Rangitikei District Council

# DETAILED SEISMIC ASSESSMENT

## 46 HIGH STREET, MARTON

1 NOVEMBER 2021

CONFIDENTIAL

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## DETAILED SEISMIC ASSESSMENT
## 399 WELLINGTON ROAD, MARTON

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| REV | DATE | DETAILS |
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| | NAME | DATE | SIGNATURE |
|---|---|---|---|
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# EXECUTIVE SUMMARY

WSP has been engaged by the Rangitikei District Council to complete a Detailed Seismic Assessment (DSA) of the Memorial Hall at 399 Wellington Road. 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 a community activity hall with a maximum seated capacity of 442 and indoor basketball court. The building is therefore Importance Level 3 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-1000-year ground shaking.

The Memorial Hall was designed in 1959 and extended in 1985. The structure comprises of structural steel moment frames in the transverse direction and cross bracing at roof plane and wall lines in the longitudinal direction. A mezzanine floor is present in the East section of the building. On the Southern side there is a single-story section that houses the ablution facilities.

The results of the DSA find the building's *Earthquake Rating* to be **41%*NBS* (IL3)** when assessed in accordance with the Guidelines. Therefore, this is a **grade C building** following the New Zealand Society for Earthquake Engineering (NZSEE) grading scheme. Grade D buildings represent a risk to occupants 5-10 times greater than expected for a new building, indicating a **medium-safety risk exposure**.

A building with an *Earthquake Rating* less than 34%NBS when assessed in accordance with the Version 1 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. Marton Memorial Hall **is therefore categorised as an Earthquake Risk Building and does not 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 – IL3) | Structural Weakness Type | Mode of Failure |
|---|---|---|---|
| 310UB Rafters | 90% | SW | Flexural capacity |
| 310UB Columns | 91% | SW | Flexural capacity |
| 250UB Rafters | 58% | SW | Flexural capacity |
| 25UB Columns | 58% | SW | Flexural capacity |
| Roof bracing | 95% | SW | Weld capacity |
| Foundations | 52% | SW | Uplift resistance |
| Existing portal frames bracing mezzanine - Rafters | 41% | SW | Flexural capacity |
| Existing portal frames bracing mezzanine - Columns | 52% | SW | Flexural capacity |
| Ablutions building | 48% | SW | Wall bracing capacity |

Based on the outcomes of our assessment, we recommend strengthening the building to achieve a seismic rating 67%*NBS* (IL3).

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 Memorial Hall at 399 Wellington Road. 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:

Ground and first floor plans (1959)

Frame detail col 4-13 frames col 4-13 to 4-17 similar (1959)

Side elevation and roof plan (1959)

Portal frame col 3-9 portals 10-11, 12-18, 19-20 to 29-34 similar (1959)

Plan of Memorial Hall (1985)

Marton Borough Council Additions to Community Hall Sheets 1 – 9 (1985)

## 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

Based on on-site scala penetrometer testing, the ultimate bearing capacity was found to be > 300 kPa at 300 mm below ground.

d) Bounding properties

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

# 3 SITE AND BUILDING DECRIPTION

## 3.1 SITE

399 Wellington Road, Marton, Manawatu-Whanganui

Image from: https://maps.rangitikei.govt.nz/IntraMaps90/?project=RangitikeiDC&module=Rangitikei


## 3.2 BUILDING SIZE AND USAGE

The building consists of the below spaces:

| | |
|---|---|
| Supper room and kitchen | - 120m² |
| Main Hall | - 540m² |
| Mezzanine and kitchen | - 150m² |
| East storerooms | - 30m² |
| South ablutions block | - 110m² |

## 3.3 STRUCTURAL SYSTEMS

The single storey sections of the building (east storerooms and south ablutions block) consist of gib ceiling diaphragms and gib lined bracing walls in both directions.

The main hall building was originally built in 1959 and has moment resisting steel portal frames, constructed from 250UB37 sections, in the transverse direction. These frames have semi-circular haunches welded into the knee locations and lightweight steel fabricated truss eaves braces.

The 1985 building extension saw the building lengthened by 2 additional bays of moment resisting portal frames. The additional frames were constructed from 310UB40 sections and has a similar semi-circular haunch detail.

