

Christchurch City Council

**Jura Courts
Housing Complex
PRO 0840**

**Detailed Engineering Evaluation
Quantitative Assessment Report**

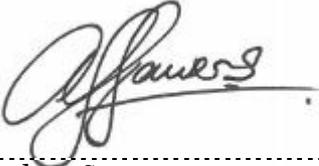
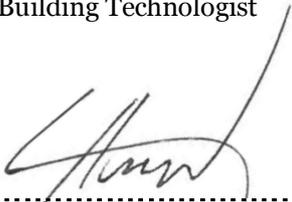




Christchurch City Council

Jura Courts Housing Complex Quantitative Assessment Report

**30 Jura Courts, Linwood, Christchurch
8062**

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Summary

Jura Courts Housing Complex
PRO 0840

Detailed Engineering Evaluation
Quantitative Report - Summary
Final

Background

This is a summary of the quantitative report for the Jura 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 28 residential units and residents lounge.

Key Damage Observed

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 wall and ceiling linings in some residential unit blocks. The floor slopes in Unit 7 exceeded the DBH limitation of 5mm/m.

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 0840 B001 (Block A)	83%	Pass	Pass
PRO 0840 B002 (Block B)	58%	Fail	Pass
PRO 0840 B003 (Block C)	58%	Pass	Pass
PRO 0840 B004 (Block D)	58%	Pass	Pass
PRO 0840 B005 (Block E)	58%	Pass	Pass
PRO 0840 B006 (Block F)	58%	Pass	Pass
PRO 0840 B007 (Block G)	58%	Pass	Pass

Recommendations

It is recommended that;

- A strengthening works scheme be developed to increase the seismic capacity of Blocks B-G 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.
- Cosmetic repairs be undertaken.

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1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council to undertake a detailed seismic assessment of the Jura Courts Housing Complex, located at 30 Jura Place, Linwood, Christchurch, following the Canterbury Earthquake Sequence since September 2010. The site was inspected by Opus on 3 July 2013. The residents lounge was revisited on 13 September 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	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 Order¹ 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 DBH guidance document dated 12 June 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 28 residential units which were constructed in 1975 and a residents lounge. A site plan showing the location of the units, numbered 3 to 30, and the residents lounge is shown in Figure 2. The units are split into 7 blocks made up of 2, 3, 4, 5 or 6 residential units. Figure 3 shows the location of the site in Christchurch City.



Figure 2: Site plan for Jura Courts Housing Complex.

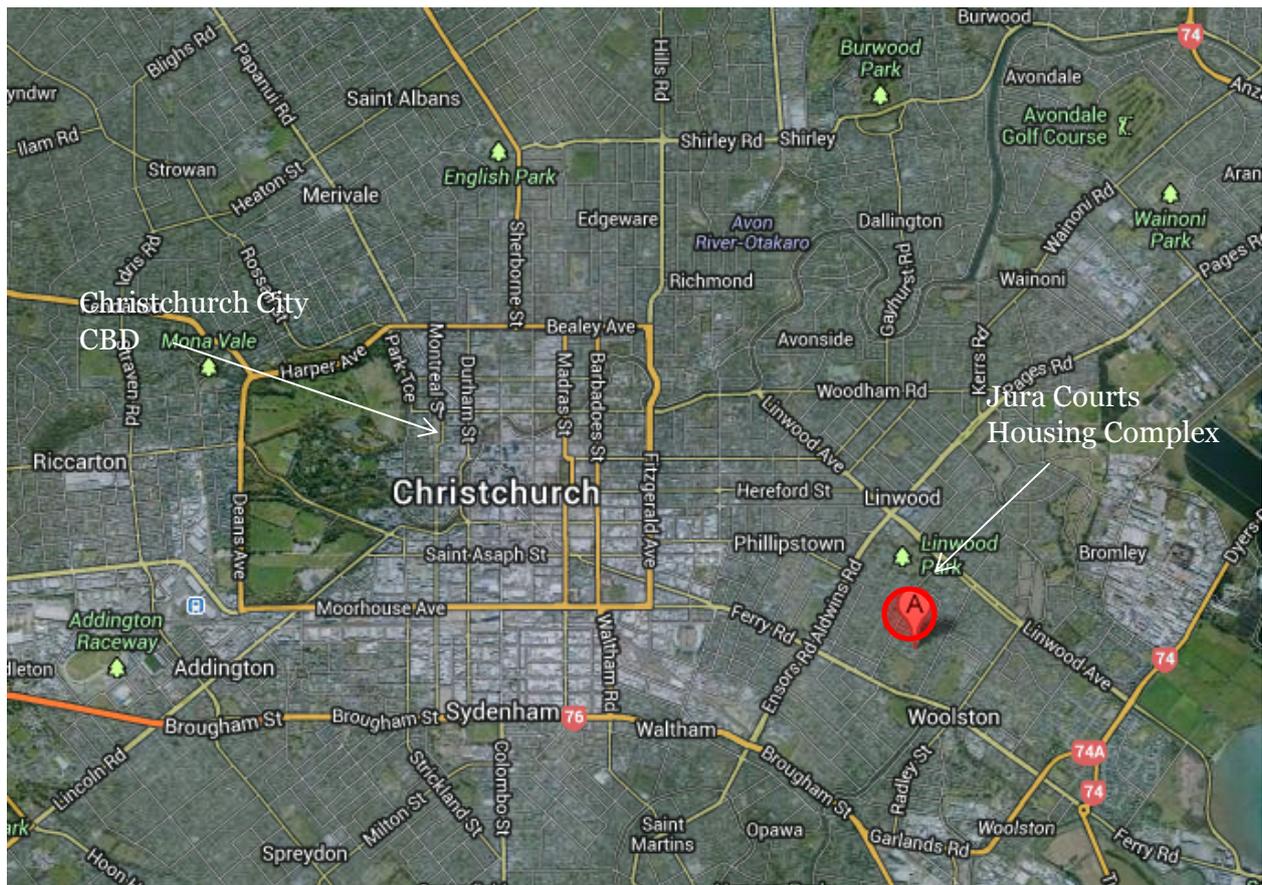


Figure 3: Location of site relative to Christchurch City CBD. (Source: Google Maps).

