Rangitikei District Council

DETAILED SEISMIC ASSESSMENT

31 HIGH STREET, MARTON

3 DECEMBER 2021

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DETAILED SEISMIC ASSESSMENT
31 HIGH STREET, MARTON

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REV	DATE	DETAILS
1	19/11/2021	For Client Comment

	NAME	DATE	SIGNATURE
Prepared by:	Rudi van Schalkwyk	03/12/2021	
Reviewed by:	Andre Ferreira	03/12/2021	
Approved by:	Robert Jeans	03/12/2021	

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EXECUTIVE SUMMARY

WSP has been engaged by the Rangitikei District Council to complete a Detailed Seismic Assessment (DSA) of the Marton Library building at 31 High Street. Our assessment has been completed in accordance with the MBIE document "The Seismic Assessment of Existing Buildings – Technical Guidelines of Engineering Assessments", July 2017 (the 'Red Book').

The building is used as an office for general use with an approximate capacity of 5 staff. The building is therefore Importance Level 2 in accordance with the joint Australian/New Zealand standard Structural Design Actions Part 0, AS/NZS 1170.0:2002. It has hence been assessed for actions from a seismic event causing 1-in-500-year ground shaking.

The Library was originally built in 1910 and extended in 1956. The original structure comprises of timber roof trusses supported on unreinforced masonry walls supported by currently unknown foundations. The building additions comprises of reinforced concrete moment frames with masonry infill panels. Lateral loads are resisted by in plane actions of the reinforced concrete moment frames. Reinforced concrete strip foundations support the infill wall panels and reinforced concrete isolated foundations support the moment frames.

The results of the DSA find the building's *Earthquake Rating* to be **18%*NBS* (IL2)** when assessed in accordance with the Guidelines. Therefore, this is a **grade E building** following the New Zealand Society for Earthquake Engineering (NZSEE) grading scheme. Grade E buildings represent a risk to occupants more than 25 times greater than expected for a new building, indicating a **very-high life-safety risk exposure.**

A building with an *Earthquake Rating* less than 34%NBS when assessed in accordance with Version 1 of the Guidelines (the 'Red book') fulfils one of the requirements for the Territorial Authority to consider it to be an Earthquake-Prone Building (EPB) in terms of the Building Act 2004. A building rating less than 67%NBS is considered as an Earthquake-Risk Building by the NZSEE. Rangitikei District Council Library Building **is therefore categorised as an Earthquake Risk Building and does fall below the criteria that could categorise it as an EPB.**

The assessment identified the following structural weaknesses in the building:

Structural Component/System	Seismic Score (%NBS – IL2)	Structural Weakness Type	Mode of Failure
Walls	20%	CSW	Out of plane capacity
Reinforced concrete beam	67%	SW	Flexural capacity
Reinforced concrete column	48%	SW	Flexural capacity
Foundation beams	18%	CSW	Flexural capacity
Isolated foundation	30%	SW	Uplift capacity
Parapet walls	25%	SW	Flexural capacity
Infill panels	47%	SW	Out of plane capacity

Based on the outcomes of our assessment, we recommend strengthening the building to achieve a seismic rating 67%*NBS* (IL2).

A technical summary of the DSA is presented in Appendix A.

1 PROJECT BACKGROUND

1.1 INTRODUCTION

WSP has been engaged by the Rangitikei District Council to complete a Detailed Seismic Assessment (DSA) of the Marton Library building at 31 High Street. This report summarises the inputs, methodology and findings of the assessment.

1.2 DSA SCOPE AND PURPOSE

A DSA is one of two forms of *Engineering Assessment* (the other being an ISA) permitted by the Earthquake Prone Building Methodology of the Ministry of Business, Innovation and Employment to determine a building's *Earthquake Rating* (see Section 1.3) as part of the system for managing earthquake earthquake-prone buildings.

