Executive Summary

The War Memorial Library, located at 2 Queens Drive, Lower Hutt, is a two-storey reinforced concrete moment frame structure with masonry infill panels. The building was originally designed and constructed circa 1953. The building is currently used as a library.

The building was recently upgraded and seismically strengthened in 2003 by [redacted]

The upgrading work included constructing a new entrance way, flight of stairs, and the reconfiguration of the mezzanine floor.

The seismic strengthening work included the installation of new reinforced concrete shear walls, timber shear walls, securing the brickwork panels (connecting the outer layer to the inner layer), and installing a roof diaphragm.

The gravity load resisting system of the War Memorial Library building is comprised of primary and secondary reinforced concrete beams and columns. The concrete columns transfer the loads from the concrete beams and floor slabs down to the foundation.

The lateral load resisting system of the War Memorial Library building is comprised of reinforced concrete shear walls located at the ground floor and at the mezzanine floor levels, and plywood shear walls located at the first floor level.

This building has been subjected to a Detailed Seismic Assessment (DSA), using the procedures recommended in the NZSEE Guidelines in particularly Section C5 [Concrete Buildings] and C7 [Moment Resisting Frame with Infill panels].

The limiting feature is the in-plane bending capacity of the reinforced concrete walls on the South end of the building. This detailed assessment found that the building's compliance to be in the order of 40%-45% of a New Building built to the current Standards (%NBS), based on a building importance level of 2 **(40%-45% NBS IL2)**.

The failure mode of the concrete shear walls is considered to be 'ductile', and not a quick sudden and brittle mode.

This results in the building being classified as 'Earthquake Risk' and corresponds to a 'Grade C' building as defined by the New Zealand Society for Earthquake Engineering (NZSEE) building grading scheme.

In summary, these structural vulnerabilities were found:

- The in-plane bending capacity of the concrete shear walls were found to be 40% NBS.
- The in-plane shear capacity of the concrete shear walls were found to be 54% NBS
- The presence of the infill brick panels at height represents a life safety hazard, as the connection around the panels are not designed based on the current design standard so may become distorted and fall from height onto the occupants. The out-of-plane [face-load] bending capacity of the infill brick panels were found to be 44% NBS
- The roof above the new South entrance is comprised of 'hollowcore' precast floor units. As highlighted in recent events, there is a potential for these precast units to lose their seatings and collapse during strong earthquake accelerations. These were found to have limited seating only and would require to be increased.

Strengthening options for the building have been identified. However a more detailed design will need to be undertaken in order to be able to submit to the Council for Building Consent. To strengthen the building to 80% NBS, the options will include, but are not limited to:

- Replacing the infill brick wall next to the Southern entrance with a new reinforced concrete shear wall.

- Replacing the infill brick wall at the South-East corner of the building with a new reinforced concrete shear wall or infill the window openings with reinforced blockwork, and apply a layer of 'shotcrete' to the existing brick panel.
- Replacing the infill brick panels at the First floor and the mezzanine floor levels with reinforced concrete infill panels (connected to the concrete frames).
- Provide additional seatings [by installing a steel angle bracket] to increase the available seating for the precast floor units to be supported on.

Refer to the drawings in Section 5 of the report for the indicative location of the proposed strengthening options,

Generally, as the preferred performance increases above 80% NBS, so does the number of items requiring strengthening. The preferred level of strengthening should be chosen before a detailed strengthening concept can be prepared.

This report is subjected to, and must be read in conjunction with, the limitations set out in Section 7 and the assumptions and qualifications contained throughout the report.

It is our recommendation that the following items are carried out:

- A detailed Geotechnical investigation of the underlying soil at the site.
- A detailed seismic assessment of the adjacent theatre building.

Note: There have been no detailed geotechnical soil investigation nor soil liquefaction study carried out at the site of the War Memorial Library to obtain the true soil parameters and properties to support the seismic assessment.

This was specifically omitted at the request of our client. The resultant seismic rating for the building in this assessment with only the assumed desktop derived soil parameters may differ significantly from a further assessment with actual site specific soil parameters.

This means that upon full consideration of the ground conditions once a detailed geotechnical soil investigation has been carried out, the seismic rating of the building could potentially be lower than the score being reported in this assessment.

Table of Contents

Appendices

1. Introduction

1.1 Introduction

This report provides the results of a Detailed Seismic Assessment (DSA) completed for the War Memorial Library, located at 2 Queens Drive Lower Hutt, on behalf of the Hutt City Council. This report provides an assessment of the building's seismic capacity and highlights the key risks.

Specifically, this report:

- Provides an assessment of the building's capacity in terms of a percentage of New Building Standard (%NBS) as defined in New Zealand loading standard NZS 1170.5:2004
- Reports any specifically identified Critical Structural Weaknesses (CSW) or life safety hazards associated with the building and presents recommendations for seismic improvements (if required)

1.2 [redacted] Scope of Work

Based on our understanding above we anticipate the following scope of works:

Part 1A – Seismic Assessment

- Site inspection to confirm / validate actual site conditions, as well as a rudimentary site measure;
- Preparing a 3D computer model of the building and preparing structural calculations sufficient to determine the current %NBS rating.
- Identify any Critical Structural Weaknesses (CSWs) that the building may have.
- Prepare a Detailed Seismic Assessment (DSA) report in accordance with the current NZSEE guidelines,
- Identifying any specific risks as well as our comments and findings; and
- Provision of a building rating in accordance with the NZSEE rating system.

Part 1B – Strengthening Concepts (where required only)

- Strengthening options with discussion of advantages and disadvantages as well as our recommendations of preferred solutions; and
- Rudimentary general arrangement drawings of strengthening concepts as detailed in Section 5 of the report.
- Deliverables for Stage 1 will take the form of a concise written report, calculations and engineering sketches of any proposed strengthening concepts and a cost estimate of strengthening concepts.

Exclusions:

- Detailed Geotechnical investigation and study
- Seismic assessment of the adjacent theatre building.

1.3 Assessment Process

The War Memorial Library building was recently upgraded and seismically strengthened in 2003 by [redacted]

The seismic strengthening work included the installation of new reinforced concrete shear walls, timber shear walls, securing the brickwork panels (connecting the outer layer to the inner layer), and installing a roof diaphragm to meet the code-requirements of the day.

The War Memorial Library has been subject to an Initial Seismic Assessment (ISA) in 2018. This was carried out by [redacted] and identified the building as having a potential compliance in the order of 35-45% NBS IL2.

The present assessment for this structure has involved the following:

- Review of the pertinent drawings and specifications information as well as assessing the building based on the site inspections, measurements and photographs taken.

  The drawings reviewed included:

  - The original Architectural and Structural drawings of the building prepared by Structon Group numbered C/N1118 and dated February 1952.
  - The seismic strengthening drawings of the building prepared by [redacted] numbered 6223/5 and dated July 2003.
- Visual inspection of the building to confirm its general conformance with available design documentation
- Undertaking detailed analysis to determine the seismic strength of the building in accordance with current New Zealand Design and material standards to estimate the building's compliance with current building code requirements
- Where elements of the building have been identified as not meeting acceptable levels of seismic strength, recommendations for structural improvements are made

2. Building Description

A visual inspection of War Memorial Library was carried out in May 2018. A review of the original construction drawings has indicated that the building was constructed circa 1952 and was upgraded and strengthened in 2003. The following paragraphs provide detail descriptions of the building. A summary table of the building description can be found in Appendix B.

