OPUS

Christchurch City Council

Akaroa Museum BU 3635-002 EQ2

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Akaroa Museum

Quantitative Assessment Report

71 Rue Lavaud, Akaroa

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

Reviewed & Approved By
Alistair Boyce
Senior Structural Engineer
CPEng 209860

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

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Akaroa Museum
BU 3635-002 EQ2

Detailed Engineering Evaluation
Quantitative Report – SUMMARY
Final

71 Rue Lavaud, Akaroa

Background

This is a summary of the quantitative assessment report for the Akaroa Museum located at 71 Rue Lavaud, Akaroa, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 12 April 2012, intrusive investigation on 24 September 2012 and available drawings.

Key Damage Observed

- Minor settlement to the pavers at the entrance porch.
- Dislodged paver at base of the entrance steel portal frame.
- Out of plumb door frame at entrance way between the Concourse and Gallery 2.
- Minor cracking to internal plaster lined walls and ceilings at Concourse.
- Minor cracking to joints between the ceiling plasterboard and steel frame at the Store's mezzanine level.

Critical Structural Weaknesses

The following critical structural weaknesses have been identified:

- Gallery 1 is an unreinforced masonry (URM) building. Furthermore, the lack of roof diaphragm/bracing will result in increased levels of damage to the longitudinal east and west elevation walls. This is because the transverse seismic load cannot be transferred back to the northern and southern in-plane shear walls, causing out of plane bending to the east and west walls. This could result in brittle collapse of the wall.

- Plan irregularity in Gallery 2 & 3. There is a weakened bracing element along the south elevation of Gallery 2, which is also used to resist Gallery 3 lateral loads. The structural framing on this elevation was initially constructed with blockwall infill within the RC frame. However, during the construction of Gallery 3, most of the infill wall was removed, therefore reducing its seismic capacity. As a result, the eccentricities between the centre of rigidity and the centre of mass of the respective buildings becomes significant. In addition, part of the Gallery 3 roof load is also supported on the same structural frame further stressing the lateral capacity of this bracing element.

Indicative Building Strength (from quantitative assessment)

Based on the information available, and from undertaking a quantitative assessment, the buildings' existing seismic capacities have been assessed to be in the order of 12 – 19 %NBS except for the Store, which is estimated to have a capacity of 38%NBS. Hence, apart from the Store area, the building is therefore considered to be earthquake prone in accordance with the Building Act 2004.

The respective seismic capacities based on this quantitative assessment are as follows:

Building	Minimum Seismic Capacity [%NBS]
Gallery 1	19%
Gallery 2	12%
Gallery 3	12%
Concourse	19%
Store	38%

Recommendations
Develop options to strengthen the respective buildings to at least 67% and as nearly as is reasonably practicable to 100%NBS.

Contents

1 Introduction

Opus International Consultants Limited (Opus) has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Akaroa Museum located at 71 Rue Lavaud, Akaroa following the M6.3 Christchurch earthquake on 22 February 2011.

A qualitative assessment of the Akaroa Museum complex was undertaken by Opus in August 2012, which reported the seismic capacity of the various buildings as follows:

Building	Minimum Seismic Capacity	Risk Classification
Gallery 1	7% NBS	Grade E
Gallery 2	15% NBS	Grade E
Concourse	32% NBS	Grade D
Gallery 3	32% NBS	Grade D
Store	43% NBS	Grade C

A detailed analysis was recommended in order to more accurately determine the seismic capacity of the various buildings.

This report is a Stage Two quantitative assessment of the building structure, and is based on the qualitative and quantitative procedures detailed in the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011.

2 Compliance

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

2.1 Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

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

It is anticipated that a number of factors, including the following, will determine the extent of evaluation and strengthening level required:

1. The importance level and occupancy of the building.
2. The placard status and amount of damage.
3. The age and structural type of the building.
4. Consideration of any critical structural weaknesses.

Christchurch City Council requires any building with a capacity of less than 34% of New Building Standard (including consideration of critical structural weaknesses) to be strengthened to a target of 67% as required under the CCC Earthquake Prone Building Policy.

2.2 Building Act

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

Section 112 - Alterations

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

The Earthquake Prone Building policy for the territorial authority shall apply as outlined in Section 2.3 of this report.

Section 115 – Change of Use

This section requires that the territorial authority is satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'.

This is typically interpreted by territorial authorities as being 67% of the strength of an equivalent new building or as near as practicable. This is also the minimum level recommended by the New Zealand Society for Earthquake Engineering (NZSEE).

Section 121 – Dangerous Buildings

This section was extended by the Canterbury Earthquake (Building Act) Order 2010, and defines a building as dangerous if:

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

Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone (EPB) if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property.

A moderate earthquake is defined by the building regulations as one that would generate loads 33% of those used to design an equivalent new building.

Section 124 – Powers of Territorial Authorities

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

Section 131 – Earthquake Prone Building Policy

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

2.3 Christchurch City Council Policy

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

The 2010 amendment includes the following:

1. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
2. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
3. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,

4. Repair works for buildings damaged by earthquakes will be required to comply with the above.

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

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

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

Where an application for a change of use of a building is made to Council, the building will be required to be strengthened to 67% of New Building Standard or as near as is reasonably practicable.

2.4 Building Code

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

On 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

- Increase in the basic seismic design load for the Canterbury earthquake region (Z factor increased to 0.3 equating to an increase of 36 – 47% depending on location within the region);
- Increased serviceability requirements.

2.5 Institution of Professional Engineers New Zealand (IPENZ) Code of Ethics

One of the core ethical values of professional engineers in New Zealand is the protection of life and safeguarding of people. The IPENZ Code of Ethics requires that:

Members shall recognise the need to protect life and to safeguard people, and in their engineering activities shall act to address this need.

1.1 Giving Priority to the safety and well-being of the community and having regard to this principle in assessing obligations to clients, employers and colleagues.

1.2 Ensuring that responsible steps are taken to minimise the risk of loss of life, injury or suffering which may result from your engineering activities, either directly or indirectly.

All recommendations on building occupancy and access must be made with these fundamental obligations in mind.

3 Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The loadings are in accordance with the current earthquake loading standard NZS1170.5 [1].

A generally accepted classification of earthquake risk for existing buildings in terms of %NBS that has been proposed by the NZSEE 2006 [2] is presented in Figure 1 below.

Description	Grade	Risk	%NBS	Existing Building Structural Performance	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 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 Akaroa Museum consists of a reception area/concourse and several galleries with a climate controlled archive room, storage area and toilet facilities at the rear of the building. There are also two other heritage buildings within the site, namely, the Courthouse and the Langlois Eteveneaux Cottage; but these are not within the scope of this report. Refer to the site plan photo in Figure 2 for the layout of the buildings.

