CLIENTS | PEOPLE | PERFORMANCE

# Sign of the Kiwi - Toilet Block
# PRK 1823 BLDG 004

Detailed Engineering Evaluation

Quantitative Report

Version FINAL

561 Dyers Pass Road

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

# Sign of the Kiwi – Toilet Block
# PRK 1823 BLDG 004

## Detailed Engineering Evaluation
## Quantitative Report
## Version FINAL

561 Dyers Pass Road

## Christchurch City Council


**Prepared By**
Kevan O’Brien

**Reviewed By**
David Lee


**Date**
22nd May 2013

# Contents

## Table Index



## Figure Index



## Appendices

# Quantitative Report Summary

**Sign of the Kiwi - Toilet Block**

**PRK_1823_BLDG_004**

**Detailed Engineering Evaluation**

**Quantitative Report - SUMMARY**

**Version FINAL**

**561 Dyers Pass Road**

### Background

This is a summary of the Quantitative report for the Sign of the Kiwi Toilet Block, and is based in part on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and visual inspections on 28th July 2012 and 18th October 2012.

### Building Description

The overall structure comprises of a single level toilet block. The roof and wall construction is consistent throughout. The roof is formed by lightweight corrugated steel on timber purlins, rafters, and timber trusses. Walls extending from strip footings to eaves level are formed by reinforced fully filled 190mm wide concrete masonry block units. The walls on the north and west faces of the building have additional heavy stone and mortar cladding on the external side of the masonry walls.

### Key Damage Observed

Key damage observed includes:-

- No key damage was observed.

### Critical Structural Weaknesses

No potential Critical Structural Weaknesses were identified in the structure.

### Building Strength

Based on the information available, and using the NZSEE guidelines for a Quantitative Assessment, the building's baseline post-earthquake capacity (including critical structural weaknesses and earthquake damage) has been assessed to be in the order of 74% NBS.

There were no critical structural weaknesses identified in the inspection; consequently there has been no reduction of the baseline %NBS. The building has been assessed to have a seismic capacity in the order of 74% NBS and is therefore considered to be neither Earthquake Prone nor an Earthquake Risk.

## Recommendations

The recent seismic activity in Christchurch has not caused visible damage to The Sign of the Kiwi – Toilet Block, 561 Dyers Pass Road. The building has achieved 74% NBS following a Quantitative Detailed Engineering Evaluation. Therefore further assessment is not required. In accordance with the NZSEE guidelines, no further action is required at this time.

# 1. Background

GHD has been engaged by Christchurch City Council (CCC) to undertake a detailed engineering evaluation of the Sign of the Kiwi toilet block, 561 Dyers Pass Road.

This report is a Quantitative Assessment and is based on NZS 1170.5: 2004 and NZS 4230: 2004.

The quantitative assessment of the building comprises an investigation on in-plane and out-of-plane strength of the reinforced masonry block walls. The investigation is based on the analysis of the seismic loads that the structure is subjected to, the analysis of the distribution of these forces throughout the structure and the analysis of the capacity of existing structural elements to resist the forces applied. The capacity of the existing structural elements is compared to the demand placed on the elements to give the percentage of New Building Standard (%NBS) of each of the structural elements.

Electromagnetic scans have been carried out on site to ascertain the extent of the reinforcement in the masonry walls.

At the time of this report, no finite element modelling of the building structure has been carried out.

# 2. Compliance

This section contains a brief summary of the requirements of the various statutes and authorities that control activities in relation to buildings in Christchurch at present.

## 2.1 Canterbury Earthquake Recovery Authority (CERA)

CERA was established on 28 March 2011 to take control of the recovery of Christchurch using powers established by the Canterbury Earthquake Recovery Act enacted on 18 April 2011. This act gives the Chief Executive Officer of CERA wide powers in relation to building safety, demolition and repair. Two relevant sections are:

**Section 38 – Works**

This section outlines a process in which the chief executive can give notice that a building is to be demolished and if the owner does not carry out the demolition, the chief executive can commission the demolition and recover the costs from the owner or by placing a charge on the owners' land.

**Section 51 – Requiring Structural Survey**

This section enables the chief executive to require a building owner, insurer or mortgagee carry out a full structural survey before the building is re-occupied.