2.1 Description of Building

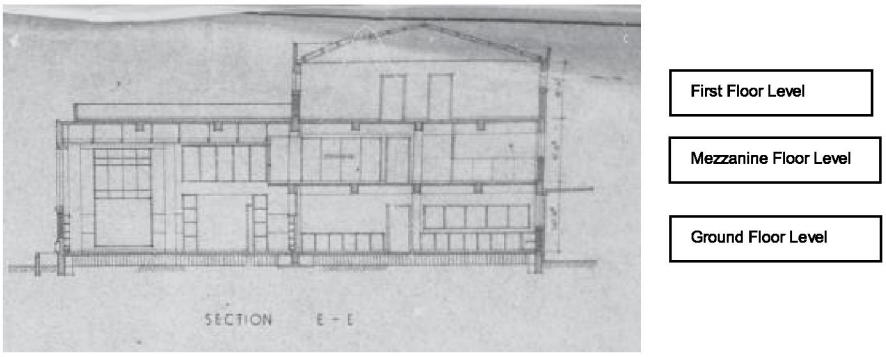


Figure.1: Typical cross section through the War Memorial Library building showing the extent of the mezzanine floor, and the first floor level. [Note the First Floor is directly above the mezzanine floor]

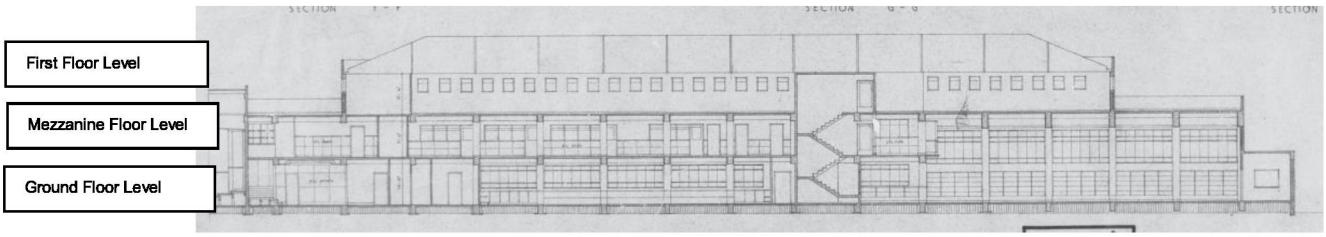


Figure.2: Typical long section through the War Memorial Library building showing the extent of the mezzanine floor, and the first floor level.

The War Memorial Library is a two-storey reinforced concrete moment frame structure with masonry infill panels.

The mezzanine floor and the first floor level are only partially occupying the full building footprint.

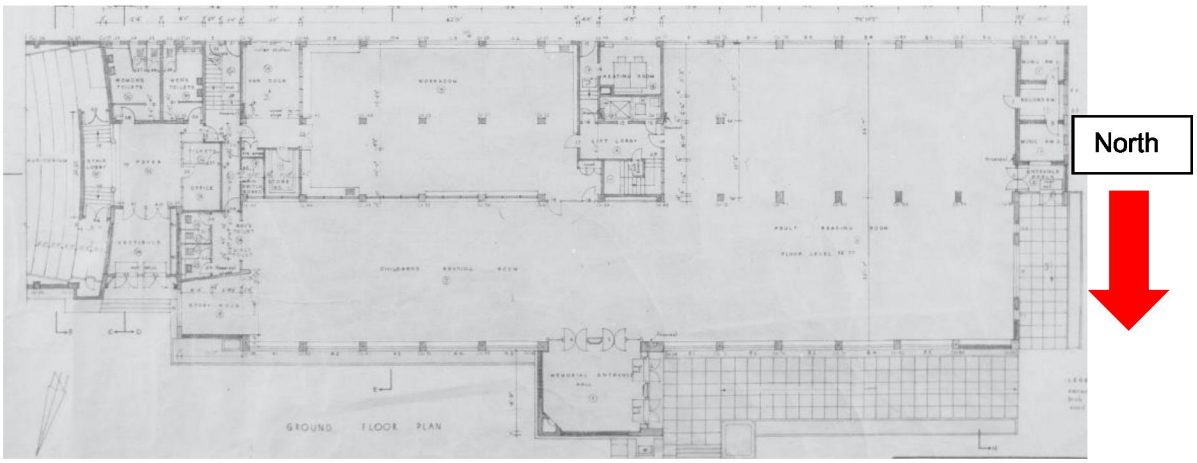


Figure.3: Plan view of the Ground Floor of the War Memorial Library building.

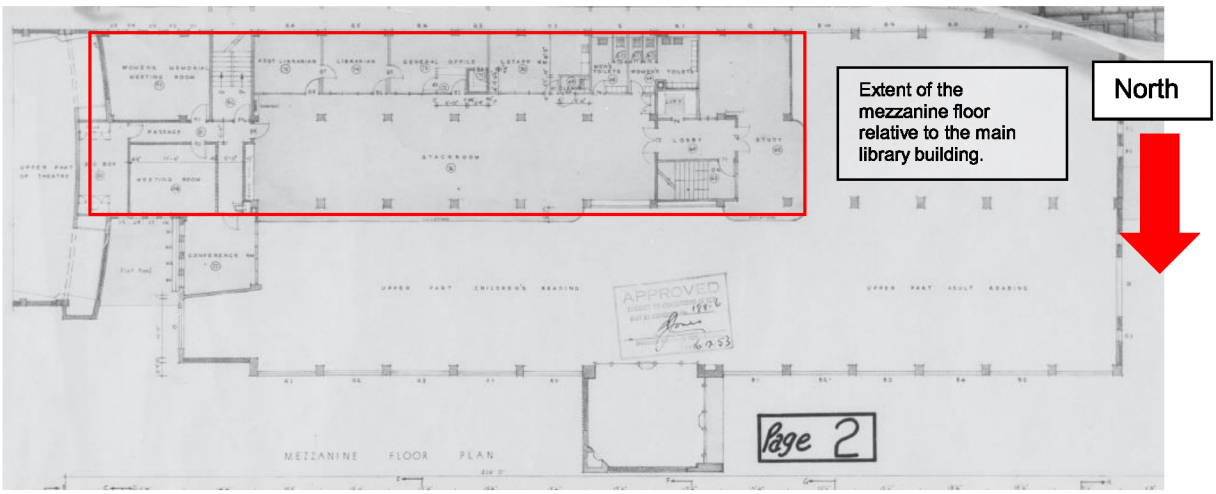


Figure.4: Plan view of the Mezzanine Floor of the War Memorial Library building.

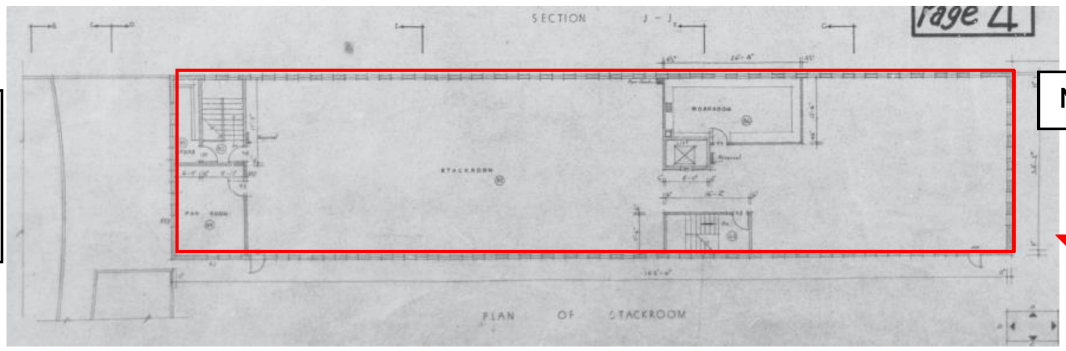


Figure.5: Plan view of the First Floor of the War Memorial Library building.

The construction of the mezzanine floor and the first floor are comprised of 'in-situ' concrete slabs (4" thick) supported on a system of primary and secondary concrete beams.

The roof structure to the first floor level is comprised of light-weight steel trusses (Equal Angle sections) with timber purlins and corrugated fibre cement sheet cladding.

