Elma Turner Library

Detailed Seismic Assessment

Prepared for Nelson City Council
Prepared by Beca Limited

18 November 2022

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Revision History

Revision N°	Prepared By	Description	Date
1	[redacted]	Draft – For Client Preview	1/11/22
2	[redacted]	Draft – minor text revisions as per client comments.	9/11/22
3	[redacted]	Final – revised following comments from Territorial Authority.	18/11/22

Document Acceptance

Action	Name	Signed	Date
Prepared by	[redacted]	[redacted]	18/11/22
Reviewed by	[redacted]		18/11/22
Approved by	[redacted]		18/11/22
on behalf of	Beca Limited		

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Executive Summary

A Detailed Seismic Assessment has been completed for Elma Turner Library located at 27 Halifax Street, Nelson in accordance with the MBIE technical guidelines for engineering assessments, *The Seismic Assessment of Existing Buildings*, dated July 2017.

Elma Turner Library is a single storey concrete, steel and timber structure constructed and modified in various stages from approximately 1956 to 2004. There is a small area that is two storeys. Records indicate that the original 1956 building was a garage/car workshop that was first converted into a library in 1985. Major extensions occurred in 1989 and 2004.

The building is generally founded on shallow foundations, across a flat site adjacent to the Maitai River on its northern boundary. The primary use of the building is as Nelson's central public library.

Our Detailed Seismic Assessment of the building structure indicates the building's earthquake rating is **30%*NBS* (IL2)**. Aspects that limit the rating are:

- The connections between the roof bracing system and the boundary concrete/masonry walls in the Halifax Street side (southern section) of the building (30%NBS (IL2))
- The end connections of the steel rod bracing to the timber trusses in the Halifax Street (southern section) of the building (34%NBS (IL2))
- The bracing of the Maitai River side (northern section) of the building (roof connection to central portion of building) (45%*NBS* (IL2))
- The capacity of the cantilever reinforced concrete columns along the eastern boundary wall of the Halifax Street (southern) side of the building (55%NBS (IL2))
- The capacity of the cantilever reinforced concrete columns in the central portion of the building (45-50%NBS (IL2))

While the roof bracing scores in one part of the building govern the earthquake rating of the building at 30%*NBS* (IL2), there are other building elements, widespread throughout the building footprint, that have been found to have earthquake scores in the order of 40-60%*NBS* (IL2). Additionally, the building is founded on shallow foundations that are not robustly tied together.

The structure is not expected to be resilient to potential liquefaction-induced ground deformations and lateral spreading of the ground under the building. The Draft Tonkin + Taylor Geotechnical Assessment Report (2022) for adjacent site suggest that liquefaction is likely to cause ground movements and loss of bearing capacity that could limit the seismic rating of the Elma Turner Library Building. Beca's assessment has found that the structural capacity governs the seismic rating.

This earthquake rating means the building would be a **Grade D** building under the New Zealand Society for Earthquake Engineering (NZSEE) grading scheme, and as such would indicate **high risk** exposure for occupants compared with a similar new building.

As the earthquake rating is less than 34%*NBS*, the building fulfils one of the criteria that may lead it to be categorised as an Earthquake-Prone Building in accordance with the New Zealand Building Act. If the building was determined to be Earthquake Prone by Nelson City Council (acting in its role as the Territorial Authority), Nelson City Council (as building owner) would be required to carry out seismic work to bring the building above 34%*NBS* within a specified timeframe. The timeframe will be determined based on whether or not the Territorial Authority determines the building to be a priority building.

As part of the assessment, we also noted the following:

- The building currently has heavy suspended ceilings in most areas. Beca has completed a separate assessment of the suspended ceilings and partitions in the building for NCC. The assessment found that many areas of the library had heavy, unrestrained ceiling systems with insufficient lateral bracing to the ceiling grid (quantitatively scoring <34%*NBS*). NCC have added bracing and ceiling tile clips to the Children's Library and Activity Room areas since the Beca assessment was completed to improve the expected seismic performance of those areas to 67%*NBS* (IL2).
- The building has been extended and modified significantly in approximately five major stages from 1956 to 2004. This has led to a complex, mixed structural form with difficult to identify and indirect load paths. Seismic loads are resisted by a combination of timber bracing walls, cantilever concrete columns, masonry block shear walls, precast concrete panels, steel strap bracing and steel portal frames. Differential movement between these structural elements during a moderate earthquake is expected to be significant and damage to non-structural elements (such as glazing, internal partitions and ceilings) is expected to be extensive.

In response to this earthquake rating, we recommend:

- Nelson City Council consider strengthening the roof bracing elements identified as less than 34%*NBS* (IL2) in this report. Strengthening the structure beyond this level is likely to require extensive structural works to the building and foundations and potential site ground improvement (for example to limit lateral spreading toward the river).
- A site-specific, geotechnical investigation and assessment if Nelson City Council would like a more detailed and accurate assessment of the expected geotechnical performance of the site and its impact on the Elma Turner Library building structure. This is only recommended to facilitate a retrofit project.

The main body of the report contains further details and explanations of the assessment we have completed.

1 Introduction

This report has been prepared for Nelson City Council, NCC, the owner of the Elma Turner Library building located at 27 Halifax Street, Nelson, to describe the results of our Detailed Seismic Assessment.

1.1 Scope of Assessment

The purpose of this assessment is to establish the earthquake rating of the Elma Turner Library Building. The assessment has been completed in accordance with the New Zealand *Technical Guidelines for Engineering Assessments* [MBIE, 2017] (herein referred to as the *Engineering Assessment Guidelines*) with the focus on the life safety of persons occupying or in the immediate vicinity of the building. Specific consideration of building damage and repairability or business interruption is not included within the scope of this assessment.

Our scope of work includes:

- A review of the available structural and architectural drawings, geotechnical report (for the neighbouring site provided by NCC), publicly available geotechnical data, previous seismic assessment reports and council property files provided to Beca.
- Analysis of the building structure and evaluation of the capacity and seismic demands on key elements and systems.
- A brief commentary on the attributes of key building features such as non-structural elements and exterior cladding, and the associated seismic risk.
- A summary of the findings, comments on the differences with previous assessments, and general recommendations for further actions.

1.2 Regulatory Framework

New Zealand's earthquake-prone building regulatory framework underwent significant changes following the 2011 Christchurch earthquake. These changes included the introduction of the *Building (Earthquake-prone Buildings) Amendment Act 2016*, which sets the core framework for managing earthquake-prone buildings.

Earthquake-prone buildings (EPBs) are defined in section 133AB of the *Building Act 2004* as buildings whose ultimate capacity will be exceeded in a moderate earthquake and, if it were to collapse, would likely result in injury or death or damage to another property. A moderate earthquake is defined as approximately one-third as strong but of the same duration as the earthquake shaking assumed in the design of a new building.

As part of the framework for managing earthquake-prone buildings, the *Building Act 2004* sets timeframes in which Territorial Authorities (TAs) must identify potentially earthquake-prone buildings. Identification of earthquake-prone buildings is carried out in accordance with the "EPB methodology" set by the Ministry of Business, Innovation and Employment (MBIE). Timeframes are also given for owners of earthquake-prone buildings to undertake seismic work (i.e., upgrade or demolish), which vary depending on the building type (priority or normal) and the location (high, medium or low risk areas). The EPB Methodology sets the technical requirements for engineering assessments, which includes that they must be undertaken in accordance with the *Engineering Assessment Guidelines.*

The official determination of whether a building is earthquake prone, or not, is the responsibility of the relevant TA. The earthquake rating resulting from an engineering assessment is only one, albeit significant, aspect considered by the TA in making their determination. If the TA determines a building to be earthquake prone, it will issue an EPB notice for the building, add it to the EPB register, and require seismic work to be undertaken to raise the earthquake rating to greater than 34*%NBS* within the relevant timeframe shown in Table 1.

If a building is not earthquake prone, there is no requirement to undertake seismic strengthening work. However, this does not mean that the seismic risk posed by the building is negligible. The *Engineering Assessment Guidelines* define a building with an earthquake rating less than 67*%NBS* as an earthquake-risk building (ERB), and the New Zealand Society for Earthquake Engineering recommends a minimum target strengthening level of 67*%NBS*.

Table 1.1 outlines the timeframes for identifying potentially earthquake-prone buildings and undertaking seismic work. A map of the seismic risk areas can be obtained from www.building.govt.nz.

Table 1.1: Timeframes for identifying potentially earthquake-prone buildings and undertaking seismic work. Reproduced from MBIE.

Seismic Risk Area	TAs must identify potentially earthquake-prone building by		Owners of earthquake-prone buildings must carry out seismic work within (time from issue of EPB notice):	
	Priority	Other	Priority	Other
High	1 Jan 2020	1 July 2022	7.5 years	15 years
Medium	1 July 2022	1 July 2027	12.5 years	25 years
Low	N/A	1 July 2032	N/A	35 years

1.3 Assessment Methodology

We have used simple analysis methods of analysis to determine the earthquake rating of the building. The techniques used are generally as outlined in the *Engineering Assessment Guidelines.* The use of these guidelines is mandatory for assessments in evaluating whether or not a building is earthquake prone and are the industry standard for seismic assessments in New Zealand generally.

