CLIENTS | PEOPLE | PERFORMANCE

Dwelling
PRO 3525 001
Detailed Engineering Evaluation
Qualitative Report
Version Final

42 Exeter Street

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

Dwelling
PRO 3525 001

Detailed Engineering Evaluation
Qualitative Report
Version Final

42 Exeter St

Christchurch City Council

Prepared By
Simon Barker

Reviewed By
Stephen Lee

Date
17th May 2013

Contents

Table Index

Figure Index

Appendices

Qualitative Report Summary

Dwelling

PRO 3525 001

Detailed Engineering Evaluation

Qualitative Report - SUMMARY

Version Final

42 Exeter Street

Background

This is a summary of the Qualitative report for the building structure, and is based in part on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and visual inspections on 28th of July 2012.

Building Description

The dwelling on 42 Exeter Street is a timber frame construction and is assumed to be built just prior to 1965.

The timber roof structure is supported by the load bearing timber framed walls. These walls are assumed to be supported by floors constructed of timber joists and timber bearers. The foundations are assumed to be constructed with timber piles and concrete perimeter strips which are typical of structures built around this date.

The dwelling is located on a hill in a small suburban area with the closest home being approximately 3m to the east. The site slopes at approximately 1:10.

Key Damage Observed

Key damage observed includes:-

- Cracking to perimeter strip footing
- Damage to chimneys (now removed)

Critical Structural Weaknesses

No critical structural weaknesses have been identified in the structure.

Indicative Building Strength (from IEP and CSW assessment)

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the capacity of the building before including earthquake damage has been assessed to be in the order of 43% NBS.

To incorporate the damage observed in our visual inspection the NBS has been reduced to 37%.

The building has therefore been assessed to have a seismic capacity in the order of 37% NBS and is therefore potentially Earthquake Risk, but is not Earthquake Prone.

Recommendations

As the building has achieved less than 67% NBS following a qualitative Detailed Engineering Evaluation of the building, further assessment is required. It is recommended that a quantitative assessment be carried out and if necessary strengthening options explored.

As the building has achieved greater than 34% NBS, occupation of the building is permitted.

1. Background

GHD has been engaged by the Christchurch City Council (CCC) to undertake a detailed engineering evaluation of the dwelling at 42 Exeter St.

This report is a Qualitative Assessment of the building structure, and is based in part on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011.

A qualitative assessment involves inspections of the building and a desktop review of existing structural and geotechnical information, including existing drawings and calculations, if available.

The purpose of the assessment is to determine the likely building performance and damage patterns, to identify any potential critical structural weaknesses or collapse hazards, and to make an initial assessment of the likely building strength in terms of percentage of new building standard (%NBS).

At the time of this report, no intrusive site investigation, detailed analysis, or modelling of the building structure had been carried out. Construction drawings were made available, and these have been considered in our evaluation of the building. The building description below is based on a review of the drawings and our visual inspections.

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 carry out a full structural survey before the building is re-occupied.

We understand that CERA will 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). It is anticipated that CERA will adopt the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This document sets out a methodology for both qualitative and quantitative assessments.

The qualitative assessment is a desk-top and site inspection assessment. It is based on a thorough visual inspection of the building coupled with a review of available documentation such as drawings and specifications. The quantitative assessment involves analytical calculation of the buildings strength and may require non-destructive or destructive material testing, geotechnical testing and intrusive investigation.

It is anticipated that factors determining the extent of evaluation and strengthening level required will include:

- The importance level and occupancy of the building
- The placard status and amount of damage
- The age and structural type of the building
- Consideration of any critical structural weaknesses
- The extent of any earthquake damage

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 any alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) be satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'. Regarding seismic capacity 'as near as reasonably practicable' has previously been interpreted by CCC as achieving a minimum of 67% NBS however where practical achieving 100% NBS is desirable. The New Zealand Society for Earthquake Engineering (NZSEE) recommend a minimum of 67% NBS.