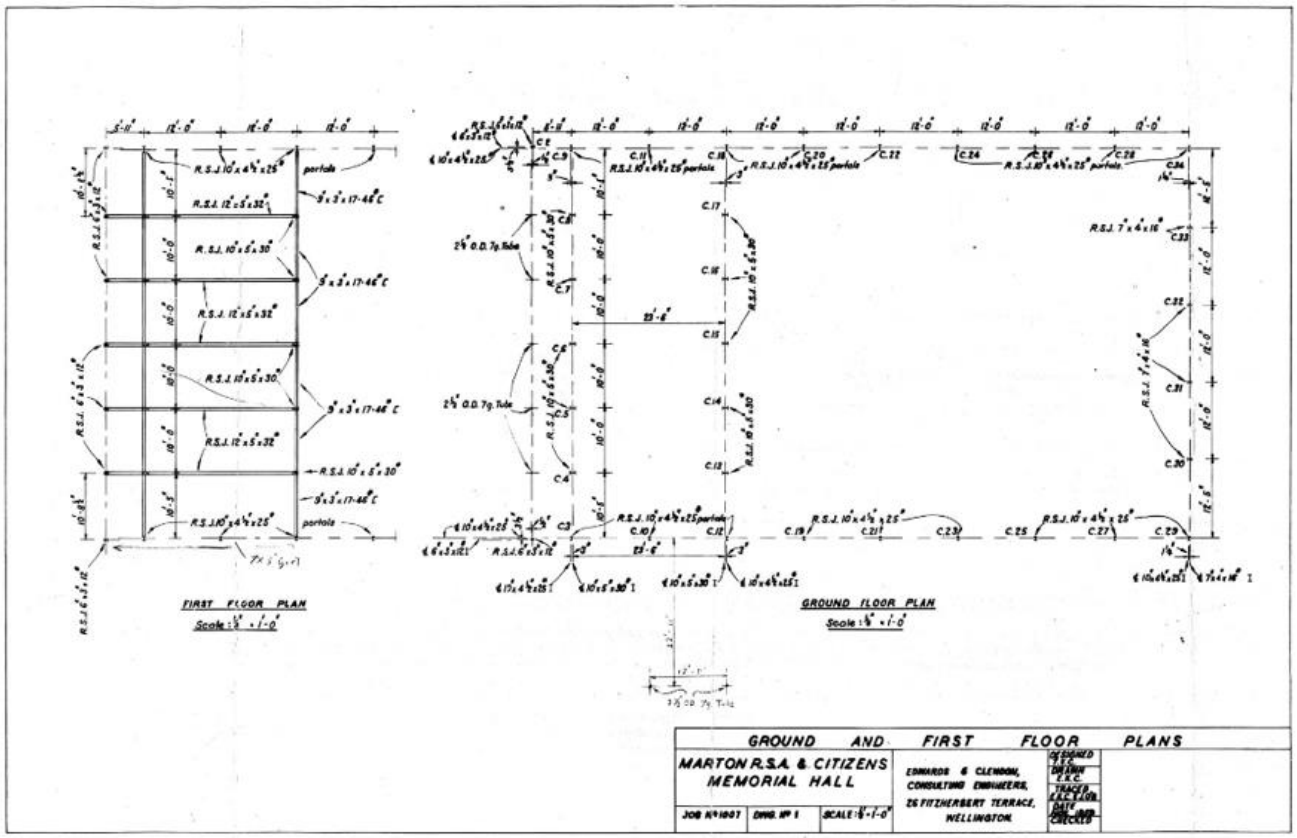
All portal frames are pinned at the foundation level onto isolated concrete pad (1959) or pile (1985) footings.

