Christchurch City Council

Weaver Courts Housing Complex PRO 1565

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Weaver Courts Housing Complex

Quantitative Assessment Report

Weaver Place, Sockburn, Christchurch 8042

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Summary

Weaver Courts Housing Complex
PRO 1565

Detailed Engineering Evaluation
Quantitative Report - Summary
Final

Background

This is a summary of the quantitative report for the Weaver Courts 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 35 residential units and the block of 6 storage garages.

Key Damage Observed

There was no damage observed to the garages.

The residential units suffered minor damage to non-structural elements.

Structural damage to the residential units was generally minor and was limited to the cracking of the walls and ceilings.

Level Survey

All floor slopes assessed were less than the 5mm/m limitation set out in the MBIE guidelines [6].

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	DEE Code	NBS%	Level Survey	Nail Spacings
Block A	PRO 1565 B001	72%	Pass	Pass
Block B	PRO 1565 B004	72%	Pass	Pass
Block C	PRO 1565 B005	72%	Pass	Pass
Block D	PRO 1565 B006	72%	Pass	Pass
Block E	PRO 1565 B007	72%	Pass	Pass
Block F	PRO 1565 B003	68%	Pass	Pass
Block G	PRO 1565 B008	100%	Pass	Pass
Block H	PRO 1565 B009	100%	Pass	Pass
Block I	PRO 1565 B010	100%	Pass	Pass
Block J	PRO 1565 B011	100%	Pass	Pass
Block K	PRO 1565 B012	100%	Pass	Pass

The residential units numbered 1-25 have capacities of 72%NBS and are limited by the in-plane shear capacity lined timber-framed shear walls in the longitudinal direction. The residential units numbered 26-35 have capacities of 100%NBS.

The garages have a capacity of 68%NBS and are limited by the in-plane capacity of the steel braces and plywood piers in the longitudinal direction.

Recommendations

- Veneer at height (gable ends) have the veneer ties checked.
- Cosmetic repairs are undertaken.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council to undertake a detailed seismic assessment of the Weaver Courts Housing Complex, located at Main South Road, Sockburn, Christchurch, following the Canterbury Earthquake Sequence since September 2010. The site was visited by Opus International Consultants on 25 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.

Description	Grade	Risk	%NBS	Existing Building Structural Performance
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement required under Act)

Improvement of Structural Performance	
Legal Requirement	NZSEE Recommendation
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
	Not recommended. Acceptable only in exceptional circumstances
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 35 residential units and a block of 6 garages. A site plan showing the locations of the units, numbered 1 to 35, and garages is shown in Figure 2. Units 1-25 were constructed in 1965 and are split into 5 blocks with each block containing 5 units. Units 26-35 were relocated to the site from 203 Opawa Road between the 1980's – 1990's and are split into 5 blocks with each block containing two units, these are colloquially known as 'Commonwealth' blocks due to their use in the 1974 Christchurch Commonwealth Games. Figure 3 shows the location of the site in Christchurch City.

Figure 2: Site plan of Weaver Courts Housing Complex.

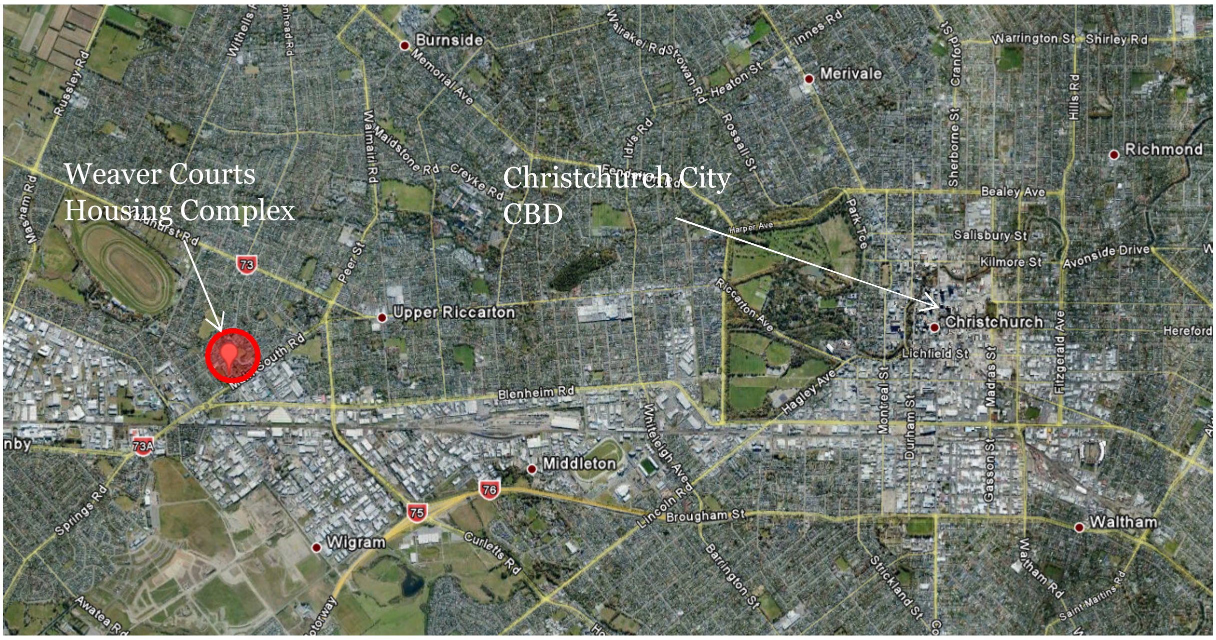


Figure 3: Location of site relative to Christchurch City CBD *(Source: Google Maps).*

