Christchurch City Council

Sandilands Housing Complex PRO 0755

Detailed Engineering Evaluation

Quantitative Assessment Report

OPUS

Christchurch City Council

Sandilands Housing Complex

Quantitative Assessment Report

Coulter Street, Griffiths Avenue and Nicholas Drive, Aranui,

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Summary

Sandilands Housing Complex
PRO 0755

Detailed Engineering Evaluation
Quantitative Report - Summary
Final

Background

This is a summary of the quantitative report for the Sandilands 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 24 residential units which are located on different streets within close proximity to one another throughout the site.

Key Damage Observed

The residential units have suffered minor to moderate damage to non-structural elements. This included cracking of the weatherboard and plaster veneer. Moderate cracking was noted to the concrete foundation perimeter footing in some residential unit blocks. Cracking to the wall linings was observed in all units, typically above doorways and around windows. This damage was deemed low enough to not affect the capacities of the buildings.

Level Survey

All accessible floor slopes were assessed with a laser level survey. Eight units had floor slopes that were greater than the 5mm/m limitation set out in the MBIE guidelines [6], as shown below.

Critical Structural Weaknesses

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

Indicative Building Strength

Table A: Summary of Seismic Performance by Blocks

Block	NBS%	Indicative Floor Levels
Residential Units		
PRO 0755 B001 (29,31 Griffiths Avenue)	84%	Pass
PRO 0755 B002 (23,25 Griffiths Avenue)	84%	Fail
PRO 0755 B003 (15,17 Griffiths Avenue)	84%	Fail
PRO 0755 B004 (11,13 Griffiths Avenue)	84%	Fail (Unit 11)
PRO 0755 B005 (3 Griffiths Avenue, 12 Nicholas Drive)	84%	Pass
PRO 0755 B006 (14, 14a Nicholas Drive)	84%	Pass
PRO 0755 B007 (2, 4 Nicholas Drive)	84%	Fail (Unit 4)
PRO 0755 B008 (18,20 Griffiths Avenue)	84%	Pass

PRO 0755 B009 (22,24 Griffiths Avenue)	84%	Pass
PRO 0755 B010 (17, 19 Coulter St)	84%	Fail
PRO 0755 B011 (9, 11 Coulter St)	84%	Pass
PRO 0755 B012 (6, 8 Nicholas Drive)	84%	Pass
Laundry Buildings		
PRO 0755 B001 (29,31 Griffiths Avenue)	95%	-
PRO 0755 B002 (23,25 Griffiths Avenue)	95%	-
PRO 0755 B003 (15,17 Griffiths Avenue)	95%	-
PRO 0755 B004 (11,13 Griffiths Avenue)	95%	-
PRO 0755 B005 (3 Griffiths Avenue, 12 Nicholas Drive)	95%	-
PRO 0755 B006 (14, 14a Nicholas Drive)	95%	-
PRO 0755 B007 (2, 4 Nicholas Drive)	95%	-
PRO 0755 B008 (18,20 Griffiths Avenue)	95%	-
PRO 0755 B009 (22,24 Griffiths Avenue)	95%	-
PRO 0755 B010 (17, 19 Coulter St)	95%	-
PRO 0755 B011 (9, 11 Coulter St)	95%	-
PRO 0755 B012 (6, 8 Nicholas Drive)	95%	-
Garages		
PRO 0755 B001 a (29 Griffiths Avenue)	100%	-
PRO 0755 B001 b (31 Griffiths Avenue)	90%	-
PRO 0755 B002 a (23 Griffiths Avenue)	100%	-
PRO 0755 B002 b (25 Griffiths Avenue)	100%	-
PRO 0755 B003 a (15 Griffiths Avenue)	100%	-
PRO 0755 B003 b (17 Griffiths Avenue)	100%	-
PRO 0755 B004 a (11 Griffiths Avenue)	100%	-
PRO 0755 B004 b (13 Griffiths Avenue)	100%	-
PRO 0755 B005 a (3 Griffiths Avenue)	100%	-

PRO 0755 B005 b (12 Nicholas Drive)	>33%	-
PRO 0755 B006 a (14 Nicholas Drive)	100%	-
PRO 0755 B006 b (14a Nicholas Drive)	100%	-
PRO 0755 B007 a (2 Nicholas Drive)	100%	-
PRO 0755 B007 b (4 Nicholas Drive)	100%	-
PRO 0755 B008 a (18 Griffiths Avenue)	>33%	-
PRO 0755 B008 b (20 Griffiths Avenue)	100%	-
PRO 0755 B009 a (22 Griffiths Avenue)	100%	-
PRO 0755 B010 a (17-19 Coulter St)	65%	-
PRO 0755 B011 a (9-11 Coulter St)	65%	-
PRO 0755 B012 a (6 Nicholas Drive)	100%	-
PRO 0755 B012 b (8 Nicholas Drive)	100%	-

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

The residential units have capacities of 84% NBS, as limited by the out of plane capacity of the unreinforced concrete fire walls. They are deemed to be a 'low risk' in a design seismic event according to NZSEE guidelines.

The laundry buildings have capacities of 95% NBS, as limited by the in-plane capacity of the concrete walls. They are deemed to be a 'low risk' in a design seismic event according to NZSEE guidelines.

The garages at 12 Nicholas Drive and 18 Griffiths Avenue have capacities of more than 33%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. These garages have inadequate connection of rafters at the apex affecting capacity to resist gravity loading.

The garage at 31 Griffiths Avenue has a capacity of 90% NBS, as limited by the out-of-plane capacity of the concrete walls. It is deemed to be a 'low risk' in a design seismic event according to NZSEE guidelines.

The garages at 17-19 Coulter Street and 9-11 Coulter Street have capacities of 65%NBS, as limited by the out of plane capacity of the unreinforced concrete block wall. They are deemed to be a 'moderate risk' in a design seismic event according to NZSEE guidelines.

All other garages on site have a capacities of 100%NBS and are deemed to be a 'low risk' in a design seismic event according to NZSEE guidelines.

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

Recommendations

It is recommended that;

- The timber garages at 12 Nicholas Drive and 18 Griffiths Avenue be strengthened to support gravity loads and to at least 67%NBS.
- Strengthening schemes be developed to bring the capacities of the garages at 9-11 and 17-19 Coulter Ave to at least 67%NBS.
- Concrete header tanks be removed.
- Cosmetic repairs be undertaken as required.

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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 Sandilands Housing Complex, located at Coulter Street, Griffiths Avenue and Nicholas Drive, Aranui, following the Canterbury earthquake sequence since September 2010. The site was visited by Opus International Consultants on 23 September 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 24 residential units which were constructed in 1947. A site plan showing the location of the units, is shown in Figure 2. Figure 3 shows the location of the site in Christchurch City. The units are grouped together such that each separate structure contains two units in mirror image. The unit blocks are spread out amongst private dwellings and are located on three different street addresses – Coulter Street, Griffiths Avenue and Nicholas Drive.