2.2.1 Section 121 – Dangerous Buildings

The definition of dangerous building in the Act was extended by the Canterbury Earthquake (Building Act) Order 2010, and it now defines a building as dangerous if:

- 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
- 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
- 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
- There is a risk that that other property could collapse or otherwise cause injury or death; or
- 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 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 ground shaking 33% of the shaking 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 2006. This policy was amended immediately following the Darfield Earthquake of the 4th September 2010.

The 2010 amendment includes the following:

- A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
- A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
- A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
- 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.

We anticipate that any building with a capacity of less than 33% NBS (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67% NBS of new building standard as recommended by the Policy.

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.

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.

After the February Earthquake, on 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

- Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)
- Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

The increase in the above factors has resulted in a reduction in the level of compliance of an existing building relative to a new building despite the capacity of the existing building not changing.

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 new building standard load requirements have been determined in accordance with the current earthquake loading standard (NZS 1170.5:2004 Structural design actions - Earthquake actions - New Zealand).

The likely capacity of this building has been derived in accordance with the New Zealand Society for Earthquake Engineering (NZSEE) guidelines 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' (AISPBE), 2006. These guidelines provide an Initial Evaluation Procedure that assesses a buildings capacity based on a comparison of loading codes from when the building was designed and currently. It is a quick high-level procedure that can be used when undertaking a Qualitative analysis of a building. The guidelines also provide guidance on calculating a modified Ultimate Limit State capacity of the building which is much more accurate and can be used when undertaking a Quantitative analysis.

The New Zealand Society for Earthquake Engineering has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is shown 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	Unacceptable	Unacceptable

Figure 1 NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE

Table 1 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). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

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

Table 1 %NBS compared to relative risk of failure

4. Building Description

4.1 General

The dwelling is located at 42 Exeter Street, Lyttelton. It has been assumed the dwelling was constructed just prior to 1965. The building is used as a residential dwelling.

The building is timber frame construction. Because of the plaster ceiling, the interior of the roof structure was not clearly visible from the inside of the dwelling. The exterior of the roof was constructed from light weight corrugated iron cladding on timber framing.

The roof structure is supported by the load bearing timber framed walls. Internally the walls were lined with plasterboard; there were some internal areas lined with timber boards. All external walls are clad with weatherboards. The four existing chimneys have been knocked down.

We have assumed the floors are constructed of timber joists on timber bearers and the foundations are constructed with timber piles and concrete perimeter strips. This is typical of structures built around this date.

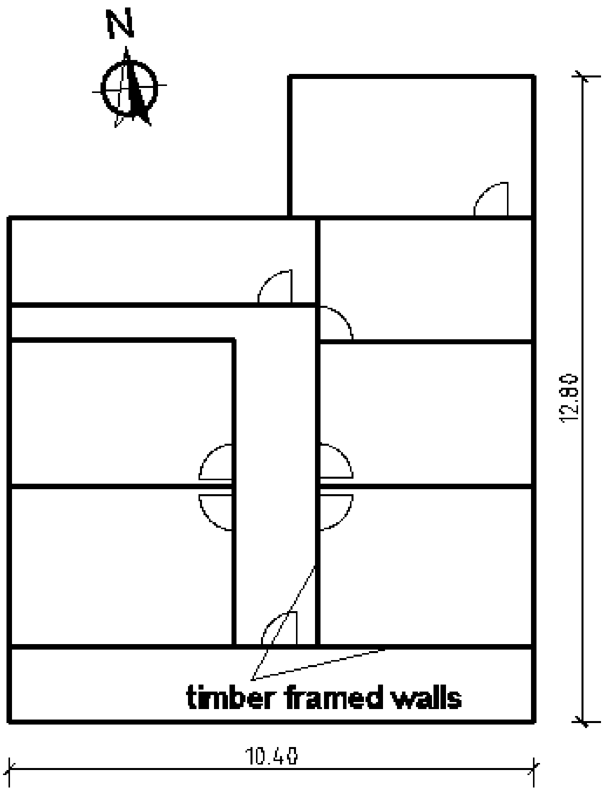


Figure 2 Plan Sketch Showing Key Structural Elements

The building is approximately 13m in length and 10m in width. There is a smaller (2.5m by 4.6m) section built off the northern corner. The height of the building varies from 6m to 1.5m between the southern and northern ends respectively. The plan area is approximately 160m^2.