1.4 Explanatory Statement

- This report has been prepared by Beca at the request of our Client and is exclusively for our Client's use for the purpose for which it is intended in accordance with the agreed scope of work. Beca accepts no responsibility or liability to any third party for any loss or damage whatsoever arising out of the use of or reliance on this report by that party or any party other than our Client.
- The inspections of the building discussed in this report have been undertaken to assist in the structural assessment of the building structure for seismic loads only. This assessment does not consider gravity or wind loading or cover building services or fire safety systems, or building finishes, glazing systems or the weather tightness envelope.
- This assessment does not include an assessment of the building condition or repairs that may be required.
- No geotechnical ground investigations or quantitative assessments have been undertaken as part of this DSA. The qualitative geotechnical assessments were limited to a desktop review using existing information and findings from the adject site (draft report by Tonkin + Taylor [2022], refer Appendix A).

- Beca is not able to give any warranty or guarantee that all possible damage, defects, conditions or qualities have been identified. The work done by Beca and the advice given is therefore on a reasonable endeavours basis.
- Except to the extent that Beca expressly indicates in the report, no assessment has been made to determine whether or not the building complies with the building codes or other relevant codes, standards, guidelines, legislation, plans, etc.
- The assessment is based on the information available to Beca at the time of the assessment and assumes the construction drawings supplied are an accurate record of the building. Further information may affect the results and conclusion of this assessment. The information used to undertake the seismic assessment is listed in Appendix A.
- Beca has not considered any environmental matters and accepts no liability, whether in contract, tort, or otherwise for any environmental issues.
- The basis of Beca's advice and our responsibility to our Client is set out above and in the terms of engagement with our Client.

Sensitivity: General

2 Building Description

2.1 General

Summary information about the building is presented in Table 2.1. Reference information used to undertake this seismic assessment is listed in Appendix A. For the purposes of the building description and the remainder of this report, we have divided the building into three sections as shown below.

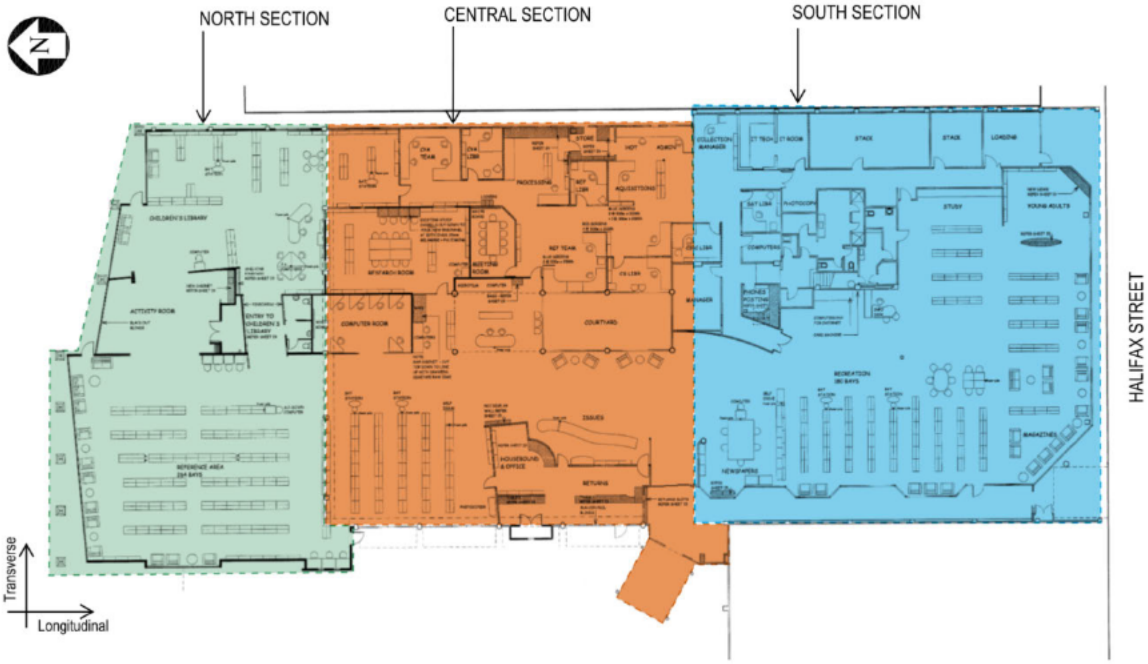

Figure 2.1: Building reference plan showing north, central and southern section areas used in this report.

Table 2.1: Building summary information.

Item	Details	Comment
Building name	Elma Turner Library	
Street Address	27 Halifax Street, Nelson	
Age	Original building constructed in 1956 and modified in various stages until the final extension circa 2004.	Refer to Figure 2.3 for further detail and Appendix A for timeline of construction obtained from council archives and property file.
Description / Building Occupancy	Library. Central Nelson public library and associated staff areas.	Public areas are all on ground level, two storey area houses staff facilities only (staffroom, bathrooms, offices etc)
Importance Level(s) As defined by NZS 1170.0 and Nelson City Council instruction.	Importance Level 2 - The importance level has been discussed and agreed between Beca and NCC. Refer to comments for justification.	With reference to Table 3.1 and 3.2 of NZS 1170.0 2022 • the building does not have more than 300 people congregating in one area (2004 extension, fire report dated June 2004 provides the maximum occupant load as 312 for the entire building, the maximum in the library space is 236).

Item	Details	Comment
		• the building does not contain contents of high value to the community (discussed with NCC, NCC considered that there were no contents of sufficiently high value to the community that loss would amount to 'very great' economic or social consequence)
Building Footprint / Floor Area	Approximately 2400 m^2 Building perimeter shown on Figure 2.2.	Longitudinal (North-South) and transverse (East-West) building lengths measuring approx. 75m and 35 m respectively.
No. of storeys / basements	Predominantly single storey with the exception of the staff area (two storey).	Refer Figure 2.3.
Structural system	**North** – Structural steel frame with internal timber walls. Cantilever concrete columns along eastern boundary wall	2004
	Central – Timber roof trusses on reinforced concrete cantilever columns. Some structural steel rafters and posts.	1989
	South – Predominantly timber roof trusses (some steel trusses and timber rafters) on reinforced concrete cantilever columns and steel posts. Precast concrete and masonry block perimeter walls supported by reinforced concrete cantilever columns. Timber framed two-storey section with some steel cross bracing and concrete columns.	1956, 1961, 1973, 1975, 1985, 1989
Lateral load resisting system	**North (longitudinal and transverse directions)** - Proprietary "multibrace angle braces" within timber walls. Steel rod roof bracing connects to reinforced concrete cantilever columns along boundary to central portion of building. Steel portal frames in both directions.	
	Central (longitudinal and transverse directions) – Flat strap roof bracing to timber truss top chords. Reinforced concrete cantilever columns.	
	South (longitudinal) – Steel rod roof bracing at bottom chord of timber truss. Concrete/masonry walls along eastern and western boundary and internal. **South (transverse)** – Reinforced concrete cantilever columns along eastern and western boundary. **South, two storey section (longitudinal)** – Timber bracing walls, concrete columns and steel cross bracing.	Refer Figure 2.4 for layout.

Item	Details	Comment
	South, two storey section (transverse) – Timber framed bracing walls	
Foundation system	Slab on grade. Generally shallow reinforced concrete foundations except for the columns along the Maitai River boundary of the North section which have 600mm dia x 3m bored concrete piles.	Concrete beams used to create cantilever column footings. Foundations between sections are isolated and not tied together across the site.
Stair system	Timber to access two storey section.	
Other notable features	Predominantly light weight cladding and roof except for the boundary walls in the South section (precast and masonry). Masonry parapet on the eastern boundary wall of the South section. Heavy suspended ceiling system.	Refer to Appendix E for further details on the ceiling.
Past seismic strengthening	None specifically, although a degree of strengthening occurred during the various extensions in 1973, 1985 and 1989.	Main strengthening occurred in 1989 to the eastern boundary of the southern section of the building. Included replacing masonry infills with precast panels and strengthening cantilever concrete columns.
Construction information	Some structural drawings/details and for all known phases of construction.	1956 drawings are very limited. There is a possibility that other phases of construction have occurred that are unknown and undocumented. This assessment assumes that the as built construction matches the structural drawings available. No structural drawings for the 2004 extensions (details only in the specification). No drawings for the blockwork walls on the eastern boundary wall of the south section.
Likely Loading Standards for original building design	NZSS 1900:1965 Chapter 8, NZS 4203:1976, NZS 4203:1984, NZS 4203: 1994, NZS 1170:2004	
Heritage Status	None	
Seismic Risk Area	Medium – Z=0.27	As defined by Section 133AA of the Building (Earthquake-prone Buildings) Amendment Act 2016 a medium seismic risk area is one with a Z factor greater than 0.15 and less than 0.3.
Priority building status	Territorial Authority to confirm	Territorial Authority to determine priority building status

Figure 2.2: Aerial photograph of site plan.