The wall cladding of the building is comprised of a combination of double-skin brick panels and reinforced concrete panels.

The building foundation is comprised of a system of concrete ground beams supported on deep concrete piles.

The War Memorial Library building is located beside the Little Theatre. Based on the available drawings, it has been observed that there is no physical connection between the War Memorial Library and the Little Theatre. Refer to Figures 6 and 7 below.

The War Memorial Library building has been assumed to be structurally independent from the Little Theatre in the assessment (ie: there is no load sharing transfer between the two buildings).

Note: The seismic capacity of the Little Theatre is excluded from the scope of this assessment. It is highly recommended that a separate assessment is carried out for this building in the near future.

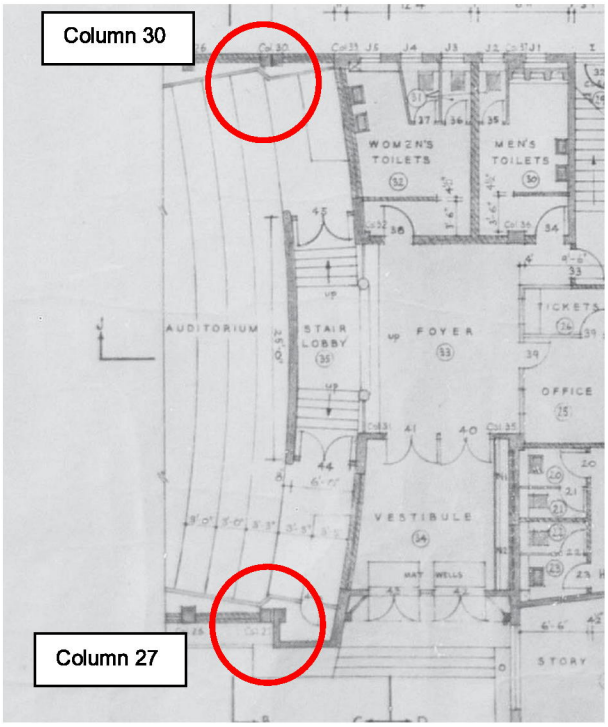


Figure.6: Plan view of the Ground Floor at the interface of the Little Theatre and the War Memorial Library building.

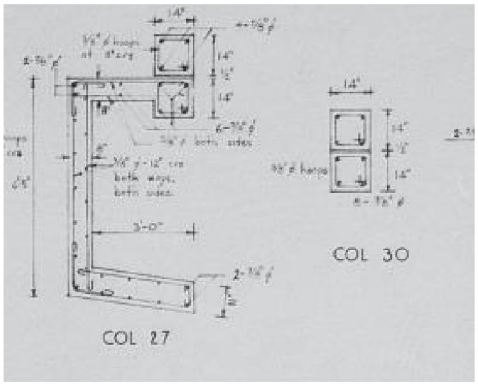


Figure.7: Close up view of columns 27 and 30 at the interface of the Little Theatre and the War Memorial Library building showing no connections between the two structures.

The War Memorial Library was recently upgraded in 2003. The work carried out during the upgrade included the following:

- Constructing a new entrance and masonry blockwork stairwell on the South side of the building.

  Note: The roof slab of the stairwell is comprised of 200 series Hollowcore units. These units are support on 50mm wide low friction bearing strips with 85mm seatings. Each unit also have 2 flues filled with reinforcing bars and concrete connected back to the bond beam above the blockwork walls.

- Installing a new flight of structural steel stairs to the mezzanine floor,
- Extending the mezzanine floor slab to increase the width of the stair landing on the mezzanine floor.
- Infilling the mezzanine floor slab over the old stairwell and lift shaft.

Part of the upgrading work included the seismic strengthening of the building. The strengthening work included the following:

- Constructing new 250mm thick reinforced concrete shear walls along the North and South ends of the building (spanning up to the underside of the first floor level),
- Constructing new 250mm thick reinforced concrete shear walls at the centre and at the East end of the mezzanine floor (The centre wall spans up to the underside of the mezzanine floor while the East end wall spans up to the underside of the first floor level).
- Infilling window and door openings at the East end of the building with reinforced blockwork, and applying a layer of 'shotcrete' to part of this wall. (concrete skin).
- Installing 'HeliFix' dry pin anchors to connect the two brick layers of all the double brick walls (including spandrels) throughout the building.
- Installing a 17mm plywood diaphragm at the ceiling level of the first floor (note: The roof over the first floor level is of light-weight steel trusses construction with timber purlins).
- Constructing new timber plywood shear walls on the first floor level.

Based on the Subsoil map of Lower Hutt City, the subsoil classification of the War Memorial Library building site is considered to be Class D in accordance with NZS1170.5:2004.

Based on the GWRC Hazard map, it has been identified that the underlying soil beneath the War Memorial Library building site has the potential to liquefy during an earthquake due to its close proximity to the Hutt River.

2.2 Gravity Load Resisting System

The gravity load resisting system of the War Memorial Library building is comprised of a system of primary and secondary reinforced concrete beams and columns. The concrete columns transfer the loads from the concrete beams and floor slabs down to the foundation.

2.3 Lateral Load Resisting System

The lateral load resisting system of the War Memorial Library building is comprised of a system of reinforced concrete shear walls located at the ground floor and at the mezzanine floor levels, and plywood shear walls located at the first floor level. These walls were installed as part of the 2003 upgrading and strengthening work to the building.

When the structure is subjected to seismic loadings, the inertia loads from the roof, floors, and walls are transferred through the shear walls down to the foundation through shear wall actions. The location of the shear walls are shown in Figure 8, Figure 9, and Figure 10 below.

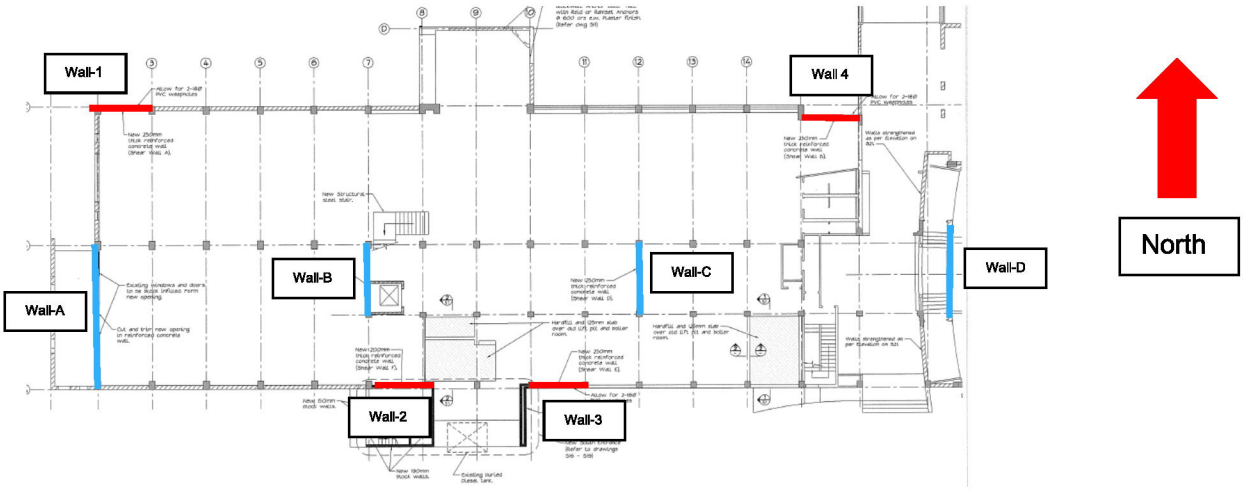


Figure.8: Locations of the existing reinforced concrete shear walls on the Ground floor