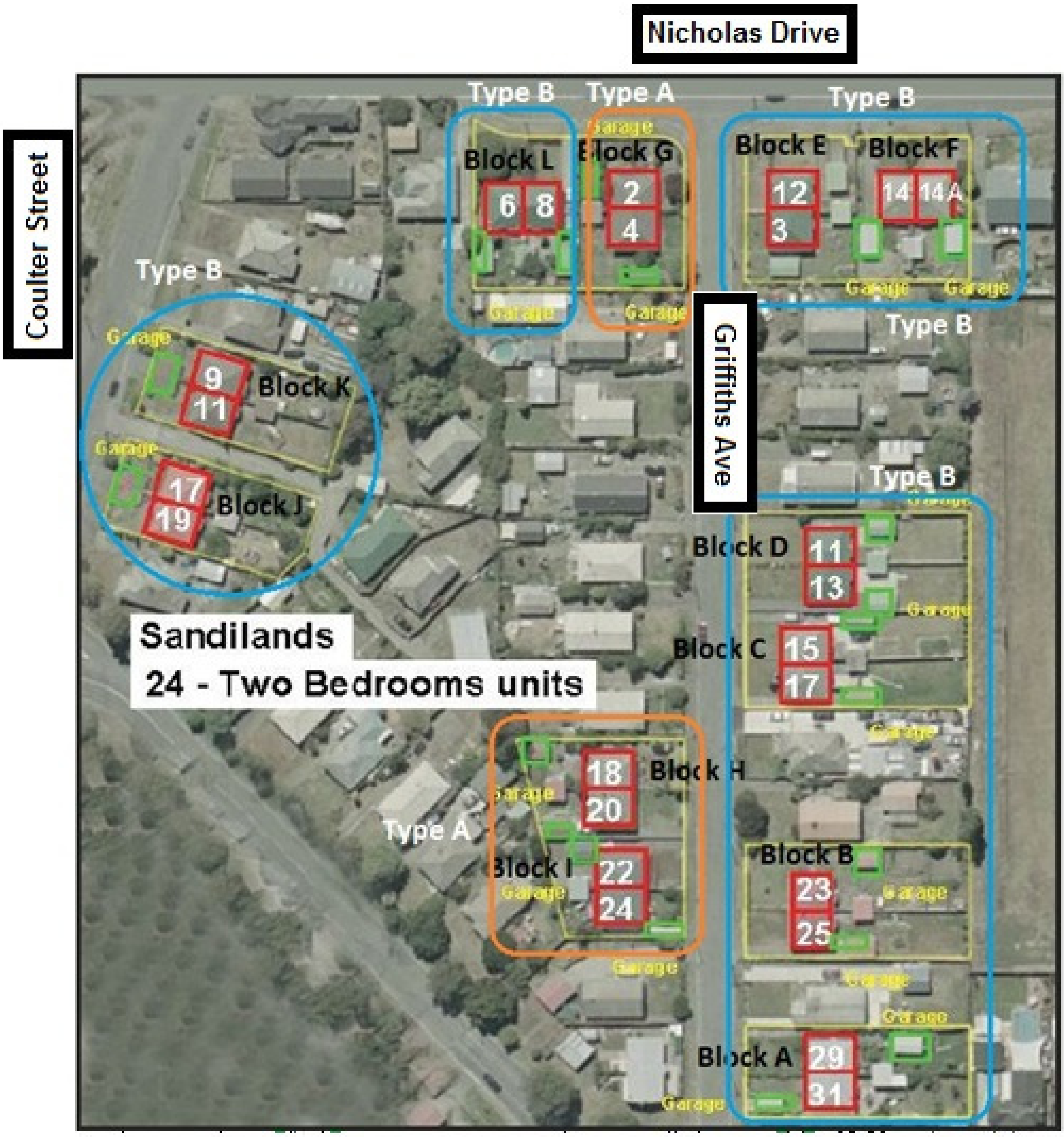


Figure 2: Site plan of Sandilands Housing Complex.

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

The residential units are timber-framed buildings with diagonal timber braces. The roof structure comprises of timber roof framing supporting lightweight metal profiled roofs. The walls and ceilings are lined with lathe and plaster. External walls are clad with either light timber weatherboards or plaster. Foundations consist of concrete perimeter walls with concrete piles. All units are separated by 230mm thick in situ concrete fire wall which is assumed to be reinforced to its perimeter, as typical of buildings of similar age and construction.

The exterior laundry buildings are timber-framed buildings with diagonal timber braces. The roof structure comprises of timber roof framing supporting light-weight metal roofs. External walls are clad with weatherboard and plaster veneers. Foundations are strip footings around the perimeter of a reinforced concrete slab.

The garages on Griffiths Ave, except 18, 24 and 31, and Nicholas Drive, except 12, are timber framed, metal, skyline garages.

The garage at 31 Griffiths Ave is a poured in situ concrete structure to the roof level. The walls of this garage are reinforced with 12mm bars (assumed) at 300mm centres. The roof is clad with lightweight metal roofs and timber rafters. The foundation is a concrete slab.

The double garages at 9, 11 and 17, 19 Coulter St are composite concrete and timber framed buildings with weatherboard veneers. The external walls are retaining walls to mid height (1.13m) of the back and side external walls with timber framing to roof height. These retaining walls are reinforced with bars horizontally at 150mm, 400mm and 800mm from the floor. The dividing wall is a concrete block wall. The roof structure consists of a timber truss supporting a light weight, flat metal roof. The foundations are concrete slabs.

The garages at 12 Nicholas Drive and 18 Griffiths Ave is timber framed clad with lightweight weatherboards. The roofs are timber framed supporting lightweight metal roof with timber sarking. The garage at 18 Griffiths Ave also has central support columns which are not fixed at the ground level, potentially installed by the owner.

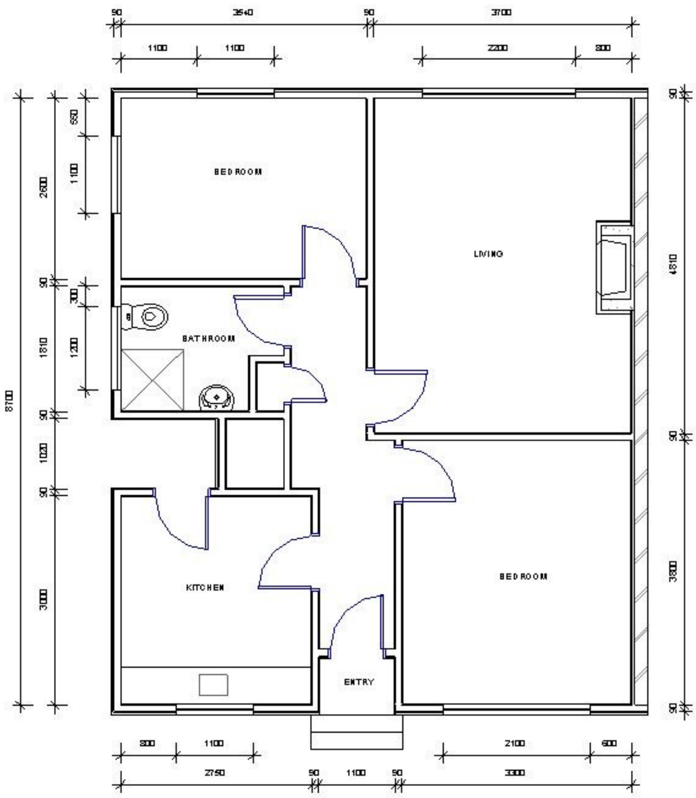
There is no garage at 24 Griffiths Ave.

A summary of the garages and their location is detailed below in Table 2.

Table 2: Summary of Garage Construction

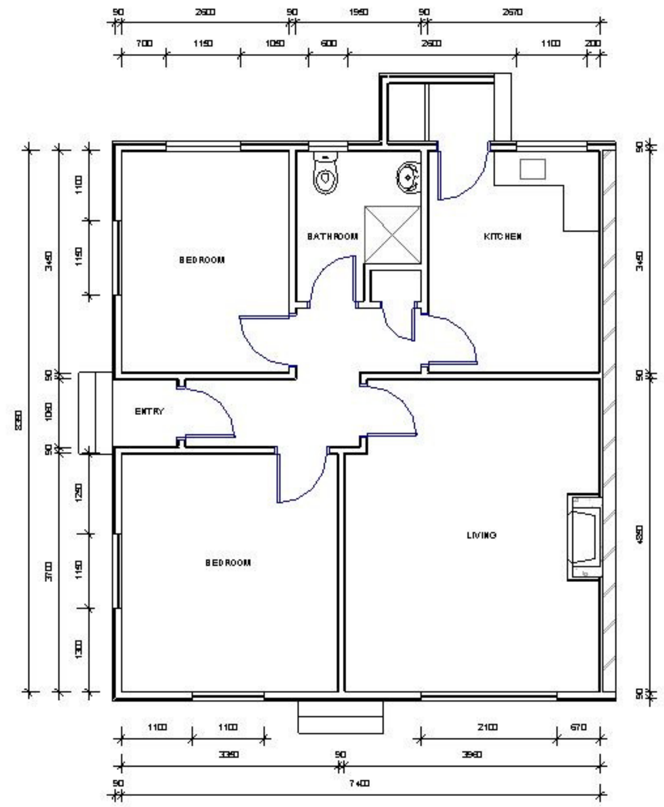
Block	Unit No.	Garage Construction
Griffiths Avenue		
A	29	Skyline
	31	Concrete
B	23	Skyline
	25	Skyline
C	15	Skyline
	17	Skyline
D	11	Skyline
	13	Skyline
E	3	Skyline
	12 (Nicholas Dr)	Timber
H	18	Timber
	20	Skyline
I	22	Skyline
	24	None
Coulter Street		
J	17	Concrete
	19	Concrete
K	9	Concrete
	11	Concrete
Nicholas Drive		
F	14	Skyline
	14a	Skyline
G	2	Skyline
	4	Skyline
L	6	Skyline
	8	Skyline

Figure 4 and Figure 5 show a typical floor plan of Type A and B (refer Figure 2) residential units produced from site measurements by Opus. Figure 6 shows a cross section used in calculations, from similar units in the original complex.



Type A Unit

Figure 4: Typical partial floor plan of residential unit block – Type A.



Type B Unit

Figure 5: Typical partial floor plan of residential unit block – Type B.

