Residential building repair cost and claim settlement time from the Canterbury Earthquake Sequence

S. Khakurel, R. P. Dhakal
Department of Civil and Natural Resources Engineering, University of Canterbury, Christchurch.

T. Z. Yeow
Earthquake Research Institute, The University of Tokyo, Japan.

S. Saha
School of Engineering, Indian Institute of Technology Mandi, India.

ABSTRACT

This study analyses the Earthquake Commission's (EQC) insurance claims database to investigate the influence of seismic intensity and property damage resulting from the Canterbury Earthquake Sequence (CES) on the repair costs and claim settlement duration for residential buildings. Firstly, the ratio of building repair cost to its replacement cost was expressed as a Building Loss Ratio (*BLR*), which was further extended to Regional Loss Ratio (*RLR*) for greater Christchurch by multiplying the average of all building loss ratios with the proportion of building stock that lodged an insurance claim. Secondly, the total time required to settle the claim and the time taken to complete each phase of the claim settlement process were obtained. Based on the database, the regional loss ratio for greater Christchurch for three events producing shakings of intensities 6, 7, and 8 on the modified Mercalli intensity scale were 0.013, 0.066, and 0.171, respectively. Furthermore, small (less than NZD15,000), medium (between NZD15,000 and NZD100,000), and large (more than NZD100,000) claims took 0.35-0.55, 1.95-2.45, and 3.35-3.85 years to settle regardless of the building's construction period and earthquake intensities. The number of claims was also disaggregated by various building characteristics to evaluate their relative contribution to the damage and repair costs.

1 INTRODUCTION

During 2010-11, a sequence of significant seismic events struck the Canterbury region of New Zealand. This caused damage to a large portion of the residential building stock, resulting in many people being displaced from their homes into temporary shelters and/or to undergo a long insurance claim process. New Zealand is in a unique situation as most residential homes were covered by the New Zealand Earthquake Commission (EQC) EQCover scheme for the first NZD100,000 of dwelling losses [EQC Act 1993], though homeowners would have to arrange for extra coverage with their private insurers if the losses exceeded this value. To keep track of claims made during the 2010-11 Canterbury Earthquake Sequence (CES), EQC had compiled a large dataset of information regarding claims lodged.

This study looks to utilise this dataset to understand the factors that might affect the claim settlement duration and the insured amount, which could be useful for predicting the impact of future New Zealand earthquakes. Note, however, that this study's scope will only focus on learning from the CES and will not cover any aspect of modelling for future events.

2 BACKGROUND

2.1 Christchurch residential building stock

Residential buildings in New Zealand can be broadly categorised into four groups based on their construction periods: Pre-1935, 1935-1960, 1960-1980, and Post-1980. This grouping approximately corresponds to major changes in the building standards as listed below:

1. Pre-1935: Most houses from this era were of timber frame construction, and the *Recommended Minimum Requirements for Safe and Economical Construction of Small Wooden Frame Buildings* document was introduced in 1924 [Cooney 1979]
2. 1935-1960: The first building standard NZS: 95 [NZS 1935] for the construction of light timber frame houses was published following the 1931 Hawke's Bay earthquake, and *Part IX Light Timber Construction* was published in 1944.
3. 1960-1980: NZS: 1900 [NZS 1964] superseded NZS: 95.
4. Post-1980: New standard NZS: 3604 was introduced in 1978 as the first engineering standard for timber-framed houses [NZS 1978].

Table 1 shows the residential building stock in greater Christchurch as of March 2006 [Page and Fung 2008], where the smallest proportion (Pre-1935) was still sizeable (13.5% based on all three areas combined).

Table 1: Residential building stock in greater Christchurch [Page and Fung 2008].