The main museum complex comprises five adjoining buildings constructed over the last 50 years. The first single storey building, (referred to as Gallery 1) was constructed in 1962. It is made up of unreinforced block cavity perimeter walls on 4 sides supported on perimeter ground beams with an unreinforced slab on grade. It has flat timber roofing with several sky lights. The building is 18.29m long, 7.2m wide and 3.7m high.

The second single storey extension (referred to as Gallery 2) was built in 1975. This area is 13.4m in length and width and has a height of 3.7m. It consists of a reinforced concrete (RC) frame with cavity blockwall infill to 3 sides and has similar roofing and foundations as Gallery 1.

The third single storey building (referred to as the Concourse) was added in 1993. It houses the current reception area and is constructed from perimeter timber framing with a concrete block veneer. The front half of the roof is a gable roof made up of corrugated steel roofing on timber trusses while the rear section has flat timber roofing. There is also an architectural entrance steel frame at the building's west elevation. The foundation consists of a perimeter RC ground beam and ground bearing slabs with slab thickenings where the internal partition walls are located. The building is 13.65m long and 6.6m wide, and the height to the roof apex is 5m.

The museum was further extended in 1998. This addition (referred to as Gallery 3) has a hipped roof made of corrugated colorsteel on timber trusses with a smaller flat roof area towards the rear. The roofing is partly supported on adjacent Gallery 2 structural framing and partly on a new internal timber partition wall and a perimeter reinforced concrete masonry (RCM) wall, which is supported on a RC ground beam. The ground bearing floor slab is a mesh reinforced RC slab with thickenings at the locations of the internal load bearing walls. The building is 13.8m long by 10.5m wide with a 6.7m high roof apex.

The most recent extension in 2008 was the storage area at the rear section of the property (referred to as the Store). It is constructed from perimeter RCM walls with internal structural steel framework supporting a flat roof and reinforced concrete mezzanine floor. The mansard roof to the mezzanine floor is made up of corrugated metal roofing on timber framing on structural steelwork. The storage building is 17.86m long by 15.64m wide, and the height of the mansard roof is 5.9m.

The museum fronts Rue Lavaud and is predominantly west facing. For the purpose of this report, we refer to the direction parallel to Rue Lavaud as north-south (or longitudinal) and the direction parallel to Rue Balguerie as east-west (or transverse) for all the buildings assessed in this report.

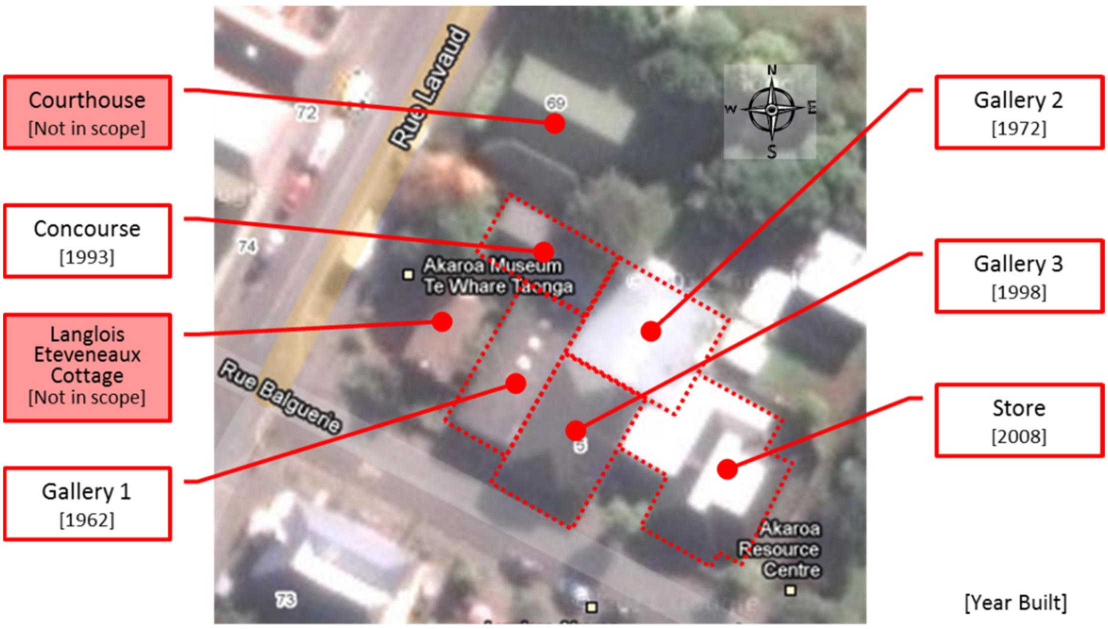


Figure 2: Akaroa Museum Site Layout

4.2 Gravity Load Resisting System

Gallery 1

The roof gravity loads are resisted by transverse 305x95mm glulam beams supported on a perimeter RC bond beam. The bond beam is supported on 280mm thick external cavity unreinforced block walls onto the full perimeter 457x267mm RC ground beams.

Gallery 2

The roof gravity loads are resisted by transverse 250x80mm glulam beams supported on 300x330mm RC ceiling cross beams, which in turn are supported on 300x380mm RC columns at the building perimeter and two internal 300x300mm RC columns. The perimeter infill cavity wall is made up from partially reinforced 150mm blockwall with a 100mm external block veneer. The foundations are generally made up of perimeter 600x300mm RC ground beams and 700x700mm RC pad foundations to the internal columns.

Concourse

The Concourse roof is divided into 2 halves. The west roof gravity load is resisted by timber trusses supported on perimeter timber framing on RC ground beams. The east roof gravity load is resisted by timber purlins on transversely spanning back to back cold formed channels supported on the Gallery 2 bond beam to the east and central internal load bearing timber framing to the west. The foundation consists of a mesh reinforced ground bearing slab with edge thickenings along the slab perimeter and slab thickenings under internal load bearing walls.

Gallery 3

The hipped roof gravity loads are resisted by transversely spanning timber trusses supported on load bearing timber stud walls at both ends. Part of the roof load to the north is supported on the Gallery 2 RC bond beam. The flat roof gravity loads are resisted by timber rafters on the perimeter RCM walls and internal timber framing. All foundations are either RC ground beams at the perimeter or slab thickenings under internal load bearing walls.

Store

The mansard roof gravity loads are resisted by 200x50mm timber joists supported on structural steel portal frames that are supported on the mezzanine floor. The mezzanine floor loads are resisted by a 75mm thick precast concrete Unispan flat slab system with a mesh reinforced 90mm topping, and the floor spans 6m longitudinally between a 310x97UC beam and perimeter 140mm/190mm thick blockwalls or 200x60UC edge beams.

The gravity loads of the flat roof above part of the ground floor level are resisted by timber joists supported on transversely spanning cranked 200 UB beams fixed to existing RC bond beams (Gallery 2 & 3) to the west and mezzanine edge beam to the east.