4.1.1 Residential Units 1-25

Units 1 – 25 are timber-framed buildings with timber-framed roofs supporting light-weight metal roofs. Internal walls and ceilings are lined with GIB. External walls are clad with 100mm thick Summerhill Stone with small portions below the front facing windows clad with light-weight Harditex-type cladding. Each block has a perimeter foundation with concrete piles overlaid by timber flooring. Figure 4 shows a typical floor plan of a residential unit produced from site measurements by Opus.

It was noted that a number of the sub-floor ventilation holes in the perimeter foundation had been covered up by the front step of many of these units (Appendix A, photo 12).

The units are separated by 190mm concrete block fire wall which (based on information available for other similar blocks of the same era) is potentially filled with reinforcement to its perimeter.

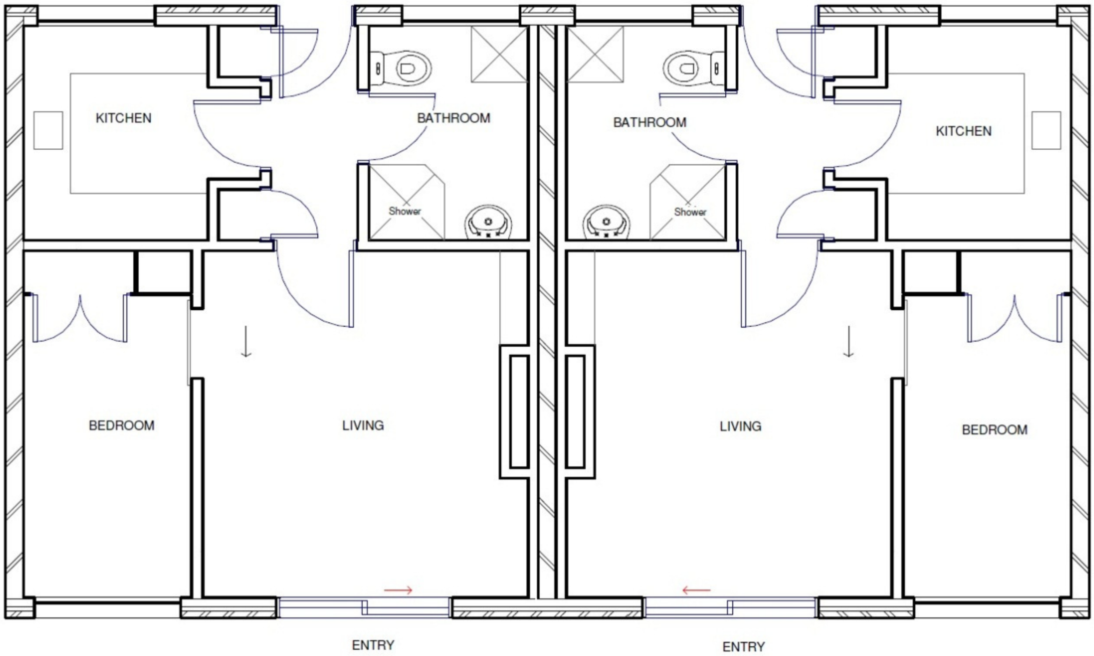


Figure 4: Floor plan of residential units 1-25 at Weaver Courts Housing Complex.

4.1.2 Residential Units 26 - 35

Units 26 - 35 are timber-framed buildings with timber-framed roofs supporting light-weight metal roofs. Internal walls and ceilings are lined with GIB and the external walls are clad with Hardies weatherboards. The foundations are timber piles overlaid by timber flooring. Figure 5 shows a typical floor plan of a single residential unit.

The units are separated by a 150mm firewall with two layers of 12mm 'fire stop' on both sides of the wall.

