Christchurch City Council

Westburn Reserve Toilets
PRK 0273 BLDG 001 EQ2

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Westburn Reserve Toilets

Quantitative Assessment Report

32 Westburn Terrace, Burnside

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Status: Final

Summary

Westburn Reserve Toilets
PRK 0273 BLDG 001 EQ2

Detailed Engineering Evaluation
Quantitative Report - Summary
Final

Background

This is a summary of the quantitative report for the Westburn Reserve Toilets building , and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 27 July 2012, measured-up sketch drawings and calculations.

Key Damage Observed

No damage was identified.

Critical Structural Weaknesses

The external unreinforced concrete block masonry walls of this building support the roof and their seismic capacity under out-of-plane response is assessed as only 35%. Collapse of the external walls would result in collapse of the roof, hence we consider the external walls to be a Critical Structural Weakness (CSW).

Indicative Building Strength

Based on the information available, and from undertaking a quantitative assessment, the building's seismic capacity has been assessed to be 35%NBS across and along the building, as limited by out of plane capacity of unreinforced masonry block walls.

The building is not classed as an earthquake prone building under the NZSEE classification system.

Recommendations

We make the following recommendations:

a) Strengthening of the building should be undertaken to increase the overall building capacity to greater than 67% NBS and to address the critical structural weaknesses.
b) Due to the walls being considered a critical structural weakness, occupancy of the building should be reviewed until strengthening has been undertaken.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Westburn Reserve Toilets, located in Westburn Terrace, Burnside, following the earthquake sequence since September 2010.

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

The seismic assessment and reporting have been undertaken based on the quantitative procedures detailed in the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011.

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 Westburn Reserve Toilets building is a single storey unreinforced block masonry building with block veneer wall cladding, and a light-weight metal sheet roof on timber framing. The floor is slab-on-grade.

The building is 8.7m long and 6.4m wide. The apex of the roof is 3.4m from the ground and the wall height is 2.5m. The building consists of a store room and two toilets.

The building has a plasterboard lined ceiling.

The building age is unknown, but it is expected to have been built before the 1960s.

4.2 Gravity Load Resisting System

The roof is a timber framed roof clad in corrugated iron sheet, with the ceiling lined with Gib plasterboard.

4.3 Seismic Load Resisting System

Seismic loads in both principal directions are resisted by unreinforced masonry walls. The ceiling is expected to provide an adequate flexible diaphragm to distribute the seismic induced lateral loads to the walls.

5 Survey

Copies of the following drawings were referred to as part of the assessment:

- Measured-up sketches of the building completed by Opus International Consultants, titled “Westburn Reserve Toilets”.

No copies of the design calculations nor structural drawings have been obtained for this building.

The sketch drawings and survey photos have been used to confirm the structural systems, investigate potential critical structural weaknesses (CSW) wherever possible, and identify details which required particular attention.

6 Damage Assessment

The building structure does not appear to have any sustained damage as a result of the recent earthquake events.

7 General Observations

Overall the building has performed well under seismic conditions with no observable damage.

Due to the non-intrusive nature of the original survey, many connection details could not be ascertained.

8 Detailed Seismic Assessment

8.1 Critical Structural Weaknesses

As outlined in the Critical Structural Weakness and Collapse Hazards draft briefing document, issued by the Structural Engineering Society (SESOC) on 7 May 2011, 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 the building.

The unreinforced concrete block masonry external walls of this building support the roof and under out-of-plane seismic actions they have capacities of only 35% in a rocking failure mode. Collapse of the external walls would result in collapse of the roof, hence we consider the external walls to be a CSW.

8.2 Seismic Coefficient Parameters

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

- Site soil class D, 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;
- μ_{max} = 1.0 for wall bracing elements

8.3 Detailed Seismic Assessment Results

A summary of the structural performance of the building is shown in the following table.

Table 2: Summary of Seismic Performance

Structural Element/System	**Failure mode and description of limiting criteria**	**% NBS based on calculated capacity**
Wall along Grid 2, W6 i.e. along the building	In-plane diagonal tension failure mode	96%
Wall along Grid 2, W4 i.e. along the building	In-plane diagonal tension failure mode	100%
Wall along Grid 1, W2 i.e. Along the building	In-plane diagonal tension failure mode	>100%
Wall along Grid A, W1 i.e. across the building	In-plane diagonal tension failure mode	>100%
Internal wall, W9 i.e. across the building	In-plane diagonal tension failure mode	>100%
Wall along Grid B, W3 & W3a i.e. across the building	In-plane diagonal tension failure mode	>100%
External Walls	Rocking mode failure –Out of plane	35%

Note: Refer to Appendix B for drawing of building and Grid layout.