The residential units and residents lounge are timber-framed buildings with diagonal timber braces. The roof structure comprises of timber roof trusses supporting light-weight metal roofs. Walls and ceilings are lined with plasterboard. Cladding outside the kitchen area is light-weight Harditex-type cladding with the remaining wall areas clad with block veneer. The foundations of the residential units and residents lounge are reinforced concrete pads supported by foundation beams around the perimeter of the blocks and under the fire walls. The foundation beams are supported by prestressed concrete piles at approximately 900mm centres. Figure 4 shows a typical floor plan of a block of residential units produced from site measurements by Opus. Figure 5 shows a typical cross section from the original construction drawings.

The units are separated by 190mm block masonry fire walls which are filled with reinforcement to its perimeter as shown in Figure 6.

The residents lounge was converted from two adjacent residential units in 2001. Additions to the structure were also made to the entrance of the building and internal walls removed, including partial removal of the concrete block fire wall (shown in photo 19). Figure 7 shows the floor plan of the residents lounge produced from site measurements by Opus.

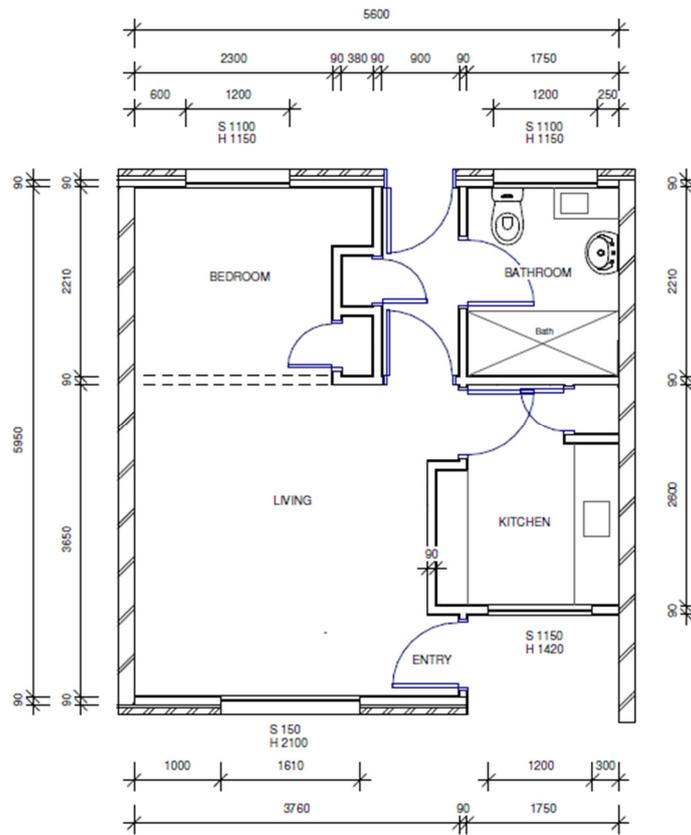


Figure 4: Typical floor plan of a residential unit within each block.