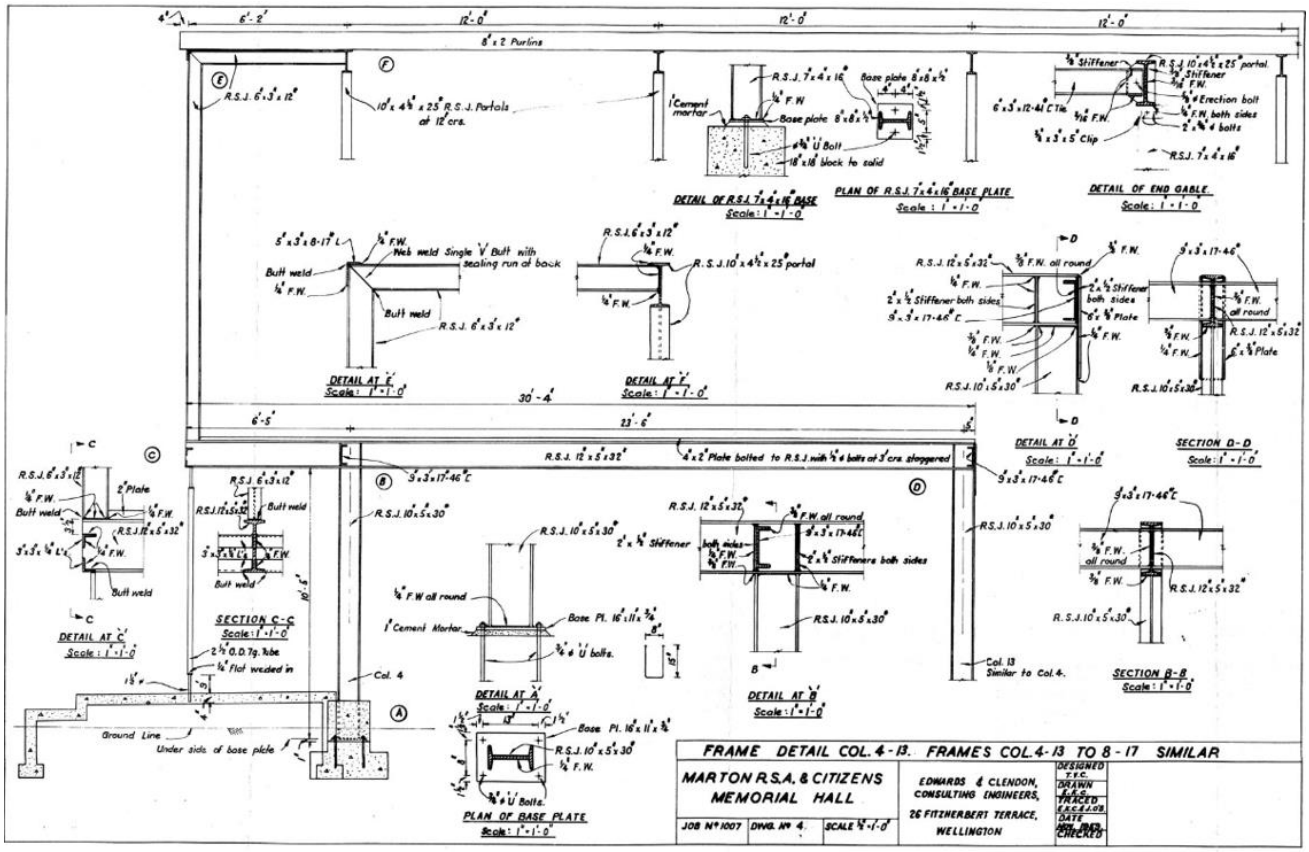
In the longitudinal direction the building has 2 pairs of cross braced bays.