The dwelling is located on a hill in a small suburban area with the closest residence being approximately 3m to the east. The site slopes at approximately 1:10.

There were no detailed plans available; however, a rough plan sketch was provided.

4.2 Gravity Load Resisting System

Gravity loads are initially carried by the roof structure; these are then transferred to the timber framed walls. The walls then pass the loads to the foundations and finally the ground.

Internal gravity loads are passed directly into the timber floor, through the timber joists, bearers, piles and finally to the ground.

4.3 Lateral Load Resisting System

Lateral load resisting systems in the longitudinal and transverse direction are similar.

The horizontal diaphragm provided by the roof/ceiling structure transfers lateral loads to the timber framed internal and external walls. These transmit the lateral loads to the substructure via in plane shear.

5. Assessment

An inspection of the building was undertaken on the 28th of June, 2012. Both the interior and exterior of the building were inspected. The main structural components of the roof of the building were unable to be viewed. Similarly the entirety of the foundations could not be seen. The inspection consisted of scrutinising the building to determine the structural systems and likely behaviour of the building during an earthquake. The site was assessed for damage, including examination of the ground conditions, checking for damage in areas where damage would be expected for the type of structure and noting general damage observed throughout the building in both structural and non-structural elements.

The %NBS score determined for this building has been based on the IEP procedure described by the NZSEE and based on the information obtained from visual observation of the building.

6. Damage Assessment

6.1 Surrounding Buildings

No obvious damage was noted to neighbouring structures, although no extensive visual investigation was made for these. However, much of Lyttleton was subject to large amounts of damage.

6.2 Residual Displacements and General Observations

No residual displacements of the structure were noticed during the inspection of the building.

Cracking was noted to the internal plasterboard linings in several locations throughout the building and on the perimeter strip footing (see photographs 5 to 13).

There may have been damage to the chimneys as a result of the earthquake. These have now been intentionally collapsed, either as a necessity or precaution. Subsequently, the flue masonry, which has been dropped on itself, has pushed out plasterboard wall cladding and fireplace mantels.

6.3 Ground Damage

There was no evidence of ground damage on the property or surrounding neighbours land.

7. Critical Structural Weakness

7.1 Short Columns

No short columns are present in the structure.

7.2 Lift Shaft

The building does not contain a lift shaft.

7.3 Roof

The roof was unable to be viewed upon inspection, however; the assumed timber elements, cladding and ceiling linings are expected to provide adequate bracing to the roof structure.

7.4 Staircases

The building contains a small stair with 2 steps. This is not of structural significance and cannot be considered a critical structural weakness.

7.5 Site Characteristics

Following the geotechnical appraisal it was found that the site has a moderate potential for liquefaction. For the purposes of the IEP assessment of the building and the determination of the %NBS score, the effects of soil liquefaction on the performance of the building has been assessed as an 'insignificant' site characteristic in accordance with the NZSEE guidelines.

7.6 Plan Irregularity

There is no significant plan irregularity.

7.7 Vertical irregularity

There is no significant vertical irregularity.

7.8 Pounding effect

There is no potential for pounding.

8. Geotechnical Consideration

8.1 Site Description

The site is situated in the suburb of Lyttelton, southeast of Christchurch City centre. It has relatively sloping terrain at approximately 60m above mean sea level. It is approximately 300m east of Main South Line Railway, 1.3km north of the Lyttelton Harbour, and 5km west of the coast (Pegasus Bay).

8.2 Published Information on Ground Conditions

8.2.1 Published Geology

The geological map of the area[1] indicates that the site is underlain by:

- Loess dominantly yellow-brown windblown silt on Banks Peninsula, greater than 3m thick and commonly in multiple layers, Pleistocene in age.

