Christchurch City Council

Martindales Road Housing Complex PRO 1731

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Martindales Road Housing Complex

Quantitative Assessment Report

10 Martindales Road, Heathcote Valley

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Summary

Martindales Road Housing Complex
PRO 1731

Detailed Engineering Evaluation
Quantitative Report - Summary
Final

Background

This is a summary of the quantitative report for the Martindales Road Housing Complex, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This assessment covers the 15 residential units and 4 garages on the site.

Key Damage Observed

The residential units have suffered minor damage to non-structural elements. This included cracking of the internal plasterboard linings and separation of external garden block walls. Minor cracking of the concrete block work was widespread. This damage was deemed low enough to not affect the capacities of the buildings.

Level Survey

All floor slopes assessed in a laser level survey. None of the floor slopes were greater than the 5mm/m limitation set out in the MBIE guidelines [6], as shown below.

Internal Lining Nail Spacings

The internal lining nail spacings were measured on site to vary between 250-300mm.

Critical Structural Weaknesses

No critical structural weaknesses were found in any of the buildings.

Indicative Building Strength

Table A: Summary of Seismic Performance by Blocks

Block	NBS%	Floor Levels	Nail Spacings
PRO 1731 B001 (Block A)	43%	Pass	Pass
PRO 1731 B002 (Block B)	39%	Pass	Pass
PRO 1731 B003 (Block C)	39%	Pass	Pass
PRO 1731 B004 (Block D)	39%	Pass	Pass
PRO 1731 B005 (Block E)	39%	Pass	Pass
PRO 1731 B006 (Block F)	43%	Pass	Pass
PRO 1731 B007 (Garage)	65%	Pass	Pass

No buildings on the site are considered to be Earthquake Prone.

Blocks A and F have capacities of 43% NBS as limited by the in-plane shear capacity of the timber-framed shear walls in the longitudinal direction.

Blocks B, C, D and E have capacities of 39% NBS as limited by the in-plane shear capacity of the timber-framed shear walls in the longitudinal direction.

The garage has a capacity of 65% NBS as limited by the in-plane shear capacity of the timber-framed shear walls in the longitudinal direction.

Increasing the number of nails in the plasterboard will not significantly improve the strength of the buildings.

Recommendations

It is recommended that;

- Strengthening schemes be developed to increase the seismic capacity of all buildings to at least 67%NBS.
- The concrete perimeter footings be repaired on blocks where severe cracking occurs.
- Cracks in the concrete block work be repaired.
- Cosmetic repairs be undertaken as required, including repair of damage to blockwork fences.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council to undertake a detailed seismic assessment of the Martindales Road Housing Complex, located at 10 Martindales Road, Heathcote Valley following the Canterbury earthquake sequence since September 2010. The site was visited by Opus International Consultants on 13 November 2013 and 9 December 2013.

The purpose of the assessment is to determine if the buildings in the village are classed as being earthquake prone in accordance with the Building Act 2004.

The seismic assessment and reporting have been undertaken based on the qualitative and quantitative procedures detailed in the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) [2] [3] [4] [5].

2 Compliance

This section contains a brief summary of the requirements of the various statutes and authorities that control activities in relation to buildings in Christchurch at present.

2.1 Canterbury Earthquake Recovery Authority (CERA)

CERA was established on 28 March 2011 to take control of the recovery of Christchurch using powers established by the Canterbury Earthquake Recovery Act enacted on 18 April 2011. This act gives the Chief Executive Officer of CERA wide powers in relation to building safety, demolition and repair. Two relevant sections are:

Section 38 – Works

This section outlines a process in which the chief executive can give notice that a building is to be demolished and if the owner does not carry out the demolition, the chief executive can commission the demolition and recover the costs from the owner or by placing a charge on the owners' land.

Section 51 – Requiring Structural Survey

This section enables the chief executive to require a building owner, insurer or mortgagee to carry out a full structural survey before the building is re-occupied.

We understand that CERA require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). CERA have adopted the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011. This document sets out a methodology for both initial qualitative and detailed quantitative assessments.

It is anticipated that a number of factors, including the following, will determine the extent of evaluation and strengthening level required:

1. The importance level and occupancy of the building.

2. The placard status and amount of damage.

3. The age and structural type of the building.

4. Consideration of any critical structural weaknesses.

Christchurch City Council requires any building with a capacity of less than 34% of New Building Standard (including consideration of critical structural weaknesses) to be strengthened to a target of 67% as required under the CCC Earthquake Prone Building Policy.

2.2 Building Act

Several sections of the Building Act are relevant when considering structural requirements:

Section 112 - Alterations

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to the alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

The Earthquake Prone Building policy for the territorial authority shall apply as outlined in Section 2.3 of this report.

Section 115 – Change of Use

This section requires that the territorial authority is satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'.

This is typically interpreted by territorial authorities as being 67% of the strength of an equivalent new building or as near as practicable. This is also the minimum level recommended by the New Zealand Society for Earthquake Engineering (NZSEE).

Section 121 – Dangerous Buildings

This section was extended by the Canterbury Earthquake (Building Act) Order 2010, and defines a building as dangerous if:

1. In the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
2. In the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
3. There is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
4. There is a risk that other property could collapse or otherwise cause injury or death; or
5. A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone (EPB) if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property.

A moderate earthquake is defined by the building regulations as one that would generate loads 33% of those used to design an equivalent new building.

Section 124 – Powers of Territorial Authorities

This section gives the territorial authority the power to require strengthening work within specified timeframes or to close and prevent occupancy to any building defined as dangerous or earthquake prone.

