Alexandra Service Centre, 1 Dunorling Street, Alexandra

DETAILED SEISMIC ASSESSMENT REPORT

Client Name:	Central Otago District Council
BMC Reference:	1708-2227a
Date Issued:	8/08/2023

BMC

Quality Statement and Document Control

This Detailed Seismic Assessment (DSA) report has been prepared for Central Otago District Council by Batchelar McDougall Consulting Ltd. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other parties.

This disclaimer shall apply notwithstanding that the documents may be made available to other persons for an application for permission or approval to fulfil a legal requirement.

Issue Register:

<table>
<tr><th>Revision</th><th>Date</th><th colspan="3">Description</th></tr>
<tr><td rowspan="4">A</td><td rowspan="2">8/08/2023</td><td colspan="3">Issue to client</td></tr>
<tr><td>Prepared by</td><td>Reviewed by</td><td>Approved by</td></tr>
<tr><td>Name</td><td>Warren Holt</td><td>Graham McDougall</td><td>Graham McDougall</td></tr>
<tr><td>Signature</td><td>BEng (Hons), CMEngNZ, CPEng, IntPE(NZ), MIStructE(UK), CEng(UK)</td><td>BE, CMEngNZ, CPEng, IntPE(NZ)</td><td>Director</td></tr>
</table>

Document version code: 403.003-V1.0-DSA

Revision History:

Rev. No	Date	Issue Description	Prepared by	Reviewed by
A	8/08/2023	Issue to client	WH	GRM

BMC

Contents:

1 Executive Summary

This report covers a Detailed Seismic Assessment of the building at Alexandra Service Centre, 1 Dunorling Street, Alexandra. The building consists of two main elements the William Fraser Block and the Kelman Street Block. The assessment is required for the William Fraser Building only. It is single storey in height having a U-shaped footprint. It comprises a timber trussed stepped duo pitch roof structure supported by internal and external load bearing timber framed walls on RC foundations with a timber cladding to the window heights and a brick masonry veneer under the sill level.

Documentation available to BMC for the purposes of this assessment are summarised in Section 2. This assessment is based on these documents and site visit observations.

For the purposes of this evaluation, the above described building has been assessed as a single monolithic structure of Importance Level 4.

The assessment has been carried out in accordance with the requirements for a Detailed Seismic Assessment as defined in "*The Seismic Assessment of Existing Buildings, Technical Guidelines for Engineering Assessments*" issued in July 2017 by MBIE et al.

Loading Direction	%NBS (IL 4)	Alpha Rating
NW-SE (Longitudinal)	100%	Seismic Grade A
SW-NE (Transverse)	100%	Seismic Grade A

Table 1: Seismic ratings for both loading directions

The building is considered to have a capacity of 100%NBS of New Building Standard (IL4) which gives and overall Seismic Grade A for the building.

BMC consider the Critical Structural Weakness to be: Not Applicable to this building.

As the building has/ does not have structural components with a seismic capacity of less than 33%NBS, BMC consider it to (not) meet the first criteria in the definition of an earthquake-prone building, as set out in Clause 133AB of the Building (Earthquake-prone Buildings) Amendment Act 2016. This assessment can be used by the relevant Territorial Authority for the purpose of deciding whether the building is earthquake-prone or not, in accordance with legislation.

A Desktop Geotechnical Report was undertaken by Geosolve Limited Reference 230125 dated March 2023 which determined the assessment to be Structurally Dominated. This has been utilised when determining the building's seismic rating.

A concept strengthening design has not been carried out as part of this assessment, but this would likely consist of the: -

- Not Applicable to this building.

BMC

2 Scope of Our Engagement

BMC have been engaged by Central Otago District Council to undertake a Detailed Seismic Assessment (DSA) of the buildings at Alexandra Service Centre, 1 Dunorling Street, Alexandra. The purpose of this report is to ascertain the anticipated seismic performance of the structures (as an Importance level4 (IL4) building) compared to current design standards and comment on a likely concept strengthening strategy, (if required).

Please note that BMC have previously completed a remodelled wall/structure layout for the building, but this was as an Importance Level (IL2). IL4 seismic design loading is significantly higher than IL2 and thus a more sophisticated assessment approach along with site specific geotechnical input was required as part of this assessment.

The seismic assessment and reporting has been undertaken in accordance with the qualitative and quantitative procedures detailed in "*The Seismic Assessment of Existing Buildings, Technical Guidelines for Engineering Assessments*" (SEAB) issued in July 2017 by the Ministry of Business, Innovation and Employment (MBIE), the Earthquake Commission (EQC), the New Zealand Society for Earthquake Engineering (NZSEE), the Structural Engineering Society of New Zealand (SESOC) and the New Zealand Geotechnical Society (NZGS). This suite of documents, previously known as ‘The Red Book’ is henceforth referred to in this report as “*The MBIE Technical Guidelines”.* This report meets the reporting requirements of a ‘Detailed Seismic Assessment’ as described in Sections A8 and C1.10 of these guidelines.

This structural assessment includes: -

- Review of existing building plans and reports (including previous BMC calculations).
- Undertaking additional interior and exterior visual inspections of exposed elements on-site.
- Consideration of the site-specific geotechnical engineer’s report commissioned as part of this assessment.
- Undertake detailed calculations on all primary seismic elements and parts, and
- Comment on a likely general strengthening strategy to either >34% or >67%NBS (IL4), as required.

This structural assessment is based on information provided to us, which includes documentation listed in Section 2 of this DSA. The assessment is also based on the visual evidence & indications present at the time of inspection, along with limited invasive investigations described in Section 6 of this report. The findings of this report may therefore be subject to revision pending more detailed/invasive investigations or deterioration of elements from future earthquakes or ground settlement. This report does not address any hidden or latent defects that may have been incorporated in the original design and construction.

This assessment is restricted to structural aspects only. Waterproofing elements, electrical and mechanical equipment, fire protection and safety systems, service connections, water supplies and sanitary fittings have not been reviewed. Architectural elements (except those with a structural function or affecting the structural system) have not generally been reviewed.

The scope of this evaluation is limited to the assessment of the potential performance of the building in an earthquake only. No assessment has been made of other load cases, such as wind, snow and gravity. The assessment is being undertaken to determine if the building meets any of the criteria of an Earthquake Prone building as identified in the Earthquake Prone Building (EPB) provisions of the Building Act (2004), incorporating the Building (Earthquake Prone Building) Amendment Act 2016.

BMC has not made any Geotechnical assessment of the soils on the site, however, Geosolve were engaged to provide site specific information. Refer to Section 7 of this report for recommendations and Geotechnical reports that we have obtained.

With respect to any strengthening works (if required) this is a scoping document only and under no circumstances shall recommendations and/or sketches included in this report be used for construction. They are for feasibility/pricing purposes only.

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. No other warranty, expressed or implied, is made as to the professional advice presented in this report.

This Detailed Seismic Assessment (DSA) report has been prepared by Batchelar McDougall Consulting Ltd for the sole use of our client Central Otago District Council, for the particular brief and on the terms and conditions agreed with our client. It may not be used or relied on (in whole or part) by anyone else, or for any other purpose or in any other contexts.

This disclaimer of liability shall apply notwithstanding that this DSA may be made available to other persons for an application for permission or approval to fulfil a legal requirement.

It may however be used by the Territorial Authority in the course of defining the buildings classification in accordance with the Building Act 2004 incorporating the Building (Earthquake-prone Buildings) Amendment Act 2016.

Information Used for the Assessment

Documentation received and or issued by us that we consider relevant to this report includes: -

Description	Revision	Issue Date
Architectural & Structural Drawings of G.O.A.B. Alexandra Job Ref: 7/286/2 Sheets 78No. dated Dec 1978 by: Ministry Of Works.		12/1978
Architectural Drawings of Alterations to William Fraser Building Job Ref: 3137/w7 Sheets (13No.) dated Apr 1993 by: Salmond Anderson Heath Architects. Structural Drawings of Refurbishment of William Fraser Building Job Ref: 14455 Sheets S1-2 dated Jun 1993 by: Duffill Watts & King Ltd		04/1993
Architectural & Structural Drawings of Extension to William Fraser Building, Alexandra Job Ref: 7/286/19 Sheets (25No.) dated Dec 1986 by: Ministry Of Works.		06/1986
There were no previous seismic assessment reports available for the building elements other than the checks provided as part of the 2019-2023 alteration works BMC Ref 1708-2227		2019-2023

Table 2: Summary of documentation reviewed for this assessment

3 Statutory Requirements

This section contains a brief summary of the requirements of the various statutes and authorities that control activities in relation to the structural aspects of buildings subject to earthquake effects at present.

3.1 Building Act 2004 (Incorporating the Building (Earthquake Prone Building) Amendment Act 2016)

Several sections of the Building Act are relevant when considering earthquake 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).

For an Earthquake Prone Building (EPB) (a building or part of a building subject to an EPB notice) Section 133AT supersedes Section 112. Under this section:

- Alterations to Earthquake-prone buildings may be allowed even if after those alterations the building will not comply with the provisions of the Building Code that relate to means of escape from fire and disabled access. The Territorial Authority must be satisfied that the proposed alteration would contribute towards making the building no longer earthquake-prone and that carrying out other upgrades would be unduly onerous on the owner.
- The Territorial Authority will be able to require the owner to carry out strengthening works in addition to other alterations where the alterations are ‘substantial alterations’. The definition of ‘substantial alterations’ is work that is valued at more than 25% of the building’s rateable value, in accordance with Building Regulations.

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 as near as is reasonably practicable to 100% of the strength of an equivalent new building.

Section 133 – Earthquake-prone Building Policy

This section covers the specific provisions relating to earthquake-prone buildings and includes:

- Exclusions from the policy,
- Definitions of earthquake-prone buildings, earthquake ratings, seismic risk and priority buildings,
- Territorial Authority and Owner requirements for identifying, assessing and strengthening earthquake-prone buildings,
- Issuing and display of EPB notices,
- Timeframes for reporting and remedying earthquake-prone buildings.

It is the responsibility of the Territorial Authority, not the author of engineering assessments, to declare a building as being earthquake-prone.

Definition of 'earthquake-prone'

The Building (Earthquake Prone Building) Amendment Act 2016 defines an 'earthquake-prone building' by:

- Clarifying that an earthquake-prone building can be one that poses a risk to people on adjoining properties and not just those within the building itself.
- Excluding from the definition of earthquake-prone building certain residential housing, farm buildings, retaining walls, wharves, bridges, tunnels and monuments.
- Including in the definition of earthquake-prone building: hostels, boarding houses and residential buildings that are more than two storeys and contains three or more household units.

Seismic Risk

New Zealand is divided into 'seismic risk' zones as shown in Figure 1. Three different categories as defined by the seismic hazard factor (Z) in the New Zealand Loadings Code (NZS 1170.5:2004) are referenced by the Building (Earthquake Prone Building) Amendment Act 2016:

- High seismic risk – Z greater than or equal to 0.30
- Medium seismic risk – Z between 0.15 and 0.30
- Low seismic risk – Z lower than 0.15

The seismic risk relates to timeframes for strengthening and identification of potentially earthquake-prone buildings. The building at 1 Dunorling Street, Alexandra is in a Medium seismic risk zone.

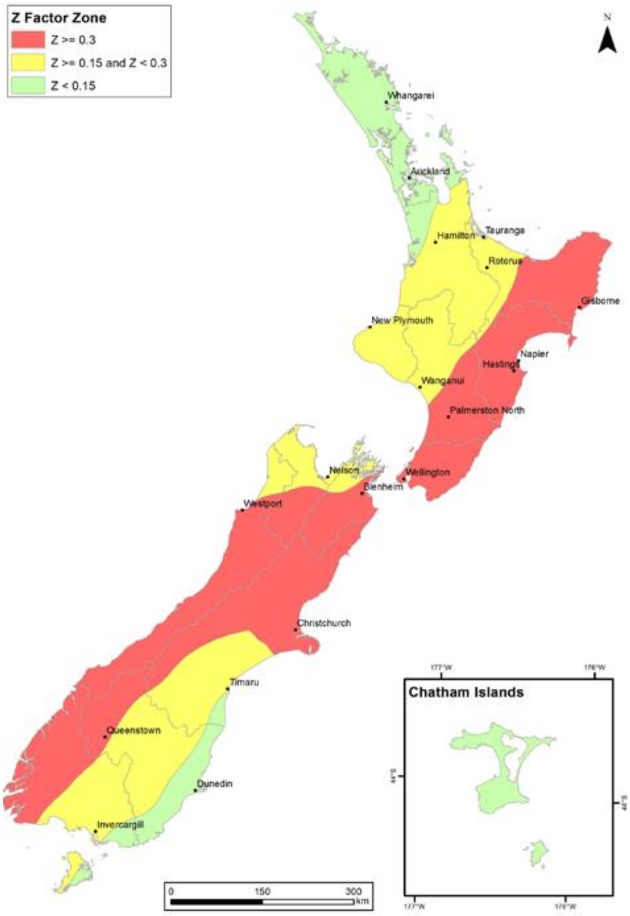


Figure 1: Three seismic risk areas in map format (map produced by GNS Science)

Importance Level (IL)

Clause A3 of the Building Act describes the IL of buildings that relate to the consequence of failure. All normal buildings are IL2. The CODC have requested that this building be assessed as IL4 which means it must be capable of being operative immediately after an earthquake or other significant event. Design and assessment of IL4 buildings are much higher than IL2 loads. Of course, other factors that relate to the building serviceability are appropriate to consider e.g. power. Water supply, sewerage disposal. Flooding etc.) but these are not dealt with as part of this assessment.

Priority Buildings

Priority buildings are defined as buildings that:

- Are generally used for health or emergency services or used as educational facilities,
- Contain unreinforced masonry that could fall on to busy thoroughfares in an earthquake – such as parapets,
- The territorial Authority have identified as having the potential to impede strategic transport routes after an earthquake.

Priority buildings have shorter timeframes for identification and strengthening of earthquake-prone buildings.

BMC consider the building at 1 Dunorling Street, Alexandra is likely to be classified as a priority building by Central Otago District Council, in accordance with Section 133AE of the Building (Earthquake-prone Buildings) Amendment Act 2016.

Timeframes for Identifying and Strengthening Earthquake-prone Buildings

The Building (Earthquake Prone Building) Amendment Act 2016 contains maximum timeframes for Territorial Authorities to assess and identify potentially earthquake-prone buildings as outlined below.

Following identification of a building as being potentially earthquake-prone by the Territorial Authorities, building owners are required to provide an engineering assessment of the building within twelve months. Upon receipt of the engineering assessment the Territorial Authority decides whether the building should be declared earthquake-prone. The Territorial Authority must issue an earthquake-prone building notice when it determines that a building or part of a building is earthquake-prone.

The Amendment Act contains maximum timeframes for strengthening earthquake-prone buildings after notice has been issued by the Territorial Authority as outlined in Table 3:

Seismic Risk	Building	Timeframe for Assessment (from 1st July 2017)	Timeframe for Remediation of EPB (from date of EPB Notice Issue)
Low ($Z < 0.15$)	All	15 years	35 years
Medium ($0.15 \leq Z < 0.3$)	Priority	5 years	12.5 years
	Other	10 years	25 years
High ($Z \geq 0.3$)	Priority	2.5 years	7.5 years
	Other	5 years	15 years

Table 3: Time frames for the identification and remediation of earthquake-prone buildings

If the assessment determines that elements of the building have a seismic rating of less than 34% NBS(IL4), the Territorial Authority can either declare it to be earthquake prone and issue an earthquake-prone building notice or can downrate the Importance Level (and therefore change its intended use). The owner will have 12.5 years from the date of the notice to increase the seismic rating of the building to above 34% NBS by undertaking structural strengthening work.

3.2 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 MBIE and its predecessor, The Department of Building and Housing, can be used to demonstrate compliance with the Building Code.

BMC

4 Seismic Resistance Standards

For this assessment, the building's Ultimate Limit State 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 for an IL4 structure.

The likely ultimate capacity of this building has been derived in accordance with *The MBIE Technical Guidelines* which sets out the types of analysis that can be used.

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 Table 4.

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%	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
Risk Building	D or E	High	33 or lower	Unacceptable (Improvement required under Act)	Unacceptable	Unacceptable

Table 4: NZSEE Risk classifications extracted from Table 2.2 of the MBIE 2006 AISPBE Guidelines

Table A3.1 of *The MBIE Technical Guidelines* is shown in Table 5. It compares the %NBS to the relative risk of the building failing in a seismic event to that of a new building of the same importance level.

Percentage of New Building Standard (%NBS)	Alpha Rating	Approx. risk relative to a new building.	Life-Safety Risk Description
>100	A+	Less than or comparable to	Low Risk
80-100	A	1-2 times greater	Low Risk
67-80	B	2-5 times greater	Low to Medium Risk
33-67	C	5-10 times greater	Medium Risk
20-33	D	10-25 times greater	High Risk
<20	E	25 times greater	Very High Risk

Table 5: Table A3.1 of the MBIE Seismic Assessment of Existing building guidelines, %NBS compared to relative risk of failure

The target %NBS for the IL4 assessment of the William Fraser Block at the 1 Dunorling Street building is 100%NBS(IL4).

5 Building Description

5.1 General Overview

The building consists of two main elements the William Fraser Block and the Kelman Street Block. The assessment is required for the William Fraser Building only. It is single storey in height having a U-shaped footprint. It comprises a timber trussed stepped duo pitch roof structure supported by internal and external load bearing timber framed walls on RC foundations with a timber cladding to the window heights and a brick masonry veneer under the sill level. The building does not comprise a shared structural form on elements with adjacent titles.

A summary of the building's features relevant to this assessment is provided in Table 6.

Building Feature	Description
Building address:	Address, Alexandra
Overall plan dimensions:	William Fraser Block – 41.28 m (NW-SE) x 38.18 m (SW-NE)
Number of storeys:	1No. Stories
Gross floor area:	Approximately 2250m2 William Fraser Block – 1296.6m2.
Building history:	The William Fraser building was constructed in Circa 1978 with 2No known alterations since in 1993 and 2019-2023. The building was likely designed to: NZS4203-1976, NZS4203-1984. There has been no specific seismic strengthening undertaken in the building.
Occupancy:	2 Public Office Tenancies
Importance Classification: (AS/NZS 1170.0:2002: Table 3.2)	IL4 (DESCRIPTION FORM NZS1170.0)
Heritage Issues/ Status	Central Otago District Council District Plan Schedule 194. Listing Ref - None. Heritage New Zealand Pouhere Taonga – None

Table 6: Building Information

Please note as a single storey timber framed building there is significant inherent resilience that exists and therefore is appropriate to assess it as an IL4 structure.

Figure 2: Aerial photograph of site (source: CODC GIS Maps)

Figure 3: Front view of William Fraser Block looking from the West direction.

Figure 4: Rear view of William Fraser Block looking from the South direction.