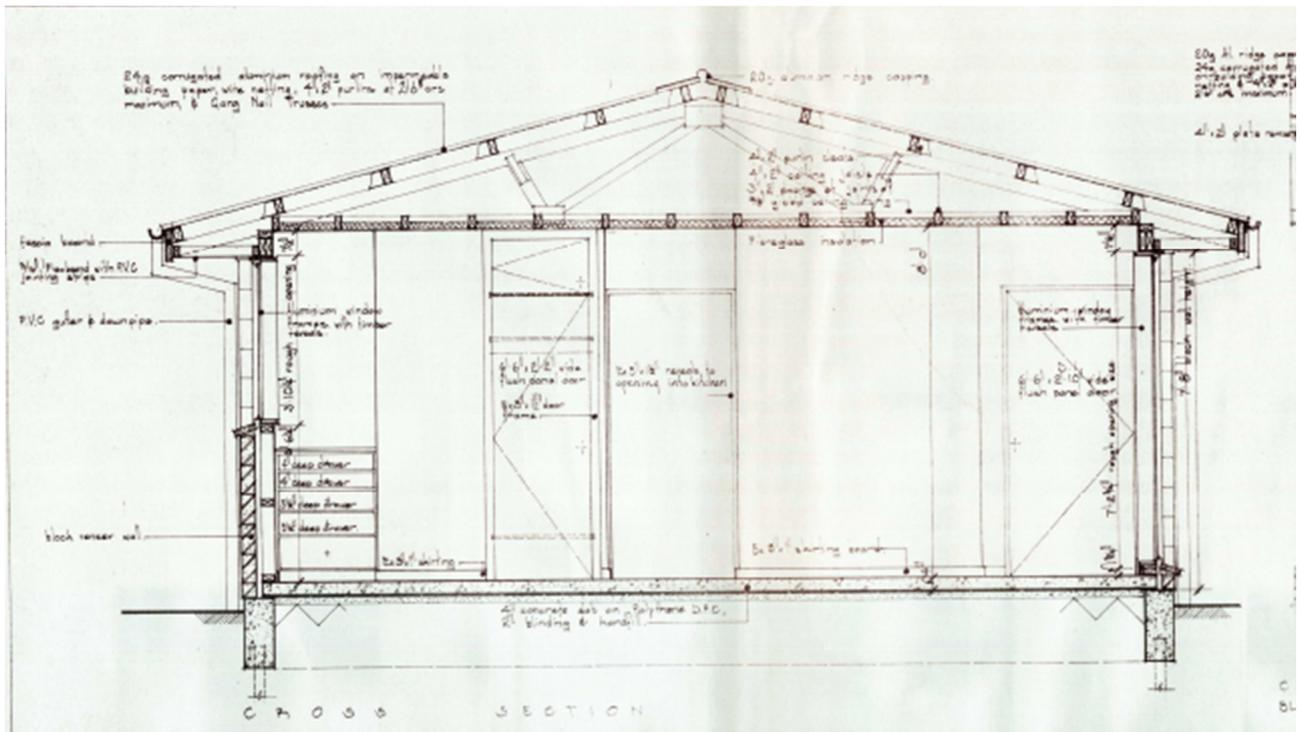


Figure 5: Typical section of a residential unit.

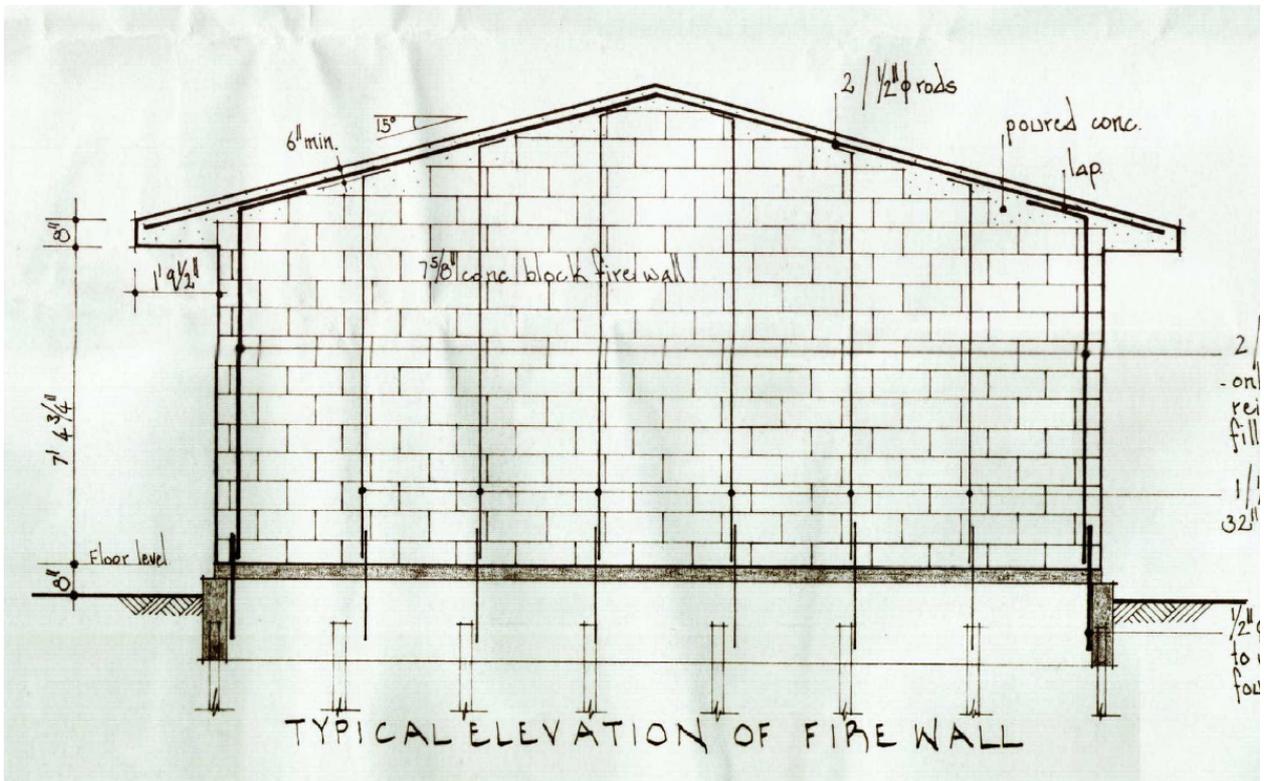


Figure 6: Typical elevation of Fire Wall, showing reinforcing.