At depth volcanic rocks at the Banks Peninsula are expected. Due to the sloping terrain of the site, elevated ground water table is not considered likely.

8.2.2 Environment Canterbury Logs

Information from Environment Canterbury (ECan) indicates that there are no boreholes located with within 200m of the site. The nearest boreholes shown in the table are relatively shallow and approximately 600m from the site in the port area (see Table 2).

These boreholes indicate that the area they are located in is underlain by gravel, sandy gravel and sand with varying amount of silt, and clay.

Table 2 ECan Borehole Summary

Bore Name	Log Depth	Groundwater	Distance & Direction from Site
M36/20222	4.52 m	Not indicated	550m SW
M36/20223	4 m	Not indicated	550m SW
M36/20224	4 m	Not indicated	550m SW

It should be noted that the boreholes were sunk for groundwater extraction and not for geotechnical purposes. Therefore, the amount of material recovered and available for interpretation and recording will have been variable at best and may not be representative. The logs have been written by the well driller and not a geotechnical professional or to a standard. In addition strength data is not recorded.

8.2.3 EQC Geotechnical Investigations

The Earthquake Commission has not undertaken geotechnical testing in the area of the subject site.

[1] Forsyth, P. J., Barrell, D. J. A., & Jongens, R. (2008): *Geology of the Christchurch Urban Area*. Institute of Geological and Nuclear Sciences 1:250,000 Geological Map 16. IGNS Limited: Lower Hutt.

8.2.4 Land Zoning

Canterbury Earthquake Recovery Authority (CERA) has classified 42 Exeter Street, Lyttelton as "Green Zone, N/A, Port Hills & Banks Peninsula" category.

Land in this zone is generally considered suitable for residential construction, though some areas may require stronger foundations or design where rebuilding or repairs are required.

The "Not Applicable" technical category is the classification given for those properties within Port Hills and Bank Peninsula and non-residential properties in a rural area or beyond the extent of land damage mapping.

8.2.5 Post February Aerial Photography

Aerial photography taken following the 22 February 2011 earthquake shows minor signs of liquefaction in road corridors near the site, as shown in Figure 3**.**

Figure 3 Post February 2011 Earthquake Aerial Photography [2]

8.2.6 Summary of Ground Conditions

There is no site specific ground information for this site. It is considered likely that the property is underlain by fill material, loess and volcanic rock at depth. However, given the site's proximity to the hills it is considered possible that colluvium is present.

[2] Aerial Photography Supplied by Koordinates sourced from http://koordinates.com/layer/3185-christchurch-post-earthquake-aerial-photos-24-feb-2011/

8.3 Seismicity

8.3.1 Nearby Faults

There are many faults in the Canterbury region, however only those considered most likely to have an adverse effect on the site are detailed below.

Table 3 Summary of Known Active Faults[3][4]

Known Active Fault	Distance from Site	Direction from Site	Max Likely Magnitude	Avg Recurrence Interval
Alpine Fault	135 km	NW	~8.3	~300 years
Greendale (2010) Fault	28 km	W	7.1	~15,000 years
Hope Fault	115 km	NW	7.2~7.5	120~200 years
Kelly Fault	115 km	NW	7.2	150 years
Porter Pass Fault	70 km	NW	7.0	1100 years

The recent earthquakes since 4 September 2010 have identified the presence of a previously unmapped active fault system underneath the Canterbury Plains, including Christchurch City, and the Port Hills. Research and published information on this system is in development and not generally available. Average recurrence intervals are yet to be estimated.

8.3.2 Ground Shaking Hazard

New Zealand Standard NZS 1170.5:2004 quantifies the Seismic Hazard factor for Christchurch as 0.30, being in a moderate to high earthquake zone. This value has been provisionally upgraded recently (from 0.22) to reflect the seismicity hazard observed in the earthquakes since 4 September 2010.