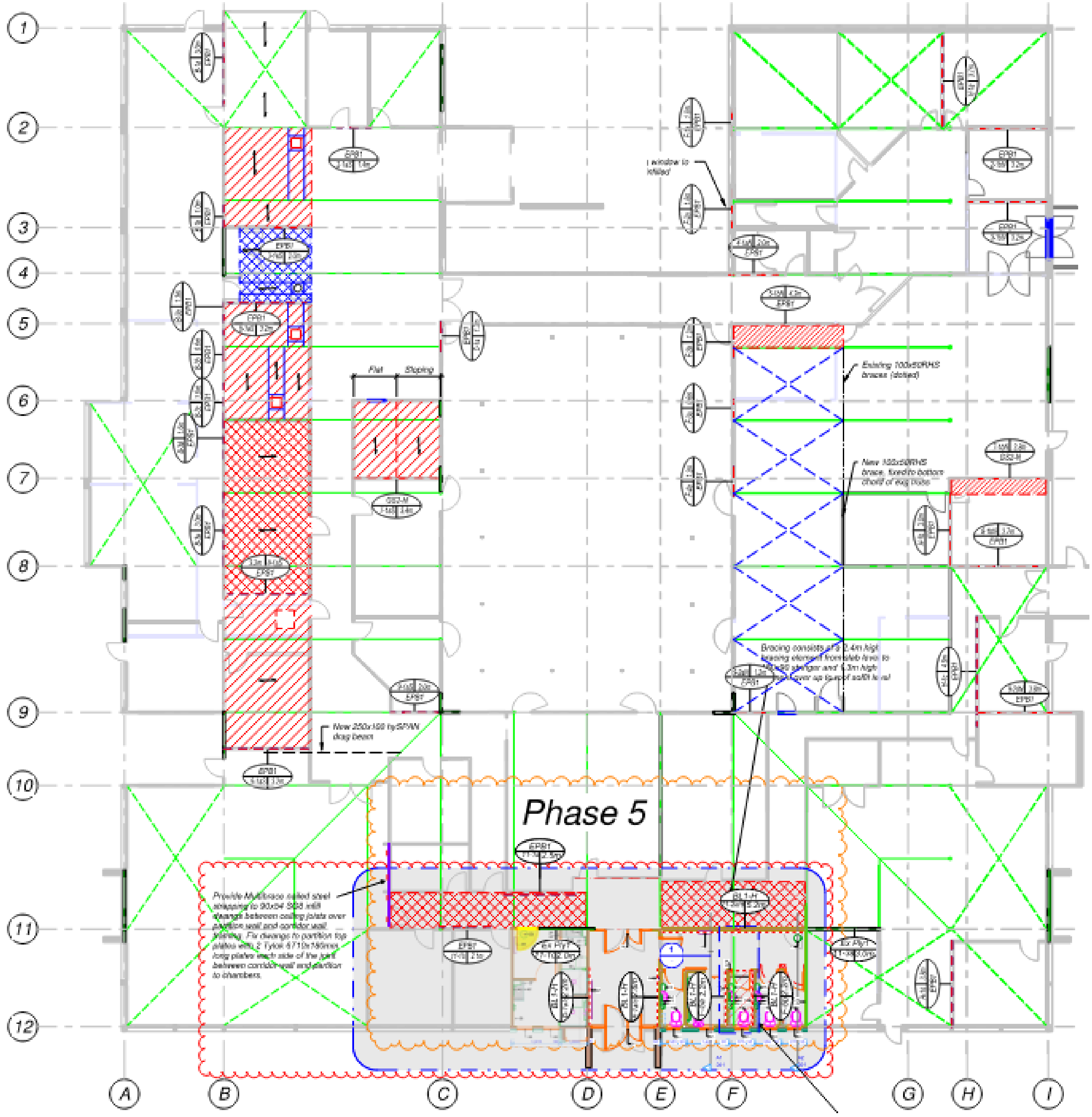


Figure 5: Plan view of William Fraser Block showing Existing Structure, Bracing walls and new alteration provisions.

5.2 Gravity Load Resisting System

The roof structure of the William Fraser Block building consists of profiled metal sheeting on timber purlins to rafters to under purlins to mono pitch timber spaced trusses to the internal pitch of the stepped duo pitched roof. The shorter pitch comprises of a similar construction to timber rafters fixed to the vertical face of the intern span monopitch trusses. The internal truss supports are steel posts and externally the mono-pitch trusses and rafter are supported on timber framed walls or steel posts.

The floor structure comprises ground bearing reinforced concrete slab with perimeter integral strip footings (ref sect 5.4).

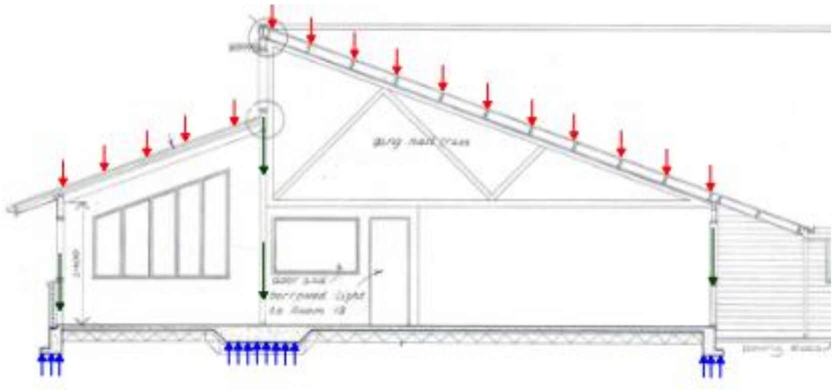


Figure 6: Typical Gravity Load Path Diagrams to William Fraser

5.3 Lateral Load Resisting System

The lateral load resisting system of the building in each orthogonal direction is provided by timber framed bracing walls with either steel cross bracing, plywood sheathing or GIB sheathing walls (some of this work was carried out as part of the previous remodelling work).

The out of plane walls and the roof structure are stabilized by the orthogonal bracing walls by the roof / ceiling diaphragms.

The bracing walls transfer the lateral loads to the foundations through their bracing (shear) resistance. The structure is typically connected to the foundations using holding down anchors to the ends of the bracing walls.

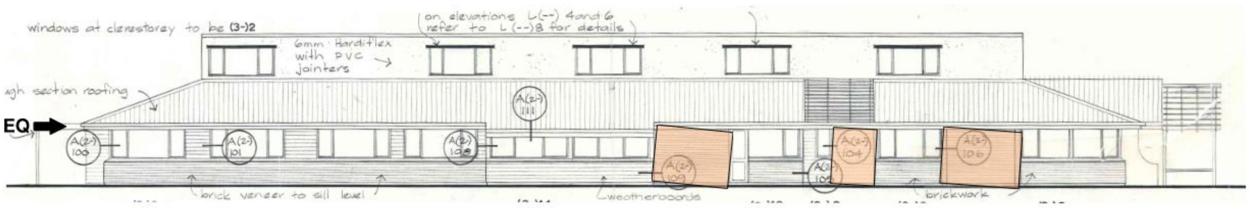


Figure 7: Typical Lateral Load Path Diagram in the NW-SE Direction (William Fraser Block SW elevation)

5.4 Foundation system

The foundation system comprises reinforced concrete strip footings with starters into the ground bearing reinforced concrete ground floor slab.

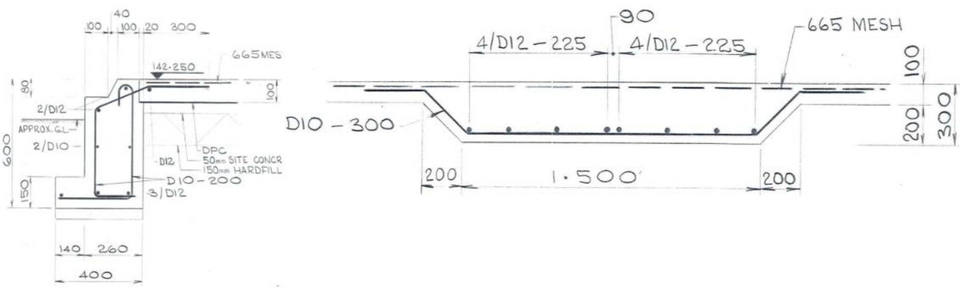


Figure 8: Typical foundation details, William Fraser.

BMC

5.5 Potential 'Severe Structural Weaknesses'

The MBIE Technical Guidelines clarifies many of the definitions used to identify structural components. These include:

Structural Weakness (SW)	An aspect of the building structure and/or the foundation soils that scores less than 100%*NBS*. An aspect of the building structure scoring less than 100%NBS but greater than or equal to 67%*NBS* is still considered to be a Structural Weakness even though it is considered to represent an acceptable risk.
Critical Structural Weakness (CSW)	The lowest scoring Structural Weakness determined from a DSA. For an ISA, all Structural Weaknesses are considered to be *potential* Critical Structural Weaknesses.
Severe Structural Weakness (SSW)	A defined Structural Weakness that is potentially associated with catastrophic collapse and for which the capacity may not be reliably assessed based on current knowledge. For an ISA, potential SSWs are expected to be noted when identified, and may extend to issues that require detailed seismic assessment before they can be removed from consideration.

Table 7: MBIE et al structural weakness descriptions

Many existing buildings are likely to have Structural Weaknesses (SWs) and therefore a Critical Structural Weakness (CSW), however this does not mean the building is unsafe. A Severe Structural Weakness (SSW) has the potential to result in catastrophic failure with severe consequences to building occupants.

An initial review of the available documentation for the building at 1 Dunorling Street, Alexandra has been performed to identify potential SSWs for closer inspection during the quantitative phase of the assessment however none were identified.

6 Building Observations

6.1 BMC Building Inspection

Before undertaking a building inspection, BMC carried out preliminary structural analyses in order to gauge areas of the building likely to be subject to damage when exposed to seismic loading, and therefore requiring specific attention. These areas may be described as 'potential structural hot-spots'. As BMC were engaged to undertake recent alterations to the building new invasive opening-up works were not subsequently required for this assessment other than an external inspection of the building. The findings of the external building inspection and our internal inspection of the previous alteration works are included below.

No#	Photo	Comments
1		William Fraser Block East Corner The exposed foundation shows cracking to the corner. The cracks do not extend to the brick veneer so this does not provide evidence of settlement. The West and south corners of the block exhibit similar cracking to foundation element.
2		William Fraser Block East Corner The North east entrance canopy comprises a slender steel moment resisting frame which will require consideration with regards to stability.
3		Both Blocks External Cladding The external veneer is generally windows and timber cladding from sill to eaves with a single wythe of brick veneer to ground level from sill. To the William Fraser Block only there are 2 full height buttressed brick veneer panels to the south west and north east side elevations and a higher masonry veneer to the toilets of this block to the south east elevation.

No#	Photo	Comments
4		Dunorling Street Roof Structure The roof structure comprises spaced timber trusses to internal timber or external steel posts to the internal courtyard area with loose timber rafters to the outer external walls. These are gravity frame only so the roof or ceiling diaphragm needs to transfer the lateral loads to the bracing wall locations.
5	 	Dunorling Street Internal Bracing Walls The internal bracing walls are a mixture of steel cut in angle cross bracing walls and plywood sheathed walls with varying nailing centres.
6		Dunorling Street Internal Bracing Walls The internal bracing walls from the alteration works also include roof diaphragms to the skillion elements of the roof (see 7 below).
7		Dunorling Street Internal Bracing Walls The internal bracing walls from the alteration works where required to transfer lateral loads from the roof structure to the bracing walls.

7 Geotechnical Considerations

7.1 Geotechnical Investigation

A Desktop Geotechnical Report was undertaken by Geosolve Limited Reference 230125 dated March 2023 which determined the assessment to be Structurally Dominated. The reader is advised to refer to and make themselves familiar with the Geosolve Limited report in full as our comments are intended as a brief summary only. BMC are not specialist geotechnical engineers and such work is outside our area of expertise. We have therefore relied on the advice provided by Geosolve Limited as specialist geotechnical engineers.

7.1.1 Subsurface Conditions

Geosolve Limited undertook a review of the soil maps and previous local borehole testing in the area. Table 8 summarises the subsurface composition as described in their report.

Soil	Description	Start Depth (m)	End Depth (m)
Fill	Asphalt pavement and gravel sub-base	0	Varies
Loess	Firm to stiff and loose to medium dense sandy SILT and silty Sand	Varies	2.2
Outwash Deposits	Medium dense to dense sandy Gravel with silt cobbles and boulders and inter beds of SAND with minor trace gravel and silt	2.2	>15.5 (18 – 50m from site)
Schist Bedrock	Haast Schist	>15.5 (18 – 50m from site)	

Table 8: Site soil profile as identified by Geosolve Limited

Groundwater levels were recorded at depths of 10.5m approx. 100m from the site below ground level (bgl).

7.1.2 Seismic Category

Geosolve Limited have stated that the soils correspond to a site subsoil Ground Class C Shallow Soil as referenced in NZS1170.5:2004.

7.1.3 Liquefaction Assessment

Geosolve Limited have undertaken a liquefaction assessment for the site using the method of a review of soil records and local historic testing. They note that there is no risk of significant settlement under a ULS event.

Structure Importance Level	Limit State Design	Annual Probability of Exceedance	Peak Ground Acceleration (g)
Level 4	Serviceability (SLS II)	1:500	0.30
	Ultimate (ULS)	1:2500	0.53

Table 9: Design Earthquake Scenarios and Peak Ground Acceleration as identified by Geosolve Limited

A depth to groundwater of 10.0m bgl has been assumed by Geosolve Limited for this evaluation.

The results of the analysis indicate that the site is classified as having a Negligible risk from liquefaction.

8 Quantitative Seismic Assessment

8.1 Seismic Design Loads

This quantitative assessment are based upon the MIBE et al Guidance documents "The Seismic Assessment of Existing Buildings" July 2017 Including Sections C1-4 and with particular reference to Section C9 – Timber Buildings & C10-Secondary Structural and Non-structural Elements.

8.1.1 Importance Level

On the basis that the current use of the building is for governance for post disaster function, the Importance Level of the building has been categorised as IL4 in accordance with Table 3.2 of AS/NZS1170.0:2002. Based on a design working life of 50 years, the annual probability of exceedance of an Ultimate Limit State (ULS) earthquake is 1/2500 in accordance with Table 3.3 of NZS1170.0:2002.

8.1.2 Seismic Assessment Parameters

For the assessment of the two blocks (timber framed buildings) Section C9 of the Technical Guideline documents states, "For timber framed buildings no more than two storeys high and with regular layouts, the bracing design provisions of NZS 3604:2011 can be adopted. This option should only be adopted if the distribution and spacing of bracing walls is generally in accordance with NZS 3604:2011. As bracing demands given in NZS 3604:2011 are derived from $\mu = 3.5$ and Sp = 0.70, these demands should be scaled accordingly for other values of μ and Sp". "A structural performance factor of Sp = 0.5 is recommended for the assessment of timber buildings." It is proposed to adopt this approach for both blocks.

The seismic loads used in this assessment are based on the provisions of the current loadings standard NZS1170.5:2004. In light of the recent release of the 2022 National Seismic Hazard Model (NSHM) the use of this as the basis of all assessments remains the required method to determine the loadings for the assessment. Further guidance on how this may effect assessments in the future can be found in the following document https://www.nzsee.org.nz/db/PUBS/Earthquake-Design-for-Uncertainty-Advisory_Rev1_August-2022-NZSEE-SESOC-NZGS.pdf which should be read in conjunction with further guidance "Seismic Risk Guidance for Buildings" (see the link in Section 11 of this report).

The base shear coefficient C(T) is a function of the building period, the structure ductility and the site geology, including proximity to known fault lines. The assumed seismic parameters for the building are summarised in Table 10:

Seismic Parameter	Values	Notes/Comments
Spectral Shape Factor $C_h(T)$	3.0	NZS1170.5:2004 Clause 3.1.2
Soil category:	C	NZS1170.5.2004 Clause 3.1.3, Ground Class C (DESCRIPTION FROM NZS1170.5:2004 cl 3.1.3)
Hazard factor Z:	0.21	NZS1170.5:2004 Clause 3.1.4
Return period factor R:	1.8	NZS1170.5:2004 Table 3.5

Seismic Parameter	Values	Notes/Comments
Near-fault factor N(T,D):	1	NZS1170.5:2004 Clause 3.1.6
Elastic site hazard spectrum C(T1):	0.89	NZS1170.5:2004 Equation 3.1 (1)

Table 10: Seismic parameters used in this assessment

Please note that BMC has only considered 'Ultimate Limit State' (ULS) performance of the structure (that is its capacity to resist a 'significant' seismic event without collapse). No assessment or consideration of Serviceability Limit State (SLS) performance has been made (that is the performance of the structure to resist 'small' more frequent earthquakes WITHOUT damage to the fittings / services etc).

8.1.3 Structural Ductility

Ductility is a measure of a building or its individual components ability to undergo sustainable inelastic displacements whilst maintaining sufficient residual strength to carry load. The term "inelastic" refers to actions beyond the base yield strength of the building or component being considered. The more ductile a building, the more energy it is able to dissipate. Since ductility inherently requires building structural components to be stressed beyond yield, there will be some permanent damage and deflections associated with this form of energy dissipation.

By considering available building ductility, the magnitude of the seismic forces for which the building is being assessed are able to be reduced to capture the effect of the energy dissipation. The structural ductility factors adopted in this seismic assessment are summarised in Table 11:

Element	Action	Ductility Factor μ	Structural Performance Factor S_p
Reinforced Concrete	Flexure	2.0	For nominally ductile structures (i.e. μ = 1.25 or less) S_p = 0.9. For structures with a ductility factor μ equal to 2, S_p = 0.8.
	Shear, Rocking	1.0	
	Out-of-Plane Actions	1.25	
Floor Diaphragm	All	1.0	
Steel Struts	Tension/Compression	1.0	
Timber Framing	Shear	3.5	S_p = 0.5 - SEAB C9.4.2
Parts and portions	All	1.25	

Table 11: Structural ductility factors

The reduced forces must be accompanied by the ability to take additional displacement (without collapse) after the structure has yielded. The structure must therefore be detailed for this additional displacement.

As stated earlier the primary lateral load-resisting system being timber framed ply/GIB clad walls are resilient seismic elements by nature.

8.2 Material Properties

Because the original specification was not available for this building, the material properties used as part of this quantitative assessment have been based typical values for the period of construction. Where appropriate, probable values have been used for the assessment, in preference to characteristic values that would be used for the design of new structures, in accordance with *The MBIE Technical Guidelines*. Details are summarised in

Timber frame construction	Wall Lining (Plaster Board fixed @ 300mm)	Probable Strength		1.0 kN/m each side	SAEB C9.6.2.3 T9.2
	Roof Diaphragm (Straight Board)	Probable Strength	Parallel Perpendicular	4.0 kN/m 3.0 kN/m	SAEB C9.6.2.3 T9.3
		Probable Stiffness	Parallel Perpendicular	250 kN/m 180 kN/m	
	Plaster Board Ceilings to roof or Floors	Probable Strength		1.5 kN/m	SAEB C9.6.2.3 T9.3 (additional capacity to Board values above)
		Probable Stiffness		400 N/m	

Table 12:

Material	Structural Element	Material Property	Characteristic Value	Probable Value	Notes/comments/ assumptions
Reinforcing steel	All denoted by ‘H’	Yield strength f_y	500	540 (Char x 1.08 post-1970)	SAEB Part C Section 5 C5.4.3.2 & Table C5C.2
	All denoted ‘D or R’		300	375 (Char x 1.25 pre-1970)	SAEB Part C Section 5 C5.4.3.2 & Table C5C.2
Concrete	Ground slab	Compressive strength f'_c	20	30 (Char x 1.5)	SAEB Part C Section 5 C5.4.2.2 Table C5.3
	Other slabs		20	30 (Char x 1.5)	
	Foundations		20	30 (Char x 1.5)	
Structural Steel	Portal frame members	Yield strength f_y	300	330 (Char x 1.1 pre-1960 or post 1960 300 and above) (Char x 1.15	SAEB Part C Section 6 C6.4.4, Table C6.2 & App C6B

Material	Structural Element	Material Property	Characteristic Value	Probable Value	Notes/comments/ assumptions
				post1960 300 and below)	
Timber	Walls/ Roof	Probable strength, (MPa) bending compressive tensile		24.5 24.2 12.2	SAEB Part C Section 9 Table C9.1
Timber frame construction	Wall Lining (Plaster Board fixed @ 300mm)	Probable Strength		2.0 kN/m each side	SAEB C9.6.2.3 T9.2
	Roof Diaphragm (Straight Board)	Probable Strength	Parallel Perpendicular	4.0 kN/m 3.0 kN/m	SAEB C9.6.2.3 T9.3
		Probable Stiffness	Parallel Perpendicular	250 kN/m 180 kN/m	
	Plaster Board Ceilings to roof or Floors	Probable Strength		1.5 kN/m	SAEB C9.6.2.3 T9.3 (additional capacity to Board values above)
		Probable Stiffness		400 N/m	

Table 12: Material properties used in this assessment

8.3 Modelling Approach and Assumptions

As stated in 8.1.2 above the modelling approach adopted for the timber framed portion of the building (Dunorling St Block Only), is effectively using the bracing design provisions of NZS 3604:2011 as per the criteria for their use stated in Section C9 of the Technical Guideline documents.