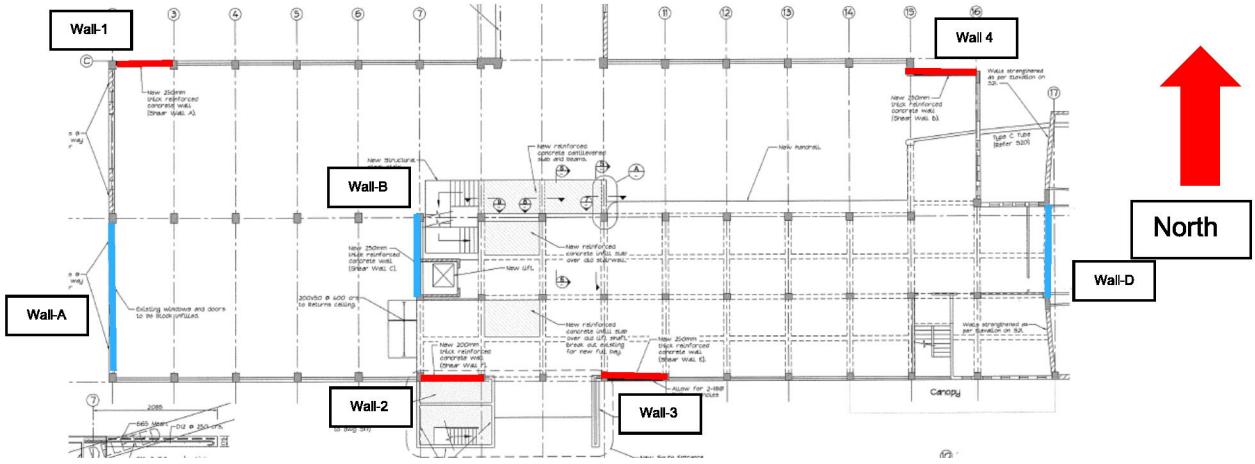


Figure.9: Locations of the existing reinforced concrete shear walls on the mezzanine floor.

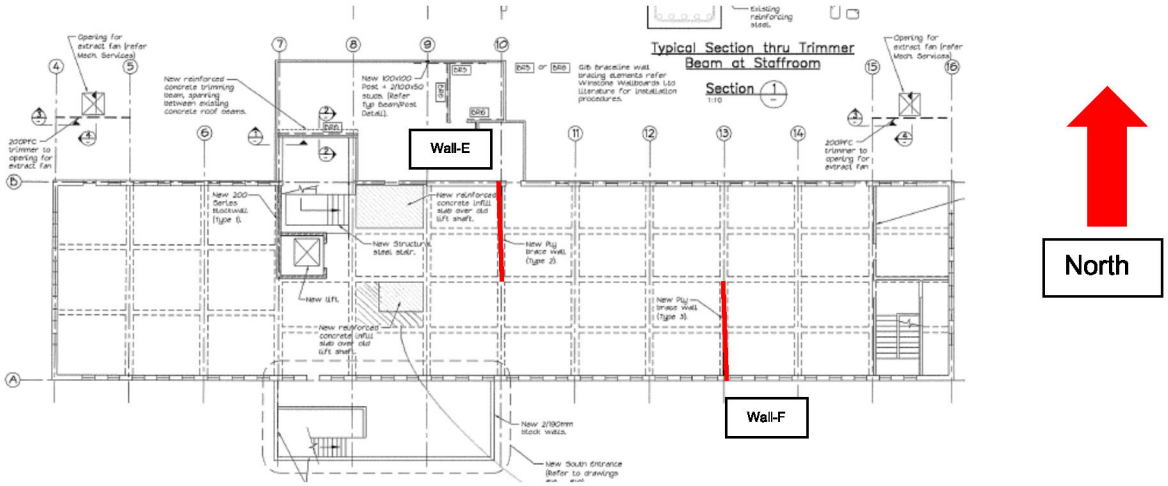


Figure.10: Locations of the existing plywood shear walls on the first floor

3. Seismic Assessment of the Building

Analysis Methodology

The original construction drawings has indicated that the War Memorial Library building was designed and constructed in 1952.

It is likely that the design of the building only considered a modest magnitude of seismic loadings in comparison to what would be required in the current loading standards NZS 1170.5:2004.

The building's seismic capacity has been assessed in accordance with the NZSEE Guidelines, measured as a percentage of New Building Standard (%NBS), the standard to which a new building must perform in terms of current design codes and standards.

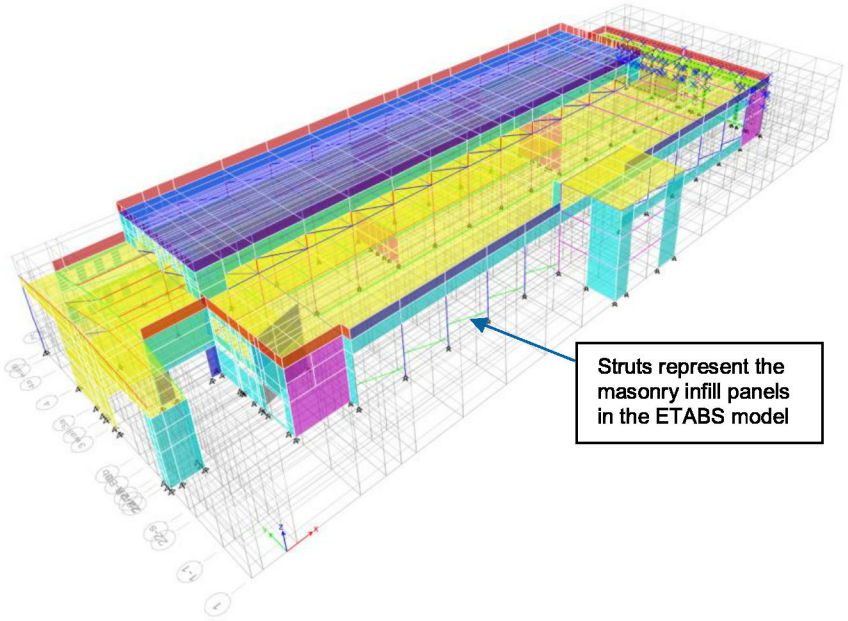


Figure.11: 3D View of the ETABS model of the War Memorial Library.

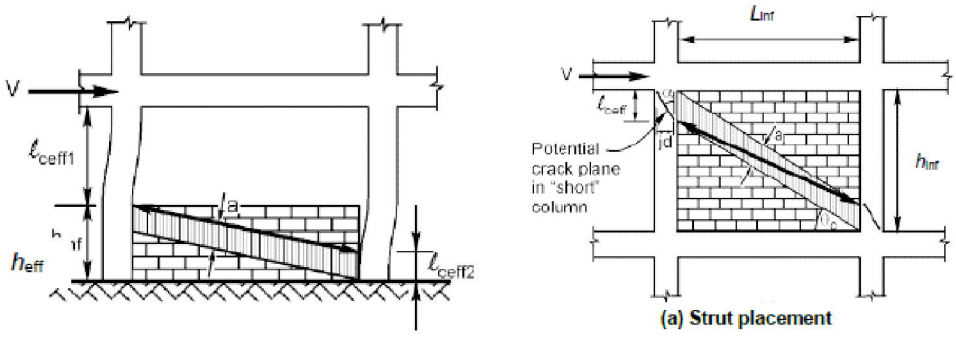


Figure.12: The solid masonry infill panels in the building have been modelled as an equivalent diagonal compression strut as recommended in Section C7.7.1 of the NZSEE guidelines.

