Christchurch City Council

Yaldhurst Domain Toilet Block PRK 1642 BLDG 003

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Yaldhurst Domain Toilet Block Quantitative Assessment Report

Yaldhurst Domain, Christchurch

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Summary

Yaldhurst Domain Toilet Block
PRK 1642 BLDG 003

Detailed Engineering Evaluation
Quantitative Report - Summary
Final V2

Background
This is a summary of the quantitative report for the toilet building at Yaldhurst Domain. The summary is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group, visual inspections and measurements taken during August 2012, and calculations.

Critical Structural Weaknesses
The following CSW's have been identified for this building:

- Masonry walls along the structure, out of plane flexure (external walls) calculated as 27% NBS.
- Masonry walls across the structure, bracing capacity of the walls calculated as 17% NBS.

Indicative Structure Strength
Based on the information available, and from undertaking a quantitative assessment, the structure's original capacity has been assessed to be less than 34% NBS, both along and across the structure, and therefore is considered earthquake prone.

Recommendations
The following recommendations have been made for this site:

- Strengthening options be developed for increasing the seismic capacity of the building to at least 67% NBS.

A cordon is placed around the tank and toilet block until such a time that the damaged tank stand leg is repaired or replaced.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the toilet building located at Yaldhurst Domain, Christchurch. This report was commissioned following the M6.3 Christchurch earthquake on 22 February 2011.

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 the qualitative and quantitative procedure 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	Improvement of Structural Performance: Legal Requirement	Improvement of Structural Performance: NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended		Not recommended. Acceptable only in exceptional circumstances
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement required under Act)	Unacceptable	Unacceptable

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

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 Yaldhurst Domain toilet block is a single storey concrete masonry structure with a timber framed roof. The floor is a concrete slab on-grade. The building inspection noted the wall reinforcement as being rods located vertically in all corners and at end of walls, and a horizontal bond beam all around located in the course below window level. We have assumed the masonry walls to be ungrouted, except for the reinforced cells.

We have no information on the foundation and have assumed that the concrete slab is likely to have a concrete edge beam all around along with internal beams or slab thickening at the internal masonry wall locations.

The building is situated on a flat section and is approximately 7m long and 4.2m wide. The apex of the roof is approximately 3.0m above the ground. The building has a maximum masonry wall height of 2.2m along the 7m sides. The free standing masonry walls defining the male and female entries are 1.8m high.

We have no information on when the structure was constructed.

4.2 Gravity Load Resisting System

The roof is timber frame construction, clad with corrugated iron sheeting and supported on the masonry walls.

4.3 Seismic Load Resisting System

Lateral resistance for the structure in both directions is provided through the masonry walls.

5 Building 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.

6 Geotechnical Appraisal

Due to a lack of observed ground damage at the site, a geotechnical appraisal was not carried out.

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 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.
- Ductility factor μ_{max} = 1.25 for the intermittently filled reinforced masonry 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 (across) direction, masonry walls	Bracing capacity of the walls Out of plane flexure (external walls)	17% 59%
Longitudinal (along) direction, masonry walls	Bracing capacity of the walls Out of plane flexure (external walls)	42% 27%

7.3 Discussion of Results

The analysis carried out for the structure determined that the walls are weak in resisting in-plane shear and have insufficient reinforcement for out-of-plane flexural demands. The entry walls, internal dividing walls and building end walls are not connected to the roof structure and therefore must cantilever from the foundation.

From calculations we have concluded that the structure has the following critical structural weaknesses.

- Masonry walls across direction: Bracing capacity of the walls 17% NBS
- Masonry walls along direction: Out of plane flexure 27% NBS

These results are below 34% NBS and therefore the structure is classed as an Earthquake Prone building in accordance with the NZSEE guidelines.

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 relatively small loads being imparted on them, it is assumed that their capacity is greater than 33% NBS.

8 Adjacent Tank Stand

8.1 Description

A steel tank stand supporting a concrete tank is located adjacent to the toilet block.