Area	Pre-1935	1935-1960	1960-1980	Post-1980	Total in 2006
Waimakariri	1,274 (7.8%)	3,542 (21.5%)	5,073 (30.8%)	6,572 (39.9%)	16,461
Christchurch	20,517 (14.4%)	47,924 (33.6%)	39,604 (27.7%)	34,670 (24.3%)	142,715
Selwyn	1,350 (10.8%)	3,447 (27.5%)	3,468 (27.7%)	4,263 (34.0%)	12,528
Total	23,141 (13.5%)	54,913 (32.0%)	48,145 (28.0%)	45,505 (26.5%)	171,704

2.2 Canterbury Earthquake Sequence (CES)

The CES produced more than 8700 earthquakes larger than M_L 2 as shown in Figure 1, with a diverse mixture of strike-slip and reverse faulting occurring on previously unknown faults [Sibson et al. 2011]. The four largest events were the 4th September 2010, 22nd February 2011, 13th June 2011 and 23rd December 2011 earthquakes, with each followed by smaller events which reduced in occurrence frequency and intensity with time. Key features of these events from the CES are presented in Table 2. Note that while the maximum recorded seismic intensities were even greater in some areas, the intensities reported in the Table were average values for the greater Christchurch region.

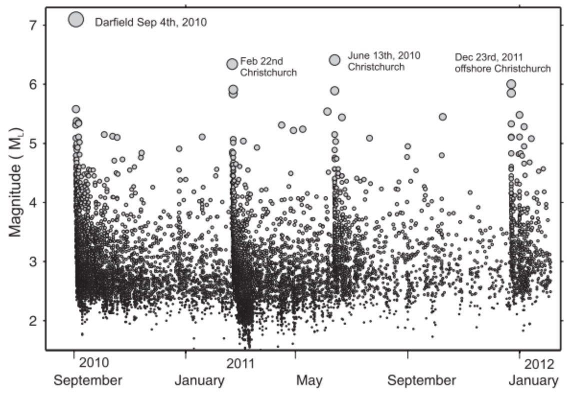


Figure 1: Magnitude of events during the Canterbury Earthquake Sequence [Bannister and Gledhill 2012]

Table 2: Summary of the main features of the CES.

Event date	NZST	Mw	Depth (km)	Epicentre	Distance from CBD	Intensity (MMI)	Max *PGA* (*g*)	
							Epicentre	CBD
4 Sep 2010	4:35	7.1	10	Darfield	37 km W	7	1.26	0.3
22 Feb 2011	12:51	6.2	5	Port Hills	10 km SE	8	2.2	0.8
13 Jun 2011	14:20	6.0	9	Sumner	10 km SE	6	2.0	0.4

2.3 Claim settlement process

Figure 2 shows an overview of the EQC residential building claims settlement process [EQC, 2021]. EQC sent out claim assessors to each household that lodged claim(s) within three months from the occurrence of an earthquake. They recorded the incurred damage and estimated the repair cost. In the case of multiple events, as in the CES, often a building was only assessed once during the sequence, and repair costs were apportioned across the events. This was achieved from statistical modelling by using assessed losses to similar building types in the vicinity for each event [Horspool et al. 2016].

