briefing note 222 June 2011

The June 13, 2011 Christchurch Earthquakes, and Lessons for Australia.

Paul Somerville, Risk Frontiers, 17 June 2011

The Canterbury Plain earthquake sequence, which began with the Mw 7.1 event of September 4, 2010 and was followed by the much more devastating Mw 6.1 event of February 22, lurched back into the headlines with the occurrence of two strong earthquakes on Monday June 13: an Mw 5.3 event at 1:00 pm local time, followed by an Mw 6.0 event at 2:20pm. (We prefer the Harvard Mw magnitudes over the GNS Science ML magnitudes because the former are used in ground motion prediction equations and seismic hazard analysis). The earthquakes occurred close to but just south of the February 22 event, on fault planes that have similar orientation. However, unlike the February 22 event, which had a large component of dip-slip faulting, the June 13 earthquakes had mostly strike-slip faulting. The earthquakes came just after the mayor of Christchurch had expressed concern about GNS Science's forecast of continuing earthquake activity, which was abruptly borne out by the occurrence of the June 13 events. These events extended the aftershock zone eastward, as shown in Figure 1.

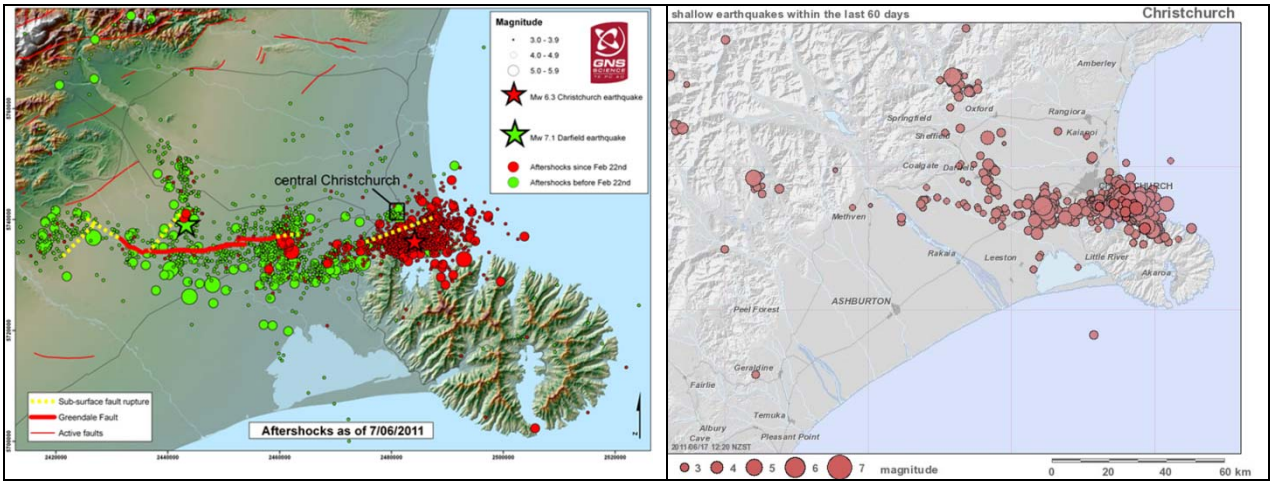

Figure 1. Left: Locations of faults and aftershocks of the Sept.4 and Feb. 22 events prior to June 6. Right: Locations of aftershocks for the past 60 days, including the June 13 events. Source: Geonet.

Figure 2 compares the recorded peak accelerations of the Mw 6.1 Feb 22 and Mw 6.0 June 13 events. The Mw 6.0 earthquake generated ground motions in Sumner, Lyttelton and the eastern suburbs that were as strong as those of the Feb 22 Mw 6.1 event. In the CBD, the shaking from the Mw6 event was approximately half that of the Feb 22 event and very similar to that of the Sept 4 2010 event. To the north and west, the ground motions were generally weaker than those of both the Feb 22 and Sept 4 events. The June 13 earthquakes once again caused extensive soil liquefaction in the eastern suburbs.

The complexity of the earthquake sequence probably reflects the fact that not many earthquakes have occurred on the Canterbury Plain fault system under the current stress regime, so there has not been time to smooth out the kinks and bends that are evident in the fault traces mapped in Figure 1. Forecasting the future evolution of this earthquake sequence is a difficult task. The same kinds of complex faulting characteristics have been observed in Australia, for example in the 1988 Tennant Creek earthquake sequence.

