Christchurch City Council

Britomart Reserve Toilets PRK 3649 BLDG 001 EQ2

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Britomart Reserve Toilets

Quantitative Assessment Report

82 Beach Road, Akaroa

Opus International Consultants Ltd
Christchurch Office
20 Moorhouse Avenue
PO Box 1482, Christchurch Mail
Centre, Christchurch 8140
New Zealand

Telephone: +64 3 363 5400
Facsimile: +64 3 365 7858

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Status: Final

Summary

Britomart Reserve Toilets
PRK 3649 BLDG 001 EQ2

Detailed Engineering Evaluation
Quantitative Report
Final

Background
This is a summary of the quantitative report for the Britomart Reserve Toilets and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group, visual inspections and measurements taken during July 2012, and calculations.

Critical Structural Weaknesses
No critical structural weaknesses have been identified for this structure.

Indicative Structure Strength
Based on the information available, and from undertaking a quantitative assessment, the structure's original capacity has been assessed as over 100% NBS, and therefore is not considered as an earthquake prone building.

Recommendations
As the capacity of the building has been assessed as over 100%NBS, no further actions are recommended. However, repair to the cracks in the plaster finish of the foundation may be desirable.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Britomart Reserve Toilets located at 82 Beach Road, Akaroa. This report was commissioned following the Canterbury Earthquake Sequence since September 2010.

The purpose of the assessment is to determine if the structure is classed as being earthquake prone in accordance with the Building Act 2004.

The seismic assessment and reporting have been undertaken based on a quantitative procedure detailed in Opus document 'Guidelines for Detailed Engineering Evaluation of Timber Framed Buildings', referencing NZS 1170.5 – Structural Design Actions.

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 2006. This policy was amended immediately following the Darfield Earthquake on 4 September 2010.

The 2010 amendment 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

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 DBH guidance document dated 12 June 2012 [6], this notice is likely to prohibit occupancy of the building (or parts thereof), until its seismic capacity is improved to the point that it is no longer considered an EPB.

3.1.2 Cordoning

Where there is an overhead falling hazard, or potential collapse hazard of the building, the areas of concern should be cordoned off in accordance with current CERA/territorial authority guidelines.

3.1.3 Strengthening

Industry guidelines (NZSEE 2006 [2]) strongly recommend that every effort be made to achieve improvement to at least 67%NBS. A strengthening solution to anything less than 67%NBS would not provide an adequate reduction to the level of risk.

It should be noted that full compliance with the current building code requires building strength of 100%NBS.

3.1.4 Our Ethical Obligation

In accordance with the IPENZ code of ethics, we have a duty of care to the public. This obligation requires us to identify and inform CERA of potentially dangerous buildings; this would include earthquake prone buildings.

[1] This Order only applies to buildings within the Christchurch City, Selwyn District and Waimakariri District Councils authority

4 Building Description

4.1 General

The building is located on a flat section near the water on the Britomart Reserve in Akaroa. It has an approximate footprint of 5.45m by 5.45m. The apex of the roof is approximately 3.73m above the ground and the building has a wall height of approximately 2.25m. There is no information available regarding the date of construction.

The building is a single storey timber framed structure with hard pressed metal tiles and a skylight in the centre of the building. It is not clear from the site inspection whether the skylight is constructed from glass or plastic.

No foundation detail was available at the time of the assessment but from the inspection it appears that the foundation consists of a mass concrete platform, varying in height. It is partially supported on the river bank in one corner.

4.2 Gravity Load Resisting System

The building is timber framed with 9mm Hardisheet cladding. The roof is also timber framed with plasterboard on the underside and hard pressed metal tiles as the external cladding. The roof has a 450mm overhang over the exterior walls. The skylight at the centre of the building is supported by steel framing.

It is believed that the building is constructed in general accordance with NZS 1900: Chapter 6.1:1964.

4.3 Seismic Load Resisting System

Lateral resistance for the structure is likely to be provided by the Hardi compressed sheet lining in the full height exterior and interior walls. The lines of bracing wall are spaced at no more than 2m apart. The timber walls hold down detail could not be confirmed without intrusive investigation.

The plasterboards in the ceiling will likely provide some flexible diaphragm action to distribute the roof seismic loading to adjacent walls. However, it is unlikely to be a critical element as the bracings walls are spaced closely together.

5 Survey

No copies of the design calculations or structural drawings have been obtained for this structure but we have now measured the structure accurately and made calculations based on these figures.

Non-intrusive inspections have been used to confirm the structural systems, and to identify details which required particular attention. Due to a lack of observed ground damage, no geotechnical assessment had been undertaken.

6 General Observations

The structure has performed well under seismic conditions. There are some minor horizontal cracks noted along the mass concrete platform foundation. The cracking is more severe at one corner of the platform, near the river bed. However, all the cracking appears to be confined to the plaster finish only.

