OPUS

*Christchurch City Council*

# Botanical Gardens Toilet Block

## PRK 1566 BLDG 024

### Detailed Engineering Evaluation

### Quantitative Assessment Report

*Christchurch City Council*

# Botanical Gardens Toilet Block

# Quantitative Assessment Report


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# Summary


Botanical Gardens Toilet Block
PRK 1566 BLDG 024

Detailed Engineering Evaluation
Quantitative Report - Summary
Draft

### Background

This is a summary of the quantitative report for the Botanical Gardens Toilet Block, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and a visual inspection carried out.

### Key Damage Observed

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

### Critical Structural Weaknesses

No critical structural weaknesses have been identified for this building.

### Indicative Building Strength

The structure has been found to have a structural capacity of 37% as governed by the capacity of the connections between the concrete roof and reinforced brick walls, and is therefore not classed as earthquake prone. It is highly recommended that the connection between the roof and walls is strengthened as the current building rating depends on frictional load paths, which are considered less reliable and robust than traditional load transferring systems.

# Contents

# 1 Introduction

Opus International Consultants Limited has been engaged by the Christchurch City Council to undertake a detailed seismic assessment of Botanical Gardens Toilet Block, located near the corner of Rolleston Ave and Worcester Street, Christchurch.

The purpose of the assessment is to assess the current seismic capacity of the building and 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 qualitative and quantitative procedures detailed in the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) [3] [4].

# 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 Background Information

## 4.1 Building Description

The Botanical Gardens Toilet Block is located in the Botanical Gardens near the corner of Rolleston Ave and Worcester Street. The building is a small, single storey reinforced brick structure with brick veneer cladding, tile lined internal walls, a concrete double tee beam roof and sits on concrete strip footings. The building has a small extension attached on the south side constructed in 1997 with brick clad timber walls and lightweight monoslope roof.

The building is approximately 8.9m long in the east-west direction and 4.4m wide in the north-south direction. The apex of the roof is approximately 3m from the ground with a wall height of approximately 2.4m. The building consists of a male bathroom at the eastern end, a female bathroom at the western end, and a small service room in the centre of the building.

Lateral restraint of the building is provided by the shear capacity of the reinforced brick walls. The original drawings indicate that the concrete roof is fixed to the walls in four discrete locations with cast in weld plates in the walls and roof units as shown in Figure 2. The analysis was conducted assuming the roof was physically fixed only at these four locations, with a contribution from friction between the roof units and bond beam on the front and rear walls.

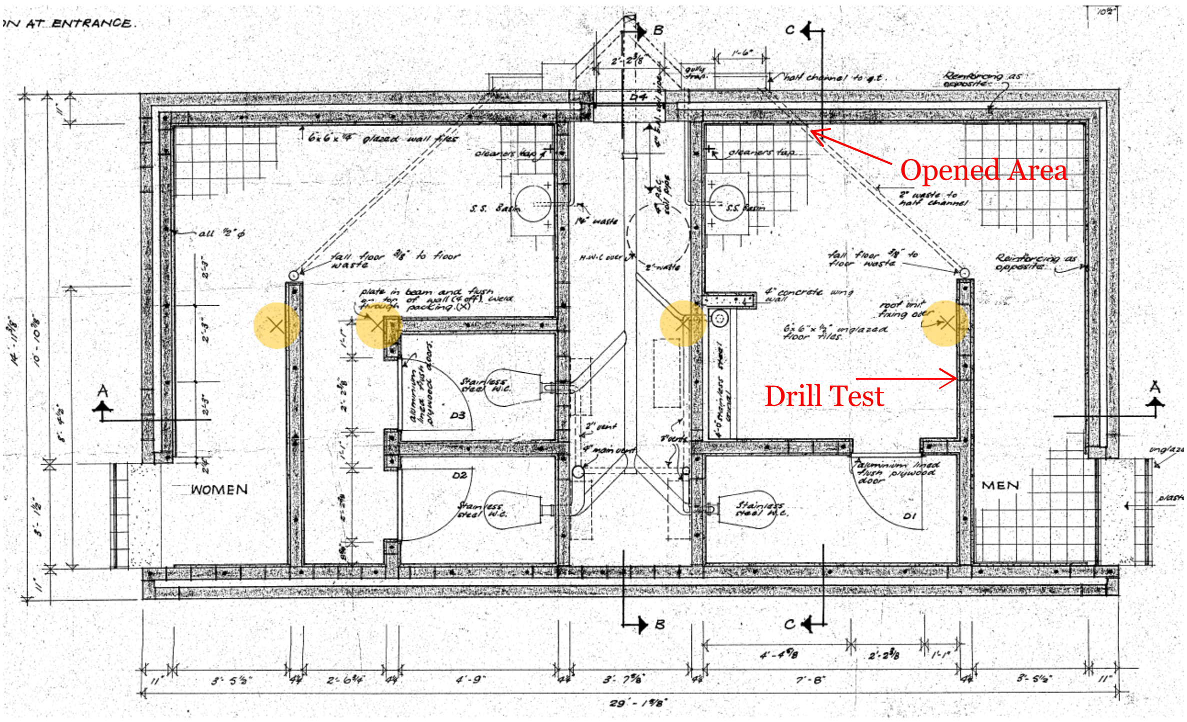


Figure 2: Wall plan of the toilets highlighting indicative locations of roof fixings.

