Christchurch City Council

Mary McLean Place Housing Complex PRO 0942

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Mary McLean Place Housing Complex

Quantitative Assessment Report

202a Opawa Road, Woolston, Christchurch 8023

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Date: November 2013
Reference: 6-QC379.00
Status: Final

Summary

Mary McLean Place Housing Complex
PRO 0942

Detailed Engineering Evaluation
Quantitative Report - Summary
Final

Background

This is a summary of the quantitative report for the Mary McLean Place 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 40 residential units at this site.

Key Damage Observed

The residential units suffered minor damage to non-structural elements and cracking to perimeter foundations.

Unit 18 has suffered damage to the structure and is being stretched by about 40mm. Damage includes cracking in the perimeter foundation and moderate cracking in the brick veneer. Damage to the remaining residential units is generally minor and is limited to the cracking of the walls and ceiling linings.

Level Survey

All floor slopes assessed were less than the 5mm/m limitation set out in the MBIE guidelines [6] except for units 17, 18 and 19 in Block E.

Critical Structural Weaknesses

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

Indicative Building Strength

No buildings on the site are considered to be earthquake prone.

Table A: Summary of Seismic Performance by Blocks

Block	NBS%	Floor Levels	Nail Spacings
PRO 0942 B001 (Block A)	53%	Pass	Pass
PRO 0942 B002 (Block B)	53%	Pass	Pass
PRO 0942 B003 (Block C)	53%	Pass	Pass
PRO 0942 B004 (Block D)	53%	Pass	Pass
PRO 0942 B005 (Block E)	53%	Fail	Pass
PRO 0942 B006 (Block F)	53%	Pass	Pass
PRO 0942 B007 (Block G)	53%	Pass	Pass

PRO 0942 B008 (Block H)	53%	Pass	Pass
PRO 0942 B009 (Block I)	53%	Pass	Pass
PRO 0942 B010 (Block J)	53%	Pass	Pass

The residential units have capacities of 53% NBS and are limited by the in-plane shear capacity lined timber-framed shear walls in the longitudinal direction. The units are deemed to be a 'moderate risk' building in a design seismic event according to NZSEE guidelines.

Recommendations

It is recommended that;

- A strengthening works scheme be developed to increase the seismic capacity of all buildings to at least 67% NBS. This will need to consider compliance with accessibility and fire requirements.
- Veneer at height (gable ends) have the veneer ties checked.
- Block E be relevelled and the timber framing straightened to relieve the residual stresses induced by the stretching action of the floor structure.
- Fire walls in Block E (between unit 17-18 and units 23-24) be realigned vertically.
- Cosmetic repairs are undertaken.
- Chimneys are removed to at least ceiling level, this would slightly increase the %NBS of the structures.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council to undertake a detailed seismic assessment of the Mary McLean Place Housing Complex, located at 202A Opawa Road, Woolston, Christchurch, following the Canterbury Earthquake Sequence since September 2010. The site was visited by Opus International Consultants on 27 June 2013.

The purpose of the assessment is to determine if the buildings in the complex 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.

<table>
<tr><th rowspan="2">Description</th><th rowspan="2">Grade</th><th rowspan="2">Risk</th><th rowspan="2">%NBS</th><th rowspan="2">Existing Building Structural Performance</th><th colspan="2">Improvement of Structural Performance</th></tr>
<tr><th>Legal Requirement</th><th>NZSEE Recommendation</th></tr>
<tr><td>Low Risk Building</td><td>A or B</td><td>Low</td><td>Above 67</td><td>Acceptable (improvement may be desirable)</td><td rowspan="2">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.</td><td>100%NBS desirable. Improvement should achieve at least 67%NBS</td></tr>
<tr><td>Moderate Risk Building</td><td>B or C</td><td>Moderate</td><td>34 to 66</td><td>Acceptable legally. Improvement recommended</td><td>Not recommended. Acceptable only in exceptional circumstances</td></tr>
<tr><td>High Risk Building</td><td>D or E</td><td>High</td><td>33 or lower</td><td>Unacceptable (Improvement required under Act)</td><td>Unacceptable</td><td>Unacceptable</td></tr>
</table>

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 40 residential units which were constructed in 1969. A site plan showing the locations of the units, numbered 1 to 40, is shown in Figure 2. There are 10 blocks on site with each block containing 4 units. Figure 3 shows the location of the site in Christchurch City.

