OPUS

Christchurch City Council

Hagley Park South Garage and Soil Shed PRK 1507 BLDG 005 EQ2

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Hagley Park South Garage and Soil Shed

Quantitative Assessment Report

Hagley Avenue, Christchurch

Prepared By

Mark Ryburn
Senior Structural Engineer

Reviewed By

Dave Morrison
Senior Structural Engineer
CPEng 229083

Approved By

Paul Campbell
Principal Structural Engineer
CPEng 197688

Opus International Consultants Ltd
Wellington Civil
Level 7, Majestic Centre, 100 Willis St
PO Box 12 003, Wellington 6144
New Zealand

Telephone: +64 4 471 7000
Facsimile: +64 4 471 1397

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Reference: 6-QUCC1.90
Status: Final

Summary

Hagley Park South Garage and Soil Shed
PRK 1507 BLDG 005 EQ2

Detailed Engineering Evaluation
Quantitative Report - SUMMARY
Final

Background

This is a summary of the quantitative report for the Hagley Park South Garage and Soil Shed, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections and sketches on 10 August 2012.

Key Damage Observed

No damage was identified.

Critical Structural Weaknesses

No critical structural weaknesses have been identified.

Indicative Building Strength

Based on the information available, and from undertaking a quantitative assessment, the building's seismic capacity has been assessed to be greater than 100%NBS across and along the building.

Due to the compliant capacity and the lack of observed damage, no further action is recommended.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Hagley Park South Garage and Soil Shed, located in South Hagley Park, Hagley Avenue, following the M6.3 Christchurch earthquake on 22 February 2011.

The purpose of the assessment is to determine if the building is classed as being earthquake prone in accordance with the Building Act 2004.

The seismic assessment and reporting have been undertaken based on the 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.

Any building with a capacity of less than 34% of new building standard (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67% as required by 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).

Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) 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 CCC as being 67% of the strength of an equivalent new building. 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.

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:

- 36% increase in the basic seismic design load for Christchurch (Z factor increased from 0.22 to 0.3);
- Increased serviceability requirements.

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

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

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

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

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

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

3 Earthquake Resistance Standards

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

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

Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance: Legal Requirement	Improvement of Structural Performance: NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
Moderate Risk Building	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). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance 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

[1] This Order only applies to buildings within the Christchurch City, Selwyn District and Waimakariri District Councils authority

they are made aware of our assessment. Based on information received from CERA to date, 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/Christchurch City Council 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.

4 Building Description

4.1 General

The Hagley Park South Garage and Soil Shed building is a single storey, lightweight clad timber framed garage and shelter enclosed on three sides.

The building is approximately 12m long in the east-west direction and 6m wide in the north-south direction. The apex of the roof is approximately 3m from the ground and the stud height is approximately 2.4m

The building age is unknown, but it is expected to have been built in the last 10years as existing drawings for the site showed a different building which has been replaced in that time.

4.2 Gravity Load Resisting System

The roof is a timber framed clad in corrugated iron sheet with steel strap bracing and timber rafters onto timber framing and lightweight metal cladding.

The ground floor is a slab on grade with likely minimal reinforcement and local piles for the cantilever timber poles.

4.3 Seismic Load Resisting System

Seismic loads in both directions are resisted by the cantilever poles and to some degree by the lightweight cladding although the fixing of this cladding is minimal and the internal framing is not in accordance with NZS3604 requirements.

5 Survey

The building does not currently have a placard and we are not aware if one has been assigned previously.

Copies of the following drawings were referred to as part of the assessment:

- Measured-up sketches of the building completed by Opus, titled "Hagley Park South Garage and Soil Shed, Existing Plan and Section".

No copies of the design calculations or structural drawings have been obtained for this building.

The sketch drawings and survey photos have been used to confirm the structural systems, investigate potential critical structural weaknesses (CSW) wherever possible, and identify details which required particular attention.