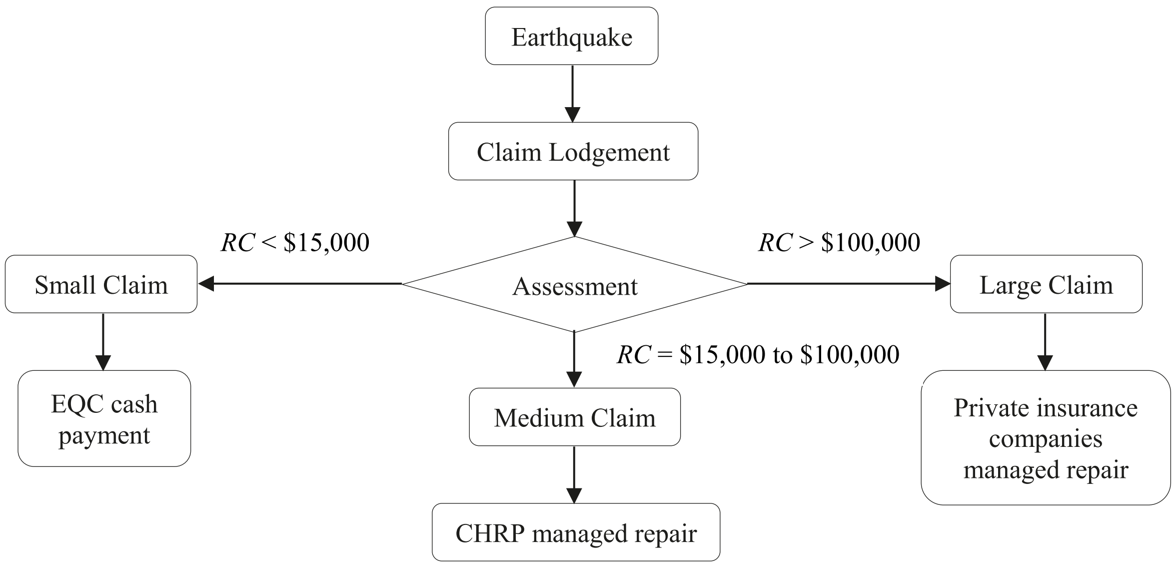


Figure 2: Overview of EQC claim settlement process (RC – repair cost in NZD) [EQC 2021]

Based on the repair cost estimation, claims are settled in different ways depending on the size of the claims [EQC Act 1993]:

1. **Small (Cash) Claims:** Claims raised from non-structural damage and estimate of repair cost (*RC*) less than the cash settlement limit if NZD15,000. These claims were settled by cash payments.
2. **Medium (CHRP) Claims:** (i) claims associated with structural damage for the repair cost below the cash settlement limit, and (ii) claims with total repair cost falling between the cash settlement limit and the EQC cap (i.e. NZD100,000). These claims were managed through the Canterbury Home Repair Programme (CHRP).
3. **Large (Over-cap) Claims:** Claims with the total repair cost exceeding the EQC cap for a single event. These claims were managed through a private insurance company.

3 METHODOLOGY

This section details the EQC data processing performed in this study, where the database comprised of information on: (i) the building characteristics, (ii) the amount paid to each claimant, or/and spent on repair, and (iii) key milestone dates of the claim settlement process.

3.1 Loss ratio

Two measures of loss were considered; (i) the building loss ratio (*BLR*) which defines the repair cost as a portion of the maximum payable amount as per the EQCover scheme, and (ii) the regional loss ratio (*RLR*) which estimates the average *BLR* of all households within the region. *BLR* was obtained for each building by dividing its building repair cost (*RC*, taken from the apportioned repair cost from the EQC database) with its maximum payable amount (RC_{MP}, taken from the building sum insured value from the EQC database), as shown in Equation 1:

$$BLR = \frac{Building\ Repair\ Cost\ (RC)}{Maximum\ Payable\ Repair\ Cost\ by\ EQC\ (RC_{MP})} \tag{1}$$

Note that the maximum payable repair cost is lesser of the insured value of the building and the EQC cap (i.e. NZD100,000), which does not represent the replacement cost of most buildings. This also implies that for buildings assessed to require more than NZD100,000 to repair, *BLR* is bound to be greater than 1. To avoid this anomaly, *BLR* was restricted to 1 for such cases.

After computing the building loss ratio for all the individual claims lodged in a single event, the weighted average *BLR* for an event $(\overline{BLR})$ was calculated from Equation 2:

$$\overline{BLR} = \frac{BLR_{small} \times SC + BLR_{medium} \times MC + BLR_{large} \times LC}{100}\% \tag{2}$$

where, BLR_{small}, BLR_{medium}, and BLR_{large} are the average building loss ratios for small, medium, and large claims categories in a single event; *SC*, *MC*, and *LC* are the percentage of small, medium, and large claims of the total claims for that event.