We understand that CERA will require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). It is anticipated that CERA will adopt the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This document sets out a methodology for both qualitative and quantitative assessments.

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

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

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

## 2.2 Building Act

Several sections of the Building Act are relevant when considering structural requirements:

**Section 112 – Alterations**

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to any alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

**Section 115 – Change of Use**

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

### 2.2.1 Section 121 – Dangerous Buildings

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

- In the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
- In the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
- There is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
- There is a risk that other property could collapse or otherwise cause injury or death; or
- A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

**Section 122 – Earthquake Prone Buildings**

This section defines a building as earthquake prone if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property. A moderate earthquake is defined by the building regulations as one that would generate ground shaking 33% of the shaking used to design an equivalent new building.

**Section 124 – Powers of Territorial Authorities**

This section gives the territorial authority the power to require strengthening work within specified timeframes or to close and prevent occupancy to any building defined as dangerous or earthquake prone.

**Section 131 – Earthquake Prone Building Policy**

This section requires the territorial authority to adopt a specific policy for earthquake prone, dangerous and insanitary buildings.

## 2.3 Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in 2006. This policy was amended immediately following the Darfield Earthquake of the 4th September 2010.

The 2010 amendment includes the following:

- A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
- A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
- A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
- Repair works for buildings damaged by earthquakes will be required to comply with the above.

The council has stated their willingness to consider retrofit proposals on a case by case basis, considering the economic impact of such a retrofit.

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

If strengthening works are undertaken, a building consent will be required. A requirement of the consent will require upgrade of the building to comply 'as near as is reasonably practicable' with:

- The accessibility requirements of the Building Code.
- The fire requirements of the Building Code. This is likely to require a fire report to be submitted with the building consent application.

## 2.4 Building Code

The building code outlines performance standards for buildings and the Building Act requires that all new buildings comply with this code. Compliance Documents published by The Department of Building and Housing can be used to demonstrate compliance with the Building Code.

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

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

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

# 3. Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The new building standard load requirements have been determined in accordance with the current earthquake loading standard (NZS 1170.5:2004 Structural design actions - Earthquake actions - New Zealand).

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

The New Zealand Society for Earthquake Engineering has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is shown in Figure 1 below.

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

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

Table 1 compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

| Percentage of New Building Standard (%NBS) | Relative Risk (Approximate) |
| --- | --- |
| >100 | <1 time |
| 80-100 | 1-2 times |
| 67-80 | 2-5 times |
| 33-67 | 5-10 times |
| 20-33 | 10-25 times |
| <20 | >25 times |

**Table 1 %NBS compared to relative risk of failure**

# 4. Building Description

## 4.1 General

The toilet block is located at the southern end of the property at 561 Dyers Pass Road. There are no records of when the toilet was constructed however, based on site observation is estimated to be between 1989 and 2004. The toilets and additional stone veneer appear to have been renovated within the last 2 years. The park site is bordered by rural land on all sides.

The toilet is rectangular; 8m in width and 4m in length. The building has a plan area of 32m$^2$ and stands 3.1m tall. There is a shed 3m north of the toilet and the historic 'Sign of the Kiwi' building 2m to the east.

The site has been excavated into the side of a steep slope. There is an unsupported cut into the slope 1m to 1.5m from the southern face of the toilet.

Due to the plasterboard ceiling the roofs interior was unable to be observed; it is assumed timber trusses brace the roof structure and form a connection with the top of the concrete masonry block walls. The roof is clad with corrugated steel cladding.

