



## Recovery following the Canterbury Earthquakes of 2010-11 The Experiences of a Major Residential Insurer

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### ABSTRACT

Post disaster recovery can be significantly shortened by predefining the requirements for repairing and rebuilding insured property. With specific reference to a large private insurer transformed in the aftermath of the Canterbury Earthquake Sequence in 2010-11, the paper outlines the challenges faced in applying new building guidelines to settle policyholder claims. In the Canterbury context the guidelines were a vital part of the recovery and without them the delays would have been much greater and more shambolic. However, the implementation and amendment of guidelines after the earthquakes had occurred, led to challenges arising from a lack of stakeholder familiarity with new methods and their application. A key lesson for future disaster management is to identify gaps in the information likely to be needed for the post disaster recovery phase and seek to develop those areas before an event occurs.

### Introduction – AMI and the formation of Southern Response

On 4 September 2010 at 4.35am, Christchurch, New Zealand (NZ) was struck by an Mw = 7.1 earthquake, with its epicentre 30km west of Christchurch ('Darfield Earthquake'). A significant number (51,000) of the houses in and around Christchurch were damaged by liquefaction, as they were founded on loose alluvial soils, with a water table within 2 m of the ground surface. AMI Insurance Limited ('AMI'), which was responsible for approximately one third of the residential insurance market at the time, received a large number of claims.

Early quantification of AMI's exposure to this earthquake indicated it would be able to meet its liabilities. However, the large aftershock (Mw = 6.2) on 22 February 2011, on the southern urban boundary of the city ('Lyttleton Earthquake') led to extensive additional liquefaction in eastern Christchurch, along with damage to houses from rockfalls and large scale earth movements on the Port Hills, causing extensive losses for AMI and its policyholders. As the extent of AMI's losses was quantified, it became apparent that AMI would be unable to meet its liabilities. AMI notified the NZ Government of its position and in response, the NZ Government began to formulate a financial support package culminating in the tendered sale of the business. In addition to this support, IAG (NZ) Holdings Ltd (IAG) purchased part of AMI's insurance business on 5 April 2012. AMI changed its name to Southern Response Earthquake Services

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Limited ('Southern Response') and became a Crown-owned company. Southern Response retained liability for all claims for damage resulting from the Canterbury earthquakes under AMI policies which occurred before 5 April 2012.

Given the large numbers of claims for house damage, it became apparent that Southern Response would need to focus its resource on the claims assessment and reconstruction response. This meant proactively managing the investigation, design and construction phases for house reinstatement.

This paper outlines some of the experiences of Southern Response in assessing and settling its liabilities in Canterbury. It highlights that the absence of specific foundation designs for houses on liquefiable land, together with established earthquake damage assessment criteria before the earthquakes, contributed to the extended period of time required for assessing and responding to claims.

### **Pre-earthquake Residential Building Standards and Knowledge of the Liquefaction Vulnerability in Christchurch**

Previous geotechnical studies e.g. Soils and Foundations Ltd (1991) had identified that loose, saturated soils below Christchurch were vulnerable to liquefaction during large earthquakes. Liquefaction had occurred in the town of Kaiapoi, just north of Christchurch, following the Cheviot earthquake ( $M_s = 6.9 \pm 0.2$ ) in 1901 (Berrill 1994). Consequently, local Councils had a policy of placing a note identifying liquefaction potential on the affected properties' Land Information Memorandum ('LIM'), to ensure that purchasers were aware of the hazard. However, with the exception of the Pegasus Bay Town north of Christchurch, few housing projects incorporated specific measures to mitigate the effects of liquefaction and generally no specific measures were required for new housing subdivisions. Furthermore, the New Zealand Building Code and other legislative building standards did not require designers to take explicit account of liquefaction in foundation design for houses.

The two key house design standards, NZS 3604:1999 for timber framed houses and the structures loading standard NZS 1170:2004, specifically excluded the effects of liquefaction in their application to house and commercial building design. Prior to the earthquakes, designer judgment would determine whether to incorporate liquefaction mitigation into the foundation design. Invariably this did not happen, partly on the grounds of cost, partly on the basis that designers were uncertain as to how to achieve compliance with the Building Code, and partly on the public supposition that liquefaction was unlikely to occur during the life of the building - defined as 50 years. This highlights one of the challenges in hazard management, where the hazard can be confidently identified, but its allied rate of recurrence cannot. As a result, if a hazard has not been observed within living memory, society tends to discount the likelihood and potential consequences of its occurrence. This phenomenon was apparent in Canterbury, where the liquefaction hazard was clearly recorded on the property LIM, but was disregarded by prospective purchasers or developers.

