Initial Seismic Assessment Report

Address: State Highway 48, Mt Ruapehu 3951, Old Fire Station/Garage at Chateau Tongariro

Date: **29 September 2023**

Project Number**: 220138**

Prepared for: **Department of Conservation New Zealand**

Report Tracking - State Highway 48, Mt Ruapehu 3951, Old Fire Station/Garage at Chateau Tongariro

Revision	Status	Date	Prepared by	Reviewed by
A	Issued for Client review	29/09/2023	Scott Lange	Umair Siddiqui

Authorisation

Reviewer's Signature		**Approver's Signature**	Amir Moshref
Name	Umair Siddiqui	**Name**	Amir Moshref
Title	Senior Structural Engineer CPEngNZ, CMEngNZ	**Title**	Director CPEngNZ, CMEngNZ

Miyamoto International New Zealand Ltd
236 Hereford Street. Christchurch 8011 • T +64 3 377 4095
187 Broadway, Newmarket, Auckland 1023 • T +64 9 940 4069
Level 7/138 The Terrace, Wellington 6011 • T +64 4 801 9026
53 Kapiti Road, Paraparaumu 5032 • T +64 4 974 1272
www.miyamotointernational.co.nz

Table of Contents

Executive Summary

Miyamoto International NZ Ltd (MINZ) is commissioned by the Department of Conservation (DoC) to complete an Initial Seismic Assessment (ISA) of the Old Fire Station building located at State Highway 48, Mt Ruapehu 3951.

The 1930s single storey brick masonry building sits across the road to the Chateau Tongariro Hotel. It is currently used as a storage facility and accessed infrequently. DoC would like to conduct seismic assessment to broadly understand the seismic risks and likely %NBS rating of the building and guidance around life safety implications of the risk posed by the building.

Miyamoto carried the assessment in accordance with MBIE 2017 guidelines IEP (initial evaluation procedure) after collecting data from the visual site inspection, which concluded;

Building %NBS Rating and Risk

☐ The building has an expected rating of less than ***34% NBS*** in both principal longitudinal and transverse directions, giving an overall rating of ***15% NBS*** when assessed as an **Importance Level 2** building.

☐ The key structural weaknesses identified are the unreinforced hollow brick masonry veneer walls present around the building which are susceptible to outward fall (out of plane failure).

☐ The building meets one of the criteria under the Earthquake Prone Building Methodology 2017 for the local territorial authority to identify it as Potentially Earthquake Prone building.

Life Safety Risk and Implications

☐ The building seismic rating is 15%NBS(IL2) and it achieves a seismic grading of **Grade E** which means it poses a **risk that is 25 times higher** as compared to the risk posed by a building with 100%NBS rating or higher.

☐ Once the capacity of critical structural elements is exceeded during seismic event, they pose a risk of failure in a manner which could potentially affect the occupants, the street public thoroughfare, and the outdoor area adjacent to building which is designated as an 'Assembly Point' under an emergency.

☐ The building entry is *controlled* and the occupancy is *infrequent*. Therefore, the risk to the occupants is considered low. We suggest removing the designated emergency point from adjacent to the building and relocating it away from the building somewhere safe.

☐ Miyamoto suggest placing localized cordons to deter public from accessing the area at the rear of the building near the Gable end walls.

☐ We have not noted any risk in the building at the time of inspection which would mean the building is considered at an imminent risk of collapse under the ordinary course of events.

Limitations

The ISA is considered to provide a relatively quick, high-level and qualitative measure of the building's performance. A Detailed Seismic Assessment is recommended to confirm the seismic performance of the building in detail if the seismic status of a building is critical to any decision-making, particularly for the strengthening design and for detailed evaluation of life safety risk posed by each structural deficiency.

1. Introduction

Miyamoto International NZ Ltd (MINZ) was engaged by the Department of Conservation (DOC) to complete an Initial Seismic Assessment (ISA) of the existing structure located at State Highway 48, Mt Ruapehu 3951.

