Christchurch City Council

PRK_3575_BLDG_001 Port Levy Fire Shed

Detailed Engineering Evaulation Report

September 2013

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Qualitative Report Summary

Port Levy Fire Shed

PRK 3575 BLDG 001

Detailed Engineering Evaluation

Qualitative Report - SUMMARY

Version Final

1679, Western Valley Road

Background

This is a summary of the Qualitative report for the above building structure, and is based in part on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on the 19th of July 2011, visual inspections on the 8th of August 2013 and available construction drawings.

Building Description

The building is a single storey steel portal frame and reinforced concrete masonry wall structure. The roof consists of corrugated metal cladding on timber purlins. The timber purlins are bolted to the load bearing steel portal frame at each end and at midspan. Corrugated metal cladding on timber framing makes up the external walls. The walls on the eastern side of the building, and the internal wall are constructed from reinforced concrete masonry. The ground floor slab consists of a 100 mm reinforced concrete slab on grade. Foundations consist of isolated concrete pad foundations

Key Damage Observed

No damage was observed to the structure.

Critical Structural Weaknesses

No critical structural weaknesses have been identified in the structure.

Indicative Building Strength (from IEP and CSW assessment)

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the original capacity of the building has been assessed to be in the order of 76% NBS and post-earthquake capacity also in the order of 76% NBS. The buildings post-earthquake capacity excluding critical structural weaknesses was also in the order of 76% NBS, as none were identified.

The building has been assessed to have a seismic capacity in the order of 76% NBS and is therefore neither potentially Earthquake Risk nor potentially Earthquake Prone.

Recommendations

No further action is necessary as the building is not a potential Earthquake Risk building.

1. Background

GHD has been engaged by the Christchurch City Council (CCC) to undertake a detailed engineering evaluation of the Port Levy Fire Shed PRK_3575_BLDG_001, at 1679 Western Valley Road.

This report is a Qualitative Assessment of the building structure, and is based in part on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on the 19th of July 2011.

A qualitative assessment involves inspections of the building and a desktop review of existing structural and geotechnical information, including existing drawings and calculations, if available.

The purpose of the assessment is to determine the likely building performance and damage patterns, to identify any potential critical structural weaknesses or collapse hazards, and to make an initial assessment of the likely building seismic capacity in terms of percentage of New Building Standards (%NBS).

At the time of this report, no intrusive site investigation, detailed analysis, or modelling of the building structure had been carried out. Construction drawings were made available, and these have been considered in our evaluation of the building. The building description below is based on a review of the drawings and our visual inspections.

2. Compliance

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

2.1 Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

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

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

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

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

2.2 Building Act

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

Section 112 – Alterations

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

Section 115 – Change of Use

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

2.2.1 Section 121 – Dangerous Buildings

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

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

Section 122 – Earthquake Prone Buildings

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

Section 124 – Powers of Territorial Authorities

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

Section 131 – Earthquake Prone Building Policy

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

2.3 Christchurch City Council Policy

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

The 2010 amendment includes the following:

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

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

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

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

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

2.4 Building Code

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

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

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

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

3. Earthquake Resistance Standards

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

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

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

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

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

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

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

Table 1 %NBS compared to relative risk of failure

4. Building Description

4.1 General

The building is located in Port Levy on Western Valley Road. The building was constructed in 1985 according to available original drawings. The building is used as the local fire shed.

The building is a single storey steel portal frame and reinforced concrete masonry wall construction. The roof is pitched to a central transverse ridge; the roof consists of corrugated