Section 131 – Earthquake Prone Building Policy

This section requires the territorial authority to adopt a specific policy for earthquake prone, dangerous and insanitary buildings.

2.3 Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in October 2011 following the Darfield Earthquake on 4 September 2010.

The policy includes the following:

1. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
2. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
3. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
4. Repair works for buildings damaged by earthquakes will be required to comply with the above.

The council has stated their willingness to consider retrofit proposals on a case by case basis, considering the economic impact of such a retrofit.

If strengthening works are undertaken, a building consent will be required. A requirement of the consent will require upgrade of the building to comply 'as near as is reasonably practicable' with:

- The accessibility requirements of the Building Code.
- The fire requirements of the Building Code. This is likely to require a fire report to be submitted with the building consent application.

Where an application for a change of use of a building is made to Council, the building will be required to be strengthened to 67% of New Building Standard or as near as is reasonably practicable.

2.4 Building Code

The Building Code outlines performance standards for buildings and the Building Act requires that all new buildings comply with this code. Compliance Documents published by The Department of Building and Housing can be used to demonstrate compliance with the Building Code.

On 19 May 2011, Compliance Document B1: Structure, was amended to include increased seismic design requirements for Canterbury as follows:

- Increase in the basic seismic design load for the Canterbury earthquake region (Z factor increased to 0.3 equating to an increase of 36 – 47% depending on location within the region);
- Increased serviceability requirements.

2.5 Institution of Professional Engineers New Zealand (IPENZ) Code of Ethics

One of the core ethical values of professional engineers in New Zealand is the protection of life and safeguarding of people. The IPENZ Code of Ethics requires that:

Members shall recognise the need to protect life and to safeguard people, and in their engineering activities shall act to address this need.

1.1 Giving Priority to the safety and well-being of the community and having regard to this principle in assessing obligations to clients, employers and colleagues.

1.2 Ensuring that responsible steps are taken to minimise the risk of loss of life, injury or suffering which may result from your engineering activities, either directly or indirectly.

All recommendations on building occupancy and access must be made with these fundamental obligations in mind.

3 Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The loadings are in accordance with the current earthquake loading standard NZS1170.5 [1].

A generally accepted classification of earthquake risk for existing buildings in terms of %NBS that has been proposed by the NZSEE 2006 [2] is presented in Figure 1 below.

Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance: Legal Requirement	Improvement of Structural Performance: NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended		Not recommended. Acceptable only in exceptional circumstances
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement required under Act)	Unacceptable	Unacceptable

Figure 1: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines [2]

Table 1 below compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year).

Table 1: %NBS compared to relative risk of failure

Percentage of New Building Standard (%NBS)	Relative Risk (Approximate)
>100	<1 time
80-100	1-2 times
67-80	2-5 times
33-67	5-10 times
20-33	10-25 times
<20	>25 times

3.1 Minimum and Recommended Standards

Based on governing policy and recent observations, Opus makes the following general recommendations:

3.1.1 Occupancy

The Canterbury Earthquake Order[1] in Council 16 September 2010, modified the meaning of "dangerous building" to include buildings that were identified as being EPB's. As a result of this, we would expect such a building would be issued with a Section 124 notice, by the Territorial Authority, or CERA acting on their behalf, once they are made aware of our assessment. Based on information received from CERA to date and from the MBIE guidance document dated December 2012 [6], this notice is likely to prohibit occupancy of the building (or parts thereof), until its seismic capacity is improved to the point that it is no longer considered an EPB.

3.1.2 Cordoning

Where there is an overhead falling hazard, or potential collapse hazard of the building, the areas of concern should be cordoned off in accordance with current CERA/territorial authority guidelines.

3.1.3 Strengthening

Industry guidelines (NZSEE 2006 [2]) strongly recommend that every effort be made to achieve improvement to at least 67%NBS. A strengthening solution to anything less than 67%NBS would not provide an adequate reduction to the level of risk.

It should be noted that full compliance with the current building code requires building strength of 100%NBS.

3.1.4 Our Ethical Obligation

In accordance with the IPENZ code of ethics, we have a duty of care to the public. This obligation requires us to identify and inform CERA of potentially dangerous buildings; this would include earthquake prone buildings.

[1] This Order only applies to buildings within the Christchurch City, Selwyn District and Waimakariri District Councils authority.

4 Background Information

4.1 Building Descriptions

The site contains 15 residential units which were constructed in 1974. A site plan showing the location of the units, numbered 1 to 15, is shown in Figure 2. The garages are located behind the Heathcote Library at 8 Martindales Rd. Figure 3 shows the location of the site in Christchurch City. The units are grouped together to form blocks of two, three or four units.

Figure 2: Site plan of Martindales Road Housing Complex.

Figure 3: Location of Martindales Road (circled) relative to Christchurch City CBD (Source: Google Earth).

The residential units have reinforced concrete block walls in the transverse direction at the end of the blocks and in the fire walls. The internal walls and external walls in the longitudinal direction are timber framed. The roof structure comprises of timber roof framing supporting light-weight metal roofs. The walls and ceilings are lined with 9.5mm plasterboard. External walls are clad with lightweight Hardiplank boards and exposed concrete block. Foundations are strip footings under fire walls and around the perimeter of reinforced concrete slabs.

The units are separated by 190mm block masonry fire walls which are reinforced with 5 12mm diameter bars vertically. The block walls on the ends of the units have similar reinforcing layout with a gap in the middle to allow for a full length window. All concrete block walls have bond beams at roof height.