The recent seismic activity has produced earthquakes of Magnitude-6.3 with peak ground accelerations (PGA) up to twice the acceleration due to gravity (2g) in some parts of the city. This has resulted in widespread liquefaction throughout Christchurch.

8.4 Slope Failure and/or Rockfall Potential

Given the site's location in Lyttelton, global slope instability is considered negligible. However, any localised retaining structures or embankments should be further investigated to determine the site-specific slope instability potential.

8.5 Liquefaction Potential

The site is considered to be moderately susceptible to liquefaction, due to the following reasons:

[3] Stirling, M.W, McVerry, G.H, and Berryman K.R. (2002) A New Seismic Hazard Model for New Zealand, Bulletin of the Seismological Society of America, Vol. 92 No. 5, pp 1878-1903, June 2002.

[4] GNS Active Faults Database

- Signs of liquefaction in road corridors near the site (evidence from the post-earthquake aerial photograph); and,
- Anticipated presence of silt and sand deposits beneath the site.

Due to the limited subsoil information, further investigation is recommended to better determine subsoil conditions. From this, a more comprehensive liquefaction assessment could be undertaken.

8.6 Conclusions & Recommendations

This assessment is based on a review of the geology and existing ground investigation information, and observations from the Christchurch earthquakes since 4 September 2010.

The site appears to be situated on yellow-brown silt deposits also known as loess, with fine sand or clay. Associated with this the site also has a moderate liquefaction potential, in particular where sands and/or silts are present.

A soil class of **D** (in accordance with NZS 1170.5:2004) should be adopted for the site.

Should a more comprehensive liquefaction and/or ground condition assessment be required, it is recommended that intrusive investigation be conducted.

9. Survey

No level or verticality surveys have been undertaken for this building at this stage as indicated by Christchurch City Council guidelines.

10. Initial Capacity Assessment

10.1 % NBS Assessment

The building has had its capacity assessed using the Initial Evaluation Procedure based on the information available. The buildings capacity excluding and including critical structural weaknesses is expressed as a percentage of new building standard (%NBS). These are shown below in Table 4. These capacities are subject to confirmation by a more detailed quantitative analysis.

Item	%NBS
Building before including earthquake damage (No CSW's observed)	43
Building damage (15% reduction)	37

Table 4 Indicative Building and Critical Structural Weaknesses Capacities based on the NZSEE Initial Evaluation Procedure

Following an IEP assessment, the building has been assessed as achieving 37% New Building Standard (NBS). Under the New Zealand Society for Earthquake Engineering (NZSEE) guidelines the building is considered Earthquake Risk as it achieves more than 33% NBS but less than 67%.

10.2 Seismic Parameters

The seismic design parameters based on current design requirements from NZS 1170:2002 and the NZBC clause B1 for this building are:

- Site soil class: D, NZS 1170.5:2004, Clause 3.1.3, Soft Soil
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- Return period factor R_u = 1.0, NZS 1170.5:2004, Table 3.5, Importance level 2 structure with a 50 year design life.

An increased Z factor of 0.3 for Christchurch has been used in line with requirements from the Department of Building and Housing resulting in a reduced % NBS score.

10.3 Expected Structural Ductility Factor

A structural ductility factor of 2.0 has been assumed based on the structural system observed and the date of construction.

10.4 Discussion of Results

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the baseline capacity (excluding critical structural weaknesses and earthquake damage) of the building has been assessed to be in the order of 22% NBS.

Because the building is a single story, leightweight and rectangular in shape, an F factor of 2 is taken, and the building achieved 43% of NBS (before earthquake damage).

Including the observed earthquake damage as a 15% reduction of the achieved NBS, the assessed NBS post-earthquake was estimated as 37%.

The building has therefore been assessed to have a seismic capacity in the order of 37% NBS and is therefore of Earthquake Risk.