8.4 Discussion of Results

The building has a calculated capacity of 35%NBS, as limited by the out of plane capacity of unreinforced masonry walls.

It has been assumed that the ceiling lining acts as an adequate flexible diaphragm to satisfactorily distribute seismic induced roof loads to return walls.

As the building has a capacity of more than 33%NBS it is defined as a moderate earthquake risk building under the NZSEE classification system.

8.5 Limitations and Assumptions in Results

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.

9 Geotechnical

Due to a lack of observed ground damaged, no specific geotechnical assessment has been undertaken for this site. The site parameters used for the structural analysis have been taken as site subsoil class D, based on geotechnical advice.

10 Remedial Options

Although this building has not been damaged by the earthquakes this assessment indicates that it does not have adequate seismic capacity due to the unreinforced masonry walls. Strengthening options should be investigated to determine the best method to retrofit the building including intrusive investigations to determine the adequacy of the ceiling diaphragm connection to the block walls.

11 Conclusions

The building has a seismic capacity of 35%NBS and is therefore not classed as an earthquake prone building in accordance with the Building Act 2004, however the masonry block walls are unreinforced and strengthening to more than 67%NBS is required.

Due to the low assessed seismic capacity and critical structural weakness (CSW) of the external walls, use of the public toilets should be reviewed and access to the store room should be limited or discontinued.

12 Recommendations

We make the following recommendations:

a) Strengthening of the building should be undertaken to increase the overall building capacity to greater than 67% NBS and to address the critical structural weaknesses.
b) Due to the walls being considered a critical structural weakness (CSW), occupancy of the building should be reviewed until strengthening has been undertaken.

13 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 buildings and facilities. It is not intended for any other party or purpose.

14 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: View of the building from the street

