STRUCTURAL CONCEPTS LIMITED
Emajineer™ Conceptualisers
55 DUNLOP ROAD, PO BOX 3315, NAPIER, 4142, NEW ZEALAND – P (06) 842 0111 – F (06) 842 0113 – E info@structuralconcepts.co.nz

Our Ref: 1584

30 June 2011

Insight Unlimited Ltd
P.O Box 1219
GISBORNE 4040

Attention: John Radburn

Dear John,

Re: Opawa Library – POST-EARTHQUAKE INSPECTION

Scope of this Report

This report covers our assessment of the structural condition of the Opawa Library building at 151 Opawa Rd, Opawa, Christchurch, following the magnitude 6.3 earthquake on 22nd February 2011. Our assessment is based on a visual inspection inside and out, which was carried out on the 28th April 2011and again on 11th May 2011.

This report describes the damage observed, and comments on remedial work options for both temporary securing of the building, and long term repair where appropriate. This report does not cover a detailed structural strength assessment or detailed specification of remedial works, which may be required by the client following consideration of this report.

1. Scope of Investigation

On the 28th April 2011and again on 11th May 2011, we visually inspected the building including:
The exterior from ground level
The interior

This report is based on our assessment of the building at the time stated. Photos attached in Appendix A are indicative of the damage. Any subsequent loading by aftershocks, or high winds, may initiate further damage.

2. Building Description

General description:
The Opawa Library is a single storey gable structure consisting of double skin unreinforced brick walls with light timber framed roof structure supporting concrete roof tiles. The building is approximately 11m wide by 22m long and approximately 240m2 with an eaves

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dimension approximately 3.0m. It has a small lean to attached of approximately 10m2 to the rear. The occupancy classification is library.
The building was first constructed in the early 1900's, with the rear addition added at a later date.

The building was being used as a library, but is currently unoccupied due to earthquake damage. The occupancy classification in NZS1170 is E (Reading rooms with book storage e.g. libraries) with an occupant load of 36 as classified by the Building Code Clause C table 2.2 and importance level of 2.

Roof construction:
Concrete tiles on timber framing.

External Wall construction:
Double skin unreinforced brick walls with solid plaster over.

Internal Wall construction:
Double skin unreinforced brick walls with solid plaster over. Light timber framing lined with plasterboard.

Floor construction:
Timber framing on piles, with a concrete perimeter foundation wall.

Structural System:
The structural system can be described as face loaded unreinforced masonry nominally supported at floor level and ceiling/roof level but nominal diaphragms taking loads back to unreinforced masonry walls acting in-plane. Load then transfers to mass concrete foundations to the ground.

3. Strength
The strength of the building has been determined as a % NBS using methodologies provided by NZSEE.
Before September 2010:
The strength of the building before September 2010 is determined as
Using pre 19 May 2011 site hazard coefficient of 0.22

Main Building	40% NBS
Gables	14% NBS

Using post 19 May 2011 site hazard coefficient of 0.3

Main Building	30% NBS
Gables	10% NBS (using post 19 May 2011 site hazard factor of 0.3)

On day of inspection:
The strength of the building on the day of inspection is determined as
Using post 19 May 2011 site hazard factor of 0.3

Main Building	30% NBS
Gables	0% NBS

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The % NBS determined relies upon the ceiling acting as a diaphragm adequately tied to the walls and it has also been assumed that there is a concrete beam running around the top of the wall. These elements have yet to be confirmed and require destructive investigation to assess. From our inspection of the ceiling and walls and their intersection we believe that this is a reasonable assumption for the %NBS level determined.

4. Damage Description

Damage caused by the February earthquake to the Opawa Library is described below. Damage described is additional to earlier earthquake damage. Refer to Appendix B for marked-up drawings indicating damaged locations.

i. General Damage:
General damage includes cracking of plaster on masonry walls and foundations.

ii. Damage to Gables:
The Front Gable has collapsed. The remaining two side gables on the original building are cracked at their support and leaning.

iii. Damage to Join between Original and Extension:
A large vertical crack has opened up between the original construction and extension.

iv. Damage to Interior Walls:
The interior walls have numerous cracks in the surface plaster to brick walls and timber framed walls

v. Damage to Ceilings:
The ceilings have numerous cracks mainly around the edges and in the front portion of the building.

vi. Liquefaction:
There is general liquefaction around the greater local area but none adjacent to the building. Liquefaction does not appear to have affected the foundations.