The weighted average *BLR* for an event was finally multiplied by the claim proportion for each event to obtain the regional loss ratio for the greater Christchurch area (*RLR*) for that event as shown in Equation 3.

$$RLR = \overline{BLR} \times Claim\ Proportion \tag{3}$$

3.2 Quantification of settlement duration

The database lists the following key dates for each claim: (i) the event date, (ii) the claim open date, (iii) the assessment date, and (iv) the repair date. Based on this, three key phase durations were identified as follows:

1. **Claim Duration (T_c):** Time taken to lodge a claim for the damaged buildings, which was computed by subtracting the event date from the claim open date.
2. **Assessment Duration (T_A):** Time taken to assess the claimed properties by EQC assessors, which was computed by subtracting the claim open date from the assessment date.
3. **Repair Duration (T_R):** Time taken to complete repair works after the most recent assessment performed, which was computed by subtracting the assessment date from the repair date.
4. **Settlement Duration (T_S):** Time taken to settle the claim, which was computed by subtracting the event date from the repair/settlement date (this also equals the sum of T_c, T_A and T_R).

3.3 Building characteristics

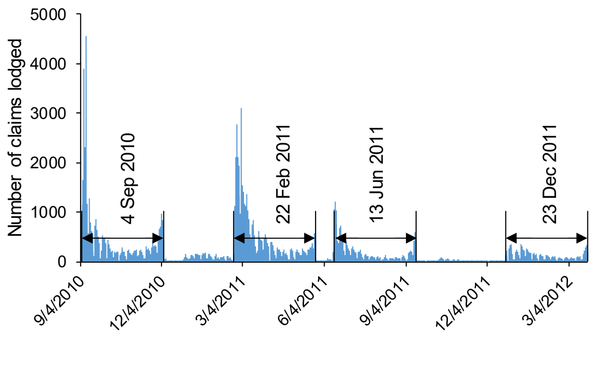
The number of claims was disaggregated based on the following building characteristics:

- Construction period: Pre-1935, 1935-1960, 1960-1980, and Post-1980
- Number of storeys: single and multiple
- Foundation type: concrete pile, concrete slab, and wood
- Floor-type: concrete, particleboard, and tongue-and-groove
- Cladding type: brick veneer, fibre cement, stucco, and weatherboard
- Roof type: clay tile, concrete tile, metal tile, and metal sheet

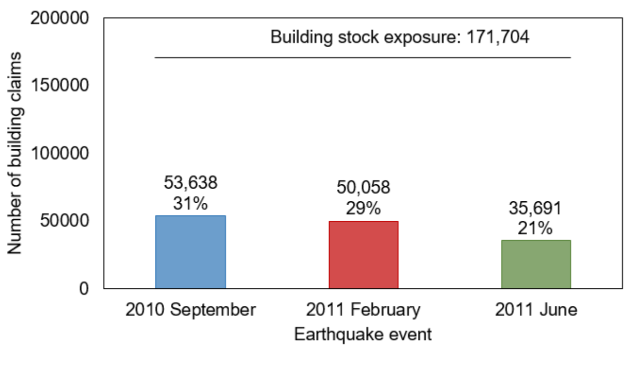
4 RESULTS

4.1 Overview of EQC claims

Each of the four significant seismic events produced distinct claim-lodgement bands for claims lodged with EQC during the CES, as shown in Figure 3a. The duration of each band spanned three months due to EQC's claims lodgement time requirements and resulted in many last-minute claims being lodged at the end of each band. Some claims lodged between the first and second bands was due to a sizeable event occurring on the 23rd of December 2010, though not to the same size as the other four events. Both the June and December events from 2011 had similar intensities and had produced similar claim lodgement trends and hence are grouped as a single event. Thus, claims were grouped by the following three events: (i) September 2010 event, (ii) February 2011 event, and (iii) June 2011 event. The number of building claims lodged disaggregated by the three events are shown in Figure 3b, where 21% to 31% of the households in the region lodged claims.



(a)



(b)

Figure 3: EQC building claims; (a) daily number of claims, (b) number per event category

Table 3 shows the breakdown of claims by event and claim size. Following the September 2010 event, most claims were small (59.5%). In contrast, only 20% of claims lodged following the February event were small while over 40% were large which reflected the higher intensity of the February 2011 event within the Christchurch area. As the impact of the June 2011 event was much smaller, 81.2% of the claims were small.

Table 3: Breakdown of EQC claims.