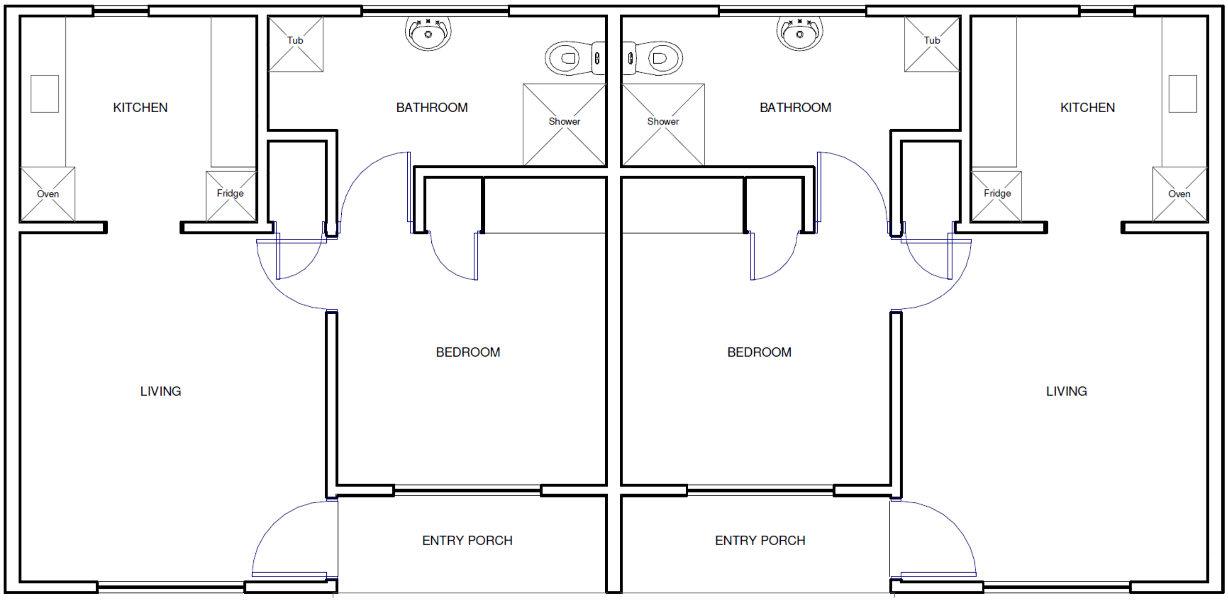


Figure 5: Floor plan of units 26-35.

4.1.3 Garages

The garage is a timber-framed building with a timber-framed roof supporting light-weight metal sheeting. The internal transverse walls are lined on one side with plywood while the longitudinal walls are supported using steel braces and plywood piers. The external walls are clad with weatherboard and Summerhill stone. The foundation is a mesh reinforced concrete pad with ground beams at the extremities and below the transverse shear walls. Figure 6 shows the floor plan of the garage and Figure 7 shows the cross section.

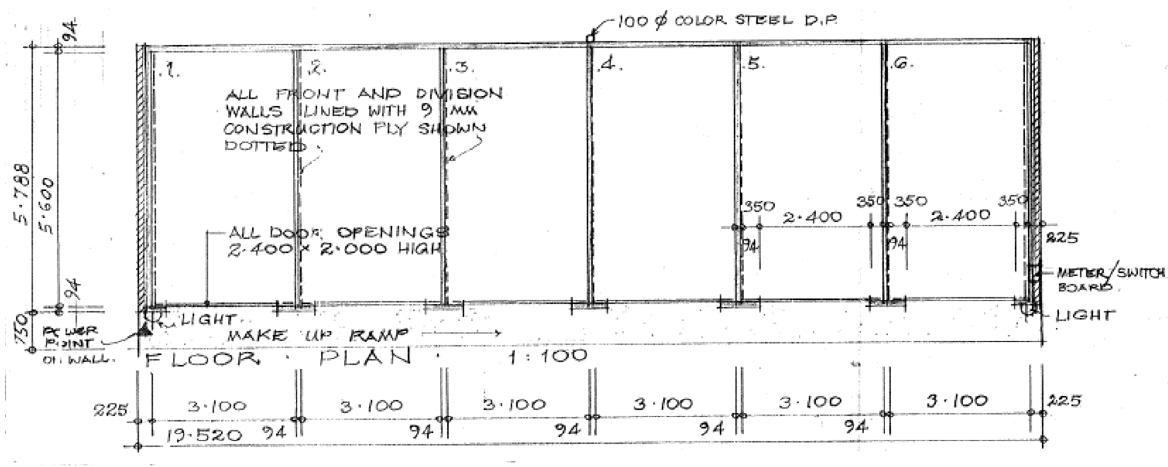


Figure 6: Floor plan of the garage at Weaver Courts Housing Complex.