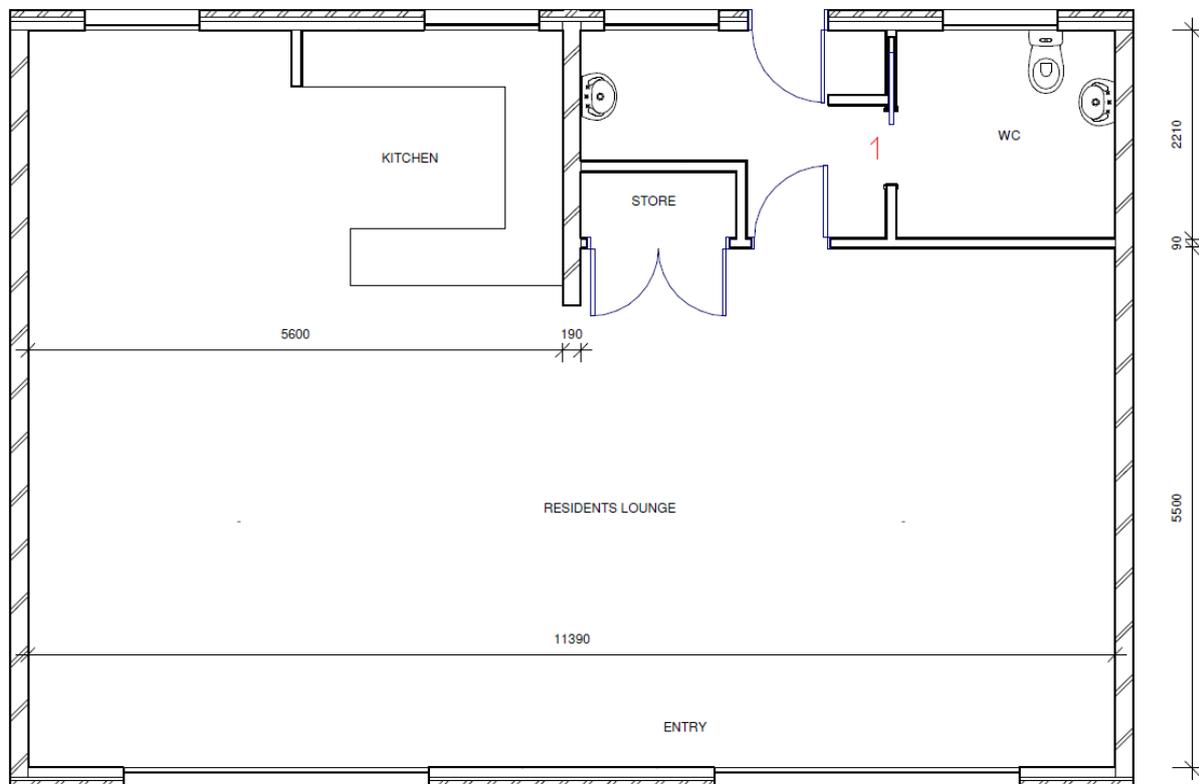


Figure 7: Floor plan of the residents lounge.

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 8th, 2011 by Opus International Consultants.

4.2.2 Level Survey

A full level survey was not deemed to be necessary at Jura Courts 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. These values could then be used to determine the floor slope of the entire unit. For this site, the maximum slope in a unit (Unit 7) was 10mm/m (which exceeds the 5mm/m limitation recommended by MBIE). The general slopes across all other units and the residents lounge were less than the limitation.

4.2.3 Plasterboard Nail Spacing

Nails spacings were checked in the residential units and were consistently less than 200mm.

4.3 Original Documentation

Copies of the following construction drawings were provided by CCC:

- Plans, elevations, sections and details for the construction of the residential units (File No. BU/18/1/30 Drawn 1974).

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 and plans of the residents lounge 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

The floor slopes in Unit 7 were measured to be beyond the 5mm/m limitation imposed by MBIE guidelines. This indicates the possibility of ground settlement due to earthquake imposed actions. There is also evidence of settlement in the interface between the entrance path and door of the residents lounge. There are no indications of settlement in any other units.

5.2 Foundations

Foundation damage was not observed in the buildings.

5.3 Primary Gravity Structure

No damage was evident in the timber framing or roof structure.

5.4 Primary Lateral-Resistance Structure

No damage to the primary lateral resistance structure.

5.5 Non Structural Elements

Stepped cracking of the mortar joints and through the block veneer exterior cladding was observed on some units (photo 8-10). This form of damage is not widespread.

Minimal cracking of plasterboard ceiling diaphragms and wall linings was observed in the units. This form of damage is not widespread throughout the units.

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 the same floor plan, the analysis was simplified by conducting the analysis of one multi-unit block with block veneer 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. During the initial qualitative stage of the assessment the following potential CSW's were identified for each of the buildings and have been considered in the quantitative analysis.

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 Figure 8 and Figure 9, were used for bracing in their respective directions.

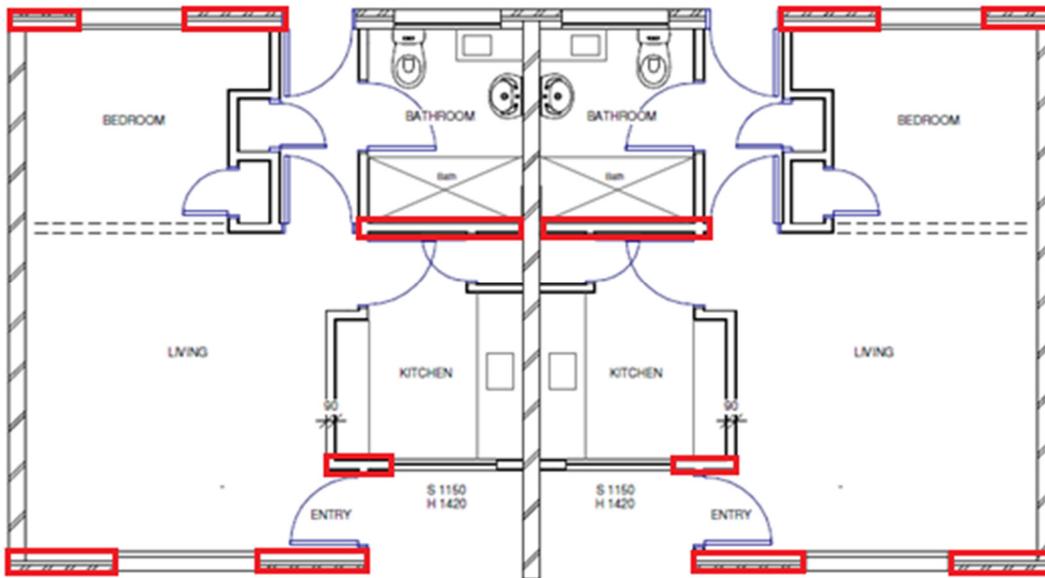


Figure 8: Walls used for bracing in the longitudinal direction.