Units have two different floor layouts. The majority of units have a 'single unit' layout. Units 1 and 15 are double units, which corresponds to a larger bedroom.

The garages are reinforced concrete block structures, it is assumed that the walls are reinforced vertically with 12mm bars at 600mm centres. The garages have timber framed roof structures supporting light weight metal cladding. Foundations are strip footings under block walls and around the perimeter of a reinforced concrete slab.

Figure 4 and 5 show typical floor plans of a single and double residential unit, respectively, produced from site measurements by Opus. Figure 6 shows a cross section used in calculations.

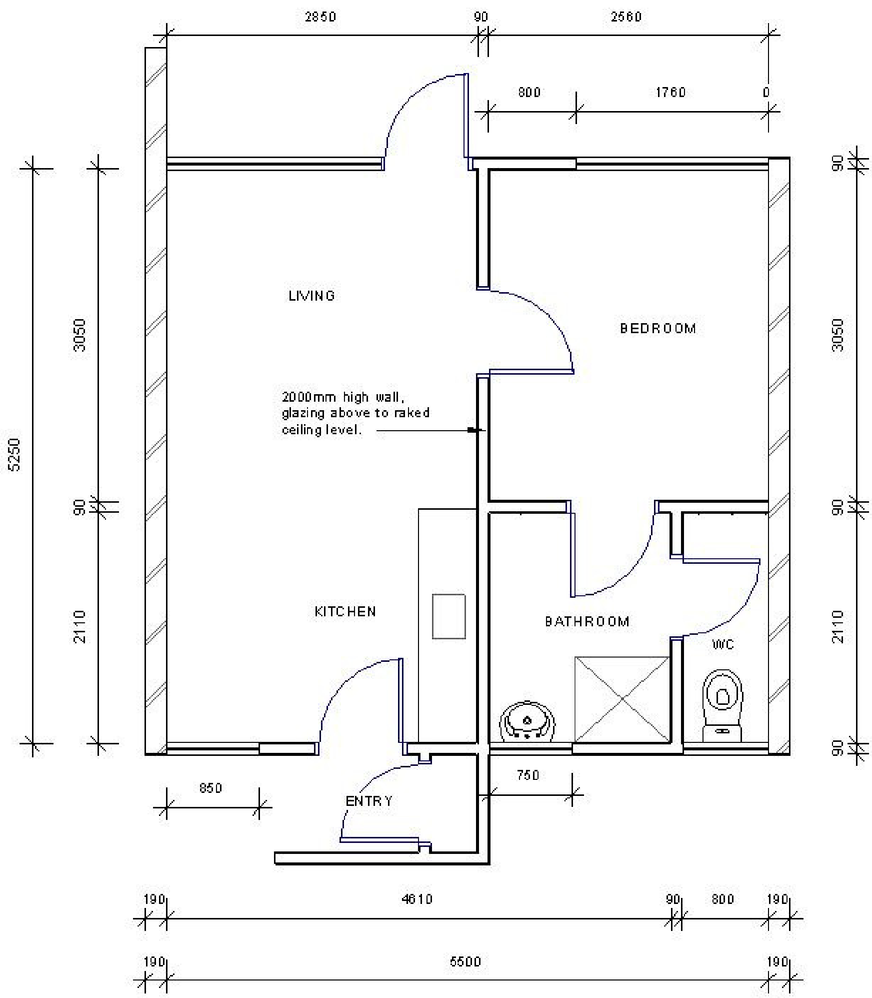

Figure 4: Typical single unit floor plan of residential unit blocks.