All foundations are either perimeter RC strip foundations; RC pad foundations under internal columns or slab thickening under internal load bearing walls.

4.3 Lateral Load Resisting System

An overview of the key lateral resisting elements for the main museum complex is shown in Figure 3 below.

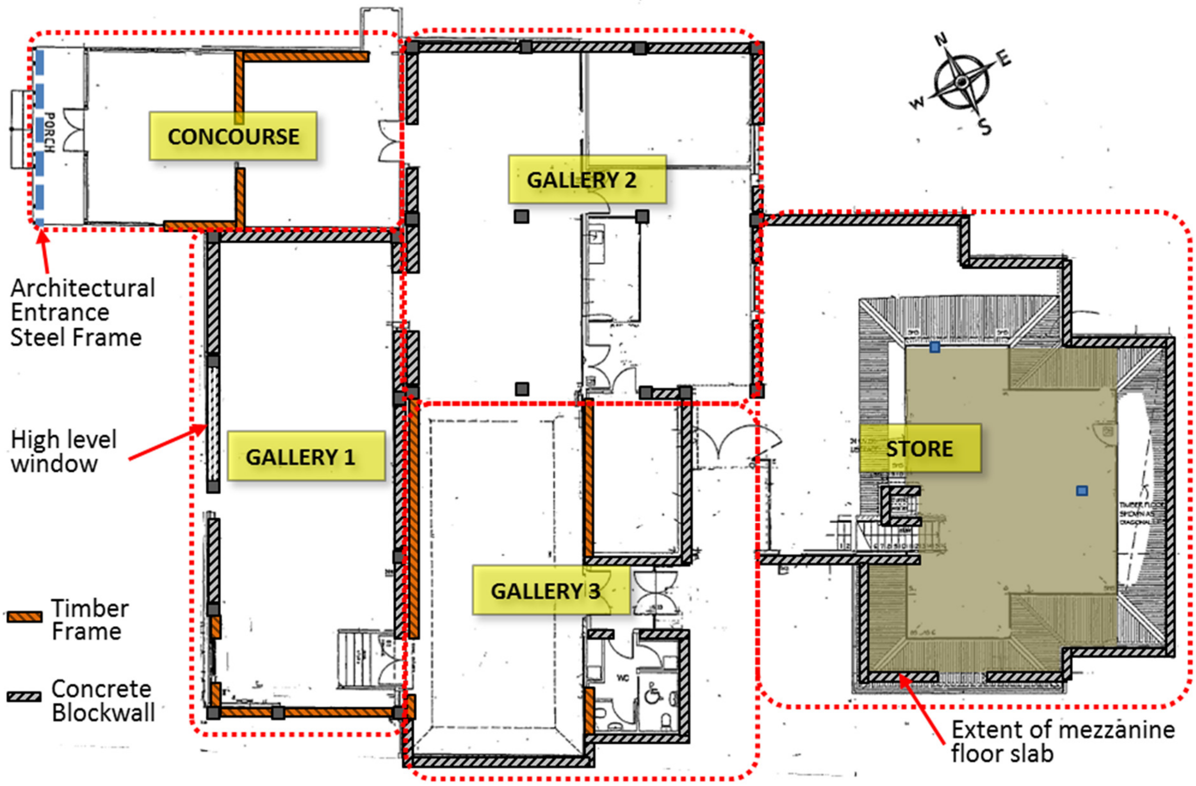


Figure 3 - Building Layout Showing Key Lateral Load Resisting System

Gallery 1
The lateral load resisting system in both principal directions is the perimeter 280mm thick external unreinforced cavity block wall acting primarily as in-plane bending shear wall. Since there is no cross bracing or roof diaphragm action due to the central row of sky light openings, the perimeter walls perpendicular to the direction of the lateral load direction would bend out-of-plane. The out of plane bending will be most severe along the longer spanning longitudinal wall, i.e. the north and south elevation walls.

Gallery 2
The lateral loads are resisted primarily by the RC frame in both orthogonal directions. In the original design, there were significant partially filled concrete masonry infill walls within the perimeter RC frame which would improve the seismic capacity. However, during subsequent alterations, additional door openings were introduced and notably the south elevation where almost the entire infill wall was removed. This has reduced the lateral resisting capacity along this bracing line.

Concourse
In the east-west direction, the lateral load is resisted by the braced timber walls along the north and south elevations and partly by the Gallery 1 north elevation cavity block wall. The north-south lateral load is resisted by the central internal braced timber wall and the Gallery 2 west elevation concrete masonry infill wall. The architectural entrance steel frame at the Concourse west elevation can be utilised to resist lateral loads.

Gallery 3
The longitudinal lateral load is resisted by the western and central timber framed walls and the RCM wall along the east elevation. In the transverse direction, the lateral load is resisted by the perimeter RCM wall to the south and the Gallery 2 RC frame to the north.

Store
The mezzanine roof lateral load is transferred to the foundation via the mezzanine floor acting as a rigid diaphragm. In the transverse direction the slab edge is connected directly to the perimeter RCM shear walls on the north and south elevation, as well as a dumb-waiter lift core to the west. Longitudinally, the lateral load is transferred to the west perimeter RCM wall and the dumb-waiter lift core where there is direct connection. Near the north east corner of the mezzanine slab, a collector element was detailed into the slab in order to transfer the lateral load into the longitudinal RCM wall located at the north east corner.

Part of the lateral load of the flat roof area is transferred to the longitudinal bracing elements of Gallery 2 and Gallery 3.

4.4 Original Documentation

Copies of the following drawings were provided by the CCC:

Gallery 1
- Part cross section and eave details only, dated 31 October 1962. Architect and engineer not known.

Gallery 2

- "Additions & Alterations to Akaroa Museum" architectural drawings sheet no. 1 to 3 by John A Hendry, dated 13 October 1975.
- "Akaroa Museum Extensions" structural drawings sheet no. 4976/S1 & S2 by Powell Fenwick & Partners, dated 25 November 1975.

Concourse

- Part "Proposed Extension to Akaroa Museum", combined architectural and engineering drawings sheet no. 1 to 4 by C.A. Pilbrow, dated March 1993.

Gallery 3

- "Alterations & Additions to Akaroa Museum", combined architectural and engineering drawings sheet no. 2462/1 to 6 (Revision A), by Pascoe Linton Sellars Architects, dated 19 November 1998.

Store

- "Akaroa Museum – New Store" architectural drawings A1.1-2, A2.1, A3.1–5, A4.1-2 by Wilkie & Bruce Architects Ltd, dated April 2008.
- "Akaroa Museum" structural drawings S0.1, S1.1-4, S2.1-4, S3.1-4 (various revisions) by Lewis Bradford Consulting Engineers, dated August 2008.