6 Damage Assessment

The building structure does not appear to have suffered any damage as a result of the recent earthquake events. There are some areas of cladding with local buckling although these are not likely from seismic events.

7 General Observations

Overall the building has performed well under seismic conditions which would be expected for a single-storey timber framed structure. It is likely this structure would be wind-governed due to its open nature and lightweight construction.

No foundation details were available.

8 Detailed Seismic Assessment

8.1 Critical Structural Weaknesses

As outlined in the Critical Structural Weakness and Collapse Hazards draft briefing document, issued by the Structural Engineering Society (SESOC) on 7 May 2011, 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 the building.

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

8.2 Seismic Coefficient Parameters

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

- Site soil class D, clause 3.1.3 NZS 1170.5:2004;
- Site hazard factor, Z=0.3, B1/VM1 clause 2.2.14B;
- Return period factor R_u = 1.0 from Table 3.5, NZS 1170.5:2004, for an Importance Level 2 structure with a 50 year design life;
- μ_{max} = 1.25 for cantilever columns as per NZS3603.

8.3 Detailed Seismic Assessment Results

A summary of the structural performance of the building is shown in the following table.

Table 2: Summary of Seismic Performance

Structural Element/System	Failure mode and description of limiting criteria	% NBS based on calculated capacity
Walls in the longitudinal direction	Cantilever flexural capacity of the columns	>100%
Walls in the transverse direction	Cantilever flexural capacity of the columns	>100%

8.4 Discussion of Results

The building has a calculated capacity exceeding 100%NBS across and along the building. This is based on the capacity of the cantilever poles.

8.5 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:

- Foundation details could not be confirmed and the assessment assumes these are adequate.
- 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.

9 Geotechnical Assessment

Due to a lack of observed ground damage, no geotechnical assessment was carried out.

10 Conclusions

The building has a seismic capacity of greater than 100%NBS and is therefore classified as a low earthquake risk building in accordance with the Building Act 2004. This classification is based on the adequacy of the foundation details and the fact the building is likely to be wind governed.

Due to the compliant capacity and the lack of observed damage, no further action is recommended.

11 Limitations

a. This report is based on an inspection of the structure with a focus on the damage sustained from the 22 February 2011 Canterbury Earthquake and aftershocks only. Some non-structural damage is mentioned but this is not intended to be a comprehensive list of non-structural items.
b. Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at the time.
c. This report is prepared for the CCC to assist with assessing remedial works required for council buildings and facilities. It is not intended for any other party or purpose.