In July 2017 the latest revision of the "The Seismic Assessment of Existing Buildings – Technical Guidelines for Engineering Assessments" was issued. This is a document managed jointly by the Ministry of Business, Innovation and Employment, the Earthquake Commission, the New Zealand Society for Earthquake Engineering, the New Zealand Structural Engineering Society and the New Zealand Geotechnical Society. The part of the technical guidelines covering concrete buildings is Section C5. This section is also known to the industry as the "C5 Red Book".

In November 2018 an updated revision to the technical guidelines Section C5 was issued. This is known to the industry as the revised guidelines or the "C5 Yellow Book". The C5 Yellow Book included substantial updates to the main body of the guidelines for the assessment of the primary structure for concrete buildings and included updates to several of the appendices, including the precast floor section (now appendix C5E), of the guidelines. The updates to the guidelines included lessons learned from the recent University research and the 2016 Kaikoura Earthquake as well as findings from the MBIE "Statistics House" Investigation.

A DSA aims to achieve an understanding of the likely behaviour of a building in earthquakes by:

- Quantifying the strength and deformation capacities of the various structural elements, and;
- Checking the building's structural integrity against the loads/deformations (demands) that would be used for the design of a similar building on the same site.

A building with an *Earthquake Rating* less than 34%NBS fulfils one of the requirements for the Territorial Authority to consider it to be an Earthquake-Prone Building (EPB) in terms of the Building Act 2004. For concrete buildings, the C5 Red Book must be utilised when determining the earthquake-prone status. A building rating less than 67%NBS is considered as an Earthquake-risk Building by the New Zealand Society of Earthquake Engineering (NZSEE).

Table 1 shows the grading system developed by the NZSEE for communicating the relative risk of a building compared to a that of a similar new building on the same site, based on the *Earthquake Rating* determined by a DSA.

Table 1: NZSEE grading system and relative risk description.

Percentage of New Building Standard (*%NBS*)	Alpha rating	Approx. risk relative to a new building	Life-safety risk description
>100 A+	A+	Less than or comparable to	Low risk
80-100	A	1-2 times greater	Low risk
67-79	B	2-5 times greater	Low to Medium risk
34-66	C	5-10 times greater	Medium risk
20 to <34	D	10-25 times greater	High risk
<20	E	25 times greater	Very high risk

1.3 %NBS CALCULATION

The *%NBS Earthquake Rating* for a building is found by a DSA from the following equation:

%NBS = Ultimate capacity (seismic) x 100% / ULS seismic demand

The Ultimate capacity (seismic) of a building is taken as the minimum of:

- The probable capacity of the primary lateral structure of the building, including the impact of geotechnical issues, or;
- The probable capacity of structural elements, the failure of which could lead to a significant life safety hazard, or;
- The capacity of any Severe Structural Weaknesses (refer Section 1.4), or;
- The probable capacity of Secondary Structure and Non-Structural (SSNS) elements.

The items above are only considered should failure result in a significant life safety hazard. This is generally considered as failures that would result in collapse of all or part of a building and that would reasonably affect a number of people.

1.4 STRUCTURAL WEAKNESSES

A structural weakness (SW) is an aspect of the building structure and/or the foundation soils that scores below 100*%NBS* and the failure of which would be considered a significant life safety hazard.

The critical structural weakness (CSW) is the lowest scoring SW of a building. The *%NBS* of the CSW will be the *%NBS* of the building.

Severe structural weaknesses (SSW's) are a predefined list of SW's in the Guidelines that are not readily amenable to reliable assessment using usual methods. The Guidelines require the calculated probable capacity of these elements/systems to be halved.

2 SOURCES OF BUILDING DATA

The following documents and information were referred to for the assessment of the buildings.

2.1 DRAWING, CALCULATIONS & REPORTS

Drawings:

Drawing provided by Rangitikei District Council:

R. G. Talboys & Associates – New Council Chambers for the Marton Borough Council

Sheets 1 to 5 showing reinforced concrete frames on the perimeter of the 1956 extension

2.2 SITE GEOTECHNICAL INFORMATION

a) Site sub-soil Class

The site subsoil class for this area may be conservatively assumed as *Class D* in the absence of a full geotechnical report. The natural site period of 0.4 seconds was considered in the assessment.

b) Liquefaction

No liquefaction potential

Based on page 8 of "Update of hazard Information for 2015 Lifelines Risk & Responsibilities Report" published by GNS Science in the "GNS Science Consultancy Report 2016/40 May 2016"

c) Soil bearing capacity

Assumed to be good ground to NZS3604.

d) Bounding properties

The building does not have any properties immediately adjacent to it.