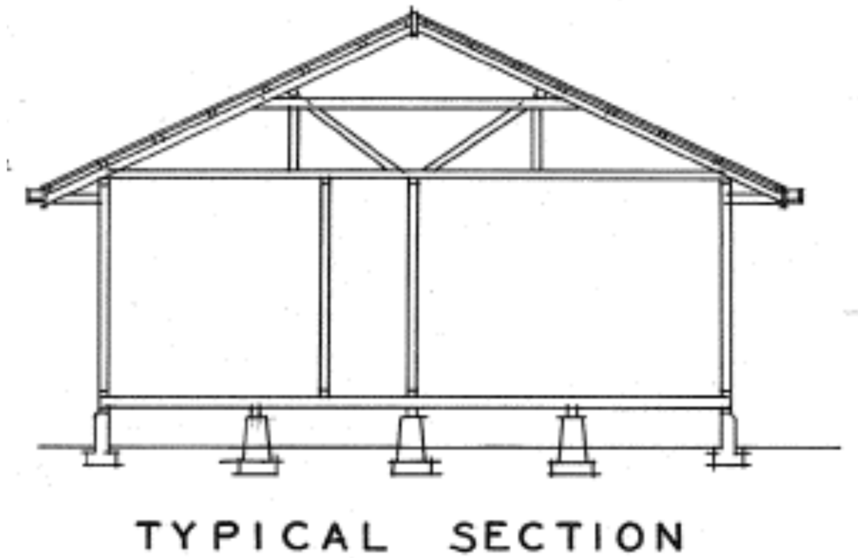


Figure 6: Cross section from similar buildings in the original complex.

4.2 Survey

4.2.1 Post 22 February 2011 Rapid Assessment

A structural (Level 2) assessment of the buildings/property was undertaken on 30 March 2011 by Opus International Consultants.

4.2.2 Level Survey

While a full level survey was not deemed to be necessary at Sandilands as it is located in a TC2 zone, it was discovered on site that some unit floor levels had considerable variation. As a result it was decided that some units should have a full survey completed, which was completed during the same visit. Properties in TC2 zones suffered minor to moderate damage due to liquefaction and/or settlement. Prior to a full level survey being undertaken, 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. An identical process was used for a full level survey with a gas level if deemed necessary after the initial inspection. For this site the maximum slope in a unit was 19mm/m, which exceeds the 5mm/m limitation imposed by MBIE guidelines.

Table 3: Summary of the Level Survey

Block	Unit No.	Comment	Maximum Fall*
Griffiths Avenue			
A	29	Pass	
	31	Pass	
B	23	Fail	15 mm/m
	25	Fail	16 mm/m
C	15	Fail	10 mm/m
	17	Fail	19 mm/m
D	11	Fail	14 mm/m
	13	Pass	
E	3	Pass	
	12	Pass	
H	18	Pass	
	20	Pass	
I	22	Pass	
	24	Pass	
Coulter Street			
J	17	Fail	14 mm/m
	19	Fail	11 mm/m
K	9	Pass	
	11	Pass	
Nicholas Drive			
F	14	Pass	
	14a	Pass	
G	2	Pass	
	4	Fail	13mm/m
L	6	Pass	
	8	Pass	

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

4.3 Original Documentation

The following plans were made available for this assessment and were used in calculations;

- C7/19F – Christchurch City Council – Houses for Christchurch City Council at Sandilands – p. 1-12/12 – Locality Plan; Type A; Type B; Type C; Type D; Type E; Type F; Type G; Construction Details; Unit Details; Laundry Shed Details.

Copies of design calculations were not available for the site assessment. A typical floor plan of the residential units has been produced by Opus from site measurements to help investigate potential critical structural weaknesses (CSWs) and identify details which required particular attention.

5 Damage

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

It is noticeable that some residential unit blocks, and individual units, have suffered more damage than others. Overall, 11, 15, 17, 23, 25 Griffiths Ave, 17 Coulter St and 4 Nicholas Drive appeared to have suffered the highest levels of damage.

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

5.1 Residual Displacements

The results of the level survey indicate the possibility of ground settlement due to the earthquakes. This is particularly evident in the units at 11, 15, 17, 23, 25 Griffiths Ave, 17, 19 Coulter St and 4 Nicholas Drive, where the floor slopes were measured to be beyond the 5mm/m limitation imposed by MBIE guidelines.

5.2 Foundations

Level results indicate that there is damage to the concrete pile foundations in the units at 11, 15, 17, 23, 25 Griffiths Ave, 17 Coulter St and 4 Nicholas Drive. Piles appear to have sunk or risen causing varying degrees of unevenness in the floor levels. Minimal cracking in the concrete perimeter footing was also observed on some of the blocks. Cracking of the concrete pad foundation was observed in the 17 Griffiths Ave garage.

5.3 Primary Gravity Structure

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

5.4 Primary Lateral-Resistance Structure

Cracking of ceiling diaphragms was observed in many of the units, typically at the joint between panels. Cracking of the lathe and plaster wall linings was observed in most units, typically around windows and above doorways. While this was consistent throughout all the units visited, this damage was more significant in the units at 11, 15, 17, 23, 25 Griffiths Ave, 17 Coulter St and 4 Nicholas Drive. This damage however is deemed minor and does not affect the lateral resistance structure.

5.5 Non Structural Elements

Splitting between internal wall linings and the firewall was observed in all units. Cracking of the weatherboard veneer was observed between the board joints. Cracking of the plaster veneers was also observed, typically above or below window frames. Cracking of the concrete entrance stairs was observed across the majority of units.

5.6 General Observations

A concrete header tank was observed in the roof space of all units.

The buildings appeared to have performed reasonably well, as would be expected for buildings of this type, during the earthquakes. While most have suffered minor damage, there have been some buildings which have suffered distributed amounts of moderate to severe damage.

6 Detailed Seismic Assessment

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

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

6.1 Critical Structural Weaknesses

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

No CSWs were identified in the buildings.

6.2 Quantitative Assessment Methodology

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

Hand calculations were performed to determine seismic forces from the current building codes. These forces were applied globally to the structure and the capacities of the walls were calculated and used to estimate the %NBS. The walls, highlighted in Figures 7 through 12, were used for bracing in their respective directions.

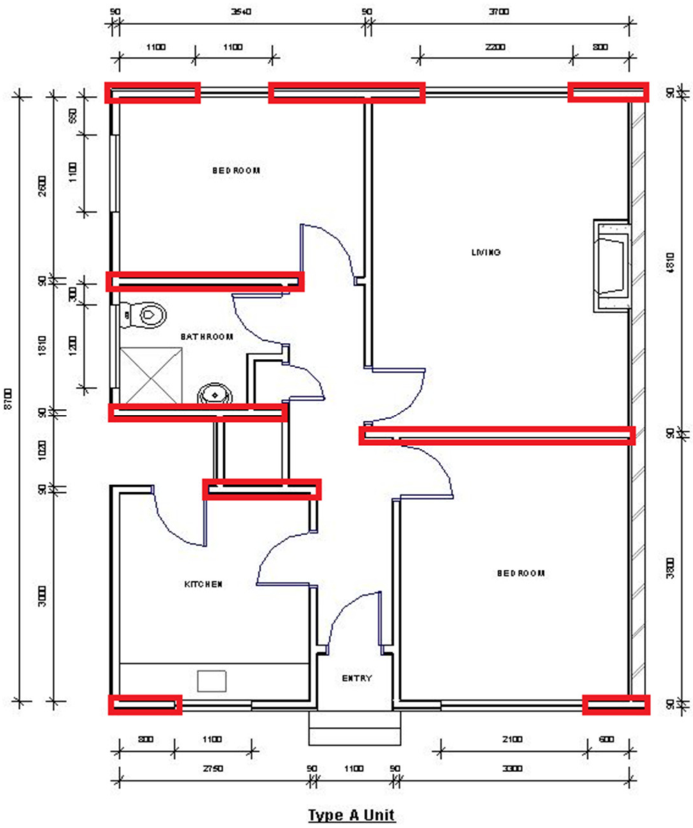


Figure 7: Walls used for bracing in the longitudinal direction Type A.

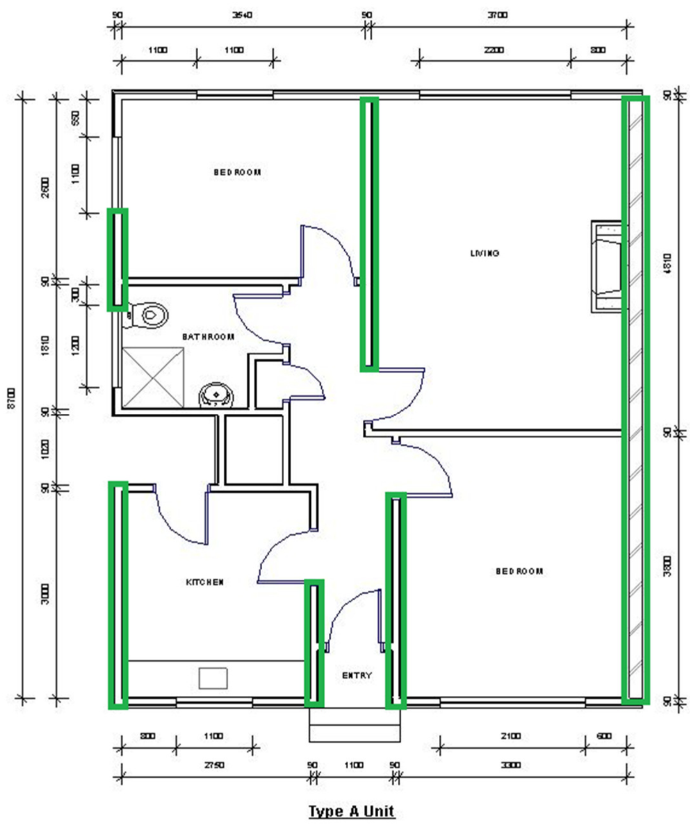


Figure 8: Walls used for bracing in the transverse direction Type A.