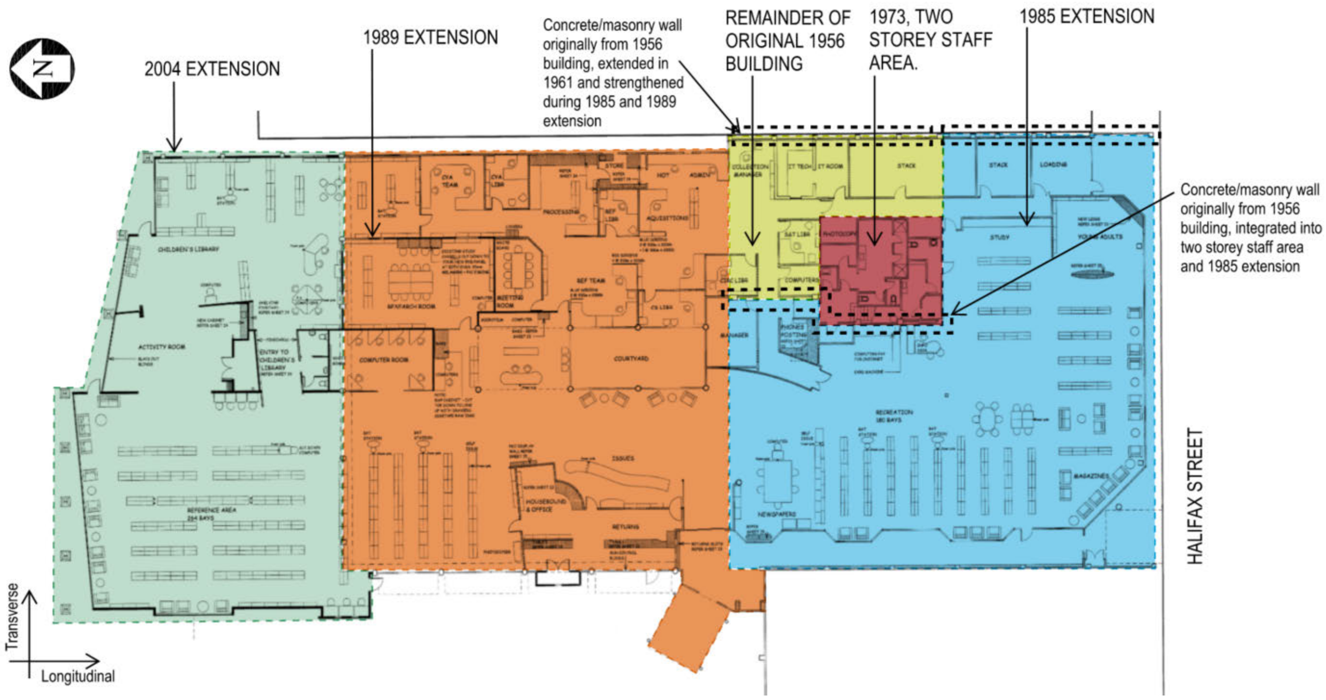

Figure 2.3: Plan of building indicating key construction phases and building features.

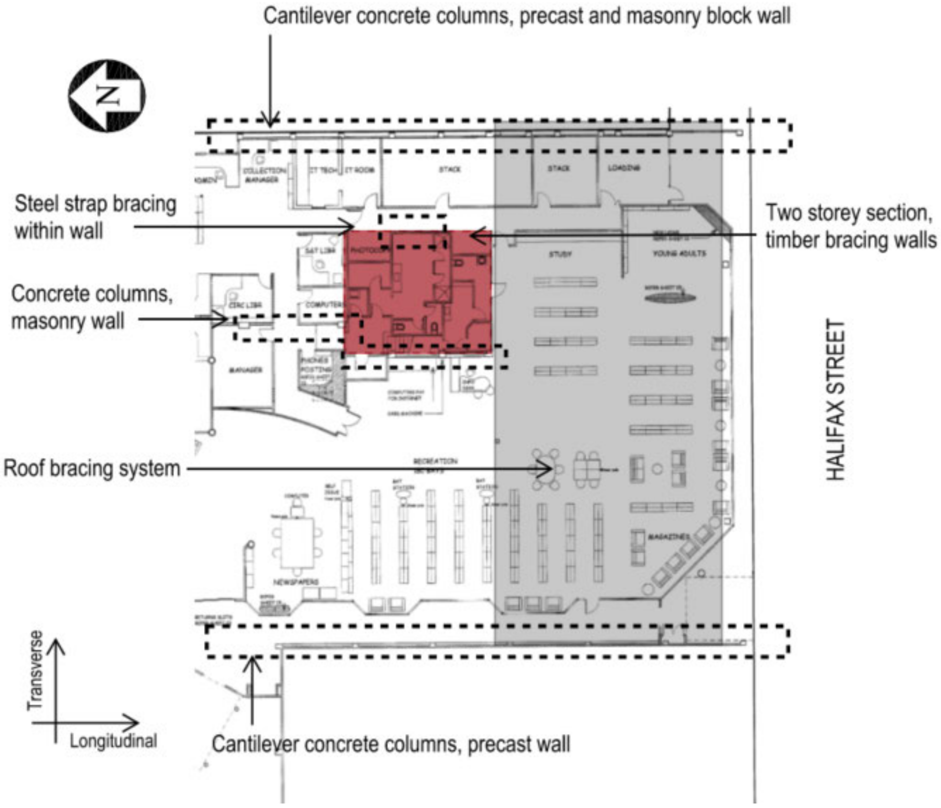

Figure 2.4: Close up of South section of the building indicating the lateral load resisting systems.

2.2 Site Conditions and Potential Geohazards

The site is relatively flat and low lying at approximately 3.0 m RL (New Zealand Vertical Datum 2016), and is located on the southern bank of the Maitai River in the north of the Nelson Central Business District. Our review of the existing data (Refer Section 9) nearby the site suggests that the ground conditions consist of a shallow soil profile comprising of a layer of loose to medium dense fill overlying Quaternary aged estuarine and alluvial deposits. Very dense Port Hills Gravel was encountered at depths between 27.9 and 28.8 m bgl (-24.2 and -25.3 m RL).

Borehole logs from the draft Tonkin + Taylor (2022) report for the adjacent site indicate that these estuarine and alluvial deposits include variable mixtures of clay, silt, sand, and gravel, with the potential for cobbles, boulders, and trace organics. Standard Penetration Tests (SPTs) show 'N' values between 12 and 50 in these soils with a 1.5 m thick lens of very soft silt (SPT 'N' count = 0) located at 7.2 m bgl (-3.5 m RL) in BH01 adjacent to the river.

Standpipe piezometers installed at the site show relatively shallow groundwater levels ranging between 2.7 to 3.7 m bgl (1.0 to 0 m RL). A slight tidal influence between 0.2 and 0.9 m was recorded.

The nearest mapped active fault is the West Flaxmore Fault which is about 800 m to the southeast (Johnston et al, 2021) and is a major fault of the Waimea-Flaxmore Fault System (Beca, 2021). Amplification of ground shaking at the site is likely in much of Nelson City (Rattenbury and Johnston, 1998).

Based on the information provided in the borehole logs at 29-35 Halifax Street, adjacent to this site, and the reported results of the Multichannel Analysis of Surface Waves (MASW) testing at the Trafalgar Centre (Taylor et al, 2018), the shear waves velocities in the very dense Port Hills Gravels indicate that the site subsoil class is Class C shallow soil in accordance with NZS 1170.5:2004. Reference information used to undertake this assessment is listed in Appendix A.

We have undertaken a desktop assessment of potential geohazards and present those in Table 2.2 as likely relevant for this building.

Table 2.2: Potential geohazards

Potential Geohazard	Hazard	Comment
Liquefaction (Lateral spreading, cyclic softening, liquefaction-induced settlement)	Moderate to High	Tonkin + Taylor (2022) reported that the neighbouring site is prone to liquefaction with an average Recurrence Interval (RI) of around 50 to 100 years, with more liquefaction predicted on the river side of the site. The following summaries the liquefaction-induced ground damage: • Horizontal displacement toward the river is anticipated in earthquake shaking events of 100 years RI and upwards. The potential horizonal displacements of 80 mm for a 1/100 year RI, to 800 mm for a 1/2500 year RI. • Liquefaction-induced settlement is anticipated to be differential. The potential surface settlement for a 1/100 year and 1/500 year RI event was 40 to 60 mm riverside and 0 to 20 mm on the inland side of the site. For a 1/2500 year RI event, 80 to 100 mm riverside and 40 to 60 mm on the inland side was estimated. • Cyclic softening is anticipated to be localised to the base of the upper fill material. For a 1/100 year RI event it is anticipated to be minor, while for a 1/500 year and 1/2500 year RI event it is anticipated to be widespread. Under a 1/25 year RI event, the effects of liquefaction-induced ground damage are expected to be minor.
Fault rupture near building	Very Low	The nearest mapped fault is located 800 m to the southwest of the site (West Flaxmore Fault). This fault was identified by Beca (2021) to be outside of the fault deformation overlay zone which indicates that future movement on this fault is unlikely to affect structures at this site.
Ground shaking	Moderate to High	Due to the known faulting, ground amplification and shaking is expected.
Slope instability	Moderate to High	The north side of the site lies directly adjacent to the Maitai River. Given the likelihood of lateral spreading during a seismic event is moderate to high, the risk of slope instability resulting from an earthquake is also moderate to high.
Rockfall	N/A	The site is not located next to any cliffs or significant slopes, therefore there is no risk of rockfall at this site.
Flooding	High	River flooding maps produced by the Nelson City Council (2021) indicate that the site is at high risk of flooding from the Maitai River.
Tectonic movement leading to flood risk	Moderate to High	The likelihood of liquefaction-induced settlement is moderate to high, therefore the tectonic movement leading to flood risk is also considered moderate to high.