5. Immediate Securing of the Building

The following works are required to mitigate immediate hazards, temporarily secure the building, and provide weather tightness:
Fence of site completely and restrict access especially adjacent gables and at the vertical crack location.
The three front gables should be removed and a temporary plywood lining over new framing installed to provide temporary water proofing.
The wall adjacent the vertical crack should be propped to prevent the possibility of collapse.
Access to the front section of the building is viable without further need for securing.
Books etc may be retrieved under supervision of an Engineer.

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Due care, safety equipment and precautions must be taken when carrying out the above work. Maintain awareness of fall hazards and escape routes if entering the building.

6. Long Term Repair

This section of the report outlines options for repair to restore the building to its pre-earthquake condition. Options for repair and/or strengthening will need to be discussed with the owner, and will be subject to revised local authority legislation.

i. Gables:

Install new timber framing and solid plaster gable on cavity battens to the three gables to the original building.

ii. Joint Between Original and Extension:

Seal crack using a pressure injected epoxy (e.g. Sikadur injectokit and Sikadur520, or similar). Install new steel plate to exterior and interior and bolt through wall sandwiching the wall plus install new bolts epoxied into the back of the return wall.

iii. General Cracking to Foundations:

Seal all cracks in concrete foundation wall larger than 0.2mm with a pressure injected epoxy (e.g. Sikadur injectokit and Sikadur52[0)], or similar). Seal smaller cracks by painting over with a brushable crack filler (e.g. Resene Brushable Crack Filler).

iv. General Interior Repair to Cracks in Walls and Ceilings:

Repair as appropriate using one of the following: Grind-out v-shape into cracked plaster. Re-plaster and overlay crack with fibreglass reinforcing mesh. Re-plaster over to provide a smooth finish. Remove lath and plaster walls and replace with Braceline GIB, or plaster over corru-lath/rib-lath.
In all cases, wall ties and hold-down straps should be installed in accordance with GIB braced wall and ceiling diaphragm specifications.
Realign, re-fix and re-paint racked door frames and architraves.

iv. Strengthening to provide 67%NBS or 100%NBS if this was necessary:

Two options are available

1. Strengthening could be completed the installation of ceiling diaphragms and substantial fixings between diaphragm and walls. Walls will require strengthening for face loading via ties being installed between the brick skins (e.g. Helifix Cemtie) and either filling the cavity or installing steel mullions internally.

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2. Strengthening could be successfully completed by removing the internal brick skin and replacing it with a new timber framed wall. Tying the external skin to the new framing. Install new linings to provide any bracing required. Install conventional ceiling diaphragms. Steel studs will be required adjacent windows to support any concrete lintels.

   Either option is likely to bring the building back up to 100%NBS by default.

The costs associated with the repairs would require the appropriate professional to visit the site to view the extent of damage. At this stage we have not provided any specific detailing for repair works but can so at your request.

7. Elements Not Inspected

The following is a list of elements not specifically inspected:

- Subfloor construction
- Piles
- Roof space
- Soils

8. Limitations

Findings presented in this report are for the sole use of the client. The findings may not contain sufficient information for use by other parties, and as such should not be relied upon unless discussed with Structural Concepts Ltd. We have exercised our services in a professional manner using a degree of care and skill normally, under similar circumstances, by reputable consultants practicing in this field at this time. No other warranty, expressed or implied, is made as to the professional advice presented in this report.