The previous analysis used for the remodelling work carried out by BMC used standard GIB Ezybrace design values which are conservative compared with bespoke shear wall design techniques and use probable strength values that have all material properties safety factors set to 1.0.

BMC has reviewed the building's lateral load resisting systems and its part's and reviewed each bracing line with its tributary loading based on a flexible roof/ ceiling diaphragm. These have been individually assessed as part of this report as an SED review of each line:

The following specific assumptions relate to this assessment,

- The use of bracing design provisions of NZS3604 for timber framed construction (via SED – Bracing line capacity spreadsheets), meets the criteria stated in Section C9 of the Technical Guideline documents.
- Geotech ground conditions and foundations are expected to perform adequately based on the significant in-service history and the fact no significant foundation settlement was observed.
- It is understood that the exterior brick veneer elements that exist in the ground floor of building are adequate fixed to the timber studs of the walls for this assessment.

- The numerous alterations that have occurred throughout the life of the building have been generally carried out in accordance with ‘good practice’ of the day.
- The condition of the hidden timber structure has not been fully viewed but given the condition from the recent localised cladding removal work for the alterations it is assumed that they are in a good condition. It should be noted that this can only be fully determined if wall linings are stripped.

8.4 Overall Building Performance

The building will act with respect to a series of bracing lines both longitudinal and transverse to the main ridge of the building. These bracing lines are considered to be spaced at reasonable centres in both directions. Additional seismic load from the masonry veneer panels have been allowed for and distribute to the roof level dependent upon the panel’s height. Roof and ceiling diaphragms in plywood will allow the loads from the roof and out of plane walls to distribute the load to the bracing line shear walls. The shear walls have a variation of sheathing materials resulting in varying bracing capacity based upon the time of construction which has been allowed for in the assessment.

8.5 Quantitative Results Summary

A summary of the results from the quantitative assessment is provided in the table below. These values/ratings effectively represent an estimate of the original seismic load resistance of the building.

The percentage of the current New Building Standard (NBS) with respect to seismic loads for the structures as examined (that is in ‘as is’ condition), is as follows:

Specific structural review element	Direction	%NBS (IL4)	SSW	Notes/description of limiting criteria
Dunorling Street Block				
Bracing Lines	NW-SE (Longitudinal)		No	Shear capacity
	A-West	100%		
	B-West	100%		
	C-West	100%		
	D-Central	100%		
	E-Central	100%		
	F-East	100%		
	G-East	N/A		
	H-East	100%		
	I-East	100%		
	SW-NE (Transverse)		No	Shear capacity
	1-West	Load to GL2		
	1-East	Load to GL2		
	2-West	100%		
	2-East	100%		
	3-West	100%		
	3-East	100%		

Specific structural review element	Direction	%NBS (IL4)	SSW	Notes/description of limiting criteria
	4-West	N/A		
	4-East	100%		
	5-West	100%		
	5-East	100%		
	6-West	N/A		
	6-East	N/A		
	7-West	100%		
	7-East	100%		
	8-West	100%		
	8-East	100%		
	9-Cental	100%		
	10-Central	N/A		
	11-Central	100%		
	12-Central	Load to GL11		
Roof Diaphragm	Link Roof 11.8m x 2.6m (Longitudinal)	100%	No	Bending and Deflection Capacity
Parts	Studs OOP wit URM Veneer Parts loading (Transverse and Longitudinal)	100%	No	Bending Capacity

Table 13: Quantitative results summary (for Bracing Line Grid References refer to figure 5.)

Summary calculations / assessment outputs are included in Appendix B.

The results are such that BMC consider the %NBS value for the building to be 100%NBS(IL4). BMC consider the Critical Structural Weakness to be: Not Applicable to this building.

This puts the building into the category of a Seismic Grade A building as defined by the NZSEE Rating system (see Table 4).

As the building has no structural components with a seismic capacity of less than 33%NBS, BMC consider it does not meet the first criteria of the definition of an earthquake-prone building, as set out in Clause 133AB of the Building (Earthquake-prone Buildings) Amendment Act 2016.

The elements of the building overall which place the building in the “Earthquake-prone” Building classification are: Not Applicable to this building. The mode of failure is Not Applicable to this building.

The elements of the building parts which place the building in the Earthquake-prone building classification are: Not Applicable to this building The mode of failure is Not Applicable to this building

9 Strengthening Strategy

The findings of the assessment have determined a seismic rating of the building to be 100%NBS(IL4) and as such the requirement for a Strengthening Strategy is not required.

As stated previously to ensure the successful continued operation of the building ‘post disaster’ other aspects (e.g. power / water supply, sewerage disposal, flooding proneness etc.) will need to be considered

10 Seismic Restraint of Non-Structural Items

During an earthquake, the safety of people can be put at risk due to non-structural items falling on them. These items should be adequately seismically restrained, where possible, to the NZS 4219:2009 "The Seismic Performance of Engineering Systems in Buildings".

The following Secondary Structural and Non-structural elements have been identified and assessed: -

Masonry Veneers
Ceilings
Canopies and other appendages

An assessment has been made of these elements with the following findings: -

- The studwork walls supporting the Masonry veneers have adequate strength to stabilise the loads and it is assumed given the age of the building, that the wall ties are effective in providing the restraint, but it is recommended that this is checked visually around the building.
- The Suspended ceilings are predominantly GIB fixed to the ceiling and roof construction or to Plywood diaphragms. Tile system suspended ceilings are not present the William Fraser building but are present within the Kelman Street element but this building does not form part of this assessments scope.
- Canopy and walkway Roof diaphragms have been assessed as being sufficient to stabilise the wall loading back to the main building bracing walls.

11 Continued Occupancy Recommendations

Based on our assessment of the building, BMC consider continued occupancy is appropriate *subject to the conditions of the Earthquake Prone Buildings Act*. That is, if the Territorial Authority has: issued an Earthquake Prone Notice for the Building then it is displayed in accordance with Section 133AP; not determined that any safety actions in accordance with Section 133AR are required; or, the building is located within an area that has been affected by an emergency under subpart 6B of Section 133.

MBIE have prepared a guidance document for building owners and key stakeholders that provides a framework for making decisions relating to continued occupancy of earthquake prone buildings. The document also provides further context to the %NBS ratings reported in seismic assessment reports. A link to the guidance document is found below:

https://www.building.govt.nz/assets/Uploads/getting-started/seismic-risk-guidance-for-buildings.pdf

12 Recommendations

BMC's recommendations are summarised as follows:

- Ensure the Brickwork veneers are adequately tied to the Timber framed studwork..

Note that some localised loss of the veneer cladding may occur under a ULS event, but this is not considered to compromise the overall structural integrity or utility of the building.

BMC

Appendix A – Technical Summary Sheet

(to be provided to the Territorial Authority as per the MBIE Technical Guidance)

BMC

1. Building Information	
Building Name/ Description	Alexandra Service Centre
Street Address	1 Dunorling Street, Alexandra
Territorial Authority	Central Otago District Council
No. of Storeys	1No. Stories
Area of Typical Floor (approx.)	Approximately 2250m2
Year of Design (approx.)	Circa 1978
NZ Standards designed to	The building was likely designed to: NZS4203-1976, NZS4203-1984.
Structural System including Foundations	The building consists of two main elements the William Fraser Block and the Kelman Street Block. The assessment is required for the William Fraser Building only. It is single storey in height having a U-shaped footprint. It comprises a timber trussed stepped duo pitch roof structure supported by internal and external load bearing timber framed walls on RC foundations with a timber cladding to the window heights and a brick masonry veneer under the sill level.
Does the building comprise a shared structural form or shares structural elements with any other adjacent titles?	The building does not comprise a shared structural form on elements with adjacent titles.
Key features of ground profile and identified geohazards	The geotechnical review of existing reports / documentation of the site has determined it to be: - The Site is in Ground Class C - Shallow Soil and has a Negligible risk from liquefaction.
Previous strengthening and/ or significant alteration	There has been no specific seismic strengthening undertaken in the building.
Heritage Issues/ Status	Central Otago District Council District Plan Schedule 194. Listing Ref - None. Heritage New Zealand Pouhere Taonga – None
Other Relevant Information	None

BMC

2. **Assessment Information**	
Consulting Practice	Batchelar McDougall Consulting
CPEng Responsible, including: • Name • CPEng number • A statement of suitable skills and experience in the seismic assessment of existing buildings[1]	Warren Holt 1026871 - Practice Area description - Structural design, seismic assessment, and construction monitoring for low rise buildings. 10 years experience of seismic assessment in New Zealand NZSEE Conference 2013, 2015, 2021 & 2023 NZSEE seminars on ISA's 2013, 2014 NZSEE Seismic assessment of URM seminar 2015 NZSEE – Seismic Assessment of Existing Building Seminar 2016 Concrete NZ – Displacement Based Seismic Design Assessment Seminar 2018 SESOC/NZSEE – Seismic Assessment of Existing Building Seminar 2019 MIBE - Earthquake Prone Building Methodolgy 2020 ISEC Seismic Engineering Workshop and URM Strengthening 2020
Documentation reviewed, including: • date/ version of drawings/ calculations[2] • previous seismic assessments	Architectural & Structural Drawings of G.O.A.B. Alexandra Job Ref: 7/286/2 Sheets 78No. dated Dec 1978 by: Ministry Of Works. Architectural Drawings of Alterations to William Fraser Building Job Ref: 3137/w7 Sheets (13No.) dated Apr 1993 by: Salmond Anderson Heath Architects. Structural Drawings of Refurbishment of William Fraser Building Job Ref: 14455 Sheets S1-2 dated Jun 1993 by: Duffill Watts & King Ltd Architectural & Structural Drawings of Extension to William Fraser Building, Alexandra Job Ref: 7/286/19 Sheets (25No.) dated Dec 1986 by: Ministry Of Works.
Geotechnical Report(s)	A Desktop Geotechnical Report was undertaken by Geosolve Limited Reference 230125 dated March 2023 which determined the assessment to be Structurally Dominated.
Date(s) Building Inspected and extent of inspection	23/03/2021
Description of any structural testing undertaken and results summary	The walls where drilled to confirm composition where not visually evident and the RC elements scanned to determine centres of reinforcement.
Previous Assessment Reports	There were no previous seismic assessment reports available of the building elements.
Other Relevant Information	None

[1] This should include reference to the engineer's Practice Field being in Structural Engineering, and commentary on experience in seismic assessment and recent relevant training
[2] Or justification of assumptions if no drawings were able to be obtained

BMC

3. Summary of Engineering Assessment Methodology and Key Parameters Used	
Occupancy Type(s) and Importance Level	IL4
Site Subsoil Class	Ground Class C Shallow Soil
Summary of how Part C was applied, including: • the analysis methodology(s) used from C2 • other sections of Part C applied	These quantitative assessments are based upon the MIBE et al Guidance documents "The Seismic Assessment of Existing Buildings" July 2017. Including Sections C1-4 and with particular reference to C9 - Timber Buildings & C10 - Secondary Structural and Non-Structural Elements.
Other Relevant Information	None

<table>
<tr><th colspan="3">4. Assessment Outcomes</th></tr>
<tr><td>Assessment Status
(Draft or Final)</td><td colspan="2">Final (DSA)</td></tr>
<tr><td>Assessed %NBS Rating</td><td colspan="2">100%NBS(IL4)</td></tr>
<tr><td>Seismic Grade and Relative Risk (from Table A3.1)</td><td colspan="2">Seismic Grade A</td></tr>
<tr><td>Comment on the nature of Secondary Structural and Non-structural elements/ parts identified and assessed</td><td colspan="2">The following Secondary Structural and Non-structural elements have been identified and assessed: -
Masonry Veneers
Ceilings
Canopies and other appendages</td></tr>
<tr><td>Describe the Governing Critical Structural Weakness</td><td colspan="2">BMC consider the Critical Structural Weakness to be: Out-of-plane rocking failure of the upper portions of the unreinforced masonry side and rear perimeter wall elevations</td></tr>
<tr><td rowspan="5">If the results of this DSA are being used for earthquake prone decision purposes, <u>and</u> elements rating <34<i>%NBS</i> have been identified (including Parts)[3]:</td><td>Engineering Statement of Structural Weaknesses and Location</td><td>Mode of Failure and Physical Consequence Statement(s)</td></tr>
<tr><td colspan="2">Building Overall</td></tr>
<tr><td>Not Applicable to this building</td><td>Not Applicable to this building</td></tr>
<tr><td colspan="2">Parts of Building</td></tr>
<tr><td>Not Applicable to this building</td><td>Not Applicable to this building</td></tr>
<tr><td>Recommendations
(optional for EPB purposes)</td><td colspan="2">• Not Applicable to this building.</td></tr>
</table>

[3] If a building comprises a shared structural form or shares structural elements with other adjacent titles, information about the extent to which the low scoring elements affect, or do not affect the structure.

BMC

Appendix B – Summary Calculations / Assessment Outputs

BMC BATCHELAR MCDOUGALL CONSULTING

		Job No:	1708-2227a		
		By:	WH	**Checked**:	GRM
Job Name:	Alexandra Service Centre	**Page**:		**of**:	
Subject:	Assessment Summary William Fraser Block	**Date**:	7/08/23		

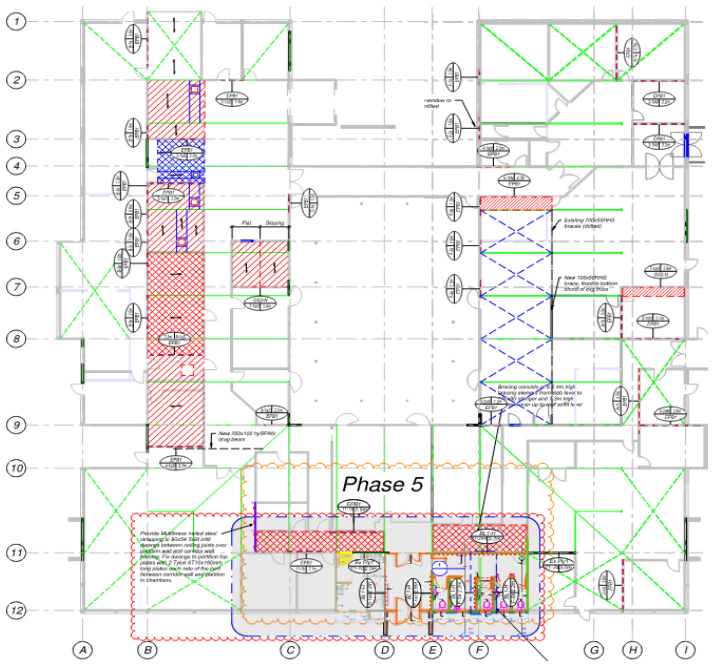
Assessment Summary

Loading

Ductility	μ	3.5	
Structural Performance Fac	S_p	0.5	
Importance Level	IL	4	
ULS Seismic Coefficient	$C_d(T)$	0.45	g

Building Information

Built in		1974		
Length	BL	41.3	m	
Width	BW	38.3	m	
Ground Floor Height	H_{GF}	2.35	m	*Varies*
Ridge Height	R_{GF}	5.7	m	
East / West Wing width	W_{EW}	13.3	m	



URM Veneers OOP

Check Typical Brick Wall Veneer OOP Loads

Horizontal Eq Coeff	F_{ph}	0.66	g
Tributary Weight	Wt	1.935	kPa
Fixing Eq Coeff	F_{ph}	1.03	g
Shear	V*	2.34	kN/m
Mmt to Studs	M*	0.64	kNm/600mm stud
Moment Capacity	ϕM_n	0.68	kNm
		100	**%NBS (IL2)**

In-Plane Bracing Capacity

Longitudinal Gridlines

A	100	%NBS(IL4)
B	100	%NBS(IL4)
C	100	%NBS(IL4)
D	100	%NBS(IL4)
E	100	%NBS(IL4)
F	100	%NBS(IL4)
G	N/A	%NBS(IL4)
H	100	%NBS(IL4)
I	100	%NBS(IL4)

Transverse Gridlines

1W	to 1W	%NBS(IL4)	1E	to 1E	%NBS(IL4)
2W	98	%NBS(IL4)	2E	100	%NBS(IL4)
3W	100	%NBS(IL4)	3E	100	%NBS(IL4)
4W	N/A	%NBS(IL4)	4E	100	%NBS(IL4)
5W	100	%NBS(IL4)	5E	100	%NBS(IL4)
6W	N/A	%NBS(IL4)	6E	N/A	%NBS(IL4)
7W	100	%NBS(IL4)	7E	100	%NBS(IL4)
8W	100	%NBS(IL4)	8E	100	%NBS(IL4)
9	100	%NBS(IL4)			
10	N/A	%NBS(IL4)			
11	100	%NBS(IL4)			
12	to 11	%NBS(IL4)			

Timber Diaphragms

Link Walkway Diaphragm (Exg.) 100 **%NBS (IL2)** *GIB sarking. Assessed using Section C9 MBIE.*

Overall Building Seismic Capacity 98 **%NBS (IL2)**

BATCHELAR McDOUGALL CONSULTING
Structural & Civil Engineers

Job No: 1708-2227a
By: WH **Checked**:
Job Name: Alexandra Service Centre **Page**: L1 **of**:
Subject: Earthquake Coefficient **Date**: 4/08/23

NZS1170
Pt 5:2004

Equivalent Static Earthquake Coefficient

Soil Type	C - Shallow Soil	*Refer to Cl 3.1.3*
Building Design Life	50 Years	
Importance Level	4	*See Table 3.1 (NZS1170.0)*
Building Location	Alexandra	

ULS Return Period	1/2500 Years
SLS Return Period	1/25 Years
Hazard Factor, Z	0.21
R_u	1.8
R_s	0.25

Direction	Period, T_1	Ductility		N(T,D),	N(T,D), $_{SLS}$	$C_h(T)$	$C(T)_{ULS}$	$C(T)_{SLS}$
	(s)	μ_{ULS}	μ_{SLS}	ULS				
X	0.4	1	1	1.0	1.0	2.36	0.89	0.12
Y	0.4	3.5	1	1.0	1.0	2.36	0.89	0.12

Direction X

S_p Factor *from NZS1170*	1	
S_p Factor Overide	0.5	*(leave blank to use 1170 default)*
Chosen S_p Factor	0.5	
k_μ	1.0	*uls*
	1.0	*sls*

ULS Seismic Coefficient, C	**0.45**	g	
SLS Seismic Coefficient, C	0.09	g	*(S_p = 0.7)*

Direction Y

S_p Factor *from NZS1170*	0.7	
S_p Factor Overide	0.5	*(leave blank to use 1170 default)*
Chosen S_p Factor	0.5	
k_μ	2.4	*uls*
	1.0	*sls*