Potential Geohazard	Hazard	Comment
Tsunami	Low to High	The site is located near the coast and is mapped within the Orange Tsunami Evacuation Zone produced by GNS (2013). This zone suggests that the site is in an area that is at risk of impacts from a potential tsunami. The orange zone is anticipated to be of low risk from small, more frequent, tsunamis and high for larger distant sourced tsunamis.
Dam Break	Moderate to High	Dam break flood maps produced by Tonkin + Taylor (2013) show the site to be at risk of flooding from a dam break. Flood depths are estimated to be between 0.2 to 0.8 m across the site.

2.3 Identified Structural Systems

The lateral load resisting systems bracing the Elma Turner Library are described below.

2.3.1 North Section (2004)

2.3.1.1 Both Directions

Refer to Figure 2.5 for a sketch indicating the key structural features of the north section of the building.

a. Primary lateral load resisting system

Seismic loads are initially resisted by the proprietary “multibrace angle braces” within the timber framed walls. Once the capacity of these braces is exceeded seismic loads are resisted by the reinforced concrete cantilever columns along the boundary of the central section and steel portal frames on grids in the longitudinal direction. There is some portal action also available from the steel columns/frames along the front (river side) façade of the building.

Cantilever concrete columns along the eastern boundary wall resist seismic loads in that area.

b. Diaphragms at roof level:

Roof steel bracing provided diaphragm action to transmit loads to the angle braces. Roof rafters act as struts to transmit loads to the reinforced concrete cantilever columns.

c. Foundations

- Slab on grade.
- Shallow pad footings beneath gravity posts.
- 600mm dia. x 3m deep concrete piles under columns along Maitai river.
- Reinforced concrete ground beams to support cantilever columns along western boundary, and central section boundary.
- Foundations are generally not tied together.

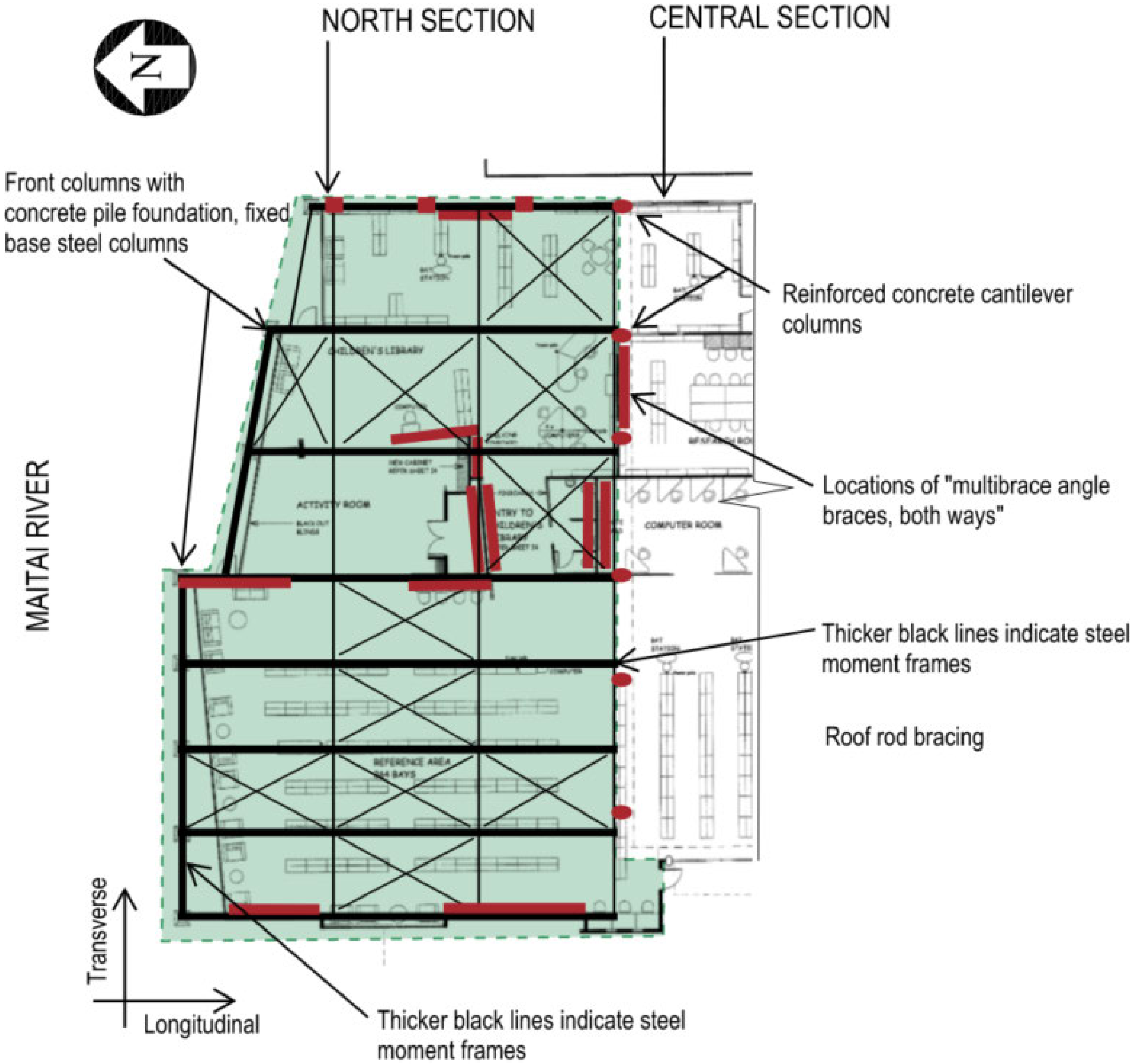

Figure 2.5: Key structural features of the north section of the building.

2.3.2 Central Section (1989)

Refer to Figure 2.6 for a sketch indicating the key structural features of the central section of the building.

2.3.2.1 Both Directions

a. Primary lateral load resisting system

Seismic loads are resisted by reinforced concrete cantilever columns. These columns are able to resist seismic loads from the central and north section of the building as they are connected.

There are steel posts along the eastern elevation of the building that have some cantilever capacity. These are significantly more flexible than the concrete columns so do not contribute

b. Diaphragms at roof level:

Steel strap bracing to the top chords of the timber trusses distributes loads to the cantilever columns. Roof space diagonal bracing and truss members brace the roof down to the bottom chord level.

Clerestory roof around the courtyard area creates a discontinuity in the diaphragm in that area.

c. Foundations

- Slab on grade.
- Reinforced concrete ground beams to support cantilever columns.

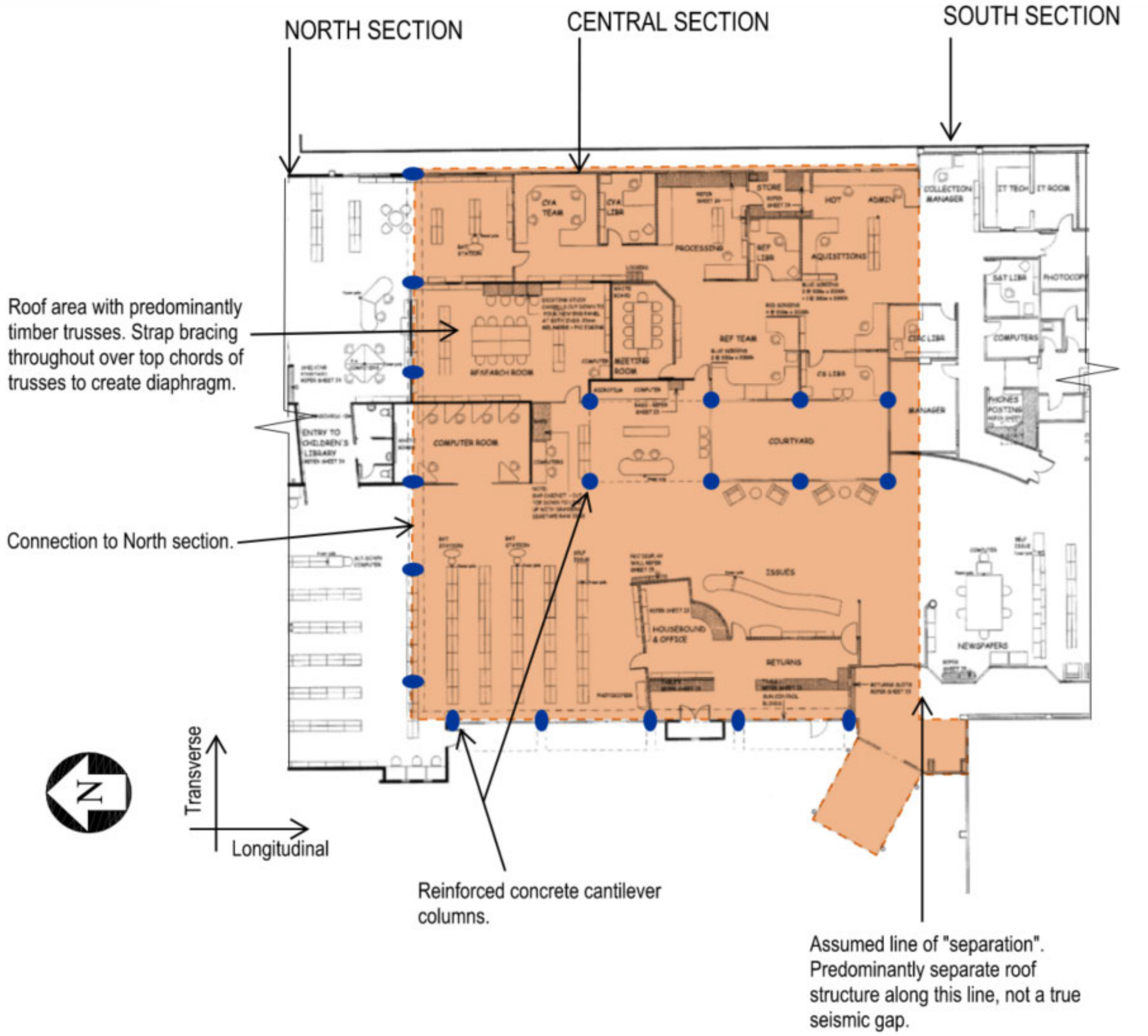

Figure 2.6: Key structural features of the central section of the building.