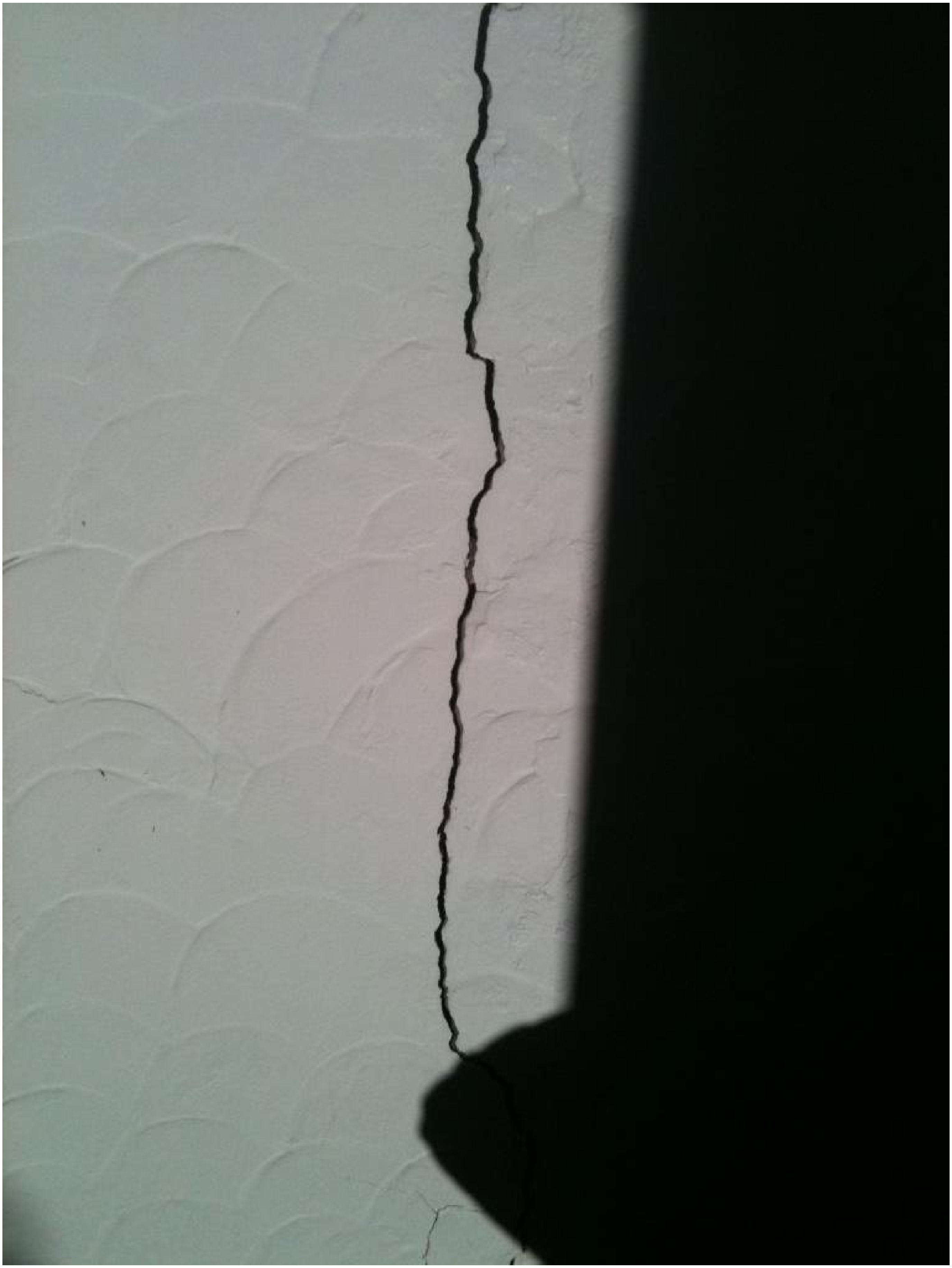
Yours faithfully
STRUCTURAL CONCEPTS LTD

Garry Newton
BE (Civil), MIPENZ(Civil, Structural), CPEng, IntPE(NZ)

Director

APPENDIX A. PHOTOGRAPHS

Please note that the photographs provided in this report are not high quality and are for providing information that shows the indicative damage found around the building for structural engineering assessment only.