Miyamoto assessed the building by following the Initial Evaluation Procedure (IEP) as described in the MBIE/NZSEE publication *The Seismic Assessment of Existing Buildings* (*the Technical Guidelines*), 2017 a successor of the New Zealand Society of Earthquake Engineers' (NZSEE) building assessment guidelines.

1.1 Purpose of Assessment

DoC would like to conduct initial seismic assessment of the garage building to understand its seismic performance and likely %NBS rating for the purpose of determining if the building is potentially earthquake prone.

They have also asked Miyamoto to provide guidance around life safety risks to occupants and public due to its seismic performance.

1.2 Sources of Information

In the absence of drawings or design data of the existing structure, Miyamoto's assessment is based on the following information:

☐ Visual site inspection of the building carried out by Miyamoto engineer Umair Siddiqui on 1st September 2023. This included a walkover survey of the building both internally and externally to understand the building materials, construction typology and approximate geometry.

☐ The date of the building construction is taken as 1930, similar to the main Chateau building that sits across the road. This is based on the discussion with the DoC representative on-site and also inferred from observing the brick masonry used in the garage which appears to be of similar origin as of the Chateau Tongariro original 1929 building.

☐ Masonry material properties are assumed to be similar to the main Chateau building.

☐ DoC has informed us that the building is currently in use only as a garage and is occupied momentarily on infrequent basis to store and retrieve the items.

1.3 IEP Background and Limitations

The IEP procedure was developed in 2006 by the New Zealand Society for Earthquake Engineering (NZSEE) and updated in 2017 to reflect experience with its application and also as a result of experience from the Canterbury earthquakes of 2010/11. It is a tool to assign a percentage of New Building Standard (%NBS) rating and associated grade to a building as part of an Initial Seismic Assessment of existing buildings.

Characteristics and limitations of the IEP include:

☐ An IEP assessment is primarily concerned with life safety. It does not consider the susceptibility of the building to damage, and therefore to economic losses.

☐ It tends to be somewhat conservative, identifying some buildings as earthquake-prone, or having a lower %NBS score, which subsequent detailed investigation may indicate is less than actual performance. However, there will be exceptions, particularly when potential critical structural weaknesses (CSWs) are present that have not been recognised from the level of investigation employed.

☐ An IEP can be undertaken with variable levels of available information: e.g. exterior-only inspection, structural drawings available or not, interior inspection, etc. The more information available, the more representative the IEP result is likely to be. The IEP records the information that has formed the basis of the assessment and consideration of this is important when determining the likely reliability of the result.

☐ It is an initial, first-stage review. Buildings or specific issues which the IEP process flags as being problematic or as potentially critical structural weaknesses need further detailed investigation and evaluation. A Detailed Seismic Assessment is recommended if the seismic status of a building is critical to any decision making.

☐ The IEP assumes that buildings have been designed and built in accordance with the building standard and good practice current at the time. In some instances, a building may include design features ahead of its time, leading to better than predicted performance. Conversely, some unidentified design or construction issues not picked up by the IEP process may result in the building performing not as well as predicted.

☐ It is a largely qualitative process and should be undertaken or overseen by an experienced Engineer. It involves considerable knowledge of the earthquake behaviour of buildings, and judgement as to key attributes and their effect on building performance. Consequently, it is possible that the %NBS derived for a building by independent experienced Engineers may differ.

☐ An IEP may over-penalise some apparently critical features which could have been satisfactorily taken into account in the design.

☐ An IEP does not take into account the seismic performance of non-structural items such as ceilings, plant, services or general glazing that are not considered to present a significant life safety hazard.

Experience to date is that the IEP is a useful tool to identify potential issues and expected overall performance of a building in an earthquake. However, the process and the associated %NBS rating and grade should be considered as only providing an indication of the building's compliance with current code requirements. A detailed investigation and analysis of the building will typically be required to provide a definitive assessment.