## **New Zealand's Natural Disaster Insurance Cover for Residential Houses**

Insurance coverage for natural disaster damage (including earthquakes) to residential houses in New Zealand is comprised of two layers:

- The first layer is provided by way of a statutory regime, administered through the New Zealand Government agency, the Earthquake Commission ('EQC'). For houses, EQC provides cover in any one earthquake event of up to \$100,000 (excluding GST).
- The second layer is provided by way of 'top-up' cover, up to the insured value of the house. This cover is provided through private insurers such as AMI.

In the Canterbury earthquake sequence, EQC was tasked with the role of first response and only when EQC determined that the damage to the house exceeded \$100 000 (plus GST) for any one earthquake event, would management of the house claim be passed on to the private insurer. Also unique to New Zealand is that EQC also provides land cover, providing compensation for natural disaster damage to land.

### **Ministry for Building, Innovation and Employment (MBIE) Guidelines**

Liquefaction-induced foundation deformation was the leading cause of damage to houses on Christchurch's alluvial soils. Given the historic use of flexible timber frames and the development of sound superstructure building standards (e.g. NZS 3604:1999), the majority of modern New Zealand house structures above the foundations were capable of resisting strong earthquake shaking without severe damage. The exceptions included brittle components such as older masonry, brick chimneys and poorly attached brick cladding.

Following the Darfield Earthquake, it quickly became apparent that there were no explicit New Zealand standards or engineering guidance to assist insurers, project management offices and engineers in assessing both the extent of the damage and the required scope of repair or replacement of earthquake damaged houses. This had a significant impact on insurers as they grappled with ways to respond to this earthquake event. Defining how to comply with New Zealand's Building Act and the Building Code in the aftermath of the Canterbury earthquakes became the task of the New Zealand Government's Department of Building and Housing ('DBH'), now the Ministry for Building, Innovation and Employment ('MBIE').

Compounding MBIE's challenge of delivering guidance, MBIE also faced the challenge that the Building Code only dealt with expected house structure performance during Serviceability Limit State (SLS) and Ultimate Limit State (ULS) earthquakes. The Building Code did not mention required land performance below the building (DBH, 2010). For this reason, MBIE developed guidelines on how to:

- Assess the required extent of reinstatement response to earthquake damaged houses, and
- Achieve compliance with the NZ Building Act of 2004 and its Building Code when

developing house reinstatement methodologies on liquefaction damaged land.

The MBIE guidance provided the building blocks for the residential recovery. In addition to Southern Response being guided by its insurance policy obligations, the MBIE guidance was a vital tool. The challenge for Southern Response and its technical advisors was to quickly familiarise themselves with the guidance details.

Over time, the guidelines were updated to include the rapidly developing base of knowledge. These changes, while necessary, led to additional challenges for Southern Response. The following sections outline the key aspects of the evolution of the guidelines.

### ***Darfield Earthquake & Department of Building and Housing Guidelines December 2010.***

DBH published its first guidelines (the 2010 Guidelines) for the repair and replacement of damaged houses in Christchurch in December 2010 (DBH, 2010), less than four months after the first earthquake. At the time of publication there were about 160,000 insurance claims from the Darfield Earthquake, with 16,000 claims related to land damage (DBH 2010).

The 2010 Guidelines classified the houses according to foundation and floor types and described foundation re-leveling, rebuilding guidance and methods for assessing earthquake damaged houses. A key aspect of the 2010 Guidelines was how differential settlement of house floors could inform the reinstatement response, which included re-leveling or partial or full foundation replacement.

The 2010 Guidelines also classified land damage into three *recovery zones*: Zone A had no land damage; Zone B had some land damage which could be repaired as part of normal engineering and consenting processes; and Zone C had severe or major land damage and would likely need large-scale engineering EQC sponsored works to prevent future lateral spreading. In addition to the EQC works the 2010 Guidelines described a series of ‘beam and grid’ or concrete foundations as solutions for differential settlement. Specific engineering design of new foundations in Zone C was *not envisaged* (DBH 2010).

### ***Lyttelton Earthquake & Department of Building and Housing Guidelines November 2011***

Before the 2010 Guidelines could be effectively put into practice, the Lyttelton Earthquake occurred, causing a significant increase in the scale of land and building damage. Many areas which had been left largely unaffected by the Darfield Earthquake suffered extensive damage.