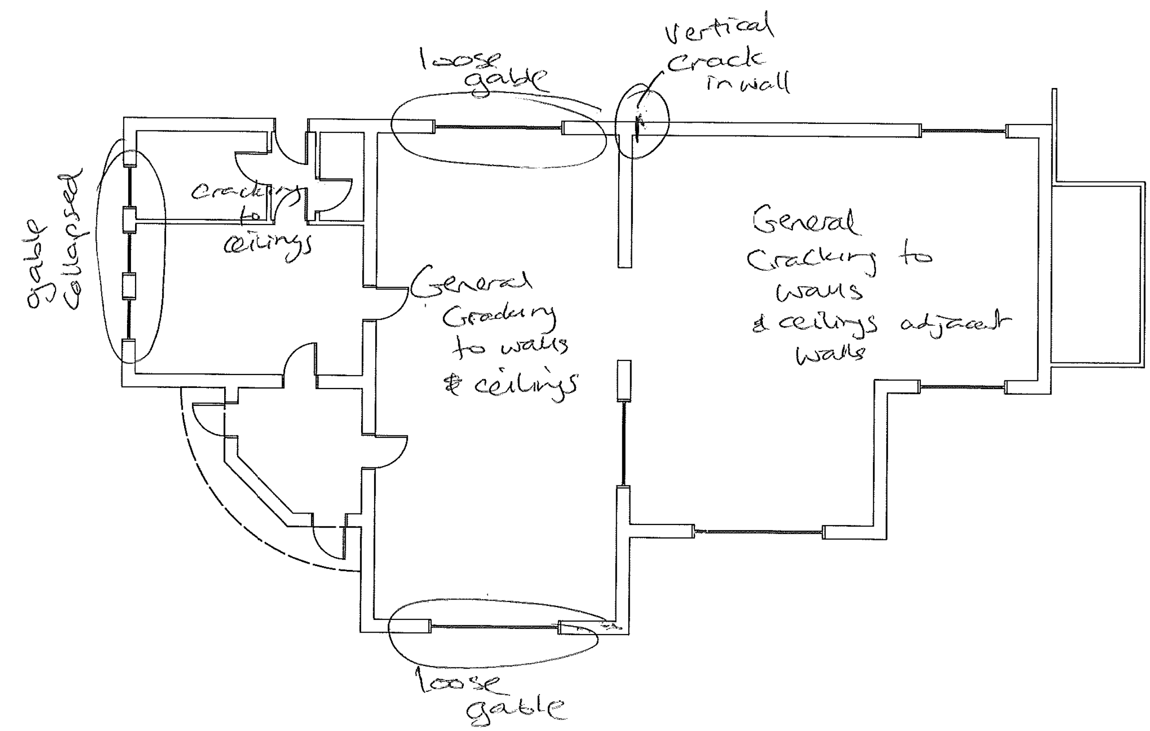



OPAWA
OPAWA
LIBRARY
HOURS


OPAWA
LIBRARY


FIRE EXIT

APPENDIX B. MARKED-UP DRAWING INDICATING DAMAGED LOCATIONS



OPAWA LIBRARY
1:100 at A3

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APPENDIX C. REPAIR AND STRENGTHENING WORKS

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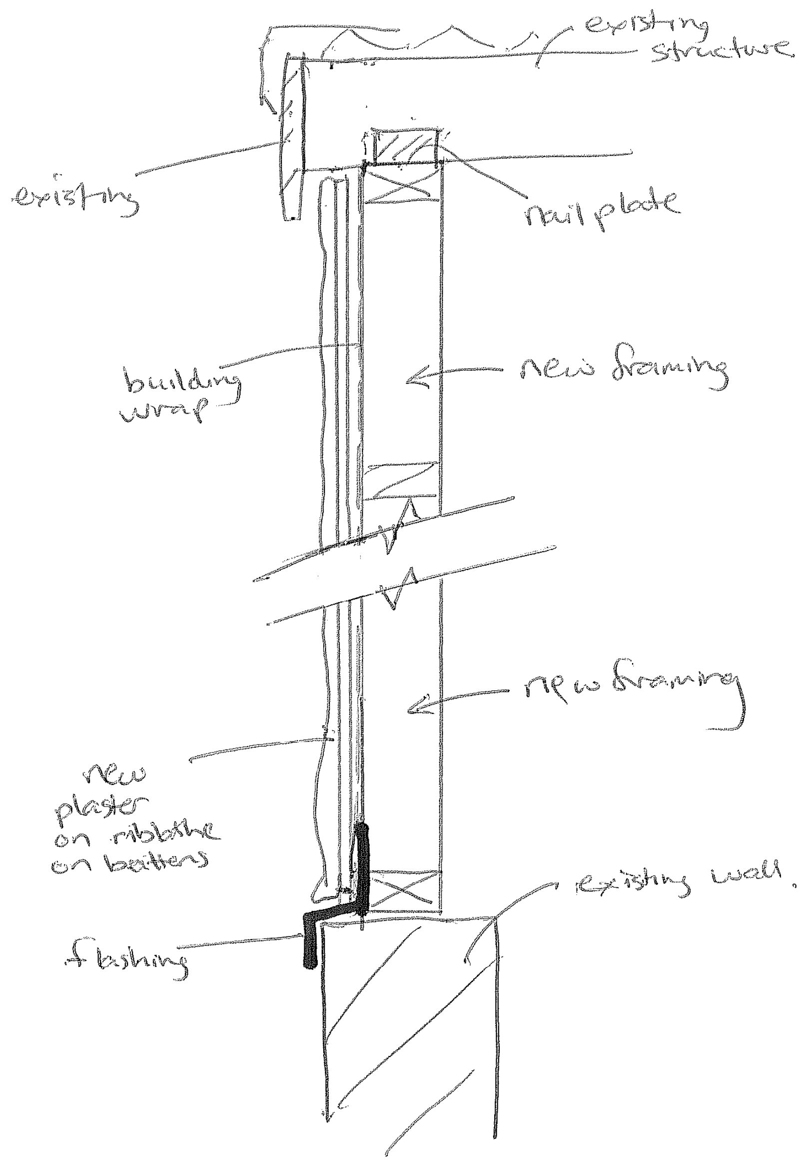
Client:	Christchurch City Council	Ref:	1584
Project:	Opawa Library	Date:	26/5/11
	151 Opawa Road, Opawa, Christchurch	BY:	GN
Subject:			