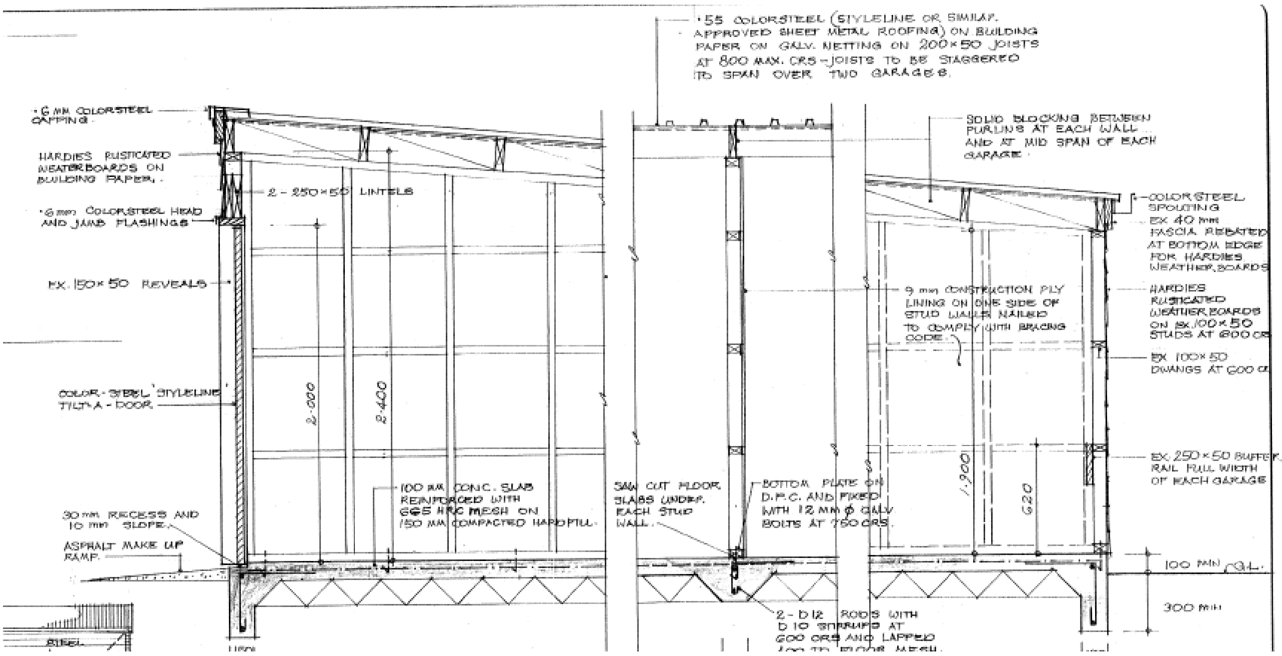


Figure 7: Cross section of the garage at Weaver Courts Housing Complex.

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 10th, 2011 by Opus International Consultants.

4.2.2 Level Survey

A full level survey was not deemed necessary at Weaver Courts Housing Complex as it is located in a TC1 zone (Figure 12). Properties in TC1 zones suffered negligible 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. 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 CERA [6].

4.2.3 Nail Spacing

Spacing of the nails on the internal linings of the units and garages were checked and consistently met the manufactures standards.

4.3 Original Documentation

Copies of the following construction drawings were provided by CCC:

- B339/4 - Paparua County Council – Pensioners Cottages Weaver Place Sockburn – Site plan - 1966

- 509.78 - Christchurch City Council – 6 New Garages at No 10 Weaver Place – Plans and elevations – Undated.
- No detailed plans, elevations, sections or details included in these drawings for units 1-25. These were drawn up by Opus from details gathered on site.
- A262 – Christchurch City Council Units – Relocatable Elderly Persons Housing 203 Opawa Road – Elevations, Sections, Plan and Details - Dated May 1976 (These are the plans for units 26-35).

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 be identified with a visual inspection only.

5.1 Residual Displacements

There are no indications of settlement due to earthquake imposed actions in the residential units or in the garages.

5.2 Foundations

No damage was observed to the foundations of the residential units or to the garages.

5.3 Primary Gravity Structure

No damage was observed to the timber-framed roof or timber-framed walls of the residential units or to the garages.

5.4 Primary Lateral-Resistance Structure

Some minor cracking of GIB-lined walls was observed in the majority of units that were inspected. The blocks containing units 26-35 suffered slightly more damage to the GIB linings than other units on site.

5.5 Non Structural Elements

No damage to non-structural elements was observed.

5.6 General Observations

The buildings appeared to have performed reasonably 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 construction 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 one of only two styles of floor plan, the analysis was simplified by conducting the analysis of each style of multi-unit block only once. The two resulting values were then applied to all of the units which have a floor plan correlating to one of the styles analysed.

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.

6.2.1 Walls used for bracing in units 1-25

The walls, highlighted in Figure 8 and Figure 9, were used for bracing in their respective directions for units 1-25.

