THE CANTERBURY EARTHQUAKES – LESSONS FOR CONSTRUCTION LAWYERS

Authors: Dr Donald Charrett

Date: June 2013

This article was first published in Construction Law International Volume 8 Issue 2 June 2013

Christchurch, New Zealand, following the earthquake damage in 2011

The Canterbury earthquakes – lessons for construction lawyers

Dr Donald Charrett

Barrister, Melbourne TEC Chambers

Following the earthquakes near Christchurch in 2010 and 2011 in which 185 people lost their lives, the New Zealand government implemented a Royal Commission to investigate how such devastation could be prevented in the future. This article highlights the most important issues and lessons learnt from the Royal Commission Report that are of interest to construction lawyers around the world.

The Canterbury earthquakes – a human tragedy in which 185 people lost their lives and severe damage was caused to the built environment – occurred near to and within the city of Christchurch, New Zealand in 2010 and 2011. Eighteen people died in one building (PGC) and 115 in another (CTV). A further 42 people died from the failure of other buildings and many more were injured.

Credit: NigelSpiers / Shutterstock.com

The New Zealand government subsequently implemented a Royal Commission, the terms of reference for which required recommendations to be made on:

- the measures necessary or desirable to prevent or minimise the failure of buildings due to earthquakes likely to occur during the lifetime of those buildings;
- the cost of those measures; and
- the adequacy of legal and best practice requirements for building design, construction and maintenance related to managing the risks of building failures caused by earthquakes.

This article endeavours to highlight what the author considers are the most important issues and lessons learnt from the Royal Commission Report (the 'Report') that are of interest to construction lawyers around the world. Given the breadth and depth of the issues covered in the Report, this paper can only touch the surface in the space available here.

The Report is, however, an invaluable resource for those interested in the causes of earthquakes, their impact on the built environment, the design of structures to resist earthquakes, and how the prevailing legal and regulatory framework of building regulations intersects with the protection of human life in a location known to be susceptible to earthquakes. Moreover, the Report discusses a number of issues of considerable interest to construction lawyers, of which the building design standards in relation to the risk of structural failure, the engineer's duty to warn of known hazardous structures, and the liability of volunteers wishing to assist in post-earthquake recovery are merely a sample.

For readers interested in reading the Report in greater detail, it is readily available on the internet (via **http://canterbury.royalcommission.govt.nz**) and in hard copy.

The Royal Commission Report

The comprehensive final report of the Royal Commission comprises seven volumes and was released late in 2012. The commissioners were a New Zealand High Court judge and two engineers. The Report is self-contained and includes detailed background material on the seismicity of the Canterbury area, earthquakes, structural design and codes for earthquake-resistant design, and the legal and regulatory environment in the Canterbury area.

As an investigation into the causes of loss of life and property, the Royal Commission, unlike in litigation, was not concerned with any legal liability. The Commission thus investigated all aspects it considered relevant to its enquiry, subject of course to the terms of reference set by the government. These terms of reference required the commissioner to investigate the performance of a reasonably representative sample of buildings in the Christchurch central business district, including four nominated buildings that collapsed totally or partially. In the event, the Royal Commission investigated all buildings that caused a fatality, all except five of which were located within the central business district.

The Royal Commission made a total of 189 recommendations, the majority of which related to the engineering aspects of earthquake-resistant building design. Seventy-five recommendations were made on roles and responsibilities in relation to building management after earthquakes, the regulatory framework for buildings and the training and education of civil engineers and organisation of the civil engineering profession.

Expert evidence in the Royal Commission

Much of the evidence before the Royal Commission was of a highly technical nature, involving structural design at the cutting edge of the worldwide practice of earthquake engineering. The procedures for submission and testing of expert evidence adopted by the Commission represented a comprehensive application of what would generally be regarded as world's best practice in the common law world. The Commission considered expert evidence put before it by interested parties and commissioned its own expert evidence on a number of issues.