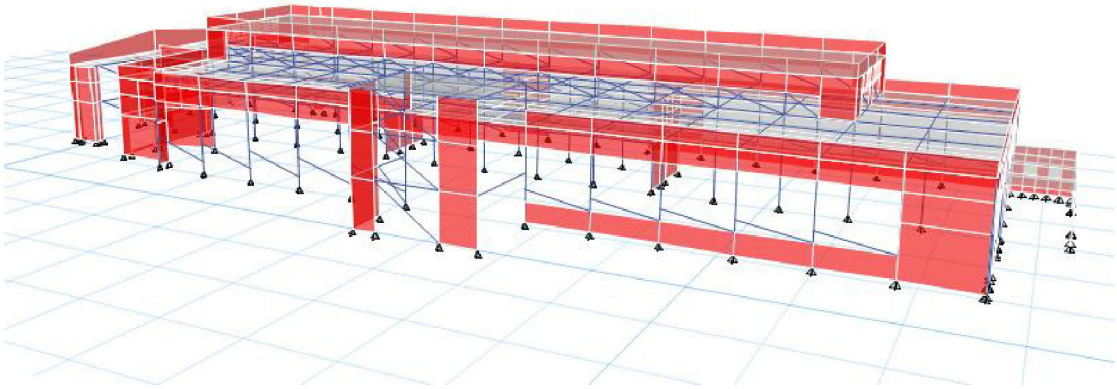


Figure.13: 3D View of the ETABS model of the War Memorial Library showing the concrete wall elements, frame elements, and diagonal struts [which represent the masonry infill panels].

Note: There have been no detailed geotechnical soil investigation nor soil liquefaction study carried out at the site of the War Memorial Library to obtain the true soil parameters and properties to support the seismic assessment.

This was specifically omitted at the request of our client. The resultant seismic rating for the building in this assessment with only the assumed desktop derived soil parameters may differ significantly from a further assessment with actual site specific soil parameters.

This means that upon full consideration of the ground conditions once a detailed geotechnical soil investigation has been carried out, the seismic rating of the building could potentially be lower than the score being reported in this assessment.

Prior to carrying out the detailed seismic assessment of the War Memorial Library building, a damage assessment of the existing building was undertaken to observe the overall condition and any damage sustained that may reduce the strength capacity of the building during an event.

The damage assessment consisted of a visual observation of the exterior and the interior of the building. The damage recorded is limited to what was visible. No intrusive investigation or material testing was undertaken.

3.1 Assessment Criteria and Building Properties Assumptions

3.1.1 Seismic Assessment Parameters

Seismic, permanent and live loads were applied based on criteria specified by the New Zealand Standards (NZS1170.5:2004 and AS/NZS1170.1:2002).

The seismic design parameters used to estimate the building seismic demand are described in the following table. The values of the live loads considered at both the first floor and mezzanine floor were 4kpa.

Table 1 Seismic parameters

Seismic Parameter	Value
Importance Level	2
Site Subsoil Classification*	D
Hazard factor, Z (Lower Hutt)	0.4
Annual Probability of Exceedance	1/500 (ULS)
Return Period Factor, Ru	1.0
Ductility Factors (governed by the infill masonry panels)	1.25
Structural Performance factor S_p	0.9

*Site subsoil classification is based on Subsoil map of Hutt City.

3.1.2 Material Properties

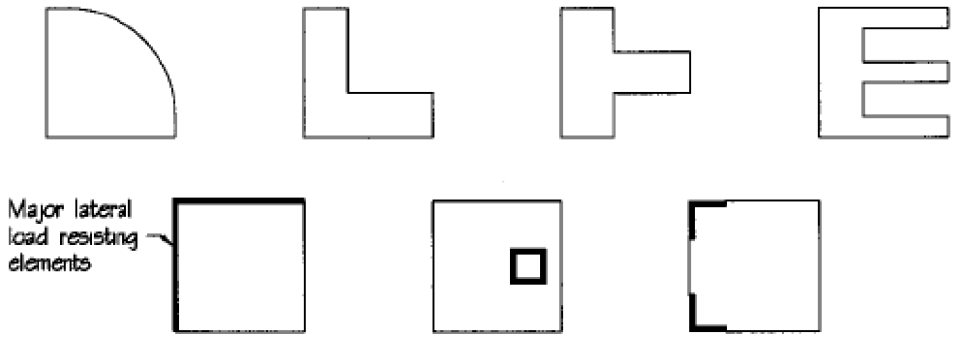
Material properties were assigned based on criteria defined by the NZSEE C05 Concrete Buildings and NZSEE C07 Moment Resisting Frames with Infill Panels publication recommendations for the reinforced concrete and steel properties, and has been adopted for this seismic assessment.

- Unit weight of concrete $\gamma = 24$ kN/m^3
- Unit weight of masonry $\gamma = 18$ kN/m^3
- Yield strength of reinforcing bars in concrete shear walls (installed in 2003) $f_y = 500$ MPa
- Yield strength of reinforcing bars in concrete columns (1.08fy) $f_y = 324$ MPa
- Yield strength of reinforcing bars in concrete beams (1.08fy) $f_y = 324$ MPa
- Compressive strength of concrete $f'_c = 30$ MPa
- Compressive strength of brick $f'_m = 12$ MPa
- Strength reduction factor of concrete in shear $\phi=0.85$
- Strength reduction factor of reinforced concrete in Flexure $\phi=1.0$

4. Structural Assessment

4.1 Structural Vulnerabilities

4.1.1 Plan Irregularity



a) Examples of Plan Irregularity

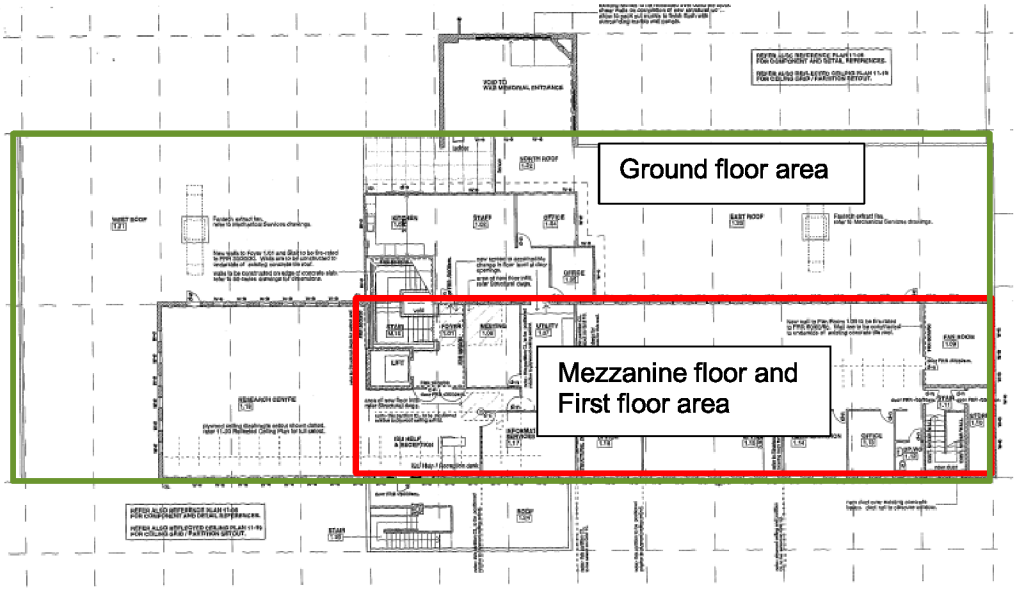


Figure.14: Floor plan showing the extent of the mezzanine Floor relative to the Ground Floor.

The regularity of a building footprint and shape affects the way that a building can respond to lateral loading. Irregularity in the building shape can mean that the lateral loads are applied in an uneven distribution across the floor, resulting in higher concentration of loads and irregular building responses.

Refer to Figure 14 above, the mezzanine and the first floors are occupying a small and eccentric portion of the total floor footprint. Therefore, the area differs from the area of ground floor, and so does the storey mass. When the building is subjected to the lateral load, differing floor areas alter the loading distribution across the floor, which could induce irregular performance of the building.