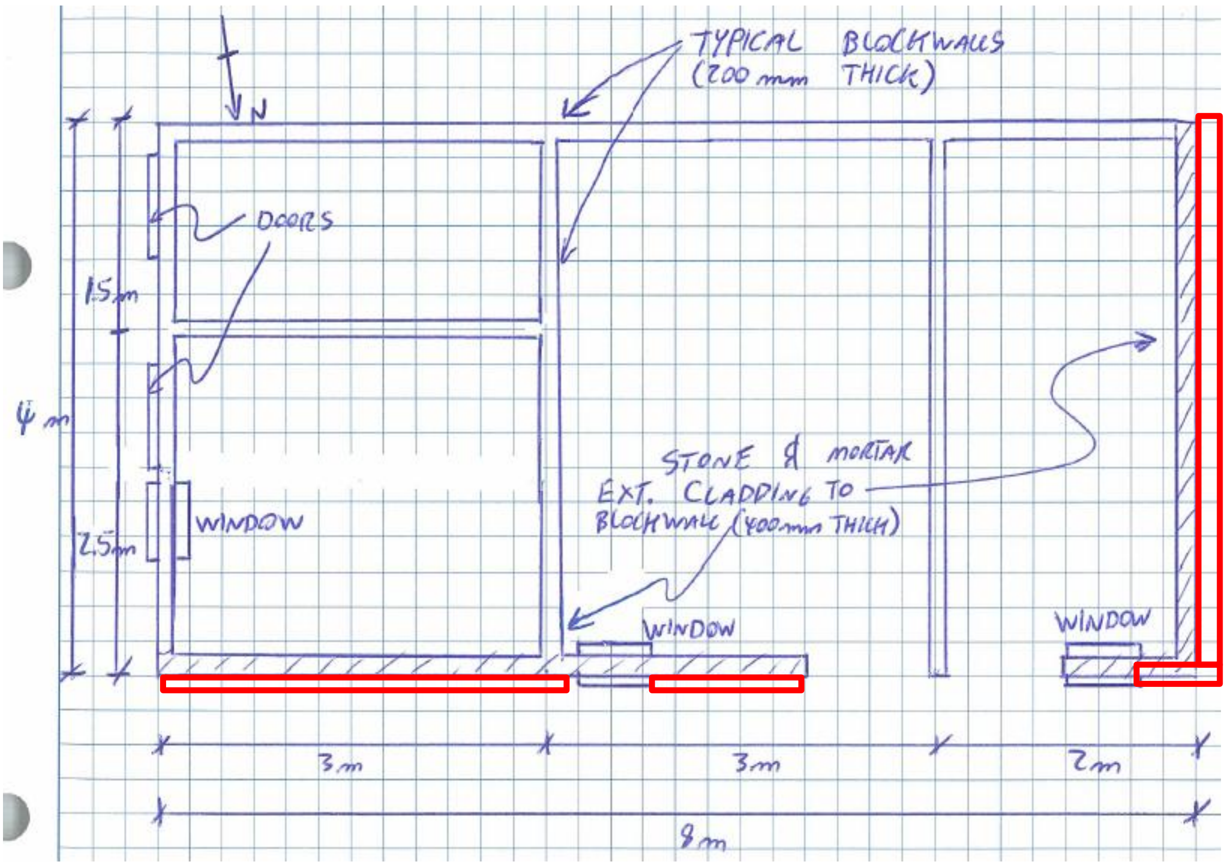


**Figure 2 Plan Sketch Showing Key Structural Elements**

All of the walls are load bearing 200 series concrete masonry block. All internal walls are lined with plasterboard. Externally, the northern and western facing block walls are clad with 200mm thick heavyweight stone and mortar to the external face. The southern and eastern block walls are clad with fibre cement sheeting.

The building floor is a concrete slab on grade. It cannot be confirmed if perimeter thickening is present in the floor.

No construction plans have been made available.

## 4.2 Gravity Load Resisting System

The gravity roof loads in the structure are supported by timber trusses along the structure. The corrugated type roof is supported by timber purlins and rafters onto the timber trusses. The roof loads are transferred into the concrete block walls at the front and rear of the building. From the block walls the loads are taken by the slab on-grade footings and then into the ground. The masonry wall loads are supported by the concrete floor slab and strip footings.

## 4.3 Lateral Load Resisting System

The roof consists of timber framing. The connections for the trusses in the roof are not visible.

The masonry walls are the primary lateral load resistance system in this structure and serve to carry wall and roof seismic loads through to the foundation level. The walls provide this function by in-plane panel action in shear and moment resistance. Upon reaching the foundations these lateral loads are dispersed into the founding soils via bearing and frictional resistance. The masonry walls are propped at the eaves level by the roof structure. The masonry walls are considered to be laterally supported by the roof framing, roof trusses and ceiling linings. Return walls also provide restraint to out-of-plane face loading to the masonry walls.

# 5. Damage Assessment

## 5.1 Surrounding Buildings

The Sign of the Kiwi toilets are located in Thompson Park in an area that is mostly rural. There are no residential properties in the area and the nearest adjacent property is approximately 800m away. The toilet block is located approximately 2m away from the café and 5m from a garage. The café building is currently cordoned off.

