucharest, Romania
3ecees.ro/

12th US National Conference on Earthquake Engineering and 2022 EERI Annual Meeting
27 June – 1 July 2022
Salt Lake City, UT
eeri.org/about-eeri/news/7277-save-the-date-for-12ncee-and-2022-eeri-annual-meeting