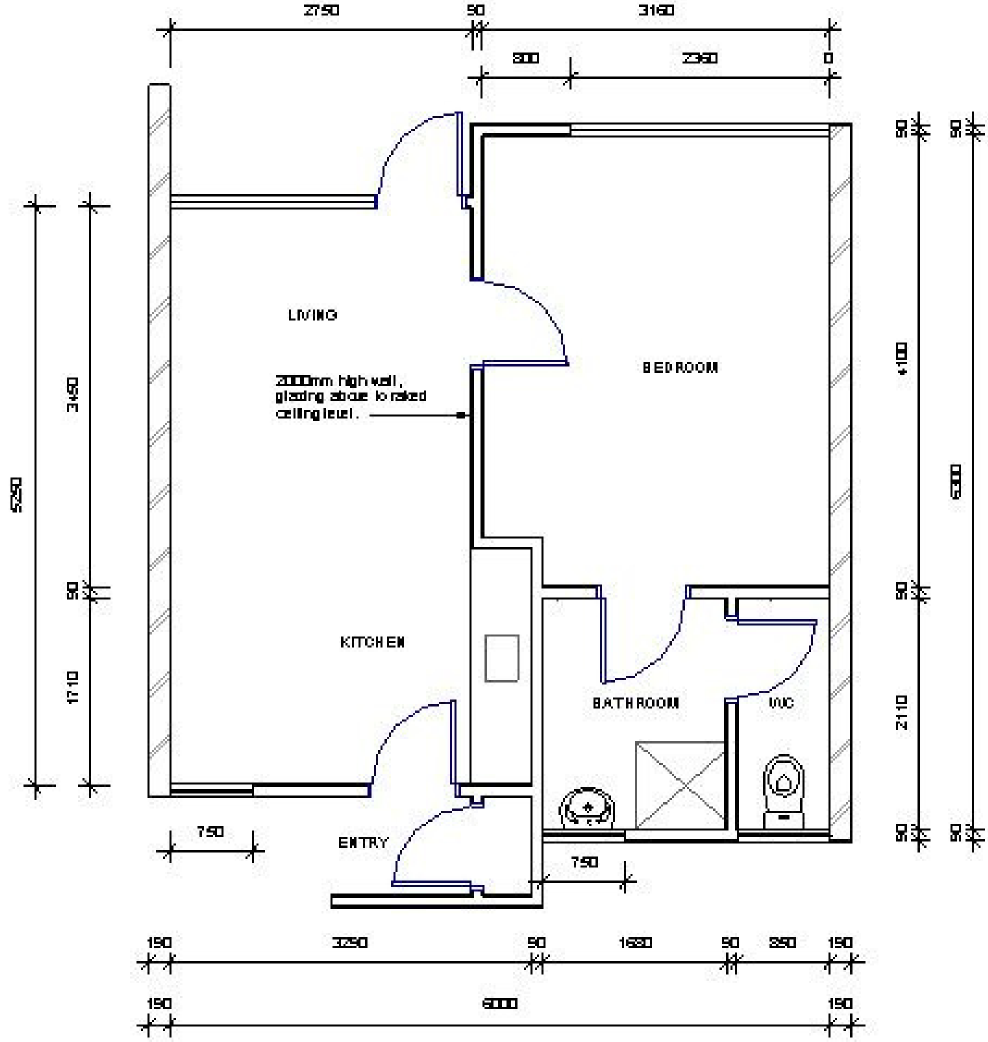

Figure 5: Double unit floor plan.

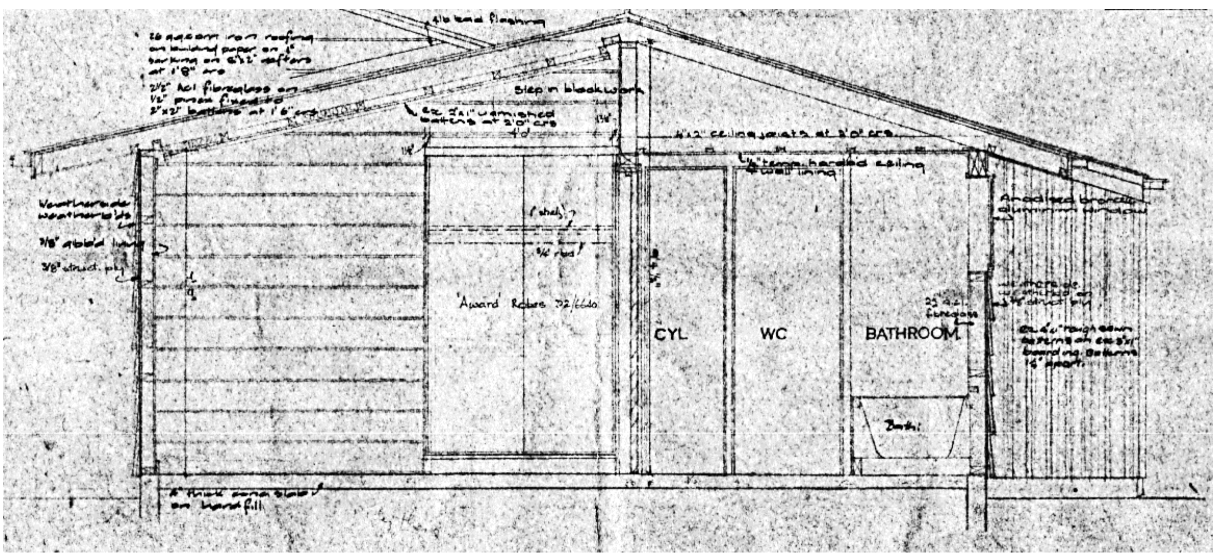

Figure 6: Cross section of Martindales Road .

4.2 Survey

4.2.1 Level Survey

A full level survey was not deemed to be necessary at Martindales Road as it is located in a TC2 zone. Properties in TC2 zones suffered minor to moderate damage due to liquefaction and/or settlement. In lieu of a full level survey, a laser level was placed in each unit so that differentials in vertical levels could be measured at the extreme ends of the unit. These values could then be used to determine the floor slope of the entire unit. For this site, all floor slopes were less than the 5mm/m limitation imposed by MBIE guidelines.

Table 2: Summary of the Level Survey

Block	Unit No.	Comment	Maximum Fall*
A	1	Pass	
	2	Pass	
B	3	Pass	
	4	Pass	
C	5	Pass	
	6	Pass	
	7	Pass	
	8	Pass	
D	9	Pass	
	10	Pass	
	11	Pass	
E	12	Pass	
	13	Pass	
F	14	Pass	
	15	Pass	

* Values are only recorded if greater than 5mm/m

4.2.2 Nail Spacings

The internal lining nail spacings were measured on site to vary between 250 - 300mm.

4.3 Original Documentation

The following documentation was provided by the Christchurch City Council:

- 894 – Heathcote County Council – Pensioners Cottages Martindales Road – Site plan, floor plans, elevations and sections – 1973

In addition a typical floor plan of the residential units has been produced by Opus from site measurements to help investigate potential Critical Structural Weaknesses (CSWs) and identify details which required particular attention.

Copies of design calculations were not available for the site assessment.

5 Damage

This section outlines the damage to the buildings that was observed during site visits. It is not intended to be a complete summary of the damage sustained by the buildings due to the earthquakes. Some forms of damage may not be able to be identified with a visual inspection only.