4.1.2 Reinforced concrete shear walls

The reinforced concrete walls were constructed in 2003 to strengthen the building. The lateral loads are transferred to the reinforced concrete wall through the concrete slab-to-wall connection. The in-plane walls resist these lateral loads and self-weight through the shear wall action (bending of

the walls). The in-plane shear and flexural capacity of the walls have been assessed to make sure that the force can be transferred to the ground.

The failure mode of the concrete shear walls is considered to be 'ductile', and not a quick sudden and brittle mode.

4.1.3 Masonry in-fill panels

The reinforced concrete frames with masonry infill panels are along the building length transverse to the street frontage with few openings. When the building is subject to the lateral load, the reinforced concrete frames deform and bend. A diagonal compression strut develops on the diagonal in between the beams and columns. The compression capacities of the in-fill panels have been assessed as part of this report.

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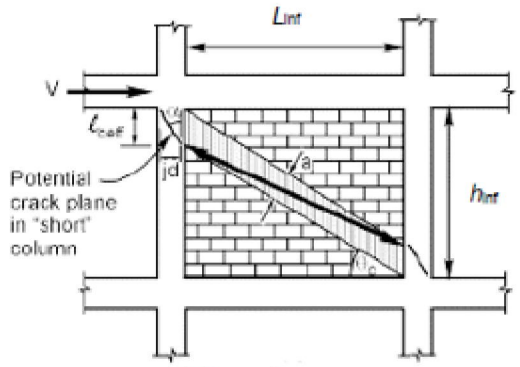


(a) Strut placement

In addition, the presence of the infill brick panels at height represents a life safety hazard, as the connection around the panels are not designed based on the current design standard so may become distorted and fall from height onto the occupants.

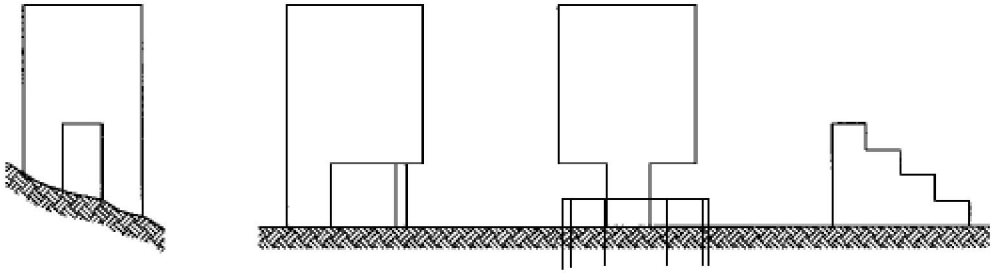
An out-of-plane capacity assessment of the infill brick panels at height have been carried out as part of this report.

4.1.4 Reinforced concrete columns

The concrete shear walls and the brick panels are connected to the reinforced concrete columns. The seismic loads are transferred from the shear walls and brick panels to the columns. An assessment of flexural capacities in the reinforced concrete columns have been carried out as part of this report.

The concrete columns on their own would fail in a brittle failure mode, however when responding in combination with the concrete shear walls, the columns and walls would fail in a ductile failure mode.

4.1.5 Vertical Irregularity



b) Examples of Vertical Irregularity

The vertical regularity of a building affects the way that lateral loads are distributed up the height of the building. Irregularity in the building height can mean that some levels are more flexible or attract disproportionately higher lateral loads.

Heights of the storeys are different. The ground floor has a double height area, as shown in Figure 15 below. When the building is subjected to the lateral load, differing floor heights alter the loading distribution over the height of the building, which could induce torsional moment in the building.

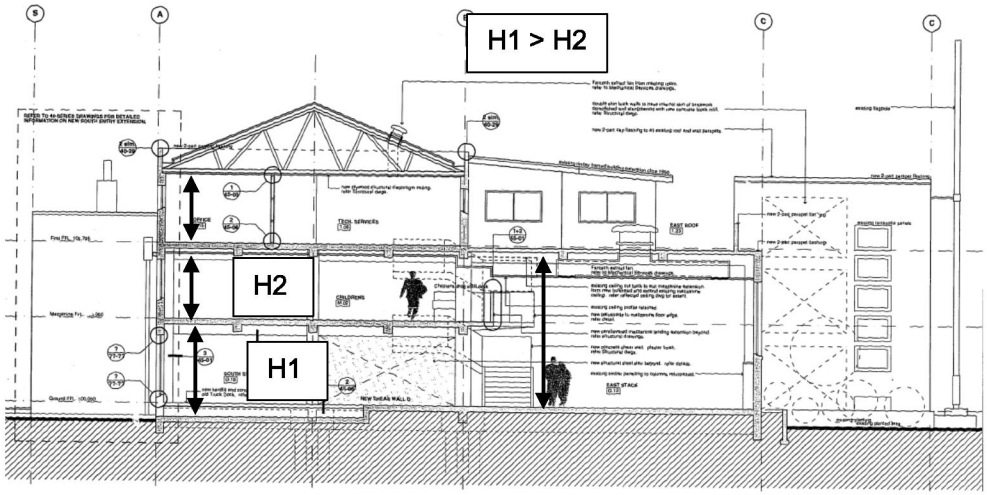


Figure.15: Cross section through the building showing the different storey heights.

4.2 Seismic Capacity Assessment

The following table summarises the calculated %NBS capacity for the various seismic resisting elements in the building based on the detailed seismic analysis.

Structural Element	Longitudinal Direction	Transverse Direction
RC columns	100% NBS	100% NBS
RC beams	100% NBS	100% NBS
RC walls	**44% NBS (Flexural)** 54% NBS (Shear)	**46% NBS (Flexural)** 68% NBS (Shear)
RC wall/column connection (starter bars)	100% NBS	100% NBS
RC wall/foundation connection (starter bars)	100% NBS	100% NBS
Infill brick panels	100% NBS (In-plane) **44% NBS (Out-of-plane)**	100% NBS (In-plane) **44% NBS (Out-of-plane)**
First floor level concrete diaphragm	100% NBS	100% NBS
Mezzanine floor level concrete diaphragm	100% NBS	100% NBS
Roof diaphragm	100% NBS	100% NBS
First floor diaphragm/wall connection	100% NBS	100% NBS
Mezzanine floor diaphragm/wall connection	100% NBS	100% NBS
Roof diaphragm/wall connection	100% NBS	100% NBS
Foundations	100% NBS	100% NBS
Building score	44% NBS	46% NBS

The assessment confirms that the War Memorial Library building achieves an overall calculated seismic capacity of **40%-45% NBS** (IL2). This score was governed by the failure of the in-plane flexural capacity of the reinforced concrete wall and out-of-plane capacity of the infill brick panel.

A score of 40% - 45% NBS IL2 corresponds to a "Grade C" building as defined by the New Zealand Society for Earthquake Engineering (NZSEE) building grading scheme, as per the following table:

% of NBS	Letter Grade	Classification	Approx. Relative Risk
> 100	A+		< 1 times
80 – 100	A		1 – 2 times
67 – 80	B		2 – 5 times
33 – 67	**C**	**Earthquake Risk**	**5 – 10 times**
20 – 33	D	Earthquake Prone	10 – 25 times
< 20	E	Earthquake Prone	> 25 times

5. Seismic Improvements

5.1 Suggested Improvements

The building has a calculated seismic rating of **40%-45% NBS** (IL2), which corresponds to a "Grade C" building as defined by the New Zealand Society for Earthquake Engineering (NZSEE) building grading scheme (hence is defined as a medium Earthquake Risk Building ERB). Suggestions to strengthen the structure to a target level of 80% NBS are presented below. Conceptual strengthening options are presented and a more detailed design and documentation will need to be undertaken to further develop the suggested seismic improvements.