2. Site Information

2.1 Site Description

The building was constructed circa 1930s, [rectangular plan size = 15m x 32m], on a relatively flat site at State Highway 48, Mt Ruapehu 3951 – see to Figure 1 below.

Figure 1 - Aerial view of the building

2.2 Building Description & Use

The old fire station building is a single storey structure consisting of unreinforced brick masonry cavity walls around the perimeter with the concrete bounding frame. Roof is constructed of lightweight sheet-metal roofing membrane over timber purlins and trusses supported by a combination of timber posts and concrete columns.

The masonry walls on the east elevation at the front façade are of 3 wythe construction with solid bricks. West elevation of the machine room has tall gable-end URM wall made of weak hollow bricks. The walls on all other elevations are cavity veneer walls constructed with two wythes of hollow bricks. The inner wythe constitute an infill wall bounded by the concrete columns and the bond beam at the top, whereas the outer layer veneer sits outside the bounding frame and loosely tied to the inner layer by means of scattered steel wire ties.

The masonry walls with or without infilled frames serve as the gravity load resisting system and the primary lateral load resisting system in both the longitudinal and transverse directions.

The existing building was originally constructed for use as a fire station; however, it is currently being used as a storage facility and is infrequently accessed.

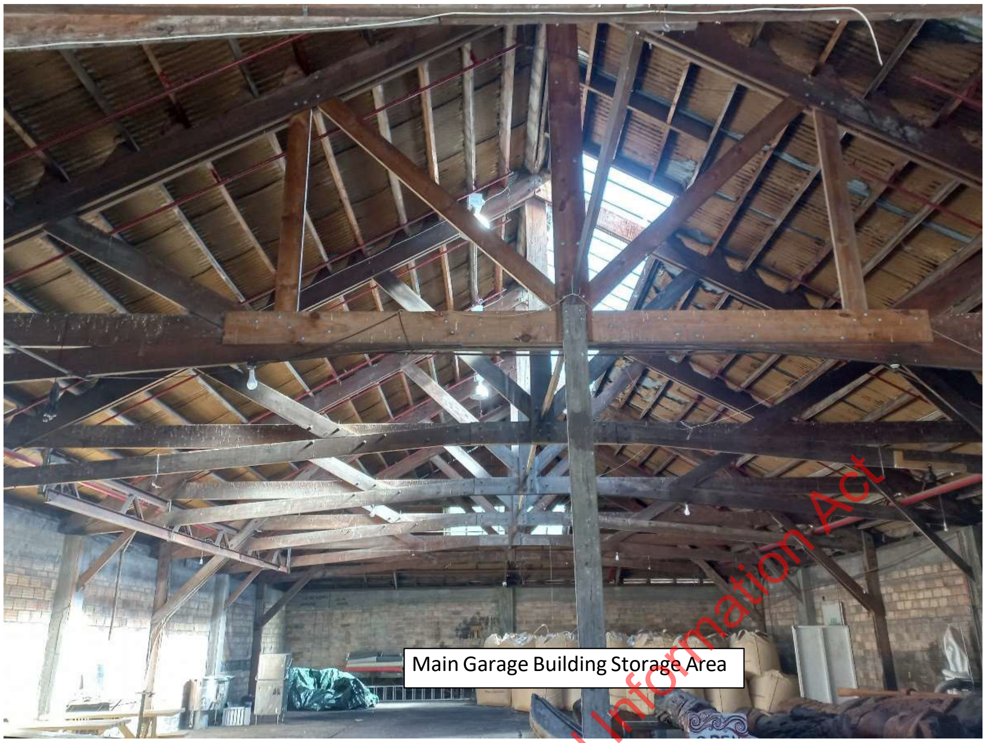


Figure 2 - Interior view of the building from main entrance (looking west)

Figure 3 – Exterior view of the building Front (East) elevation

3. Assessment Methodology

Our methodology to conduct the initial seismic assessment is as follows:

a) Evaluate the existing structure seismic performance by:
  - Visiting the building to visually check the primary structural components and connections and compare them to the available building plans.
  - Assess the building following the Initial Evaluation Procedure (IEP).
  - Perform supplementary calculations using simplified analysis methods to check the capacity of URM walls.
  - Note primary critical structural weakness, significant hazards and identify any maintenance issues.
  - Recommendations for the next stages.

b) Provide high-level commentary on the life safety risk posed by the structural weaknesses identified in the seismic assessment, including recommendations on health and safety protocols specifically relating to its seismic performance of items currently rated as less than 34%NBS.