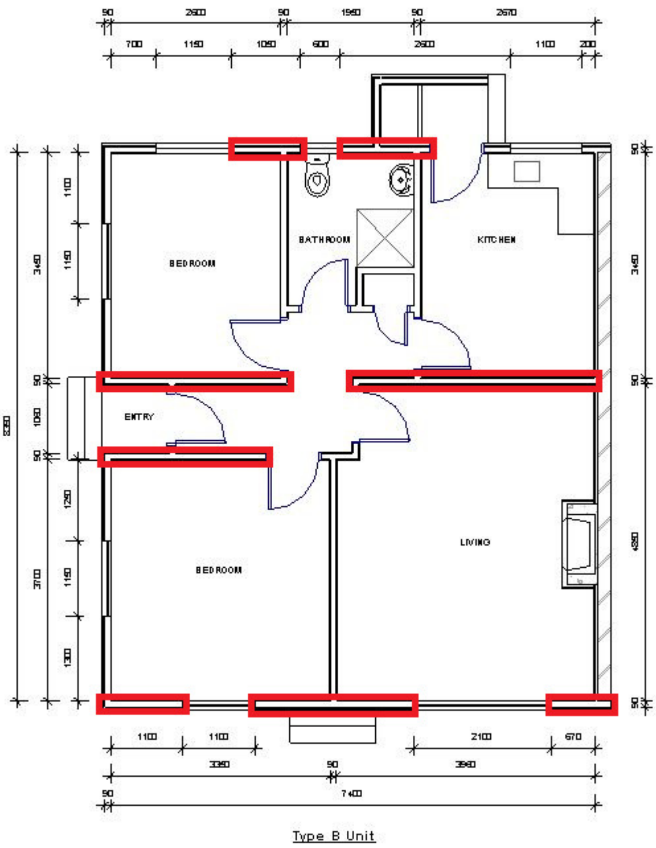


Figure 9: Walls used for bracing in the longitudinal direction Type B.

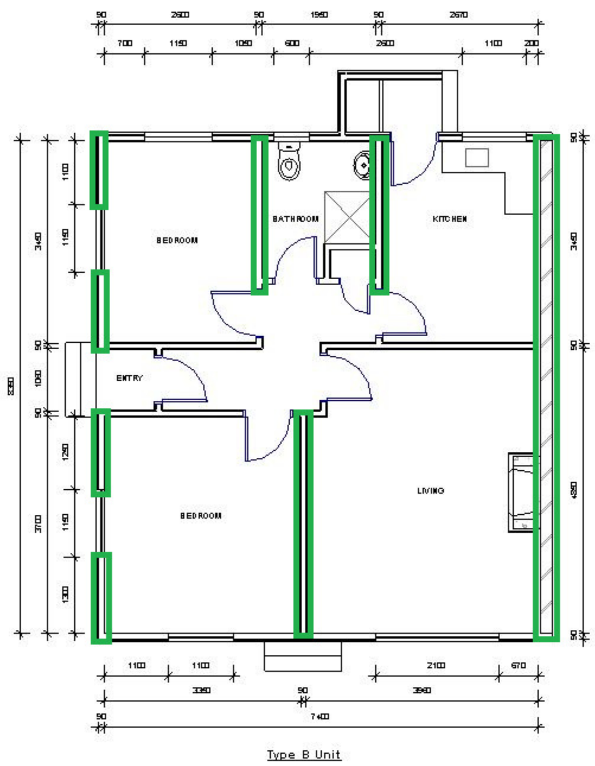


Figure 10: Walls used for bracing in the transverse direction Type B.

Figure 11: Walls used for bracing in the longitudinal direction laundry building.

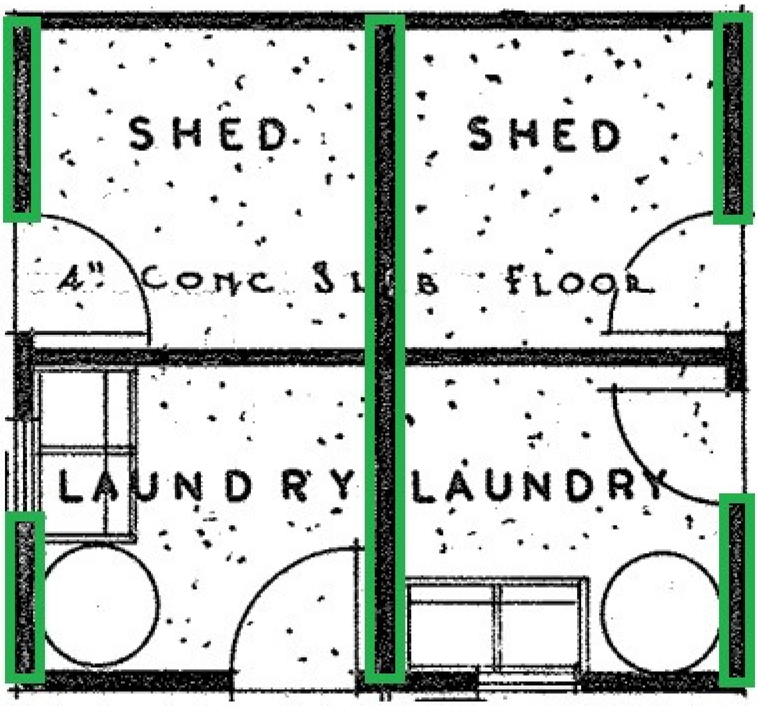


Figure 12: Walls used for bracing in the transverse direction laundry building.

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 4. 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 4: Summary of Seismic Performance

Building Description	Critical element	% NBS based on calculated capacity in longitudinal direction	% NBS based on calculated capacity in transverse direction.
Residential Units			
PRO 0755 B001 (29,31 Griffiths Avenue)	Bracing walls in plane	100%	100%
	Unreinforced concrete fire wall out of plane	84%	-
PRO 0755 B002 (23,25 Griffiths Avenue)	Bracing walls in plane	100%	100%
	Unreinforced concrete fire wall out of plane	84%	-

PRO 0755 B003 (15,17 Griffiths Avenue)	Bracing walls in plane	100%	100%
	Unreinforced concrete fire wall out of plane	84%	-
PRO 0755 B004 (11,13 Griffiths Avenue)	Bracing walls in plane	100%	100%
	Unreinforced concrete fire wall out of plane	84%	-
PRO 0755 B005 (3 Griffiths Avenue, 12 Nicholas Drive)	Bracing walls in plane	100%	100%
	Unreinforced concrete fire wall out of plane	84%	-
PRO 0755 B006 (14, 14a Nicholas Drive)	Bracing walls in plane	100%	100%
	Unreinforced concrete fire wall out of plane	84%	-
PRO 0755 B007 (2, 4 Nicholas Drive)	Bracing walls in plane	100%	100%
	Unreinforced concrete fire wall out of plane	84%	-
PRO 0755 B008 (18,20 Griffiths Avenue)	Bracing walls in plane	100%	100%
	Unreinforced concrete fire wall out of plane	84%	-
PRO 0755 B009 (22,24 Griffiths Avenue)	Bracing walls in plane	100%	100%
	Unreinforced concrete fire wall out of plane	84%	-
PRO 0755 B010 (17, 19 Coulter St)	Bracing walls in plane	100%	100%
	Unreinforced	84%	-