3 SITE AND BUILDING DECRIPTION

3.1 SITE

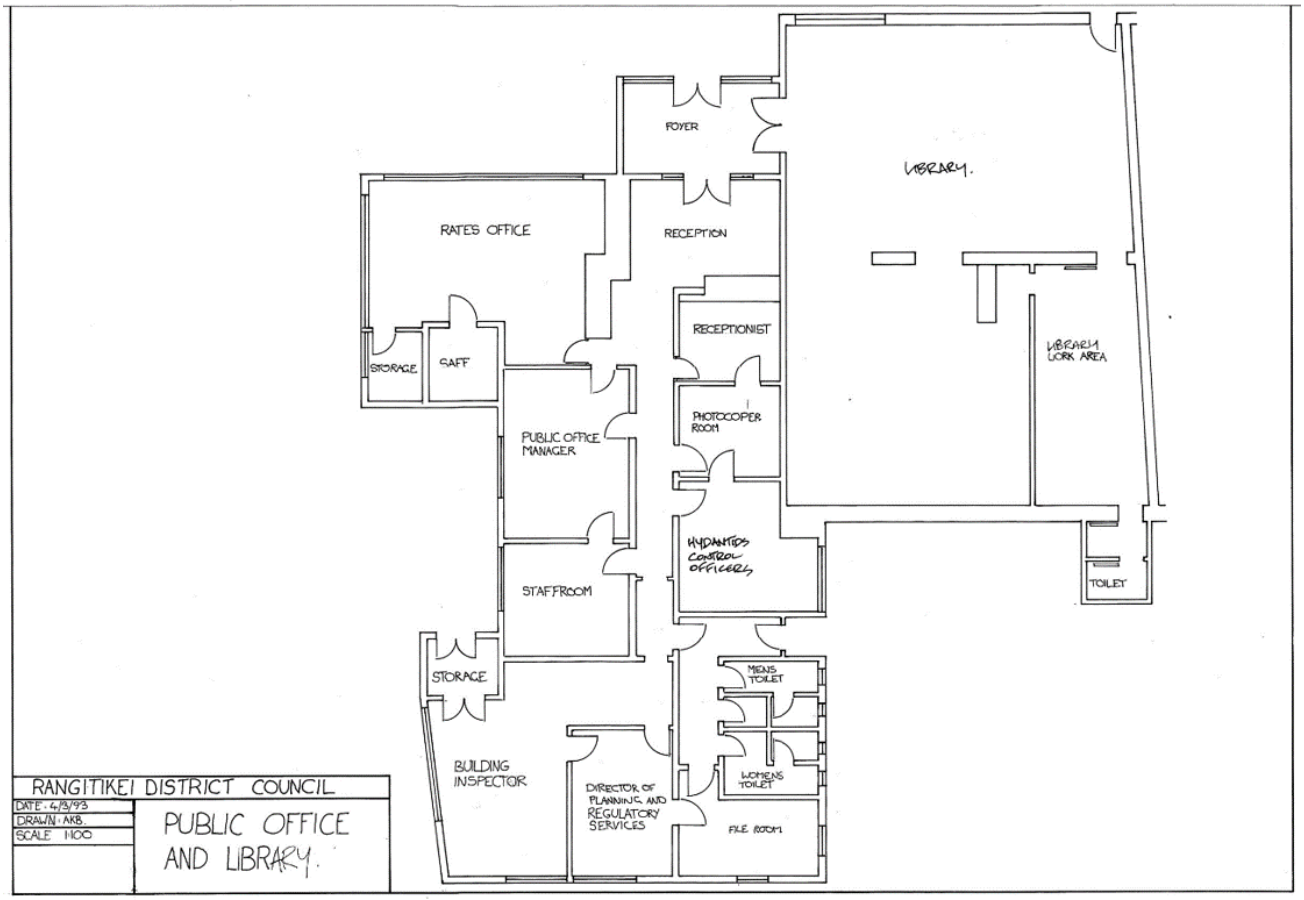
31 High Street, Marton, Manawatu-Whanganui.