5.2 Strengthening Scheme

5.2.1 Strengthening to Reinforced concrete Walls – Target 80% NBS Strengthening

The calculated %NBS shows that the reinforced concrete shear walls located in both the longitudinal and the transverse directions are the governing features. The lateral load resisting capacity is limited by the number of the reinforced concrete shear walls.

The response of the walls can be improved by installing additional concrete shear walls

Increasing the number of reinforced concrete shear walls can be an option to increase the building's lateral load resisting capacity.

One suggested option to increase the lateral load resisting capacity of the building in both directions is to replace the in-fill brick panels with reinforced concrete shear walls at the East side and South side as shown below.

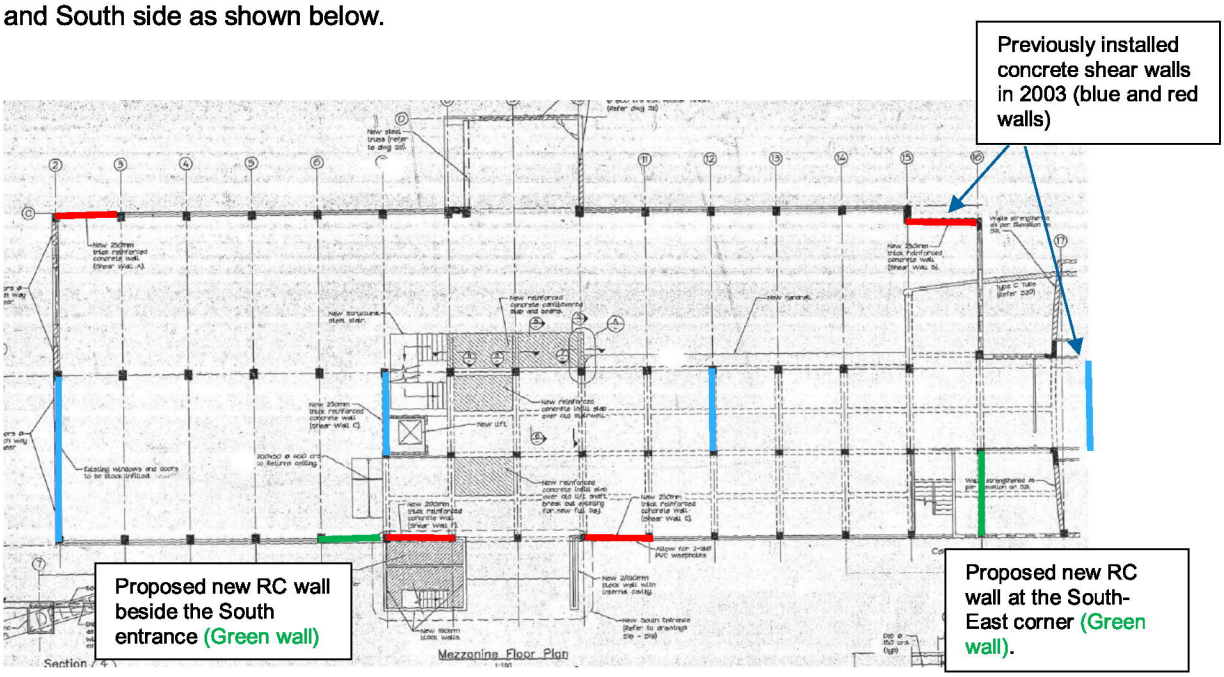


Figure. 16: Strengthening to lateral load resisting system in both directions by replacing the in-fill brick panels with RC shear walls

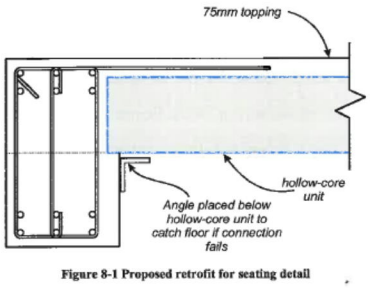


Figure. 17: Proposed additional steel angle bracket to be installed underneath the Hollowcore floor units above the South entrance way.

5.2.2 Providing additional seating to the Hollowcore floor units above the South entrance.

It is recommended to provide additional seatings [by installing a steel angle bracket] as shown above in Figure 17 to increase the available seating for the precast floor units to be supported on, and also to catch the units in the event that the connection fails.

5.2.3 Strengthening of brick in-fill wall in Transverse (N-S) Direction – Target 80% Strengthening

Another option to increase the lateral load resisting capacity in the transverse direction is to strengthen the existing infill brick panel, which is located at the South-East end of the building. We suggest to infill windows at the east end of the building with reinforced blockwork, and apply a layer of 'shotcrete' to the existing brick panel. The advantage of this strengthening option is that it is simple to construct, and would make the East end robust compared to the original design.

5.2.4 Strengthening of out-of-plane capacity of Infill Brick Panel – Target 80% Strengthening

Our assessment has found that the out-of-plane moment demand expected in the infill brick panels is likely to exceed the capacity. This issue may be effectively addressed by replacing the infill brick panels at the First floor and the mezzanine floor levels with reinforced concrete in fill panels (connected to the concrete frames).

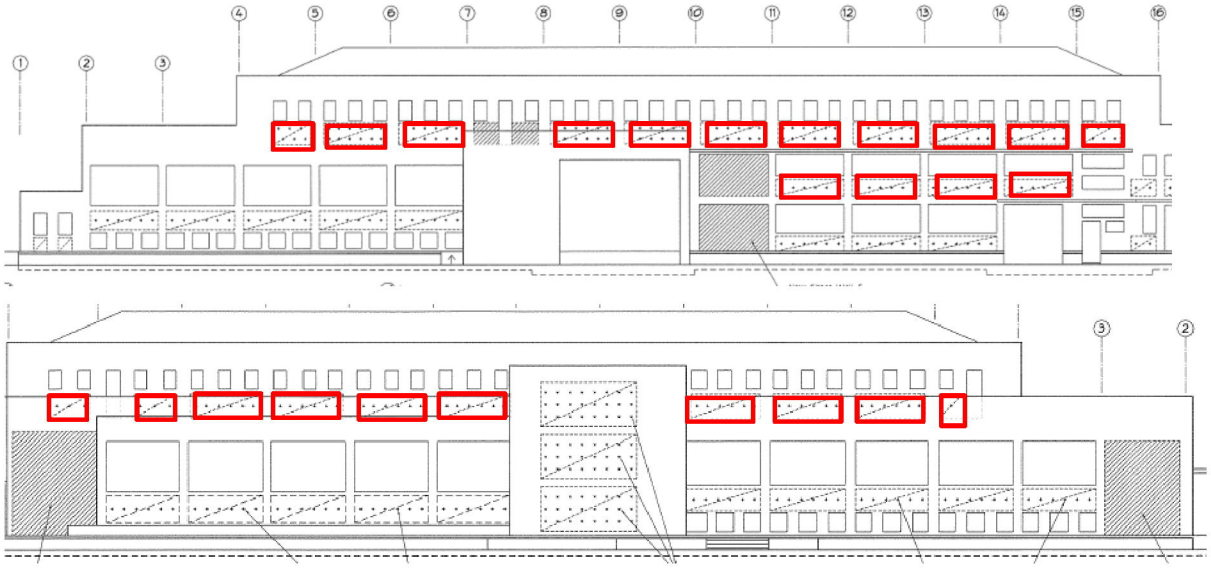


Figure. 18: In-fill brick panels at height that can be replaced with in-fill concrete panels

6. Conclusion and recommendations

The building has a calculated seismic rating of **40%-45% NBS** (IL2), which corresponds to a "Grade C" building as defined by the New Zealand Society for Earthquake Engineering (NZSEE) building grading scheme (hence is defined as a medium Earthquake Risk Building ERB).