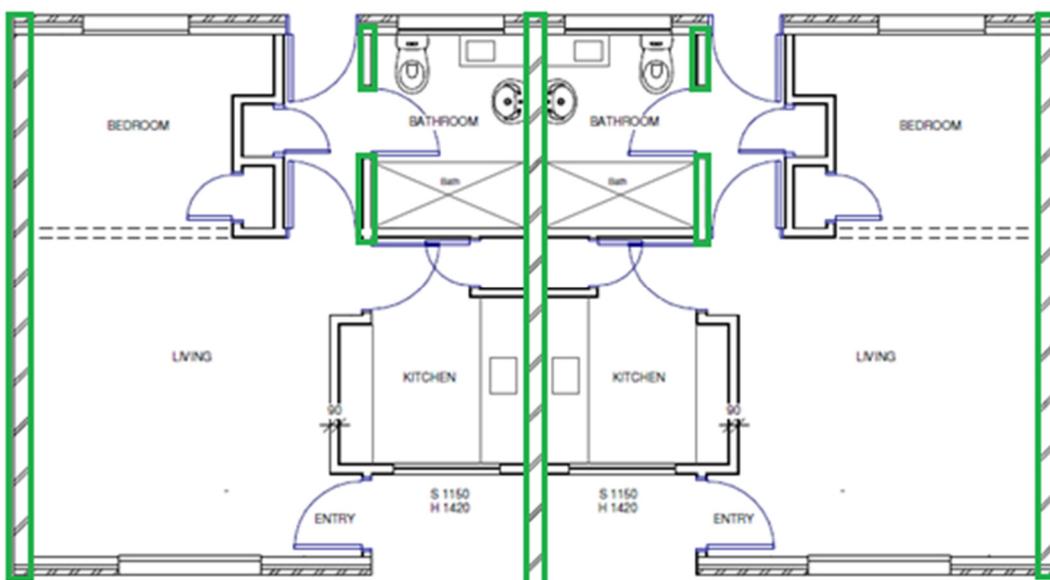


Figure 9: Walls used for bracing in the transverse direction.

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 2 below. 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

Building Description	Critical element	% NBS based on calculated capacity in longitudinal direction	% NBS based on calculated capacity in transverse direction.
All Multi-Unit Blocks	Bracing capacity of structural walls.	58%	100%
Block A (with Residents Lounge)	Bracing capacity of structural walls.	83%	98%

7 Geotechnical Summary

CERA indicates that Jura Courts is located in a TC2 zone (as shown in Figure 10). This classification suggests future significant earthquakes will cause minor to moderate land damage due to liquefaction and settlement.

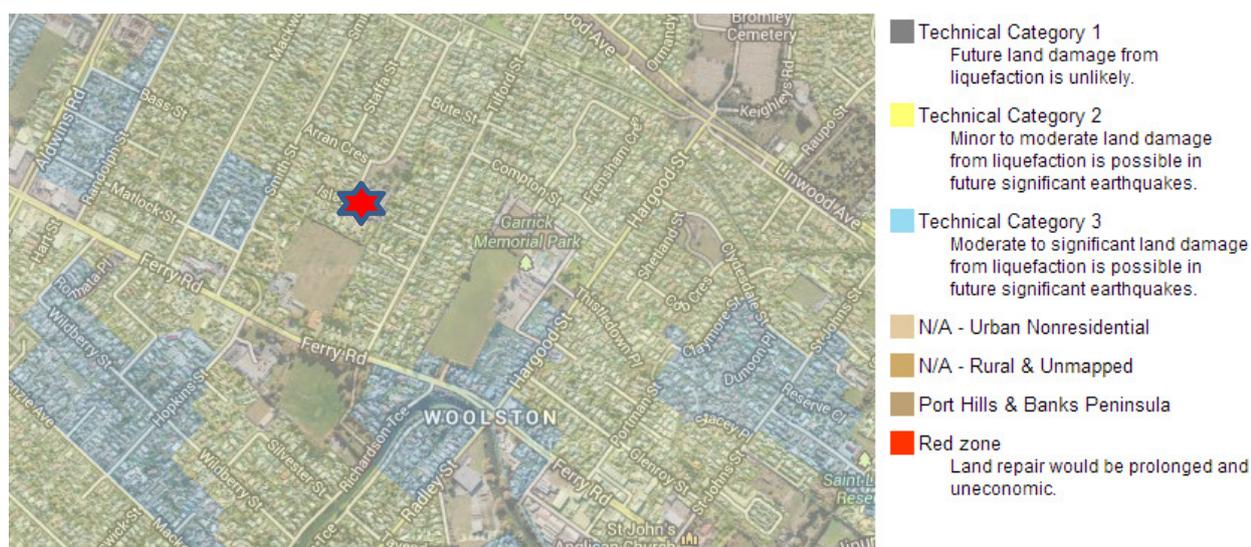


Figure 10: TC2 zoning for Jura Courts Housing Complex.

It is noted that the buildings are on piles so it is unlikely that the bearing capacity will meet the NZS3604 requirements for good ground. A detailed geotechnical report would be required as part of any foundation work or development to be done on the site.

8 Conclusions

- None of the buildings on site are considered to be Earthquake Prone.
- The residential units (except Block A) have a capacity of 58% 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).
- Block A (with the residents lounge) has a capacity of 83% NBS, as limited by the in-plane capacity of the bracing walls. They are deemed to be a ‘low risk’ in a design seismic event according to NZSEE guidelines. Their level of risk is 1-2 times that of a 100% NBS building (Figure 1).

9 Recommendations

It is recommended that;

- A strengthening works scheme be developed to increase the seismic capacity of Blocks B-G 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.
- Cosmetic repairs be 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 Jura 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

Jura Courts Housing Complex – Detailed Engineering Evaluation

Jura Courts Housing Complex		
No.	Item description	Photo
Residential Units		
1	Exterior elevation (front).	 A wide-angle photograph of a long, single-story residential building with a dark roof and light-colored walls. A satellite dish is mounted on the roof. The building is set on a green lawn under a clear blue sky.
2	Exterior elevation (front).	 A closer view of the front entrance of a residential unit, showing a concrete walkway leading to a door and windows with light-colored curtains. The building has a dark roof and light-colored walls.
3	Exterior elevation (front).	 A view of the front elevation of a residential unit from a different angle, showing two satellite dishes on the roof and a concrete area in front of the building. The building has a dark roof and light-colored walls.