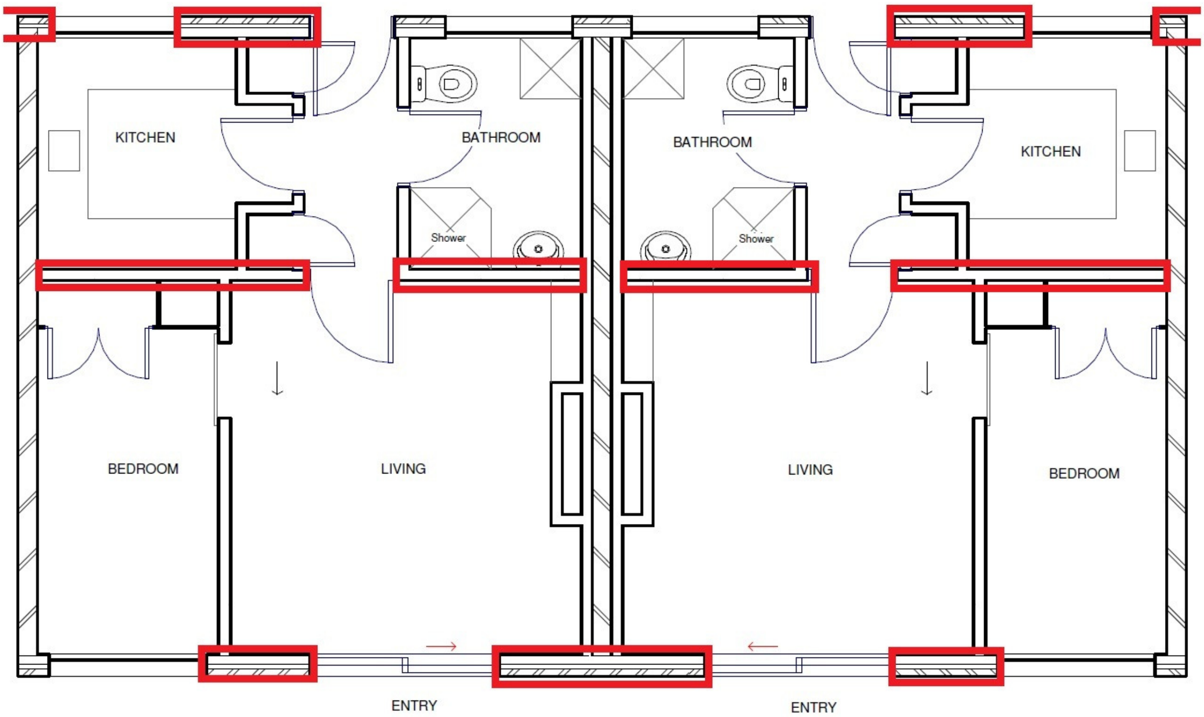


Figure 8: Walls used for bracing in the longitudinal direction (Units 1-25).

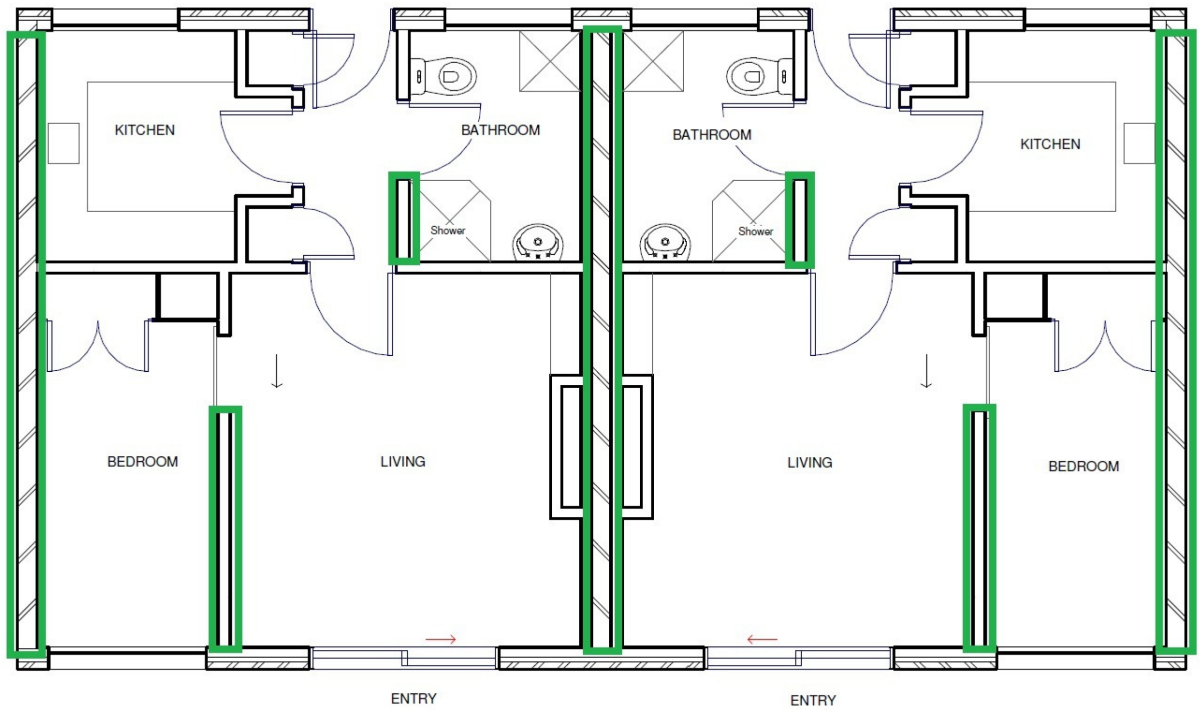


Figure 9: Walls used for bracing in the transverse direction (Units 1-25).

6.2.1 Walls used for bracing in units 26-35

The walls, highlighted in Figure 10 and Figure 11, were used for bracing in their respective directions for units 26-35.