Damage was consistent across all units where cracking to the concrete block work was commonly observed.

Note: Any photo referenced in this section can be found in Appendix A.

5.1 Residual Displacements

Minor residual displacements were observed in all units, however these were below the MBIE guideline of 5mm/m.

5.2 Foundations

Minor hairline cracking was observed in the foundation of Block B (photo 15). Spalling of the concrete foundation was observed in the corner of Block E (photo 14), this has been caused by tilting of the footing of the concrete block 'garden' wall. This damage is deemed to not affect the structural performance of the foundation.

5.3 Primary Gravity Structure

Hairline cracking was observed in the concrete block work in all units. This damage is deemed minor and not to affect the gravity structure.

5.4 Primary Lateral-Resistance Structure

Hairline cracking was observed in the concrete block work in all units. This damage is deemed minor and not to affect the lateral-resistance structure.

5.5 Non Structural Elements

Minor plasterboard cracking was observed, typically above doorways and window frames. Slight splitting was observed between the block work and the weatherboard veneer. Minor cracking in the concrete retaining walls on site was observed.

Concrete block fences have experienced tilt in some locations (photo 13).

5.6 General Observations

The buildings appeared to have performed well as would be expected for buildings of this type, during the earthquakes. They have suffered distributed amounts of minor damage which is typical of the type and age of construction.

6 Detailed Seismic Assessment

The detailed seismic assessment has been based on the NZSEE 2006 [2] guidelines for the "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes" together with the "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure" [3] draft document prepared by the Engineering Advisory Group on 19 July 2011, and the SESOC guidelines "Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes" [5] issued on 21 December 2011.

As the residential units have the same floor plan, the analysis was simplified by conducting the analysis of one multi-unit block with similar cladding and using this for all multi-unit blocks.

6.1 Critical Structural Weaknesses

The term Critical Structural Weakness (CSW) refers to a component of a building that could contribute to increased levels of damage or cause premature collapse of a building.

No CSWs were identified in the buildings.

6.2 Quantitative Assessment Methodology

The assessment assumptions and methodology have been included in Appendix B. A brief summary follows:

Hand calculations were performed to determine seismic forces from the current building codes. These forces were applied globally to the structure and the capacities of the walls were calculated and used to estimate the %NBS. The walls, highlighted in Figures 7 through 10, were used for bracing in their respective directions.

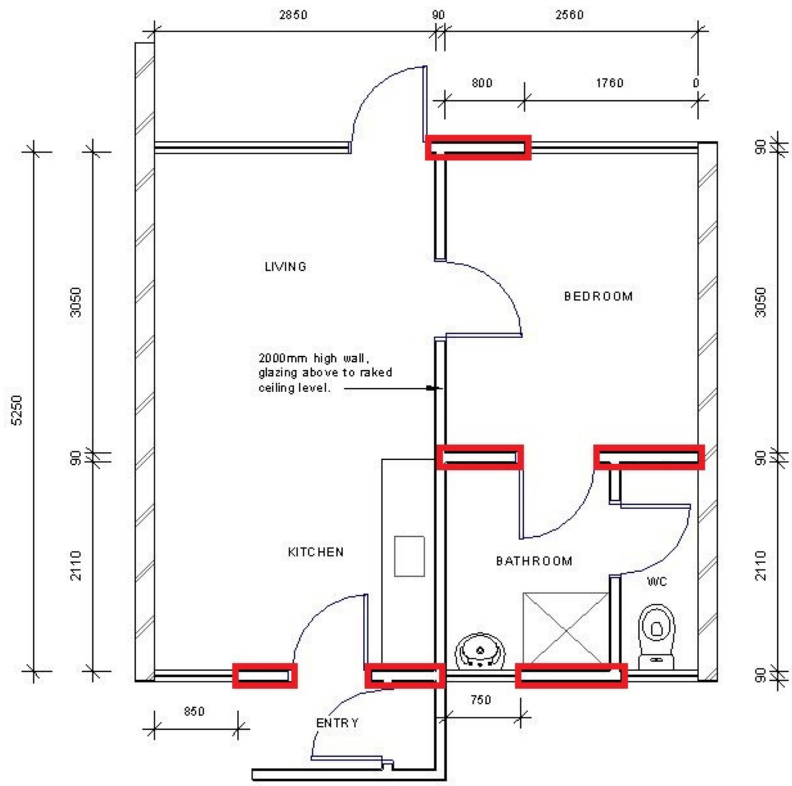

Figure 7: Walls used for bracing in the longitudinal direction, single unit.