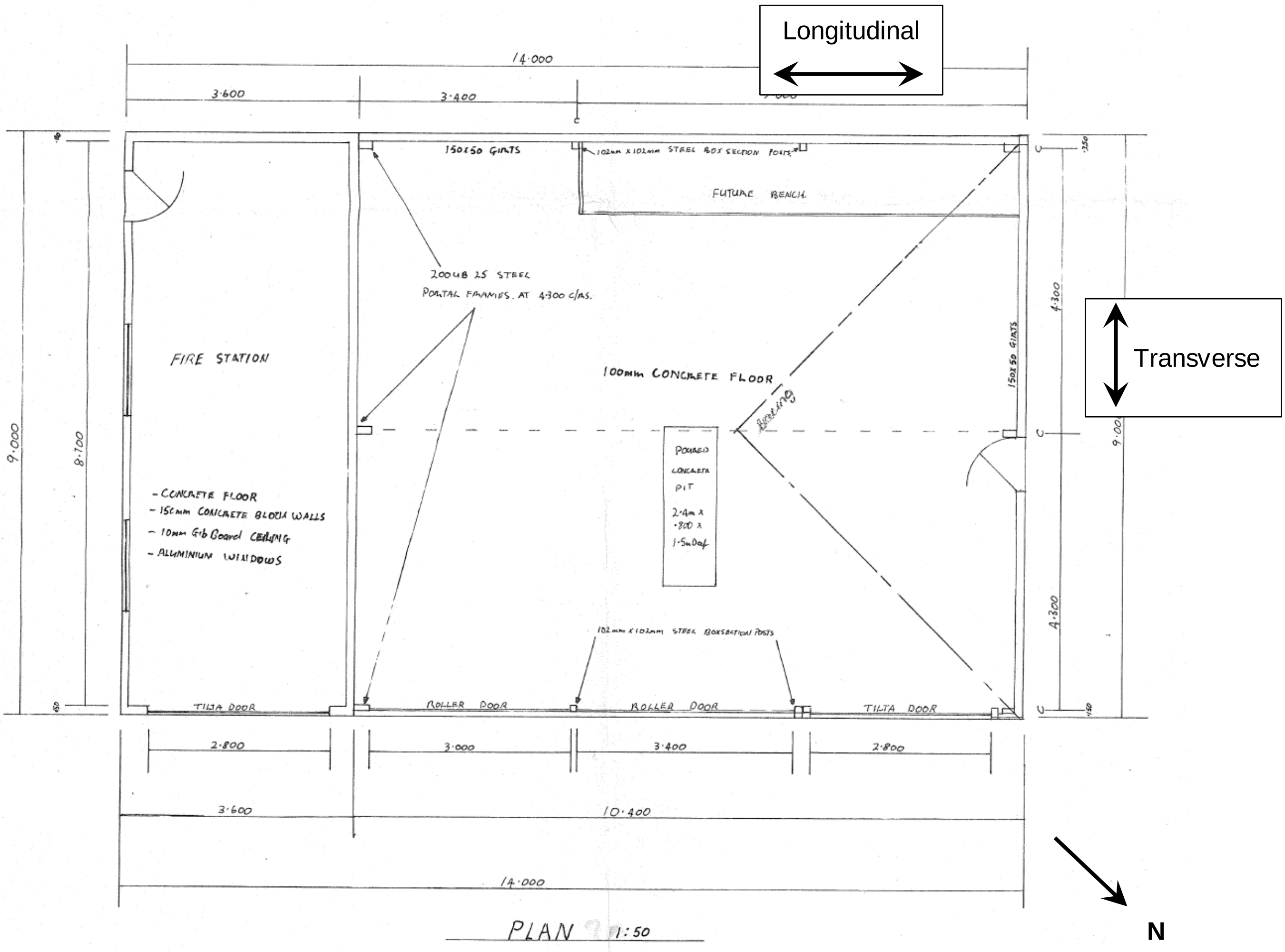

Figure 2 Original building plan

metal cladding on timber purlins. The timber purlins are bolted to the load bearing steel portal frame at each end and at midspan. Corrugated metal cladding on timber frames makes up the external walls. The walls on the eastern side of the building, and the internal wall are constructed from reinforced concrete masonry. The ground floor slab consists of 100 mm reinforced concrete slab on grade. Foundations consist of isolated concrete pad foundations.

The building is approximately 14.0 m in length by 9.0 m in width, giving it an approximate footprint of 126 m^2. The building is split into two sections; a large steel portal framed garage, and a smaller reinforced concrete masonry garage on the side. There are no other nearby buildings. The site is predominantly flat, with a few variations in ground level. It is located approximately 900 m from the coastline.

Some original drawings were available for the structure. See Appendix B.

4.2 Gravity Load Resisting System

Gravity loads from the roof cladding are supported by timber purlins. These loads are then transferred from the timber purlins to a combination of both the steel portal frames and timber trusses. The steel portal frames transfer load directly to the isolated concrete pad foundations, where they are distributed into the ground. Gravity loads from the timber trusses are transferred to reinforced concrete masonry walls, and down to concrete strip foundations, where they are distributed into the ground.

4.3 Lateral Load Resisting System

The main lateral load resistance in the longitudinal direction is provided by the three (3) steel portal frames spanning across the majority of the building. Foundations to the steel portal frames consist of reinforced concrete isolated pad foundations, which transfer lateral load from the steel portal frames into the ground. Some additional lateral load resistance in the longitudinal direction is provided by the Gib board ceiling in the smaller garage which transfers loads to the reinforced concrete masonry walls. Load is transferred from the masonry walls to reinforced concrete strip foundations and into the ground.

In the transverse direction, lateral load resistance is provided by the reinforced concrete masonry walls, Gib board ceiling lining in the smaller garage acts as a ceiling diaphragm, transferring lateral loads to the reinforced concrete masonry walls. Further lateral load resistance in the transverse direction is also provided by roof and wall steel strap cross bracing which transfers loads to the steel portal frames.

5. Assessment

A visual inspection of the building was carried on the 8th of August 2013. The main structural components of the building were all able to be viewed due to its relatively open nature.

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

The %NBS score determined for this building has been based on the IEP procedure described by the NZSEE and based on the information obtained from visual observation of the building and available drawings.

5.1 Damage Assessment

5.1.1 Surrounding Buildings

There was no damage identified in nearby buildings.