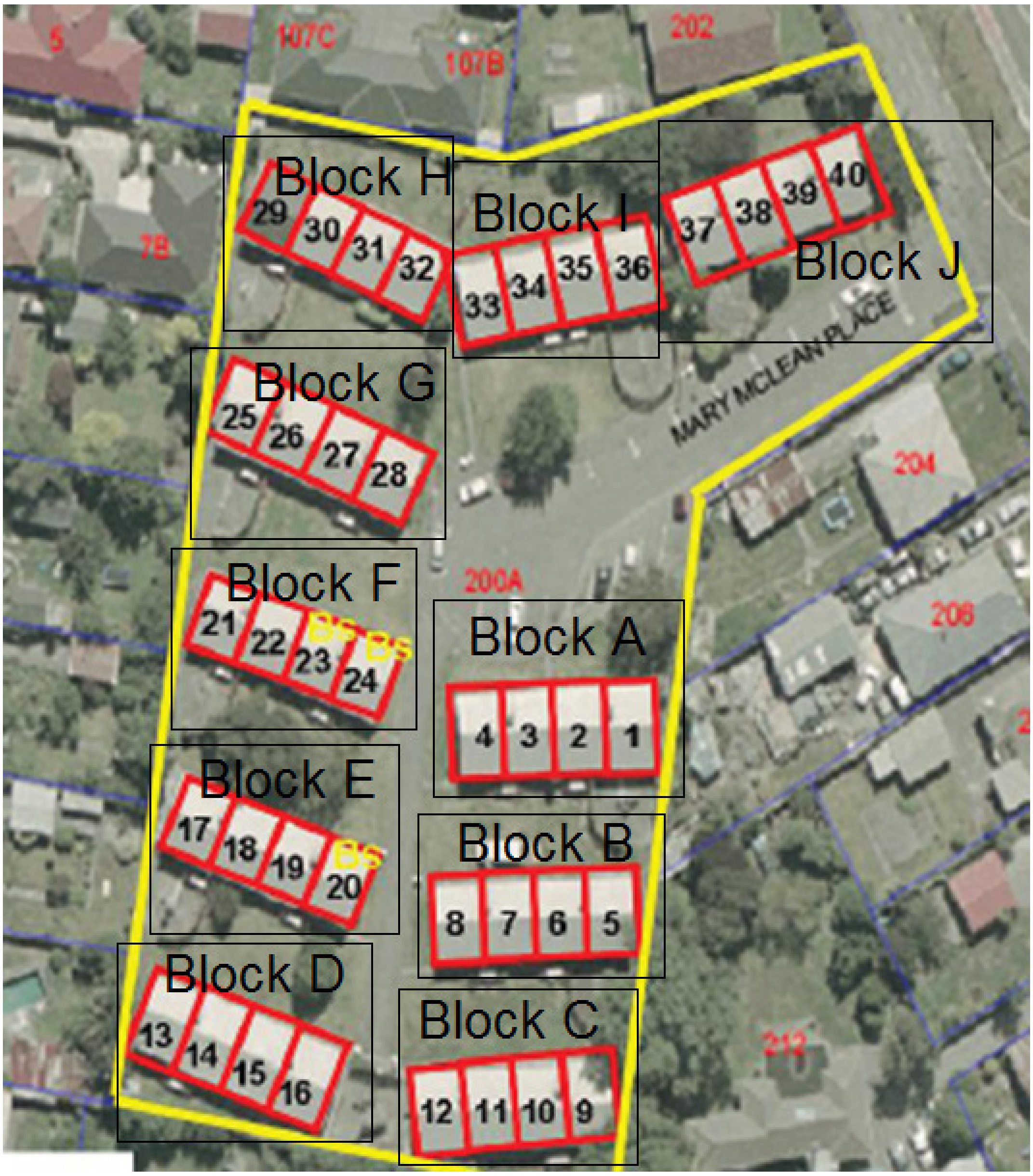


Figure 2: Site plan of Mary McLean Place Housing Complex.