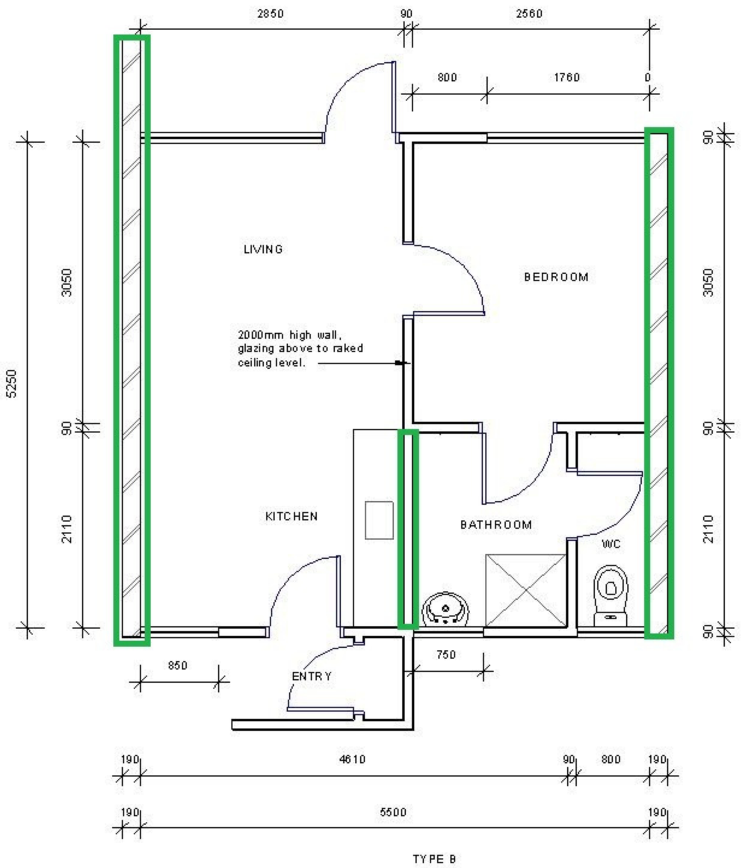

Figure 8: Walls used for bracing in the transverse direction, single unit.

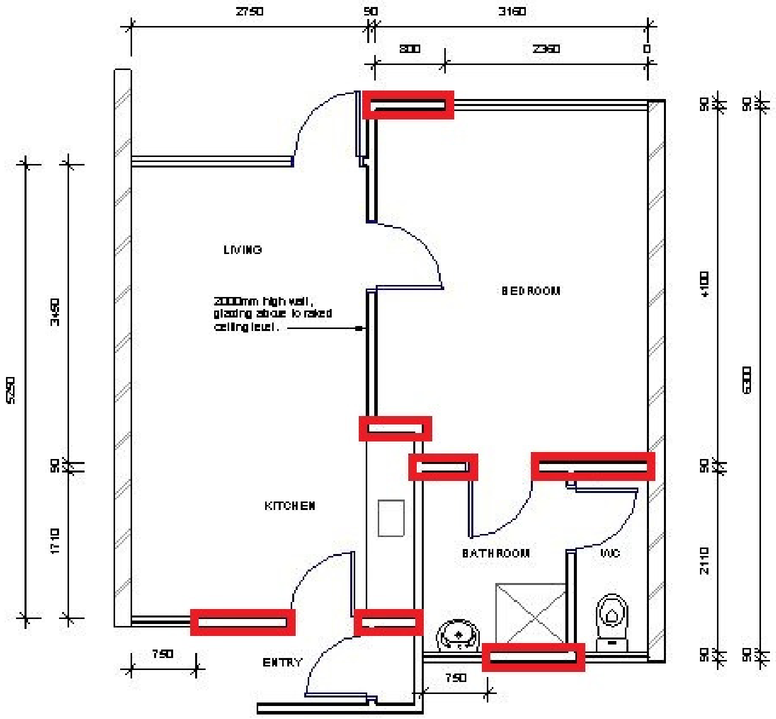

Figure 9: Walls used for bracing in the longitudinal direction, double unit.

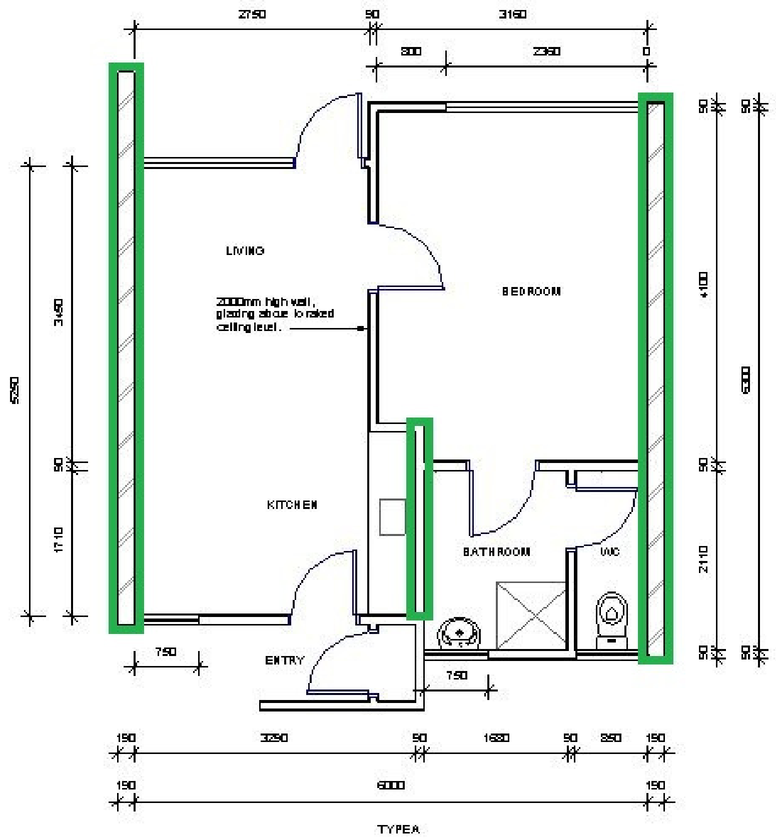

Figure 10: Walls used for bracing in the transverse direction, double unit.

6.3 Limitations and Assumptions in Results

The observed level of damage suffered by the buildings was deemed low enough to not affect their capacity. Therefore the analysis and assessment of the buildings was based on them being in an undamaged state. There may have been damage to the buildings that was unable to be observed that could cause the capacity of the buildings to be reduced; therefore the current capacity of the buildings may be lower than that stated.