The building was built in the 1969 with extension added in 1997 (not shown in Figure 2).

Drawings were initially unavailable at the beginning of the assessment and the results of the investigative works carried out previously by SKM did not confirm all required details. Therefore a small scale intrusive investigation of the walls was undertaken. This involved drilling into one wall and opening up a small area (one brick) of another. The positions of these works are indicated in Figure 2.

## 4.2 Original Documentation

Copies of the original structural drawings were provided. The drawings are titled "New Conveniences in Botanic Gardens for Christchurch City Council – Sheets 1 and 2" and are date stamped 22 October 1969.

# 5 General Observations

Overall the building has performed well under seismic conditions. The building has sustained only minor seismic damage.

# 6 Detailed Seismic Assessment

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

## 6.1 Critical Structural Weaknesses

The term Critical Structural Weakness (CSW) refers to a component of a building that could contribute to increased levels of damage or cause premature collapse of a building. During the initial qualitative stage of the assessment the following potential CSW's were identified for each of the buildings and have been considered in the quantitative analysis.

We have not identified any critical structural weaknesses with this building.

## 6.2 Quantitative Assessment Methodology

Due to the limited fixing of the roof to the structure, the roof was considered as a 'part' and analysed using the 'Parts and Portions' section (Section 8) of NZS 1170.5:2004. The reactions at the connections were then applied at the top of the connected walls.

The walls were analysed to resist only their self-weight and the reactions from the roof where necessary.

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.
- $\mu$ = 1.25 for reinforced brick walls.
- $\mu$ = 2 for roof part ductility factor.

## 6.3 Limitations and Assumptions in Results

Onsite observations did not identify any damage deemed severe enough to affect the capacity of the building. Consequently, the analysis and assessment is based on an assessment of the building in its undamaged state. There may have been damage to the building that was unable to be observed during the assessment that could cause the capacity of the building to be reduced; therefore the current capacity of the building maybe lower than that stated.

The results have been reported as a %NBS and the stated value is that obtained from our analysis and assessment. Despite the use of best national and international practice in this analysis and assessment, this value contains uncertainty due to the many assumptions and simplifications which are made during the assessment. These include:

a. Simplifications made in the analysis, including boundary conditions such as foundation fixity.
b. Assessments of material strengths based on limited drawings, specifications and site inspections
c. The normal variation in material properties which change from batch to batch.
d. Approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.

## 6.4 Assessment

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

Table 2: Summary of Seismic Performance

| Structural Element/System | Failure mode and description of limiting criteria based on elastic capacity of critical element. | % NBS based on calculated capacity |
|---|---|---|
| In-plane wall capacity along the building | Capacity of the reinforced brick walls along the building | 100% |
| In-plane wall capacity across the building | Capacity of the reinforced brick walls across the building | 50% |
| Out-of-Plane wall capacity | Capacity of the reinforced brick walls | 78% |
| Disabled Toilet capacity | Capacity of SHS posts. | 100% |
| Roof to wall connection capacity | Shear failure of cast in anchor rods. | 37% |

## 6.5 Discussion

The building has a seismic capacity of 37% NBS, as governed by the capacity of the connection between the roof and the walls in the transverse direction. This result is based on the assumption that some lateral load from the roof will be resisted by friction between the underside of the roof T-beams and the top of the reinforced masonry walls, with the remainder of the load passing through the connections. Friction is not considered to be a reliable load path and if these connections were to fail in a design level earthquake, the roof may permanently displace/rotate relative to the walls. It is unlikely that the level of relative displacement/rotation will lead to collapse of the roof or the building as a whole, but it has the potential to lead to costly repairs. We highly recommend strengthening the roof to wall connections in order to increase the robustness of the structure as a whole, and to mitigate against future potential damage.

# 7 Geotechnical Appraisal

No geotechnical investigation has been carried out as part of this assessment.

# 8 Conclusions

a) The building has a seismic capacity of 37% NBS and is therefore not classed as earthquake prone.

b) The seismic capacity is governed by the shear capacity of the connection between the reinforced brick walls and the roof. The assessed capacity depends on frictional resistance between the roof and walls of the building, this is considered less reliable than physical connections and it is highly recommended that the connection between the roof and walls is retrofitted.

c) The existing foundations have performed satisfactorily, and no geotechnical testing is required.

# 9 Recommendations

It is recommended that strengthening options be developed to increase the seismic capacity of the building to greater than 67%NBS and to provide a more robust seismic load resisting system for the roof.

# 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. Some non-structural damage is mentioned but this is not intended to be a comprehensive list of non-structural items.
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.

# 11 References

[1] NZS 1170.5: 2004, Structural design actions, Part 5 Earthquake actions, Standards New Zealand.