ULS Seismic Coefficient, C	**0.18**	g	
SLS Seismic Coefficient, C	0.09	g	*(S_p = 0.7)*

BMC BATCHELAR McDOUGALL CONSULTING
Structural & Civil Engineers

Job Name:	Alexandra Service Centre	**Job No**:	1708-2227A		
Subject:	Earthquake Parts Coefficient for URM	**By**:	W Holt	**Checked**:	
		Page:		**of**:	
		Date:	4/08/23		

NZS1170 Pt 5:2004

Building Parts Seismic Coefficient

Part Classification	P.1	*Refer NZS1170.5 Table 8.1*
Part Risk Factor	1.0	*Part representing a hazard to life outside the structure (ULS) e.g. cladding, glazing, veranda, sign*
Structure Limit State	ULS	

Elastic Site Spectra for the Building

Site Subsoil Class:	C	Shallow Soil	*Table 3.1 NZS1170.5*
Spectral shape factor T=0 Ch(0)	1.33		*Ref Table 3.1, NZS1170.5, Note 1*
Location of Site	Alexandra		
Hazard Factor, Z	0.21		
Building Importance level	4		*AS/NZS1170.0 Table 3.2*
Design working life	50 years		*AS/NZS1170.0 Table 3.3*
SLS category	SLS1		
Annual probability of exceedance			
ULS	1/2500		*AS/NZS1170.0 Table 3.3*
SLS	1/25		*AS/NZS1170.0 Table 3.3*
Risk Factor			
Ru	1.80		*AS/NZS1170.0 Table 3.5*
Rs	0.25		
Use	1.80		
Near-fault factor N(T,D)	1.0		*eqtn 3.1(2), 3.1(3) of NZS1170.5*
ZRu	0.38		*(maximum value is 0.7)*
C(0) = Ch(0) z R N(T,D) =	**0.50**		

Floor Height Coefficient C_{Hi}

Height of structure, h_n	5.7	m	*height from base to uppermost seismic mass*
Height of part, h_i	1.2	m	
Floor Height Coeficcient, C_{Hi}	**1.2**		*eqtn 8.3 (1) or (2) or (3) of NZS1170.5*

Part Spectral Shape Coefficient

Period of the Part, Tp	0.40	s	*NB: Use the period of the part not the building.*
Part Spectral Shape Coeff, Ci(Tp)	**2.0**		*NZS1170.5 eqtn 8.4.1*

Ductility of the Part

Preselected part no#	8	*Ref NZS1170.5 table C8.2*
Description of Part	External wall or cladding (masonry- including glass blocks)	
Indicative deformation limits for onset of damage	H/300 (face loading), H/600 (in-plane)	
Part Ductility, m_p ULS	2.00	
SLS1/SLS2	1.00	
Limit State (ULS or SLS) m_p	2.00	Ultimate Limit State
Part Response Factor, Cph	0.55	*refer table 8.2, take as Cpv ref 8.6*

Design Response Coefficient

$Cp(Tp) = C(0)\ C_{Hi}\ C_i(Tp) =$ 1.21

Horizontal Earthquake Coefficient

Part $F_{ph} = C_p\ (T_p)\ C_{ph}\ R_p, < 3.6 =$	0.66
Part Fixing F_{ph} (m=1.25, C_{ph}=0.85)=	1.03

Vertical Earthquake Coefficient

$C_{vd} = Cv(Tv)Sp = 0.7C(T)Sp =$	0.25	Sp	0.70
Part $F_{pv} = C_{pv}\ C_{vd}\ R_p, < 2.5 =$	0.14		
Part Fixing F_{pv} (m=1.25, C_{ph}=0.85)=	0.21		

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS www.bmconsult.co.nz

Wanaka Office: Level 3, 99 Ardmore Street. Phone: (03) 443 4531

Alexandra Service Centre
1 Dunolring Street
Alexandra

1708-2227A	Aug-23	WH

ref

Beam Span =	2.4	m

Uniformly Distributed Loads

#	Load Type	Description	Tributary Width (m)	Uniform Pressure (kPa)	Additional UDL (kN/m)	Total UDL (kN/m)	a (m)	b (m)
w_1	*Snow, S*		*0.6*	*1.2177*		*0.73*	*0*	*2.4*
w_2								
w_3								
w_4								
w_5								
w_6								
w_7								
w_8								

Point Loads

#	Load Type	Description	Tributary Area (m^2)	Uniform Pressure (kPa)	Additional PL (kN)	Total PL (kN)	c (m)
P_1							
P_2							
P_3							
P_4							
P_5							
P_6							
P_7							
P_8							

Try Timber Beam

Strength Reduction Factor, ϕ = 0.8
Timber Environment: Dry — Load Duration Factor, k_1 = 1
Timber Grade: SG8 — Parallel Support Factor, k_4 = 1
Shape: Rectangular — Slenderness, S = 9.2
Section Size: *Use 1 x* 090x045 *SG8* — Reduction Factor, k_8 = 1.00
(Enter custom sections freely as ###x### or ### for circular sections)
Number of Elements in System: 1 Element in system
Grid System: No

Ultimate Limit State - Strength Calculation

Spacing of Lateral Restraints, $L_{ay,c}$ 1200 mm (on compression edge)
Spacing of Lateral Restraints, $L_{ay,t}$ 1200 mm (on tension edge)

Bending Strength, f_b = 14 MPa
Moment Demand, M* = 0.5 kNm — Shear Strength, f_s = 3.8 MPa
Shear Demand, V* = 0.9 kN — Mod. Of Elasticity, E = 5.4 GPa
Section Modulus, Z = 60750 mm^3

Allowable Bending Strength, ϕM_n = 0.68 kNm - OK
Allowable Shear Strength, ϕV_n = 8.2 kN - OK

Serviceability Limit State - Deflection Calculation

Deflection Limit, L/?? 150 — Allowable Deflection = 16.0 mm
2_{nd} Moment of Area, I_x = 2.7 $x10^6 mm^4$

Maximum Deflection 14.7 mm
≡ **L / 163** OK

Moments & Reactions			
	Moment	Reaction A	Reaction B
G	0.0	0.0	0.0
Q	0.0	0.0	0.0
Wup	0.0	0.0	0.0
Wdn	0.0	0.0	0.0
S	0.5	0.9	0.9
1.35G	0.0	0.0	0.0
1.2G+1.5Q	0.0	0.0	0.0
1.2G+Q+Wdn	0.0	0.0	0.0
0.9G+Wup	0.0	0.0	0.0
1.2G+S	0.5	0.9	0.9
Maximum	**0.5**	**0.9**	**0.9**

Deflections		
G only	0.0	mm
2G+0.7Q	0.0	mm
G+0.4Q+Wdn,sls	0.0	mm
Wup,sls	0.0	mm
2G+S,sls	14.7	mm
1kN pt load	19.51	mm

Notes:

Seismic Acceleration

Material	µ	$C_d(T)$	NBS%	$C_d(T)$ (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
OoP Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type **Timber Bracing**

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	**84.6**	**0.0**	84.6	**8.48**	718	#VALUE!	#VALUE!
1	**0.0**	**0.0**		**3.35**	#VALUE!	#VALUE!	#VALUE!
totals	**84.6**	**0.0**	**84.6**		**#VALUE!**	**#VALUE!**	**#VALUE!**

Base shear, V = $C_d(T_1)\,W_t$

Cd(T) 0.18 g

V = 15.2 kN

Building Dimensions

Bracing Line Tributary Width	1.975	m
Building West Width	13.3	m
Building Length	41.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS

Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Alexandra Service Centre
1 Dunorling St
Alexandra
Dunorling Street Block

1708-2227A	Aug-23	WH

Subject: Seismic Demand Calculations Gridline A - Ground Floor

Ground Floor

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	In Plane External Timber Frame	GL A	8.29		1.18		x	0.35	kPa	3.41	0.18	0.6		0.0
w_2	Glazing	GLA	33.01		1.18		x	0.25	kPa	9.70	0.18	1.7		0.0
w_3	URM Wall Veneer	GLA Full Height	5.40	0.10	1.18		x	18.00	kN/m3	11.71	0.18	2.1		0.0
w_4	URM Wall Veneer	GLA below sill	26.21	0.10	0.20		x	18.00	kN/m3	9.7	0.18	1.7		0.0
w_5	In Plane External Timber Frame	GLA below sill	6.80		0.20		x	0.35	kPa	0.5	0.18	0.1		0.0
w_6														
w_7	Glazing		3.95		1.18		x	0.25	kPa	1.2	0.18	0.2		0.0
w_8	URM Wall Veneer	below sill	3.95	0.10	0.20		x	18.00	kN/m3	1.5	0.18	0.3		0.0
w_9	OoP Ext Timber Framing	below sill	3.95		0.20		x	0.35	kPa	0.3	0.18	0.0		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	9.88		1.50		x	0.25	kPa	3.7	0.18	0.7		0.0
w_{12}	Internal Timber Framing	in-plane	3.64		1.75		x	0.25	kPa	1.6	0.18	0.3		0.0
w_{13}														
w_{14}	Timber Roof		2.48	41.90			x	0.40	kPa	41.5	0.18	7.5		0.0
w_{15}														
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
w_{32}														
w_{33}														
										85	**F(kN) =**	**15.2**	**0.0**	**0.0**

Ground Floor Summary

Weight	85	kN
V*	15.2	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)
Ex.Ply1	0.50	2.40	Concrete	6.50	3.25
Ex.Ply1	1.37	2.40	Concrete	6.50	8.91
Ex.Ply1	2.90	2.40	Concrete	6.50	18.85

Total Capacity	**31.0**	**kN**
Demand	**15.2**	**kN**
	100%	**%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline B

Seismic Acceleration

Material	μ	C_d(T)	NBS%	C_d(T) (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type **Timber Bracing**

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	**196.4**	**0.0**	196.4	**8.48**	1666	#VALUE!	#VALUE!
1	**0.0**	**0.0**		**3.35**	#VALUE!	#VALUE!	#VALUE!
totals	**196.4**	**0.0**	**196.4**		**#VALUE!**	**#VALUE!**	**#VALUE!**

Base shear, V = **$C_d(T_1)\ W_t$**

Cd(T) **0.18** **g**

V = **35.4** **kN**

Building Dimensions

Bracing Line Tributary Width	6.65	m
Building West Width	13.3	m
Building Length	41.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS

Wanaka Office: Level 3, 99 Ardmore Street | Phone: (03) 443 4531 | www.bmconsult.co.nz

Alexandra Service Centre
1 Dunorling St
Alexandra
Dunorling Street Block
1708-2227A | Aug-23 | WH

Subject: Seismic Demand Calculations Gridline B - Ground Floor

Ground Floor

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and C_d(T) =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL B In-plane	27.60		2.53	0.80	x	0.25	kPa	13.94	0.18	2.5		0.0
w_2	Ext Timber Framing	GLB upper	31.50		2.10	0.80	x	0.35	kPa	18.52	0.18	3.3		0.0
w_3														
w_4														
w_5														
w_6	Ext Timber Framing		1.55		1.18		x	0.35	kPa	0.6	0.18	0.1		0.0
w_7	Glazing		11.75		1.18		x	0.25	kPa	3.5	0.18	0.6		0.0
w_8	URM Wall Veneer	below sill	9.80	0.10	0.20		x	18.00	kN/m3	3.6	0.18	0.7		0.0
w_9	Ext Timber Framing	below sill	3.50		0.20		x	0.35	kPa	0.2	0.18	0.0		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	27.65		1.18	0.85	x	0.25	kPa	6.9	0.18	1.2		0.0
w_{12}	Internal Timber Framing	in-plane	3.64		1.18		x	0.25	kPa	1.1	0.18	0.2		0.0
w_{13}														
w_{14}	Timber Roof		6.65	41.90			x	0.40	kPa	111.5	0.18	20.1		0.0
w_{15}	Timber Floor		3.98	23.00			x	0.40	kPa	36.6	0.18	6.6		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										196	**F(kN) =**	**35.4**	**0.0**	**0.0**

Ground Floor — **Summary**

Weight	196	kN
V*	35.4	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)
EP1	1.00	2.40	Concrete	5.25	5.25
Ex.Ply1	2.00	2.40	Concrete	6.50	13.00
EP1	1.30	2.40	Concrete	6.75	8.78
EP1	0.60	2.40	Concrete	5.25	3.15
EP1	1.60	2.40	Concrete	6.75	10.80
EP1	1.60	2.40	Concrete	6.75	10.80
EP1	3.00	2.40	Concrete	6.75	20.25
Ex.Ply1	0.70	2.40	Concrete	6.50	4.55
Ex.Ply1	0.70	2.40	Concrete	6.50	4.55

Total Capacity	**81.1**	**kN**
Demand	**35.4**	**kN**
	100%	**%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline C

Seismic Acceleration

Material	μ	$C_d(T)$	NBS%	$C_d(T)$ (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
OoP Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type: Timber Bracing

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	191.8	0.0	191.8	8.48	1626	#VALUE!	#VALUE!
1	0.0	0.0		3.35	#VALUE!	#VALUE!	#VALUE!
totals	191.8	0.0	191.8		#VALUE!	#VALUE!	#VALUE!

Base shear, V = $C_d(T_1)\ W_t$
Cd(T) 0.18 g
V = 34.5 kN

Building Dimensions

Bracing Line Tributary Width	4.675	m
Building West Width	13.3	m
Building Length	41.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m
Part Trib width 1	2.9	m

BATCHELAR McDOUGALL CONSULTING
STRUCTURAL & CIVIL ENGINEERS
Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Alexandra Service Centre			
1 Dunorling St			
Alexandra			
Dunorling Street Block			
1708-2227A	Aug-23	WH	

Subject: Seismic Demand Calculations Gridline C - Ground Floor

Ground Floor

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	In Plane External Timber Frame	GL A	10.43		1.18		x	0.35	kPa	4.29	0.18	0.8		0.0
w_2	Glazing	GLA	17.73		1.18		x	0.25	kPa	5.21	0.18	0.9		0.0
w_3														
w_4	URM Wall Veneer	GLA below sill	7.20	0.10	0.20		x	18.00	kN/m3	2.7	0.18	0.5		0.0
w_5	In Plane External Timber Frame	GLA below sill	14.15		0.20		x	0.35	kPa	1.0	0.18	0.2		0.0
w_6	Internal Timber Framing		13.15		2.88	0.85	x	0.25	kPa	8.0	0.18	1.4		0.0
w_7	Glazing		4.53		1.18		x	0.25	kPa	1.3	0.18	0.2		0.0
w_8	URM Wall Veneer	below sill	3.05	0.10	0.20		x	18.00	kN/m3	1.1	0.18	0.2		0.0
w_9	OoP Ext Timber Framing	below sill	7.58		0.20		x	0.35	kPa	0.5	0.18	0.1		0.0
w_{10}	OoP Ext Timber Framing		3.05		1.18		x	0.35	kPa	1.3	0.18	0.2		0.0
w_{11}	Internal Timber Framing	OoP	37.45		1.18		x	0.25	kPa	11.0	0.18	2.0		0.0
w_{12}	Internal Timber Framing	in-plane	51.85		3.18		x	0.25	kPa	41.2	0.18	7.4		0.0
w_{13}														
w_{14}	Timber Roof	E	5.68	41.90			x	0.40	kPa	95.1	0.18	17.1		0.0
w_{15}	Timber Roof	C	2.90	13.15			x	0.40	kPa	15.3	0.18	2.7		0.0
w_{16}	Timber Roof	LW	2.90	3.30			x	0.40	kPa	3.8	0.18	0.7		0.0
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
w_{32}														
w_{33}														
										192	**F(kN) =**	**34.5**	**0.0**	**0.0**

Ground Floor Summary

Weight	192	kN
V*	34.5	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)
Ex.Ply1	2.40	2.40	Concrete	6.50	15.60
EP1	1.36	2.40	Concrete	6.75	9.18
Ex.Ply1	0.80	2.40	Concrete	6.50	5.20
EP1	1.20	2.40	Concrete	6.75	8.10
Ex.Ply2	0.95	2.40	Concrete	7.40	7.03

Total Capacity	**45.1**	**kN**
Demand	**34.5**	**kN**
	100%	**%NBS (IL2)**

Seismic Acceleration

Material	μ	$C_d(T)$	NBS%	$C_d(T)$ (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type **Timber Bracing**

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	**53.5**	**0.0**	53.5	**8.48**	453	#VALUE!	#VALUE!
1	**0.0**	**0.0**		**3.35**	#VALUE!	#VALUE!	#VALUE!
totals	**53.5**	**0.0**	**53.5**		**#VALUE!**	**#VALUE!**	**#VALUE!**

Base shear, V = $C_d(T_1)\,W_t$

Cd(T) **0.18** **g**

V = **9.6** **kN**

Building Dimensions

Bracing Line Tributary Width	4.4	m
Building Centre Width	11.6	m
Building Centre Length	15.8	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS

Wanaka Office: Level 3, 99 Ardmore Street   Phone: (03) 443 4531   www.bmconsult.co.nz

Alexandra Service Centre
1 Dunorling St
Alexandra
Dunorling Street Block
1708-2227A | Aug-23 | WH

Subject: Seismic Demand Calculations Gridline D - Ground Floor

Ground Floor

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and C_d(T) =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL B In-plane	11.06		2.53	0.80	x	0.25	kPa	5.59	0.18	1.0		0.0
w_2														
w_3														
w_4														
w_5														
w_6	Glazing		5.40		1.18		x	0.25	kPa	1.6	0.18	0.3		0.0
w_7														
w_8	Ext Timber Framing	below sill	4.40		0.20		x	0.35	kPa	0.3	0.18	0.1		0.0
w_9	URM Wall Veneer	full height	3.00	0.10	1.18	0.90	x	18.00	kN/m3	5.7	0.18	1.0		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	6.40		4.83	0.85	x	0.25	kPa	6.6	0.18	1.2		0.0
w_{12}														
w_{13}														
w_{14}	Timber Roof		4.40	16.60			x	0.40	kPa	29.2	0.18	5.3		0.0
w_{15}	Timber Roof	porch	2.50	4.50			x	0.40	kPa	4.5	0.18	0.8		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										53	**F(kN) =**	**9.6**	**0.0**	**0.0**

Ground Floor — **Summary**

Weight	53	kN
V*	9.6	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)
BL1-H	2.20	2.40	Concrete	5.25	11.55

Total Capacity	**11.6**	**kN**
Demand	**9.6**	**kN**
	100%	**%NBS (IL2)**

Seismic Acceleration

Material	µ	C_d(T)	NBS%	C_d(T) (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type **Timber Bracing**

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	**53.5**	**0.0**	53.5	**8.48**	453	#VALUE!	#VALUE!
1	**0.0**	**0.0**		**3.35**	#VALUE!	#VALUE!	#VALUE!
totals	**53.5**	**0.0**	**53.5**		**#VALUE!**	**#VALUE!**	**#VALUE!**

Base shear, V = $C_d(T_1)\, W_t$

Cd(T) **0.18** **g**

V = **9.6** **kN**

Building Dimensions

Bracing Line Tributary Width	4.4	m
Building Centre Width	11.6	m
Building Centre Length	15.8	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m

BATCHELAR McDOUGALL CONSULTING
STRUCTURAL & CIVIL ENGINEERS

Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Alexandra Service Centre
1 Dunorling St
Alexandra
Dunorling Street Block