The Commission used at least three 'best practice' techniques for critically assessing the expert evidence put before it. The first of these was peer review – the engagement of international experts to independently review and comment on reports prepared by the foremost experts in New Zealand. The second technique was to orchestrate a conference of experts who had addressed a common issue, chaired by an independent facilitator. The experts' conference prepared a joint report identifying areas of agreement and disagreement. The third technique was to have expert evidence presented orally to the Commission in a 'hot tub' – all experts giving evidence on a particular issue appearing before the Commission simultaneously and subject to questioning by the commissioners and the other experts.

Interestingly, the Commission used a further technique for expert evidence that is not available to judges in litigation or arbitrators in arbitration. On a number of issues, the Commission used its own expertise to carry out independent analyses to determine for itself the cause of failure of some buildings. This was done in cases where the Commission apparently did not agree with the findings of the expert reports and reviews submitted to it.

This approach was clearly within the terms of reference that enabled the Commission to 'conduct, where appropriate, your own research'. It was made possible through the appointment of highly qualified engineer commissioners who had the experience and ability to carry out detailed analyses using state-of-the-art analytical tools and assumptions. Such a 'hands-on' approach by the tribunal may be possible in an expert determination, and is certainly provided for in many dispute board procedures for determining disputes, such as the FIDIC 'rainbow' suite of standard contracts.

Legal and statutory requirements

An important aspect of the Royal Commission's terms of reference was the requirement to enquire into 'the adequacy of the current legal and best practice requirements for the design, construction, and maintenance of buildings in central business districts in New Zealand to address the known risk of earthquakes'. Volume 7 of the Report addresses this in sections covering building management after earthquakes, roles and responsibilities in the building control framework, training and education of civil engineers and organisation of the civil engineering profession, and the roles of the regional authorities in the management of earthquake risk.

While some of this material is particular to the New Zealand situation, a number of the issues addressed are of much wider interest. One of these is the extent to which the regulation of 'social' issues of importance to the community – in particular, the preservation of heritage listed buildings – may be in conflict with the fundamental requirement of ensuring public safety. A number of heritage listed buildings required demolition after the September earthquake to ensure public safety, as they could not be economically repaired. In the Commission's view, the regulatory environment, which required a time-consuming process to obtain the requisite approvals, did not appropriately provide for the more immediate needs of protecting the safety of the public. Its recommendation 111 was that: 'Life safety should be the overarching objective of building management after earthquakes as communities both respond to and recover from the disaster.'

It is sobering to realise that a number of fatalities in the February 2011 earthquake were caused by the collapse of 'red-carded' buildings that had been vacated and barricaded, but not demolished, after the September 2010 earthquake. Unfortunately, the extent of the barricades was inadequate to protect passers-by from the total collapse of the buildings.

Another issue of general interest is the extent to which the regulation of buildings provides adequate protection to the public from the collapse of buildings from a foreseeable earthquake event. Even before the Canterbury earthquakes, it was well known that unreinforced masonry structures perform poorly in earthquakes and can suffer sudden catastrophic collapse. Under the prevailing regulatory environment in New Zealand, there is no obligation to carry out any form of building strengthening to resist earthquakes, unless there is change of use and a consequent obligation to obtain a building permit.

Even in such a situation, the extent of strengthening required is only to bring the building up to 33 per cent of the current earthquake load standard. It is generally not possible to build any significant ductility into an unreinforced masonry structure. Accordingly, such structures have little capacity to deform and may fail catastrophically in an earthquake of a magnitude considerably less than the current 'design' earthquake.

Ultimately, the community will have to balance the conflicting requirements of an acceptable level of public safety mandated by statute and regulation, with the high costs of replacing legacy buildings that cannot be economically upgraded to meet modern standards. As the number of fatalities of passers-by in the February 2011 earthquake demonstrated, the performance of buildings in earthquakes is not just a matter for building owners and the occupants they are responsible for, it has much wider implications for the public at large.