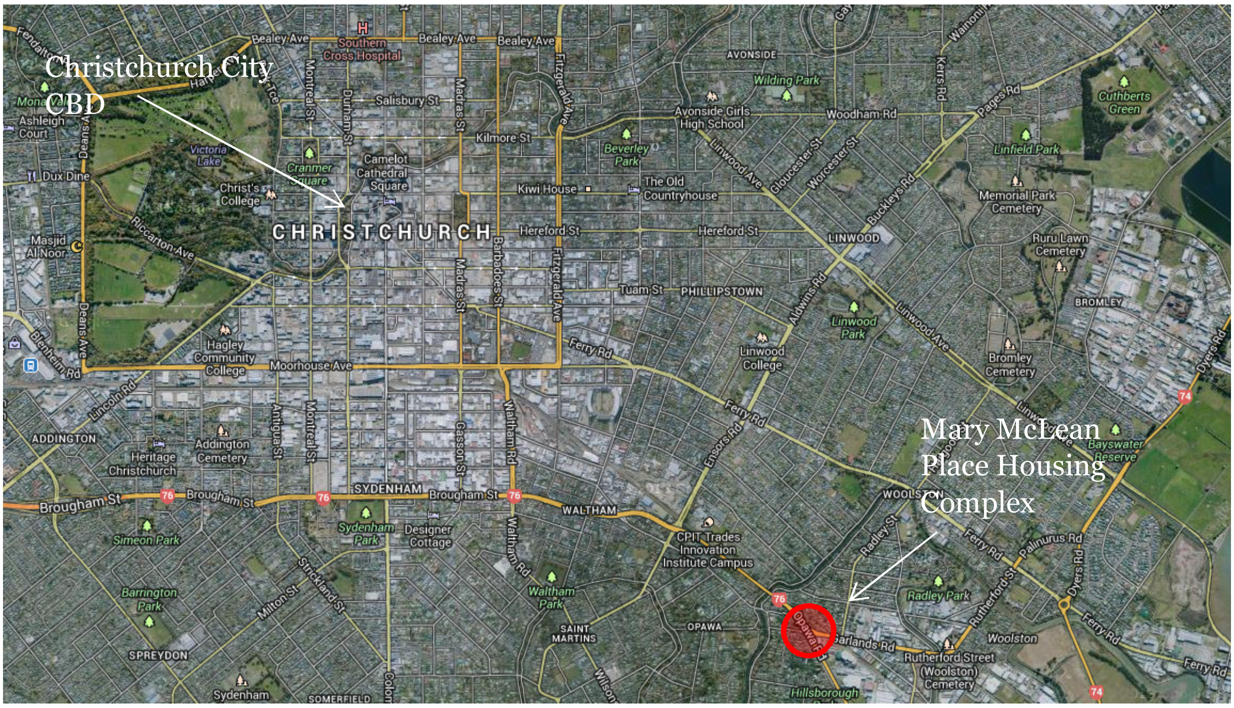


Figure 3: Location of site relative of Christchurch City CBD *(Source: Google Maps).*

The residential units are timber-framed buildings with diagonal timber braces. The roof structure comprises timber roof beams supporting light-weight metal roofs. Internal walls and ceilings are lined with plasterboard and external walls are clad with a brick veneer with small portions on the external walls of the bathroom and above and below the windows clad with light-weight Harditex-type cladding. Each block has a perimeter foundation with ordinary concrete piles supporting a timber floor. Figure 4 shows a typical floor plan of two residential units based on site measurements by Opus.

The units are separated by 190mm concrete block fire walls which (based on information available) have reinforcement to the perimeter. There are two precast concrete double chimneys in each block of four units, these are connected to the fire wall and shared between neighbouring units.