5 Survey

5.1 Post 22 February 2011 Rapid Assessment

An Engineer from Opus undertook a Level 2 assessment of the building on 3 March 2011. The inspection included external and internal visual inspections of all structural elements above foundation level, and areas of damage to structural and non-structural elements. No linings were removed.

5.2 Further Inspections

A further detailed inspection was undertaken by Opus on 12 April 2012 for the purpose of this detailed engineering evaluation. A minor intrusive investigation was carried out on 24 September 2012.

6 Damage Assessment

The following damage has been noted:

6.1 Floor Slab

No observed earthquake related damage. The museum curator highlighted an area of minor slab hogging at the north-west corner of the gallery within the Concourse. However, this is likely to be due to the root expansion of a tree adjacent to the building.

6.2 Roofing

No observed earthquake related damage.

6.3 Load Bearing Wall

No observed earthquake related damage apart from a minor crack to the blockwall in the small object room in Gallery 3.

6.4 Non Structural

- Minor settlement to the pavers at the entrance porch. See Photo 2 in Appendix 1.
- Dislodged paver at base of the entrance steel portal frame. See Photo 3 in Appendix 1.
- Out of plumb door frame at entrance way between the Concourse and Gallery 2. See Photo 4 in Appendix 1.
- Minor cracking to internal plaster lined walls and ceilings at Concourse. See Photo 5 in Appendix 1.
- Minor cracking to joints between the ceiling plasterboard and steel frame at the Store's mezzanine level. See Photo 6 in Appendix 1.

7 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.

7.1 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 quantitative stage of the assessment the following potential CSW's were identified

a) Gallery 1 is an unreinforced masonry building. Furthermore, the lack of roof diaphragm/bracing will result in increased levels of damage to the longitudinal east and west elevation walls. This is because the transverse seismic load cannot be transferred back to the northern and southern in-plane shear walls, causing out of plane bending to the north and south walls. This could result in brittle collapse of the wall.

b) Plan irregularity in Gallery 2 & 3. There is a weakened bracing element along the south elevation of Gallery 2, which is also used to resist Gallery 3 lateral loads. The structural framing on this elevation was initially constructed with blockwall infill within the RC frame. However, during the construction of Gallery 3, most of the infill wall was removed, therefore reducing its seismic capacity. As a result, the eccentricities between the centre of rigidity and the centre of mass of the respective buildings becomes significant. In addition, part of the Gallery 3 roof load is also supported on the same structural frame further stressing the lateral capacity of this bracing element.

7.2 Quantitative Assessment Methodology

The equivalent static load method was used to analyse the forces in the key components of the buildings' lateral load resisting systems. The common parameters used for the detailed analyses are as follows:

7.2.1 Seismic coefficient parameters

The seismic design parameters based on current design requirements from NZS1170.5:2004 [1] and the NZBC clause B1 for this building complex are:

- Site soil class C, clause 3.1.3 NZS 1170:2002
- Site hazard factor, Z=0.3, B1/VM1 clause 2.2.14B
- Return period factor R_u = 1.3 (from table 3.5, NZS 1170.5:2004 [1] with a 50 year design life and based on an Importance Level 3 based on the building containing contents of a high value to the community).

7.2.2 Expected ductility factors

Based on our assessment of the structural drawings and using guidance from the steel structures standard NZS3404:1997, the timber structures standard NZS3603:1993, the masonry structures standard NZS4230:2004 and the concrete structures standard NZS3101:2006, our estimates for the expected maximum structural ductility factors for the main seismic resisting systems of the respective buildings are as follows:

Building	Estimated fundamental period, T (s)	Assumed ductility, μ	
		Transverse	Longitudinal
Gallery 1	< 0.4	1.0	1.0
Gallery 2	< 0.4	1.25	1.25
Gallery 3	< 0.4	1.5	1.5
Concourse	< 0.4	2.0	2.0
Store	< 0.4	1.25	1.25

7.3 Reinforcing Estimates and Material Properties

Structural details were available for Gallery 2, Gallery 3 and the Store. For buildings where limited or no structural drawings are available, we have made assumptions of the likely structural details of typical construction practice when the building was built. Intrusive investigations were also undertaken to confirm the following critical elements:

a. the connection capacity between the Concourse roof frame and the entrance steel frame; and

b. the diameter of the steel reinforcing bar to the Gallery 1 perimeter RC columns.

The following material properties were assumed in the analysis:

Building	Strength Adopted		
	Reinforcing steel, f_y	Concrete compressive strength, f'_c	Masonry compressive strength, f'_m
Gallery 1	300 MPa [1]	25 MPa [2] based on (2,500 psi x 1.5)	8 MPa
Gallery 2	300 MPa	36 MPa	8 MPa
Gallery 3	300 MPa	n/a	8 MPa
Store	500 MPa	36 MPa	12 MPa

7.4 Limitations and Assumptions in Results

Our analysis and assessment is based on an assessment of the building 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.
- Approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.
- Uncertainty of reinforcement and structural detailing as noted in section 7.3.

[1] In accordance with Clause 7.1.1 (e) NZSEE (June 2006) [2]
[2] In accordance with Clause 7.1.1 (f) NZSEE (June 2006) [2]

7.5 Quantitative Assessment Results

Based on the criteria as listed above, the estimated structural performance of the respective primary structural load resisting elements is as follows.

7.5.1 Gallery 1

Structural Element / System	Failure mode or description of limiting criteria based on elastic capacity of critical element	% NBS (based on calculated capacity)
North-South Direction		
Perimeter cavity blockwall along the east and west elevations	Unreinforced cavity blockwall resisting in-plane load in the north-south direction. The failure mode is brittle.	100%
Common unreinforced infill blockwall between Gallery 1 and Concourse	Unreinforced cavity blockwall resisting out of plane load. The failure mode is brittle.	19%
East - West Direction		
Perimeter cavity blockwall along the east and west elevations	Unreinforced cavity blockwall resisting out of plane load. The failure mode is brittle.	19%
Common unreinforced infill blockwall between Gallery 1 and Concourse	Unreinforced cavity blockwall resisting in-plane load in the east-west direction. The failure mode is brittle.	100%
Intermediate perimeter RC column along east and west elevations.	Cantilevering RC column resisting roof seismic load and infill blockwall face loading. Failure mode is flexure.	30%