Event	**September 2010**		**February 2011**		**June 2011**		**Total**
Claim categories	**Number**	**%**	**Number**	**%**	**Number**	**%**	**Number**
Small	31,896	59.5	10,007	20.0	28,980	81.2	70,883
Medium	17,743	33.1	19,421	38.8	6,121	17.1	43,285
Large	3,999	7.4	20,630	41.2	590	1.7	25,219
Total	53,638	100	50,058	100	35,691	100	139,387

Figure 4 shows the cumulative probability distribution for the repair cost of the damaged residential buildings which lodged claims for the CES. A clear gap between the EQC cap and the median repair cost of Large Claims can be observed. It should be noted that this gap had been addressed in the renewed EQC cover policies from 1 July 2019 by extending the maximum cover for residential buildings to NZD150,000 [EQC 2021].

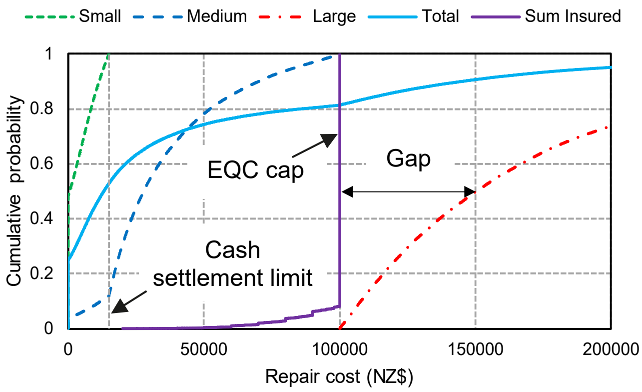


Figure 4: Cumulative distribution function of the repair cost

4.2 Characteristics of buildings with EQC claims

This section covers the disaggregation of claims by building characteristics. Due to insufficient data on general building stock characteristics (except for construction periods), a judgement could not be made on the susceptibility of elements to incur damage. Nonetheless, the authors viewed it important to present these results due to their potential usefulness in future studies.

4.2.1 Construction period

Figure 5a shows the disaggregation of claims by the building's construction period. In comparing these percentages by that of the actual building stock from Table 1, post-1980 houses had a disproportionately larger contribution to claims (32% versus 26.5%), while 1935-1960 houses had the largest decrease (23% versus 32.0%). This could potentially indicate that Post-1980 houses could be more prone to damage compared to houses built during other construction periods. It should, however, be noted that the values from Table 1 were about 4 to 5 years out-of-date and thus the proportion of Post-1980 homes could have increased before the occurrence of the CES.

4.2.2 Foundation type

Figure 5b shows the breakdown of claims by foundation type (e.g. concrete piles, concrete slab, and wood), where concrete slab construction had the greatest proportion of claims, narrowly followed by concrete piles.

4.2.3 Number of storeys

Figure 5c shows the breakdown of claims by the number of storeys, where "single" referred to one-storey houses while "multiple" included houses with two or more storeys and split level houses with staggered floor levels. A significant majority of claims were of single-storey construction.

4.2.4 Floor-type

Figure 5d shows the breakdown of claims by floor construction (e.g. concrete, particleboard, or tongue-and-groove), where 51% of claims utilized tongue-and-groove construction while 39% had concrete floors.