The tank is 1.7m diameter x 1.3m high with a 50mm concrete base slab.

The stand is 2.7m high with a square base of 1.6m. The stand is seated on concrete pads in each corner.

8.2 Discussion

Calculations have been carried out to review the tank stand compliance with current codes. We conclude from calculations that the tank stand strength is approximately 70% of the current seismic code requirements.

We do not hold details of the tank stand foundation blocks located at each corner. Due to their unknown size, we have been unable to determine their uplift capacity.

The site inspection noted impact damage to one leg of the tank stand. This damage reduces the axial load capacity of the leg and requires repair or replacement. The tank and tank stand appear stable, but being a little under code strength by calculation, and exhibiting one damaged leg, there is a moderate risk of toppling which could impact the toilet block.

9 Conclusions

- The toilet block has a seismic capacity of less than 34% NBS and is therefore considered earthquake prone in accordance with the Building Act 2004.
- The seismic capacity is governed by the bracing capacity of the walls.
- The adjacent tank has a moderate risk of toppling which could impact the toilet block due to damage to one of the stand legs.

10 Recommendations

It is recommended that:

- The building is strengthened to at least 67%NBS.
- A cordon is placed around the tank and toilet block until such a time that the damaged tank stand leg is repaired or replaced.

11 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.

12 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 entry

Photo 2: Building end wall

Photo 3: Building rear wall

Photo 4: Roof structure

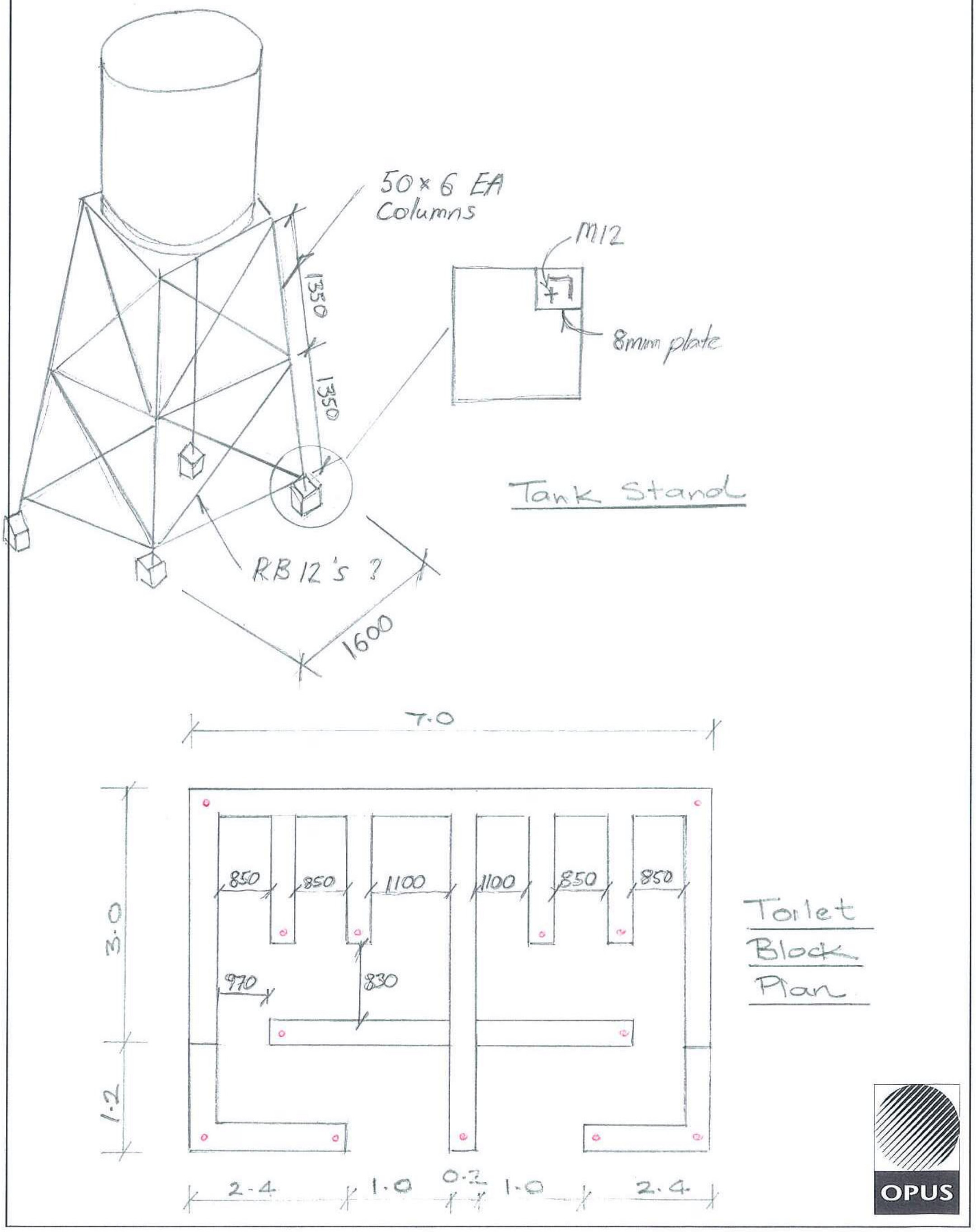
Photo 5: Roof structure and internal walls