	concrete fire wall out of plane		
PRO 0755 B011 (9, 11 Coulter St)	Bracing walls in plane	100%	100%
	Unreinforced concrete fire wall out of plane	84%	-
PRO 0755 B012 (6, 8 Nicholas Drive)	Bracing walls in plane	100%	100%
	Unreinforced concrete fire wall out of plane	84%	-
Laundry Buildings			
PRO 0755 B001 (29,31 Griffiths Avenue)	Concrete walls in plane	95%	100%
PRO 0755 B002 (23,25 Griffiths Avenue)	Concrete walls in plane	95%	100%
PRO 0755 B003 (15,17 Griffiths Avenue)	Concrete walls in plane	95%	100%
PRO 0755 B004 (11,13 Griffiths Avenue)	Concrete walls in plane	95%	100%
PRO 0755 B005 (3 Griffiths Avenue, 12 Nicholas Drive)	Concrete walls in plane	95%	100%
PRO 0755 B006 (14, 14a Nicholas Drive)	Concrete walls in plane	95%	100%
PRO 0755 B007 (2, 4 Nicholas Drive)	Concrete walls in plane	95%	100%
PRO 0755 B008 (18,20 Griffiths Avenue)	Concrete walls in plane	95%	100%
PRO 0755 B009 (22,24 Griffiths Avenue)	Concrete walls in plane	95%	100%
PRO 0755 B010 (17, 19 Coulter St)	Concrete walls in plane	95%	100%
PRO 0755 B011 (9, 11 Coulter St)	Concrete walls in plane	95%	100%
PRO 0755 B012 (6, 8 Nicholas Drive)	Concrete walls in	95%	100%

	plane		
Garages			
PRO 0755 B001 a (29 Griffiths Avenue)	Timber framed walls in plane	100%	100%
PRO 0755 B001 b (31 Griffiths Avenue)	Reinforced concrete walls out of plane	90%	90%
PRO 0755 B002 a (23 Griffiths Avenue)	Timber framed walls in plane	100%	100%
PRO 0755 B002 b (25 Griffiths Avenue)	Timber framed walls in plane	100%	100%
PRO 0755 B003 a (15 Griffiths Avenue)	Timber framed walls in plane	100%	100%
PRO 0755 B003 b (17 Griffiths Avenue)	Timber framed walls in plane	100%	100%
PRO 0755 B004 a (11 Griffiths Avenue)	Timber framed walls in plane	100%	100%
PRO 0755 B004 b (13 Griffiths Avenue)	Timber framed walls in plane	100%	100%
PRO 0755 B005 a (3 Griffiths Avenue)	Timber framed walls in plane	100%	100%
PRO 0755 B005 b (12 Nicholas Drive)	Timber framed walls in plane	>33%*	>33%*
PRO 0755 B006 a (14 Nicholas Drive)	Timber framed walls in plane	100%	100%
PRO 0755 B006 b (14a Nicholas Drive)	Timber framed walls in plane	100%	100%
PRO 0755 B007 a (2 Nicholas Drive)	Timber framed walls in plane	100%	100%
PRO 0755 B007 b (4 Nicholas Drive)	Timber framed walls in plane	100%	100%
PRO 0755 B008 a (18 Griffiths Avenue)	Timber framed walls in plane	>33%*	>33%*
PRO 0755 B008 b (20 Griffiths Avenue)	Timber framed walls in plane	100%	100%
PRO 0755 B009 a (22 Griffiths Avenue)	Timber framed walls in plane	100%	100%
PRO 0755 B010 a (17,19 Coulter St)	Timber walls in plane	100%	100%
	Concrete block wall out of plane	65%	-
PRO 0755 B011 a (9,11 Coulter St)	Timber walls in plane	100%	100%
	Concrete block wall out of plane	65%	-

PRO 0755 B012 a (6 Nicholas Drive)	Timber framed walls in plane	100%	100%
PRO 0755 B012 b (8 Nicholas Drive)	Timber framed walls in plane	100%	100%

*Gravity load path inadequate due to apex connection of rafters, permanent strengthening recommended.

7 Geotechnical Summary

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

Sandilands Housing Complex is a registered contaminated land site.

Figure 13: CERA Technical Categories map (loc. starred).

A desktop study for Sandilands Housing Complex was conducted by GHD in 2013 [7]. 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 have capacities of 84% NBS, as limited by the out of plane capacity of the unreinforced concrete fire walls. 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).
- The laundry buildings have capacities of 95% NBS, as limited by the in-plane capacity of the concrete walls. 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).
- The garages at 12 Nicholas Drive and 18 Griffiths Avenue have capacities of more than 33%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). These garages have inadequate connection of rafters at the apex affecting capacity to resist gravity loading.
- The garage at 31 Griffiths Avenue has a capacity of 90% NBS, as limited by the out-of-plane capacity of the concrete walls. It is 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).
- The garages at 17-19 Coulter Street and 9-11 Coulter Street have capacities of 65%NBS, as limited by the out of plane capacity of the unreinforced concrete block wall. 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).
- All other garages on site have a capacity of 100%NBS and are deemed to be a 'low risk' in a design seismic event according to NZSEE guidelines

9 Recommendations

It is recommended that;

- The timber garages at 12 Nicholas Drive and 18 Griffiths Avenue be strengthened to support gravity loads and to at least 67%NBS.
- Strengthening schemes be developed to bring the capacities of the garages at 9-11 and 17-19 Coulter Ave to at least 67%NBS.
- Concrete header tanks be removed.
- Cosmetic repairs be undertaken as required.

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 Sandilands 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.

[7] GHD (2013), Sandilands Geotechnical Desk study, GHD, October 2013.

Appendix A - Photographs

Sandilands Housing Complex		
No.	Item description	Photo
Residential Units Layout		
1.	Type A - Typical exterior elevation (front)	
2.	Type B - Typical exterior elevation (front)	

3.	Type B - Typical exterior elevation (rear)	
4.	Typical ceiling void	
5.	Typical floor void	

6.	Typical lounge view	
7.	Typical bedroom view	

8.	Typical kitchen view	
9.	Typical bathroom view	

10.	Concrete header tank in roof space	
11.	Typical cracking of the roof diaphragm	
12.	Typical cracking around windows	

13.	Typical cracking above doorways	
14.	Splitting between interior walls and the firewall	
15.	Typical laundry building	

16.	Typical cracking in concrete perimeter foundation footing	
17.	Typical cracking in concrete perimeter foundation footing	

18.	22 Griffiths Ave – Cracking to exterior plaster cladding	
19.	Cracking to exterior plaster cladding	

20.	Concrete gully trap surround separated from building	
Garages		
21.	Typical Skyline garage, exterior elevation (front)	

22.	Typical Skyline garage, exterior elevation (side)	
23.	Typical Skyline garage	
24.	Garage at 31 Griffiths Ave	

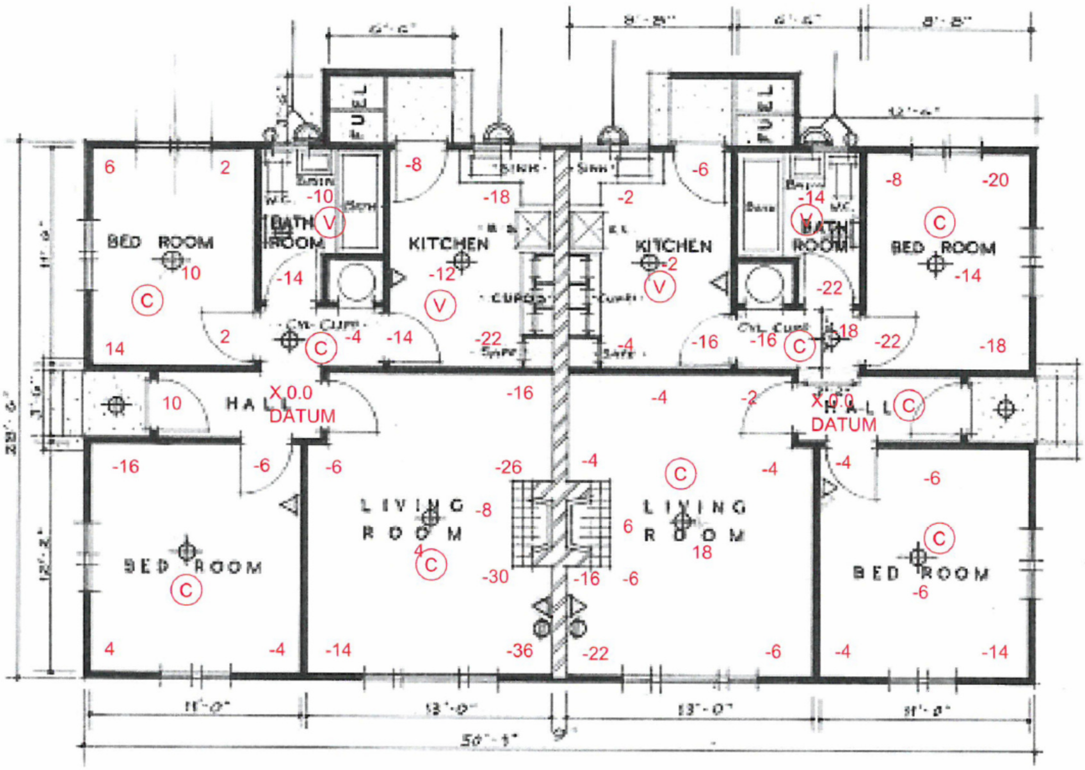
25.	Garage at 31 Griffiths Ave (internal)	
26.	Garage at 17 and 19 Coulter St (front exterior elevation)	
27.	Garage at 17 and 19 Coulter St (internal)	