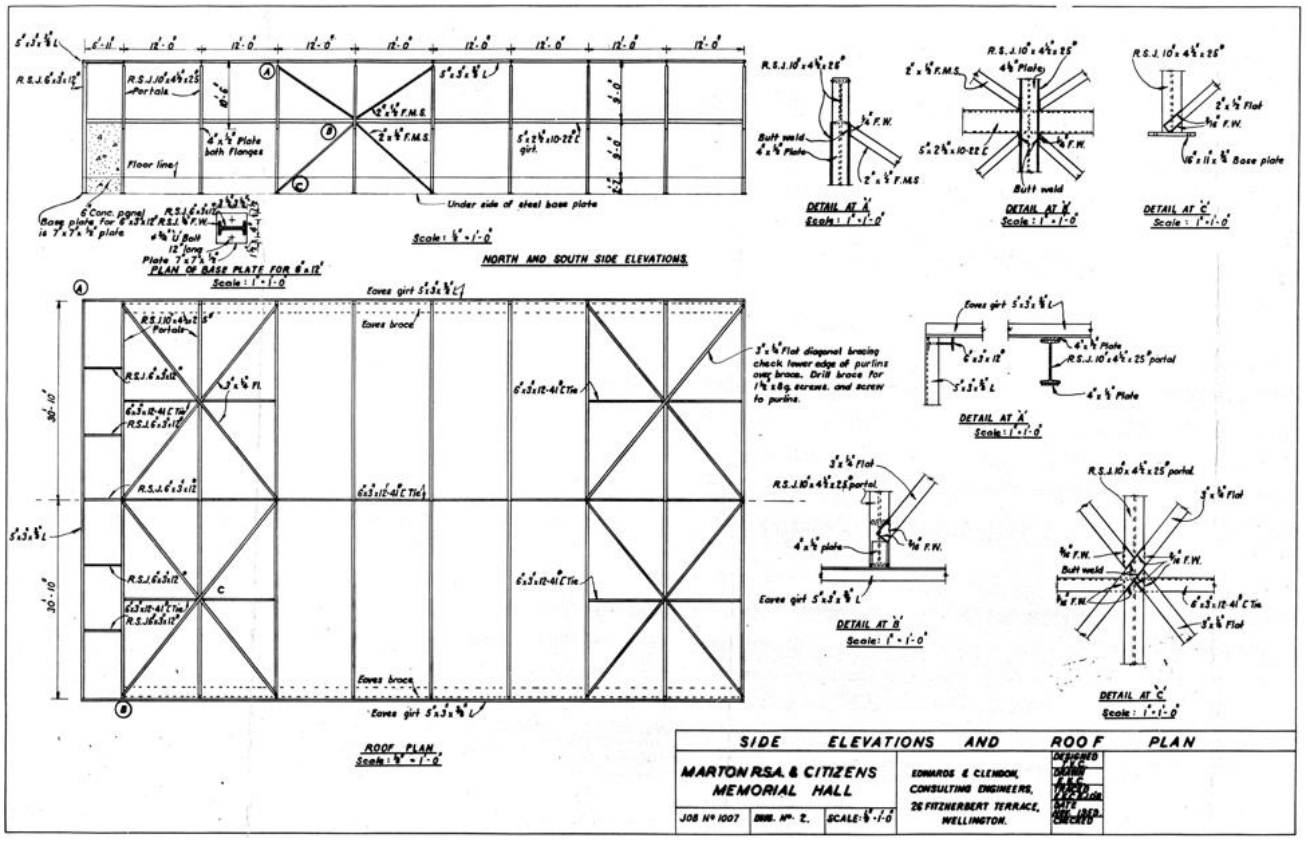
Roof bracing was constructed of 75x6 mild steel flat bar welded to the portal frames with 5mm fillet weld. Compression struts in the roof plane are 150PFC sections.

Wall bracing consists of 50x12 (1959) and 80x6 (1985) mild steel flat bar welded to the portal frames with 6mm fillet welds. Compression struts in the walls are 125PFC sections.

The mezzanine section is constructed of a timber floor diaphragm over 310UB47 steel sections in the longitudinal direction of the main building. In the transverse direction of the building, loads are resisted by the portal frames of the main structure.




FRAME DETAIL COL. 4-13. FRAMES COL. 4-13 TO 8-17 SIMILAR
MARTON R.S.A. & CITIZENS MEMORIAL HALL
EDWARDS & CLENDON, CONSULTING ENGINEERS, 26 FITZHERBERT TERRACE, WELLINGTON
JOB Nº 1007
DWG. Nº 4.
SCALE ½"-1'-0"
DESIGNED T.Y.C.
DRAWN A.A.
TRACED E.K.C.&J.H.B.
DATE
CHECKED