## 5.2 Residual Displacements and General Observations

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

No damage was evident to the concrete masonry block walls or the stone and mortar veneer of the building.

Minor cracks were visible in the slab on grade floors, but do not appear to be significant (See photograph 8).

## 5.3 Ground Damage

There was no visible evidence of ground damage or slope instability on the property or surrounding neighbouring land. The site has been classified as a green zone and is therefore considered to be safe from rock fall.

# 6. Geotechnical Consideration

## 6.1 Site Description

The site is situated within a recreational reserve, on the Port Hills in southern Christchurch. It is located on a saddle (Dyers Pass) at approximately 300m above mean sea level, with steep slopes dipping to the northwest and southeast. It is approximately 6km west of Lyttleton, and 2km north of Governors Bay.

## 6.2 Published Information on Ground Conditions

### 6.2.1 Published Geology

The geological map of the area[1] indicates that the site is underlain by Miocene volcanic rock of the Lyttleton Volcanic Group, comprising basaltic to trachytic lava flows Interbedded with breccia and tuff, numerous dikes and minor domes (Mvl).

### 6.2.2 Environment Canterbury Logs

Information from Environment Canterbury (ECan) indicates that four boreholes are located within a 400m radius of the site (see Table 2). All of these boreholes had lithographic logs, which indicate the area to typically be underlain by 0.4 to 2m of loess/colluvium, overlying volcanic rock.

**Table 2 ECan Borehole Summary**

| Bore Name | Log Depth | Groundwater | Distance & Direction from Site |
|---|---|---|---|
| M36/1026 | ~21.1m | ~2.8m bgl | 400m NE |
| M36/1027 | ~15.2m | ~2.8m bgl | 400m NE |
| M36/1028 | ~21.3m | ~2.8m bgl | 400m NE |
| M36/1029 | ~15.2m | ~2.8m bgl | 400m NE |

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

### 6.2.3 EQC Geotechnical Investigations

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

### 6.2.4 CERA Land Zoning

Canterbury Earthquake Recovery Authority (CERA) has indicated the site is situated within the Green Zone, indicating that repair and rebuild may take place.

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

Land in the CERA green zone has been divided into three technical categories. These categories describe how the land in expected to perform in future earthquakes.

The site has been classified as Technical Category N/A - Port Hills and Banks Peninsula. Properties in the Port Hills and Banks Peninsula have not been given a Technical Category due to their differing underlying geology.

### 6.2.5 Post February Aerial Photography

Aerial photography taken following the 22 February 2011 earthquake shows no signs of liquefaction outside the building footprint or adjacent to the site, as shown in Figure 3.

**Figure 3 Post February 2011 Earthquake Aerial Photography** [2]


### 6.2.6 Summary of Ground Conditions

From the information presented above, the ground conditions underlying the site are anticipated to comprise a varying thickness of loess/loess colluvium underlain by basalt.

## 6.3 Seismicity

### 6.3.1 Nearby Faults

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

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

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

| Known Active Fault | Distance from Site | Direction from Site | Max Likely Magnitude | Avg Recurrence Interval |
|---|---|---|---|---|
| Alpine Fault | 130 km | NW | ~8.3 | ~300 years |
| Greendale (2010) Fault | 23km | W | 7.1 | ~15,000 years |
| Hope Fault | 110 km | N | 7.2~7.5 | 120~200 years |
| Kelly Fault | 110 km | NW | 7.2 | ~150 years |
| Porters Pass Fault | 65 km | NW | 7.0 | ~1100 years |

Recent earthquakes since 22 February 2011 have identified the presence of a previously unmapped active fault system underneath Christchurch City and the Port Hills. Research and published information on this system is in development and not generally available. Average recurrence intervals are yet to be estimated.

### 6.3.2 Ground Shaking Hazard

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

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

Due to the sites location atop a ridgeline, there is potential for topographical amplification effects in a seismic event.

## 6.4 Slope Failure and/or Rockfall Potential

Given the site's location in the Port Hills global slope instability potential is considered moderate. The site has also been cut into the slope creating local retaining structures which increase slope instability potential.