Sheet No.: SK 1

Sketch Details Gable Sketch – Section



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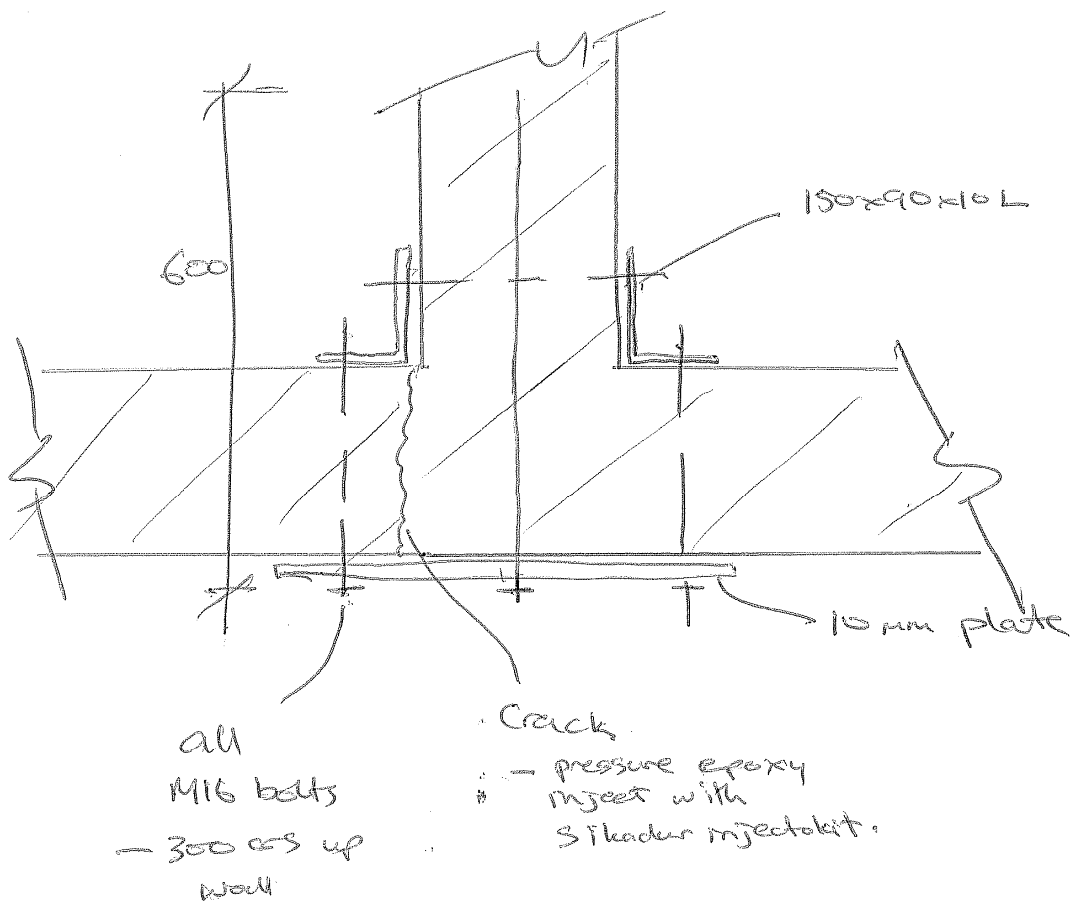
	151 Opawa Road, Opawa, Christchurch	BY:	GN
Subject:			