1708-2227A	Aug-23	WH

Subject: Seismic Demand Calculations Gridline E - Ground Floor

Ground Floor

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL B In-plane	11.06		2.53	0.80	x	0.25	kPa	5.59	0.18	1.0		0.0
w_2														
w_3														
w_4														
w_5														
w_6	Glazing		5.40		1.18		x	0.25	kPa	1.6	0.18	0.3		0.0
w_7														
w_8	Ext Timber Framing	below sill	4.40		0.20		x	0.35	kPa	0.3	0.18	0.1		0.0
w_9	URM Wall Veneer	full height	3.00	0.10	1.18	0.90	x	18.00	kN/m3	5.7	0.18	1.0		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	6.40		4.83	0.85	x	0.25	kPa	6.6	0.18	1.2		0.0
w_{12}														
w_{13}														
w_{14}	Timber Roof		4.40	16.60			x	0.40	kPa	29.2	0.18	5.3		0.0
w_{15}	Timber Roof	porch	2.50	4.50			x	0.40	kPa	4.5	0.18	0.8		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										53	**F(kN) =**	**9.6**	**0.0**	**0.0**

Ground Floor **Summary**

Weight	53	kN
V*	9.6	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)
BL1-H	2.20	2.40	Concrete	5.25	11.55

Total Capacity	**11.6**	**kN**
Demand	**9.6**	**kN**
	100%	**%NBS (IL2)**

Seismic Acceleration

Material	µ	C_d(T)	NBS%	C_d(T) (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
OoP Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type **Timber Bracing**

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	**166.3**	**0.0**	166.3	**8.48**	1410	#VALUE!	#VALUE!
1	**0.0**	**0.0**		**3.35**	#VALUE!	#VALUE!	#VALUE!
totals	**166.3**	**0.0**	**166.3**		**#VALUE!**	**#VALUE!**	**#VALUE!**

Base shear, V = $C_d(T_1)\,W_t$
Cd(T) 0.18 **g**
V = 29.9 **kN**

Building Dimensions

Bracing Line Tributary Width	6.2	m
Building West Width	13.3	m
Building Length	41.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m
Part Trib width 1	2.9	m

BATCHELAR McDOUGALL CONSULTING
STRUCTURAL & CIVIL ENGINEERS
Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Subject: Seismic Demand Calculations Gridline F - Ground Floor

Ground Floor

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	In Plane External Timber Frame	GL F	7.50		1.18		x	0.35	kPa	3.08	0.18	0.6		0.0
w_2	Glazing	GL F	20.65		1.18		x	0.25	kPa	6.07	0.18	1.1		0.0
w_3	URM Wall Veneer	High Sill	3.10	0.10	0.26		x	18.00	kN/m3	1.45	0.18	0.3		0.0
w_4	URM Wall Veneer	GL F below sill	7.20	0.10	0.20		x	18.00	kN/m3	2.7	0.18	0.5		0.0
w_5	In Plane External Timber Frame	GL F below sill	14.15		0.20		x	0.35	kPa	1.0	0.18	0.2		0.0
w_6	Internal Timber Framing		30.45		2.88	0.85	x	0.25	kPa	18.6	0.18	3.3		0.0
w_7	Glazing	OPP	9.75		1.18		x	0.25	kPa	2.9	0.18	0.5		0.0
w_8	URM Wall Veneer	OOP below sill	10.70	0.10	0.20		x	18.00	kN/m3	3.9	0.18	0.7		0.0
w_9	OoP Ext Timber Framing	below sill			0.20		x	0.35	kPa	0.1	0.18	0.0		0.0
w_{10}	OoP Ext Timber Framing		2.65		1.18		x	0.35	kPa	1.1	0.18	0.2		0.0
w_{11}	URM Wall Veneer	High Sill	6.20	0.10	0.26		x	0.25	kPa	0.0	0.18	0.0		0.0
w_{12}	Internal Timber Framing	OoP	28.30		2.18		x	0.25	kPa	15.4	0.18	2.8		0.0
w_{13}	Internal Timber Framing	in-plane	2.00		1.18		x	0.25	kPa	0.6	0.18	0.1		0.0
w_{14}	Timber Roof	E	6.20	41.90			x	0.40	kPa	103.9	0.18	18.7		0.0
w_{15}		C												
w_{16}	Timber Roof	LW	5.80	2.40			x	0.40	kPa	5.6	0.18	1.0		0.0
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
w_{32}														
w_{33}														
										166	**F(kN) =**	**29.9**	**0.0**	**0.0**

Ground Floor **Summary**

Weight	166	kN
V*	29.9	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
EP1	1.00	2.40	Concrete	5.25	5.25	F-1a
EP1	1.60	2.40	Concrete	6.75	10.80	F-2a
EP1	1.20	2.40	Concrete	6.75	8.10	F-2b
EP1	0.60	2.40	Concrete	5.25	3.15	F-3a
EP1	1.20	2.40	Concrete	6.75	8.10	F-4a
Ex.Ply1	0.90	2.40	Concrete	5.25	4.73	F-5o
BL1-H	2.20	2.40	Concrete	5.25	11.55	F-5a
BL1-H	2.20	2.40	Concrete	5.25	11.55	F-5b
				Total Capacity	**63.2**	**kN**
				Demand	**29.9**	**kN**
				100%		**%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline H

Seismic Acceleration

Material	μ	$C_d(T)$	NBS%	$C_d(T)$ (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type **Timber Bracing**

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	**183.5**	**0.0**	183.5	**8.48**	1556	#VALUE!	#VALUE!
1	**0.0**	**0.0**		**3.35**	#VALUE!	#VALUE!	#VALUE!
totals	**183.5**	**0.0**	**183.5**		**#VALUE!**	**#VALUE!**	**#VALUE!**

Base shear, V = $C_d(T_1)\,W_t$

Cd(T) **0.18** **g**

V = **33.0** **kN**

Building Dimensions

Bracing Line Tributary Width	6.65	m	
Building West Width	13.3	m	
Building Length	41.3	m	
Ground Floor Height	2.35	m	
Sill Height 1	0.825	m	0.2
Ridge Height	5.7	m	
Sill Height 2	1.425	m	0.46

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS
Wanaka Office: Level 3, 99 Ardmore Street Phone: (03) 443 4531 www.bmconsult.co.nz

Alexandra Service Centre
1 Dunorling St
Alexandra
Dunorling Street Block
1708-2227A | Aug-23 | WH

Subject: Seismic Demand Calculations Gridline H - Ground Floor

Ground Floor

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL H In-plane	33.96		2.53	0.80	x	0.25	kPa	17.15	0.18	3.1		0.0
w_2	Ext Timber Framing	GLB upper	31.50		2.10	0.80	x	0.35	kPa	18.52	0.18	3.3		0.0
w_3														
w_4														
w_5														
w_6	Ext Timber Framing		1.25		1.18		x	0.35	kPa	0.5	0.18	0.1		0.0
w_7	Glazing		12.05		1.18		x	0.25	kPa	3.5	0.18	0.6		0.0
w_8	URM Wall Veneer	below sill	11.80	0.10	0.20		x	18.00	kN/m3	4.4	0.18	0.8		0.0
w_9	URM Wall Veneer	sill 2	1.50	0.10	0.26		x	18.00	kN/m3	0.7	0.18	0.1		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	56.95		1.18	0.85	x	0.25	kPa	14.2	0.18	2.6		0.0
w_{12}														
w_{13}														
w_{14}	Timber Roof		7.05	41.90			x	0.40	kPa	118.2	0.18	21.3		0.0
w_{15}	Timber Floor		3.98	4.00			x	0.40	kPa	6.4	0.18	1.1		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										184	**F(kN) =**	**33.0**	**0.0**	**0.0**

Ground Floor Summary

Weight	184	kN
V*	33.0	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)
EP1	3.70	2.40	Concrete	6.75	24.98
EP1	3.00	2.40	Concrete	6.75	20.25
EP1	4.50	2.40	Concrete	6.75	30.38
EP1	3.80	2.40	Concrete	6.75	25.65

Total Capacity	**101.3**	**kN**
Demand	**33.0**	**kN**
	100%	**%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline I

Seismic Acceleration

Material	µ	$C_d(T)$	NBS%	$C_d(T)$ (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
OoP Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type: Timber Bracing

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	98.4	0.0	98.4	8.48	835	#VALUE!	#VALUE!
1	0.0	0.0		3.35	#VALUE!	#VALUE!	#VALUE!
totals	98.4	0.0	98.4		#VALUE!	#VALUE!	#VALUE!

Base shear, V = $C_d(T_1)\,W_t$

Cd(T) 0.18 g

V = 17.7 kN

Building Dimensions

Bracing Line Tributary Width	1.975	m
Building West Width	13.3	m
Building Length	41.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS

Wanaka Office: Level 3, 99 Ardmore Street | Phone: (03) 443 4531 | www.bmconsult.co.nz

Alexandra Service Centre
1 Dunorling St
Alexandra
Dunorling Street Block
1708-2227A | Aug-23 | WH

Subject: Seismic Demand Calculations Gridline I - Ground Floor

Ground Floor

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	In Plane External Timber Frame	GL I	12.84		1.18		x	0.35	kPa	5.28	0.18	1.0		0.0
w_2	Glazing	GL I	28.46		1.18		x	0.25	kPa	8.36	0.18	1.5		0.0
w_3	URM Wall Veneer	GL I Full Height	5.40	0.10	1.18		x	18.00	kN/m3	11.71	0.18	2.1		0.0
w_4	URM Wall Veneer	GL I below sill	34.50	0.10	0.20		x	18.00	kN/m3	12.7	0.18	2.3		0.0
w_5	In Plane External Timber Frame	GL I below sill	6.80		0.20		x	0.35	kPa	0.5	0.18	0.1		0.0
w_6	OoP Ext Timber Framing	full height	2.00		1.18		x	0.35	kPa	0.8	0.18	0.1		0.0
w_7	Glazing	OOP	3.95		1.18		x	0.25	kPa	1.2	0.18	0.2		0.0
w_8	URM Wall Veneer	below sill	3.95	0.10	0.20		x	18.00	kN/m3	1.5	0.18	0.3		0.0
w_9	OoP Ext Timber Framing	below sill	3.95		0.20		x	0.35	kPa	0.3	0.18	0.0		0.0
w_{10}	Glazing	walkway	11.90		1.18		x	0.25	kPa	3.5	0.18	0.6		0.0
w_{11}	Internal Timber Framing	OoP	15.80		1.50		x	0.25	kPa	5.9	0.18	1.1		0.0
w_{12}	Internal Timber Framing	in-plane	0.00		1.75		x	0.25	kPa	0.0	0.18	0.0		0.0
w_{13}														
w_{14}	Timber Roof		2.48	41.90			x	0.40	kPa	41.5	0.18	7.5		0.0
w_{15}	Timber Roof		5.95	2.20			x	0.40	kPa	5.2	0.18	0.9		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
w_{32}														
w_{33}														
										98	**F(kN) =**	**17.7**	**0.0**	**0.0**

Ground Floor Summary

Weight	98	kN
V*	17.7	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)
Ex.Ply1	2.30	2.40	Concrete	6.50	14.95
Ex.Ply1	2.90	2.40	Concrete	6.50	18.85

Total Capacity 33.8 **kN**

Demand 17.7 **kN**

100% **%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline 1

Seismic Acceleration

Material	μ	$C_d(T)$	NBS%	$C_d(T)$ (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type **Timber Bracing**

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	**24.7**	**0.0**	24.7	**8.48**	209	6.4	6.4
1	**21.7**	**0.0**	21.7	**3.35**	73	2.0	8.3
totals	**46.3**	**0.0**	**46.3**		**282**	**8.3**	**8.3**

Base shear, V = $C_d(T_1)\,W_t$
Cd(T) **0.18** **g**
V = **8.3** **kN**

Building Dimensions

W Bracing Line Tributary Width	2.25	m
Building West Width	41.3	m
Building Length	13.9	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m
E Bracing Line Tributary Width	2.25	m

BATCHELAR McDOUGALL CONSULTING
STRUCTURAL & CIVIL ENGINEERS
Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Subject: Seismic Demand Calculations Gridline 1 - West Wing

West Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Ext Timber Framing	GL 1 In-plane	0.80		1.18	1.00	x	0.35	kPa	0.33	0.18	0.1		0.0
w_2	Glazing	GL 1 In-plane	9.20		0.88	1.00	x	0.25	kPa	2.01	0.18	0.4		0.0
w_3	Ext Timber Framing	GL 1 In-plane	9.20		0.30	1.00	x	0.35	kPa	0.97	0.18	0.2		0.0
w_4														
w_5														
w_6														
w_7	Ext Timber Framing	OoP Ext	2.60		1.18	1.00	x	0.35	kPa	1.1	0.18	0.2		0.0
w_8	Glazing	OoP Ext	1.90		0.88	1.00	x	0.25	kPa	0.4	0.18	0.1		0.0
w_9	Ext Timber Framing	OoP Ext	1.90		0.30	1.00	x	0.35	kPa	0.2	0.18	0.0		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	6.75		2.00	0.85	x	0.25	kPa	2.9	0.18	0.5		0.0
w_{12}	Glazing	in-plane	6.40		1.18	0.80	x	0.25	kPa	1.5	0.18	0.3		0.0
w_{13}														
w_{14}	Timber Roof	area 1	2.75	13.90			x	0.40	kPa	15.3	0.18	2.8		0.0
w_{15}														
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										25	**F(kN) =**	**4.4**	**0.0**	**0.0**

West Wing Summary

Weight	25	kN
V*	4.4	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
Ex GIB 1 side & weatherboard	0.80	2.40	Concrete	1.30	1.04	3-1aS

Total Capacity	**1.0**	**kN**	
Demand	**4.4**	**kN**	roof bracing transfers load to Gridline 2
	23%	**%NBS (IL2)**	

Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Subject: Seismic Demand Calculations Gridline 1 - East Wing

East Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Ext Timber Framing	GL 1 In-plane	0.80		1.18	1.00	x	0.35	kPa	0.33	0.18	0.1		0.0
w_2	Glazing	GL 1 In-plane	12.50		0.88	1.00	x	0.25	kPa	2.73	0.18	0.5		0.0
w_3	Ext Timber Framing	GL 1 In-plane	12.50		0.30	1.00	x	0.35	kPa	1.31	0.18	0.2		0.0
w_4														
w_5														
w_6														
w_7	Ext Timber Framing	OoP Ext	2.70		1.18	1.00	x	0.35	kPa	1.1	0.18	0.2		0.0
w_8	Glazing	OoP Ext	1.80		0.88	1.00	x	0.25	kPa	0.4	0.18	0.1		0.0
w_9	Ext Timber Framing	OoP Ext	1.80		0.30	1.00	x	0.35	kPa	0.2	0.18	0.0		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	1.13		1.18	1.00	x	0.25	kPa	0.3	0.18	0.1		0.0
w_{12}	Internal Timber Framing	in-plane	0.00		1.18	1.00	x	0.25	kPa	0.0	0.18	0.0		0.0
w_{13}														
w_{14}	Timber Roof	area 1	2.75	13.90			x	0.40	kPa	15.3	0.18	2.8		0.0
w_{15}														
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
w_{32}														
w_{33}														
										22	**F(kN) =**	**3.9**	**0.0**	**0.0**

East Wing Summary

Weight	22	kN
V*	3.9	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)

3-1bN

Total Capacity **0.0** **kN**
Demand **3.9** **kN** roof bracing transfers load to Gridline 2
0% **%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline 2

Seismic Acceleration

Material	μ	C_d(T)	NBS%	C_d(T) (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type: Timber Bracing

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	28.9	0.0	28.9	8.48	245	7.5	7.5
1	26.3	0.0	26.3	3.35	88	2.4	9.9
totals	55.2	0.0	55.2		333	9.9	9.9

Base shear, V = $C_d(T_1)\,W_t$

Cd(T) 0.18 g

V = 9.9 kN

Building Dimensions

W Bracing Line Tributary Width	3.4	m
Building West Width	41.3	m
Building Length	13.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m
E Bracing Line Tributary Width	3.4	m

BATCHELAR McDOUGALL CONSULTING
STRUCTURAL & CIVIL ENGINEERS
Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Subject: Seismic Demand Calculations Gridline 2 - West Wing

West Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and C_d(T) =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 2 In-plane	5.50		1.18	0.85	x	0.25	kPa	1.37	0.18	0.2		0.0
w_2	Ext Timber Framing	GL 2 In-plane	1.00		1.18	1.00	x	0.35	kPa	0.41	0.18	0.1		0.0
w_3	Glazing	GL 2 In-plane	3.60		0.88	1.00	x	0.25	kPa	0.79	0.18	0.1		0.0
w_4	Ext Timber Framing	GL 2 In-plane	3.60		0.30	1.00	x	0.35	kPa	0.4	0.18	0.1		0.0
w_5														
w_6														
w_7	Ext Timber Framing	OoP Ext	3.00		1.18	1.00	x	0.35	kPa	1.2	0.18	0.2		0.0
w_8	Glazing	OoP Ext	3.80		0.88	1.00	x	0.25	kPa	0.8	0.18	0.1		0.0
w_9	Ext Timber Framing	OoP Ext	3.80		0.30	1.00	x	0.35	kPa	0.4	0.18	0.1		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	6.80		2.00	0.85	x	0.25	kPa	2.9	0.18	0.5		0.0
w_{12}	Internal Timber Framing	in-plane	0.00		2.00	0.80	x	0.25	kPa	0.0	0.18	0.0		0.0
w_{13}														
w_{14}	Timber Roof	area 1	3.40	13.90			x	0.40	kPa	18.9	0.18	3.4		0.0
w_{15}	Ext Timber Framing	roof wall	4.90		1.00	1.00	x	0.35	kPa	1.7	0.18	0.3		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										29	F(kN) =	5.2	0.0	0.0

West Wing Summary

Weight	29	kN
V*	5.2	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
EP1	1.40	2.40	Concrete	6.75	9.45	2-1aS

Total Capacity		**9.5**	**kN**
Demand		**5.2**	**kN**
	100%		**%NBS (IL2)**
Grid 1 Demand		**4.4**	**kN**
Total Demand		**9.6**	**kN**
	98%		**%NBS (IL2)**

Grid 1 Demand: Transferred through cross bracing and hips

Subject: Seismic Demand Calculations Gridline 2 - East Wing

East Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 2 In-plane	4.30		2.00	1.00	x	0.25	kPa	2.15	0.18	0.4		0.0
w_2														
w_3														
w_4														
w_5														
w_6														
w_7	Ext Timber Framing	OoP Ext	1.65		1.18	1.00	x	0.35	kPa	0.7	0.18	0.1		0.0
w_8	Glazing	OoP Ext	5.15		0.88	1.00	x	0.25	kPa	1.1	0.18	0.2		0.0
w_9	Ext Timber Framing	OoP Ext	5.15		0.30	1.00	x	0.35	kPa	0.5	0.18	0.1		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	3.40		2.00	1.00	x	0.25	kPa	1.7	0.18	0.3		0.0
w_{12}	Internal Timber Framing	in-plane	0.00		2.00	1.00	x	0.25	kPa	0.0	0.18	0.0		0.0
w_{13}														
w_{14}	Timber Roof	area 1	3.40	13.90			x	0.40	kPa	18.9	0.18	3.4		0.0
w_{15}	Ext Timber Framing		3.40		1.00	1.00	x	0.35	kPa	1.2	0.18	0.2		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
w_{32}														
w_{33}														
										26	**F(kN) =**	**4.7**	**0.0**	**0.0**

East Wing — **Summary**

Weight	26	kN
V*	4.7	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
EP1	3.20	2.70	Concrete	2.80	8.96	3-1bN

Total Capacity	**9.0**	**kN**	
Demand	**4.7**	**kN**	
100%		**%NBS (IL2)**	
Grid 1 Demand	**3.9**	**kN**	Transferred through cross bracing and hips
Total Demand	**8.6**	**kN**	
100%		**%NBS (IL2)**	

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS
Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz
www.bmconsult.co.nz