7.5.2 Gallery 2

Structural Element / System	Failure mode or description of limiting criteria based on elastic capacity of critical element	% NBS (based on calculated capacity)
North-South Direction		
RC bond beam along south elevation.	Minor axis bending of RC bond beam arising from lateral load transfer from Gallery 2 roof to Gallery 3 internal bracing wall. The failure mode is flexure.	46%
Perimeter infill concrete blockwall along west elevation	Lightly reinforced blockwall resisting in-plane load in the north-south direction. The failure mode may be brittle.	100%
East - West Direction		
RC bond beam along east and west elevation	Minor axis bending of RC bond beam transferring transverse roof lateral load to the north and south elevation shear walls. The failure mode is flexure.	77%
Internal RC cross beam (running north-south direction)	Bi-axial bending of RC cross beam resisting roof gravity load and transferring roof lateral loads to perimeter shear walls on the north and south elevations. The failure mode is flexure.	73%
Perimeter infill concrete blockwall along west elevation	Lightly reinforced blockwall resisting out-of-plane load. The failure mode may be brittle.	48%
Internal infill blockwall located between Gallery 2 & Gallery 3	RC end column of infill blockwall acting in tension resisting in-plane load in the east-west direction. The failure mode is ductile.	36%
	Shear resistance of infill blockwall transferring roof lateral load to the foundation. The failure mode is brittle.	39%
	Uplift force to the foundation below the end columns of the infill wall. Resulting excessive displacement may cause local collapse of bond beam and roof structure.	12%

7.5.3 Gallery 3

Structural Element / System	Failure mode or description of limiting criteria based on elastic capacity of critical element	% NBS (based on calculated capacity)
North-South Direction		
RC block wall along east elevation	RC blockwall resisting in-plane load in the north-south direction. The failure mode is flexure.	100%
Internal RC blockwall and timber bracing wall	RC blockwall and timber bracing wall resists lateral load in north-south direction loading. The failure mode is likely to be ductile failure of nail connection to the timber bracing wall.	40%
RC blockwall and timber bracing wall along west elevation	RC blockwall and timber bracing wall resists lateral load in north-south direction loading. The failure mode is likely to be ductile failure of nail connection to the timber bracing wall.	76%
East - West Direction		
Internal infill blockwall located between Gallery 2 and Gallery 3	As described in Gallery 2 above.	12% governs
RC blockwall along east elevation	RC blockwall resisting out-of-plane load. The failure mode is flexure	100%
Internal RC block wall adjacent to small object room	RC blockwall resisting in-plane load in the east-west direction. The failure mode is flexure.	100%
RC block wall along south elevation	RC blockwall resisting in-plane load in the east-west direction. The failure mode is flexure.	100%
	Connection capacity between timber roof truss and blockwall. The failure mode is likely to be ductile failure of nail connection between the roof frame and the top plate.	82%

7.5.4 Concourse

Structural Element / System	Failure mode or description of limiting criteria based on elastic capacity of critical element	% NBS (based on calculated capacity)
North-South Direction		
Moment resisting steel frame along west elevation	Structural steel moment resisting frame resist lateral load in the north-south direction. The failure mode is in flexure.	100%
Internal timber bracing wall	Timber bracing wall resisting lateral load in north-south direction. The failure mode is likely to be ductile failure of the nail connection.	83%
East - West Direction		
External timber bracing wall along north elevation.	Timber bracing wall resisting lateral load in east-west direction. The failure mode is likely to be ductile failure of the nail connection.	44%
Common unreinforced infill blockwall between Gallery 1 and Concourse	As described in Gallery 1 above.	19%

7.5.5 Store

Structural Element / System	Failure mode or description of limiting criteria based on elastic capacity of critical element	% NBS (based on calculated capacity)
North-South Direction		
RC blockwall along west and east elevations	RC blockwall resisting in-plane load in the north-south direction. The failure mode is flexure.	38%
	RC strip foundation resisting flexure at base of RC masonry wall.	91%
	Overturning moments on the RC blockwall. The failure mode is rocking of the wall foundation causing in-plane rotation to the wall which may result in local collapse of roof structure.	57%
	Ground bearing pressure below the strip foundation. There may be some ability for the foundation to redistribute load and to rock.	52%
East - West Direction		
Reinforced concrete masonry shear wall along north & south elevations	Reinforced concrete blockwall resisting in-plane load. The failure mode is flexure.	83%
	Overturning moments on the RC blockwall. The failure mode is rocking of the wall foundation causing in-plane rotation to the wall which may result in local collapse of roof structure.	46%
	Ground bearing pressure below the foundation. There may be some ability for the foundation to redistribute load and to rock.	61%

8 Discussion of Results

8.1 Gallery 1

Based on the analysis, Gallery 1 has a seismic capacity of approximately 19% NBS and is therefore considered to be earthquake prone in accordance with the Building Act 2004. This is limited by the perimeter unreinforced infill blockwall. Although the wall in-plane capacity is 100%NBS, the seismic capacity is governed by its out of plane bending capacity of 19% NBS.

Another earthquake prone element within Gallery 1 is the intermediate RC columns along the east and west elevations resisting transverse roof lateral loads and face loading from the infill blockwall. The seismic capacity is 30% NBS. The significant seismic demand on this structural element is due to the lack of a roof diaphragm to distribute the transverse lateral loads to the bracing walls along the north and south elevations.

8.2 Gallery 2

The seismic capacity of Gallery 2 is limited by the shear wall shared between Gallery 2 and Gallery 3. The shear wall's capacity is 36%NBS, however, the existing foundation, which has previously been modified, is inadequate to resist the resulting uplift force and therefore the seismic capacity of the element is 12% NBS. The building is therefore considered earthquake prone in accordance with the Building Act 2004.

Due to the lack of a roof diaphragm, the perimeter RC bond beams and internal cross beams at roof level also act as lateral load transfer beams. The minimum seismic capacity is 46%NBS.

8.3 Gallery 3

Gallery 3 has a seismic capacity of 12%NBS, as limited by capacity of the foundation of the shared shear wall between Gallery 2 and 3. Another significant weak lateral resistance element is the longitudinal bracing wall between the audio-visual room and the small object room. This wall comprises part timber and part blockwall, and is resisting lateral loads from Gallery 2 and Gallery 3. Its seismic capacity is calculated to be 40%NBS.

The building is therefore considered to be earthquake prone in accordance with the Building Act 2004.

8.4 Concourse

The seismic capacity of the Concourse is limited by the capacity of the common unreinforced blockwall with Gallery 1, which is 19% NBS. Otherwise, the Concourse seismic capacity is limited by the timber bracing wall along the north elevation which has a seismic capacity of 39%NBS.

This assessment considers the entrance steel frame along the west elevation as part of the north-south lateral load resisting system. The seismic capacity of the moment resisting steel frame is 100% NBS.

The building is therefore considered to be earthquake prone in accordance with the Building Act 2004.

8.5 Store

The Store's seismic capacity is calculated to be 38% NBS, which is governed by the in-plane bending capacity of the north-east corner blockwall resisting lateral load in the north-south direction. It is also assumed that the foundation is supported on good ground with an ultimate bearing capacity of minimum 300 kPa. The worst case for ground bearing capacity is 52%NBS.