The results have been reported as a %NBS and the stated value is that obtained from our analysis and assessment. Despite the use of best national and international practice in this analysis and assessment, this value contains uncertainty due to the many assumptions and simplifications which are made during the assessment. These include:

- Simplifications made in the analysis, including boundary conditions such as foundation fixity.
- Assessments of material strengths based on limited drawings, specifications and site inspections.
- The normal variation in material properties which change from batch to batch.
- Approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.
- Construction is consistent with normal practise of the era in which constructed.

6.4 Assessment

A summary of the structural performance of the buildings is shown in Table 3. Note that the values given represent the worst performing elements in the building, where these effectively define the building's capacity. Other elements within the building may have significantly greater capacity when compared with the governing elements.

Table 3: Summary of Seismic Performance

Building Description	Critical element	% NBS based on calculated capacity in longitudinal direction	% NBS based on calculated capacity in transverse direction.
Blocks A and F	Timber bracing in the longitudinal direction	43%	100%
Blocks B, C, D and E	Timber bracing in the longitudinal direction	39%	100%
Garages	Concrete block walls in the longitudinal direction.	65%	100%

7 Geotechnical Summary

CERA indicates that Martindales Road is located in a TC2 zone (as shown in Figure 11). This classification suggests future significant earthquakes will cause minor to moderate land damage due to liquefaction and settlement.

Figure 11: CERA Technical Categories map (loc. starred).

There is no evidence to suggest that further geotechnical investigation is warranted for this site.

8 Conclusions

- None of the buildings on site are considered to be Earthquake Prone.
- Blocks A and F have capacities of 43% NBS, as limited by the in-plane capacity of the bracing walls. They are deemed to be a 'moderate risk' in a design seismic event according to NZSEE guidelines. Their level of risk is 5-10 times that of a 100% NBS building (Figure 1).
- Blocks B, C, D and E have capacities of 39% NBS, as limited by the in-plane capacity of the bracing walls. They are deemed to be a 'moderate risk' in a design seismic event according to NZSEE guidelines. Their level of risk is 5-10 times that of a 100% NBS building (Figure 1).
- The garage has a capacity of 65% NBS, as limited by the in-plane capacity of the bracing walls. It is deemed to be a 'moderate risk' in a design seismic event according to NZSEE guidelines. The level of risk is 5-10 times that of a 100% NBS building (Figure 1).

9 Recommendations

It is recommended that;

- Strengthening schemes be developed to increase the seismic capacity of all buildings to at least 67%NBS.
- The concrete perimeter footings be repaired on blocks where severe cracking occurs.
- Cracks in the concrete block work be repaired.
- Cosmetic repairs be undertaken as required, including repair of damage to blockwork fences.

10 Limitations

- This report is based on an inspection of the buildings and focuses on the structural damage resulting from the Canterbury Earthquake sequence since September 2010. Some non-structural damage may be described but this is not intended to be a complete list of damage to non-structural items.
- Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at this time.
- This report is prepared for the Christchurch City Council to assist in the assessment of any remedial works required for the Martindales Road Housing Complex. It is not intended for any other party or purpose.

11 References

[1] NZS 1170.5: 2004, Structural design actions, Part 5 Earthquake actions, Standards New Zealand.

[2] NZSEE (2006), Assessment and improvement of the structural performance of buildings in earthquakes, New Zealand Society for Earthquake Engineering.

[3] Engineering Advisory Group, Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure, Draft Prepared by the Engineering Advisory Group, Revision 5, 19 July 2011.

[4] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Non-residential buildings, Part 3 Technical Guidance*, Draft Prepared by the Engineering Advisory Group, 13 December 2011.

[5] SESOC (2011), Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes, Structural Engineering Society of New Zealand, 21 December 2011.

[6] MBIE (2012), Repairing and rebuilding houses affected by the Canterbury earthquakes, Ministry of Building, Innovation and Employment, December 2012.

Appendix A – Photographs

Martindales Road Housing Complex		
No.	Item description	Photo
1.	Typical double unit exterior elevation (back)	
2.	Typical double unit exterior elevation (front)	

3.	Typical exterior elevation (end)	
4.	Typical single unit exterior elevation (back)	
5.	Typical single unit exterior elevation (front)	

6.	Typical living area	
7.	Typical kitchen area	
8.	Typical bedroom area	

9.	Typical bathroom area	
10.	Offset firewall in Blocks C and D	
11.	Typical cracking above doorways	

12.	Typical cracking of the block work (interior)	
13.	Splitting of exterior garden walls (due to tilt of garden wall) and unit blockwork	

14.	Spilt in footing between garden wall and units (Block E) causing spalling for foundation of unit.	
15.	Cracking in foundation (Block B)	

Appendix B – Methodology and Assumptions

Seismic Parameters

As per NZS 1170.5:

- T < 0.4s (assumed)
- Soil: Category D
- Z = 0.3
- R = 1.0 (IL2, 50 year)
- N(T,D) = 1.0

For the analyses, a μ of 2 was assumed for the residential units.

Analysis Procedure

As the units are small and have a number of closely spaced walls in both directions, the fibrous plaster board ceilings are assumed to be capable of transferring loads to all walls. It was therefore assumed that a global method could be used to carry the forces down to ground level in each direction. Bracing capacities were found by assuming a certain kN/m rating for the walls along each line. Due to the relatively unknown nature of the walls, the kN/m rating was taken as 3 kN/m for all timber walls with an aspect ratio (height: length) of less than 2:1. This was scaled down to zero kN/m at an aspect ratio of 3.5:1 as per NZSEE guidelines. %NBS values were then found through the ratio of bracing demand to bracing capacity for all walls in each direction.