Alexandra Service Centre
1 Dunorling St
Alexandra
Dunorling Street Block
1708-2227A | Aug-23 | WH

Subject: Seismic Demand Calculations Gridline 3

Seismic Acceleration

Material	μ	$C_d(T)$	NBS%	$C_d(T)$ (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type **Timber Bracing**

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	**38.5**	**0.0**	38.5	**8.48**	327	9.6	9.6
1	**29.3**	**0.0**	29.3	**3.35**	98	2.6	12.2
totals	**67.9**	**0.0**	**67.9**		**425**	**12.2**	**12.2**

Base shear, V = $C_d(T_1) W_t$
Cd(T) **0.18** **g**
V = **12.2** **kN**

Building Dimensions

W Bracing Line Tributary Width	4.4	m
Building West Width	41.3	m
Building Length	13.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m
E Bracing Line Tributary Width	3.45	m

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS
Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Alexandra Service Centre			
1 Dunorling St			
Alexandra			
Dunorling Street Block			
1708-2227A	Aug-23	WH	

Subject: Seismic Demand Calculations Gridline 3 - West Wing

West Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 3 In-plane	3.20		1.18	0.85	x	0.25	kPa	0.80	0.18	0.1		0.0
w_2														
w_3														
w_4														
w_5														
w_6														
w_7	Ext Timber Framing	OoP Ext	5.25		1.18	1.00	x	0.35	kPa	2.2	0.18	0.4		0.0
w_8	Glazing	OoP Ext	9.15		0.88	1.00	x	0.25	kPa	2.0	0.18	0.4		0.0
w_9	Ext Timber Framing	OoP Ext	9.15		0.30	1.00	x	0.35	kPa	1.0	0.18	0.2		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	11.00		2.00	0.85	x	0.25	kPa	4.7	0.18	0.8		0.0
w_{12}	Internal Timber Framing	in-plane	0.00		2.00	0.80	x	0.25	kPa	0.0	0.18	0.0		0.0
w_{13}														
w_{14}	Timber Roof	area 1	4.40	13.90			x	0.40	kPa	24.5	0.18	4.4		0.0
w_{15}	Ext Timber Framing	roof wall	4.40		1.00	1.00	x	0.35	kPa	1.5	0.18	0.3		0.0
w_{16}	Timber Roof	porch	3.00	1.60			x	0.40	kPa	1.9	0.18	0.3		0.0
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										39	**F(kN) =**	**6.9**	**0.0**	**0.0**

West Wing — **Summary**

Weight	39	kN
V*	6.9	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
EP1	2.00	2.40	Concrete	6.75	13.50	3-1aS

Total Capacity	**13.5**	**kN**
Demand	**6.9**	**kN**
	100%	**%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline 3 - East Wing

East Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and C_d(T) =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 3 In-plane	4.30		2.00	1.00	x	0.25	kPa	2.15	0.18	0.4		0.0
w_2														
w_3														
w_4														
w_5														
w_6														
w_7	Ext Timber Framing	OoP Ext	2.70		1.18	1.00	x	0.35	kPa	1.1	0.18	0.2		0.0
w_8	Glazing	OoP Ext	4.20		0.88	1.00	x	0.25	kPa	0.9	0.18	0.2		0.0
w_9	Ext Timber Framing	OoP Ext	4.20		0.30	1.00	x	0.35	kPa	0.4	0.18	0.1		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	5.45		2.00	1.00	x	0.25	kPa	2.7	0.18	0.5		0.0
w_{12}	Internal Timber Framing	in-plane	3.20		2.00	1.00	x	0.25	kPa	1.6	0.18	0.3		0.0
w_{13}														
w_{14}	Timber Roof	area 1	3.45	13.90			x	0.40	kPa	19.2	0.18	3.5		0.0
w_{15}	Ext Timber Framing		3.45		1.00	1.00	x	0.35	kPa	1.2	0.18	0.2		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
w_{32}														
w_{33}														
										29	**F(kN) =**	**5.3**	**0.0**	**0.0**

East Wing **Summary**

Weight	29	kN
V*	5.3	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
EP1	3.20	2.70	Concrete	2.80	8.96	3-1bN

Total Capacity	**9.0**	**kN**
Demand	**5.3**	**kN**
100%		**%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline 4

Seismic Acceleration

Material	μ	C_d(T)	NBS%	C_d(T) (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type: Timber Bracing

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	0.0	0.0		8.48	#VALUE!	#VALUE!	#VALUE!
1	21.4	0.0	21.4	3.35	72	#VALUE!	#VALUE!
totals	21.4	0.0	21.4		#VALUE!	#VALUE!	#VALUE!

Base shear, V = $C_d(T_1)\,W_t$

Cd(T) 0.18 g

V = 3.8 kN

Building Dimensions

W Bracing Line Tributary Width	5.25	m
Building West Width	41.3	m
Building Length	13.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m
E Bracing Line Tributary Width	2.05	m

Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Subject: Seismic Demand Calculations Gridline 4 - East Wing

East Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 4 In-plane	7.75		2.00	1.00	x	0.25	kPa	3.88	0.18	0.7		0.0
w_2														
w_3														
w_4	Ext Timber Framing	IP link	0.60		1.18	1.00	x	0.35	kPa	0.2	0.18	0.0		0.0
w_5	Glazing	IP link	5.30		0.88	1.00	x	0.25	kPa	1.2	0.18	0.2		0.0
w_6	Ext Timber Framing	IP link	5.30		0.30	1.00	x	0.35	kPa	0.6	0.18	0.1		0.0
w_7	Ext Timber Framing	OoP Ext	0.80		1.18	1.00	x	0.35	kPa	0.3	0.18	0.1		0.0
w_8	Glazing	OoP Ext	3.30		0.88	1.00	x	0.25	kPa	0.7	0.18	0.1		0.0
w_9	Ext Timber Framing	OoP Ext	3.30		0.30	1.00	x	0.35	kPa	0.3	0.18	0.1		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	4.00		2.00	1.00	x	0.25	kPa	2.0	0.18	0.4		0.0
w_{12}	Internal Timber Framing	in-plane	0.00		2.00	1.00	x	0.25	kPa	0.0	0.18	0.0		0.0
w_{13}														
w_{14}	Timber Roof	area 1	2.05	13.90			x	0.40	kPa	11.4	0.18	2.1		0.0
w_{15}	Ext Timber Framing		2.05		1.00	1.00	x	0.35	kPa	0.7	0.18	0.1		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
w_{32}														
w_{33}														
										21	**F(kN) =**	**3.8**	**0.0**	**0.0**

East Wing **Summary**

Weight	21	kN
V*	3.8	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
EP1	2.00	2.70	Concrete	2.80	5.60	4-1aN

Total Capacity	**5.6**	**kN**
Demand	**3.8**	**kN**
	100%	**%NBS (IL2)**

BATCHELAR McDOUGALL CONSULTING
STRUCTURAL & CIVIL ENGINEERS

Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz www.bmconsult.co.nz

Alexandra Service Centre		
1 Dunorling St		
Alexandra		
Dunorling Street Block		
1708-2227A	Aug-23	WH

Subject: Seismic Demand Calculations Gridline 5

Seismic Acceleration

Material	μ	C_d(T)	NBS%	C_d(T) (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type **Timber Bracing**

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	**44.8**	**0.0**	44.8	**8.48**	380	11.3	11.3
1	**35.9**	**0.0**	35.9	**3.35**	120	3.2	14.5
totals	**80.8**	**0.0**	**80.8**		**501**	**14.5**	**14.5**

Base shear, V = $C_d(T_1)\ W_t$

Cd(T) **0.18** **g**

V = **14.5** **kN**

Building Dimensions

W Bracing Line Tributary Width	5.25	m
Building West Width	41.3	m
Building Length	13.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m
W Bracing Line Tributary Width	4.165	m

West Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 5 In-plane	3.20		1.18	0.85	x	0.25	kPa	0.80	0.18	0.1		0.0
w_2														
w_3														
w_4	Ext Timber Framing	IP link	1.40		1.18	1.00	x	0.35	kPa	0.6	0.18	0.1		0.0
w_5	Glazing	IP link	10.40		0.88	1.00	x	0.25	kPa	2.3	0.18	0.4		0.0
w_6	Ext Timber Framing	IP link	10.40		0.30	1.00	x	0.35	kPa	1.1	0.18	0.2		0.0
w_7	Ext Timber Framing	OoP Ext	1.70		1.18	1.00	x	0.35	kPa	0.7	0.18	0.1		0.0
w_8	Glazing	OoP Ext	8.80		0.88	1.00	x	0.25	kPa	1.9	0.18	0.3		0.0
w_9	Ext Timber Framing	OoP Ext	8.80		0.30	1.00	x	0.35	kPa	0.9	0.18	0.2		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	13.13		2.00	0.85	x	0.25	kPa	5.6	0.18	1.0		0.0
w_{12}	Internal Timber Framing	in-plane	3.00		2.00	0.80	x	0.25	kPa	1.2	0.18	0.2		0.0
w_{13}														
w_{14}	Timber Roof	area 1	5.25	13.30			x	0.40	kPa	27.9	0.18	5.0		0.0
w_{15}	Ext Timber Framing	roof wall	5.25		1.00	1.00	x	0.35	kPa	1.8	0.18	0.3		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										45	**F(kN) =**	**8.1**	**0.0**	**0.0**

West Wing **Summary**

Weight	45	kN
V*	8.1	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
EP1	3.20	2.40	Concrete	6.75	21.60	5-1aS

Total Capacity	**21.6**	**kN**
Demand	**8.1**	**kN**
	100%	**%NBS (IL2)**

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS

East Wing

Alexandra Service Centre	
1 Dunorling St	
Alexandra	
Dunorling Street Block	
1708-2227A	Aug-23	WH

Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Subject: Seismic Demand Calculations Gridline 5 - East Wing

East Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 5 In-plane	4.20		2.00	1.00	x	0.25	kPa	2.10	0.18	0.4		0.0
w_2														
w_3														
w_4	Ext Timber Framing	IP link	0.00		1.18	1.00	x	0.35	kPa	0.0	0.18	0.0		0.0
w_5	Glazing	IP link	5.90		0.88	1.00	x	0.25	kPa	1.3	0.18	0.2		0.0
w_6	Ext Timber Framing	IP link	5.90		0.30	1.00	x	0.35	kPa	0.6	0.18	0.1		0.0
w_7	Ext Timber Framing	OoP Ext	3.45		1.18	1.00	x	0.35	kPa	1.4	0.18	0.3		0.0
w_8	Glazing	OoP Ext	4.88		0.88	1.00	x	0.25	kPa	1.1	0.18	0.2		0.0
w_9	Ext Timber Framing	OoP Ext	4.88		0.30	1.00	x	0.35	kPa	0.5	0.18	0.1		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	1.00		2.00	1.00	x	0.25	kPa	0.5	0.18	0.1		0.0
w_{12}	Internal Timber Framing	in-plane	2.00		2.00	1.00	x	0.25	kPa	1.0	0.18	0.2		0.0
w_{13}														
w_{14}	Timber Roof	area 1	4.17	13.30			x	0.40	kPa	22.2	0.18	4.0		0.0
w_{15}	Ext Timber Framing		4.17		1.00	1.00	x	0.35	kPa	1.5	0.18	0.3		0.0
w_{16}	Timber Roof	Link	5.93	1.60			x	0.40	kPa	3.8	0.18	0.7		0.0
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
w_{32}														
w_{33}														
										36	**F(kN) =**	**6.5**	**0.0**	**0.0**

East Wing	Summary	
Weight	36	kN
V*	6.5	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
EP1	4.20	2.70	Concrete	2.80	11.76	5-1bN

Total Capacity	**11.8**	**kN**
Demand	**6.5**	**kN**
	100%	**%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline 7

Seismic Acceleration

Material	μ	$C_d(T)$	NBS%	$C_d(T)$ (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type **Timber Bracing**

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	**52.4**	**0.0**	52.4	**8.48**	444	12.8	12.8
1	**36.9**	**0.0**	36.9	**3.35**	124	3.2	16.1
totals	**89.3**	**0.0**	**89.3**		**568**	**16.1**	**16.1**

Base shear, V = $C_d(T_1)\,W_t$
Cd(T) **0.18** **g**
V = **16.1** **kN**

Building Dimensions

Bracing Line Tributary Width	5.1	m
Building West Width	41.3	m
Building Length	13.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS

Alexandra Service Centre	
1 Dunorling St	
Alexandra	
Dunorling Street Block	
1708-2227A	Aug-23	WH

Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Subject: Seismic Demand Calculations Gridline 7 - West Wing

West Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and C_d(T) =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 7 In-plane	3.40		2.85	0.85	x	0.25	kPa	2.06	0.18	0.4		0.0
w_2														
w_3														
w_4														
w_5														
w_6														
w_7	Ext Timber Framing	OoP Ext	1.40		1.18	1.00	x	0.35	kPa	0.6	0.18	0.1		0.0
w_8	Glazing	OoP Ext	8.80		0.88	1.00	x	0.25	kPa	1.9	0.18	0.3		0.0
w_9	Ext Timber Framing	OoP Ext	8.80		0.30	1.00	x	0.35	kPa	0.9	0.18	0.2		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	20.40		2.85	0.85	x	0.25	kPa	12.4	0.18	2.2		0.0
w_{12}	Internal Timber Framing	in-plane	10.95		2.00	0.80	x	0.25	kPa	4.4	0.18	0.8		0.0
w_{13}														
w_{14}	Timber Roof	area 1	5.10	13.90			x	0.40	kPa	28.4	0.18	5.1		0.0
w_{15}	Ext Timber Framing	roof wall	5.10		1.00	1.00	x	0.35	kPa	1.8	0.18	0.3		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										52	**F(kN) =**	**9.4**	**0.0**	**0.0**

West Wing	Summary	
Weight	52	kN
V*	9.4	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
GS2-N	3.20	2.40	Concrete	4.25	13.60	7-1aS

Total Capacity	**13.6**	**kN**
Demand	**9.4**	**kN**
	100%	**%NBS (IL2)**

Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Subject: Seismic Demand Calculations Gridline 7 - East Wing

East Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 7 In-plane	3.70		2.00	1.00	x	0.25	kPa	1.85	0.18	0.3		0.0
w_2														
w_3														
w_4														
w_5														
w_6														
w_7	Ext Timber Framing	OoP Ext	3.00		1.18	1.00	x	0.35	kPa	1.2	0.18	0.2		0.0
w_8	Glazing	OoP Ext	7.20		0.88	1.00	x	0.25	kPa	1.6	0.18	0.3		0.0
w_9	Ext Timber Framing	OoP Ext	7.20		0.30	1.00	x	0.35	kPa	0.8	0.18	0.1		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	1.70		2.00	1.00	x	0.25	kPa	0.9	0.18	0.2		0.0
w_{12}	Internal Timber Framing	in-plane			2.00	1.00	x	0.25	kPa	0.5	0.18	0.1		0.0
w_{13}														
w_{14}	Timber Roof	area 1	5.10	13.90			x	0.40	kPa	28.4	0.18	5.1		0.0
w_{15}	Ext Timber Framing		5.10		1.00	1.00	x	0.35	kPa	1.8	0.18	0.3		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
w_{32}														
w_{33}														
										37	**F(kN) =**	**6.6**	**0.0**	**0.0**

East Wing **Summary**

Weight	37	kN
V*	6.6	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
GS2-N	3.70	2.70	Concrete	2.80	10.36	7-1bN

Total Capacity	**10.4**	**kN**
Demand	**6.6**	**kN**
	100%	**%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline 8

Seismic Acceleration

Material	μ	$C_d(T)$	NBS%	$C_d(T)$ (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type: Timber Bracing

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	**47.7**	**0.0**	47.7	**8.48**	405	12.3	12.3
1	**41.8**	**0.0**	41.8	**3.35**	140	3.8	16.1
totals	**89.6**	**0.0**	**89.6**		**545**	**16.1**	**16.1**

Base shear, V = $C_d(T_1)\ W_t$

Cd(T) **0.18** **g**

V = **16.1** **kN**

Building Dimensions

Bracing Line Tributary Width	4.74	m
Building West Width	41.3	m
Building Length	13.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS
Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Alexandra Service Centre
1 Dunorling St
Alexandra
Dunorling Street Block
1708-2227A | Aug-23 | WH

Subject: Seismic Demand Calculations Gridline 8 - West Wing

West Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and C_d(T) =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 8 In-plane	3.40		2.85	0.85	x	0.25	kPa	2.06	0.18	0.4		0.0
w_2														
w_3														
w_4														
w_5														
w_6														
w_7	Ext Timber Framing	OoP Ext	4.00		1.18	1.00	x	0.35	kPa	1.6	0.18	0.3		0.0
w_8	Glazing	OoP Ext	6.48		0.88	1.00	x	0.25	kPa	1.4	0.18	0.3		0.0
w_9	Ext Timber Framing	OoP Ext	6.48		0.30	1.00	x	0.35	kPa	0.7	0.18	0.1		0.0
w_{10}														
w_{11}	Internal Timber Framing	OoP	14.22		2.85	0.85	x	0.25	kPa	8.6	0.18	1.6		0.0
w_{12}	Internal Timber Framing	in-plane	13.30		2.00	0.80	x	0.25	kPa	5.3	0.18	1.0		0.0
w_{13}														
w_{14}	Timber Roof	area 1	4.74	13.90			x	0.40	kPa	26.4	0.18	4.7		0.0
w_{15}	Ext Timber Framing	roof wall	4.74		1.00	1.00	x	0.35	kPa	1.7	0.18	0.3		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										48	**F(kN) =**	**8.6**	**0.0**	**0.0**

West Wing

	Summary	
Weight	48	kN
V*	8.6	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
EP1	3.20	2.40	Concrete	6.75	21.60	8-1aS

Total Capacity	**21.6**	**kN**
Demand	**8.6**	**kN**
	100%	**%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline 8 - East Wing

East Wing

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 8 In-plane	3.70		2.85	1.00	x	0.25	kPa	2.64	0.18	0.5		0.0
w_2														
w_3														
w_4														
w_5														
w_6														
w_7	Ext Timber Framing	OoP Ext	9.48		0.30	1.00	x	0.35	kPa	1.0	0.18	0.2		0.0
w_8	Glazing	OoP Ext	9.48		0.88	1.00	x	0.25	kPa	2.1	0.18	0.4		0.0
w_9														
w_{10}														
w_{11}	Internal Timber Framing	OoP	5.80		2.85	1.00	x	0.25	kPa	4.1	0.18	0.7		0.0
w_{12}	Internal Timber Framing	in-plane	5.60		2.85	1.00	x	0.25	kPa	4.0	0.18	0.7		0.0
w_{13}														
w_{14}	Timber Roof	area 1	4.74	13.90			x	0.40	kPa	26.4	0.18	4.7		0.0
w_{15}	Ext Timber Framing	roof wall	4.74		1.00	1.00	x	0.35	kPa	1.7	0.18	0.3		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
w_{32}														
w_{33}														
										42	F(kN) =	7.5	0.0	0.0

East Wing

	Summary	
Weight	42	kN
V*	7.5	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
EP1	3.70	2.70	Concrete	6.00	22.20	8-1bN

Total Capacity	**22.2**	**kN**
Demand	**7.5**	**kN**
	100%	**%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline 9

Seismic Acceleration

Material	µ	$C_d(T)$	NBS%	$C_d(T)$ (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type: Timber Bracing

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	164.9	0.0	164.9	8.48	1399	#VALUE!	#VALUE!
1	0.0	0.0		3.35	#VALUE!	#VALUE!	#VALUE!
totals	164.9	0.0	164.9		#VALUE!	#VALUE!	#VALUE!