7 Detailed Seismic Assessment

7.1 Seismic Coefficient Parameters

The seismic design parameters based on current design requirements from NZS1170.5:2004 and the NZBC clause B1 for this structure are:

- Site soil class C, clause 3.1.3 NZS 1170.5:2004
- Site hazard factor, Z=0.3, B1/VM1 clause 2.2.14B
- Return period factor R_u = 1.0 from Table 3.5, NZS 1170.5:2004, for an Importance Level 2 structure with a 50 year design life.
- Ductility factor μ_{max} = 3.0 (Pre-1978 timber framed building).

7.2 Detailed Seismic Assessment Results

A summary of the structural performance of the structure is shown in the following table. Note that the values given represent the worst performing elements in the structure, as these effectively define the structure's capacity. Other elements within the structure may have significantly greater capacity when compared with the governing element.

Table 2: Summary of Seismic Performance

Structural Element/System	Failure mode and description of limiting criteria	% NBS based on calculated capacity
Transverse direction, hardboard/ compressed sheet	Bracing capacity of the walls	100%+
Longitudinal direction, hardboard/ compressed sheet	Bracing capacity of the walls	100%+

7.3 Discussion of Results

Based on the site observation, the bracing element should be hardboard/compressed sheets equal to, or greater than 7mm thick. However, as the exact construction detail is unknown, a conservative bracing value was adopted. Hence allowing for a minimum length of 0.6m, 40 BU/m and a strength reduction factor of 0.7 was used for analysis. [2]

The structure has a calculated capacity of over 100% NBS. This is above the threshold limit for structures classified as a 'Potential Earthquake Risk' which is two third (67%) of the seismic performance specified in the current loading standard for new structures (New Building Standard, or NBS). The structure is therefore classed as being a low earthquake risk in accordance with the NZSEE guidelines.

No critical structural weaknesses (CSW) were found for this structure. Due to the inherently ductile nature of the nailed timber bracing, we do not believe this structure poses a collapse risk and is suitable for continued occupancy.

While not structurally significant, it is worth noting that the material and supporting detail of the skylight should be further investigated. This is a potential hazard in a future seismic event.

7.4 Limitations and Assumptions in Results

Our analysis and assessment is based on an assessment of the structure in its undamaged state.

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; and
- without an intrusive investigation the capacity of the foundation cannot be determined but, due to the small loads being imparted on them, it is assumed that their capacity is greater than 67% NBS.

8 Conclusions

(a) The structure has a seismic capacity of over 100% NBS and therefore is a low earthquake risk.

(b) Due to the inherently ductile nature of the nailed timber bracing, we do not believe this structure poses a collapse risk and is suitable for continued occupancy.

9 Recommendations

As the capacity of the building has been assessed as over 100%NBS, no further actions are recommended. However, repair to the cracks in the plaster finish of the foundation may be desirable.

10 Limitations

(a) This report is based on an inspection of the structure with a focus on the damage sustained from the 22 February 2011 Canterbury Earthquake and aftershocks only.

(b) 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 the time.

(c) This report is prepared for the CCC to assist with assessing remedial works required for council structures and facilities. 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, *Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes*, Structural Engineering Society of New Zealand, 21 December 2011.