Design standards and risk

New Zealand has had standards for the design of buildings and structures to resist earthquakes since 1935. The design loads and criteria for earthquake resistance have changed and evolved considerably over the years, including through the introduction of requirements for ductility and capacity design in the 1970s. The most recent design standard is NZS1170.5: 2004 'Earthquake Actions Standard', containing 153 pages of standard and commentary.

Prior to the 1960s, there was little knowledge of the principles for designing structures to resist the horizontal (and vertical) forces generated by earthquakes. The modern approach to earthquake-resistant design is to build ductility into the structure – a capability to undergo repeated deformation while dissipating substantial energy through the deformations of the structure. The majority of buildings constructed before the war were constructed of unreinforced masonry. Many buildings of this type, even those strengthened to upgrade their earthquake resistance, collapsed in the Canterbury earthquakes.

One outstanding lesson from the Report is that a building designed well to modern standards can provide life safety for its occupants, even when subjected to an earthquake of significantly greater magnitude than the 'design' earthquake. That is not to say that all the Christchurch buildings ostensibly designed to modern standards survived the earthquakes. Sadly, a number did not and the resulting collapses caused substantial loss of life. However, in virtually every such case, the Royal Commission found that there were aspects of the design, particularly in respect of ductility, that did not conform to the standards prevailing at the time they were built.

The Report highlighted a number of areas of design risk via its discussion of the behaviour of a number of buildings in the

Canterbury earthquakes. Some of these are inherent in designs being prepared by fallible human beings, some are related to the prevailing state of knowledge (or lack of it) and others are related to the procedures adopted for procurement of design, checking and certification. Substantial earthquakes, when they impact a major city, provide a load test that will result in many design risks eventuating. In addition to the two major modern buildings that failed with substantial loss of life, there were other buildings that were so severely damaged that they were subsequently demolished. The Royal Commission's investigation of these buildings drew attention to the following design risks.

Although a building may have been designed by a reputable and competent engineer, and certified by the building authority, that is no absolute guarantee that the prevailing design standards were complied with. The Royal Commission identified a number of such shortcomings in designs that apparently complied with the required standards at the time they were designed. As is demonstrated by the sophistication of the analyses that the Royal Commission itself carried out for some of these buildings, design of complex buildings to resist earthquakes requires a high level of engineering expertise and detecting non-conformance with design standards is an expensive and time-consuming exercise. In the absence of a testing event such as an earthquake that results in structural damage, or a change of occupancy, there may be no reason for a building owner to check a building's adequacy to the prevailing standards. There is, therefore, a potential risk that a building may have unknown inbuilt design weaknesses that render it unable to withstand a design earthquake.

Every earthquake that results in the failure of modern buildings adds to the knowledge of the behaviour of buildings under earthquake loads and how to design them to preclude complete collapse. Inevitably, design standards evolve to include the lessons learnt and the results of further research. The collapse of the PGC building in Christchurch clearly illustrates the evolution of design standards. The expert panel noted that the building structure was in accordance with the design requirements when it was designed in 1963, both in terms of strength and details. However, assessed against the current code for new buildings it was only compliant to a 30 to 40 per cent level with the new building standard. It collapsed because the shaking in the February earthquake was several times more intense then the capacity of the structure to resist it, and the connections between members were not designed to take the distortions that occurred.

Design risk can be reduced by careful attention to providing alternative load paths in the structure (referred to as 'redundancy' by structural engineers). For example, the Hotel Grand Chancellor suffered complete failure of a major load-bearing wall during the February earthquake. Although that failure came close to causing a catastrophic collapse of the 27-storey building, there was sufficient redundancy and resilience within the overall structure to redistribute load from the failing element and to halt the collapse.