3.2 BUIILDING SIZE AND USAGE

The building consists of the library and offices and has a footprint area of approximately 480m² .

3.3 STRUCTURAL SYSTEMS

The Library was originally built in 1910 and extended in 1956. The original structure comprises of timber roof trusses supported on unreinforced masonry walls supported by currently unknown foundations. The building additions comprises of reinforced concrete moment frames with masonry infill panels. Lateral loads are resisted by in plane actions of the reinforced concrete moment frames. Reinforced concrete strip foundations support the infill wall panels and reinforced concrete isolated foundations support the moment frames.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PHOTOCOPIER ROOM
HYDRANTS CONTROL OFFICERS
TOILET
STAFFROOM
STORAGE
MENS TOILET
BUILDING INSPECTOR
DIRECTOR OF PLANNING AND REGULATORY SERVICES
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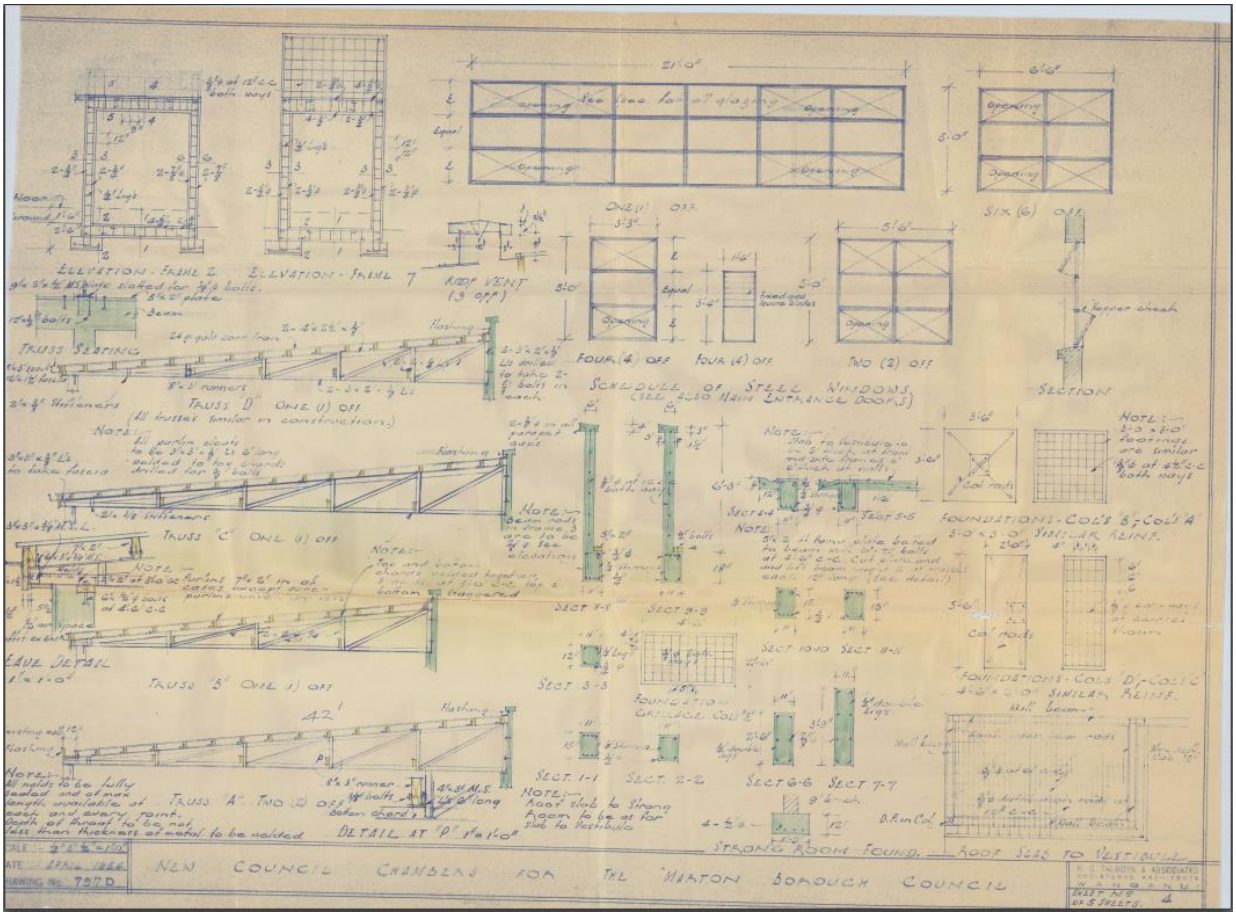
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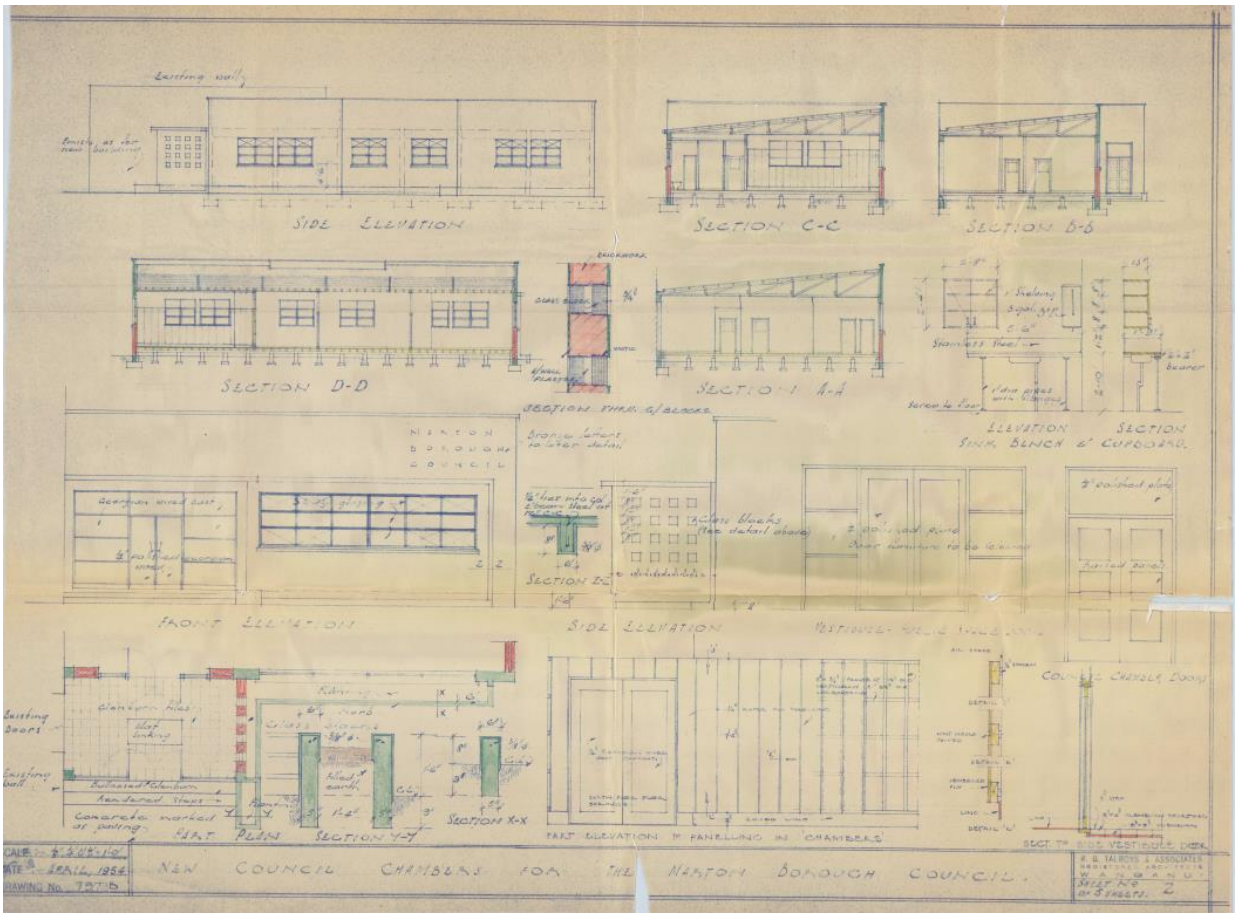
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SECTION B-B
SECTION D-D
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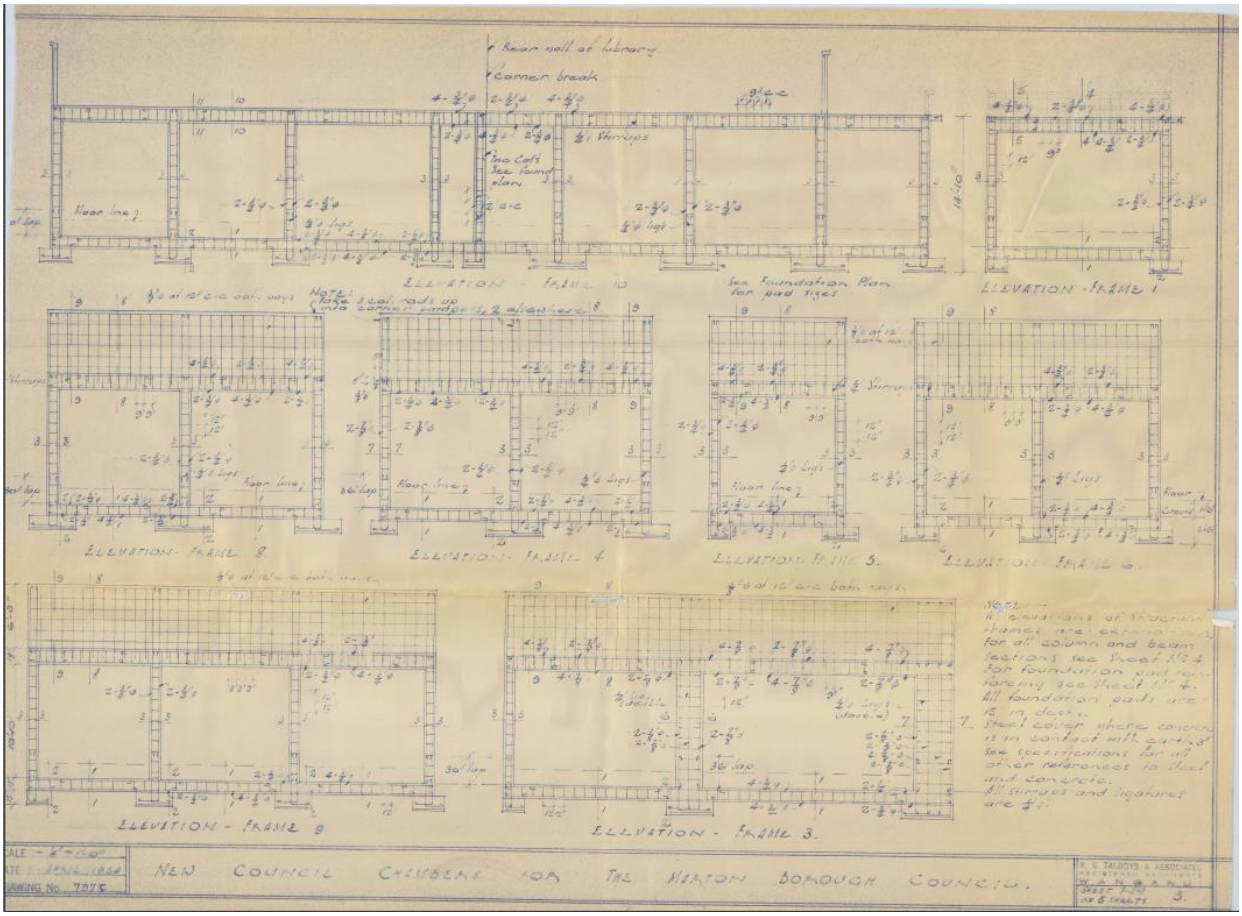
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NEW COUNCIL CHAMBERS FOR THE MARTON BOROUGH COUNCIL.