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4	Exterior elevation (side).	
5	Exterior elevation (rear).	

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6	Cracking of block veneer.	 A photograph showing a vertical crack in the white block veneer of a building's exterior wall. The crack runs vertically through several courses of blocks. A window is visible in the upper right corner of the image.
7	Cracking of exterior paving.	 A photograph showing a long, vertical crack in a concrete or asphalt exterior paving area. The crack runs from the foreground towards the background, where a doorway and some furniture are visible.

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8	Cracking of block veneer.	
9	Cracking of block veneer along horizontal mortar joint.	
10	Cracking of block veneer.	

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11	Typical roof cavity showing gable end and roof truss.	 A photograph showing the interior of a roof cavity. The structure consists of wooden trusses supported by vertical posts. A layer of pink insulation is visible on the floor of the cavity. A black mesh netting is stretched across the top of the trusses, just below the roof sheathing.
12	Typical roof cavity, showing fire wall.	 A photograph of a roof cavity showing a fire wall. The wall is constructed from grey concrete blocks and runs across the width of the cavity. Wooden trusses are visible above and below the wall. Pink insulation is on the floor, and a black mesh netting is at the top.
13	Typical cracking of wall lining.	 A photograph of an interior room. A window is covered with patterned curtains. Above the window, there is a vertical crack in the white wall lining. To the right, a framed picture is partially visible on the wall.

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14	Typical Plasterboard Nail Spacing (200mm).	
Residents lounge		
15	Exterior elevation (front).	

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16	Exterior elevation (end).	
17	Exterior elevation (rear).	
18	Connection of residents lounge to residential unit.	

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19	Partially removed fire wall.	
20	General layout of residents lounge.	
21	Evidence of settlement outside residents lounge.	

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22	Evidence of settlement outside residents lounge.	 A photograph showing a concrete step leading up to a window. The window has a white frame and a light-colored curtain. The concrete step is uneven and appears to be settling, with a noticeable gap between the step and the ground. The ground is dirt and grass. There are some plants and a white wall in the background.
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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

Location		Building Name: <input type="text" value="Jura Courts Block A"/>	Unit No: <input type="text" value="30"/>	Street: <input type="text" value="Jura Courts"/>	Reviewer: <input type="text" value="Mary Ann Halliday"/>
Building Address: <input type="text"/>	Legal Description: <input type="text"/>				CPEng No: <input type="text" value="67073"/>
					Company: <input type="text" value="Opus International Consultants"/>
					Company project number: <input type="text" value="6-OC365.00"/>
					Company phone number: <input type="text"/>
		Degrees	Min	Sec	Date of submission: <input type="text" value="14/11/2013"/>
GPS south: <input type="text"/>		43	32	34.25	Inspection Date: <input type="text" value="3-Jul"/>
GPS east: <input type="text"/>		172	40	30.87	Revision: <input type="text" value="Final"/>
Building Unique Identifier (CCC): <input type="text" value="PRO 0840"/>					Is there a full report with this summary? <input type="text" value="yes"/>

Site		Site slope: <input type="text" value="flat"/>	Max retaining height (m): <input type="text"/>
		Soil type: <input type="text"/>	Soil Profile (if available): <input type="text"/>
		Site Class (to NZS1170.5): <input type="text" value="D"/>	If Ground improvement on site, describe: <input type="text"/>
		Proximity to waterway (m, if <100m): <input type="text"/>	Approx site elevation (m): <input type="text"/>
		Proximity to cliff top (m, if < 100m): <input type="text"/>	
		Proximity to cliff base (m,if <100m): <input type="text"/>	

Building		No. of storeys above ground: <input type="text" value="1"/>	single storey = 1	Ground floor elevation (Absolute) (m): <input type="text"/>
		Ground floor split? <input type="text" value="no"/>		Ground floor elevation above ground (m): <input type="text"/>
		Storeys below ground: <input type="text" value="0"/>		if Foundation type is other, describe: <input type="text"/>
		Foundation type: <input type="text" value="mat slab"/>	height from ground to level of uppermost seismic mass (for IEP only) (m): <input type="text"/>	Date of design: <input type="text" value="1965-1976"/>
		Building height (m): <input type="text" value="3.00"/>		
		Floor footprint area (approx): <input type="text"/>		
		Age of Building (years): <input type="text" value="38"/>		
		Strengthening present? <input type="text"/>		If so, when (year)? <input type="text"/>
		Use (ground floor): <input type="text" value="multi-unit residential"/>		And what load level (%g)? <input type="text"/>
		Use (upper floors): <input type="text"/>		Brief strengthening description: <input type="text"/>
		Use notes (if required): <input type="text"/>		
		Importance level (to NZS1170.5): <input type="text" value="IL2"/>		

Gravity Structure		Gravity System: <input type="text" value="frame system"/>	truss depth, purlin type and cladding
		Roof: <input type="text" value="timber truss"/>	slab thickness (mm)
		Floors: <input type="text" value="concrete flat slab"/>	<input type="text"/>
		Beams: <input type="text"/>	<input type="text"/>
		Columns: <input type="text"/>	<input type="text"/>
		Walls: <input type="text" value="non-load bearing"/>	0 <input type="text"/>