No doubt there are a number of actions that can be taken to reduce design risk in relation to any building. One of the simplest, and in this author's view one of the most cost-effective, is an independent review of a building design, carried out by a competent engineer experienced in earthquake design. The Royal Commission noted that there tends to be insufficient external peer review by independent, experienced structural engineers, and made a number of recommendations in relation to certification of building design. This included the requirement to prepare a 'Structural Design Features Report' to describe the key elements of the design. It recommended that the relevant ministry should develop criteria for determining whether a structure is complex and, for structures determined to be complex, a 'Recognised Structural Engineer' should be required to certify the structural integrity of the design. A Recognised Structural Engineer would be a chartered professional engineer, with specialised competence in the field of structural engineering and well experienced in the design of complex structures.

Duty to warn

The Report highlighted some problem areas where engineers need to communicate the results of their investigations and their findings to other, non-technical people.

In some cases, the language used by engineers in reports does not convey the same message to lay people as it does to technical people. In other cases, the engineer needs to clearly articulate the assumptions behind and the limitations of the analyses carried out. Perhaps most important (and perhaps also the most difficult) is the requirement to explain the inherent risks notwithstanding the engineering assessment. For example, an unreinforced masonry building still has a significant risk of failure in an earthquake, even if it has been upgraded to the required 33 per cent standard of current earthquake loads.

Another important area identified by the Royal Commission is the obligations that an engineer might have in circumstances where they know that a building has a serious design deficiency and is unlikely to withstand a design-level earthquake. An engineer who has been commissioned to carry out investigations that reveal such a deficiency will usually have confidentiality obligations to their client. Further, the engineer will rarely be in a position to insist that remedial work be carried out immediately, or in extreme circumstances require the evacuation of the building. Nevertheless, the community has an overarching interest in such information being properly communicated to appropriate authorities which can ensure that the relevant action is taken.

Chartered professional engineers in New Zealand are regulated by statute and, to be so registered, an engineer must agree to be bound by the ethical rules prescribed in the Act. The ethical rules contain a number of provisions that, inter alia, oblige the engineer to take reasonable steps to safeguard health and safety, to inform others of the consequences of not following advice, and not disclose confidential information.

The Royal Commission did not consider that there was any material weakness in the Code of Ethics but recommended that it should be clarified in respect of:

- defining that the test for taking action was ensuring public health and safety;
- in a perceived conflict between two or more clauses, the question as to which clause should apply in the circumstances should be a carefully considered matter of judgement; and
- there should be clarity as to the point at which an obligation of a reviewing engineer to report a structure that has been identified to present a risk to health and safety is extinguished, and where the accountability for addressing the matter and rectifying any weaknesses rests.

A further recommendation was that the Code of Ethics should be amended to provide for an obligation to advise the relevant territorial authority and the Institution of Professional Engineers New Zealand in circumstances where a structural weakness has been discovered that gives rise to a risk to health and safety.

Engineers would no doubt appreciate some statutory clarity being provided to their duty to warn of known hazardous circumstances. More importantly, however, public safety will be enhanced if the wider dissemination of such information results in speedier rectification or other measures to protect life safety. Perhaps the most important lesson of all to be learnt from the Report is its emphasis on life safety being the guiding principle that should lie behind all aspects of design, certification, construction and management of buildings before and after earthquakes.

Conclusion

Arising from the tragedy of the Canterbury earthquakes, the Royal Commission and its Report offer tremendous insights into the international construction community and its lawyers. In this author's view, the Report will be studied for years to come by lawyers, engineers and other industry professionals for the clarity of its exposition and for the lessons that can be learnt to avoid such a large loss of life in future, inevitable earthquakes.

Dr Donald Charrett is a barrister, arbitrator and mediator based in Melbourne, Australia. He can be contacted at **d.charrett@vicbar.com.au**. Further aspects of the lessons from the Canterbury earthquakes are dealt with in Dr Charrett's article in (2013) 25(1) *Australian Construction Law Bulletin* 2.