28.	Garage at 17 and 19 Coulter St (rear exterior elevation)	
29.	Garage at 18 Griffiths Ave	

30.	Propped central beam in garage at 18 Griffiths Ave	

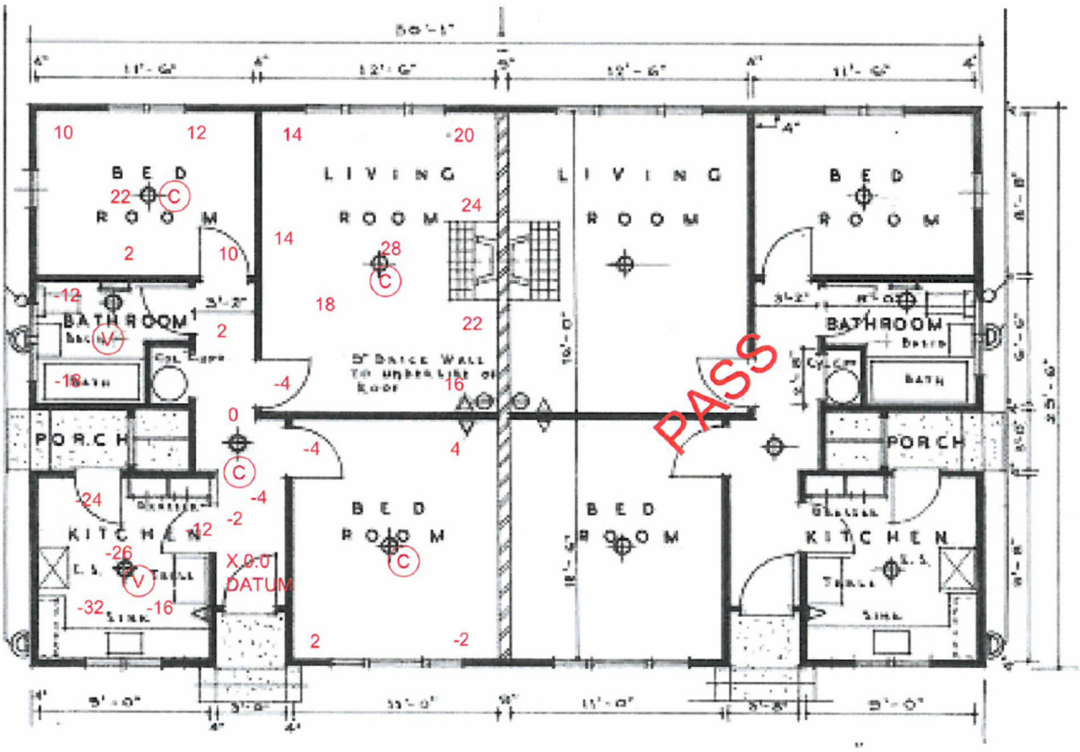
Appendix B – Level Survey

17-19 Coulter Street



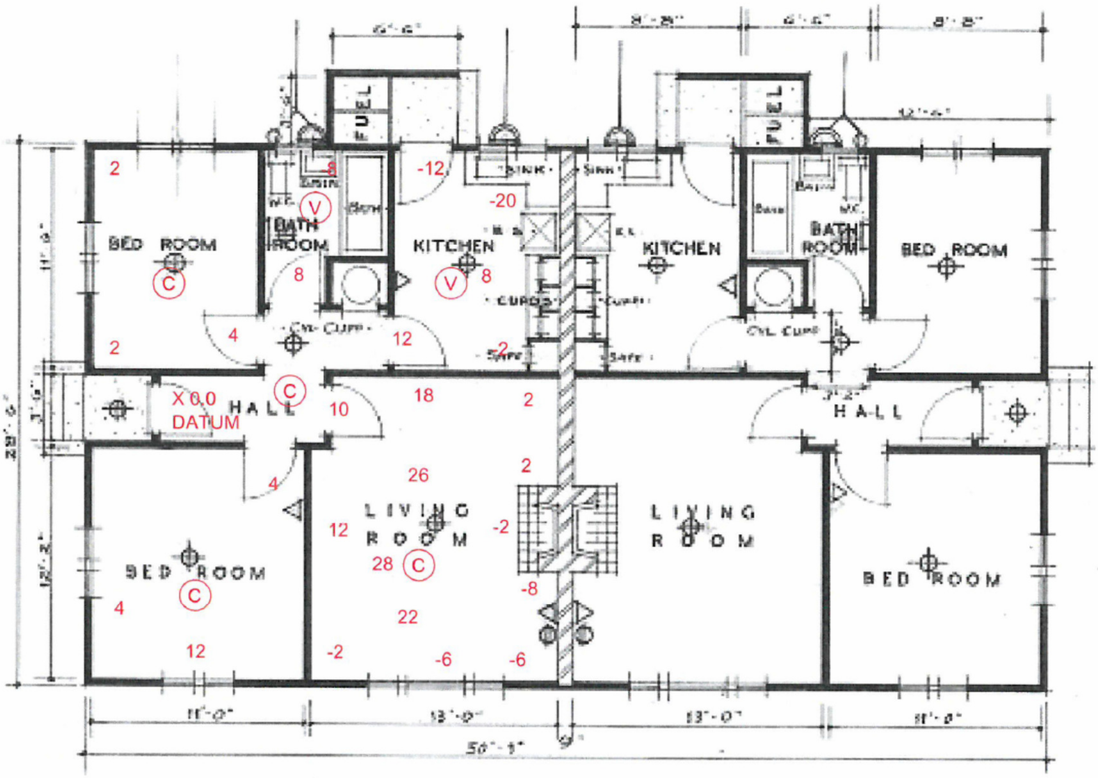
17 19

2-4 Nicholas Drive



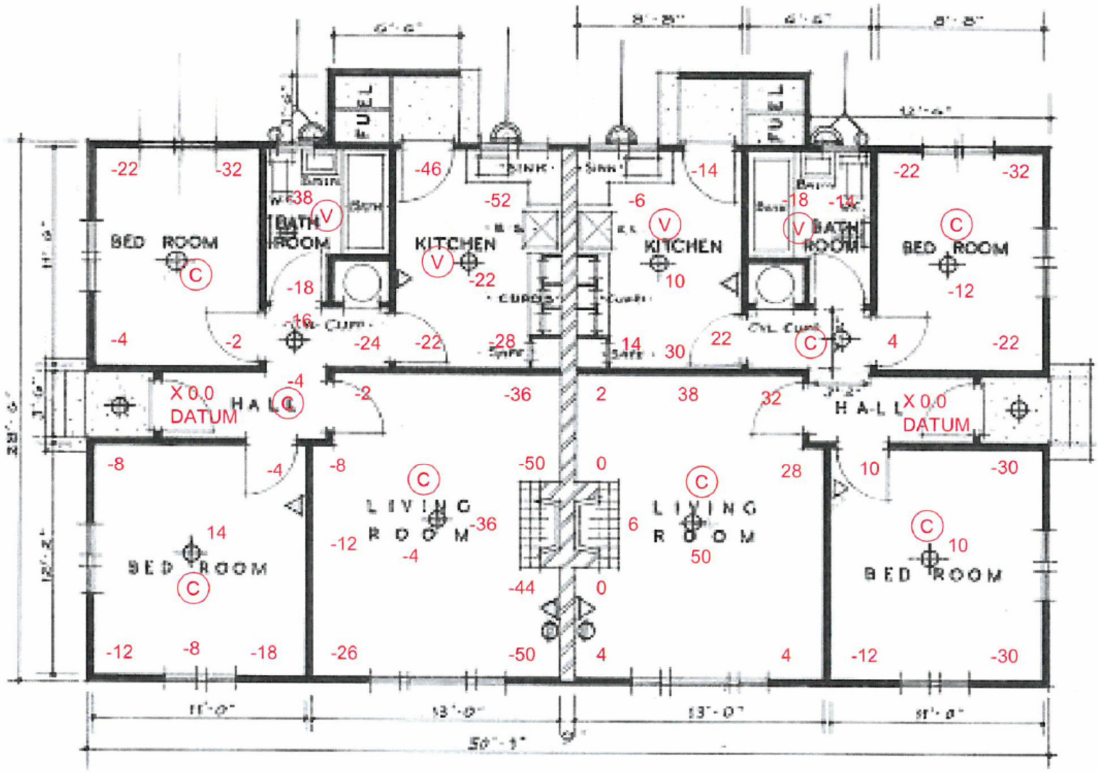
4 2

11 Griffiths Avenue

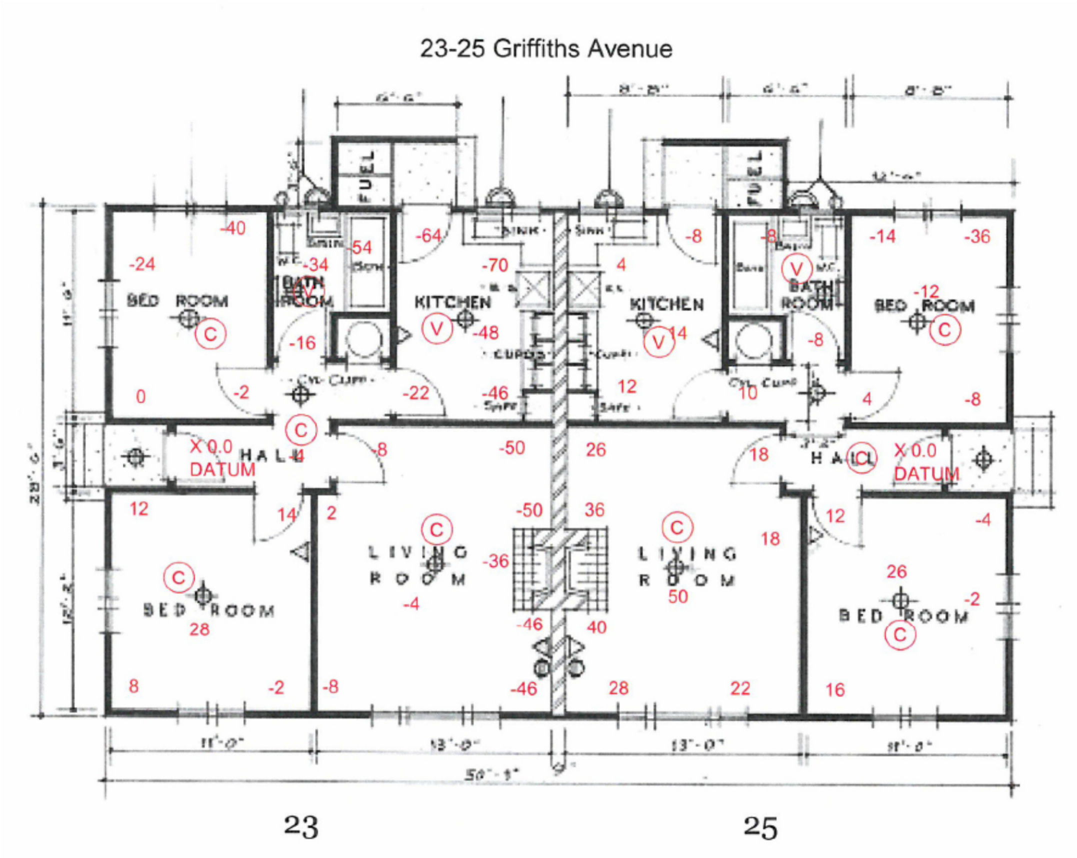


11 13

15-17 Griffiths Avenue



15 17


23-25 Griffiths Avenue
FUEL
FUEL
BED ROOM
BATH ROOM
KITCHEN
KITCHEN
BATH ROOM
BED ROOM
HALL
HALL
X 0.0
DATUM
X 0.0
DATUM
LIVING ROOM
LIVING ROOM
BED ROOM
BED ROOM
23
25

Appendix C - 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 D – CERA DEE Spreadsheet

Detailed Engineering Evaluation Summary Data V1.14

Location

Building Name:	Sandilands Complex (1 garage concrete)	Reviewer:	Mary Ann Halliday
	Unit No: Street	CPEng No:	67073
Building Address:	Griffiths, Coulter, Nicholas	Company:	Opus International Consulatants
Legal Description:		Company project number:	6-QC400.00
		Company phone number:	
	Degrees / Min / Sec		
GPS south:	43 / 31 / 34.09	Date of submission:	28-Feb-14
GPS east:	172 / 41 / 10.44	Inspection Date:	23/09/2013
		Revision:	1
Building Unique Identifier (CCC):	PRO0755	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):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	

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:	mat slab	if Foundation type is other, describe:	
Building height (m):	3.00	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):			
Age of Building (years):		Date of design:	
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	parking	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):			
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	
Floors:	concrete flat slab	slab thickness (mm)	
Beams:	none	overall depth x width (mm x mm)	
Columns:	timber	typical dimensions (mm x mm)	
Walls:	load bearing concrete	#N/A	

Lateral load resisting structure

Lateral system along:	partially filled CMU	**Note: Define along and across in detailed report!**	note total length of wall at ground (m):	
Ductility assumed, μ:	1.00			
Period along:	0.10	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	partially filled CMU		note total length of wall at ground (m):	
Ductility assumed, μ:	1.00			
Period across:	0.10	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	Weatherboard
Roof Cladding:	Metal	describe	
Glazing:	timber frames		
Ceilings:	none		
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	0-2 m³/100m²	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	slight	notes (if applicable):	

Building:

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

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

Recommendations

	Level of repair/strengthening required:	minor non-structural		Describe:	
	Building Consent required:	no		Describe:	
	Interim occupancy recommendations:	full occupancy		Describe:	
Along	Assessed %NBS before e'quakes:	90%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Equivalent Static
	Assessed %NBS after e'quakes:	90%			
Across	Assessed %NBS before e'quakes:	90%	##### %NBS from IEP below		
	Assessed %NBS after e'quakes:	90%			

Detailed Engineering Evaluation Summary Data V1.14

Location

Building Name:	Sandilands Complex (2 garage concrete)		Reviewer:	Mary Ann Halliday
	Unit / No: / Street		CPEng No:	67073
Building Address:		Griffiths, Coulter, Nicholas	Company:	Opus International Consulatants
Legal Description:			Company project number:	6-QC400.00
			Company phone number:	
	Degrees / Min / Sec			
GPS south:	43 / 31 / 34.09		Date of submission:	28-Feb-14
GPS east:	172 / 41 / 10.44		Inspection Date:	23/09/2013
			Revision:	1
Building Unique Identifier (CCC):	PRO0755		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):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	