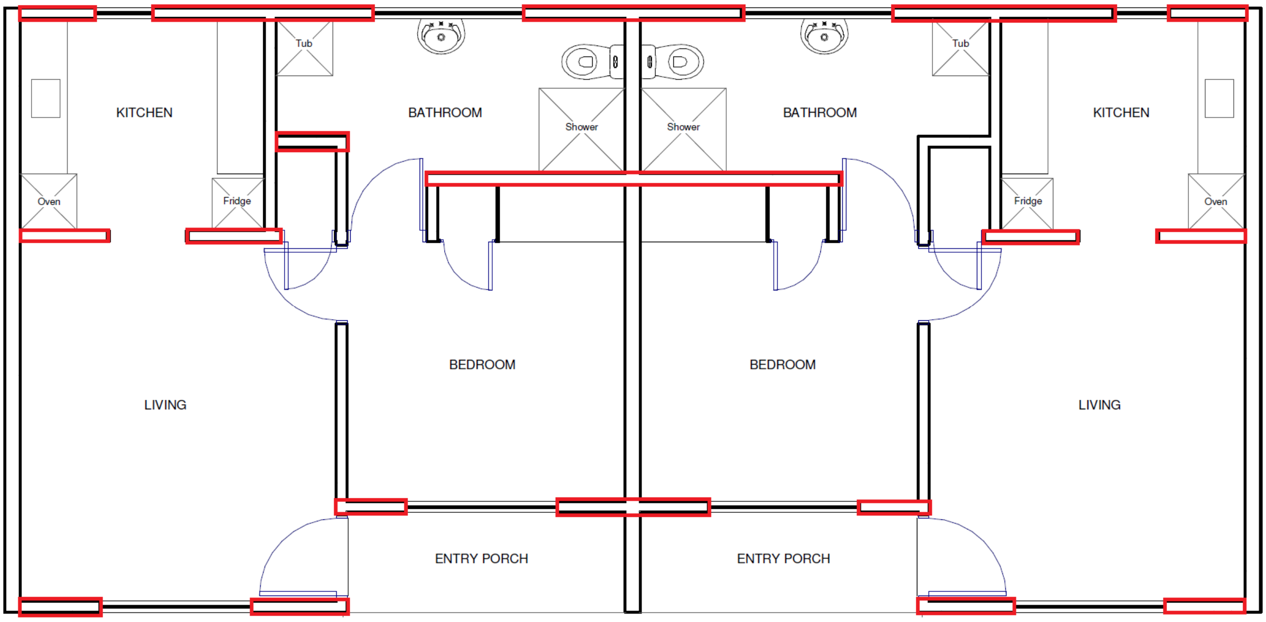


Figure 10: Walls used for bracing in the longitudinal direction. (Units 26-35)

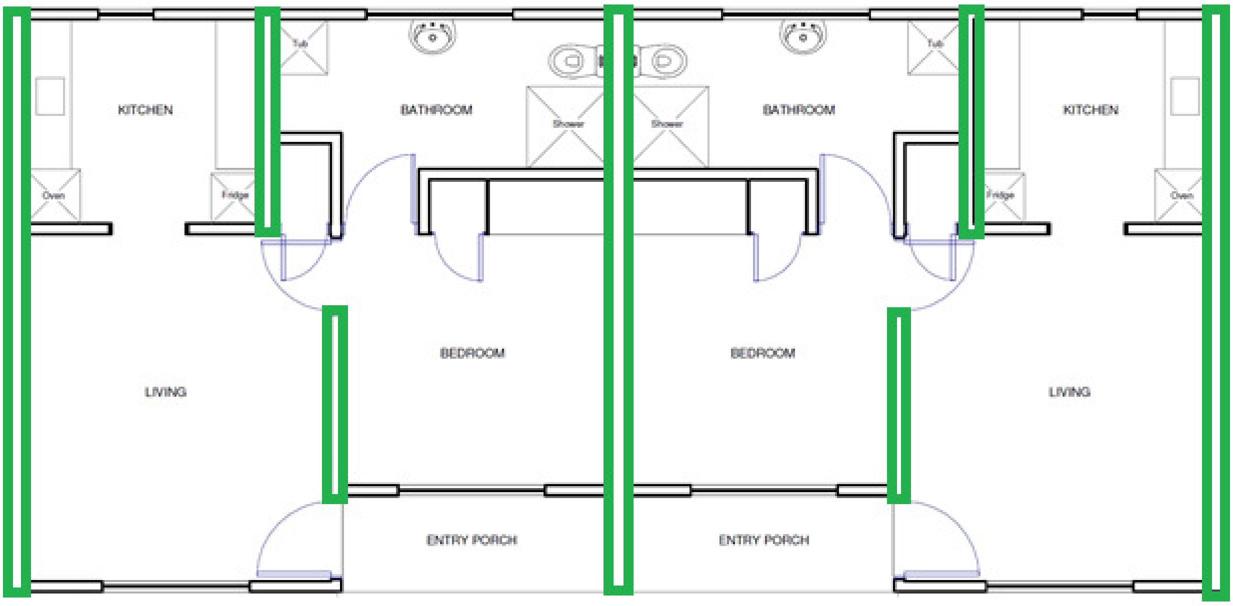


Figure 11: Walls used for bracing in the transverse direction (Units 26-35).

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 2. 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 2: 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.
Units 1-25	Bracing capacity of structural walls.	72%	100%
Units 26-35	Bracing capacity of structural walls.	100%	100%
Garages	Bracing capacity of structural walls and steel braces.	68%	100%

7 Geotechnical Summary

CERA indicates that Weaver Courts Housing Complex is located in a TC1 zone (as shown in Figure 12). This classification suggests future significant earthquakes will cause negligible land damage due to liquefaction and settlement.

Figure 12: TC1 zoning for Weaver Courts Housing Complex.

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.
- The residential units numbered 1-25 have a capacity of 72% NBS, as limited by the in-plane shear capacity of the lined shear walls. They are deemed to be a 'low risk' building in a design seismic event according to NZSEE guidelines. Their level of risk is 2-5 times that of a 100% NBS building (Figure 1).
- The residential units numbered 26-35 have a capacity of over 100% NBS. They are deemed to be a 'low risk' building in a design seismic event according to NZSEE guidelines.
- The storage garages have a capacity of 68% NBS, as limited by the in-plane capacity of the steel braces and plywood piers. They are deemed to be a 'low risk' in a design seismic event according to NZSEE guidelines. Their level of risk is 2-5 times that of a 100% NBS building (Figure 1).