To strengthen the building to 80% NBS, the options will include, but are not limited to the following:

- Replacing the infill brick wall next to the Southern entrance with a new reinforced concrete shear wall.
- Replacing the infill brick wall at the South-East corner of the building with a new reinforced concrete shear wall or infill the window openings with reinforced blockwork, and apply a layer of 'shotcrete' to the existing brick panel.
- Replacing the infill brick panels at the First floor and the mezzanine floor levels with reinforced concrete infill panels (connected to the concrete frames).
- Provide additional seatings [by installing a steel angle bracket] to increase the available seating for the precast floor units to be supported on.

It is our recommendation that the following items are carried out:

- A detailed Geotechnical investigation of the underlying soil at the site.
- A detailed seismic assessment of the adjacent theatre building.

7. Limitations of this Report

1. *This report has been prepared by [redacted] for Hutt City Council (HCC) and may only be used and relied on by HCC for the purpose agreed between [redacted] and the HCC as set out in our proposal document 51/37964 War Memorial Library Seismic Assessment*
2. *[redacted] otherwise disclaims responsibility to any person other than HCC arising in connection with this report. [redacted] also excludes implied warranties and conditions, to the extent legally permissible.*
3. *The services undertaken by [redacted] in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.*
4. *The opinions, conclusions and any recommendations in this report are based on the actual conditions encountered and information reviewed at the date of preparation of the report. [redacted] accepts no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.*
5. *The opinions, conclusions and any recommendations in this report are based on assumptions made by [redacted] described in Section 3 of this report. [redacted] disclaims liability arising from any of the assumptions being incorrect.*
6. *[redacted] has prepared this report on the basis of information provided by HCC and others who provided information to [redacted] (including Government authorities)], which [redacted] has not independently verified or checked beyond the agreed scope of work [redacted] does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.*
7. *Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.*
8. *Site conditions may change after the date of this Report. [redacted] does not accept responsibility arising from, or in connection with, any change to the site conditions. [redacted] is also not responsible for updating this report if the site conditions change*

Appendices

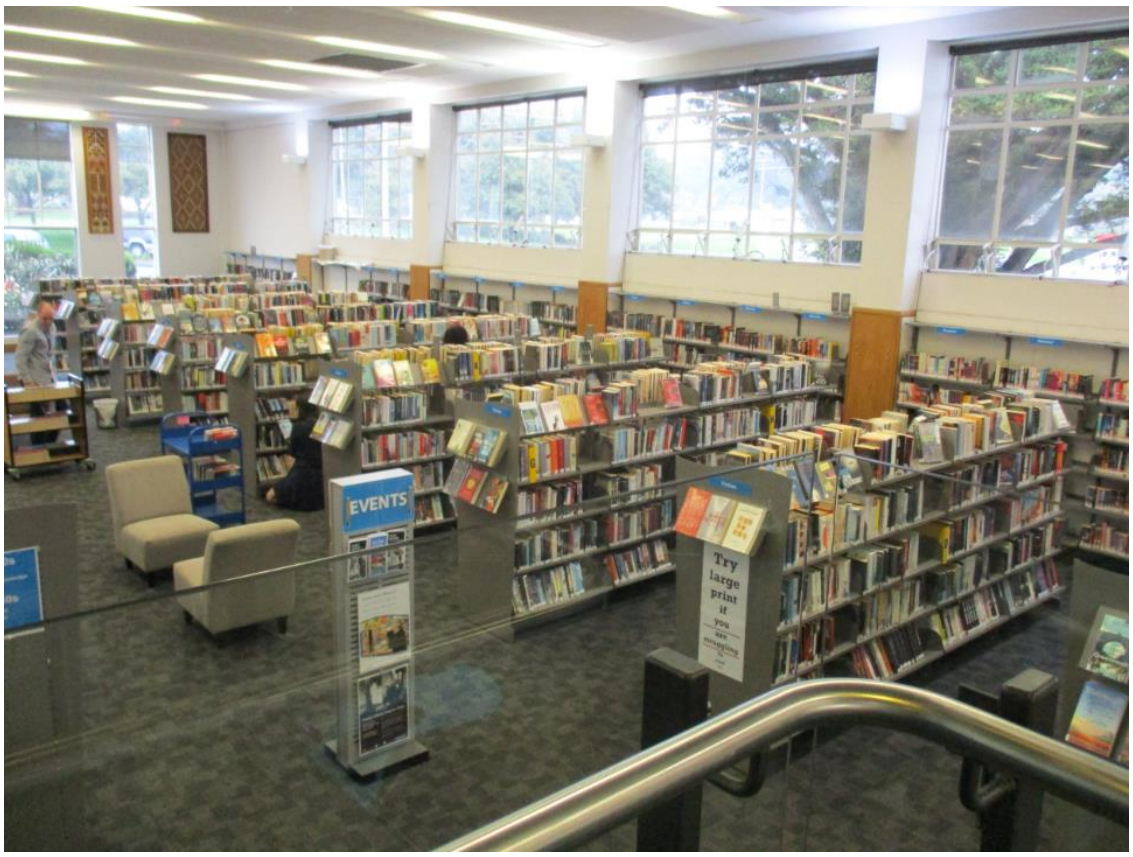
Appendix A – Photos

Example of internal RC columns

Example of RC shear wall

North entrance of the library

Example of reinforced concrete floor slabs on series of primary and secondary beams



Example of external RC columns

North elevation of the building

Example of wall with openings

Appendix B – Building description summary table

Table 2 Building Description Summary Table

Building	Description
Gross Floor Area (m^2)	Approx. 2525 m^2
Year of Design (approximate)	1952
Current use	Library
Importance Level (IL)	IL2
Structural Alterations	Strengthening work was carried out in 2003 by [redacted]
Basement	None
Description of Building	• Roof for the first floor is of light-weight steel trusses (Equal Angle sections) construction with timber purlins • Reinforced concrete roof over the remainder of the footprint • The floors are of in-situ reinforced concrete floor slabs supported on a series of primary and secondary beams to the mezzanine and the first floors • The foundation consists of a system of concrete ground beams supported on deep piles.
Assessment methodology	The seismic demand was evaluated through a Modal Response Spectrum (MRS) analysis of a 3D finite element model, using a software program called ETABS. The base shear of the Modal analysis then was scaled to 100% of the base shear obtained from the Equivalent Static analysis due to the building being classified as irregular under Clause 4.5 NZS1170.5:2004. The base shear was computed using the standard NZS1170.5:2004 under ultimate loading conditions as defined in NZS 1170.0:2002. The assessment of the seismic capacities of the lateral resisting elements, including the reinforced concrete shear walls and the brick in-fill panels are based on the procedures recommended in the NZSEE Guidelines in particularly Section C5 [Concrete Buildings] and Section C7 [Moment Resisting Frame with Infill panels].
Gravity Load Resisting System	The building is a reinforced concrete frame structure. The insitu reinforced concrete floors are supported by the internal columns.

Lateral Load Resisting System	The lateral loads from roof self-weight are transferred to in-plane shear walls in both transverse and longitudinal directions.
Wall/Bracing/Roof System	The building is braced with reinforced concrete shear walls in both the longitudinal and the transverse directions. The walls are comprised of a combination of brick infill panels and concrete panels. The roof cladding is comprised of standard corrugated fibrotile sheets (asbestos fibre-cement) on the first floor, and concrete roof slabs in the other areas**.**
Floor and foundation System	Slab on grade on Ground floor, and insitu reinforced concrete floor slabs on series of primary and secondary beams on mezzanine and first floors
Geotechnical Considerations	Based on the Subsoil map of Lower Hutt City, the subsoil classification of the War Memorial Library building site is considered to be Class D in accordance with NZS1170.5:2004. Based on the GWRC Hazard map, it has been identified that the underlying soil beneath the War Memorial Library building site has the potential to liquefy during an earthquake due to its close proximity to the Hutt river

Appendix C – Building Plans

Appendix D – Calculations