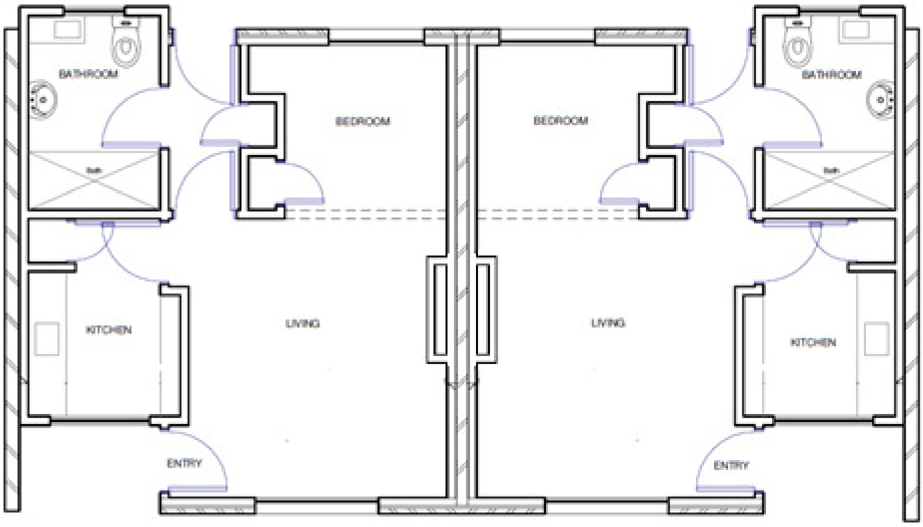


Figure 4: Typical double unit floor plan

4.2 Survey

4.2.1 Post 22 February 2011 Rapid Assessment

A structural (Level 1) assessment of the buildings/property was undertaken on March 2nd, 2011 by Opus International Consultants.

4.2.2 Level Survey

A full level survey was not deemed to be necessary at Mary McLean Place Housing Complex as it is located in a TC2 zone. Properties in TC2 zones suffered minor to moderate amounts of 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. A full level survey was undertaken in Block E due to the amount of damage observed externally the results of the survey is summarised in Table 2. These values could then be used to determine the floor slope of the entire unit. For this site, all floor slopes that were assessed (except units 17, 18 and 19) were less than the 5mm/m limitation imposed by MBIE [6].

Table 2: Summary of Block E level survey

Block	Unit	Pass/Fail	Deflection mm/m
E	17	Fail	5
	18	Fail	8
	19	Fail	6
	20	Pass	2

4.2.3 Nail Spacing

Plasterboard nail spacings are assumed to be adequate based on other units built in the same era.

4.3 Original Documentation

Copies of the following construction drawings were provided by CCC:

- A162/1 – Christchurch City Council – Pensioners Cottages Opawa Road – Site plan – 1964.
- A162/3 – Christchurch City Council – Pensioners Cottages Opawa Road – Elevations – 1964.
- A162/5 – Christchurch City Council – Pensioners Cottage Opawa Road – Details – 1964.

The drawings have been used to confirm the structural systems, investigate potential critical structural weaknesses (CSW) and identify details which required particular attention.

Copies of the design calculations were not provided.

5 Structural 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 observed with a visual inspection only.

5.1 Residual Displacements

Significant horizontal and vertical displacements were observed in block E, as shown in Table 2. No displacements were observed in any other blocks on the site.

The fire wall verticality readings between units 17-18 and units 23-24 were 8mm/m and 9mm/m respectively.

5.2 Foundations

Cracking in the foundations of units 10, 14, 18, 19 and 23 was observed. These cracks were approximately up to 50mm wide (photos 9-11) in the foundations of unit 18 and 10mm-15mm wide in units 23 and 14.

Foundation damage was not observed in the other residential units other than hairline cracking above the vents.

5.3 Primary Gravity Structure

The timber framing of Block E has raked due to the stretching of the floor structure.

No damage was observed to the timber framed walls or roof truss structure in any other units.

5.4 Primary Lateral-Resistance Structure

Some minor cracking of ceiling diaphragms and of plasterboard lined walls was observed in a majority of the units that were inspected.

5.5 Non Structural Elements

The end walls of units 12 and 28 experienced cracking in the mortar of the brick veneers (photo 13).

Cracking of the brick veneer was observed in the majority of units throughout the site.

5.6 General Observations

The buildings (apart from Block E) appeared to have performed reasonably well as would be expected during the earthquakes. They have suffered distributed amounts of minor damage which is typical of the construction type and age of construction. Unit 18 suffered moderate damage.

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 brick cladding and using this for all multi-unit blocks.

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

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 CSW's 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 Figure 5 and Figure 6, were used for bracing in their respective directions.

