



# From Christchurch to Canada

The 2010-11 earthquakes in Christchurch, New Zealand may resonate closely with Canadians because the risks are similar to those in eastern Canada.



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A recent string of disastrous earthquakes around the globe — including Haiti and Chile in 2010, New Zealand in 2010 and 2011, and Japan in 2011 — have served as stark reminders that catastrophic earthquakes are a reality. The earthquakes in Christchurch, New Zealand, in particular, may resonate closely with Canadians, since they occurred in a fellow Commonwealth country with similar building stock and design codes. Reactions vary when the topic of the probability of damaging earthquakes in Canada is broached. Some believe there is a serious risk, while others think the risk is so low that there's no chance of an event occurring in their lifetime. Many who recognize the risk in Canada believe it is limited to the West Coast. Truth be told, the risk is real and it's not only British Columbia that has to worry.

## **EARTHQUAKE RISK IN CANADA**

Some may be surprised to learn more earthquakes were felt in Ontario and Quebec in October 2011 than in British Columbia.<sup>1</sup> The recent U.S. earthquakes in Virginia (Magnitude 5.8 on Aug. 23, 2011) and Oklahoma (Magnitude 5.6 on Nov. 5, 2011) serve as reminders that earthquakes do still occur in areas of lower seismic activity.

Although large earthquakes are more frequent in B.C. than in Quebec and Ontario, that doesn't mean the eastern provinces are safe. Earthquakes occur in all regions of Canada, but certain areas are more likely to experience damaging events. Regional differences in geography cause earthquakes to affect larger areas in the East than in the West. Furthermore, the potential for an earthquake to cause damage depends on how the ground moves during the event and local building construction. On average, buildings are better constructed to withstand earthquake ground motions in B.C. than in Ontario and Quebec. Earthquakes may occur less often in eastern Canada, but the damage arising from a given event will be much larger.

## **LEARNING FROM CHRISTCHURCH**

Canada hasn't experienced a damaging earthquake in several decades, but we can gain insight into what to expect by looking at recent worldwide events. In the past 15 months, a series of strong earthquakes struck the Canterbury region of New Zealand's South Island. The most devastating of these, the Feb. 22, 2011 Lyttelton Earthquake (Magnitude-6.3), is a good example of the types of damage different regions of Canada

Illustration by Greg Stevenson/www.i2iart.com

can expect from a similar-sized event.

Victoria, B.C. and Christchurch are comparable in size with similar building stocks. Modern buildings dominate their landscapes, but each of these cities is famous for its heritage buildings. During the Lyttelton earthquake, the heritage buildings in Christchurch (the Christchurch Cathedral, for example) sustained extensive damage, which is to be expected given their pre-seismic design and materials. However, some of the most devastating damage was to modern construction — the Canterbury Television (CTV) building, for example, and the Grand Chancellor Hotel.

When it comes to different types of construction and how they hold up in earthquakes, we know some things for certain. Unreinforced masonry structures (URM) perform poorly. By comparison, wood-frame residential structures tend to perform well, but chimney damage is common. Façades and decorative features on buildings also frequently fail. All of these common types of earthquake damage were observed in Christchurch, and they can be expected to result from a similar-sized earthquake in Victoria. However, Victoria is not the only city that has this type of building stock: parts of Vancouver, Ontario and Quebec have building stocks comparable to that of Christchurch.

Several factors contributed to the level of damage sustained in the Lyttelton earthquake. At a Magnitude of 7.1, the September 2010 Darfield earthquake was the largest of a sequence of earthquakes to hit New Zealand in 2010-11, but the epicenter of the Darfield quake was approximately 45 km west of the city of Christchurch. The Magnitude-6.3 Lyttelton event, on the other hand, occurred much closer to the city — approximately 10 km to the southeast. Because of the location of the Lyttelton earthquake, the strong ground shaking had a direct impact on the buildings and infrastructure.

Additionally, the ground motion recorded in this earthquake was uncharacteristically high for its magnitude. In some ways, the ground motion experienced in Christchurch is comparable

to what may occur in Ontario or Quebec. This may seem counterintuitive, since central and eastern Canada is considered to be stable continental crust rather than the active plate boundary of New Zealand. Earthquakes in stable crust tend to exhibit slower attenuation of ground motion — i.e. they decay in amplitude and frequency with distance — than in active areas of seismicity. Also, they tend to release more energy over a given fault area (scientifically referred to as stress drop).

The Magnitude-5.9 earthquake in Saguenay, Quebec in 1988 exhibited one of the highest stress drops ever



recorded. It generated high epicentral ground motions from a relatively small magnitude event, similar to what occurred in Christchurch. The local geological conditions in Christchurch may not be common in tectonically active areas like the west coast of Canada, but high ground motions combined with a similar building inventory make the Lyttelton Earthquake a potential example of what we could see from an earthquake in Quebec.

Liquefaction, which describes a situation in which the ground loses strength and behaves like liquid, continues to be a hot topic following the New Zealand earthquakes. Prior to these events, it was expected that liquefaction could occur. But parts of the Christchurch metropolitan area experienced ground failure and flooding to an unprecedented degree. When we survey Canada for areas that could potentially experience extreme levels of liquefaction, Richmond, B.C. is of great concern. The British Columbia Geological Survey has mapped much of the City of Richmond

and rates its susceptibility<sup>2</sup> to liquefaction to be ‘High’ to ‘Very High.’ The question remains: “How bad will it be?”

## LESSONS FOR RISK MANAGEMENT

When we reflect on the state of earthquake awareness across Canada, the events in Christchurch should open the eyes of the country. Recently British Columbia has come a long way in terms of promoting earthquake awareness, with campaigns like The Great British Columbia ShakeOut. This was the largest earthquake drill in Canadian history — more than 500,000 people participated in the Oct. 20, 2011 drill<sup>3</sup> — but so much more can still be done.

Earthquake insurance, for example, has a long way to go. Take-up rates for residential properties in the Lower Mainland of B.C. are approximately 60 to 65%. But province-wide, they are less than 40%. These rates decrease substantially in Ontario and Quebec, where less than 5% of residential homeowners have earthquake insurance.

A better understanding of earthquake risk is necessary, in addition to a clear understanding of tools available to help manage the risk — including earthquake insurance and how it works. Catastrophe risk models are an essential piece to the puzzle.

While catastrophic earthquakes are rare events, many continue to believe they won’t happen. The Lyttelton Earthquake was a 1-in-10,000 year event for Christchurch. This is just one example of how rare catastrophic events can happen at any time. Few people in Christchurch believed this would actually happen in their lifetime, but their perspectives have changed. We can learn from this and prepare. ≡

1 *This is according to Natural Resources Canada’s Earthquakes Canada Web site, which provides an overview of earthquake hazard across Canada and detailed information on recent and historic events across the country. See <http://earthquakes-canada.ca>*

2 <http://www.em.gov.bc.ca/Mining/Geoscience/PublicationsCatalogue/Maps/GeoscienceMaps/Documents/GM2010-3.pdf>

3 <http://shakeoutbc.ca/>