Photo 6: Water tank and stand

Appendix B – Building Plan & Tank Stand Sketch

Calculation Sheet

Project/Task/File No: 6-QUCCC.96	Sheet No of
Project/Description: Yaldhurst Domain Toilet Block & Tank Stand	Office:
	Computed: /08/12
	Checked: / /



CSF 400 (7/2000)

Appendix C – CERA DEEP Data Sheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Yaldhurst Domain Toilet Block	Reviewer:	Dave Dekker
	Unit No: Street	CPEng No:	1003026
Building Address:	Yaldhurst Domain	Company:	Opus International Consultants
Legal Description:		Company project number:	6-QUCCC.96
		Company phone number:	3635400
	Degrees Min Sec		
GPS south:		Date of submission:	3-Apr-14
GPS east:		Inspection Date:	August & September 2012
		Revision:	Final V2
Building Unique Identifier (CCC):	PRK_1642_BLDG_003	Is there a full report with this summary?	yes

Site

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

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):
Ground floor split?	no	Ground floor elevation above ground (m):	
Storeys below ground	0		
Foundation type:	other (describe)	if Foundation type is other, describe:	concrete slab with perimeter footing
Building height (m):	3.50	height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	36		
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	timber frame with corrugated iron cladding
Floors:	concrete flat slab	slab thickness (mm)	
Beams:			
Columns:			
Walls:	partially filled concrete masonry	thickness (mm)	

Lateral load resisting structure

Lateral system along:	partially filled CMU	**Note: Define along and across in detailed report!**	note total length of wall at ground (m):	Approx 16
Ductility assumed, μ:	1.25		wall thickness (m):	0.19
Period along:	0.40	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	partially filled CMU		note total length of wall at ground (m):	Approx 16
Ductility assumed, μ:	1.25		wall thickness (m):	0.19
Period across:	0.40	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:			
Roof Cladding:	Metal	describe	corrugated iron
Glazing:			
Ceilings:	strapped or direct fixed		
Services(list):			

Available documentation

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

Damage

Site: (refer DEE Table 4-2)

Site performance:	no damage identified	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:	significant structural	Describe:	Upgrade to at least 67% NBS
	Building Consent required:		Describe:	
	Interim occupancy recommendations:	do not occupy	Describe:	Repair water tower leg then occupiable
Along	Assessed %NBS before:	27% ##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	DEE
	Assessed %NBS after:	27%		
Across	Assessed %NBS before:	17% ##### %NBS from IEP below		
	Assessed %NBS after:	17%		

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