2.3.3 South Section (1956 with 1961, 1973, 1985, 1989 modifications)

Refer to Figure 2.4 for a sketch of the key structural feature of the south section of the building.

2.3.3.1 Longitudinal Direction (north-south)

a. Primary lateral load resisting system

Seismic loads from the main building are resisted by walls along the eastern and western boundary wall and the internal wall line identified in Figure 2.4. The eastern boundary wall is a combination of precast panels, concrete frame with masonry block infills and masonry block walls. It was constructed in 1956 and 1961 and then strengthened in 1985 and 1989. Refer to Figure 2.7 for details. The western boundary wall is a precast panel wall connected to the concrete columns. The internal wall is assumed to be a reinforced concrete frame with masonry infills (few details are available for this wall).

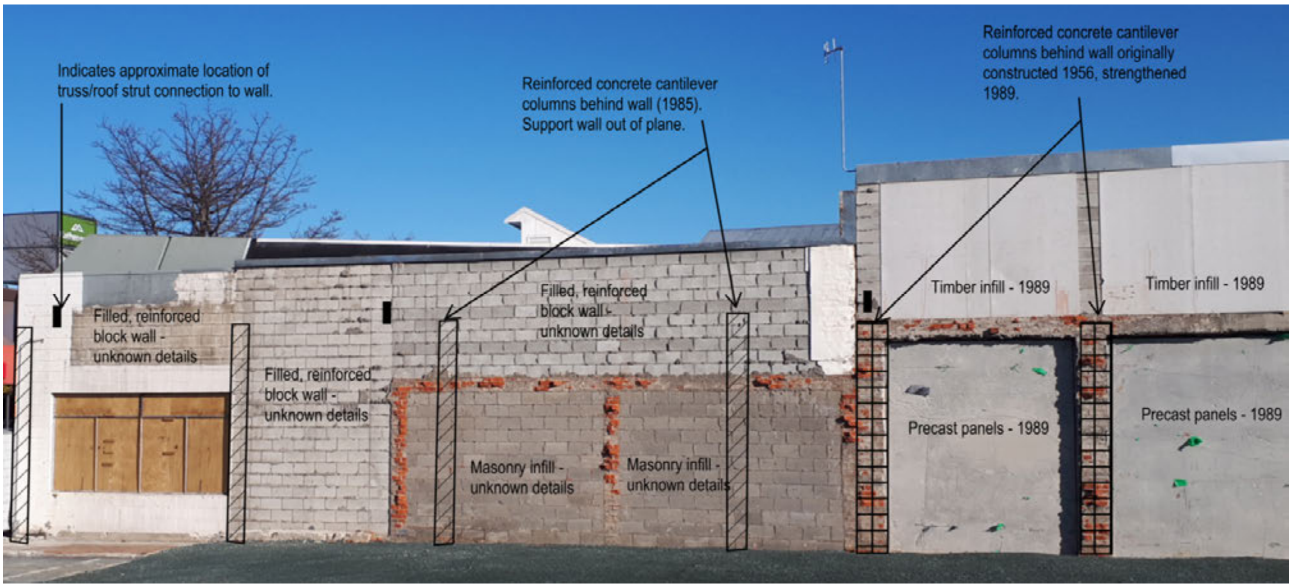

Figure 2.7: Key structural features of the eastern boundary wall of the south section of the building

Seismic loads in the two-storey section are resisted by timber bracing walls from roof to first floor level and a combination steel cross bracing and concrete frame with masonry infill wall from first floor to ground level. Given the roof and floor level of the two-storey section are offset from the roof of the main building, it has been assumed that it behaves as a relatively independent structure. There will be interaction between the two structures and the interface between the two is a potential location for localised damage to occur in a moderate earthquake.

b. Diaphragms

For the main roof there is rod bracing at the bottom chord level of the trusses to transfer loads. The timber roof trusses act as drag elements and chords to complete this bracing system. The bracing system is connected to the walls with mechanical anchors installed in the 1985 extension.

In the two-storey section there is a plasterboard ceiling at both levels indicated on the structural drawings. Bracing elements are sufficiently close together that a diaphragm has not been considered necessary to transfer roof and floor loads.

2.3.3.2 Transverse Direction (east-west)

a. Primary lateral load resisting system

Seismic loads from the main building are resisted by reinforced concrete cantilever columns along the eastern and western boundary walls. The columns must resist seismic loads from both the roof and the boundary walls.

Seismic loads in the two-storey section are resisted by timber bracing walls. Given the roof and floor level of the two-storey section are off set from the roof of the main building, it has been assumed that it behaves as a relatively independent structure. There will be interaction between the two structures and the interface between the two is a potential location for damage to occur in a moderate earthquake.

b. Diaphragms

Truss and rafters act as struts to transfer seismic loads to the cantilever columns.

In the two-storey section there is a plasterboard ceiling at both levels indicated on the structural drawings. Bracing elements are sufficiently close together that a diaphragm has not been considered necessary to transfer roof and floor loads.

2.3.3.3 Foundations

- Slab on grade.
- Reinforced concrete ground beams to support cantilever columns.

3 Results of Seismic Assessment

The results of our Detailed Seismic Assessment indicate the building's earthquake rating to be 30%*NBS* (IL2). The earthquake rating is the minimum score from either Table 3.1 or Table 3.2 that meets the requirement of a significant life safety hazard in the event of failure as defined in *The Guidelines*.

Table 3.1: Summary of structural scores for the primary structural system

System	Direction	Earthquake scores %NBS	Notes
North Section			
Reinforced concrete cantilever columns and steel frame system	Longitudinal	50%NBS (IL2)	Limited by drift of 2.5% of cantilever concrete columns (similar to ductility 2). Columns must resist combined loads from central and north section once multibrace angle bracing fails.
	Transverse	45%NBS (IL2)	Limited by capacity of roof bracing to transfer loads to columns.
Roof bracing	Transverse direction	45%*NBS* (IL2)	Brace capacity.
The north section of the building has multibrace angle wall bracing. This bracing has been found to have limited capacity to resist seismic loads. It scores 15-30%NBS (IL2). Failure of the wall bracing is not considered to contribute to the earthquake rating for the building as there are alternative load paths available (scored above)			
Central Section			
Reinforced concrete cantilever columns	Longitudinal	50%NBS (IL2)	Limited by drift of 2.5% of cantilever columns (similar to ductility 2). Columns must resist combined loads from central and north section once multibrace angle bracing fails.
	Transverse	45%NBS (IL2)	Limited by capacity of roof bracing from north section to transfer loads to columns. Otherwise score would be similar to longitudinal direction.
South Section			
Roof bracing	Longitudinal	30%*NBS* (IL2)	Governed by capacity of mechanical anchor to boundary walls. Capacity is uncertain due to lack of information available about anchor and no specific guidance in *The Guidelines*. Score reported is assuming the bolt capacity governs and is

System	Direction	Earthquake scores *%NBS*	Notes
			evaluated to C6 of *The Guidelines*. Capacity of the connections at the other end of the braces (brace to timber truss) is similar and scores are also low (34%*NBS*). Brace closest to the concrete wall is critical.
	Transverse	50%(NBS IL2)	Capacity of block walls spanning between cantilever columns to transfer roof loading.
Eastern Boundary Wall	Longitudinal	>100%*NBS* (IL2)	Governed by shear capacity of concrete columns as precast panels are not connected directly to the ground. Additional capacity provided by masonry wall.
	Transverse	50%*NBS* (IL2)	Concrete cantilever columns, original 1956 portion and masonry block wall supported by concrete cantilever columns.
Western Boundary Wall	Longitudinal	>100%*NBS* (IL2)	Governed by shear capacity of concrete columns as precast panels are not connected directly to the ground.
	Transverse	80%*NBS* (IL2)	Concrete cantilever columns, 1985 extension
Two-storey section	Longitudinal	>100%*NBS* (IL2)	Timber wall bracing.
	Transverse	>100%*NBS* (IL2)	Timber wall bracing.
Precast panels	Transverse/face loading	80%*NBS* (IL2)	Precast panels along western boundary wall governs.
Masonry infill panels	Transverse/face loading	70%*NBS* (IL2)	Based on site observations. No drawings available.