Consequently a more comprehensive, revised guidance was needed (DBH 2011) and this was issued in November 2011 (‘the 2011 Guidelines’). Zones A, B and C were replaced with ‘Technical Category’ (TC) zones, which described expected liquefaction-induced land damage in future SLS and ULS earthquakes. MBIE classified residential land into a particular TC on the basis of observed damage and not a calculation of expected liquefaction performance in future earthquakes – this would occur when formulating an appropriate foundation repair or rebuild design. Furthermore, the site investigation requirements were altered to limit shallow investigation techniques to TC1 and TC2 land only, with all TC3 house lots potentially requiring

two deep investigation points (SPTs or CPTs) to between 10 and 15 m depth.

Although this new version of the guidelines provided foundation solutions that would satisfy the Building Code for TC1 and 2 land, it specifically omitted guidance for TC3 land.<sup>4</sup> Southern Response recognised the importance of ensuring appropriate assessment techniques and foundation solutions for the worst-affected properties, but delays while these were established caused angst and uncertainty for its customers on TC3 land.

During the time the 2011 Guidelines were being revised, Southern Response (AMI at the time) was estimating its total losses by accelerating its assessments to promptly address insurance claims, and to quantify the total losses to establish if it remained solvent. Consequently, most of Southern Response's 6000 assessments were based on the 2010 Guidelines, before the 2011 Guidelines were released in December 2011, ten months after the February 2011 earthquake.

The 2011 Guidelines relaxed the extent to which floor slopes would impact on the repair or rebuild decision, a change which was of significance to Southern Response. The challenge Southern Response faced was determining how to apply the revised standard, with the knowledge that an entirely different insurance response would be possible, at odds with what had previously been communicated to customers. Some houses deemed a rebuild based on the 2010 Guidelines would now be considered repairable. After much deliberation, Southern Response determined that any first assessment it was required to make at any one point in time, would be based on the most recent guidance, balanced by its decision not to unilaterally revisit previous assessments that used older guidance.

### ***Department of Building and Housing Guidelines - Appendix C April 2012***

Appendix C to the 2011 Guidelines provided the guidance for TC3 land which was previously unspecified. It was released in its draft form to stakeholders some months earlier, including Southern Response. It provided feedback to assist MBIE, a lot of which was incorporated into this guidance. Significant new guidance included in Appendix C included:

- Mandating a single liquefaction assessment methodology for assessing future liquefaction induced land performance and subsequent foundation strategy selection.
- Prescribing peak horizontal ground motions of 0.13 g for SLS and 0.35 g for ULS events, for use in the required forward looking liquefaction assessments.
- Requirements for assessment of lateral spreading and lateral stretch along waterways.
- A settlement index number was developed to characterise the land more vulnerable to liquefaction effects over the upper 10 m of the soil profile using an SLS earthquake.
- Providing foundation options for repair or rebuilding houses on TC3 land. Selection was now based on: index settlement, global lateral spreading at ULS and lateral stretch.

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<sup>4</sup> These were not provided until the subsequent version of the guidelines issued in April 2012.

### ***MBIE Guidance Revision issued December 2012***

In December 2012, MBIE (which had replaced the DBH in 2012) reissued its guidance. The 2012 Guidelines now consolidated the previous versions into a single comprehensive document. The basic procedures for site assessment and the foundation option selection remained, but the level of detailed guidance had deepened, becoming more comprehensive in its application and reflecting practical learnings from the residential recovery in Canterbury. Further time was required by Southern Response to develop an understanding of how to apply the revised guidelines.<sup>5</sup>

### **The Experience of Southern Response in Assessing and Settling Claims**

Southern Response and its technical advisors worked collaboratively with MBIE in the creation and refinement of the guidelines. The MBIE guidelines have been a crucial element in expediting the residential recovery process. They optimised the areas where specialist engineering inputs were required, and provided consistent processes for assessment and response along with foundation types resilient to future liquefaction events. Without the Guidance, the Canterbury rebuild would not have advanced as quickly and there would have undoubtedly been uncertainty, confusion and inconsistency regarding approaches to repairing and rebuilding.

However, the introduction of new concepts in the form of specific assessment criteria, land zoning, repair/rebuild processes and foundation systems in the middle of a recovery created delays until the community became familiar with each new set of guidelines and their implications. Each time a change was made, a period of time was required by Southern Response and their Project Management Office in order to understand, implement and communicate these changes throughout the community of homeowners, engineers and the contractor supply chain. Such changes were met with resistance from some and welcomed by others. Southern Response also experienced what would be considered extreme push-back from individual advocates as to the application of the MBIE guidelines and how it interacted with any insurance response, fuelled either by financial imperatives or sanctimonious views.