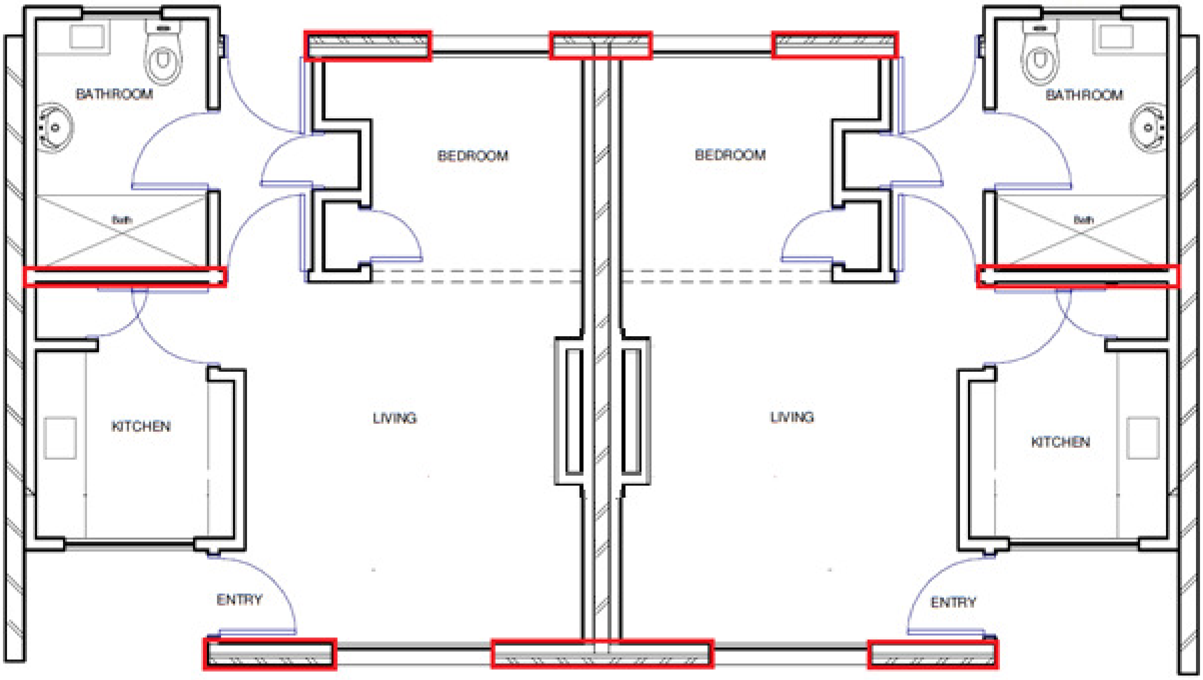


Figure 5: Walls used for bracing in the longitudinal direction.