The results obtained from the initial IEP assessment are consistent with those expected for a building of this age and construction type. It has been assumed that the building was designed shortly prior to 1965 and designed to the loading standard current at the time, NZSS 95:1935. The design loads used in this standard are significantly less than those required by the current loading standard. When this is combined with the increase in the hazard factor for Christchurch to 0.3, it would be expected that the building would score between 34% and 67% NBS and be potentially earthquake risk.

10.5 Occupancy

The building has been assessed as being Earthquake Risk and consequently, the dwelling can remain occupied.

11. Initial Conclusions

The building has been assessed to have a seismic capacity in the order of 37% NBS and is therefore potentially Earthquake Risk.

12. Recommendations

As the building has achieved less than 67% NBS following a qualitative Detailed Engineering Evaluation of the building, further assessment is required. It is recommended that a quantitative assessment be carried out and if necessary strengthening options explored.

As the building has achieved greater than 34% NBS, occupation of the building is permitted.

13. Limitations

13.1 General

This report has been prepared subject to the following limitations:

- No intrusive structural investigations have been undertaken.
- No intrusive geotechnical investigations have been undertaken.
- Visual inspections of the sub-floor space were not undertaken.
- Visual inspections of the roof space were not undertaken.
- No level or verticality surveys have been undertaken.
- No material testing has been undertaken.
- No calculations, other than those included as part of the IEP in the CERA Building Evaluation Report, have been undertaken. No modelling of the building for structural analysis purposes has been performed.

It is noted that this report has been prepared at the request of Christchurch City Council and is intended to be used for their purposes only. GHD accepts no responsibility for any other party or person who relies on the information contained in this reportrite a specific limitations section.

13.2 Geotechnical Limitations

This report presents the results of a geotechnical appraisal prepared for the purpose of this commission, and for prepared solely for the use of Christchurch City Council and their advisors. The data and advice provided herein relate only to the project and structures described herein and must be reviewed by a competent geotechnical engineer before being used for any other purpose. GHD Limited (GHD) accepts no responsibility for other use of the data.

The advice tendered in this report is based on a visual geotechnical appraisal. No subsurface investigations have been conducted. An assessment of the topographical land features have been made based on this information. It is emphasised that Geotechnical conditions may vary substantially across the site from where observations have been made. Subsurface conditions, including groundwater levels can change in a limited distance or time. In evaluation of this report cognisance should be taken of the limitations of this type of investigation.

An understanding of the geotechnical site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based. Hence this report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances, which arise from the issue of the report, which have been modified in any way as outlined above.

Appendix A

Photographs

Photograph 1 Eastern elevation.

Photograph 2 Southern elevation.

Photograph 3 Western elevation.

Photograph 4 Southern elevation and collapsed chimney.

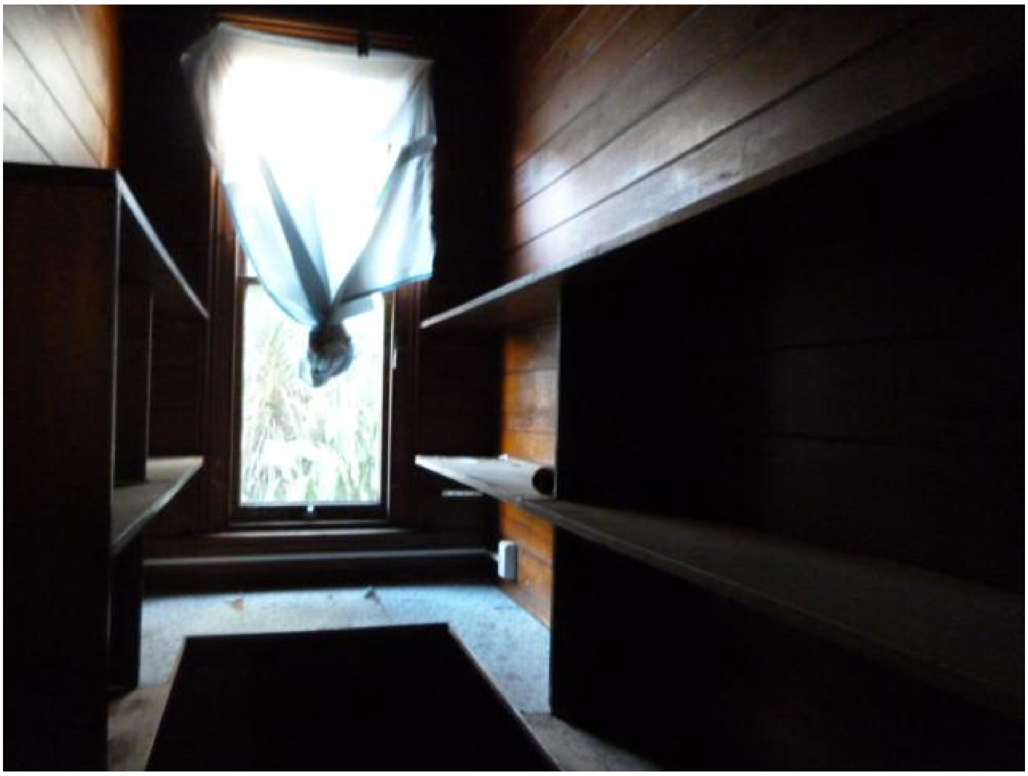
Photograph 5 Hallway.