3.1 Standards and Guidelines Employed

The following standards and guidelines have been used as references for this assessment:

- The Building Act 2004;
- AS/NZS 1170:2002 Structural Design Actions;
- NZS3604:2011 – Timber-framed Buildings;
- NZS4230:2004 – Design of Reinforced Concrete Masonry Structures;
- The Seismic Assessment of Existing Buildings: Technical Guidelines for Engineering Assessment, ch-C8, July 2017.

The key inputs, values and assumptions employed for this assessment are shown in Tables 1 and 2. For a brief outline of the initial evaluation procedure, see notes in Appendix C.

Refer also to the attached IEP assessment sheet and the engineering assessment technical summary.

3.2 Assessment Inputs

The following table summarises inputs used in the IEP calculations.

Input	Value	Comment
Date of Design	1930	Similar age as Chateau based on owners supplied information
Dead Loads	$G_{Roof} = 0.5kPa$ $G_{Wall} = 16.9kN/m^3$	Weight of lightweight timer-trussed roof and brick masonry walls.
Imposed Loads: Roof	$Q_{Roof} = 0$ $\psi_{E, Roof} = 0$	No live loading is considered at roof level during the event of an earthquake.
Earthquake: Seismic Hazard Coefficient, Z Return Period Factor, R	0.27 1.0	Importance Level 2, 10% probability of exceedance in 50 years.
Near Fault Factor, N(T,D) Site Subsoil Class	1.0 C	In accordance with NZS1170.5. assumed
Building Period Seismic Performance Factor, Sp	0.4s (assumed) 1.0	For single storey stiff URM bldg. In accordance with NZS1170.5.
Assumed ductility, μ	1.0	Unreinforced masonry walls

Table 1. Key calculation inputs & building loads.

Table 2 provides key factors for the IEP including justification for the values chosen.

Input Factor	Values Taken	Justification
Factor A – Plan irregularity	1.0	L/W = 32m / 15m = 2.1 Therefore, insignificant plan irregularity. Building approximate size is estimated using topographic map.
Factor B – Vertical irregularity	1.0	Single-storey structure
Factor C – Short columns	1.0	No short column effects.
Factor D - Pounding	1.0	NA

Factor E - Site characteristics	1.0	No site characteristics were noted to constitute significant life-safety risk
Factor F - Other factors [Longitudinal Direction]	1.0	-Concrete bounding frame generally in good condition for its age apart from some spalling of cover and cracks in scattered areas. -Hollow brick masonry cavity walls are weak, and unlikely to add to strength or cause detrimental strut action to frame. -Solid brick masonry wall located near the entrance doorway is in reasonable condition and can provide in-plane strength. -Gable ends of URM wall at each end of Machine shop are weak in out of plane direction.
Factor F – Other Factors [Transverse Direction]	0.8	-Weak bricks in most parts with damage and large cracking. -Long span timber trussed roof with flexible diaphragm preventing any transverse frame action. -Large opening at the entrance resulting in significant torsional irregularity. -Weak hollow brick masonry with corroded wire-ties between wythes is susceptible to rocking out of plane.

Table 2. IEP input factors and reasoning.

3.3 IEP Assessment Results

The IEP assessment of this building indicates an overall earthquake rating of 15%NBS(IL2) corresponding to a 'Grade E' building as defined by the NZSEE building grading scheme. This is below 34%NBS– the thresholds for earthquake prone and earthquake risk buildings, as recommended by the NZSEE. Therefore, it requires strengthening, unless further investigation into its seismic performance and a DSA determines otherwise.