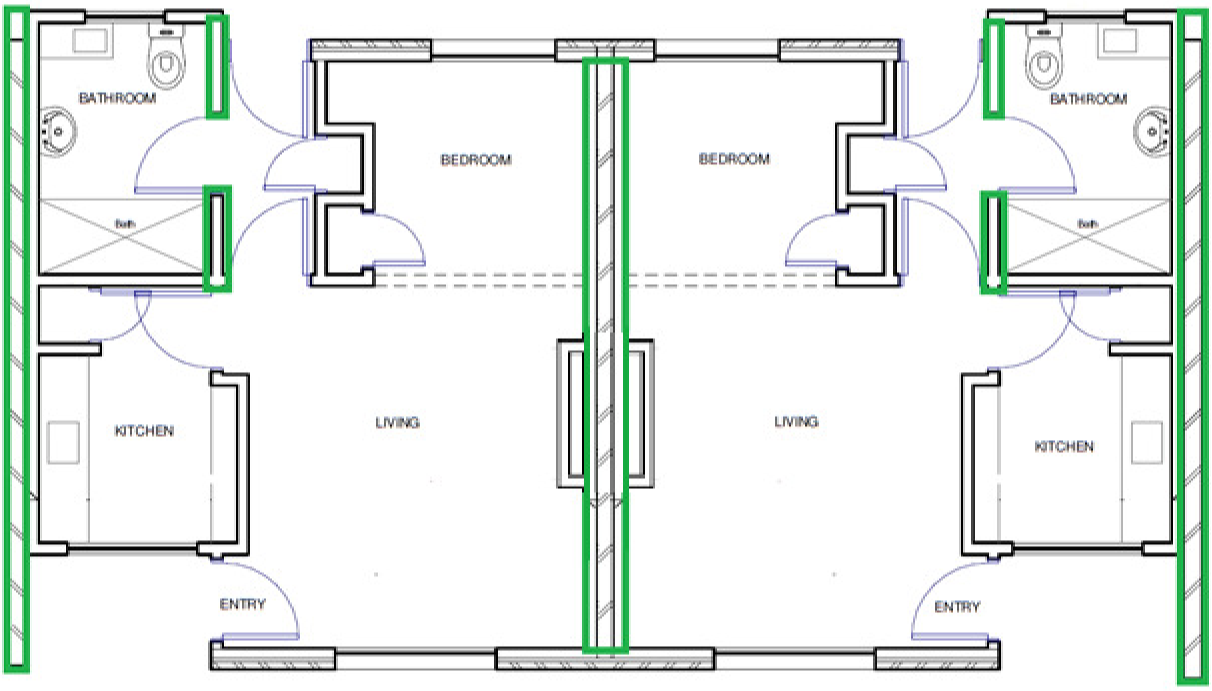


Figure 6: Walls used for bracing in the transverse direction.

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

Unit considered	Failure Mode, or description of limiting criteria based on displacement capacity of critical element.	% NBS based on calculated capacity In longitudinal direction	% NBS based on calculated capacity in transverse direction.
Blocks A-J	Bracing capacity of structural walls.	53%	100%

7 Geotechnical Summary

CERA indicates that Mary McLean Place Housing Complex is located in a TC2 zone (as shown in Figure 7). This classification suggests future significant earthquakes will cause minor to moderate land damage due to liquefaction and settlement.

Figure 7: CERA Technical Categories map (location starred).

There is a significant crack in the ground that runs approximately 8m in from the west boundary and continues for approximately 70m. It passes under unit 18 and has caused this part of the building to be stretched by approximately 50mm. The crack continues through the adjacent blocks (unit 22) to the north and (unit 14) to the south causing 10 to 15 mm cracks in these foundations. These cracks are shown in Figure 8.

Figure 8: Locations of ground crack through blocks D, E and F.

A site investigation would be required if building repairs or redevelopment is proposed. This investigation would ascertain the cause of the lateral spread ground cracking, e.g. establish if damage is either due to historic fill, old river channel or liquefaction.

8 Conclusions

- None of the buildings on site are considered to be Earthquake Prone.
- The residential units have a capacity of 53% NBS, as limited by the in-plane shear capacity of the lined shear walls. They are deemed to be a 'moderate risk' building 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).
- Cracking to veneers has occurred throughout the site.
- Block E has suffered damage due to lateral spreading beneath the block. This has caused damage to the timber framing due to stretching. The firewalls between units 17 and 18 and units 23 and 24 are up to 9mm out of vertical alignment.

9 Recommendations

It is recommended that;

- A strengthening works scheme be developed to increase the seismic capacity of all buildings to at least 67% NBS. This will need to consider compliance with accessibility and fire requirements.
- Veneer at height (gable ends) have the veneer ties checked.
- Block E be relevelled and the timber framing straightened to relieve the residual stresses induced by the stretching action of the floor structure.
- Fire walls in Block E (between unit 17-18 and units 23-24) be realigned vertically.
- Cosmetic repairs are undertaken.
- Chimneys are removed to at least ceiling level, this would slightly increase the %NBS of the structures.

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 Mary McLean 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

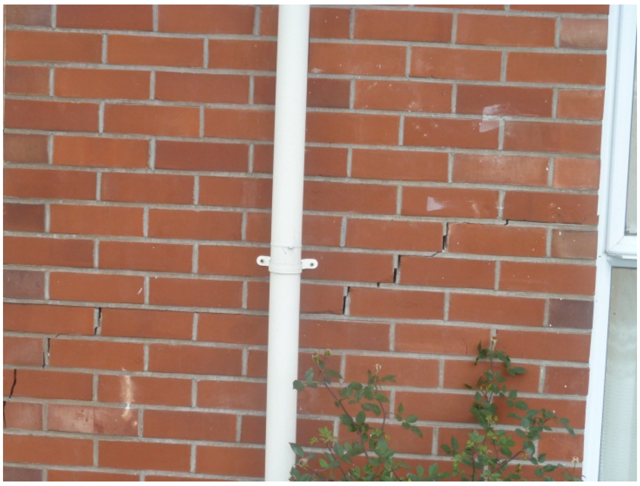
Mary McLean Housing Complex		
No.	Item description	Photo
Residential Units		
1	Typical layout of the front on the units	
2	Typical layout of the back of the units	
3	End walls of all blocks	