3.1 Commentary on Seismic Performance and Limiting Mechanisms

Our Detailed Seismic Assessment indicates the building's earthquake rating is **30%*NBS* (IL2)**, this is governed by the roof bracing system in the south section of the building.

The limiting mechanism has been determined to be failure of the bolt connecting the rod bracing to the concrete western boundary wall. The capacity of this connection is uncertain given it is a post installed (likely mechanical) anchor which is not documented on the structural drawings. The capacity of the connection at the other end of the brace (brace to timber truss) is similar and scores 34%*NBS* (IL2). The brace closest to the concrete wall is critical.

While the roof bracing score governs the earthquake rating of the building at 30%*NBS* (IL2) there are other building elements that have been found to have earthquake scores in the order of 40-60%*NBS* (IL2). These elements are widespread throughout the building footprint.

The building has been extended and modified significantly in approximately five major stages from 1956 to 2004. This has led to a complex, mixed structural form with difficult to identify and indirect load paths. Seismic loads are resisted by a combination of timber bracing walls, cantilever concrete columns, masonry block shear walls, precast concrete panels, steel strap bracing and steel portal frames. Differential movement between these structural elements during a moderate earthquake is expected to be significant potentially causing localised damage to the structure. There is also likely damage to non-structural elements (such as glazing, internal partitions and ceilings) is expected to be extensive.

Additionally, the building is founded on shallow foundations that are not robustly tied together. The structure is not expected to be resilient to potential liquefaction induced ground deformations and lateral spreading of the ground under the building. The Tonkin and Taylor report for the adjacent site suggests that the site is likely prone to liquefaction in a moderate earthquake. Liquefaction is likely to cause ground movements and a loss of bearing capacity. Beca consider that these effects could start to have an impact on the stability of the Elma Turner Library building at a level of shaking in the order of 50% ultimate limit state seismic demand. There is not expected to be a step change in behaviour that leads to a significant life safety hazard before 100% ultimate limit state seismic demand.

3.2 Commentary on Northern Section of the building

The North section of the building has three evident lateral load resisting systems:

- Diagonal steel bracing
- Cantilever concrete columns
- Steel portal frames

All three systems will, to some degree, provide stability to the structure in an earthquake. The scores reported in the table above are based on load being carried by the concrete cantilever columns which are shared with the central section of the building.

The steel moment frames on grid and along the front of the building provide additional resistance that has not been specifically quantified at this stage. Quantifying this load path could be completed in the future but was not considered worthwhile at this stage of the assessment given the potential geotechnical risk at the site. If more detailed geotechnical assessment was completed, then more accurate structural analysis to assign a score potentially greater than 50*%NBS* to the Northern Section of the building could also be undertaken.

3.3 Secondary Structural and Non-Structural Elements

A secondary structural or non-structural element is considered those not part of the primary gravity or lateral structure within a building, or a section of a building. The *Assessment Guidelines* determine that in order to be considered a life safety hazard, or to cause damage to other property, a building element must be able to fall to the extent that it is able to create the hazard to occupants. To be considered a significant life safety hazard, a number of people need to be exposed to the danger.

Table 3.2 summarises the results of our assessment of relevant secondary structural or non-structural elements that can be considered to be significant life safety hazards.

Table 3.2: Summary of structural scores for the Secondary Structural and Non-Structural elements

Element	Earthquake Score *%NBS*	Comment
Parapet – eastern boundary wall 1989	80*%NBS* (IL2)	Assumed to be a masonry block column parapet with timber infills as per 1989 drawings. Assessed using parts loading.
Suspended ceilings	Scores vary but are <34*%NBS* (IL2) in some areas. 15*%NBS* (IL2) is the lowest score (for the Research and Computer room)	Refer to appended DSA by Beca for ceilings and partitions. Ceilings are heavy in many areas and considered to be a significant life safety hazard.

The scores in Table 4.2 have not currently been applied to the building's earthquake rating.

4 Comparison to Previous Assessments

4.1 Previous Initial Seismic Assessment

Aurecon previously completed an Initial Seismic Assessment (ISA) of the building, which is summarised in a report dated 12 November 2012. The ISA determined that the building has a potential earthquake rating of 28%NBS (IL2), which corresponds to a Grade D building, as defined by the Engineering Assessment Guidelines building grading scheme.

While the ISA provides a useful indication of a building's potential earthquake rating and seismic risk relative to a new building constructed to the current code, it is only a first stage qualitative review.

As noted in the ISA, this building was penalised because of:

- the site's proximity to the river creating possibilities for soil liquefaction and lateral spreading.
- potential for pounding with neighbouring buildings (note that these have now been demolished).

4.2 Previous Detailed Seismic Assessment

Following their ISA, Aurecon completed a Detailed Seismic Assessment of the building, which is summarised in a report dated 6 December 2013. The DSA determined that the building has a potential earthquake rating of 42%NBS (IL3), which corresponds to a Grade C building, as defined by the Engineering Assessment Guidelines building grading scheme.

The Aurecon DSA should be considered to supersede their ISA as it was completed after the ISA and provided a more detailed quantitative review.

4.3 Comparison between Detailed Seismic Assessment Findings

There are numerous differences between the Aurecon DSA and this (Beca) DSA. Those that are identifiable from reading the Aurecon report are summarised in Table 4.1.

Table 4.1: Comparison of Aurecon and Beca Detailed Seismic Assessments

Item	Aurecon	Beca	Commentary
Assessment basis	Unclear	*The Guidelines*	The Aurecon assessment is pre 2017. Given it has not been completed to *The Guidelines*, it is difficult to compare the numerical results.
Assessment scope	Primary structure	As defined in *The Guidelines*	The Aurecon assessment did not consider secondary structure or non-structural elements. This only became a requirement in *The Guidelines*. Specifically, this means the Aurecon assessment did not include, or identify the heavy suspended ceilings.
Earthquake rating and governing element	Roof bracing connection 42%*NBS* (IL3)	Roof bracing connection 30%*NBS* (IL2)	The same element has been identified to govern the rating of the building. The exact score is different which is expected given the different basis of assessment.
Importance Level	3	2	Beca's assumption should lead to a higher earthquake rating which it has not done. It is difficult to compare the two assessments due to their different assessment basis.
Site subsoil class	D	C	Based on updated information available. Beca's assumption should lead to a higher earthquake rating which it has not done It is difficult to compare the two assessments due to their different assessment basis.

5 Commentary on Associated Seismic Risks not Affecting the Earthquake Rating

5.1 Risks from Adjacent Buildings

There are currently no risks from adjacent buildings. Both neighbouring buildings have recently been demolished.

5.2 Risk from Geohazards

The subsurface conditions are anticipated to be a shallow soil profile consisting of a layer of fill overlying Quaternary aged terrestrial sediments, with the potential for Port Hills Gravel and relatively shallow groundwater. Based on these conditions and previous geotechnical data available for this site, the soils are susceptible to liquefaction, lateral spreading, cyclic softening, and liquefaction-induced total and differential settlement. If liquefaction-induced settlement were to occur, the risk of flooding at the site is likely to increase. For calculating seismic loads, a Site Subsoil Class C is considered likely.

The effect of liquefaction at 29-35 Halifax Street was assessed by Tonkin + Taylor (2022), which borders the Elma Turner Library to the east. This investigation and analysis identified the following implications for development which we also considered likely for the library site:

- Under SLS (1/25 year) loading, sudden bearing capacity loss is not expected while liquefaction-induced ground settlement and lateral spreading towards the Maitai River is possible but not expected to be significant.
- Under 1/100 and 1/500 (ULS) year loading, sudden bearing capacity loss of the foundations is possible. Liquefaction-induced total and differential settlements are anticipated, with 40 to 60 mm near the river and 0 to 20 mm on the inland side of the building. Lateral spreading towards the Maitai River is anticipated to be around 80 mm for a 1/100 year event, to 300 mm for a 1/500 year event.
- Under 1/2500 year loading, which is well-beyond the ULS shaking level, widespread bearing capacity loss is possible. Liquefaction induced ground surface settlement is anticipated to be 80 to 100 mm on the river side of the building and 40 to 60 mm on the inland side, with lateral displacement of the site towards the Maitai River in the order of 800 mm.

Based on the Tonkin + Taylor assessment and expected ground movements summarised above, we consider that the current building's seismic rating remains governed by the structural capacity (that is, it is a "structurally dominated" rather than a "geotechnically dominated" building" in accordance with the guidelines). Tonkin + Taylor predict increasing ground movement of the site with a shaking level that would affect the serviceability of the structure. The settlement and lateral spreading movements predicted at 100%ULS shaking would cause significant distortion to the building but would be unlikely to affect the stability of the structure.

We recommend that if seismic retrofit design of the building is considered, then the geotechnical performance should also be considered and retrofit of the foundations would likely be necessary. Additional geotechnical investigations are also recommended.

5.3 Risks from Non-structural Building Elements

For many buildings, non-structural building elements (ceilings, internal walls, overhead services) constitute a significant portion of the repair / reinstatement cost following an earthquake. As noted in Section 3.1, the nature of Elma Turner Libraries structure is such that differential movements between building sections would be expected to be significant in an earthquake. In a moderate seismic event, non-structural element damage will likely contribute heavily to downtime and the repair costs for the building.