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:	mat slab		if Foundation type is other, describe:	
Building height (m):	3.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):				
Age of Building (years):			Date of design:	
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	parking		Brief strengthening description:	
Use (upper floors):				
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	concrete	slab thickness (mm)	
Floors:	concrete flat slab	slab thickness (mm)	
Beams:	none	overall depth x width (mm x mm)	
Columns:	timber	typical dimensions (mm x mm)	
Walls:	partially filled concrete masonry	thickness (mm)	

Lateral load resisting structure

Lateral system along:	partially filled CMU	**Note: Define along and across in detailed report!**	note total length of wall at ground (m):	
Ductility assumed, μ:	1.00			
Period along:	0.10	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	
Ductility assumed, μ:	1.00			
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	Weatherboard
Roof Cladding:	Metal	describe	
Glazing:	timber frames		
Ceilings:	none		
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	0-2 m³/100m²	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	slight	notes (if applicable):	

Building:

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

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

Recommendations

	Level of repair/strengthening required:	minor non-structural		Describe:	
	Building Consent required:	no		Describe:	
	Interim occupancy recommendations:	full occupancy		Describe:	
Along	Assessed %NBS before e'quakes:	65%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Equivalent Static
	Assessed %NBS after e'quakes:	65%			
Across	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below		
	Assessed %NBS after e'quakes:	100%			

Detailed Engineering Evaluation Summary Data V1.14

Location

Building Name:	Sandilands Complex (residential units, type A)	Reviewer:	Mary Ann Halliday
	Unit / No: / Street	CPEng No:	67073
Building Address:	Griffiths, Coulter, Nicholas	Company:	Opus International Consulatants
Legal Description:		Company project number:	6-QC400.00
		Company phone number:	
	Degrees / Min / Sec		
GPS south:	43 / 31 / 34.09	Date of submission:	28-Feb-14
GPS east:	172 / 41 / 10.44	Inspection Date:	23/09/2013
		Revision:	1
Building Unique Identifier (CCC):	PRO0755	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):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	

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):	3.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	130			
Age of Building (years):	66		Date of design:	1935-1965
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):				
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	Metal Cladding
Floors:	timber	joist depth and spacing (mm)	
Beams:	none	overall depth x width (mm x mm)	
Columns:	timber	typical dimensions (mm x mm)	
Walls:	non-load bearing	0	

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**	note typical wall length (m)	
Ductility assumed, μ:	1.00			
Period along:	0.10	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	
Ductility assumed, μ:	1.00			
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	Plaster
Roof Cladding:	Metal	describe	
Glazing:	timber frames		
Ceilings:	strapped or direct fixed		
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	0-2 m³/100m²	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	slight	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?:	yes	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	

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

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before e'quakes:	84% ##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Equivalent Static
	Assessed %NBS after e'quakes:	84%		
Across	Assessed %NBS before e'quakes:	100% ##### %NBS from IEP below		
	Assessed %NBS after e'quakes:	100%		