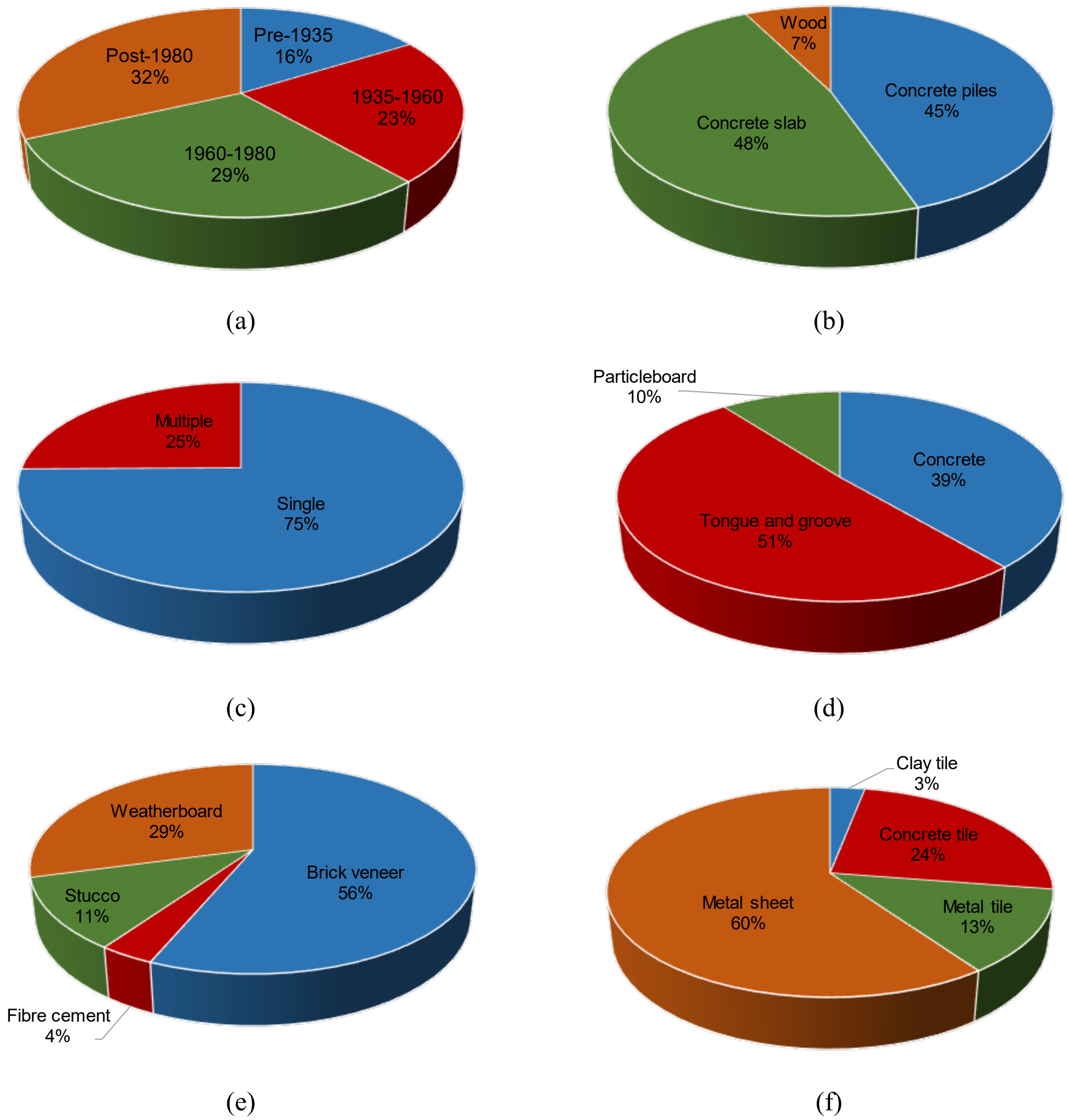


Figure 5: Disaggregation of claims by building characteristic; (a) construction period, (b) number of floors, (c) foundation type, (d) floor type, (e) cladding type and (f) roof type

4.2.5 Cladding type

Figure 5e shows the breakdown of claims by cladding material (e.g. brick veneer, fibre cement, stucco, and weatherboard), where the majority had brick veneer and about one-third had weatherboard cladding.

4.2.6 Roof type

Figure 5f shows the breakdown of claims by roof material (e.g. clay tile, concrete tile, metal tile, and metal sheet), where the majority used metal sheet roofs while 24% had concrete tile roofs.