5.4 Other

The property file for the building provides details of two previous issues with the roof as detailed below:

- The roof trusses in the south section of the building were strengthened in 1995. The consent file notes that the trusses were sagging and had suffered damage to top and bottom chords and connections. It is not noted what caused this damage but the trusses do form a component of the seismic resisting system. Our brief review of the repairs documented suggests that the damage was likely caused by overloading of the truss under gravity or wind loading.
- A portion of flat roof was leaking in 2006. This section of the roof was repitched and additional drains added.

6 Seismic Grade and Relative Seismic Risk

The assessed earthquake rating of 30%NBS (IL2) for the Elma Turner Library categorises it as Grade D in accordance with the New Zealand Society for Earthquake Engineering building grading scheme. Grade D buildings represent a life-safety risk to occupants 10 to 25 times that expected for a similar new building, indicating a high relative seismic risk compared with a similar new building.

Table 6.1: Relative Seismic Risk

Seismic Grade	*%NBS*	Approx. risk relative to a similar new building	Relative life-safety risk description
A+	>100	<1	low risk
A	80 to 100	1 to 2 times	low risk
B	67 to 80	2 to 5 times	low to medium risk
C	33 to 67	5 to 10 times	medium risk
D	20 to 33	10 to 25 times	high risk
E	<20	more than 25 times	very high risk

As the earthquake rating is less than 34*%NBS*, the building fulfils one of the criteria that may lead it to be categorised as an Earthquake-Prone Building in accordance with the New Zealand Building Act. If the building was determined to be Earthquake Prone by Nelson City Council (acting in its role as the Territorial Authority), Nelson City Council (as building owner) would be required to carry out seismic work to bring the building above 34*%NBS* within a specified timeframe. The timeframe will be determined based on whether or not the Territorial Authority determines the building to be a priority building.

7 Next Steps

We recommend NCC consider carrying out the following next steps:

- Nelson City Council consider strengthening the roof bracing elements identified as less than 34*%NBS* (IL2) in this report. Strengthening the structure beyond this level is likely to require extensive structural works to the building and foundations and potential site ground improvement (for example to limit lateral spreading toward the river).
- A site specific, geotechnical investigation and assessment if Nelson City Council would like a more detailed and accurate assessment of the expected geotechnical performance of the site and its impact on the Elma Turner Library building structure. This is only recommended to facilitate a seismic retrofit project.

8 References

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GNS Science, 2020. Active Faults database (https://data.gns.cri.nz/af/). Accessed 16/09/2022.

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Tonkin + Taylor Ltd, 2021. Nelson Plan Flood Model Updates – Maitai/Brook/York and Wakapuaka flood models.

Tonkin + Taylor Ltd, 2022. Geotechnical Assessment Report – 29-35 Halifax Street (draft), Nelson. Prepared for Wakatu Incorporation.

A

Appendix A – Sources of Information

Sources of Information

The following information regarding the building and site was used to undertake the seismic assessment:

Source of Information	Author	Comment
ISA report – NCC Seismic Assessment of Buildings, Contract No. 3443	Aurecon	Rev 1 dated 12 November 2012
DSA report – Elma Turner Library Detailed Seismic Assessment	Aurecon	Rev 1 dated 6 December 2013
Geotechnical report - Geotechnical Assessment Report – 29-35 Halifax Street (draft), Nelson prepared for Wakatu Incorporation	Tonkin and Taylor	Draft dated 13/7/2022
Structural Drawings – BUILDING PERMIT 2626 ERECT GARAGE, WORKSHOP - 1956	Unknown	Obtained from council archives, original 1956 building. Bolton Motors Garage and Workshop
Structural Drawings – BUILDING PERMIT 101015 EXTEND OFFICE SPACE -1961	Unknown	Obtained from council archives, extension of wall along eastern boundary.
Structural Drawings – BUILDING PERMIT F02925 ALTER OFFICE, SHOWROOM - 1973	M.J.B. Worseldine	Obtained from council archives, Two storey section addition
Structural Drawings – BUILDING PERMIT D018559 ALTER, EXTEND SHOWROOM, SALES YARD - 1985	Worseldine Wells	Obtained from council archives, significant extension to the south
Architectural Drawings – Building Permit 029389 ERECT LIBRARY	Upstream Design Group	Obtained from council property file. Central extension, conversion of building into a library.
Architectural Drawings – 040773 Alterations and Additions to Elma Turner Library	Arthouse Architects and W. R Andrew	Obtained from council property file. North extension. No structural drawings. Structural details provided as sketches in specifications.

In addition to the above, site inspections were undertaken on 10th June, 14th June, 21st June and 20th October.

The inspections consisted of a site walk over and was generally limited to those items readily visible from ground level. The June site visits were focused on the suspended ceiling and allowed the roof structure above the ceiling to be observed. Only limited areas of the ceiling were accessed by lifting tiles and inserting a camera.

The eastern boundary wall was viewed in May 2022 when the neighbouring building was demolished.

The following documents and references were used as the basis for the seismic assessment:

Engineering Assessment Guidelines (EAG)	Date	Comment
A - Assessment Objectives and Principles	July 2017	
C1 – General Issues	July 2017	
C2 – Assessment Procedures and Analysis Techniques	July 2017	
C3 – Earthquake Demands	July 2017	

C4 – Geotechnical Considerations	July 2017	
C5 – Concrete Buildings	July 2017	Generally adopted with the exception noted below.
Technical Proposal to Revise C5	November 2018	This section has been used to evaluate the ductility capacity of the cantilever concrete columns. These elements do not govern the rating of the building. If they were assessed using the July 2017 C5, they would not be determined to be potentially earthquake prone.
C6 – Structural Steel Buildings	July 2017	Used for capacity of bolted connections
C7 – Moment Resisting Frames with Infill Walls	July 2017	Used for the asssessment of the eastern boundary wall.
C8 – Unreinforced Masonry Buildings	July 2017	Used for the asssessment of the eastern boundary wall.
C9 – Timber Buildings	July 2017	North section, two storey section and timber trusses
C10 – Secondary Structural and Non-Structural Elements	July 2017	Suspended ceilings

The following NZ and international standards were used in the assessment.

Standard	Date and Amendment	Comment
AS/NZS1170.0 – Structural design actions – Part 0: General Principles	2002	
AS/NZS1170.1 – Structural Design actions – Part 1: Permanent, imposed and other actions	2002	
NZS1170.5 – Structural Design actions	2004	
NZS3101 – Concrete Structures Standard	2006	
NZS3404 – Steel Structures Standard	1997	
NZS3603 – Timber Structures Standard	1993	

The following other reference documents were used in the assessment:

Technical Document	Date	Comment
Mitek product data sheet – AB Angle Brace from mitek.co.nz	Obtained October 2022	Characteristic load table
Lumberlok product data sheet – catalogue “Characteristic Loadings Data” – Angle Brace	Archive 03/4 – assumed to be March 2004	Characteristic loadings data
Pryda Catalogue – “Timber connector specifications and design loads” – Angle Brace	Archive 05/09 – Assumed to be 2009	Loads table (wind only)

B

Appendix B – Basis of Assessment

Basis of Seismic Assessment

C.1 Seismic Loading

The seismic design actions have been determined in accordance with NZS1170.5:2004 with the following assumptions:

Parameter	Value
Importance Level	Importance Level 2 – The importance level has been discussed and agreed between Beca and NCC. With reference to Table 3.1 and 3.2 of NZS 1170.0 2022 • the building does not have more than 300 people congregating in one area (2004 extension, fire report dated June 2004 provides the maximum occupant load as 312 for the entire building, the maximum in the library space is 236). • the building does not contain contents of high value to the community (discussed with NCC, NCC considered that there were no contents of sufficiently high value to the community that loss would amount to 'very great' economic or social consequence)
Site Location	Nelson
Z-factor	0.27
Subsoil Class	C most likely – refer to geotechnical section of this report

Only the Ultimate Limit State (ULS) loading are considered in the seismic assessment, which is concerned with life safety of the occupants and collapse prevention.

C.2 Dead and Live Loads

The following basis has been used in establishing the dead loads for the structure. This is based on information contained on the original building structural drawings and assumptions based on our experience of the era of this building's design and construction:

Parameter	Value
Dead loads	From element self-weights
Superimposed dead loads	Roof superimposed dead load has been assumed to be 0.2kPa on average throughout the building. Minimal suspended services, heavy ceiling tile system.
Live Loads	General areas 3.0 kPa – no direct impact on the assessment as primarily on slab on grade. Staff area (two storey section, raised floor) – 3.0kPa Roof – 0.25kPa Stairwell – 4.0kPa

C.3 Assessment Assumptions

The key probable material strength assumptions made during our assessment were as follows:

Item	Assumed Probable Strength	Comments
Reinforcing Steel	Various for various ages of building.	Determined directly from *The Guidelines* section C5.
Concrete Strength	Various for various ages of building.	Determined directly from *The Guidelines* section C5.

Structural Steel Grades	Various for various ages of building.	Determined directly from *The Guidelines* section C6.

Other key assumptions for our assessment are included below:

Item	Assumption	Comments
Roof Diaphragm	Flexible	Assessed on a tributary area basis utilising the roof bracing systems.
Accidental Eccentricity	Considered for its impact on the critical scoring elements.	
Modelling	Hand calculations	
Separations	South section is seismically separate from the central section	Expected location of damage.