9 Summary of Geotechnical Appraisal

9.1 Regional Geology

The published geological map of the area, (Geology of the Christchurch Area 1:250,000, Forsyth, Barrell and Jongens, 2008) indicates the site is located on grey river alluvium beneath plains or low-level terraces.

9.2 Peak Ground Acceleration

Interpolation of United States Geological Survey (USGS) Shakemap: South Island of New Zealand (22 Feb, 2011) indicates that this location has likely experienced a Horizontal Peak Ground Acceleration (PGA) of approximately 0.05g to 0.1 g during the 22nd February 2011

Earthquake. Estimated PGA's have been cross checked with Geonets' Modified Mercalli intensity scale observations.

9.3 Expected Ground Conditions

Two ECan borehole logs are located within 120m north of the Akaroa Museum which indicates gravel with some silt. The ground conditions at the site are expected to be similar to this borehole.

9.4 Site Observation

The building was inspected by an Opus Structural Engineer on the 12th April 2012. The following observations were made from photographs taken during the site visit:

- The Akaroa Museum building is located on a flat site.
- The building appears to be founded on a concrete perimeter footing.
- The retaining walls surrounding the south and east sides of the building appear to be in good order.
- A small creek is located 70m east of the building.
- There does not appear to have been any liquefaction in the vicinity of the building.
- The concrete paving to the south of the west entrance appears to have settled by 10mm (See Photos 2 & 3 in Appendix 1).
- Fencing adjacent to Gallery 1 is suspected to have settled (See Photo 7 in Appendix 1).
- A segment of the footpath along the southern boundary of the building has cracked and subsided (See Photo 8 in Appendix 1).

9.5 Conclusions and Discussion

The existing foundations of the Akaroa Museum complex appear to have performed satisfactorily in the recent seismic events. No liquefaction has been observed on site. The settlement of the pavers at the west entrance does not appear to have been caused by the recent seismic events. The minor cracking and subsidence of the footpath on the south side is not considered to be seismically induced damage. Due to the likely presence of silty gravels at shallow depths, the risk of lateral spreading and liquefaction induced is considered low. No further geotechnical testing is recommended at this location as part of this assessment. However, further testing may be required for the design of any strengthening works.

10 Conclusions

a. The respective seismic capacities based on this quantitative assessment are as follows:

Building	Minimum Seismic Capacity [%NBS]
Gallery 1	19%
Gallery 2	12%
Gallery 3	12%
Concourse	19%
Store	38%

b. Except for the Store, all other buildings within the Akaroa Museum complex are considered to be earthquake prone in accordance with the Building Act 2004.

c. The building foundations appear to have performed satisfactory with no observed earthquake damage.

11 Recommendation

Develop options to strengthen the respective buildings to at least 67% and as nearly as is reasonably practicable to 100%NBS.

12 Limitations

a. This report is based on an inspection of the structure of the building and focuses on the structural damage resulting from the Canterbury Earthquakes and aftershocks only. Some non-structural damage is described but this is not intended to be a complete list of damage to non-structural items.

b. Apart from the minor intrusive investigations as mentioned in this report, our inspections have been visual and non-intrusive, and no linings or finishes were removed to expose structural elements. Calculations have been limited to comparisons of seismic coefficients. No other analyses have been performed. 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 this time.

c. This report is prepared for CCC to assist with assessing the remedial works required for their buildings and facilities. It is not intended for any other party or purpose.

13 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.

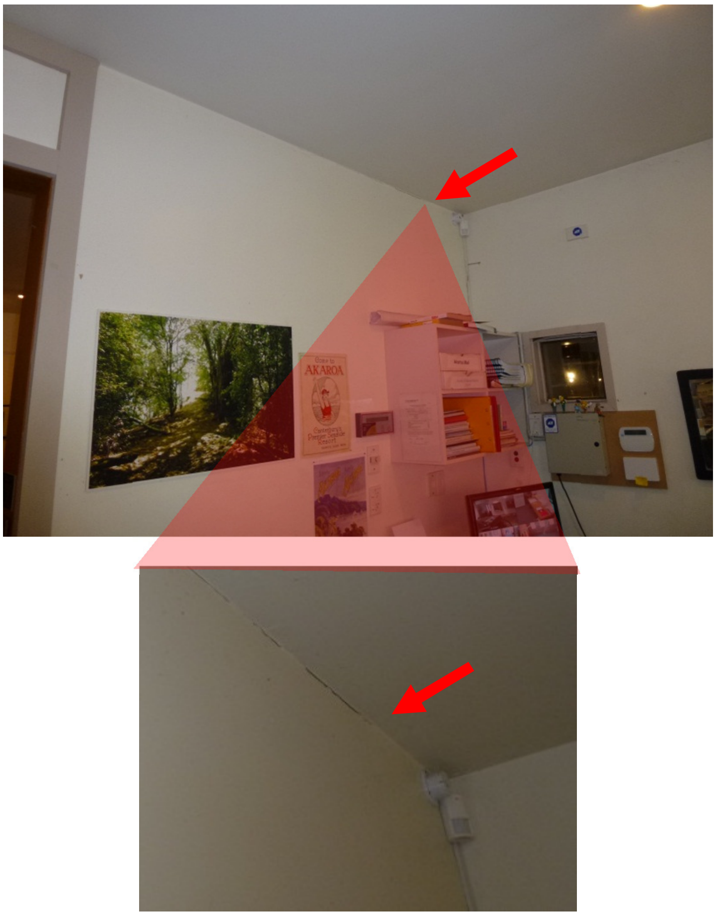
[5] SESOC (2011), *Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes*, Structural Engineering Society of New Zealand, 21 December 2011.

[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

No.	Item description	Photo
1.	General building elevations Entrance view west elevation Rear view south east elevation	 
2.	Minor localised settlement at the front entrance porch	

3.	Minor movement in the paving on the west elevation (front entrance porch)	
4.	Out of plumb door frame	

5.	Minor cracking to internal plaster lined walls and ceilings at Concourse	 

6.	Minor cracking to internal plaster lined ceilings at Concourse	 
7.	Possible settlement of the fencing	

8.	Cracking and subsidence of the footpath along the south side	

Appendix 2 – CERA DEE Data Sheets

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Akaroa Musuem - Gallery 1	Reviewer:	Alistair Boyce
	Unit No: Street	CPEng No:	209860
Building Address:	71 Rue Lavaud, Akaroa	Company:	Opus International Consultangs Ltd
Legal Description:		Company project number:	6-QUCCC.94
		Company phone number:	03-3635400
	Degrees Min Sec		
GPS south:		Date of submission:	Oct-12
GPS east:		Inspection Date:	12-Apr-12
		Revision:	Final
Building Unique Identifier (CCC):	BU 3635-002 EQ2)	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:	gravel	Soil Profile (if available):	
Site Class (to NZS1170.5):	C		
Proximity to waterway (m, if <100m):	70	If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	0.00