5.1.2 Residual Displacements and General Observations

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

The building was in a good condition and was well maintained. No damage was identified in the structure.

5.1.3 Floor Level Survey

No level or verticality surveys have been undertaken for this building.

5.1.4 Ground Damage

There was no evidence of ground damage on the property or surrounding neighbours land.

5.2 Geotechnical Assessment

A desktop report was not undertaken as there was no obvious visible evidence of liquefaction or lateral spreading.

A soil class of C (in accordance with NZS 1170.5:2004) has been adopted for the site. However, it should be noted that a soil class of B, might be appropriate, but this would be dependent on further geotechnical investigations.

6. Critical Structural Weakness

6.1 Short Columns

No short columns are present in the structure.

6.2 Lift Shaft

The building does not contain a lift shaft.

6.3 Roof

Roof elements such as timber purlins, diagonal cross bracing, and steel portal frames were clearly visible; it is expected that these will provide adequate stability.

6.4 Staircases

The building does not contain a staircase.

6.5 Site Characteristics

The site characteristic has been assessed as an ‘insignificant’ potential given the absence of liquefaction or lateral spread in the area.

6.6 Plan Irregularity

The plan irregularity has been given an ‘insignificant’ potential in both the longitudinal and transverse directions.

7. Initial Capacity Assessment

7.1 % NBS Assessment

The building has had its capacity assessed using the Initial Evaluation Procedure based on the information available. These capacities are subject to confirmation by a more detailed quantitative analysis.

Following an IEP assessment, the building has been assessed as achieving 76% New Building Standard (NBS). Under the New Zealand Society for Earthquake Engineering (NZSEE) guidelines the building is considered neither potentially Earthquake Risk nor potentially Earthquake Prone as it achieves greater than 67% NBS. This score has not been adjusted when considering damage to the structure as none was observed.

7.2 Seismic Parameters

The seismic design parameters based on current design requirements from NZS 1170:2002 and the NZBC clause B1 for this building are:

- Site soil class: C, NZS 1170.5:2004, Clause 3.1.3, Shallow Soil. It should be noted that further geotechnical investigations might define the site as Soil Class B. A change of Soil Class from C to B would increase the % NBS as calculated from the IEP assessment.
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- Return period factor R_u = 1.0, NZS 1170.5:2004, Table 3.5, Importance level 4 structure with a 50 year design life.
- An increased Z factor of 0.3 for Christchurch has been used in line with requirements from the Department of Building and Housing resulting in a reduced % NBS score.

7.3 Expected Structural Ductility Factor

A structural ductility factor of 2.0 has been assumed in the along direction, and 1.25 in the across direction, based on the structural systems observed.

7.4 Discussion of Results

The results obtained from the initial IEP assessment are consistent with those expected for a building of this age and construction type. The building was constructed in 1985 and was likely designed to the loading standard NZS4203:1984. The design loads used in this standard are likely to have been less that those required by the current loading standard. When combined with the increase in the hazard factor for Christchurch to 0.3, it would be expected that the building would not achieve 100% NBS. However, due to the lack of any significant Critical Structural Weaknesses it is reasonable to expect the building to be classified as neither potentially Earthquake Prone nor potentially Earthquake Risk.

8. Conclusions & Recommendations

The building has been assessed to have a seismic capacity in the order of 76% NBS and is therefore not potentially Earthquake Prone nor potentially Earthquake Risk.

The recent seismic activity in Christchurch has caused no identifiable damage to the building. As the building suffered no damage that would compromise the load resisting capacity of the existing structural systems and has achieved greater than 67% NBS following an initial IEP assessment of the building, no further assessment is required by Christchurch City Council to comply with the building act.

9. Limitations

9.1 General

This report has been prepared subject to the following limitations:

- No intrusive structural investigations have been undertaken.
- No intrusive geotechnical investigations have been undertaken.
- Visual inspections of the foundations could not be undertaken.
- No level or verticality surveys have been undertaken.
- No material testing has been undertaken.
- No calculations, other than those included as part of the IEP in the CERA Building Evaluation Report, have been undertaken. No modelling of the building for structural analysis purposes has been performed.

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

Appendices

Appendix A – Photographs

Photo A1: North and east elevations

Photo A2: South and east elevations

Photo A3: Interior of Fire Shed, looking towards reinforced masonry section.

Photo A4: Interior of Fire Shed, looking towards reinforced masonry section.

Photo A5: Connection between steel portal frame and timber roof framing

Photo A6: Interior view of west corner of building – showing wall and ceiling bracing.

Appendix B – Existing Drawings

Appendix C – IEP & CERA Evaluation Form

GHD

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

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
DRAFT	Helen Erentz	Hamish Mackinven	[signature]	Donna Bridgman	[signature]	09-09-13
FINAL	Helen Erentz	Hamish Mackinven	[signature]	Donna Bridgman	[signature]	11-09-13

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