Base shear, V = $C_d(T_1)\ W_t$

Cd(T) 0.18 g

V = 29.7 kN

Building Dimensions

Bracing Line Tributary Width	7.525	m
Building West Width	13.45	m
Building Length	38.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS
Wanaka Office: Level 3, 99 Ardmore Street *Phone: (03) 443 4531* www.bmconsult.co.nz

Alexandra Service Centre
1 Dunorling St
Alexandra
Dunorling Street Block
1708-2227A | Aug-23 | WH

Subject: Seismic Demand Calculations Gridline 9 - Ground Floor

Ground Floor

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and C_d(T) =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 9 In-plane	14.22		2.85	0.85	x	0.25	kPa	8.61	0.18	1.6		0.0
w_2	Ext Timber Framing	GL 9 In-plane	4.10		1.18	1.00	x	0.35	kPa	1.69	0.18	0.3		0.0
w_3	Glazing	GL 9 In-plane Low	13.28		0.88	1.00	x	0.25	kPa	2.91	0.18	0.5		0.0
w_4														
w_5														
w_6														
w_7	Ext Timber Framing	OoP Ext	3.90		1.18	1.00	x	0.35	kPa	1.6	0.18	0.3		0.0
w_8	Glazing	OoP Ext	17.35		1.18	1.00	x	0.25	kPa	5.1	0.18	0.9		0.0
w_9														
w_{10}														
w_{11}	Internal Timber Framing	OoP	40.35		2.85	0.85	x	0.25	kPa	24.4	0.18	4.4		0.0
w_{12}	Internal Timber Framing	in-plane	26.90		2.00	0.85	x	0.25	kPa	11.4	0.18	2.1		0.0
w_{13}														
w_{14}	Timber Roof	area 1	4.49	38.90			x	0.40	kPa	69.8	0.18	12.6		0.0
w_{15}	Timber Roof	Area 2 + 3	3.54	27.80			x	0.40	kPa	39.4	0.18	7.1		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										165	**F(kN) =**	**29.7**	**0.0**	**0.0**

Ground Floor — **Summary**

Weight	165	kN
V*	29.7	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
EP1	3.20	2.40	Concrete	6.75	21.60	9-1aS
EP1	2.00	2.40	Concrete	6.75	13.50	9-1bS
Ex.Ply1	1.00	2.40	Concrete	6.50	6.50	Ex
Ex.Ply1	1.00	2.40	Concrete	6.50	6.50	Ex
EP1	1.20	2.40	Concrete	6.75	8.10	9-2aN
EP1	3.80	2.40	Concrete	6.75	25.65	9-2dN

Total Capacity	**81.9**	**kN**
Demand	**29.7**	**kN**
	100%	**%NBS (IL2)**

Seismic Acceleration

Material	μ	$C_d(T)$	NBS%	$C_d(T)$ (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type: Timber Bracing

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	165.8	0.0	165.8	8.48	1406	#VALUE!	#VALUE!
1	0.0	0.0		3.35	#VALUE!	#VALUE!	#VALUE!
totals	165.8	0.0	165.8		#VALUE!	#VALUE!	#VALUE!

Base shear, V = $C_d(T_1)\ W_t$

Cd(T) 0.18 g

V = 29.8 kN

Building Dimensions

Bracing Line Tributary Width	4.485	m
Building West Width	13.45	m
Building Length	38.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m

BMC BATCHELAR McDOUGALL CONSULTING STRUCTURAL & CIVIL ENGINEERS			Alexandra Service Centre
			1 Dunorling St
			Alexandra
			Dunorling Street Block
Wanaka Office: Level 3, 99 Ardmore Street	*Phone: (03) 443 4531*	www.bmconsult.co.nz	1708-2227A · Aug-23 · WH

Subject: Seismic Demand Calculations Gridline 11 - Ground Floor

Ground Floor

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and C_d(T) =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 11 In-plane	25.05		2.53	0.80	x	0.25	kPa	12.65	0.18	2.3		0.0
w_2	Ext Timber Framing	GL 11 upper	29.90		2.10	0.80	x	0.35	kPa	17.58	0.18	3.2		0.0
w_3														
w_4														
w_5	URM Wall Veneer	Full Height	7.10	0.10	1.18		x	18.00	kN/m3	15.0	0.18	2.7		0.0
w_6	Ext Timber Framing	OoP	6.20		1.18		x	0.35	kPa	2.5	0.18	0.5		0.0
w_7	Glazing	OoP	2.77		1.18		x	0.25	kPa	0.8	0.18	0.1		0.0
w_8	URM Wall Veneer	Oop below sill	2.77	0.10	0.20		x	18.00	kN/m3	1.0	0.18	0.2		0.0
w_9														
w_{10}														
w_{11}	Internal Timber Framing	OoP	34.60		2.53	0.85	x	0.25	kPa	18.6	0.18	3.3		0.0
w_{12}	Internal Timber Framing	in-plane	15.40		4.03		x	0.25	kPa	15.5	0.18	2.8		0.0
w_{13}														
w_{14}	Timber Roof		4.49	38.90			x	0.40	kPa	69.8	0.18	12.6		0.0
w_{15}	Timber Floor		2.20	14.00			x	0.40	kPa	12.3	0.18	2.2		0.0
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										166	**F(kN) =**	**29.8**	**0.0**	**0.0**

Ground Floor — **Summary**

Weight	166	kN
V*	29.8	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)	
EP1	2.50	2.40	Concrete	6.75	16.88	11-1a
EP1	2.10	2.40	Concrete	6.75	14.18	11-1b
Ex.Ply1	2.00	2.40	Concrete	6.50	13.00	11-1c
EP1	0.80	2.40	Concrete	5.25	4.20	11-2a
EP1	1.95	2.40	Concrete	6.75	13.16	11-2b
EP1	1.25	2.40	Concrete	6.75	8.44	11-2c
EP1	1.20	2.40	Concrete	6.75	8.10	11-2d
Ex.Ply1	3.00	2.40	Concrete	6.50	19.50	11-3a
Total Capacity					**97.5**	**kN**
Demand					**29.8**	**kN**
				100%		**%NBS (IL2)**
Grid 12 Demand					**12.0**	**kN** Transferred through cross bracing and hips
Total Demand					**41.9**	**kN**
				100%		**%NBS (IL2)**

Subject: Seismic Demand Calculations Gridline 12

Seismic Acceleration

Material	μ	$C_d(T)$	NBS%	$C_d(T)$ (Design)
Steel	1.25	0.37	100%	0.37
Timber Bracing	3.5	0.18	100%	0.18

Element Properties Used in Demand Calculations

Material	Weight	
URM Wall Veneer	18.00	kN/m3
Timber Roof	0.40	kPa
Timber Floor	0.40	kPa
Floor Live Load	0.45	kPa
In Plane External Timber Frame	0.35	kPa
Glazing	0.25	kPa
Internal Timber Framing	0.25	kPa
Ext Timber Framing	0.35	kPa

Equivalent Static Method

Bracing Type **Timber Bracing**

level i	G_i [kN]	$\Sigma\psi_E Q_i$	W_i [kN]	h_i [m]	$W_i h_i$	F_i [kN]	ΣF [kN]
2	**66.9**	**0.0**	66.9	**8.48**	567	#VALUE!	#VALUE!
1	**0.0**	**0.0**		**3.35**	#VALUE!	#VALUE!	#VALUE!
totals	**66.9**	**0.0**	**66.9**		**#VALUE!**	**#VALUE!**	**#VALUE!**

Base shear, V = $C_d(T_1)\,W_t$

Cd(T) **0.18** **g**

V = **12.0** **kN**

Building Dimensions

Bracing Line Tributary Width	2.03	m
Building West Width	4.06	m
Building Length	38.3	m
Ground Floor Height	2.35	m
Sill Height	0.825	m
Ridge Height	5.7	m

Subject: Seismic Demand Calculations Gridline 12 - Ground Floor

Ground Floor

Bracing Type: **Timber Bracing** **with μ=** **3.50** **and $C_d(T)$ =** **0.18** **g**

#	Select Load Type	Description	Length (m)	Width (m)	Depth/Height (m)	Number of, #		Weight	Units	Element Weight (kN)	Cd(T) (g)	Force (kN)	Height to COM (m)	Moment (kNm)
w_1	Internal Timber Framing	GL 12 In-plane	14.76		0.20	1.00	x	0.25	kPa	0.74	0.18	0.1		0.0
w_2	URM Wall Veneer	GL 12 In-plane	14.76	0.10	0.30	1.00	x	18.00	kN/m3	7.97	0.18	1.4		0.0
w_3	Glazing	GL 12 In-plane High	23.54		1.18	1.00	x	0.25	kPa	6.91	0.18	1.2		0.0
w_4	Glazing	GL 12 In-plane Low	8.36		0.88	1.00	x	0.25	kPa	1.8	0.18	0.3		0.0
w_5	Ext Timber Framing	GL 12 In-plane	6.40		0.88	1.00	x	0.35	kPa	2.0	0.18	0.4		0.0
w_6														
w_7	Glazing	OoP	4.06		0.88		x	0.25	kPa	0.9	0.18	0.2		0.0
w_8	Ext Timber Framing	OoP	4.06		0.30		x	0.35	kPa	0.4	0.18	0.1		0.0
w_9														
w_{10}														
w_{11}	Internal Timber Framing	OoP	22.33		1.43	0.85	x	0.25	kPa	6.8	0.18	1.2		0.0
w_{12}														
w_{13}														
w_{14}	Timber Roof		2.53	38.90			x	0.40	kPa	39.4	0.18	7.1		0.0
w_{15}														
w_{16}														
w_{17}														
w_{18}														
w_{19}														
w_{20}														
w_{21}														
w_{22}														
w_{23}														
w_{24}														
w_{25}														
w_{26}														
w_{27}														
w_{28}														
w_{29}														
w_{30}														
w_{31}														
										67	**F(kN) =**	**12.0**	**0.0**	**0.0**

Ground Floor **Summary**

Weight	67	kN
V*	12.0	kN
Height to COM	0.0	m (Weighted Average)
Bending Moment	0.0	kNm

Timber Bracing - Ground Floor

Element	Length	Height	Foundation type	Capacity (kN/m)	Capacity (kN)
Ex GIB 1 side & weatherboard	2.40	2.40	Concrete	1.30	3.12
Ex GIB 1 side & weatherboard	0.75	2.40	Concrete	1.30	0.98

Total Capacity	**4.1**	**kN**
Demand	**12.0**	**kN**
	34%	**%NBS (IL2)**

BATCHELAR McDOUGALL CONSULTING
Structural & Civil Engineers

Job Name: Alexandra Service Centre	**Job No**:	1708-2227A		
Subject: Link Roof Diaphragm	**By**:	W Holt	**Checked**:	
	Page:	1	**of**:	
	Date:	4/08/23		

Plywood Diaphragm Design

NZS3603 :1993 5.2	Shear Walls and Diaphragms				
5.2.2	**Diaphragm Design Strength**				
		Plywood Grade	F8		
		Moisture Content	12	%	*Less than 15% is considered dry timber*
		t_{nom}	12	*mm*	
		No# Layers	5		
		No# of Sheets (Diaphragm)	1		*Number of sheets (1 or 2 sides of framing)*
		Framing	2 Sides		*Edge support framing conditions*
		Top Sheet Grain	Parallel to Long Edge		
5.2.4	Diaphragm Design Dimensions				
		B	2.6	*m*	*Breadth of diaphragm (perpendicular to chords)*
		L	11.8	*m*	*Length of diaphragm (Parallel to chords)*
		W	1.65	*kN/m*	*Line load on diaphragm*
		V	**9.735**	*kN*	
		l	1.2	*m*	*length between blocking parallel to L*
		w	0.9	*m*	*width between blocking parallel to B*
6.5.1.4	Diaphragm Panel Shear				
		ϕ	1		*Typically 0.9 for plywood*
2.7		k_1	1.0	Brief Load	*Load Duration Factor*
6.3.8		k_8	0.35		*From appendix G*
6.3.3		k_{14}	1.00		*Moisture reduction factor*
6.3.5		k_{15}	1.0		*See table 6.4*
6.3.7		k_{18}	0.89		
6.2.1		f_{ps}	4.2	*MPa*	*Characteristic Shear Stress*
		t_{actual}	12	*mm*	*Actual thickness of panel*
		d	2600	*mm*	*Depth of panel (= B)*
		V_{ni}	27.3	*kN*	*12mm Ply on one face*
		ϕV_{ni}	27.3	*kN*	*OK*
5.2.3	Fasteners				
		Type	Nails		
		Size	3.15		*Fastener diameter*
4.2.2.2		Q_k	0.63	*kN*	
a) to e)		k	1.4		*modification factor*
		Q_n	0.88	*kN*	
f)(i) & 4.3.2 e) & C5.2.3.2		p	60	*mm*	*minimum nail/screw length to be compliant*
5.2.4.1	Panel Nails				
		q*	3.74	*kN/m*	
		ϕQ_n	0.71	*kN*	*Individual fastener shear capacity*
C5.2.3.2		s	100	*mm*	*Spacing of fasteners*
		No# Nails	118	*nails*	
4.2.2.2 g)		k	1.3		*modification factor for No# Nails*
		$\phi Q_n/s$	9.19	*kN/m*	*OK*

5.2.2 **Wall Design Strength**

	Supported By	Plywood Wall		*Diaphragm Supported by Plywood wall*
	Plywood Grade	F14		
	Moisture Content	12	*%*	*Less than 15% is considered dry timber*
	t_{nom}	9	*mm*	
	No# Layers	3		
	No# of Sheets (Wall)	2		*N/A if diaphragm not supported by plywood wall*
	No# diaphragms on wall	1		*Diaphragms on one or both sides of wall*
	Framing	2 Sides		*Edge support framing conditions*
	Top Sheet Grain	Parallel to Short Edge		
5.2.4	Wall Design Dimensions			
	B	2	*m*	*Breadth of diaphragm (perpendicular to chords)*
	H	3	*m*	*Wall height*
	V	**9.735**	*kN*	*1 diaphragms supported on wall*
	l	0.6	*m*	*length between blocking parallel to H*
	w	1.2	*m*	*width between blocking parallel to B*
6.5.1.4	Diaphragm Panel Shear			
	ϕ	0.9		*Typically 0.9 for plywood*
6.3.8	k_8	0.11		*From appendix G*
6.3.3	k_{14}	1.00		*Moisture reduction factor*
6.3.5	k_{15}	1.0		*See table 6.4*
6.3.7	k_{18}	0.89		
6.2.1	f_{ps}	5.4	*MPa*	*Characteristic Shear Stress*
	t_{actual}	9	*mm*	*Actual thickness of panel*
	d	2000	*mm*	*Depth of panel (= B)*
	V_{ni}	12.7	*kN*	*9mm Ply on one face*
	ϕV_{ni}	11.4	*kN*	*OK*
5.2.3	Fasteners			
	Type	Nails		
	Size	3.15		*Fastener diameter*
4.2.2.2	Q_k	0.63	*kN*	
a) to e)	k	1.40		*modification factor*
	Q_n	0.88	*kN*	
f)(i) & 4.3.2 e) & C5.2.3.2	p	45	*mm*	*minimum nail/screw length to be compliant*
5.2.4.1	Panel Nails			
	q*	2.43	*kN/m*	
	ϕQ_n	0.71	*kN*	*Individual fastener shear capacity*
C5.2.3.2	s	100	*mm*	*Spacing of fasteners*
	No# Nails	20	*nails*	
4.2.2.2 g)	k	1.1		*modification factor for No# Nails*
	$\phi Q_n/s$	7.80	*kN/m*	*OK*

BATCHELAR McDOUGALL CONSULTING
Structural & Civil Engineers

Job Name:	Alexandra Service Centre	**Job No**:	1708-2227A	
Subject:	Link Roof Diaphragm	**By**:	W Holt	**Checked**:
		Page:	2	**of**:
		Date:	4/08/23	

5.2.5

Deflections

	Diaphragm	Wall		
a	2	0.5		
Timber Grade	SG8	SG8		
Environment	Dry	Dry		
Size	Custom	Custom		
Depth	90	90	*mm*	*Depth of chord*
Breadth	45	45	*mm*	*Breadth of chord*
Number	1	1		*For built up members*
A	4050	4050	*mm^2*	*Area of one chord*
e_n	0.14	0.06	*mm*	
E	4400	4400	*MPa*	*Elastic modulus of chord material*
G	455	455	*MPa*	*Shear modulus of sheathing*
m	4.92	0.83		*Number sheathing panels along chord*

4.2.2.3

W	19470	*N*	
θ	0	°	*Rotation at base of storey*
	0	*rad*	
δ_c	0	*mm*	*Vertical movement of base at comp end of wall*
δ_t	0	*mm*	*Vertical movement of base at tension end of wall*
Δ_{hmax}	39.3	*mm*	*L/300 allowable diaphragm deflection*
Δ_{wmax}	20	*mm*	*H/150 allowable wall deflection*
Δ_1	6.92	*mm*	*flexural deformation (Dependent on chords)*
Δ_2	2.02	*mm*	*shear deformation of sheathing*
Δ_3	1.06	*mm*	*deflection due to nail slip*
Δ_4	0.00	*mm*	*inter storey deflection due to chord relaxation*
Δ_5	1.78	*mm*	*inter storey deflection due to shear deformation*
Δ_6	0.15	*mm*	*inter storey deflection due to nail slip*
Δ_7	2.46	*mm*	*inter storey deflection as a cantilever*
Δ_h	10.00	*mm*	*OK* *Diaphragm*
Δ_w	4.39	*mm*	*OK* *Wall*

NZS3603 :1993

Timber Chord Design

3.3 Chord Design

Loads

	Diaphragm	Wall		
N^*_c	11.04548	14.6025	kN	
N^*_t	11.04548	14.6025	kN	

3.3.2 Effective Length

	Diaphragm	Wall		
L_x			m	*Strong axis*
k_{10}	1.00	1.00		
$L_{eff\ x}$	0.00	0.00	m	
L_y			m	*Weak axis*
k_{10}	1.00	1.00		
$L_{eff\ y}$	0.00	0.00	m	

3.3.4 Design

	Diaphragm	Wall		
k_{8x}	1.00	1.00		*Stability against lateral buckling*
k_{8y}	1.00	1.00		
f_c	18	18	MPa	
A	4050	4050	mm^2	
ϕ	0.8	0.8		
ϕN_{ncx}	58.32	58.32	kN	OK
ϕN_{ncy}	58.32	58.32	kN	OK

3.4 Tension Member Design

3.4.2

	Diaphragm	Wall		
f_t	6.00	6.00		
k_4	1.00	1.00		
ϕ	0.8	0.8		
ϕN_{nt}	19.44	19.44	kN	OK

Final Design

Diaphragm:

Sheething: 1 Layer of 12mm Ecoply, Grade F8 laid Parallel to Long Edge with 1-Custom SG8 chords

Blocking: Provide blocking at 1200mm centres along the long (L) edge and 900mm centres along the short (B) edge

Fixings: Fasteners are 3.15mm Nails with a minimum length of 60mm spaced at 100mm around the outsides of the panels and 300mm along intermediate members

Walls:

Sheething: 2 layers of 9mm Ecoply, Grade F14 laid Parallel to Short Edge with 1-Custom SG8 chords

Blocking: Provide blocking at 600mm centres along the vertical (H) edge and 1200mm centres along the horizontal (B) edge

Fixings: Fasteners are 3.15mm Nails with a minimum length of 45mm spaced at 100mm around the outsides of the panels and 300mm along intermediate members

BMC

Appendix C – Geotechnical Desktop Report

Geotechnical Desktop Study

1 Dunorling Street

Alexandra

Report prepared for:

Batchelar McDougall Consulting

Report prepared by:

GeoSolve Limited

Distribution:

Batchelar McDougall Consulting

GeoSolve Limited (File)

March 2023

GeoSolve Ref: 230125

Revision	Issue Date	Purpose	Author	Reviewed
1	15/03/2023	Client issue	JMJ	FAW
2	16/03/2023	Client issue	JMJ	FAW

GEOTECHNICAL WATER RESOURCES PAVEMENTS

Table of Contents

1 Introduction

1.1 General

This report presents the results of a geotechnical desktop study carried out by GeoSolve Ltd in order to determine likely subsoil conditions and provide preliminary geotechnical inputs for a structural assessment of 1 Dunorling Street, Alexandra.