Photograph 6 Collapsed fireplace mantel.

Photograph 7 Collapsed fireplace mantel.

Photograph 8 Displaced plasterboard.

Photograph 9 Kitchen and collapsed chimney and fireplace



Photograph 10 Pantry

Photograph 11 Displaced plasterboard

Appendix B

CERA Building Evaluation Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Dwelling 42 Exeter Street			Reviewer:	Stephen Lee
	Unit	No:	Street	CPEng No:	1006840
Building Address:		42	Exeter Street	Company:	GHD
Legal Description:	Lot 1 DP 67378			Company project number:	513090237
				Company phone number:	04 472 0799
	Degrees	Min	Sec		
GPS south:	43	35	59.13	Date of submission:	17/05/2013
GPS east:	172	43	11.79	Inspection Date:	28/06/2012
				Revision:	Final
Building Unique Identifier (CCC):	PRO 3525 001			Is there a full report with this summary?	yes

Site

Site slope:	slope < 1in 5	Max retaining height (m):	
Soil type:	mixed	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?			Ground floor elevation above ground (m):	
Storeys below ground				
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	6.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):				
Age of Building (years):			Date of design:	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:	timber	joist depth and spacing (mm)	
Beams:	none	overall depth x width (mm x mm)	
Columns:			
Walls:			

Lateral load resisting structure

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

Ductility assumed, μ:	2.00	**detailed report!**	note typical wall length (m)	
Period along:	0.40	0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls			
Ductility assumed, μ:	2.00		note typical wall length (m)	
Period across:	0.40	0.00	estimate or calculation?	
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:	cast insitu	notes	1 concrete step
Wall cladding:	plaster system	describe	Internally - Plasterboard/timber Externally - Weatherboa
Roof Cladding:	Metal	describe	Corrugated Iron
Glazing:	timber frames		
Ceilings:	fibrous plaster, fixed		
Services(list):			

Available documentation

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

Damage

Site:
(refer DEE Table 4-2)

Site performance:	Okay	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	moderate to substantial (1 in 5)	notes (if applicable):	Many of the buildings in Lyttleton severely damage.