12 References

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

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

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

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

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

Appendix A – Photographs

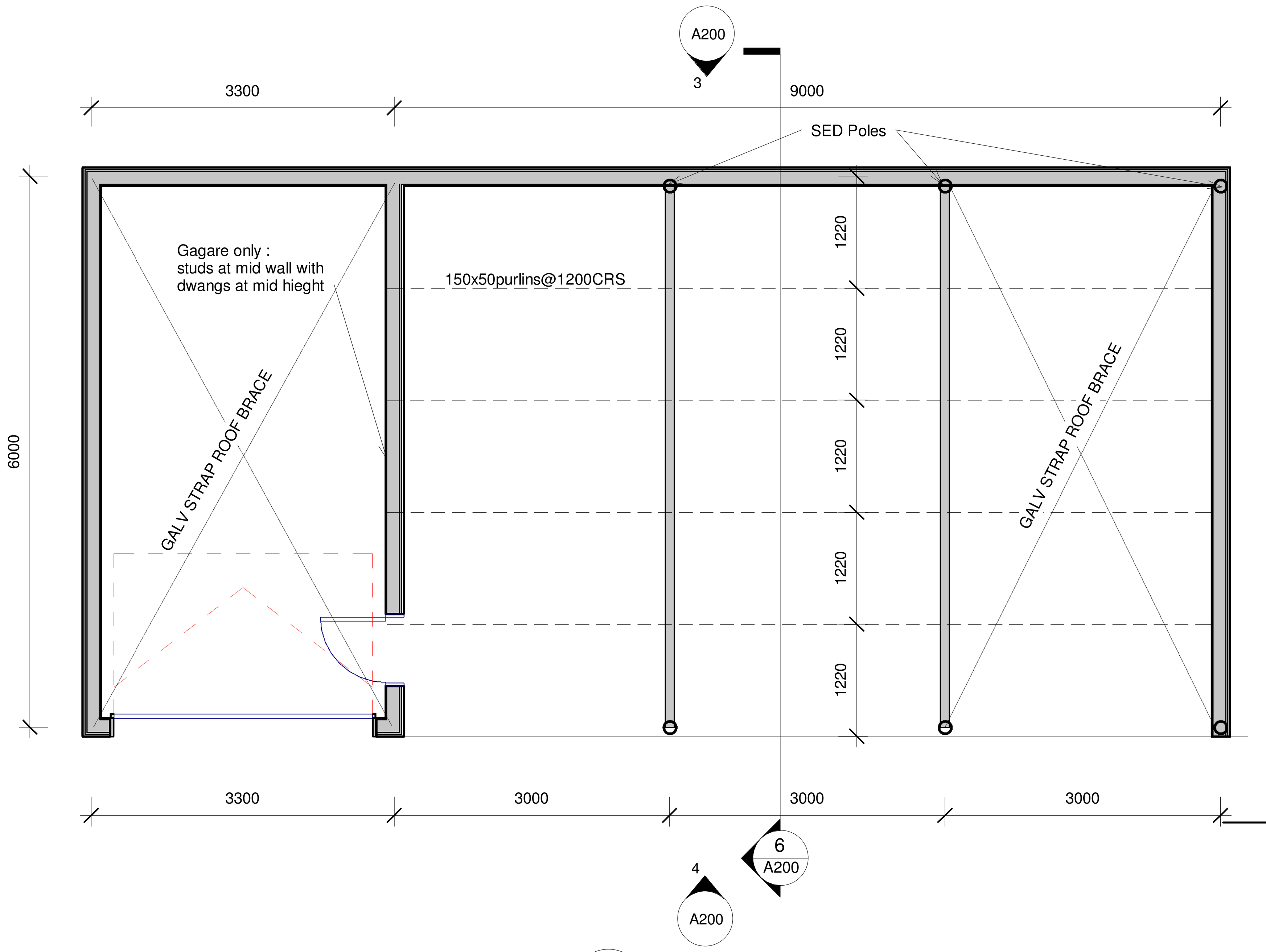
Photo 1: Front View of Building

Photo 2: View of Soil Shed Area

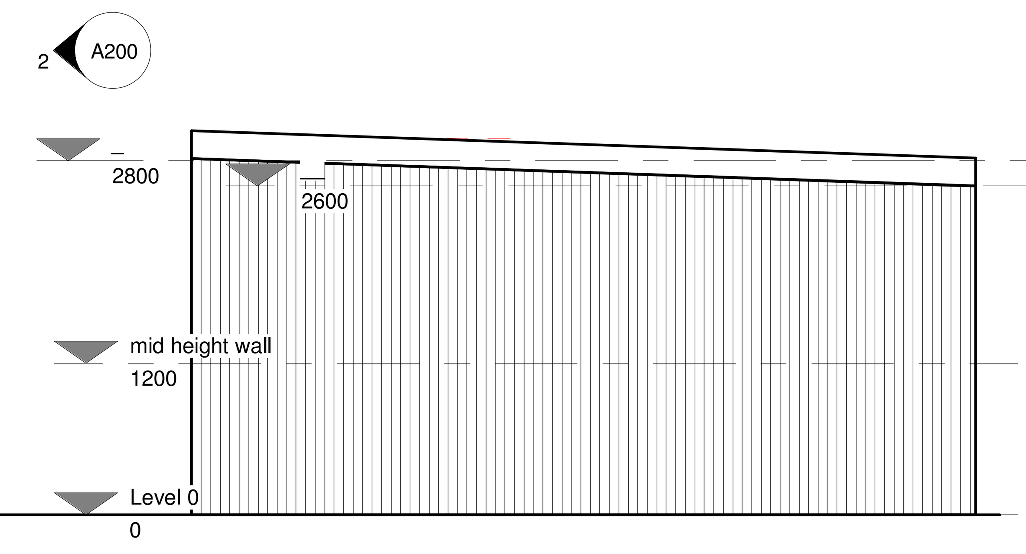
Photo 3: View of Garage Area

Photo 4: View of Roof Detail

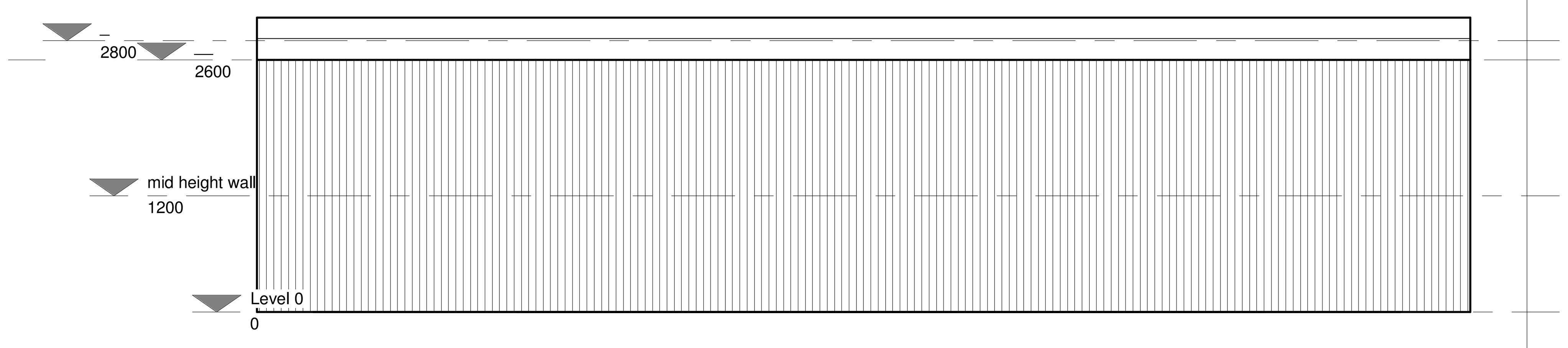
Appendix B – Measure-up Sketches



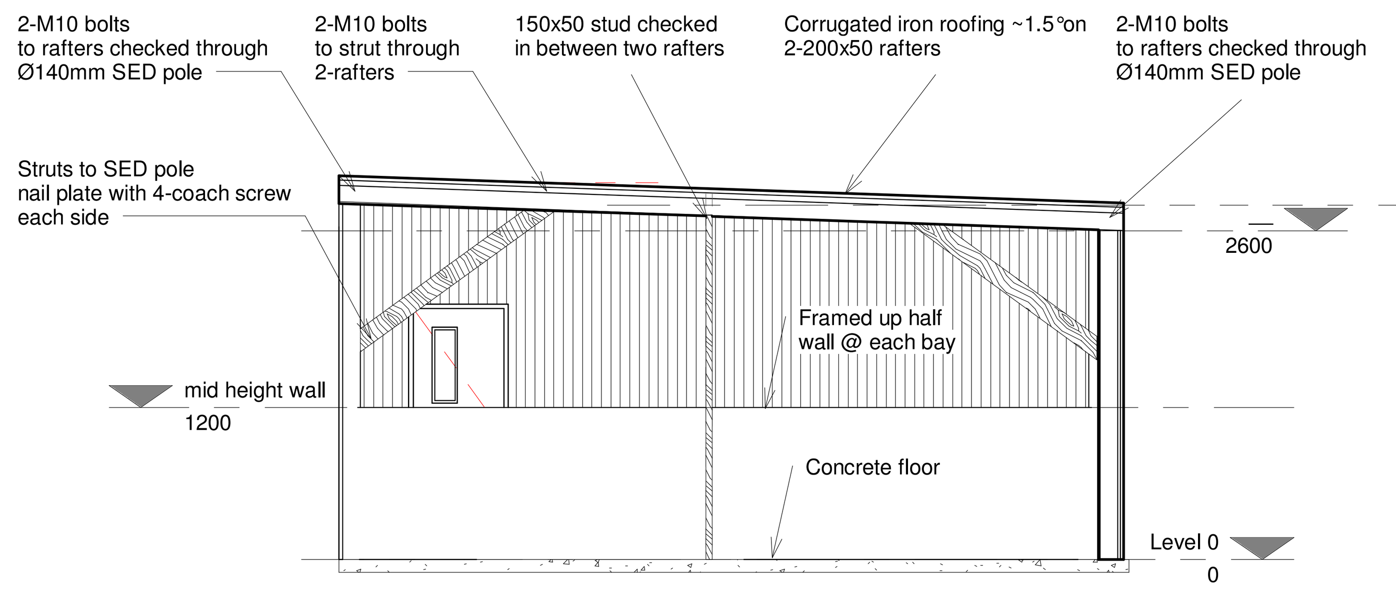
1 A200 Level 1 Plan
1 : 50



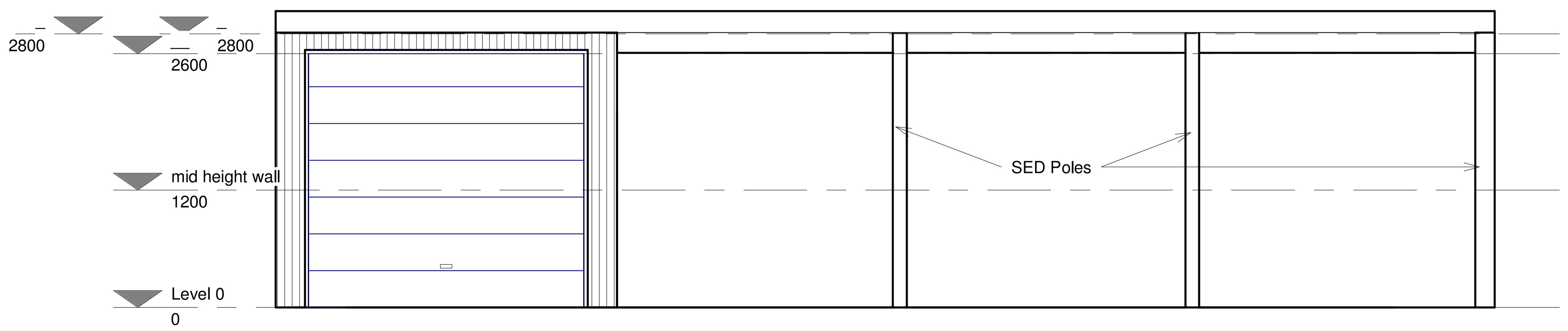
2 A200 WEST
1 : 50



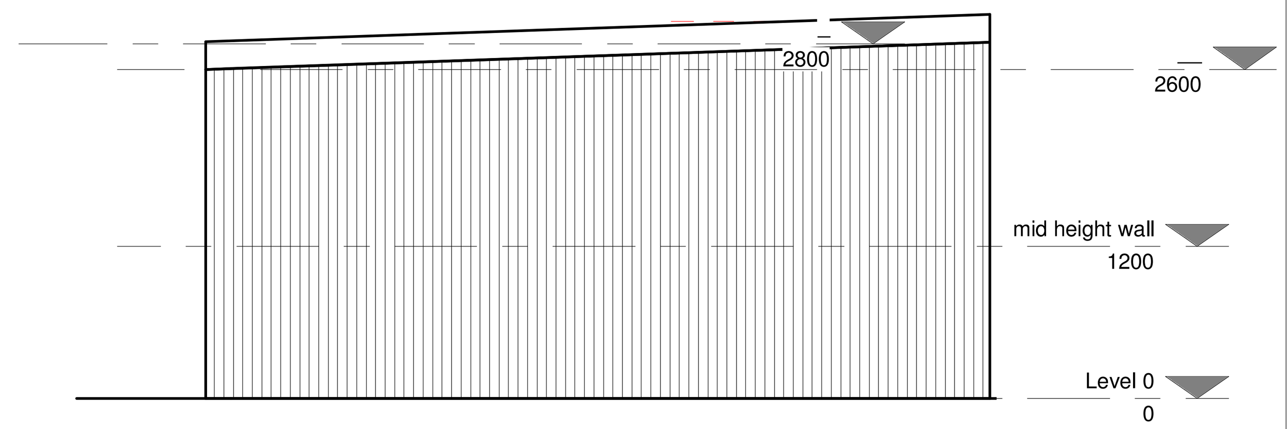
3 A200 SOUTH
1 : 50



6 A200 Section 1
1 : 50



4 A200 NORTH
1 : 50



5 EAST
1 : 50

Draft

Revision	Amendment	Approved	Revision Date

OPUS
Christchurch Office
+64 3 363 5400

PO Box 1482
Christchurch 8140