SIDE ELEVATIONS AND ROOF PLAN
MARTON R.S.A. & CITIZENS MEMORIAL HALL
EDWARDS & CLENDON, CONSULTING ENGINEERS, 26 FITZHERBERT TERRACE, WELLINGTON.
JOB Nº 1007
DWG. Nº 2.
SCALE: ½"-1'-0"
DESIGNED
DRAWN
TRACED
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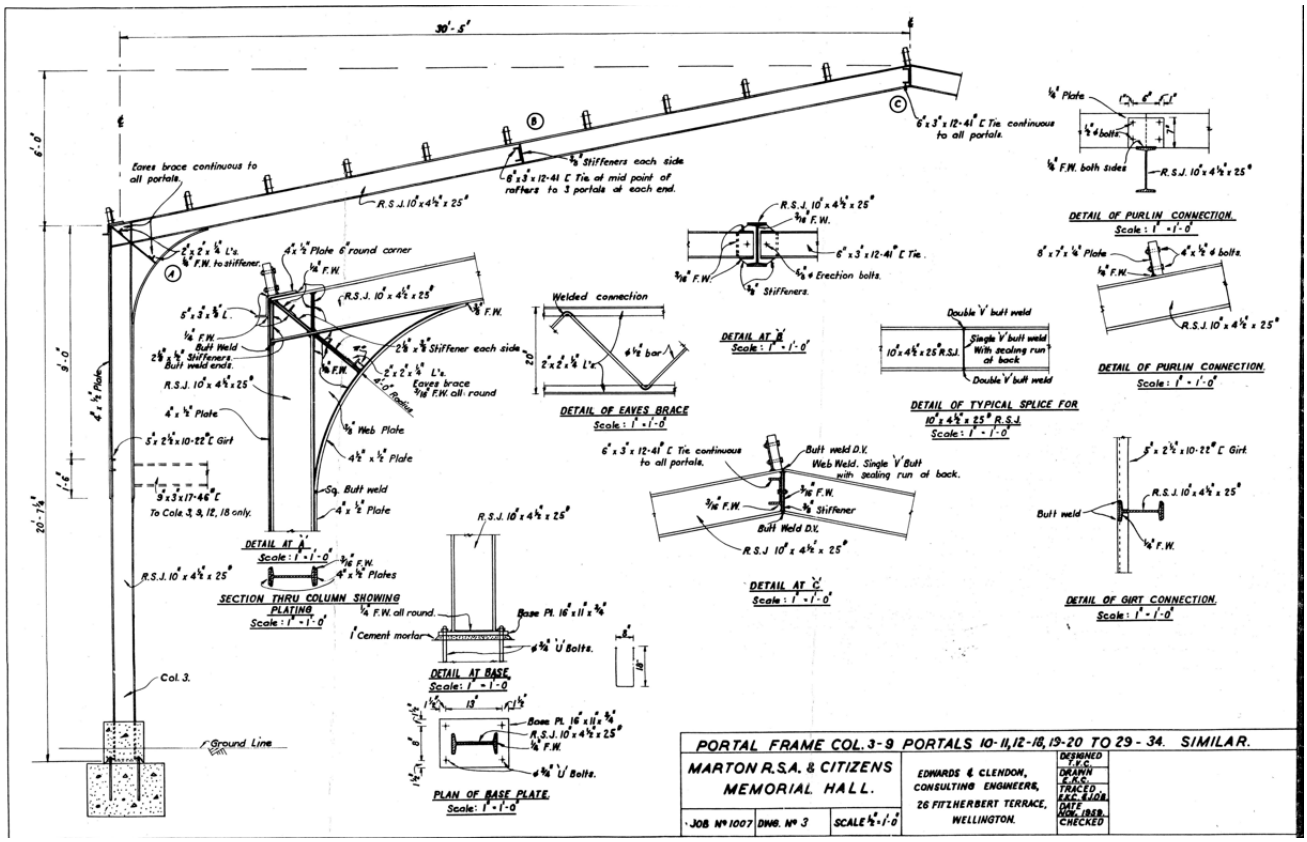
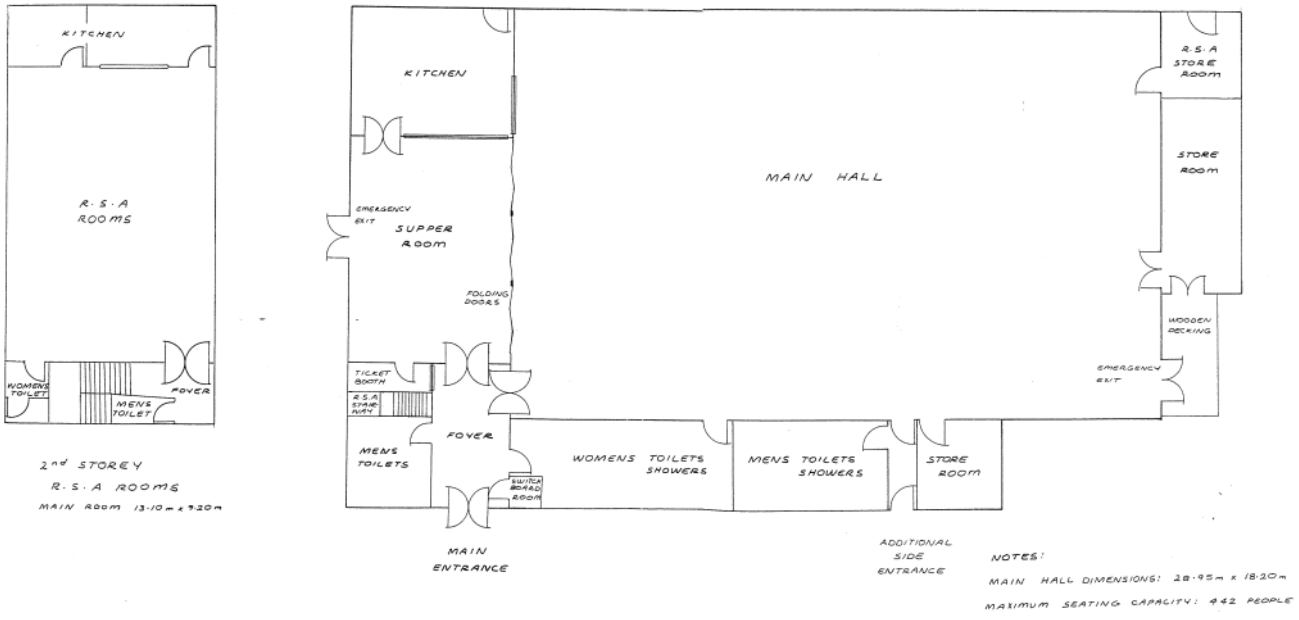