4	Typical lounge layout	
5	Typical bedroom layout	
6	Typical kitchen layout	

7	Typical bathroom layout	
Damage		
8	Typical cracking	
9	Major cracking in foundations of unit 23	

10	Major cracking in foundations of unit 14	
11	Cracking in foundations of unit 10	
12	Cracking in mortar end wall of unit 12	

13	Cracking in mortar end wall of unit 28	
Unit 18		
14	Cracking at the front door and separation from front step	
15	Cracking at the front door and separation from front step	

16	Cracking in soffit	
17	Cracking in plasterboard and ceiling lining	
18	Stepped cracking in the mortar and brick veneers between unit 17 and 18	

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 V1.11

Location

Building Name:	Mary McLean Place Housing Complex
Building Address:	Unit No: Units 1-40; Street: Mary Mclean Place
Legal Description:	Residential Units
GPS south: (Degrees / Min / Sec)	
GPS east:	
Building Unique Identifier (CCC):	PRO 0942
Reviewer:	Mary Ann Halliday
CPEng No:	67073
Company:	Opus International Consultants
Company project number:	6-QC379.00
Company phone number:	(03) 3635400
Date of submission:	14/11/2013
Inspection Date:	27-Jun-13
Revision:	Final
Is there a full report with this summary?	yes

Site

Site slope:	flat
Soil type:	
Site Class (to NZS1170.5):	
Proximity to waterway (m, if <100m):	
Proximity to clifftop (m, if < 100m):	
Proximity to cliff base (m,if <100m):	
Max retaining height (m):	
Soil Profile (if available):	
If Ground improvement on site, describe:	
Approx site elevation (m):	2.09

Building

No. of storeys above ground:	1 (single storey = 1)
Ground floor split?	no
Storeys below ground	0
Foundation type:	bored cast-insitu concrete piles
Building height (m):	
Floor footprint area (approx):	40
Age of Building (years):	44
Ground floor elevation (Absolute) (m):	
Ground floor elevation above ground (m):	
if Foundation type is other, describe:	
height from ground to level of uppermost seismic mass (for IEP only) (m):	
Date of design:	1965-1976
Strengthening present?	
If so, when (year)?	
And what load level (%g)?	
Brief strengthening description:	
Use (ground floor):	multi-unit residential
Use (upper floors):	
Use notes (if required):	
Importance level (to NZS1170.5):	IL2

Gravity Structure

Gravity System:	load bearing walls
Roof:	steel truss
Floors:	timber
Beams:	
Columns:	
Walls:	non-load bearing
truss depth, purlin type and cladding	
joist depth and spacing (mm)	
	0

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls		
Ductility assumed, μ:	2.00	note typical wall length (m)	
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:	lightweight timber framed walls		
Ductility assumed, μ:	2.00	note typical wall length (m)	
Period across:	0.10	0.00	estimate or calculation? estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	

Separations: (leave blank if not relevant)

north (mm):	
east (mm):	
south (mm):	
west (mm):	

Non-structural elements

Stairs:		
Wall cladding:	brick or tile	describe (note cavity if exists)
Roof Cladding:	Metal	describe
Glazing:	aluminium frames	
Ceilings:	strapped or direct fixed	
Services(list):		

Available documentation

		original designer name/date
Architectural	none	
Structural	partial	Christchurch City Council 1964
Mechanical	none	
Electrical	none	
Geotech report	none	

Damage

Site: (refer DEE Table 4-2)

		notes
Site performance:		Describe damage:
Settlement:		
Differential settlement:		
Liquefaction:		
Lateral Spread:		
Differential lateral spread:		
Ground cracks:		
Damage to area:		

Building:

			Describe
	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	
CSWs:	Damage?:	no	
Pounding:	Damage?:	no	
Non-structural:	Damage?:	yes	minor GIB cracking

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

Recommendations

	Level of repair/strengthening required:			Describe:
	Building Consent required:			Describe:
	Interim occupancy recommendations:			Describe:
Along	Assessed %NBS before e'quakes:	53%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative
	Assessed %NBS after e'quakes:	53%		
Across	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	
	Assessed %NBS after e'quakes:	100%		

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