Lateral load resisting structure		Lateral system along: <input type="text" value="lightweight timber framed walls"/>	Note: Define along and across in detailed report!	note typical wall length (m) <input type="text"/>
		Ductility assumed, μ: <input type="text" value="2.00"/>		estimate or calculation? <input type="text"/>
		Period along: <input type="text" value="0.10"/>		estimate or calculation? <input type="text"/>
		Total deflection (ULS) (mm): <input type="text"/>	0.00	estimate or calculation? <input type="text"/>
		maximum interstorey deflection (ULS) (mm): <input type="text"/>		
		Lateral system across: <input type="text" value="lightweight timber framed walls"/>		note typical wall length (m) <input type="text"/>
		Ductility assumed, μ: <input type="text" value="2.00"/>		estimate or calculation? <input type="text"/>
		Period across: <input type="text" value="0.10"/>		estimate or calculation? <input type="text"/>
		Total deflection (ULS) (mm): <input type="text"/>	0.00	estimate or calculation? <input type="text"/>
		maximum interstorey deflection (ULS) (mm): <input type="text"/>		estimate or calculation? <input type="text"/>

Separations:		north (mm): <input type="text"/>	leave blank if not relevant
		east (mm): <input type="text"/>	
		south (mm): <input type="text"/>	
		west (mm): <input type="text"/>	

Non-structural elements		Stairs: <input type="text"/>	describe (note cavity if exists) describe
		Wall cladding: <input type="text" value="brick or tile"/>	
		Roof Cladding: <input type="text" value="Metal"/>	
		Glazing: <input type="text"/>	
		Ceilings: <input type="text" value="fibrous plaster, fixed"/>	
		Services(list): <input type="text"/>	

Available documentation		Architectural: <input type="text" value="partial"/>	original designer name/date: <input type="text"/>
		Structural: <input type="text" value="partial"/>	original designer name/date: <input type="text"/>
		Mechanical: <input type="text"/>	original designer name/date: <input type="text"/>
		Electrical: <input type="text"/>	original designer name/date: <input type="text"/>
		Geotech report: <input type="text"/>	original designer name/date: <input type="text"/>

Damage		Site performance: <input type="text" value="Good"/>	Describe damage: <input type="text"/>
Site: (refer DEE Table 4-2)		Settlement: <input type="text" value="none observed"/>	notes (if applicable): <input type="text"/>
		Differential settlement: <input type="text" value="none observed"/>	notes (if applicable): <input type="text"/>
		Liquefaction: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>
		Lateral Spread: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>
		Differential lateral spread: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>
		Ground cracks: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>
		Damage to area: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>

Building:		Current Placard Status: <input type="text" value="green"/>	
Along	Damage ratio: <input type="text" value="0%"/>	Describe how damage ratio arrived at: <input type="text"/>	
	Describe (summary): <input type="text"/>		
Across	Damage ratio: <input type="text" value="0%"/>	Describe (summary): <input type="text"/>	
	Describe (summary): <input type="text"/>		
		$Damage_Ratio = \frac{(\%NBS\ (before) - \%NBS\ (after))}{\%NBS\ (before)}$	
Diaphragms	Damage?: <input type="text" value="no"/>	Describe: <input type="text"/>	
CSWs:	Damage?: <input type="text" value="no"/>	Describe: <input type="text"/>	
Pounding:	Damage?: <input type="text" value="no"/>	Describe: <input type="text"/>	
Non-structural:	Damage?: <input type="text" value="yes"/>	Describe: <input type="text"/>	

Recommendations		Level of repair/strengthening required: <input type="text" value="minor non-structural"/>	Describe: <input type="text"/>
		Building Consent required: <input type="text" value="no"/>	Describe: <input type="text"/>
		Interim occupancy recommendations: <input type="text" value="full occupancy"/>	Describe: <input type="text"/>
Along	Assessed %NBS before e'quakes: <input type="text" value="83%"/>	#### %NBS from IEP below	If IEP not used, please detail assessment methodology: <input type="text" value="Equivalent Static"/>
	Assessed %NBS after e'quakes: <input type="text" value="83%"/>		
Across	Assessed %NBS before e'quakes: <input type="text" value="100%"/>	#### %NBS from IEP below	
	Assessed %NBS after e'quakes: <input type="text" value="100%"/>		

Location		Building Name: <input type="text" value="Jura Courts Blocks B-G"/>	Unit No: <input type="text" value="30"/>	Street: <input type="text" value="Jura Courts"/>	Reviewer: <input type="text" value="Mary Ann Halliday"/>
Building Address: <input type="text"/>	Legal Description: <input type="text"/>				CPEng No: <input type="text" value="67073"/>
					Company: <input type="text" value="Opus International Consultants"/>
					Company project number: <input type="text" value="6-OC365.00"/>
					Company phone number: <input type="text"/>
		Degrees	Min	Sec	Date of submission: <input type="text" value="14/11/2013"/>
GPS south: <input type="text"/>		43	32	34.25	Inspection Date: <input type="text" value="3-Jul"/>
GPS east: <input type="text"/>		172	40	30.87	Revision: <input type="text" value="Final"/>
Building Unique Identifier (CCC): <input type="text" value="PRO 0840"/>					Is there a full report with this summary? <input type="text" value="yes"/>

Site		Site slope: <input type="text" value="flat"/>	Max retaining height (m): <input type="text"/>
		Soil type: <input type="text"/>	Soil Profile (if available): <input type="text"/>
		Site Class (to NZS1170.5): <input type="text" value="D"/>	If Ground improvement on site, describe: <input type="text"/>
		Proximity to waterway (m, if <100m): <input type="text"/>	Approx site elevation (m): <input type="text"/>
		Proximity to cliff top (m, if < 100m): <input type="text"/>	
		Proximity to cliff base (m,if <100m): <input type="text"/>	