Building

No. of storeys above ground:	1 (single storey = 1)	Ground floor elevation (Absolute) (m):	3.50
Ground floor split?	no	Ground floor elevation above ground (m):	0.05
Storeys below ground	0		
Foundation type:	strip footings	if Foundation type is other, describe:	
Building height (m):	3.50	height from ground to level of uppermost seismic mass (for IEP only) (m):	3.5
Floor footprint area (approx):	125		
Age of Building (years):	50	Date of design:	1935-1965
Strengthening present?		If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	public	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):	museum gallery		
Importance level (to NZS1170.5):	IL3		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	brownbuilt roofing on 200x50 rafter
Floors:	other (note)	describe sytem	unreinforced concrete ground bearing
Beams:	timber	type	300x82 timber beam
Columns:			
Walls:	load bearing concrete	#N/A	280

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	other (note)	describe system	unreinforced masonry bearing wall - concrete
Ductility assumed, μ:	1.00		
Period along:	0.22 (0.00)	estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	
Lateral system across:	other (note)	describe system	URM bearing wall - concrete (OOP bending)
Ductility assumed, μ:	1.00		
Period across:	0.22 (0.00)	estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	

Separations:

leave blank if not relevant

north (mm):	0
east (mm):	0
south (mm):	
west (mm):	

Non-structural elements

Stairs:		
Wall cladding:		
Roof Cladding:	Metal	describe
Glazing:		
Ceilings:		
Services(list):		

Available documentation

Architectural	partial	original designer name/date	
Structural	none	original designer name/date	
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	partial	original designer name/date	Opus / May 12

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: By inspection, no observed damage
	Describe (summary):		
Across	Damage ratio:	0%	
	Describe (summary):		
Diaphragms	Damage?:	no	Describe:
CSWs:	Damage?:	no	Describe:
Pounding:	Damage?:	no	Describe:
Non-structural:	Damage?:	no	Describe:

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

Recommendations

Level of repair/strengthening required:	significant structural and strengthening	Describe:
Building Consent required:	no	Describe:
Interim occupancy recommendations:	do not occupy	Describe:

Along	Assessed %NBS before:	19%	##### %NBS from IEP below
	Assessed %NBS after:	19%	
Across	Assessed %NBS before:	19%	##### %NBS from IEP below
	Assessed %NBS after:	19%	

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Akaroa Museum - Gallery 2	Reviewer:	Alistair Boyce
	Unit / No: 71 / Street: Rue Lavaud, Akaroa	CPEng No:	209860
Building Address:	71 Rue Lavaud, Akaroa	Company:	Opus International Consultangs Ltd
Legal Description:		Company project number:	6-QUCCC.94
		Company phone number:	03-3635400
	Degrees / Min / Sec		
GPS south:		Date of submission:	Oct-12
GPS east:		Inspection Date:	12-Apr-12
		Revision:	Final
Building Unique Identifier (CCC):	BU 3635-002 EQ2)	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:	gravel	Soil Profile (if available):	
Site Class (to NZS1170.5):	C		
Proximity to waterway (m, if <100m):	70	If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	0.00

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	3.50
Ground floor split?	no		Ground floor elevation above ground (m):	0.05
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	isolated pad to internal columns
Building height (m):	3.50		height from ground to level of uppermost seismic mass (for IEP only) (m):	3.5
Floor footprint area (approx):	180			
Age of Building (years):	37		Date of design:	1965-1976
Strengthening present?			If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	public		Brief strengthening description:	
Use (upper floors):				
Use notes (if required):	museum gallery			
Importance level (to NZS1170.5):	IL3			

Gravity Structure

Gravity System:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	brownbuilt roofing on 200x50 rafter
Floors:	other (note)	describe sytem	concrete ground bearing slab
Beams:	cast-insitu concrete	overall depth x width (mm x mm)	280 x 300
Columns:	cast-insitu concrete	typical dimensions (mm x mm)	300 x 300
Walls:	partially filled concrete masonry	thickness (mm)	300

Lateral load resisting structure

Lateral system along:	concrete frame with infill	**Note: Define along and across in detailed report!**	note total length of wall at ground (m):	18
Ductility assumed, μ:	1.25		wall thickness (m):	0.15
Period along:	0.21	0.03 from parameters in sheet	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	concrete frame with infill		note total length of wall at ground (m):	9
Ductility assumed, μ:	1.25		wall thickness (m):	0.15
Period across:	0.21	0.07 from parameters in sheet	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):	0	
south (mm):	0	
west (mm):	0	

Non-structural elements

Stairs:			
Wall cladding:	other heavy	describe	100mm concrete block
Roof Cladding:	Metal	describe	brownbuilt metal decking
Glazing:	steel frames		
Ceilings:			
Services(list):			

Available documentation

Architectural	full	original designer name/date	John Hendry / Nov75
Structural	full	original designer name/date	Powell Fenwick / Nov 75
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	partial	original designer name/date	Opus / May 12

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:	By inspectn, min. observed eq damage
	Describe (summary):			
Across	Damage ratio:	0%		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	significant structural and strengthening	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	do not occupy	Describe:	
Along	Assessed %NBS before:	46%	##### %NBS from IEP below	
	Assessed %NBS after:	46%		
Across	Assessed %NBS before:	12%	##### %NBS from IEP below	
	Assessed %NBS after:	12%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Akaroa Museum - Concourse			Reviewer:	Alistair Boyce
	Unit	No:	Street	CPEng No:	209860
Building Address:		71	Rue Lavaud, Akaroa	Company:	Opus International Consultangs Ltd
Legal Description:				Company project number:	6-QUCCC.94
				Company phone number:	03-3635400
	Degrees	Min	Sec		
GPS south:				Date of submission:	Oct-12
GPS east:				Inspection Date:	12-Apr-12
				Revision:	Final
Building Unique Identifier (CCC):	BU 3635-002 EQ2)			Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:	gravel	Soil Profile (if available):	
Site Class (to NZS1170.5):	C		
Proximity to waterway (m, if <100m):	70	If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	0.00

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):	0.20
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	5.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	3.5
Floor footprint area (approx):	77			
Age of Building (years):	19		Date of design:	1992-2004
Strengthening present?			If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	public		Brief strengthening description:	
Use (upper floors):				
Use notes (if required):	museum gallery			
Importance level (to NZS1170.5):	IL3			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Metal deck on timberpurlin on cold formed channel or timber truss
Floors:	other (note)	describe sytem	concrete ground bearing slab
Beams:			
Columns:			
Walls:			

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**	note typical wall length (m)	2.4
Ductility assumed, μ:	2.00			
Period along:	0.16	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	2.4
Ductility assumed, μ:	2.00			
Period across:	0.16	0.00	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

north (mm):		leave blank if not relevant
east (mm):	0	
south (mm):	0	
west (mm):		