The achievable earthquake score of the various structural elements has been estimated using the approach described in the *Engineering Assessment Guidelines*.

C.4 Seismic Mass

The seismic mass has been computed adopting the NZS1170.5:2004 loading combination $W = G + \Psi_E Q_u$ where Ψ_E is dependent on the occupancy type from AS/NZS 1170.1.

C

Appendix C – Structural Drawings

D

Appendix D – Assessment Summary Report

Seismic Assessment Summary

1. Building Information	
Building Name/ Description	Elma Turner Library
Street Address	27 Halifax Street, Nelson
Territorial Authority	Nelson City Council
No. of Storeys	Predominantly single storey. Small section of two storey containing staff areas.
Area of Typical Floor (approx.)	2400m^2 approx
Year of Design (approx.)	Original building constructed in 1956 and modified in various stages (1961, 1973, 1985, 1989) until the final extension circa 2004.
NZ Standards designed to	NZSS1900:1965 Chapter 8, NZS4203:1976, NZS4203:1984, NZS4203: 1994, potentially NZS1170:2004
Structural System including Foundations	**North section (2004)** – Structural steel frame with internal timber walls containing proprietary angle bracing. Cantilever concrete columns along eastern boundary wall and southern boundary with central section.
	Central section (1989) – Timber roof trusses on reinforced concrete cantilever columns. Some structural steel rafters and posts.
	South section (1956, 1973, 1961, 1985, 1989) – Predominantly timber roof trusses (some steel trusses and timber rafters) on reinforced concrete cantilever columns. Precast concrete and masonry block perimeter walls supported by reinforced concrete cantilever columns. Timber framed two-storey section with some steel cross bracing and concrete columns.
	Foundations – Generally shallow strip footings, isolated pads and ground beams. Columns along the Maitai River boundary of the North section which have 600mm dia x 3m bored concrete piles.
Does the building comprise a shared structural form or shares structural elements with any other adjacent titles?	No
Key features of ground profile and identified geohazards	The subsurface conditions are anticipated to be a shallow soil profile consisting of a layer of fill overlying Quaternary aged terrestrial sediments, with the potential for Port Hills Gravel and relatively shallow groundwater. Based on these conditions and previous geotechnical data available for this site, the soils are susceptible to liquefaction, lateral spreading, cyclic softening, and liquefaction-induced total and differential settlement. Low to high risk of tsunami.

	Moderate to high risk of liquefaction, ground shaking, slope instability (towards Maitai River), tectonic movement leading to flood risk and dam break. High risk of flooding
Previous strengthening and/ or significant alteration	Significant alterations in 1961, 1973, 1985, 1989, 2004
Heritage Issues/ Status	None
Other Relevant Information	N/A

2. Assessment Information	
Consulting Practice	Beca Ltd
CPEng Responsible, including: • Name • CPEng number • A statement of suitable skills and experience in the seismic assessment of existing buildings[1]	[redacted] [redacted] [redacted] has 40 years of experience in structural and earthquake engineering. He has completed training on the use of the MBIE assessment guidelines and has led the seismic assessment of numerous buildings and building portfolios.
Documentation reviewed, including: • date/ version of drawings/ calculations[2] • previous seismic assessments	Refer table in row below

[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

Source of Information	Author	Comment
ISA report – NCC Seismic Assessment of Buildings, Contract No. 3443	Aurecon	Rev 1 dated 12 November 2012
DSA report – Elma Turner Library Detailed Seismic Assessment	Aurecon	Rev 1 dated 6 December 2013
Geotechnical report - Geotechnical Assessment Report – 29-35 Halifax Street (draft), Nelson prepared for Wakatu Incorporation	Tonkin and Taylor	Draft dated 13/7/2022
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Structural Drawings – BUILDING PERMIT F02925 ALTER OFFICE, SHOWROOM - 1973	M.J.B. Worseldine	Obtained from council archives, Two storey section addition
Structural Drawings – BUILDING PERMIT D018559 ALTER, EXTEND SHOWROOM, SALES YARD - 1985	Worseldine Wells	Obtained from council archives, significant extension to the south
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Architectural Drawings – 040773 Alterations and Additions to Elma Turner Library	Arthouse Architects and W. R Andrew	Obtained from council property file. North extension. No structural drawings. Structural details provided as sketches in specifications.

Geotechnical Report(s)	Geotechnical Assessment Report – 29-35 Halifax Street (draft). Prepared for Wakatu Incorporation.
Date(s) Building Inspected and extent of inspection	Site inspections were undertaken on 10th June, 14th June, 21st June and 20th October 2022. Site inspections covered both internal and external areas. The inspections consisted of a site walk over and were generally limited to those items readily visible from ground level. The June site visits were focused on the suspended ceiling and allowed the roof structure above the ceiling to be observed. Only limited areas of the ceiling were accessed by lifting tiles and inserting a camera. The eastern boundary wall was viewed in May 2022 when the neighbouring building was demolished, and the wall was un clad.
Description of any structural testing undertaken and results summary	None
Previous Assessment Reports	Refer above table of documentation reviewed.
Other Relevant Information	None

3. Summary of Engineering Assessment Methodology and Key Parameters Used	
Occupancy Type(s) and Importance Level	Public Library and associate staff areas. Importance Level 2 – The importance level has been discussed and agreed between Beca and NCC. With reference to Table 3.1 and 3.2 of NZS 1170.0 2022: • the building does not have more than 300 people congregating in one area (2004 extension, fire report dated June 2004 provides the maximum occupant load as 312 for the entire building, the maximum in the library space is 236). • the building does not contain contents of high value to the community (discussed with NCC, NCC considered that there were no contents of sufficiently high value to the community that loss would amount to 'very great' economic or social consequence)
Site Subsoil Class	C
For an ISA:	
Summary of how Part B was applied, including: • Key parameters such as μ, S_p and F factors • Any supplementary specific calculations	
For a DSA:	
Summary of how Part C was applied, including: • the analysis methodology(s) used from C2 • other sections of Part C applied	An elastic-based assessment procedure (force based) was primarily used for this assessment. SLaMA was used to determine the critical elements of the various structural systems within the building. Equivalent static analysis was used to determine earthquake demands derived from NZS 1170.5:2004. Section C2.3. Sections C3, C4, C5, C6, C7, C8, C9 also used. Suspended ceilings assessed to C10.
Other Relevant Information	N/A

4. Assessment Outcomes		
Assessment Status (Draft or Final)	Draft	
Assessed *%NBS* Rating	30%*NBS* (IL2)	
Seismic Grade and Relative Risk (from Table A3.1)	Grade D, High Risk	
For an ISA:		
Describe the Potential Critical Structural Weaknesses		
Does the result reflect the building's expected behaviour, or is more information/ analysis required?		
If the results of this ISA are being used for earthquake prone decision purposes, and elements rating <34%*NBS* have been identified:		
For a DSA:		
Comment on the nature of Secondary Structural and Non-structural elements/ parts identified and assessed	Heavy suspended ceilings. Refer to detail in Appendix E. Ceilings have been assessed qualitatively as requested by NCC. Scores vary with the lowest ceiling grid score 15%*NBS* (IL2). Heavy tiles are generally not considered to be restrained in the grid.	
Describe the Governing Critical Structural Weakness	**For the Primary Building Structure** The governing element is the connection between roof bracing system and western boundary concrete wall in the south section of the building. The capacity of this connection is uncertain given it is a post installed (likely mechanical) anchor which is not documented on the structural drawings. Failure of the anchor is expected to be relatively brittle in nature. The connection at the other end of the roof brace (between the brace and the timber trusses) has been assessed to have a similar capacity. Failure of this connection would be expected to be slightly more ductile than the anchor to the wall (timber crushing). Following failure of a brace connections, seismic loads from the roof and façade of the south section of the building must be transferred to the concrete walls via secondary load paths such as trusses bending out of plane. This load path is not quantifiable and unreliable.	

	For the Suspended Ceilings The governing element is the connections around the perimeter of the ceiling that provide lateral support to the ceiling grid. The mode of failure is expected to be brittle. Connections between the ceiling grid elements will pull out of the grid, ceiling grid has no remaining lateral support and grid elements separate under seismic load. Tiles move independently to the grid and fall to the floor. If one tile falls from the grid, it is more likely that others will too.	
If the results of this DSA are being used for earthquake prone decision purposes, and elements rating <34*%NBS* have been identified (including Parts)[3]:	**Engineering Statement of Structural Weaknesses and Location** Roof bracing in southern section of building adjacent to Halifax Street Suspended ceilings throughout the building (refer plans appended)	**Mode of Failure and Physical Consequence Statements** Failure of roof bracing connections and roof bracing system. Loss of effectiveness of roof bracing and consequent distortion of roof framing and trusses. Eventual likely loss of gravity support for roof framing resulting in localized area of roof collapses within building (in south section of building). Connections between the ceiling grid elements will pull out of the grid, ceiling grid has no remaining lateral support and grid elements separate under seismic load. Tiles move independently to the grid and fall to the floor. If one tile falls from the grid, it is more likely that others will too as the grid system becomes unbalanced.
Recommendations (optional for EPB purposes)		

[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.

E

Appendix E – DSA of Suspended Ceilings and Non-structural Partitions