New Zealand

Drawn	Designed	Approved	Revision Date
A.SENIOR			

Project
CCC
Hagley Park South, Christchurch
Garage and Soil Shed

Title
Existing Floor Plan, Elevations, Section

Project No.	Scale	Drawing No.	Sheet No.	Revision
6-QUCC1.90	1 : 50	6/1366/324/8602	A200	RA

Original sheet size A1 (841x594) Plot date: 28/11/2012 9:39:20 a.m. C:\Revit\South hagley soil shed and garage\6_1366_324.rvt

Appendix C – CERA DEE Data Sheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Hagley park South garage and soil shed	Reviewer:	Dave Morrison
	Unit / No: / Street	CPEng No:	229083
Building Address:	Hagley Avenue, Hagley Park / PRK 1507-BLDG-005-EQ2	Company:	Opus International Consultants
Legal Description:		Company project number:	6-QUCC1.90
		Company phone number:	64 4 471 7000
	Degrees / Min / Sec		
GPS south:	43 / 32 / 3.77	Date of submission:	1/02/2013
GPS east:	172 / 37 / 12.56	Inspection Date:	10/08/2012
		Revision:	Final
Building Unique Identifier (CCC):	PRK_1507_BLDG_005 EQ2	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	5.00

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):	
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	3.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	
Floor footprint area (approx):	72			
Age of Building (years):	8		Date of design:	1992-2004
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	other (specify)		Brief strengthening description:	
Use (upper floors):	commercial			
Use notes (if required):	Park supplies			
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	Purlin
Floors:	concrete flat slab	slab thickness (mm)	
Beams:	timber	type	
Columns:	other (note)	typical dimensions (mm x mm)	Timber poles
Walls:			

Lateral load resisting structure

Lateral system along:	timber moment frame	**Note: Define along and across in detailed report!**	note typical bay length (m)	
Ductility assumed, μ:	1.25			
Period along:		0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	timber moment frame		note typical bay length (m)	
Ductility assumed, μ:	1.25			
Period across:		0.00	estimate or calculation?	
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:	other (specify)	describe	none
Wall cladding:	profiled metal	describe	corrugated iron
Roof Cladding:	Metal	describe	corrugated iron
Glazing:	other (specify)		none
Ceilings:	none		
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:		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:	no 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:	minor structural	Describe:	Confirm foundation details
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before:	100% ##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	
	Assessed %NBS after:	100%		
Across	Assessed %NBS before:	100% ##### %NBS from IEP below		
	Assessed %NBS after:	100%		

Opus International Consultants Ltd
L7, Majestic Centre, 100 Willis St
PO Box 12 003, Wellington 6144
New Zealand

t: +64 4 471 7000
f: +64 4 471 1397
w: www.opus.co.nz