4.3 Loss ratios (*BLR* and *RLR*)

Figure 6a shows the mean building loss ratio (*BLR*) for small, medium, and large claim categories with different seismic intensities based on the modified Mercalli intensity (MMI) scale. Herein, MMI 6, 7, and 8 represent June 2011, September 2010, and February 2011 earthquake events, respectively (from Table 2). It is worth noting here that as explained earlier the loss ratio for large claims (exceeding the EQC cap) was capped at 1; hence the mean *BLR* for large claims in all three events are shown as 100%. However, before deducing any conclusions from this one should not forget that the proportion of claims falling into the large category is smaller for the lower intensity events. It can be seen in Figure 6a that the *BLR* for medium claims increased with MMI, demonstrating that the extent of repairs was likely larger with increasing intensity. Likewise, the weighted average *BLR* shown in Figure 6b also increased with MMI.

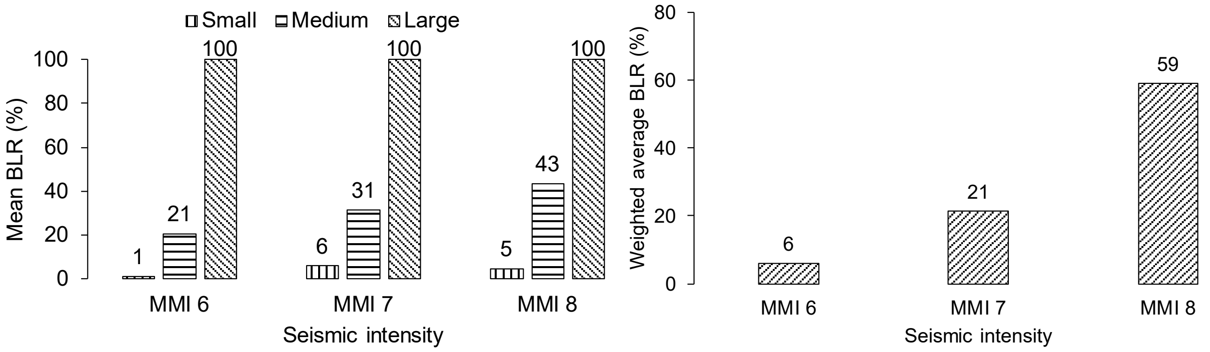


Figure 6: Building loss ratio; (a) mean BLR for small, medium, and large claims; (b) weighted average

Figure 7a shows the regional loss ratio (*RLR*) for greater Christchurch, which again increased with increasing MMI. Disaggregation of *RLR* by claim categories, as shown in Figure 7b, showed that the contribution of medium and large claims increased with the increase of seismic intensity. In contrast, the number of small claims decreased at MMI8 as buildings incurred more severe damage due to the higher shaking intensity.

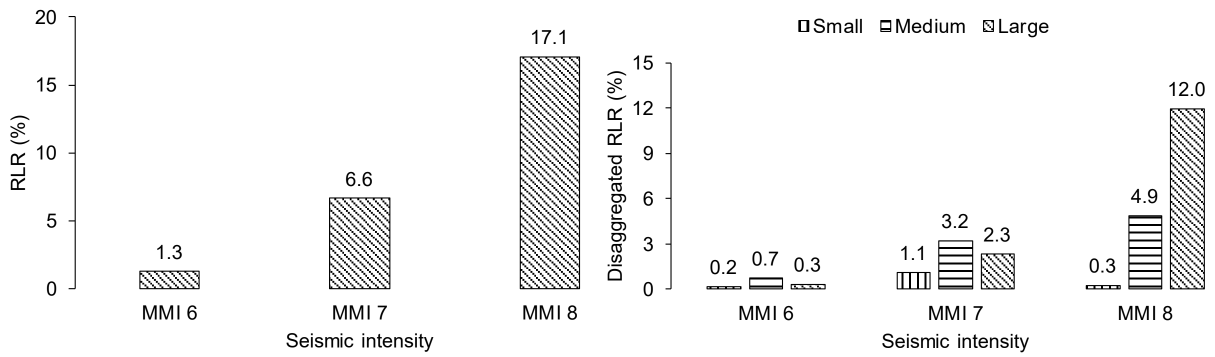


Figure 7: Regional loss ratio for greater Christchurch (a) total; (b) disaggregated value

4.4 Settlement duration

Table 4 shows the lognormal distribution parameters (median and dispersion) for each phase of the claim duration process. In general, claims were lodged earlier for larger claims as these claimants were more likely to urgently lodge claims due to either having lost their homes, needing to relocate to temporary accommodation or having to take extreme precaution using those damaged residences. In contrast, households with small claims would likely have only incurred limited damages which did not hinder occupancy. Often, people consulted others to verify the possibility of small compensation or waited for similar examples before lodging a claim.