Detailed Engineering Evaluation Summary Data V1.14

Location

Building Name:	Sandilands Complex (residential units, Type B)	Reviewer:	Mary Ann Halliday
	Unit / No: / Street	CPEng No:	67073
Building Address:	Griffiths, Coulter, Nicholas	Company:	Opus International Consulatants
Legal Description:		Company project number:	6-QC400.00
		Company phone number:	
	Degrees / Min / Sec		
GPS south:	43 / 31 / 34.09	Date of submission:	28-Feb-14
GPS east:	172 / 41 / 10.44	Inspection Date:	23/09/2013
		Revision:	1
Building Unique Identifier (CCC):	PRO0755	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):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	

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):	3.00		height from ground to level of uppermost seismic mass (for IEP only) (m):
Floor footprint area (approx):	123		
Age of Building (years):	66		Date of design: 1935-1965
Strengthening present?	no		If so, when (year)?
			And what load level (%g)?
Use (ground floor):	multi-unit residential		Brief strengthening description:
Use (upper floors):			
Use notes (if required):			
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	Metal Cladding
Floors:	timber	joist depth and spacing (mm)	
Beams:	none	overall depth x width (mm x mm)	
Columns:	timber	typical dimensions (mm x mm)	
Walls:	non-load bearing		0

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	Note: Define along and across in detailed report!	note typical wall length (m)	
Ductility assumed, μ:	2.00			
Period along:	0.10	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	
Ductility assumed, μ:	2.00			
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	Weatherboard or Heavy Plaster
Roof Cladding:	Metal	describe	
Glazing:	timber frames		
Ceilings:	strapped or direct fixed		
Services(list):			

Available documentation

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

Damage

Site:
(refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	0-2 m³/100m²	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	slight	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?:	yes	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	

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

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before e'quakes:	84%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Equivalent Static
	Assessed %NBS after e'quakes:	84%		
Across	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	
	Assessed %NBS after e'quakes:	100%		

Detailed Engineering Evaluation Summary Data V1.14

Location

Building Name:	Sandilands Complex (laundry Sheds)	Reviewer:	Mary Ann Halliday
	Unit No: Street	CPEng No:	67073
Building Address:	Griffiths, Coulter, Nicholas	Company:	Opus International Consulatants
Legal Description:		Company project number:	6-QC400.00
		Company phone number:	
	Degrees / Min / Sec		
GPS south:	43 / 31 / 34.09	Date of submission:	28-Feb-14
GPS east:	172 / 41 / 10.44	Inspection Date:	23/09/2013
		Revision:	1
Building Unique Identifier (CCC):	PRO0755	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):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	

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:	mat slab		if Foundation type is other, describe:	
Building height (m):	2.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	20			
Age of Building (years):	66		Date of design:	1935-1965
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):				
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	
Floors:	concrete flat slab	slab thickness (mm)	
Beams:	none	overall depth x width (mm x mm)	
Columns:	timber	typical dimensions (mm x mm)	
Walls:	load bearing concrete	#N/A	

Lateral load resisting structure

Lateral system along:	concrete shear wall	**Note: Define along and across in**	enter wall data in "IEP period calcs"	
Ductility assumed, μ:	1.00	**detailed report!**	worksheet for period calculation	
Period along:	0.10	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	concrete shear wall		enter wall data in "IEP period calcs"	
Ductility assumed, μ:	1.00		worksheet for period calculation	
Period across:	0.10	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	Weatherboard or Heavy Plaster
Roof Cladding:	Metal	describe	
Glazing:	timber frames		
Ceilings:	none		
Services(list):			

Available documentation

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

Damage

Site:
(refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	0-2 m³/100m²	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	slight	notes (if applicable):	

Building:

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

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

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before e'quakes:	95% ##### %NBS from IEP below	If IEP not used, please detail	Equivalent Static
	Assessed %NBS after e'quakes:	95%	assessment methodology:	
Across	Assessed %NBS before e'quakes:	100% ##### %NBS from IEP below		
	Assessed %NBS after e'quakes:	100%		

Detailed Engineering Evaluation Summary Data V1.14

Location

Building Name:	Sandilands Complex (skyline Garages)	Reviewer:	Mary Ann Halliday
	Unit / No: / Street	CPEng No:	67073
Building Address:	Griffiths, Coulter, Nicholas	Company:	Opus International Consulatants
Legal Description:		Company project number:	6-QC400.00
		Company phone number:	
	Degrees / Min / Sec		
GPS south:	43 / 31 / 34.09	Date of submission:	28-Feb-14
GPS east:	172 / 41 / 10.44	Inspection Date:	23/09/2013
		Revision:	1
Building Unique Identifier (CCC):	PRO0755	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):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	

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:	mat slab		if Foundation type is other, describe:	
Building height (m):	3.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):				
Age of Building (years):			Date of design:	
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	parking		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:	concrete flat slab	slab thickness (mm)	
Beams:	none	overall depth x width (mm x mm)	
Columns:	timber	typical dimensions (mm x mm)	
Walls:	non-load bearing	0	

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**	note typical wall length (m)	
Ductility assumed, μ:	1.00			
Period along:	0.10	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	
Ductility assumed, μ:	1.00			
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	Weatherboard
Roof Cladding:	Metal	describe	
Glazing:	timber frames		
Ceilings:	none		
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	0-2 $m^3/100m^2$	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	slight	notes (if applicable):	

Building:

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

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

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before e'quakes:	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 V1.14

Location

Building Name: Sandilands Complex (Timber Garages)
Unit / No: / Street
Building Address: Griffiths, Coulter, Nicholas
Legal Description:

	Degrees	Min	Sec
GPS south:	43	31	34.09
GPS east:	172	41	10.44

Building Unique Identifier (CCC): PRO0755

Reviewer: Mary Ann Halliday
CPEng No: 67073
Company: Opus International Consulatants
Company project number: 6-QC400.00
Company phone number:

Date of submission: 28-Feb-14
Inspection Date: 23/09/2013
Revision: 1
Is there a full report with this summary? yes

Site

Site slope: flat
Soil type:
Site Class (to NZS1170.5): D
Proximity to waterway (m, if <100m):
Proximity to clifftop (m, if < 100m):
Proximity to cliff base (m,if <100m):

Max retaining height (m):
Soil Profile (if available):
If Ground improvement on site, describe:
Approx site elevation (m):

Building

No. of storeys above ground: 1 — single storey = 1
Ground floor split? no
Storeys below ground 0
Foundation type: mat slab
Building height (m): 3.00
Floor footprint area (approx):
Age of Building (years):

Ground floor elevation (Absolute) (m):
Ground floor elevation above ground (m):
if Foundation type is other, describe:
height from ground to level of uppermost seismic mass (for IEP only) (m):
Date of design:

Strengthening present? no
If so, when (year)?
And what load level (%g)?
Brief strengthening description:

Use (ground floor): parking
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: concrete flat slab — slab thickness (mm):
Beams: none — overall depth x width (mm x mm):
Columns: timber — typical dimensions (mm x mm):
Walls: non-load bearing — 0

Lateral load resisting structure

Lateral system along: lightweight timber framed walls — note typical wall length (m):
Ductility assumed, μ: 1.00
Period along: 0.10 0.00 — estimate or calculation? estimated
Total deflection (ULS) (mm): — estimate or calculation?
maximum interstorey deflection (ULS) (mm): — estimate or calculation?

Note: Define along and across in detailed report!

Lateral system across: lightweight timber framed walls — note typical wall length (m):
Ductility assumed, μ: 1.00
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 Weatherboard
Roof Cladding: Metal — describe
Glazing: timber frames
Ceilings: none
Services(list):

Available documentation

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

Damage

Site: (refer DEE Table 4-2)
Site performance: Good — Describe damage:

Settlement: none observed — notes (if applicable):
Differential settlement: none observed — notes (if applicable):
Liquefaction: 0-2 m³/100m² — notes (if applicable):
Lateral Spread: none apparent — notes (if applicable):
Differential lateral spread: none apparent — notes (if applicable):
Ground cracks: none apparent — notes (if applicable):
Damage to area: slight — 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):

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

Diaphragms — Damage?: no — Describe:
CSWs: — Damage?: no — Describe:
Pounding: — Damage?: no — Describe:
Non-structural: — Damage?: yes — Describe:

Recommendations

Level of repair/strengthening required: minor non-structural — Describe:
Building Consent required: no — Describe:
Interim occupancy recommendations: full occupancy — Describe:

Along — Assessed %NBS before e'quakes: 34% ##### %NBS from IEP below
Assessed %NBS after e'quakes: 34%

If IEP not used, please detail assessment methodology: Equivalent Static

Across — Assessed %NBS before e'quakes: 34% ##### %NBS from IEP below
Assessed %NBS after e'quakes: 34%

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