Building		No. of storeys above ground: <input type="text" value="1"/>	single storey = 1	Ground floor elevation (Absolute) (m): <input type="text"/>
		Ground floor split? <input type="text" value="no"/>		Ground floor elevation above ground (m): <input type="text"/>
		Storeys below ground: <input type="text" value="0"/>		if Foundation type is other, describe: <input type="text"/>
		Foundation type: <input type="text" value="mat slab"/>	height from ground to level of uppermost seismic mass (for IEP only) (m): <input type="text"/>	Date of design: <input type="text" value="1965-1976"/>
		Building height (m): <input type="text" value="3.00"/>		
		Floor footprint area (approx): <input type="text"/>		
		Age of Building (years): <input type="text" value="38"/>		
		Strengthening present? <input type="text"/>		If so, when (year)? <input type="text"/>
		Use (ground floor): <input type="text" value="multi-unit residential"/>		And what load level (%g)? <input type="text"/>
		Use (upper floors): <input type="text"/>		Brief strengthening description: <input type="text"/>
		Use notes (if required): <input type="text"/>		
		Importance level (to NZS1170.5): <input type="text" value="IL2"/>		

Gravity Structure		Gravity System: <input type="text" value="frame system"/>	truss depth, purlin type and cladding
		Roof: <input type="text" value="timber truss"/>	slab thickness (mm)
		Floors: <input type="text" value="concrete flat slab"/>	<input type="text"/>
		Beams: <input type="text"/>	<input type="text"/>
		Columns: <input type="text"/>	<input type="text"/>
		Walls: <input type="text" value="non-load bearing"/>	0 <input type="text"/>

Lateral load resisting structure		Lateral system along: <input type="text" value="lightweight timber framed walls"/>	Note: Define along and across in detailed report!	note typical wall length (m) <input type="text"/>
		Ductility assumed, μ : <input type="text" value="2.00"/>		estimate or calculation? <input type="text"/>
		Period along: <input type="text" value="0.10"/>		estimate or calculation? <input type="text"/>
		Total deflection (ULS) (mm): <input type="text"/>	0.00	estimate or calculation? <input type="text"/>
		maximum interstorey deflection (ULS) (mm): <input type="text"/>		
		Lateral system across: <input type="text" value="lightweight timber framed walls"/>		note typical wall length (m) <input type="text"/>
		Ductility assumed, μ : <input type="text" value="2.00"/>	0.00	estimate or calculation? <input type="text"/>
		Period across: <input type="text" value="0.10"/>		estimate or calculation? <input type="text"/>
		Total deflection (ULS) (mm): <input type="text"/>		estimate or calculation? <input type="text"/>
		maximum interstorey deflection (ULS) (mm): <input type="text"/>		estimate or calculation? <input type="text"/>

Separations:		north (mm): <input type="text"/>	leave blank if not relevant
		east (mm): <input type="text"/>	
		south (mm): <input type="text"/>	
		west (mm): <input type="text"/>	

Non-structural elements		Stairs: <input type="text"/>	describe (note cavity if exists) describe
		Wall cladding: <input type="text" value="brick or tile"/>	
		Roof Cladding: <input type="text" value="Metal"/>	
		Glazing: <input type="text"/>	
		Ceilings: <input type="text" value="fibrous plaster, fixed"/>	
		Services(list): <input type="text"/>	

Available documentation		Architectural: <input type="text" value="partial"/>	original designer name/date: <input type="text"/>
		Structural: <input type="text" value="partial"/>	original designer name/date: <input type="text"/>
		Mechanical: <input type="text"/>	original designer name/date: <input type="text"/>
		Electrical: <input type="text"/>	original designer name/date: <input type="text"/>
		Geotech report: <input type="text"/>	original designer name/date: <input type="text"/>

Damage		Site performance: <input type="text" value="Good"/>	Describe damage: <input type="text"/>
Site: (refer DEE Table 4-2)		Settlement: <input type="text" value="none observed"/>	notes (if applicable): <input type="text"/>
		Differential settlement: <input type="text" value="none observed"/>	notes (if applicable): <input type="text"/>
		Liquefaction: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>
		Lateral Spread: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>
		Differential lateral spread: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>
		Ground cracks: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>
		Damage to area: <input type="text" value="none apparent"/>	notes (if applicable): <input type="text"/>

Building:		Current Placard Status: <input type="text" value="green"/>	
Along	Damage ratio: <input type="text" value="0%"/>	Describe how damage ratio arrived at: <input type="text"/>	
	Describe (summary): <input type="text"/>		
Across	Damage ratio: <input type="text" value="0%"/>	Describe (summary): <input type="text"/>	
	Describe (summary): <input type="text"/>		
		$Damage_Ratio = \frac{(\%NBS\ (before) - \%NBS\ (after))}{\%NBS\ (before)}$	
Diaphragms	Damage?: <input type="text" value="no"/>	Describe: <input type="text"/>	
CSWs:	Damage?: <input type="text" value="no"/>	Describe: <input type="text"/>	
Pounding:	Damage?: <input type="text" value="no"/>	Describe: <input type="text"/>	
Non-structural:	Damage?: <input type="text" value="yes"/>	Describe: <input type="text"/>	

Recommendations		Level of repair/strengthening required: <input type="text" value="minor non-structural"/>	Describe: <input type="text"/>
		Building Consent required: <input type="text" value="no"/>	Describe: <input type="text"/>
		Interim occupancy recommendations: <input type="text" value="full occupancy"/>	Describe: <input type="text"/>
Along	Assessed %NBS before e'quakes: <input type="text" value="58%"/>	#### %NBS from IEP below	If IEP not used, please detail assessment methodology: <input type="text" value="Equivalent Static"/>
	Assessed %NBS after e'quakes: <input type="text" value="58%"/>		
Across	Assessed %NBS before e'quakes: <input type="text" value="100%"/>	#### %NBS from IEP below	
	Assessed %NBS after e'quakes: <input type="text" value="100%"/>		



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