The topography of the site and presence of discontinuous bluffs above create a potential rock fall hazard. Several fallen boulders have been mapped on the hillside above the site. Established vegetation between the subject structures and the rock bluff are likely to mitigate the rockfall potential.

In accordance with the CERA Land Status Map this site is classified as Green Zone – Repair/rebuild can begin.

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

[4] GNS Active Faults Database, http://maps.gns.cri.nz/website/af/viewer

## 6.5 Liquefaction Potential

Due to the anticipated geology and groundwater not likely near the surface, subsoil liquefaction is not considered a potential hazard for this site. In addition no effects of liquefaction were reportedly observed at the ground surface on the Port Hills.

## 6.6 Conclusions & Recommendations

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

The site appears to be situated on loess and/or loess colluvium underlain by basalt, therefore subsoil liquefaction is not considered a potential hazard for this site.

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

# 7. Assessment

An initial inspection of the building was undertaken on the 16th July 2012. A further inspection of the building and scan of the reinforcement was carried out on 18th October 2012. No placard was evident during the inspection, however based on the inspection carried out it would be expected to have a green placard. Both the interior and exterior of the building were inspected. The main structural components of the building were not able to be viewed due to the nature of the walls and the fully clad ceilings.

Electro-magnetic scanning to the reinforced masonry walls was undertaken to confirm the presence, size, and spacing of reinforcement in the walls. No drawings were made available for the structure.

The inspection also consisted of scrutinising the building to determine the structural systems and likely behaviour of the building during an earthquake. The site was assessed for damage, including examination of the ground conditions, checking for damage in areas where damage would be expected for the type of structure and noting general damage observed throughout the building in both structural and non-structural elements.

Magnetic scanning indicated vertical reinforcement to be D12 bars at 900mm centres and D12 horizontal bars at top, mid-height, and bottom of the concrete masonry block walls. The walls are assumed to be fully grout filled.

## 7.1 Quantitative Assessment

The quantitative assessment of the building includes the investigation of in-plane and out-of-plane strength of the masonry block walls. The investigation was based on the analysis of the seismic loads that the structure is subjected to, distribution of these forces throughout the structure and the analysis of the capacity of existing structural elements to resist the forces applied. A Hilti PS 200 Ferroscan was used to determine the level of reinforcement present in the walls. The capacity of the existing structural elements was compared to the demand placed on the elements to give the %NBS of each of the structural elements. A methodology of the calculation process is described in the following sections.

## 7.2 Seismic Coefficient

The elastic site hazard spectrum for horizontal loading, C(T), for the building was derived from Equation 3.1(1) of NZS 1170:2004

$$C(T) = C_h \, Z \, R \, N(T.D)$$

Where

$C_h(T)$ = the spectral shape factor determined from CL 3.1.2

Z = the hazard factor from CL 3.1.4 and the subsequent amendments which increased the hazard factor to 0.3 for Christchurch

R = 1.0, the return period factor from Table 3.5 for an annual probability of exceedance of 1/500 for an Importance Level 2 building

N(T,D) = the near-fault scaling facto from CL 3.1.6

The structural performance factor, $S_P$, was calculated in accordance with CL 4.4.2

$$S_P = 1.3 - 0.3\mu$$

Where μ is the structural ductility factor. A structural ductility factor of 1.0 has been taken for lateral loading across and along the building; this is due to the walls being constructed of reinforced, filled concrete blocks.

For T1 < 0.7s and soil class B, the seismic weight coefficient was determined in accordance with Cl 5.2.1.1 of NZS 1170.5: 2011. For the purposes of calculating the seismic weight coefficient a period, T1, of 0.4 was assumed for the in-plane masonry walls. The coefficient was then calculated using Equation 5.2(1);

$$C_d(T_1) = \frac{C(T_1)S_P}{k_\mu}$$

Where

$$k_\mu = \frac{(\mu - 1)T_1}{0.7} + 1$$

## 7.3 Bracing capacity of Reinforced Masonry Walls

### 7.3.1 Shear Capacity

The shear capacity of the reinforced fully filled masonry wall was determined using NZS 4230: 2004. As there are no details as to the level of supervision during the construction stage, the Observation Type was classed in accordance with Table 3.1. The strength reduction factor, $\phi$, for shear and shear friction was taken as 0.75 in accordance with Cl 3.4.7. The overall shear capacity of the wall was calculated from Cl 10.3.2.1, Equation 10-4;

$$V_n = v_n \, b_W \, d \, \phi$$

Where

$v_n$ = the total shear stress which consists of the contribution of the masonry, $v_m$, the axial load, $v_p$ and the contribution of the shear reinforcement, $v_s$.