4 ASSESSMENT INPUTS

4.1 MATERIAL PROPERTIES

Concrete probable strength	- 30 MPa
Reinforcing probable strength	- 280 MPa
Masonry probable strength	- 35 MPa
Mortar probable strength	- 10 MPa

4.2 SEISMIC LOADING

In accordance with the Guidelines, the building has been subject to Ultimate Limit State (ULS) seismic demands that would be used to design a similar new building on the same site.

The current usage of the building means it is Importance Level 2 in accordance with the joint Australian/New Zealand standard Structural Design Actions Part 0, AS/NZS 1170.0:2002. A new building on this site would typically have a design life of 50 years.

The design life and importance level mean ULS demands results from a seismic event causing 1-in-500-year ground shaking.

The seismic loading parameters for the assessment are

Parameter	Value	Remarks
Site sub-soil category	D	
Site hazard factor, Z	0.30	Marton
Return period factor, R_u	1.0	1-in-500 year ground shaking
Near fault factor, N(T,D)	1.0	No major fault lines in proximity

4.3 ANALYSIS METHDOLOGY

The building was assessed with an equivalent static force-based approach to determine member forces. Reinforced concrete moment frames were analysed in SAP2000 software.

Masonry wall capacities were determined with the aid of a design spreadsheet written to incorporate the NZSEE Assessment Guidelines from section C8.

The bracing building systems were compared with similarly constructed new systems.

Taking into account the detailing of the reinforcement in the moment frames, a ductility of 2 was selected to obtain all seismic demands with a structural performance factor of 0.7.

Foundation pressures were calculated under combined bearing and overturning and a geotechnical reduction factor of 0.8 considered when calculating allowable bearing pressure versus ultimate bearing pressure for seismic or short duration loading.

5 ASSESSMENT RESULTS

5.1 TABULATED FINDINGS

Table 3 lists the %NBS rating for all structural elements assessed.

Table 2.1: Assessment results for individual components and/or systems (1910 Original structure).

Structural Component/System	Seismic Score (%NBS – IL2)	Structural Weakness Type	Mode of Failure
Walls	20%	CSW	Out of plane capacity
Foundations	Unknown foundations, to be determined through investigation		

Table 3.2: Assessment results for individual components and/or systems (1956 Additions).

Structural Component/System	Seismic Score (%NBS – IL2)	Structural Weakness Type	Mode of Failure
Reinforced concrete beam	67%	SW	Flexural capacity
Reinforced concrete column	48%	SW	Flexural capacity
Foundation beams	18%	CSW	Flexural capacity
Isolated foundations	30%	SW	Uplift capacity
Parapet walls	25%	SW	Flexural capacity
Infill panels	47%	SW	Out of plane capacity

5.2 COMMENTARY ON SEISMIC RISKS

The results of the DSA find the original building's *Earthquake Rating* to be **20%*NBS* (IL2)**. Therefore, this is a **grade D building** following the NZSEE grading scheme.

NZSEE guidelines state the relative risk of a grade D building compared to that of a similar new building on the same site is **10 - 25 times**. This indicates a high life-safety risk exposure.

The results of the DSA find the 1956 addition building's *Earthquake Rating* to be **18%*NBS* (IL2)**. Therefore, this is a **grade E building** following the NZSEE grading scheme.

NZSEE guidelines state the relative risk of a grade D building compared to that of a similar new building on the same site is **more than 25 times**. This indicates a very high life-safety risk exposure.