Sheet No.: SK2

Sketch Details Crack Repair



APPENDIX D. DESIGN FEATURES REPORT

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Client: Christchurch City Council

Project: Opawa Library
151 Opawa Road, Opawa, Christchurch

Ref: 1584

Date: 26-May-11

CALCULATIONS

BY GARRY NEWTON

BE (Civil) , MIPENZ(Civil, Structural), CPEng, IntPE(NZ)

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Design Features Report

Scope

In general terms, the scope of work is as follows:
- Provide bracing design for timber frame building for a residential building.

Means of compliance

The following standards have been used:
- NZS 1170.0:2002
- NZS 1170.1:2002
- NZS 1170.5:2004

THE STRUCTURE

General

The building is constructed of double skin unreinforced brick walls on a concrete ring foundation. The ground floor is timber over joists and bearers on piles. The roof consists of light timber framed roof structure supporting concrete roof tiles. The location of the building is 151 Opawa Road, Opawa, Christchurch. The importance level for the building has been assessed as Importance Level 2. The design life of the structure is 50 years. For the purpose of analysis, the across and along directions are as per the geometric shape.

Chosen Design Life	50 Years
Chosen Importance Level	2
Annual Probability of exceedance (inverse) Ultimate	500
Annual Probability of exceedance (inverse) Service	25

Gravity structure

Load paths: Trusses/rafters → Walls → → foundations

Lateral load resisting structure

Across the building
Roof → In-plane masonry walls → foundations →

Along the building
Roof → In-plane masonry walls → foundations →

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Significant Design Features

There are no special design features.

SOIL CONDITIONS

No specific Soils investigation or report has been completed at this time. We have noticed that there has been lateral spread and liquefaction adjacent to the building and we recomend that a specific soils report be sort to confirm design assumptions. at this stage we have assumed low bearing pressures of factored ULS 75 kPa.

DESIGN LOADS

Vertical loads

All Dead loads are listed on the gravity loads sheet at the front of these calculations.

All Live loads are listed on the gravity loads sheet at the front of these calculations.

Lateral Loads

Wind

Site wind speed 37.35 Ult (m/s)

Further information on wind speeds, internal pressures etc are on the main wind load sheets contained in these calculations.

Seismic loads

Analysis methodology

The seismic analysis has been completed in accordance with NZS 1170.5:2004. Design Spectra are in accordance with NZS 1170.5:2004 for site sub soil class D. Analysis has been completed using the Equivalent Static Method for bracing. A Seismic Hazard Factor of Z=0.3 has been used.

Across the building

Structural ductility factor (Ultimate)	μ	2.00
Structural Performance factor (Ultimate)	Sp	1.00

Along the building

Structural ductility factor (Ultimate)	μ	2.00
Structural Performance factor (Ultimate)	Sp	1.00

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SERVICEBILITY CRITERIA

The following servicebility criteria have been chosen for the project:
Note: These are generally in line with those recommanded in NZS1170.2 Table C1.

Seismic deflections/storey drift	Criteria	Phenomenon controlled
Maximum allowable deflection (SLS)	spacing/200	Damage to cladding
Maximum allowable storey Drift (ULS)	height/40	Soft storey protection
Wind deflections		
Maximum allowable lateral deflection (SLS)	spacing/200	Damage to cladding
Maximum allowable vertical deflection (SLS)	span/200	Damage to cladding/finishes
Gravity deflections		
Maximum allowable deflection (SLS)	span/500	Visual sag

SOFTWARE

The following computer applications were used for the design:

Analysis type	Software used
Stuctural analysis	Excel 2009
Structural design	Excel 2009

Significant or Special Construction Features

None.