$b_w$ = the thickness of the wall

d = 0.8 times the length of the wall

### 7.3.2 In-Plane Moment Capacity

The moment capacity of the reinforced filled masonry wall was determined using NZS 4230: 2004 and the user's guide to NZS 4230: 2004. The strength reduction factor, $\phi$, for flexure with or without axial tension or compression was taken as 0.85 in accordance with Cl 3.4.7. The overall moment capacity of the wall was calculated using the formula;

$$M_n = (N_n + A_s \, f_y) \times \left(\frac{t - a}{2}\right) \times \phi$$

Where

$$a = \frac{N_n + A_s f_y}{0.85 f'_m 1.0}$$

$N_n$ = the axial load due to the self-weight of the wall

$A_s$ = the area of steel reinforcement

$f_y$ = the strength of steel as specified by the NZSEE guidelines

$f'_m$ = specified compressive strength of masonry from Table 10.1

t = thickness of the masonry wall

## 7.4 Calculation of %NBS

The shear and moment capacity of the concrete masonry walls, the axial, bending and shear capacity of the concrete masonry as well as the bracing capacity of the walls both in the along and across directions were then compared to their respective demands to assess which were the most critical and thus determine the overall %NBS for the building.

# 8. Initial Capacity Assessment

## 8.1 Seismic Parameters

The seismic design parameters based on current design requirements from NZS1170:2002 and the NZBC clause B1 for this building are:

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

## 8.2 Wall Investigation

The position of each wall is indicated in the plans below and each wall is named accordingly.

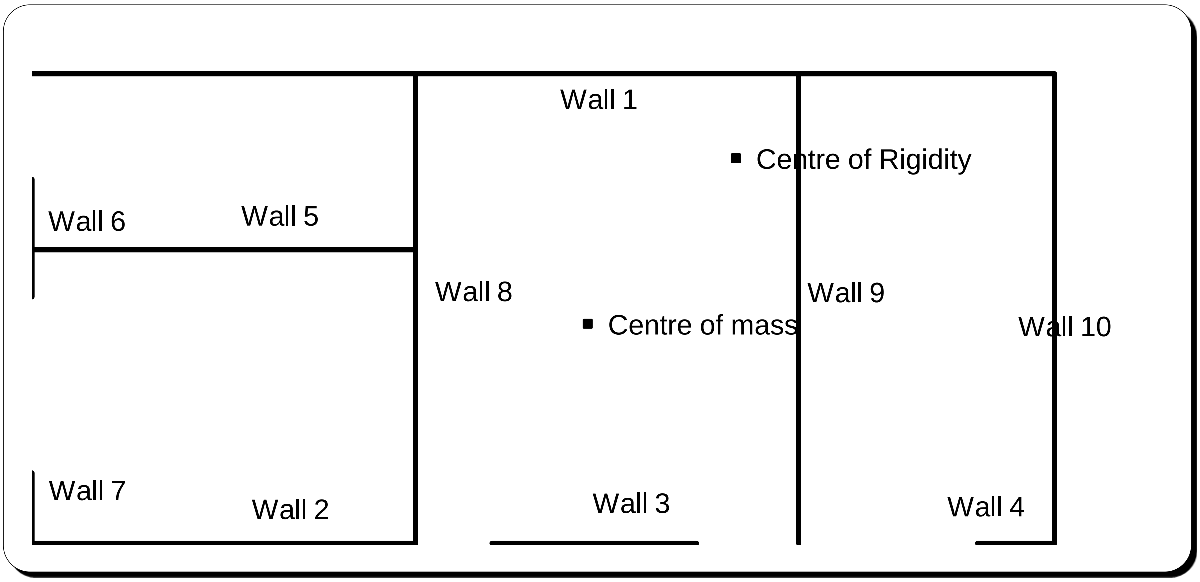


**Figure 4 Plan Details and Wall Locations**

## 8.3 Sign of the Kiwi Toilet Block Analysis Results

The results of the in plane analysis and subsequent earthquake designation under the NZSEE guidelines are listed below in Table 4.