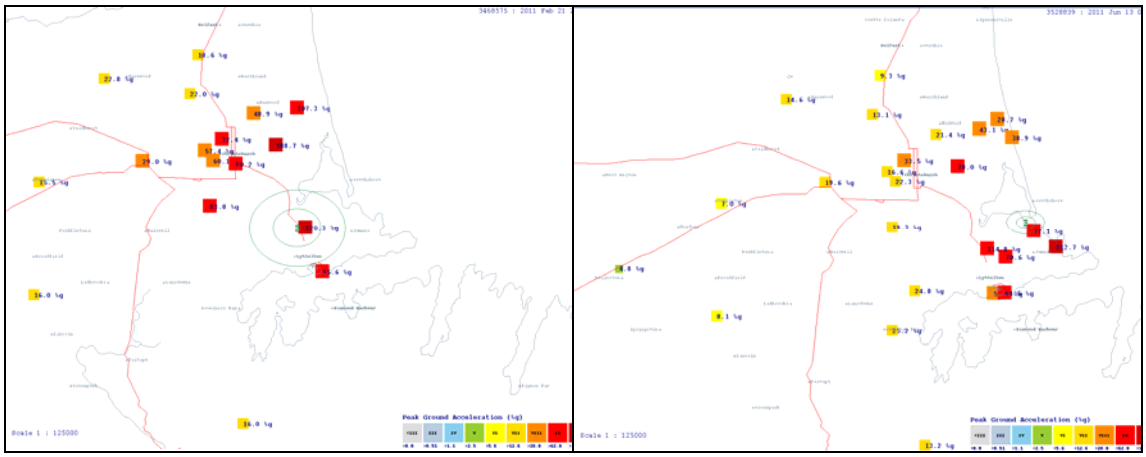

Figure 2. Peak accelerations recorded during the Feb 22 Mw 6.1 event (left) and the June 13 Mw 6.0 event (right). The colour code for peak acceleration is light yellow: 5.6%; dark yellow: 12.6%g; orange: 28%g; red: 62%g; brown: 138%g. Source: Geonet.

The following advice for Australia was written by Jason Ingham, Associate Professor of Structural Engineering at Auckland University, who has done extensive reconnaissance of reinforced masonry buildings following the earthquakes.

Reinforce you buildings, Australia, or see them crumble

February's events in Christchurch brought people's attention to the patently obvious: that old brick buildings collapse in large earthquakes. There is no shortage of past lessons regarding this fact – only a general complacency to acknowledge the hazard. The reasons for this are obvious: earthquakes are infrequent and unpredictable natural hazards, such that people generally assume that they themselves will never be involved in one. Furthermore, once they *have* been involved in a large earthquake, people are likely to assume a repeat will never occur, just as lightning never strikes twice. To do something about the vulnerability of old brick buildings so that they better withstand earthquakes costs money, and there is always something more urgent that the money could be spent on.

So we ignore the lesson from the Napier earthquake in 1931, which killed 256 people, and the lesson from the Newcastle earthquake in 1989, which killed 13 and injured more than 160. On both sides of the ditch, we happily go to brunch on Sunday in the funky cafe at the corner of the street with the interesting brick patterns on the wall. We give no thought to how the building might perform in an earthquake or what the old part of town would look like if the walls fell out of every building on Main Street.

In reality, earthquakes don't kill people – collapsed buildings kill people. And the majority of these deaths occur in buildings constructed of either bricks or adobe. It's worth noting last year's Haiti earthquake and the first Christchurch earthquake, last September, had almost identical characteristics in terms of both size and the vicinity of the earthquakes to a large city. These events resulted in an approximated death toll of 316,000 people in Haiti (recently upgraded from the earlier count of 250,000) and zero deaths in Christchurch.

The stark contrast reveals two important facts:

1) Construction practices downunder, both now and when our old brick buildings were new, are superior to those of developing countries, which is a conclusion that most people would take for granted.

2) A large dose of good luck was associated with the timing of the first Christchurch earthquake – 4.30am on a Saturday morning – with the central business district practically deserted.

Clearly, Christchurch was not so lucky in the February 22 earthquake, which struck at the end of the lunch hour on a Tuesday afternoon. Excluding two collapsed concrete buildings, the majority of injuries and fatalities were associated with the falling debris as several hundred old brick buildings, which either partially or completely collapsed in the space of about 10 seconds.

Past events cannot be undone, of course, but we are beholden to ask ourselves what we have learned from events in Christchurch, so that we can act before the memory again fades. In New Zealand, the construction of unreinforced brick buildings has been legislated against for nearly 50 years, but in fact has been unfashionable ever since the Napier quake. But in Australia, which admittedly has a far smaller earthquake risk, this form of construction is still common. This means there is a large number of buildings throughout Australia that could be expected to collapse in a major earthquake.

New Zealand legislation has defined an “Earthquake Prone Building” as one that has less than a third of the strength of an equivalent building that would be constructed today using current design standards. The goal of this legislation is to address these earthquake-prone buildings and remove the hazard that they represent, either by strengthening the building or by demolishing it. Of course, most of these earthquake-prone buildings are the old brick buildings that help to remind us of our history and of who we are as a nation. To mindlessly demolish these reminders of our cultural identity would be viewed as a catastrophic attack on our architectural heritage. But something must be done.

Arguably there are now no earthquake-prone buildings left in Christchurch – they have all collapsed – but the authorities in Wellington have publicly released a list of earthquake-prone buildings so that individuals can make an informed decision about the risk of entering a building, and authorities in Auckland are soon to release a similar list.

So what does all of this mean for Australia? The reality is that there will, at some point, be a significantly-sized earthquake with an epicentre not too far from a major Australian city. And when that earthquake happens, the old brick buildings will collapse and people will be killed. The old buildings of the city will be destroyed and the architectural landscape will be changed forever. Perhaps this risk pales against the annual hazards of bushfires and floods? Perhaps the threat of earthquakes can be ignored? Or perhaps the earthquake will strike tomorrow. If so, be shocked but not surprised when the old brick buildings in your city collapse.

http://theconversation.edu.au/reinforce-your-buildings-australia-or-see-them-crumble-1020

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