5.3 RECOMMENDATIONS

Although the legal minimum requirement for strengthening works is 34%NBS, we would strongly recommend strengthening to at least 67%NBS.

6 LIMITATIONS

This report ('Report') has been prepared by WSP New Zealand Limited ('WSP') exclusively for the Rangitikei District Council ('Client') in relation to the detailed seismic assessment of the Marton Library Building ('Purpose') and in accordance with the Short Form Agreement with the client dated 24/09/2021 ('Agreement'). The findings in this Report are based on and are subject to the assumptions specified in the Report and our Offer of Service dated 13/08/2021. WSP accepts no liability whatsoever for any use or reliance on this Report, in whole or in part, for any purpose other than the Purpose or for any use or reliance on this Report by any third party.

In preparing this Report, WSP has relied upon data, surveys, analyses, designs, plans and other information ('Client Data') provided by or on behalf of the Client. Except as otherwise stated in this Report, WSP has not verified the accuracy or completeness of the Client Data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this Report are based in whole or part on the Client Data, those conclusions are contingent upon the accuracy and completeness of the Client Data. WSP will not be liable for any incorrect conclusions or findings in the Report should any Client Data be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

APPENDIX A – TECHNICAL SUMMARY

1. Building Information	
Building Name/ Description	Marton Library
Street Address	31 High Street Road, Marton
Territorial Authority	Rangitikei District Council
No. of Storeys	1
Area of Typical Floor (approx.)	±500m^2
Year of Design (approx.)	1910 & 1956 Additions
NZ Standards designed to	Original – Unknown, Additions N.Z.S.S 95:1955
Structural System including Foundations	Original building: In plane URM shearwalls with roof level bracing. Additions: Reinforced concrete moment frames with masonry infill panels and roof level bracing.
Does the building comprise a shared structural form or shares structural elements with any other adjacent titles?	None
Key features of ground profile and identified geo-hazards	None
Previous strengthening and/ or significant alteration	None
Heritage Issues/ Status	None
Other Relevant Information	None

2. Assessment Information	
Consulting Practice	WSP New Zealand Ltd.
CPEng Responsible, including: • Name • CPEng number • A statement of suitable skills and experience in the seismic assessment of existing buildings[1]	Rudi van Schalkwyk (CPEng 1166463) - Senior Structural Engineer. Rudi has 14 years of combined consulting and construction experience and have designed a range of structures across multiple occupancies. He has undertaken numerous detailed seismic assessments across a wide range of engineering projects.
Documentation reviewed, including: • date/ version of drawings/ calculations[2] • previous seismic assessments	R. G. Talboys & Associates – New Council Chambers for the Marton Borough Council Sheets 1 to 5 showing reinforced concrete frames on the perimeter of the 1956 extension Previous DSA undertaken by MWH in June 2008
Geotechnical Report(s)	None
Date(s) Building Inspected and extent of inspection	27/10/2021
Description of any structural testing undertaken and results summary	None
Previous Assessment Reports	ISA undertaken by MWH in June 2008
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

3. Summary of Engineering Assessment Methodology and Key Parameters Used	
Occupancy Type(s) and Importance Level	Normal structure Importance level 2
Site Subsoil Class	D
Summary of how Part C was applied, including: • the analysis methodology(s) used from C2 • other sections of Part C applied	Equivalent static analysis carried out in line with C2.7.1 Reduction factors chosen in line with C2.5.1 Probable strengths calculated in accordance with C5 to C8
Other Relevant Information	None

4. Assessment Outcomes	
Assessment Status (Draft or Final)	Final
Assessed *%NBS* Rating	30%NBS (IL2)
Seismic Grade and Relative Risk (from Table A3.1)	Grade D
Comment on the nature of Secondary Structural and Non-structural elements/ parts identified and assessed	None
Describe the Governing Critical Structural Weakness	Reinforced concrete column flexural capacity and unreinforced masonry wall in of plane shear capacity.
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 Original 1910s building in plane shear capacity and 1950s building reinforced concrete column flexural capacity.
Recommendations	We recommend strengthening to at least 67%NBS

[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.