| Wall number | V* kN | $\phi V_n$ kN | %NBS | Earthquake Status | M* kNm | $\phi M_n$ kNm | %NBS | Earthquake Status |
|---|---|---|---|---|---|---|---|---|
| 1 | 171 | 1101 | 646% | Not Risk or Prone | 409 | 1091 | 267% | Not Risk or Prone |
| 2 | 67 | 326 | 486% | Not Risk or Prone | 161 | 119 | 74% | Not Risk or Prone |
| 3 | 19 | 162 | 848% | Not Risk or Prone | 46 | 60 | 130% | Not Risk or Prone |
| 4 | 3 | 61 | 2277% | Not Risk or Prone | 6 | 10 | 156% | Not Risk or Prone |
| 5 | 35 | 326 | 919% | Not Risk or Prone | 85 | 176 | 207% | Not Risk or Prone |
| 6 | 13 | 102 | 789% | Not Risk or Prone | 31 | 27 | 86% | Not Risk or Prone |
| 7 | 5 | 61 | 1309% | Not Risk or Prone | 11 | 8 | 75% | Not Risk or Prone |
| 8 | 137 | 481 | 351% | Not Risk or Prone | 329 | 298 | 90% | Not Risk or Prone |
| 9 | 79 | 481 | 608% | Not Risk or Prone | 190 | 298 | 157% | Not Risk or Prone |
| 10 | 83 | 481 | 583% | Not Risk or Prone | 198 | 298 | 150% | Not Risk or Prone |

**Table 4 In Plane Analysis Results**

The results of the out of plane displacement response capability analysis and subsequent earthquake designation under the NZSEE guidelines are listed in Table 5.

| Wall number | M* kNm/m | $\phi M_n$ kNm/m | %NBS | Earthquake Status |
|---|---|---|---|---|
| 1 | 1.71 | 2.92 | 171% | Not Risk or Prone |
| 2 | 3.73 | 3.83 | 103% | Not Risk or Prone |
| 3 | 3.73 | 3.65 | 98% | Not Risk or Prone |
| 4 | 3.73 | 4.55 | 122% | Not Risk or Prone |
| 5 | 1.71 | 3.37 | 197% | Not Risk or Prone |
| 6 | 1.71 | 4.81 | 282% | Not Risk or Prone |
| 7 | 1.71 | 4.10 | 240% | Not Risk or Prone |
| 8 | 1.71 | 3.19 | 187% | Not Risk or Prone |
| 9 | 1.71 | 3.19 | 187% | Not Risk or Prone |
| 10 | 3.73 | 3.65 | 98% | Not Risk or Prone |

**Table 5 Out Of Plane Analysis Results**

## 8.4 Discussion of Results

The building was constructed after 1976 and was likely designed for the loading standard current at the time NZS1900:1976. The design loads specified in this code are significantly less than those required by the current loading standard. In addition, the detailing requirements for ductile seismic behaviour that are present in the current codes are unlikely to have been considered in the design of this building. Also, the increase in the hazard factor for Christchurch to 0.3 further reduces the %NBS score. However, as the building is located on class b soils and is of relatively robust construction, it has achieved 74% NBS.

# 9. Recommendations

The recent seismic activity in Christchurch has not caused visible damage to The Sign of the Kiwi – Toilet Block, 561 Dyers Pass Road. The building has achieved 74% NBS following a Quantitative Detailed Engineering Evaluation. Therefore further assessment is not required. In accordance with the NZSEE guidelines, no further action is required at this time.

# 10. Limitations

## 10.1 General

This report has been prepared subject to the following limitations:

- Drawings of the building were unavailable. As a result the information contained in this report has been inferred from visual inspections of the building and site only.
- No intrusive structural investigations have been undertaken. Electro-magnetic scanning of the walls was conducted to determine the levels of steel reinforcement present.
- No level or verticality surveys have been undertaken.
- No material testing has been undertaken.
- No calculations, other than those detailed in Section 8 have been carried out on the structure.