Appendix A – Photographs

Photo 1: Building frontage and side wall

Photo 2: Building frontage

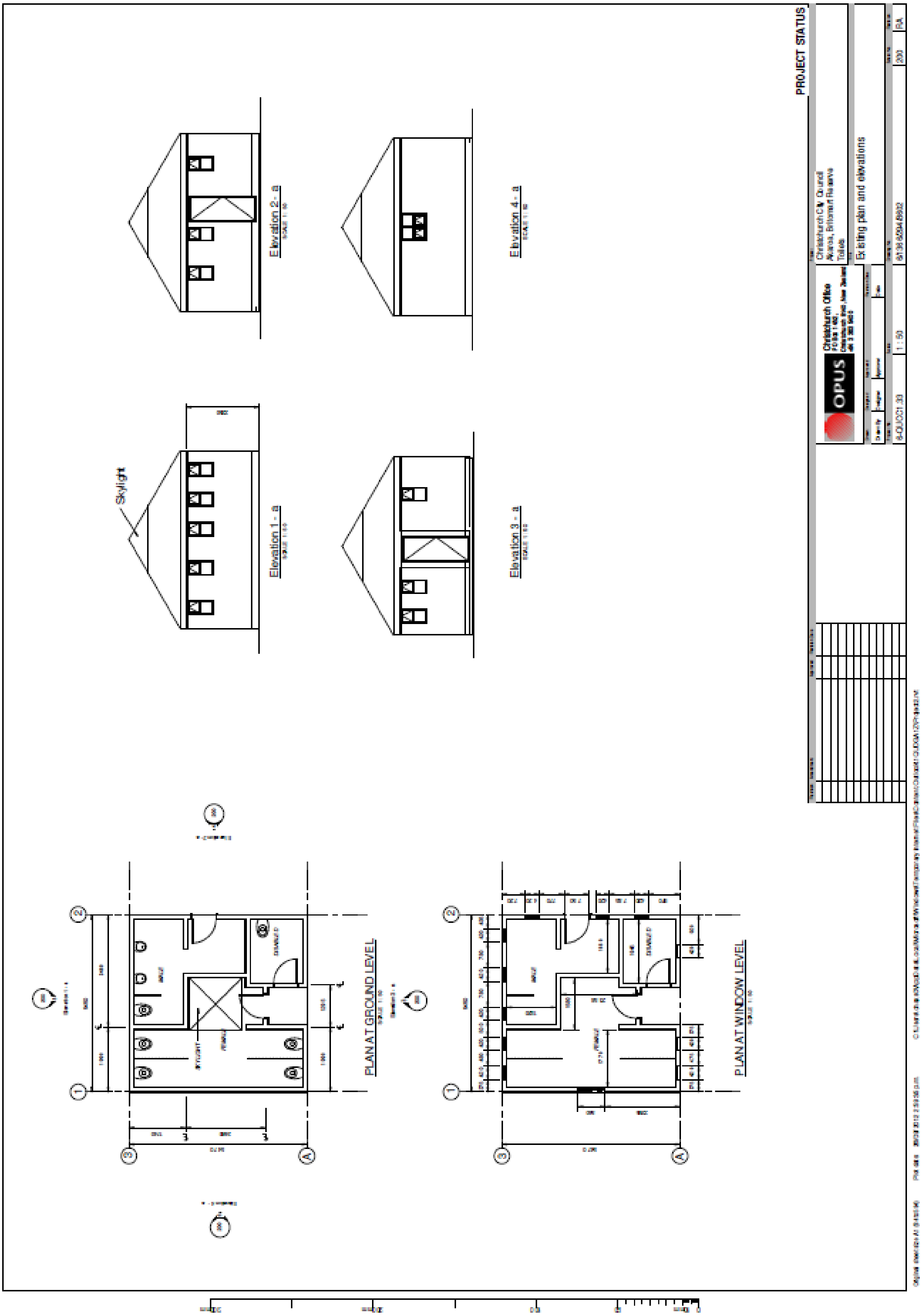
Photo 3: Building side wall

Photo 4: Building rear

Photo 5: Typical ceiling detail

Photo 6: Skylight detail

Appendix B – Part Building Plan


PROJECT STATUS
Skylight
Elevation 1 - a
Elevation 2 - a
Elevation 3 - a
Elevation 4 - a
PLAN AT GROUND LEVEL
PLAN AT WINDOW LEVEL
OPUS
Christchurch Office
Christchurch City Council
Existing plan and elevations
6-QUCC1.33
1 : 50
200
RA

Appendix C – CERA DEEP Data Sheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Britomart Reserve Toilets	Reviewer:	Dave Dekker
	Unit / No: / Street	CPEng No:	1003026
Building Address:	Britomart Reserve / 82 / Beach Road	Company:	Opus International Consultants
Legal Description:		Company project number:	6-QUCC1.33
	Degrees / Min / Sec	Company phone number:	3635400
GPS south:		Date of submission:	21-Nov-12
GPS east:		Inspection Date:	11-Jul-12
		Revision:	Final
Building Unique Identifier (CCC):	PRK 3649 BLDG 001 EQ2	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):	C		
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			
Foundation type:	other (describe)	if Foundation type is other, describe:	Mass concrete platform
Building height (m):	3.73	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	30		
Age of Building (years):		Date of design:	
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	public	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:	load bearing walls	typical dimensions (mm x mm)	
Walls:			

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!** / note typical wall length (m)	2
Ductility assumed, μ:	3.00		
Period along:	0.40 (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)	2
Ductility assumed, μ:	3.00		
Period across:	0.40 (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:	other (specify)	describe	NA
Wall cladding:	other light	describe	
Roof Cladding:	Metal	describe	
Glazing:	aluminium frames		
Ceilings:			
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		original designer name/date	

Damage

Site: (refer DEE Table 4-2)

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

Building:

	Current Placard Status:			
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	
	Describe (summary):			
Across	Damage ratio:	0%		
	Describe (summary):			
Diaphragms	Damage?:		Describe:	
CSWs:	Damage?:		Describe:	
Pounding:	Damage?:		Describe:	
Non-structural:	Damage?:		Describe:	

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

Recommendations

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

Opus International Consultants Ltd
20 Moorhouse Avenue
PO Box 1482, Christchurch Mail Centre,
Christchurch 8140
New Zealand

t: +64 3 363 5400
f: +64 3 365 7858
w: www.opus.co.nz