Photo 2: View of the building from left side

Photo 3: Right side wall

Photo 4: Rear wall

Photo 5: Front wall lintel

Photo 6: Internal wall, bond beam and ceiling

Photo 7: Internal wall, bond beam and ceiling

Photo 8: Front wall lintel

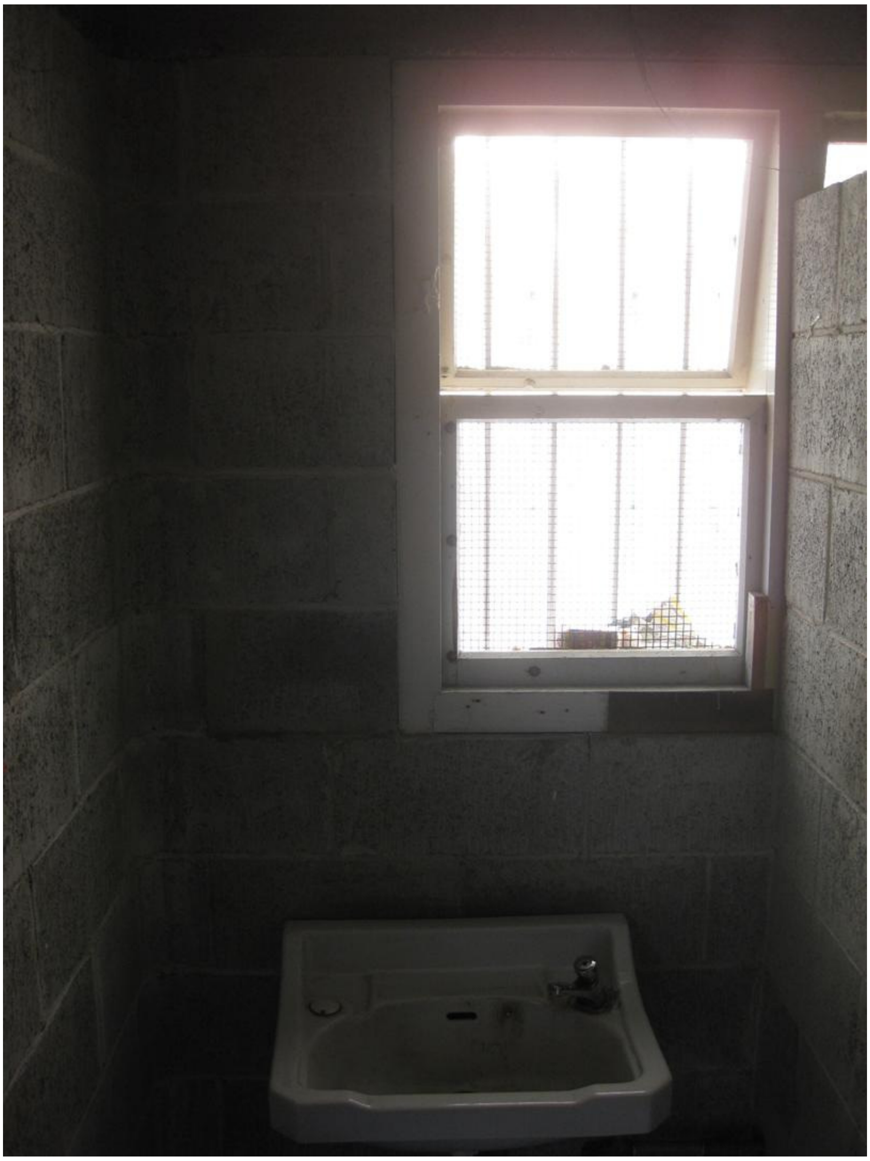
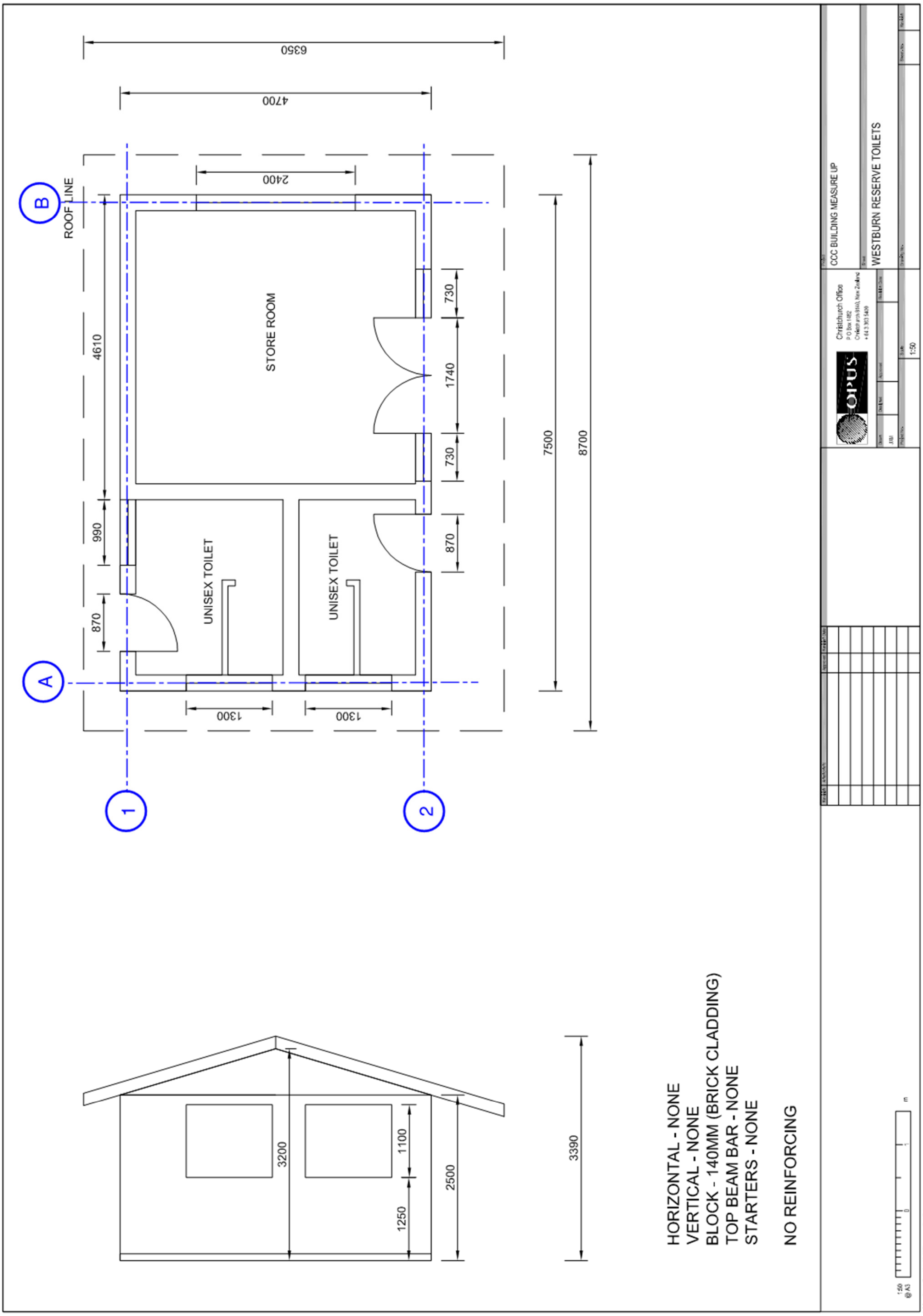