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

## 10.2 Geotechnical Limitations

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

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

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

# Appendix A
# Photographs

**Photograph 1 North elevation.**

**Photograph 2 View of the toilet block from the south east.**


**Photograph 3 View of the toilet block from the west.**

**Photograph 4 One of the two areas where wall reinforcement was checked.**

**Photograph 5 Southern side of block does not have stone and mortar veneer.**

**Photograph 6 Area on south side of building where reinforcement was checked.**

**Photograph 7 Rooms on the eastern end of the building were not accessible.**

**Photograph 8 Minor cracking in the concrete slab on grade floor.**

**Photograph 9 The hillside behind the toilet block is unsupported.**

Appendix B

# Existing Drawings

No existing drawings were available for the building.

Appendix C

# CERA Building Evaluation Form

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

## Location

| | | | | |
|---|---|---|---|---|
| Building Name: | Toilet - Sign of the Kiwi | | Reviewer: | David Lee |
| | Unit / No: / Street | | CPEng No: | 112052 |
| Building Address: | Dyers Pass Road / 561 | | Company: | GHD |
| Legal Description: | RES 3900 | | Company project number: | 51/30902/27 |
| | | | Company phone number: | 04 472 0799 |
| | Degrees / Min / Sec | | | |
| GPS south: | 43 / 36 / 23.13 | | Date of submission: | 22/05/2013 |
| GPS east: | 172 / 38 / 42.34 | | Inspection Date: | 16/11/2012 |
| | | | Revision: | FINAL |
| Building Unique Identifier (CCC): | PRK_1823_BLDG_004 | | Is there a full report with this summary? | yes |

## Site

| | | | |
|---|---|---|---|
| Site slope: | flat | Max retaining height (m): | 0 |
| Soil type: | mixed | Soil Profile (if available): | |
| Site Class (to NZS1170.5): | B | | |
| Proximity to waterway (m, if <100m): | | If Ground improvement on site, describe: | Slope Cutback |
| Proximity to clifftop (m, if < 100m): | | | |
| Proximity to cliff base (m,if <100m): | | Approx site elevation (m): | 360.00 |

## 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): | 0.00 |
| Storeys below ground | | | | |
| Foundation type: | strip footings | | if Foundation type is other, describe: | |
| Building height (m): | 3.10 | | height from ground to level of uppermost seismic mass (for IEP only) (m): | |
| Floor footprint area (approx): | 32 | | | |
| Age of Building (years): | 15 | | Date of design: | 1992-2004 |
| Strengthening present? | no | | If so, when (year)? | |
| | | | And what load level (%g)? | |
| Use (ground floor): | commercial | | 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 Trusses |
| Floors: | concrete flat slab | slab thickness (mm) | |
| Beams: | none | overall depth x width (mm x mm) | |
| Columns: | | | |
| Walls: | fully filled concrete masonry | #N/A | |

### Lateral load resisting structure

| | | | | |
|---|---|---|---|---|
| Lateral system along: | fully filled CMU | **Note: Define along and across in detailed report!** | | |
| Ductility assumed, μ: | 1.00 | | note total length of wall at ground (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: | fully filled CMU | | | |
| Ductility assumed, μ: | 1.00 | | note total length of wall at ground (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: | | | None |
| Wall cladding: | brick or tile | describe (note cavity if exists) | Externally - Stone brick |
| Roof Cladding: | Metal | describe | Corrugated Iron |
| 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: | | | |
| Along | Damage ratio: | 0% | Describe how damage ratio arrived at: | |
| | Describe (summary): | Cracking in floor slab | | |
| Across | Damage ratio: | 0% | | |
| | Describe (summary): | Cracking in floor slab | | |
| 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: | do not occupy | Describe: | |
| Along | Assessed %NBS before e'quakes: | 74% | ##### %NBS from IEP below | If IEP not used, please detail assessment methodology: Quantitative Assessment |
| | Assessed %NBS after e'quakes: | 74% | | |
| Across | Assessed %NBS before e'quakes: | 86% | ##### %NBS from IEP below | |
| | Assessed %NBS after e'quakes: | 86% | | |

**GHD**

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



**Document Status**

| Rev No. | Author | Reviewer | | Approved for Issue | | |
|---|---|---|---|---|---|---|
| | | Name | Signature | Name | Signature | Date |
| FINAL | Kevan O'Brien | David Lee | | Nick Waddington | | 22/05/13 |
| | | | | | | |
| | | | | | | |