PLAN OF MEMORIAL
RSA HALL

S 27



# 4 ASSESSMENT INPUTS

## 4.1 MATERIAL PROPERTIES

| | |
|---|---|
| 1985 Structural steel probable strength | - 317MPa |
| 1959 Structural steel probable strength | - 260MPa |
| Structural welds probable strength | - 410MPa |
| Concrete probable strength | - 30MPa |
| Reinforcing probable strength | - 320MPa |

## 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 and maximum occupancy of the building means it is Importance Level 3 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-1000-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, $R_u$ | 1.3 | 1-in-1000 year ground shaking |
| Near fault factor, N(T,D) | 1.0 | No major fault lines in proximity |

## 4.3 ANALYSIS METHDOLOGY

The portal frames, cross bracing and mezzanine frames were analysed using SAP2000 to implement an equivalent static force-based approach to determine member forces.

All portal frames were considered to be pinned at the base, accounting for the 2-bolt baseplate connection that was utilised in the design.

When assessing the cross bracing, a compression limit was applied to ensure no compression load is resisted by the tension only elements and a non-linear analysis was undertaken.

Ultimate displacements from SAP2000 were scaled with a $k_\mu = 1$ to account for the design ductility of 1 and $k_{dm}$ of 1.2 in accordance with NZS1170.5:2004 to obtain ULS drift.

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 2 lists the %NBS rating for all structural elements assessed.

Table 2: Assessment results for individual components and/or systems.

| Structural Component/System | Seismic Score (%NBS – IL3) | Structural Weakness Type | Mode of Failure |
|---|---|---|---|
| 310UB Portal frames | 66% | | Side sway |
| 310UB Rafters | 90% | SW | Flexural capacity |
| 310UB Columns | 91% | SW | Flexural capacity |
| 250UB Portal frames | 41% | | Side sway |
| 250UB Rafters | 58% | SW | Flexural capacity |
| 25UB Columns | 58% | SW | Flexural capacity |
| Roof bracing | 95% | SW | Weld capacity |
| Wall bracing | 100% | | |
| Baseplates | 100% | | |
| Foundations | 52% | SW | Uplift resistance |
| Existing portal frames bracing mezzanine | 37% | | Side sway |
| Existing portal frames bracing mezzanine - Rafters | 41% | SW | Flexural capacity |
| Existing portal frames bracing mezzanine | 23% | | Inter-storey drift |
| Existing portal frames bracing mezzanine - Columns | 52% | SW | Flexural capacity |
| Mezzanine floor beams | 100% | | |
| Mezzanine columns | 100% | | |
| Ablutions building | 48% | SW | Wall bracing capacity |

## 5.2 COMMENTARY ON SEISMIC RISKS

The results of the DSA find the building's *Earthquake Rating* to be **41%*NBS* (IL3)**. Therefore, this is a **grade C building** following the NZSEE grading scheme.