Additional Assumptions

Further assumptions about the seismic performance of the buildings were:

- Foundations and foundation connections had adequate capacity to resist and transfer earthquake loads.
- Connections between all elements of the lateral load resisting systems are detailed to adequately transfer their loads sufficiently and are strong enough so as to not fail before the lateral load resisting elements.

Appendix C – CERA DEE Spreadsheet

Detailed Engineering Evaluation Summary Data V1.14

Location

Building Name:	Martindales Road Complex (Blocks A & F)	Reviewer:	Mary Ann Halliday
	Unit / No: / Street	CPEng No:	67073
Building Address:	10 / Martindales Road	Company:	Opus International Consultants Ltd
Legal Description:	Social Housing	Company project number:	6-QC377.00
		Company phone number:	3635400
	Degrees / Min / Sec		
GPS south:	43 / 34 / 32.12	Date of submission:	28-Feb-14
GPS east:	172 / 42 / 34.83	Inspection Date:	9/12/2013
		Revision:	1
Building Unique Identifier (CCC):	PRO 1731	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	0.7
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	8.58

Building

No. of storeys above ground:	1	single storey = 1 / Ground floor elevation (Absolute) (m):	
Ground floor split?	no	Ground floor elevation above ground (m):	
Storeys below ground	0		
Foundation type:	strip footings	if Foundation type is other, describe:	
Building height (m):	3.00	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	60		
Age of Building (years):	39	Date of design:	1965-1976
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	multi-unit residential	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):			
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	
Floors:	concrete flat slab	slab thickness (mm)	
Beams:	timber	type	
Columns:	load bearing walls	typical dimensions (mm x mm)	
Walls:	fully filled concrete masonry	#N/A	

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!** / note typical wall length (m)	
Ductility assumed, μ:	2.00		
Period along:	0.10	0.00 / estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	
Lateral system across:	fully filled CMU	note total length of wall at ground (m):	
Ductility assumed, μ:	2.00		
Period across:	0.10	##### enter height above at H31 / estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	

Separations:

north (mm):		leave blank if not relevant
east (mm):		
south (mm):		
west (mm):		

Non-structural elements

Stairs:			
Wall cladding:	exposed structure	describe	Concrete block structure and weatherboard veneer
Roof Cladding:	Metal	describe	
Glazing:	timber frames		
Ceilings:	strapped or direct fixed		
Services(list):			

Available documentation

Architectural	partial	original designer name/date	
Structural	partial	original designer name/date	
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	moderate to substantial (1 in 5)	notes (if applicable):	

Building:

	Current Placard Status:	green	
Along	Damage ratio:	0%	Describe how damage ratio arrived at:
	Describe (summary):		
Across	Damage ratio:	0%	
	Describe (summary):		
Diaphragms	Damage?:	no	Describe:
CSWs:	Damage?:	no	Describe:
Pounding:	Damage?:	no	Describe:
Non-structural:	Damage?:	yes	Describe:

$$Damage\_Ratio = \frac{(\%NBS\,(before) - \%NBS\,(after))}{\%NBS\,(before)}$$

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before e'quakes:	43%	##### %NBS from IEP below / If IEP not used, please detail assessment methodology:	Equivalent Static
	Assessed %NBS after e'quakes:	43%		
Across	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	
	Assessed %NBS after e'quakes:	100%		

Detailed Engineering Evaluation Summary Data V1.14

Location

Building Name:	Martindales Road Complex (Blocks B, C, D, E)	Reviewer:	Mary Ann Halliday
	Unit / No: / Street	CPEng No:	67073
Building Address:	10 / Martindales Road	Company:	Opus International Consultants Ltd
Legal Description:	Social Housing	Company project number:	6-QC377.00
		Company phone number:	3635400
	Degrees / Min / Sec		
GPS south:	43 / 34 / 32.12	Date of submission:	28-Feb-14
GPS east:	172 / 42 / 34.83	Inspection Date:	9/12/2013
		Revision:	1
Building Unique Identifier (CCC):	PRO 1731	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	0.7
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	8.58

Building

No. of storeys above ground:	1	single storey = 1 / Ground floor elevation (Absolute) (m):	
Ground floor split?	no	Ground floor elevation above ground (m):	
Storeys below ground	0		
Foundation type:	strip footings	if Foundation type is other, describe:	
Building height (m):	3.00	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	58		
Age of Building (years):	39	Date of design:	1965-1976
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	multi-unit residential	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):			
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	
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maximum interstorey deflection (ULS) (mm):		estimate or calculation?	
Lateral system across:	fully filled CMU	note total length of wall at ground (m):	
Ductility assumed, μ:	2.00		
Period across:	0.10	##### enter height above at H31 / estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	

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(refer DEE Table 4-2)

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Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	moderate to substantial (1 in 5)	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	
	Describe (summary):			
Across	Damage ratio:	0%		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	

$$Damage\_Ratio = \frac{(\% NBS\,(before) - \% NBS\,(after))}{\% NBS\,(before)}$$

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before e'quakes:	39%	##### %NBS from IEP below / If IEP not used, please detail assessment methodology:	Equivalent Static
	Assessed %NBS after e'quakes:	39%		
Across	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	
	Assessed %NBS after e'quakes:	100%		

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