9 Recommendations

- Veneer at height (gable ends) have the veneer ties checked.
- Cosmetic repairs are undertaken.

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 Weaver Courts 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

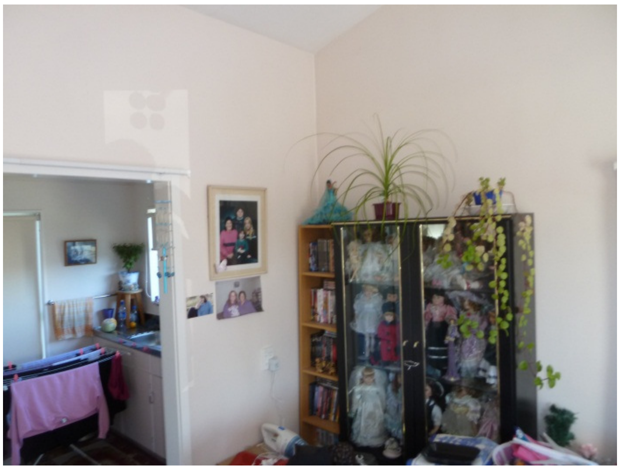
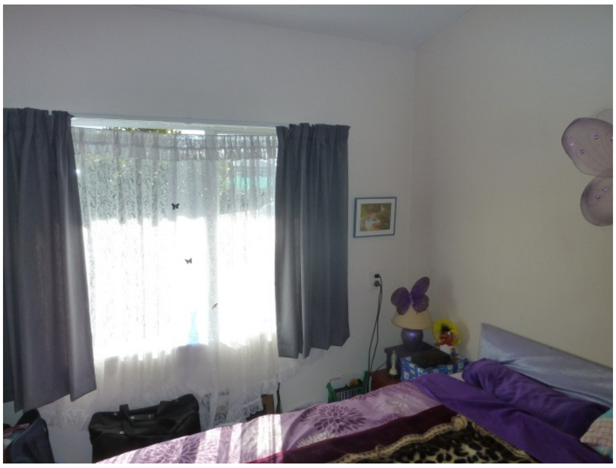
Weaver Courts Housing Complex		
Residential Units 1-25		
1.	Typical layout of the front of the units (north west facing side)	
2.	Typical layout of the back of the units (south east facing side)	
3.	End walls for all blocks (both south west facing and north east facing)	

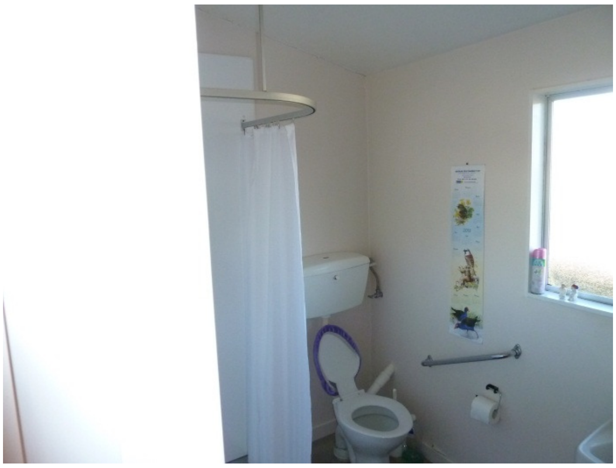
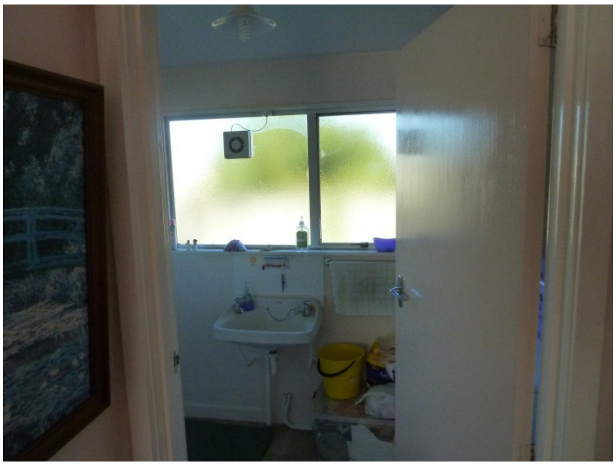
4.	Typical lounge layout	
5.	Typical bedroom layout	
6.	Typical kitchen layout	

7.	Typical bathroom layout	
8.	Typical cracking	
9.	Typical firewall foundation	

10.	Typical pile and subfloor layout	
11.	Typical roof framing layout	
12.	Vents covered by front step of units	

Residential Units 26-35		
13.	Typical layout of the front of the units	
14.	Typical layout of the back of the units	
15.	Typical end walls for all blocks	

16.	Typical lounge layout	
17.	Typical bedroom layout	
18.	Typical kitchen layout	

19.	Typical bathroom layout	
20.	Typical bathroom layout	
21.	Typical cracking	

22.	Typical pile and subfloor layout	
Garages		
23.	Exterior of garages	
24.	Typical interior of garages	

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 Spreadsheets

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Weaver Courts Housing Complex	Reviewer:	Mary Ann Halliday
	Unit / No: / Street	CPEng No:	67073
Building Address:	Units 1-25 / Weaver Place	Company:	OPUS International Consultants Ltd
Legal Description:	Residential Units	Company project number:	6-QC415.00
		Company phone number:	6433635400
	Degrees / Min / Sec		
GPS south:	-43.53626253	Date of submission:	Nov-13
GPS east:	172.5560206	Inspection Date:	25-Jun-13
		Revision:	Final
Building Unique Identifier (CCC):	PRO 1565	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):			
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):	21.00