NZSEE guidelines state the relative risk of a grade C building compared to that of a similar new building on the same site is **5-10 times**. This indicates a **medium life-safety risk exposure**.

The analysis shows that the building deflections under earthquake loads are larger than code limits. Deflections are not considered a structural weakness however large deflections will result in increased levels of damage to non-structural elements such as wall framing, ceilings, windows etc. As there are no adjacent buildings, there is no risk of damage from pounding.

The assessment shows that the performance of the main hall building is limited by the flexural capacity of the transverse portal frames and foundation uplift capacity of the pad foundations under the braced bays of the original building.

The performance of the ablutions building is limited by the bracing capacity of the gib lined walls. We have assumed a reduced capacity due to the age of the walls and unknown nailing and hold down details.

## 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 SEISMIC RETROFIT OPTIONS

Seismic retrofit options for the structural weaknesses identified in the report are described below.

To achieve a minimum of 67%NBS

- Upgrading all 250UB portal frames by adding fly braces to the rafters adjacent to the eave. Please note this will address the flexural performance but not the deflections.
- Install an additional bay of wall bracing or enlarge the foundations of the existing bracing bays.
- Replace the gib lining to the ablutions and storage facilities.

# 7 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 Memorial Hall ('Purpose') and in accordance with the Short Form Agreement with the client dated 13/09/2021 ('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 01/09/2021. 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 Memorial Hall |
| Street Address | 399 Wellington Road, Marton |
| Territorial Authority | Rangitikei District Council |
| No. of Storeys | 1 and a mezzanine |
| Area of Typical Floor (approx.) | ±600m$^2$ |
| Year of Design (approx.) | 1959 |
| NZ Standards designed to | NZS95:1955 |
| Structural System including Foundations | Portal frames on pinned foundations in the transverse direction with roof and wall bracing in the longitudinal direction |
| 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 | 2 bay extension in 1985 |
| Heritage Issues/ Status | None |
| Other Relevant Information | None |

| 2. Assessment Information | |
|---|---|
| Consulting Practice | WSP New Zealand Ltd. |
| CPEng Responsible, including:<br>• Name<br>• CPEng number<br>• A statement of suitable skills and experience in the seismic assessment of existing buildings[1] | David Dekker<br>Technical Principal – Earthquake Engineering and Building Structures<br>CPEng 1003026<br>David has 29 years' experience in the structural engineering design and seismic assessment of building structures. David has undertaken NZSEE and MBIE Training on both Initial and Detailed Seismic Assessment and well as the Earthquake Prone Buildings Methodology. |
| Documentation reviewed, including:<br>• date/ version of drawings/ calculations[2]<br>• previous seismic assessments | Ground and first floor plans (1959)<br>Frame detail col 4-13 frames col 4-13 to 4-17 similar (1959)<br>Side elevation and roof plan (1959)<br>Portal frame col 3-9 portals 10-11, 12-18, 19-20 to 29-34 similar (1959)<br>Plan of Memorial Hall (1985)<br>Marton Borough Council Additions to Community Hall Sheet 1 – 9 (1985) |
| Geotechnical Report(s) | None |
| Date(s) Building Inspected and extent of inspection | 28/09/2021 |
| Description of any structural testing undertaken and results summary | Scala penetrometer test indicate 300kPa ultimate capacity at 300mm below ground level. |
| Previous Assessment Reports | None |
| 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 | Structures where people may congregate with a capacity larger than 300. Importance level 3 |
| Site Subsoil Class | D |
| Summary of how Part C was applied, including:<br>• the analysis methodology(s) used from C2<br>• other sections of Part C applied | Equivalent static analysis carried out in line with C2.7.1<br>Reduction factors chosen in line with C2.5.1<br>Probable strengths of structural steel calculated in accordance with C6.5<br>Probable strengths of concrete calculated in accordance with C5.4 |
| Other Relevant Information | None |

| 4. Assessment Outcomes | |
|---|---|
| Assessment Status (Draft or Final) | Final |
| Assessed %*NBS* Rating | 41%NBS (IL3) |
| Seismic Grade and Relative Risk (from Table A3.1) | Grade C |
| Comment on the nature of Secondary Structural and Non-structural elements/ parts identified and assessed | None |
| Describe the Governing Critical Structural Weakness | Flexural capacity of portal frames |
| 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**<br><br>None |
| 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.