Non-structural elements

Stairs:			
Wall cladding:	other heavy	describe	100mm concrete block
Roof Cladding:	Metal	describe	colorsteel roofing
Glazing:	aluminium frames		
Ceilings:	plaster, fixed		
Services(list):			

Available documentation

Architectural	partial	original designer name/date	CA Pilbrow / Mar 1993
Structural	none	original designer name/date	
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	partial	original designer name/date	Opus / May 12

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?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	significant structural and strengthening	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	do not occupy	Describe:	
Along	Assessed %NBS before:	83%	##### %NBS from IEP below	
	Assessed %NBS after:	83%		
Across	Assessed %NBS before:	19%	##### %NBS from IEP below	
	Assessed %NBS after:	19%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Akaroa Museum - Gallery 3		Reviewer:	Alistair Boyce
	Unit / No: / Street		CPEng No:	209860
Building Address:	71 Rue Lavaud, Akaroa		Company:	Opus International Consultangs Ltd
Legal Description:			Company project number:	6-QUCCC.94
			Company phone number:	03-3635400
	Degrees / Min / Sec			
GPS south:			Date of submission:	Oct-12
GPS east:			Inspection Date:	12-Apr-12
			Revision:	Final
Building Unique Identifier (CCC):	BU 3635-002 EQ2)		Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:	gravel	Soil Profile (if available):	
Site Class (to NZS1170.5):	C		
Proximity to waterway (m, if <100m):	70	If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	0.00

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	6.50
Ground floor split?	no		Ground floor elevation above ground (m):	0.05
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	6.50		height from ground to level of uppermost seismic mass (for IEP only) (m):	4.5
Floor footprint area (approx):	140			
Age of Building (years):	14		Date of design:	1992-2004
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):	museum gallery			
Importance level (to NZS1170.5):	IL3			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber truss	truss depth, purlin type and cladding	2.4m, 100x50 purlins, colorsteel roofing
Floors:	other (note)	describe sytem	concrete ground bearing slab
Beams:	timber	type	150x50 rafters
Columns:			
Walls:	fully filled concrete masonry	#N/A	

Lateral load resisting structure

Lateral system along:	other (note)	**Note: Define along and across in detailed report!**	describe system	Fully filled CMU & light timber frame
Ductility assumed, μ:	1.50			3
Period along:	0.21	0.00	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		note total length of wall at ground (m):	15
Ductility assumed, μ:	1.50		wall thickness (m):	
Period across:	0.21	##### 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):	0	leave blank if not relevant
east (mm):	0	
south (mm):		
west (mm):	0	

Non-structural elements

Stairs:			
Wall cladding:	other light	describe	weatherboard & plaster
Roof Cladding:	Metal	describe	colorsteel roofing
Glazing:			
Ceilings:	plaster, fixed		gib ultraline
Services(list):			

Available documentation

Architectural	full	original designer name/date	Pascoe Linton Sellars / Mar 99
Structural	full	original designer name/date	Pascoe Linton Sellars / Mar 99
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	partial	original designer name/date	Opus / May 12

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:	By inspection. Min. eq damage observed
	Describe (summary):			
Across	Damage ratio:	0%		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	significant structural and strengthening	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	do not occupy	Describe:	
Along	Assessed %NBS before:	40%	##### %NBS from IEP below	
	Assessed %NBS after:	40%		
Across	Assessed %NBS before:	12%	##### %NBS from IEP below	
	Assessed %NBS after:	12%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Akaroa Museum - Store	Reviewer:	Alistair Boyce
	Unit / No: 71 / Street: Rue Lavaud, Akaroa	CPEng No:	209860
Building Address:	71 Rue Lavaud, Akaroa	Company:	Opus International Consultangs Ltd
Legal Description:		Company project number:	6-QUCCC.94
		Company phone number:	03-3635400
GPS south: (Degrees / Min / Sec)		Date of submission:	Oct-12
GPS east:		Inspection Date:	12-Apr-12
		Revision:	Final
Building Unique Identifier (CCC):	BU 3635-002 EQ2)	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:	gravel	Soil Profile (if available):	
Site Class (to NZS1170.5):	C		
Proximity to waterway (m, if <100m):	70	If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	0.00

Building

No. of storeys above ground:	2 (single storey = 1)	Ground floor elevation (Absolute) (m):	5.70
Ground floor split?	no	Ground floor elevation above ground (m):	0.05
Storeys below ground	0		
Foundation type:	strip footings	if Foundation type is other, describe:	
Building height (m):	5.70	height from ground to level of uppermost seismic mass (for IEP only) (m):	5.7
Floor footprint area (approx):	250		
Age of Building (years):	4	Date of design:	2004-
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	other (specify)	Brief strengthening description:	
Use (upper floors):	other (specify)		
Use notes (if required):	storage area for musuem		
Importance level (to NZS1170.5):	IL3		

Gravity Structure

Gravity System:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	2.4m, 100x50 purlins, colorsteel roofing
Floors:	other (note)	describe sytem	insitu conc on unispan
Beams:	steel non-composite	beam and connector type	200UB25
Columns:	structural steel	typical dimensions (mm x mm)	200SHS
Walls:	fully filled concrete masonry	#N/A	

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	fully filled CMU	note total length of wall at ground (m):	22
Ductility assumed, μ:	1.25	wall thickness (m):	0.14
Period along:	0.16 (0.05 from parameters in sheet)	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	note total length of wall at ground (m):	30
Ductility assumed, μ:	1.25	wall thickness (m):	0.14
Period across:	0.16 (0.03 from parameters in sheet)	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):	0	

Non-structural elements

Stairs:	timber	describe supports	timber stringer fixed to blockwall
Wall cladding:	other light	describe	Fibre cement weatherboard
Roof Cladding:	Metal	describe	corrugated roofing
Glazing:	aluminium frames		
Ceilings:	plaster, fixed		13mm gib board
Services(list):			

Available documentation

Architectural	full	original designer name/date	Wilkie & Bruce / Jan 09
Structural	none	original designer name/date	
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	partial	original designer name/date	Opus / May 12

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:	By inspection. Min. eq damage observed.
Describe (summary):			
Across — Damage ratio:	0%		
Describe (summary):			
Diaphragms — Damage?:	no	Describe:	
CSWs: — Damage?:	no	Describe:	
Pounding: — Damage?:	no	Describe:	
Non-structural: — Damage?:	no	Describe:	

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

Recommendations

Level of repair/strengthening required:	none	Describe:	
Building Consent required:	no	Describe:	
Interim occupancy recommendations:	full occupancy	Describe:	

Along	Assessed %NBS before:	38%	##### %NBS from IEP below
	Assessed %NBS after:	38%	
Across	Assessed %NBS before:	46%	##### %NBS from IEP below
	Assessed %NBS after:	46%	

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

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