[2] NZSEE (2006), Assessment and improvement of the structural performance of buildings in earthquakes, New Zealand Society for Earthquake Engineering.

[3] Engineering Advisory Group, Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure, Draft Prepared by the Engineering Advisory Group, Revision 5, 19 July 2011.

[4] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Non-residential buildings, Part 3 Technical Guidance*, Draft Prepared by the Engineering Advisory Group, 13 December 2011.

[5] SESOC (2011), Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes, Structural Engineering Society of New Zealand, 21 December 2011.

[6] DBH (2012), Guidance for engineers assessing the seismic performance of non-residential and multi-unit residential buildings in greater Christchurch, Department of Building and Housing, June 2012.

# Appendix 1 - Photographs

| **Botanic Gardens Toilet Block** | | |
|---|---|---|
| No. | Item description | Photo |
| General | | |
| 1. | South elevation and new extension. |  |
| 2. | North elevation. |  |
| 3. | View of the internal tiled wall in the male toilets where rebar was exposed. |  |

| | | |
|---|---|---|
| 4. | Reinforcing bar exposed (1/2 inch diameter - approximately 12mm) in the north wall. |  |
| 5. | Drill test of the internal divider wall of the male toilets confirming it is made of brick. |  |
| 6. | View of a double-tee roof beam unit with 65mm topping |  |
| 7. | View of a double-tee beam bearing on a wall |  |

# Appendix 2 – CERA DEE Spreadsheet

**Detailed Engineering Evaluation Summary Data** V1.11

**Location**

| | | | |
|---|---|---|---|
| Building Name: | Botanical Gardens Toilet Block | Reviewer: | Alistair Boyce |
| | Unit / No: / Street | CPEng No: | 209860 |
| Building Address: | | Company: | Opus International Consultants |
| Legal Description: | | Company project number: | 6-QUCC2.27 |
| | | Company phone number: | 3635400 |
| | Degrees / Min / Sec | | |
| GPS south: | | Date of submission: | 23/05/2013 |
| GPS east: | | Inspection Date: | |
| | | Revision: | Final |
| Building Unique Identifier (CCC): | PRK_1566_BLDG_024 | Is there a full report with this summary? | yes |

**Site**

| | | | |
|---|---|---|---|
| Site slope: | flat | Max retaining height (m): | 0 |
| Soil type: | silty sand | 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): | 5.00 |

**Building**

| | | | |
|---|---|---|---|
| No. of storeys above ground: | 1 | single storey = 1 / Ground floor elevation (Absolute) (m): | 5.00 |
| Ground floor split? | no | Ground floor elevation above ground (m): | 0.10 |
| Storeys below ground | 0 | | |
| Foundation type: | mat slab | if Foundation type is other, describe: | |
| Building height (m): | 3.00 | height from ground to level of uppermost seismic mass (for IEP only) (m): | |
| Floor footprint area (approx): | 40 | | |
| Age of Building (years): | 43 | Date of design: | 1965-1976 |
| 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: | concrete | slab thickness (mm) | Corrugated iron cladding |
| Floors: | concrete flat slab | slab thickness (mm) | |
| Beams: | cast-insitu concrete | overall depth x width (mm x mm) | |
| Columns: | brick masonry | typical dimensions (mm x mm) | |
| Walls: | | | |

Lateral load resisting structure

| | | | | |
|---|---|---|---|---|
| Lateral system along: | concrete shear wall | **Note: Define along and across in detailed report!** | note total length of wall at ground (m): | 3.2m - 8m |
| Ductility assumed, μ: | 1.25 | | wall thickness (m): | |
| 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: | concrete shear wall | | note total length of wall at ground (m): | 3.5 |
| Ductility assumed, μ: | 1.25 | | wall thickness (m): | |
| 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: | brick or tile | describe (note cavity if exists) | |
| Roof Cladding: | Other (specify) | describe | Concrete slab on double tee beams |
| Glazing: | | | |
| Ceilings: | none | | |
| Services(list): | | | |

**Available documentation**

| | | | |
|---|---|---|---|
| Architectural | | original designer name/date | |
| Structural | full | original designer name/date | Hardie and Anderson/1969 |
| 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: | | 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?: | yes | Describe: | Lack of subfloor bracing |
| Pounding: | Damage?: | no | Describe: | |
| Non-structural: | Damage?: | no | Describe: | |

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

**Recommendations**

| | | | |
|---|---|---|---|
| Level of repair/strengthening required: | minor structural | Describe: | |
| Building Consent required: | yes | Describe: | |
| Interim occupancy recommendations: | full occupancy | Describe: | |

| | | | | | |
|---|---|---|---|---|---|
| Along | Assessed %NBS before: | 100% | ##### %NBS from IEP below | If IEP not used, please detail assessment methodology: | Quantitative |
| | Assessed %NBS after: | 100% | | | |
| Across | Assessed %NBS before: | 37% | ##### %NBS from IEP below | | |
| | Assessed %NBS after: | 37% | | | |

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