Photo 9: Partition wall at Toilet

Appendix B – Measure-up Sketches


6350
4700
2400
ROOF LINE
STORE ROOM
UNISEX TOILET
UNISEX TOILET
4610
990
870
730
1740
730
870
7500
8700
1300
1300
3200
1100
1250
2500
3390
HORIZONTAL - NONE
VERTICAL - NONE
BLOCK - 140MM (BRICK CLADDING)
TOP BEAM BAR - NONE
STARTERS - NONE
NO REINFORCING
OPUS
Christchurch Office
CCC BUILDING MEASURE UP
WESTBURN RESERVE TOILETS
1:50

Appendix C – CERA DEE Data Sheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Westburn Park Toilet	Reviewer:	Jan Stanway
	Unit No: Street	CPEng No:	222291
Building Address:	32 Westburn Terrace	Company:	Opus International Consultants Ltd
Legal Description:		Company project number:	6-QUCC1.62
		Company phone number:	03 363 5400
	Degrees / Min / Sec		
GPS south:	43 / 30 / 32.50	Date of submission:	8/02/2013
GPS east:	172 / 34 / 19.66	Inspection Date:	27/06/2012
		Revision:	Final
Building Unique Identifier (CCC):	PRK 0273 BLDG 001 EQ2	Is there a full report with this summary?	yes

Site

Site slope:		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:	other (describe)	if Foundation type is other, describe:	
Building height (m):	3.39	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	35		
Age of Building (years):	50	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):	open ground floor		
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	
Floors:	other (note)	describe sytem	
Beams:			
Columns:			
Walls:			

Lateral load resisting structure

Lateral system along:	other (note)	Note: Define along and across in detailed report!	unreinforced ungrouted block wall
Ductility assumed, μ:	1.00	describe system	
Period along:	0.16 (0.00)	estimate or calculation?	estimated
Total deflection (ULS) (mm):	1	estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):	1	estimate or calculation?	estimated
Lateral system across:	other (note)		unreinforced ungrouted block wall
Ductility assumed, μ:	1.00	describe system	
Period across:	0.16 (0.00)	estimate or calculation?	estimated
Total deflection (ULS) (mm):	1	estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):	1	estimate or calculation?	estimated

Separations:

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

Non-structural elements

Stairs:		
Wall cladding:		
Roof Cladding:	Metal	describe
Glazing:	timber frames	
Ceilings:	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	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:	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:	none apparent	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?:	no	Describe:	

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

Recommendations

Level of repair/strengthening required:	significant structural and strengthening	Describe:	strengthen walls supporting roof
Building Consent required:	yes	Describe:	
Interim occupancy recommendations:	do not occupy	Describe:	URM load bearing walls are a CSW
Along — Assessed %NBS before e'quakes:	35% (##### %NBS from IEP below)	If IEP not used, please detail assessment methodology:	Quantitative
Assessed %NBS after e'quakes:	35%		
Across — Assessed %NBS before e'quakes:	35% (##### %NBS from IEP below)		
Assessed %NBS after e'quakes:	35%		

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