Photo 1 – 1 Dunorling Street, Alexandra

The desktop study was carried out for Batchelar McDougall Consulting in accordance with GeoSolve Ltd's proposal dated 24 February 2023, which outlines the scope of work and conditions of engagement.

1.2 Scope of Work

We understand the site above is being structurally assessed by Batchelar McDougall Consulting and to assist the assessment a geotechnical desktop study is required, outlining:

- Review of the nearby geotechnical data to determine the likely ground conditions and groundwater level below the site;
- Preliminary review of liquefaction and settlement susceptibility;
- Preliminary slope stability review of the existing flood protection embankment;
- Bearing capacity and settlement curves for strip footings at the current ground level;
- Seismic soil classification.

2 Site Description

2.1 General

The subject property is located in central Alexandra as shown in Figure 1 below and currently houses the Central Otago District Council and Oranga Tamariki offices.

It is possible to access around the entire building from Dunorling Street and State Highway 8.

2.2 Topography and Surface Drainage

The building is situated on sub-horizontal ground with contours falling slightly towards the southwest. A raised flood stopbank runs along the south-western site boundary, offset from the building by approximately 3 m at its closest point. The Clutha River is located approximately 70 m southwest of the building and is separated from the stopbank by a moderately sloping reserve area which has been earthworked into terraces. An existing pump station is located on the riverside side of the stopbank. GeoSolve understand this pump station is approximately 5.0 m deep. Earthworks to construct two storage tanks next to the pump station is currently underway and Geosolve understand these tanks will also be up to 5.0 m deep.

2.3 Existing Building and Site History

It is understood the current building originally comprised two separate buildings constructed in the late 1970's and mid 1980's respectively. A covered walkway was later retrofitted to connect the two buildings. Prior to the current building being constructed, historical aerial photographs from 1962 show two small buildings were located on the same location.

GeoSolve understands the flood stopbank was constructed in the early 2000's.

Structural plans provided to GeoSolve show the two buildings are founded on shallow foundations, which are typically 400–600 mm deep.

3 Geotechnical Investigations

No site specific investigations have been undertaken for the purpose of this report. GeoSolve has completed a review of shallow and deep site investigations in close proximity to the site in central Alexandra to infer the underlying geological model.

4 Subsurface Conditions

4.1 Geological Setting

The site is located within the Haast Schist belt which is regionally extensive across the province of Otago. The terrain in the Alexandra region is underlain by thick sequences of fluvio-glacial outwash alluvium of various ages. Over-consolidated Manuherikia Group lake sediments are present locally beneath the glacial outwash, and schist bedrock is present at varying depths. Higher terraces above the valley floor are occupied by older outwash gravels from former glacial periods. Layers of post glacial windblown silt and sand (loess) commonly blankets the ground surface.

Active fault traces were not observed onsite although the active Dunstan Fault Zone and Galloway Fault Zones are located in the immediate vicinity of Clyde and Alexandra. However, due to the estimated 5,000-10,000 year and 10,000-20,000 year average return periods for earthquakes on these fault zones respectively, the seismic risk posed by these structures is considered relatively low. Furthermore, these faults are not identified in NZS1170.5 as being major faults requiring near-fault factors for design.

The Alpine Fault, located approximately 130 km to the northwest, runs along the western foothills of the Southern Alps, and is likely to present a more significant seismic risk. There is a high probability that a major earthquake of Magnitude 8 or more will occur along the Alpine Fault within the next 50 years and such a rupture is likely to result in moderate ground shaking in the vicinity of Alexandra.

4.2 Inferred Stratigraphy

The inferred stratigraphy below has been extrapolated from site investigations carried out previously by GeoSolve comprising test pits and boreholes at locations shown in Figure 1 below.

Figure 1 – Aerial photo of Alexandra CBD showing previous site investigations locations marked by red squares carried out near the subject site (red outline). Source: Google Maps

Subsurface soils beneath the building are inferred to comprise:

- Uncontrolled fill/engineered fill, overlying;
- Loess, overlying;
- Outwash deposits, overlying;
- Schist Bedrock

Both surficial **uncontrolled fill and engineered fill** have been observed in surrounding site investigations. It is likely that uncontrolled fill exists below the surrounding pavements and landscaping areas, however it is assumed to have been removed from the building footprint areas during construction. It is unknown whether any engineered fill has been placed below the building or if the foundations are founded completely on natural ground. The uncontrolled fill was observed to generally comprise soft to very stiff SILT with sand and gravel, medium dense to dense SAND with cobbles and boulders, and medium dense sandy

GRAVEL with silt, cobbles and boulders. Rubbish including brick, plastic, steel and asphalt was also observed within the uncontrolled fill. Buried topsoil sometimes separated the uncontrolled fill and the natural soils below. The construction of the existing building predated any earthworks to form the flood stopbank.

Loess, typically comprising firm to stiff and loose to medium dense sandy SILT and silty SAND was observed in surrounding test pits to a maximum depth of 2.2 m below ground level (bgl). This wind blow material typically covers most of the Alexandra area.

Outwash deposits are inferred to underlie any fills and loess and comprise **outwash gravels** and **outwash sands** which are expected to be interbedded across the site. Outwash gravel, which constitutes the majority of this stratigraphic unit, typically comprises medium dense to dense sandy GRAVEL with silt, cobbles and boulders. Outwash sands typically comprise SAND with minor to trace gravel and silt.

The shallow outwash deposits observed in nearby test pits were logged as loose to dense while the deeper outwash deposits observed in nearby boreholes was logged as dense to very dense, established from standard penetration testing (SPT).

The **basement schist** which underlies the outwash deposits was not encountered in the nearby boreholes which extended to 15.45 m, however was encountered in one nearby test pit directly below the topsoil. Schist rock was also observed in a borehole 50 m northeast of the building. Schist rock outcrops are common in the surrounding area.

4.3 Groundwater

No groundwater seepage was observed in any of the nearby test pits. A piezometer approximately 100 m to the north of the subject building and at a similar relative level measured a static water level of 10.5 m bgl. A similar groundwater level is expected at the subject site.

5 Engineering Considerations

5.1 General

The recommendations and opinions contained in this report are based upon historical information held on the GeoSolve database. The nature and continuity of subsoil conditions is inferred and cannot be guaranteed.

5.2 Liquefaction Analysis

5.2.1 Design Earthquakes

Three earthquake scenarios have been assessed in accordance with NZS1170 – Structural Design Actions[1] for an Importance Level 4 structure with a 50-year design life. Peak

[1] NZS1170-5 (2004) Structural Design Actions, Part 5: Earthquake Actions – New Zealand.

horizontal ground accelerations and effective magnitudes were calculated using the procedure from the NZGS/MBIE Module 1[2]. Table 1 below summarises the scenarios considered.

The site is considered to be Class C (shallow soil site) in accordance with NZS 1170.5:2004 seismic provisions, based on the 18 m depth to schist bedrock in a borehole 50 m to the northeast.

Table 1 – Earthquake accelerations and effective magnitudes for liquefaction assessment

Scenario	Performance Requirements	Annual Probability of Exceedance	Peak Horizontal Ground Acceleration (PGA)	Effective Magnitude
Serviceability Limit State (SLS)	*Avoid damage that would prevent the structure being used as originally intended without repair*	1/25	0.07 g	6.3
Serviceability Limit State (SLS2)	*The structure maintains operational continuity*	1/500	0.30 g	6.3
Ultimate Limit State (ULS)	*Avoid collapse of the structural system*	1/2500	0.53 g	6.3

5.2.2 Liquefaction Summary

From the nearby investigations it is inferred that the site is underlain by shallow fill and/or loess overlying layers of medium dense to dense outwash deposits (SPTs N values of between 37-50 from 1.5 m to 15 m depth), which is typical in the Alexandra area. Groundwater is inferred to lie 10 m below the site.

Analysis was undertaken on the nearby borehole SPT results using the Boulanger & Idriss (2014)[3] deterministic method which incorporates a number of case histories from the 2010 and 2011 Christchurch earthquake events.

The liquefaction analysis indicates that no liquefaction is predicted for either of the SLS or ULS design earthquakes due to the density of the underlying soils and the depth to groundwater. The risk of lateral spreading is considered low due to unlikelihood of continuous liquefiable layers underlying the site and the inferred shallow gradient of the natural soils between the subject site and the Clutha River.

[2] NZGS/MBIE. (2021, November). *Module 1: Overview of the guidelines.* Retrieved from Building Performance: https://www.building.govt.nz/assets/Uploads/building-code-compliance/b-stability/b1-structure/geotechnical-guidelines/module-1-overview-of-earthquake-geotechnical-engineering-practice-guidelines-version-1.pd

[3] Boulanger, R.W. & Idriss, I.M. (2014). CPT and SPT Based Liquefaction Triggering Procedures. Department of Civil & Environmental Engineering, University of California.

Additional site-specific ground investigations at the subject site will allow a more detailed liquefaction and lateral spread risk assessment.

5.3 Flood Stopbank Stability

The stopbank immediately southwest of the subject building was designed to protect properties from floodwaters of the Clutha River and is administered by the ORC.

No signs of existing slope instability, erosion or soil creep were observed on the stopbank at the time of this report.

No readily available information could be obtained on how the stopbank was constructed or the soil materials used but it is expected to overlie permeable outwash sand and gravel deposits.

The stopbank is offset from the building by approximately 3 m at its closest point. Figure 2 below shows the typical stopbank dimensions at this location and the inferred ground model below the stopbank.

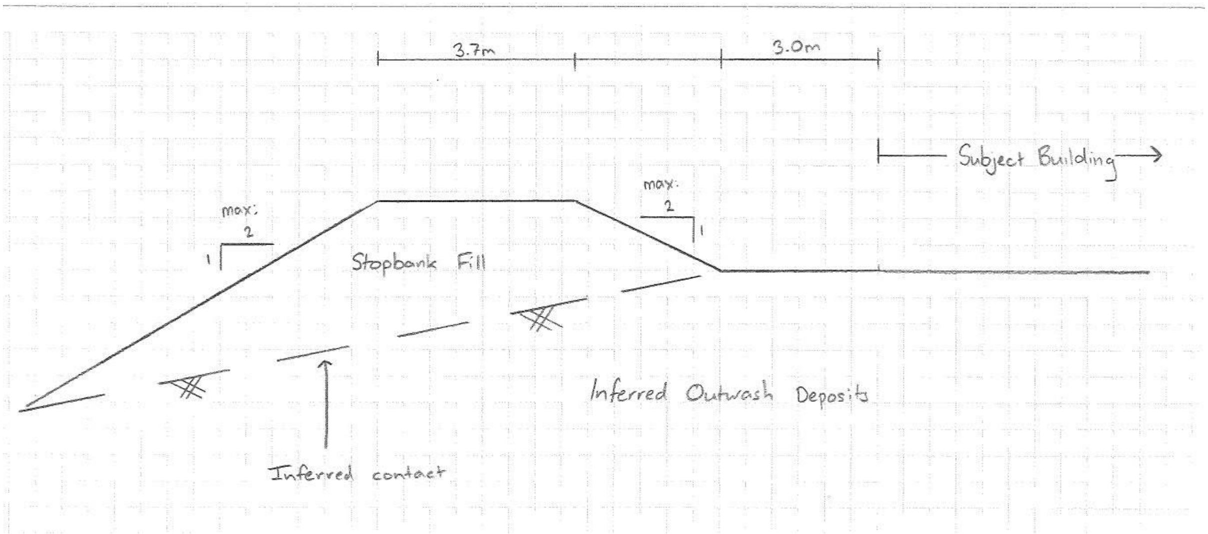


Figure 2 – Cross section sketch through the stopbank at the closest location to the subject building. The ground model has been inferred from site observations and surrounding site investigation data.

Due to the inferred gently sloping natural ground below the stopbank fill, global slope instability is not considered a hazard to the subject building. As the stopbank fill is raised above the subject building, any slope instability, erosion or soil creep of the stopbank is unlikely to affect the building.

5.4 Geotechnical Parameters

Table 2 provides a summary of the typical geotechnical design parameters for the soil materials inferred to underlie the existing building.

Table 2 – Recommended geotechnical design parameters

Unit	Bulk density γ (kN/m^3)	Effective cohesion c' (kPa)	Effective friction ϕ' (deg)	Elastic modulus E (kPa)	Poissons ratio ν
Uncontrolled fill	17	N/A			
Loess (firm to stiff and loose to medium dense sandy SILT and silty SAND)	18	0	31	5,000-10,000	0.3
Outwash sand (loose to medium dense, SAND with minor to trace gravel and silt)	18	0	32	5,000-15,000	0.3
Outwash gravel (loose to dense, sandy GRAVEL with minor to trace cobbles and trace boulders, GRAVEL with some sand and trace/minor cobbles, sandy GRAVEL with some to trace silt to sandy GRAVEL)	20	0	36	20,000-50,000+	0.3

5.4.1 Existing Foundations

A bearing capacity scenario has been calculated on the near surface loess soils as the existing building is founded on shallow foundations. Loess soils are expected to give a reduced bearing capacity in comparison to NZS 3604 "good ground" bearing capacity.

5.4.1.1 Shallow Foundations – Loess

Figure 3 below summarises typical working stresses for shallow footings, which bear upon loess soils. It should be noted the foundation working stresses presented on Figure 3 are governed by bearing capacity in the case of narrow footings and settlement in the case of wide footings.

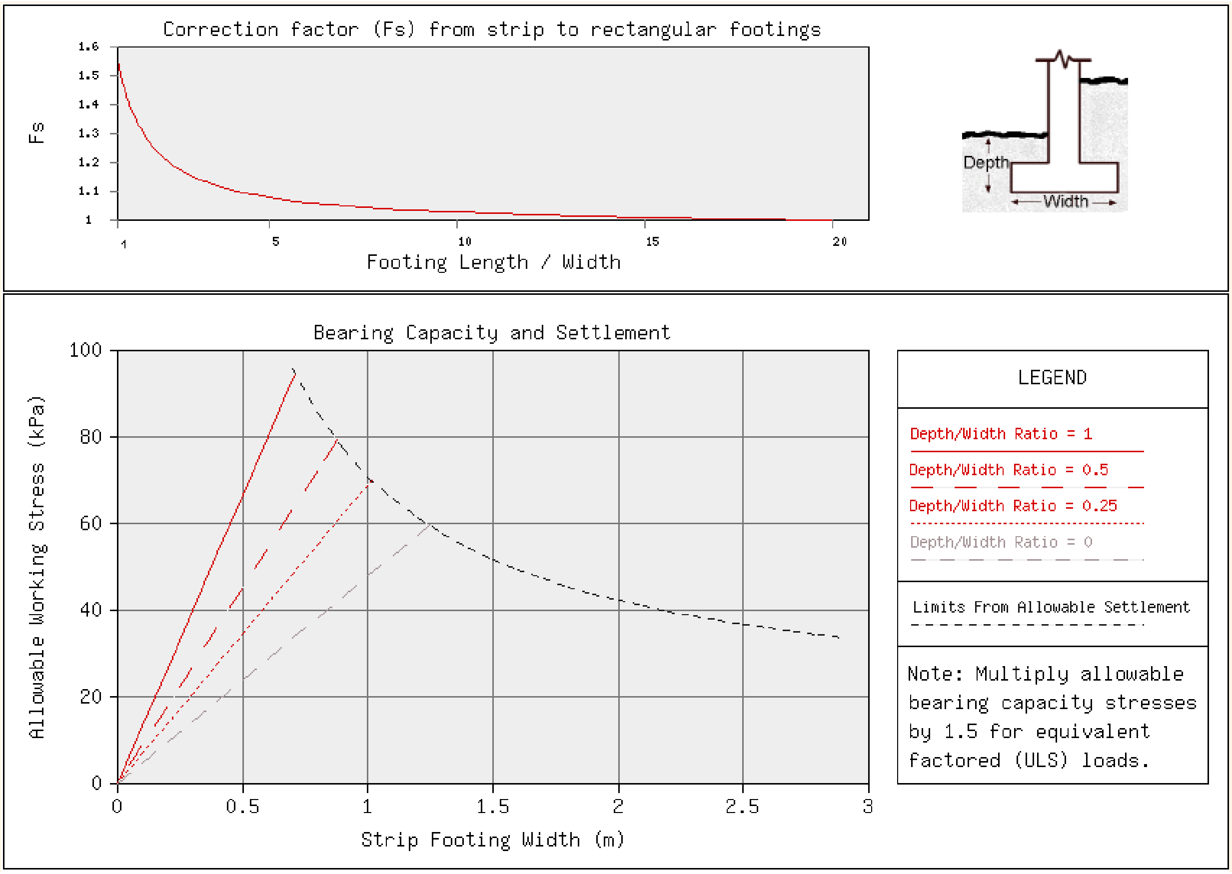


Figure 3 Recommended Bearing for Shallow Footings Founded on Loess Soils

As an example, from Figure 3 it can be seen an allowable working stress of 50 kPa is recommended for a 400 mm wide by 400 mm deep strip footing founded upon loess soils (using a depth to width ratio of 1). This corresponds to a factored (ULS) bearing capacity of approximately 75 kPa and an ultimate geotechnical bearing capacity of 150 kPa.

5.4.2 Site Subsoil Category

The site is inferred to be Class C (shallow soil site) in accordance with NZS 1170.5:2004 seismic provisions due to the depth to rock observed in a nearby borehole 50 m northeast of the building.

5.5 Summary

The subject site is considered a 'structurally dominated project' in accordance with MBIE Structural Assessment of Existing Buildings Section C4.

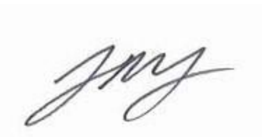
6 Conclusions and Recommendations

- Data held on the GeoSolve database infers the site is underlain by loess and outwash sand and gravel that extends to at least 15 m below existing ground level. The groundwater level was observed at 10 m depth in a neighbouring piezometer to the north.
- As the site has previously been developed, it is likely that localised pockets of uncontrolled fill will be present across the site. It is unknown if these were removed as part of the construction of the subject building.
- No liquefaction is predicted under SLS or ULS loading. This is due to the inferred depth to groundwater and the generally dense soils at depth based on site investigations from nearby sites.
- Based on site investigations from nearby sites and site observations, slope instability is not considered a risk to the existing building.
- Shallow footings bearing upon loess are expected to provide an allowable bearing capacity of 50 kPa for a 400 mm wide and 400 mm deep footing. This is significantly lower than NZS 3604's definition of "good ground".
- The seismic soil classification for the site is considered likely to be Class C (shallow soil site) in accordance with NZS 1170.5:2004 seismic provisions.
- The subject site is considered a 'structurally dominated project' in accordance with MBIE Structural Assessment of Existing Buildings Section C4.

7 Applicability

This report has been prepared for the benefit of Batchelar McDougall Consulting with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Report prepared by:



Jack Mynett-Johnson
Engineering Geologist

Report reviewed and authorised by:

Fraser Wilson
Senior Engineering Geologist