Revisions to the guidelines were necessary in response to a variety of factors, including the February 2011 earthquake, governmental zoning decisions, local government approaches, feedback from practicing engineers applying the Guidance and an increasing body of engineering knowledge. These revisions resulted in a comprehensive but complex document. Consequently, understanding of the guidelines and their application varied throughout the engineering community. These variations have led to a variety of approaches, ranging from dismissal on the basis that “they are only guidelines”, through to strict enforcement of the Guidance, sometimes at the expense of engineering judgment. In response to this, Southern Response adopted a comprehensive ‘pre-qualification’ process for procuring engineering services and built an internal technical team to ensure that a consistent approach was applied across its claims portfolio.

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<sup>5</sup> At the time of writing (March 2015) a further version of the guidelines is due to be published by MBIE.

The introduction of Technical Categories and in particular TC3, while necessary, created perception issues with homeowners. Many homeowners felt a TC3 zoning was detrimental to their property value, would impede progress, and restrict flexibility in the type of house they could rebuild. Additionally, homeowner's perceptions in Canterbury of new foundation types, including "readily repairable" timber floor foundations, were that they would be inferior to the concrete floors prevalent in new homes prior to the earthquakes.

In an effort to mitigate this, Southern Response worked closely with its engineering advisors to develop strategies for addressing the complex land conditions in TC3, the goal being to provide confidence to its policyholders. These actions included cooperation with an area wide TC3 drilling program to expedite geotechnical assessments and the development of the 'TC3 friendly' concept home dubbed 'The Cantabrian'. These initiatives took time, a luxury not afforded to Southern Response in the post-disaster recovery environment.

MBIE published the foundation types as 'standard designs' that would meet the various performance objectives of the New Zealand Building Code on liquefiable land, but they still required signoff by a designer. Southern Response also encountered reluctance from designers to adopt the new foundations. Often they would cite a lack of legislative weight for the guidelines. Some engineers were hesitant to endorse them without having undertaken specific design work from first principles. Gradually these concerns abated as engineers became comfortable with the designs.

Once designers adopted the new foundations, Southern Response encountered difficulties with the building sector tasked with the challenge of building such foundations and other construction parameters set out in the MBIE guidelines. Residential home building companies in Canterbury are often sales and project management companies, coordinating a series of subcontractors and a specialised supply chain. The introduction of new foundations disrupted this business model, leading to delays as foundation subcontractors became familiar with the concepts. Responses varied, with some builders embracing them and others initially resisting them, viewing them as labour intensive, unnecessary, expensive and overly conservative. Builder resistance subsided as they became familiar with the MBIE Guidance.

In March 2015, four years after the devastating earthquake of February 2011, Southern Response is now well advanced with its residential repair and rebuild program. The guidelines of December 2012 have been embraced by all stakeholders and are being applied on a daily basis. A further revision of the guidelines is expected shortly, incorporating new learnings in such areas as ground improvement for foundations. It is hoped that the changes will quickly be embraced as further tools to assist in the residential recovery in Canterbury.

### **Conclusions**

The New Zealand Building Code provided the foundation performance objectives for foundation design on liquefiable land. However, New Zealand standards lacked definition of acceptable liquefaction assessment methods and foundation solutions where that hazard was present. Consequently, immediately following commencement of the Canterbury Earthquake sequence, private insurers found themselves faced with many thousands of claims for house damage, but

lacked the “tools” for addressing them with methods and foundation solutions that were known to comply with the New Zealand Building Code.

This critical information gap was met with the introduction of a series of guidelines and revisions to provide all stakeholders with the assessment methods and foundation solutions for meeting the performance requirements of the New Zealand Building Code. Developing such guidance after the event, while an essential task for the recovery, inevitably delayed the insurance settlement process as the guidelines were developed and then introduced. Revisions at regular intervals exacerbated that process, as each revision needed to be understood and potentially applied to update previous assessments. MBIE delivered each version of its guidance with speed, practicality and professionalism in a challenging post-disaster recovery environment. Its contribution is held in immeasurably high regard by Southern Response and other stakeholders.

A key lesson learned by Southern Response regarding future hazard management was that efficient response to, and subsequent recovery from, natural disasters requires to the extent possible, predefinition of the means and parameters of assessing damage to homes caused by the hazard, as well as relating this to the means of repairing or rebuilding people’s homes and lives. Without these measures in place, post-disaster recovery will be inevitably delayed. In the case of Christchurch, the vulnerability of residential land to liquefaction had been recognised for nearly two decades, but there had been little or no requirement for developers and owners to address the issue during residential development. The performance-based management of hazards may be effective during “peace-time” when engineers and owners can develop unique solutions to meeting the Code, but that approach is not appropriate once the hazard has materialised and many thousands of damaged properties are requiring a consistent response. Predefining that recovery response before the hazard eventuates can significantly shorten society’s recovery.

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