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:	bored cast-insitu concrete piles		if Foundation type is other, describe:	
Building height (m):			height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):				
Age of Building (years):	48		Date of design:	1935-1965
Strengthening present?			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:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	
Floors:	timber	joist depth and spacing (mm)	
Beams:	timber	type	
Columns:			
Walls:			

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**		
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:

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

Non-structural elements

Stairs:			
Wall cladding:	other heavy	describe	100mm thick Summerhill Stone
Roof Cladding:	Metal	describe	lightweight
Glazing:	aluminium frames		
Ceilings:	strapped or direct fixed		
Services(list):			

Available documentation

Architectural	partial	original designer name/date	May-64
Structural	none	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:		Describe damage:	
Settlement:		notes (if applicable):	
Differential settlement:		notes (if applicable):	
Liquefaction:		notes (if applicable):	
Lateral Spread:		notes (if applicable):	
Differential lateral spread:		notes (if applicable):	
Ground cracks:		notes (if applicable):	
Damage to area:		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:	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:	72%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Equivalent Static
	Assessed %NBS after e'quakes:	72%		
Across	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	
	Assessed %NBS after e'quakes:	100%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Weaver Courts Housing Complex	Reviewer:	Mary Ann Halliday
	Unit / No: / Street	CPEng No:	67073
Building Address:	Units 26-35 / Weaver Place	Company:	OPUS International Consultants Ltd
Legal Description:	Residential Units	Company project number:	6-QC415.00
		Company phone number:	6433635400
	Degrees / Min / Sec		
GPS south:	-43.53626253	Date of submission:	Nov-13
GPS east:	172.5560206	Inspection Date:	25-Jun-13
		Revision:	Final
Building Unique Identifier (CCC):	PRO 1565	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):			
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):	21.00

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:	timber piles	if Foundation type is other, describe:	
Building height (m):		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):			
Age of Building (years):		Date of design:	1935-1965
Strengthening present?		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:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	
Floors:	timber	joist depth and spacing (mm)	
Beams:	timber	type	
Columns:			
Walls:			

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**		
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:

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

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	weather boards
Roof Cladding:	Metal	describe	lightweight
Glazing:	aluminium frames		
Ceilings:	strapped or direct fixed		
Services(list):			

Available documentation

Architectural	none	original designer name/date	
Structural	none	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:		Describe damage:	
Settlement:		notes (if applicable):	
Differential settlement:		notes (if applicable):	
Liquefaction:		notes (if applicable):	
Lateral Spread:		notes (if applicable):	
Differential lateral spread:		notes (if applicable):	
Ground cracks:		notes (if applicable):	
Damage to area:		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:	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:	100%	##### %NBS from IEP below / If IEP not used, please detail assessment methodology:	Equivalent Static
	Assessed %NBS after e'quakes:	100%		
Across	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	
	Assessed %NBS after e'quakes:	100%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Weaver Courts Housing Complex	Reviewer:	Mary Ann Halliday
	Unit / No: / Street	CPEng No:	67073
Building Address:	Garages 1-6 / Weaver Place	Company:	OPUS International Consultants Ltd
Legal Description:	Garage Storage Units	Company project number:	6-QC415.00
		Company phone number:	6433635400
	Degrees / Min / Sec		
GPS south:	-43.53626253	Date of submission:	Nov-13
GPS east:	172.5560206	Inspection Date:	25-Jun-13
		Revision:	Final
Building Unique Identifier (CCC):	PRO 1565	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):			
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):	21.00

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:		if Foundation type is other, describe:	
Building height (m):		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):			
Age of Building (years):		Date of design:	1976-1992
Strengthening present?		If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	parking	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):	garages also used as storage		
Importance level (to NZS1170.5):			

Gravity Structure

Gravity System:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	
Floors:	concrete flat slab	slab thickness (mm)	
Beams:	timber	type	
Columns:			
Walls:			

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	lightweight
Glazing:			
Ceilings:	none		
Services(list):			

Available documentation

Architectural	partial	original designer name/date	after 1978
Structural	partial	original designer name/date	after 1978
Mechanical		original designer name/date	
Electrical		original designer name/date	
Geotech report		original designer name/date	

Damage

Site:

(refer DEE Table 4-2)

Site performance:		Describe damage:	
Settlement:		notes (if applicable):	
Differential settlement:		notes (if applicable):	
Liquefaction:		notes (if applicable):	
Lateral Spread:		notes (if applicable):	
Differential lateral spread:		notes (if applicable):	
Ground cracks:		notes (if applicable):	
Damage to area:		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:			Describe:	
	Building Consent required:			Describe:	
	Interim occupancy recommendations:			Describe:	
Along	Assessed %NBS before e'quakes:	68%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Equivalent Static
	Assessed %NBS after e'quakes:	68%			
Across	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below		
	Assessed %NBS after e'quakes:	100%			

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