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Project:	Opawa Library	Date:	26/5/11
	151 Opawa Road, Opawa, Christchurch	BY:	GN
Subject:	Gravity Loads		

Loads

Roof

Concrete tiles	0.530
Timber 20.6	0.092
Purlins 05 .4	0.034
Battens 05 1.2	0.011
Rockwool Insu.	0.002
Gypsum Plaster	0.130
	0.800 kPa

External Walls

brick	2.200
brick	2.200
Lime Plaster	0.240
Lime Plaster	0.240
	4.880 kPa

Timber floor

21mm Particie Bd	0.150
Timber 20.6	0.092
90. Nogs & plates	0.067
Battens 05 1.2	0.011
Rockwool Insu.	0.002
Gib Board 13	0.120
	0.442 kPa

Partitions

Timber 10.4	0.069
90. Nogs & plates	0.067
Gib Board 10	0.090
Gib Board 10	0.090
	0.316 kPa

Live loads

E Reading rooms	4.00	kPa
R2 Roofs	0.25	kPa

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Client:	Christchurch City Council	Ref:	1584
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	151 Opawa Road, Opawa, Christchurch	BY:	GN
Subject:	Seismic loads to NZS1170		

Seismic Loads to NZS 1170.5 — Sheet No.: 6

Ref: | Design | Output

Design working live — 50 Years

Importance level — 2

Annual Probability of exceedance (inverse) Ultimate — 500

Annual Probability of exceedance (inverse) Service — 25

Element			Area/length	Load Kpa	Total kN
Roof			120.00	0.80	95.94
External Walls			60.00	4.88	292.80
			0.00	0.00	0.00
			0.00	0.00	0.00
			0.00	0.00	0.00
			0.00	0.00	0.00
	1.00	0.40	0.00	0.00	0.00

388.74 kN

Live load reduction

Total floor area 0.0

$$.3+\frac{3}{\sqrt{A}} = 1.000$$

But not less than .5

Total building weight

388.74 kN

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Subject:	Seismic loads to NZS1170		

Sheet No.: 7

Ref:	Design				Output
	Soil type				
	C. Shallow Soil				
	Across the building				
	Period of building across the building		0.40		
	Does the seismic bracing have ductile capabilities but is designed as nominally ductile				☐
	Structural ductility factor (Ultimate)	m =	2.00		
	Structural ductility factor (Service SLS1)	m =	1.25		
	Hazard Factor Christchurch	Z =	0.3		
	Return period factor	Ru =	1.00		
	Return period factor	Rs =	0.25		
	Structural Performance factor (Ultimate)	Sp =	0.70		
	Structural Performance factor (Service)	Sp =	0.70		
	Spectral Shape Factor (across)	Ch(T) =	2.36		
	Near Fault factor	N(T,D) =	1.0	n/a	
	Elastic site spectra (Ultimate)	C(T) =	0.71		
	Elastic site spectra (Service)	C(T) =	0.18		
	Ultimate	km =	1.57		
	Service	km =	1.14		
	Ultimate				
	Horizontal design action coefficients (Across)	Cd(T1) =	0.32	But not less than 0.030Ru	
	Ultimate force across the building	Cd(T1) x Wi =	122.60	kN Total	
	Service				
	Horizontal design action coefficients (Across)	Cd(T1) =	0.11		
	Service force across the building	Cd(T1) x Wi =	42.14	kN Total	
	Along the building				
	Period of building along the building		0.40		
	Does the seismic bracing have ductile capabilities but is designed as nominally ductile				☐
	Structural ductility factor (Ultimate)	m =	2.00		
	Structural ductility factor (Service SLS1)	m =	1.25		
	Structural Performance factor (Ultimate)	Sp =	0.70		
	Spectral Shape Factor (across)	Ch(T) =	2.36		
	Near Fault factor	N(T,D) =	1.0		
	Elastic site spectra (Ultimate)	C(T) =	0.71		
	Elastic site spectra (Service)	C(T) =	0.18		
	Ultimate	km =	1.57		
	Service	km =	1.14		
	Ultimate				
	Horizontal design action coefficients (Across)	Cd(T1) =	0.32	But not less than 0.030Ru	
	Ultimate force along the building	Cd(T1) x Wi =	122.60	kN Total	
	Service				
	Horizontal design action coefficients (Across)	Cd(T1) =	0.11		
	Service force across the building	Cd(T1) x Wi =	42.14	kN Total	