The assessment phase was also usually typically shorter for larger claims than for smaller and medium claims. Interestingly, lodging claims typically took longer after the February event, which could be because (i) more medium and large claims being lodged which required more rigorous assessments, (ii) over-stretched manpower as some might still be busy assessing losses incurred in the last event, and (iii) any other on-ground technical/nontechnical issues caused by already damaged buildings from the September 2010 event (for example, house owners initially presuming that their unsettled claim after the September event would automatically roll-over to the February event).

The repair duration for larger claims generally took longer than medium claims due to the more extensive repairs required for large claims. The repair duration of the June event (least intense) took longer than for the previous events. This was likely due to limited manpower as repair work from the September and February events were likely still ongoing. Note that the repair duration for small claims was not provided since these claims were settled by cash settlements only.

The overall claim settlement process for small, medium and large claims took 138-191 days, 712-890 days, and 1226-1392 days, respectively. This shows that despite the earlier lodgement and faster assessment of large claims, these took much longer to be settled due to the extensive repair work involved.

Table 4: Lognormal distribution parameters for claim settlement phases.

Phase	Claim category	Event					
		September 2010 (MMI7)		February 2011 (MMI8)		June 2011 (MMI6)	
		Median	Dispersion	Median	Dispersion	Median	Dispersion
Claim	Small	25	1.23	28	1.16	26	1.29
	Medium	11	1.34	18	1.18	15	1.34
	Large	4	1.15	9	1.13	11	1.48
Assessment	Small	122	0.91	146	0.85	111	1.31
	Medium	136	0.82	151	0.69	69	1.00
	Large	48	1.14	119	0.78	86	0.88
Repair	Small	-	-	-	-	-	-
	Medium	489	0.68	698	0.62	742	0.57
	Large	1158	0.78	1133	0.55	1146	0.26
Combined	Small	154	0.77	191	0.69	138	1.12
	Medium	712	0.54	890	0.45	867	0.48
	Large	1392	0.59	1316	0.43	1226	0.23

5 CONCLUSIONS

The Earthquake Commission (EQC) residential building insurance claims database provided an opportunity to study the impact of the Canterbury earthquake sequence (CES) on the damage/loss incurred by the residential buildings stock. Information on damage repair cost and key milestone dates of the insurance claim settlement process was extracted from the database and was then used to quantify the loss ratio at the building level and regional level as well as the settlement duration.

Building loss ratio (*BLR*) for the small and medium claims are found to be in the range of 1-6% and 21-43%, respectively. Large claims were above the EQC limit of NZD100,000 and the corresponding *BLR* was thus taken as 100%. The weighted average *BLR* for an event is found to be 6%, 21%, and 59% for seismic intensities 6, 7, and 8, respectively. In addition, the regional loss ratio (*RLR*) for seismic intensities 6, 7, and 8 are found to be in the range of 0.2-1.1%, 0.7-4.9%, and 0.3-12%, respectively. Overall, the region-level building losses increased with seismic intensity due to buildings incurring greater damage in more intense shakings.

For the residential building insurance claims lodged to EQC from the CES, the claim duration (i.e. the time between the event and the claim lodgement day) was found to be in the range of a few weeks; the assessment duration (i.e. the time between the claim lodgement day and the most recent assessment day) in the range of a few months; and the repair duration (i.e. the time between the most recent assessment day and the repair completion day) in the range of a few years. Generally, buildings with greater damage lodged claims earlier and were assessed quicker. However, due to the extensive repairs required, the repair duration and the overall settlement claim process were the longest for large claims.

6 ACKNOWLEDGEMENTS

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