Building:

	Current Placard Status:			
Along	Damage ratio:	15%	Describe how damage ratio arrived at:	
	Describe (summary):			
Across	Damage ratio:	15%		
	Describe (summary):			

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

Diaphragms	Damage?: no	Describe:	
CSWs:	Damage?: yes	Describe:	Damage to the foundation
Pounding:	Damage?: no	Describe:	
Non-structural:	Damage?: yes	Describe:	

Recommendations

Level of repair/strengthening required:	minor structural	Describe:	Re-attach displaced plasterboard
Building Consent required:	no	Describe:	
Interim occupancy recommendations:	full occupancy	Describe:	

Along	Assessed %NBS before e'quakes:	43%	43% %NBS from IEP below	If IEP not used, please detail assessment methodology:
	Assessed %NBS after e'quakes:	37%		
Across	Assessed %NBS before e'quakes:	43%	43% %NBS from IEP below	
	Assessed %NBS after e'quakes:	37%		

IEP **Use of this method is not mandatory - more detailed analysis may give a different answer, which would take precedence. Do not fill in fields if not using IEP.**

Period of design of building (from above): 1935-1965

h_n from above: m

Seismic Zone, if designed between 1965 and 1992: B

not required for this age of building

not required for this age of building

	along	across
Period (from above):	0.4	0.4
(%NBS)nom from Fig 3.3:	2.9%	2.9%

Note:1 for specifically design public buildings, to the code of the day: pre-1965 = 1.25; 1965-1976, Zone A =1.33; 1965-1976, Zone B = 1.2; all else 1.0	1.00
Note 2: for RC buildings designed between 1976-1984, use 1.2	1.0
Note 3: for buildngs designed prior to 1935 use 0.8, except in Wellington (1.0)	1.0

	along	across
Final $(\%NBS)_{nom}$:	**3%**	**3%**

2.2 Near Fault Scaling Factor

Near Fault scaling factor, from NZS1170.5, cl 3.1.6: 1.00

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	1	1

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:	0.30
Z_{1992}, from NZS4203:1992	0.8
Hazard scaling factor, **Factor B:**	3.333333333

2.4 Return Period Scaling Factor

Building Importance level (from above):	2
Return Period Scaling factor from Table 3.1, **Factor C**:	1.00

		along	across
2.5 Ductility Scaling Factor	Assessed ductility (less than max in Table 3.2)	1.00	1.00
	Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:	1.57	1.57
	Ductiity Scaling Factor, **Factor D**:	1.57	1.57
2.6 Structural Performance Scaling Factor:	Sp:	0.700	0.700
	Structural Performance Scaling Factor **Factor E**:	1.428571429	1.428571429
2.7 Baseline %NBS, $(NBS\%)_b = (\%NBS)_{nom}$ x A x B x C x D x E	**$\%NBS_b$:**	**22%**	**22%**

Global Critical Structural Weaknesses: (refer to NZSEE IEP Table 3.4)

3.1. Plan Irregularity, factor A:	insignificant	1
3.2. Vertical irregularity, Factor B:	insignificant	1
3.3. Short columns, Factor C:	insignificant	1
3.4. Pounding potential Pounding effect D1, from Table to right		1.0
Height Difference effect D2, from Table to right		1.0
Therefore, Factor D:		1
3.5. Site Characteristics	insignificant	1

Table for selection of D1	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Alignment of floors within 20% of H	**0.7**	**0.8**	**1**
Alignment of floors not within 20% of H	**0.4**	**0.7**	**0.8**

Table for Selection of D2	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Height difference > 4 storeys	0.4	0.7	1
Height difference 2 to 4 storeys	0.7	0.9	1
Height difference < 2 storeys	1	1	1

		Along	Across
3.6. Other factors, Factor F	For ≤ 3 storeys, max value =2.5, otherwise max valule =1.5, no minimum	2.0	2.0
	Rationale for choice of F factor, if not 1	Single story timber frame building	Single story timber frame building

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)

List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

3.7. Overall Performance Achievement ratio (PAR)		**2.00**	**2.00**
4.3 PAR x (%NBS)b:	PAR x Baselline %NBS:	**43%**	**43%**
4.4 Percentage New Building Standard (%NBS), (before)			**43%**

Official Use only:

Accepted By

Date:

GHD

GHD Building
226 Antigua Street, Christchurch 8013
T: 64 3 378 0900   F: 64 3 377 8575   E: chcmail@ghd.com

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Final	Simon Barker	Mirjana Hrnjak		Stephen Lee		17/05/13