3.4 IEP Grades and Relative Risk

The Seismic Assessment of the Existing Buildings technical guidelines Table 2, provides the basis for a proposed grading system for existing buildings, as one way of interpreting the %NBS earthquake rating.

Building Grade	Percentage of New Building Standard (*%NBS*)	Approx. Risk Relative to a New Building	Life-safety Risk Description
A+	>100	<1	low risk
A	80 to 100	1 to 2 times	low risk
B	67 to 79	2 to 5 times	low or medium risk
C	34 to 66	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

Table 3. Relative earthquake risk.

This building has been classified by the IEP as **Grade E** which is below 34%NBS– the thresholds for earthquake prone and earthquake risk buildings, as recommended by the MBIE guidelines. The building meets one of the criteria under the Earthquake Prone Building Methodology 2017 for the local Territorial Authority to identify it as Potentially Earthquake Prone building.

3.5 Seismic Restraints to Non-Structural Items

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

The garage/storage building is largely in its bare structural form with minimal non-structural elements. An assessment has not been made of any non-structural elements including any storage racks, partition walls, entrance doors and roller garage doors, lean-to-timber structure etc. These issues are outside the scope of this initial assessment.

4. Conclusions

The ISA carried out on the building indicates an overall earthquake rating of 15%NBS(IL2) corresponding to a 'Grade E' building as defined by the NZSEE building grading scheme. This is below 34%NBS(IL2) – the thresholds for earthquake prone and earthquake risk buildings, as recommended by the NZSEE. Therefore, it requires strengthening, unless further investigation into its seismic performance through a detailed seismic assessment (DSA) determines otherwise.

The key structural weaknesses identified during the initial seismic assessment are as follows;

☐ The gable end wall on the west elevation is limited to 15%NBS due to lack of out-of-plane bending capacity. The wall cantilevers approximately 3m above the bond beam level and is susceptible to outwards fall if sustained damage in a moderate level of shaking.

- ☐ The hollow brick masonry veneer cladding is limited to 20%NBS due to out-of-plane capacity.
- ☐ The unreinforced masonry façade walls on the east elevation are limited to 45% NBS(IL2) limited by out-of-plane bending capacity.

5. Recommendations

Our recommendations based on our Initial Seismic Assessment are as follows:

5.1 Strengthening to Improve Seismic Performance

To improve the seismic performance of the building, Miyamoto recommends the strengthening is carried out, targeted at resolving structural weaknesses in the building. It is imperative that prior to carrying out strengthening design, a detailed seismic and condition assessment of the building is conducted to understand all structural weaknesses which may have not been evaluated at this initial seismic assessment stage.

5.2 Recommendations for Repair of Existing Damage

The superstructure, including the roof trusses and the concrete bounding frames were generally in reasonable condition apart from scattered areas where cracks and spalling of the concrete bounding frame and the cracking on the brick masonry walls were observed during our site visit. For such areas including any brickwork that is compromised, it is recommended that;

- Building is inspected in detail for condition assessment to determine all areas of disrepair and the maintenance issues.
- Repair strategy is developed to prevent further deterioration of the structural elements.
- This includes, but not limited to, replacing damaged bricks, crack-stitching to masonry walls and spalled concrete covers be reinstated and suitably repaired as necessary.

Miyamoto would be happy to assist DoC to carry out condition assessment and in developing a detailed repair strategy if requested.

5.3 High-Level Commentary on Potential Life Safety Risk

The commentary from Miyamoto around the life safety risks are based on the following criteria with supporting illustrations in Figure 4.

Risks	**Building Use and Access**	**Public Thoroughfare**
Structural weaknesses with rating less than 34%NBS.	*Occupancy & Access*	*Exposure to Public*
Hollow brick masonry infills, particularly at the southern elevation, susceptible to out of plane (outward) collapse. Gable end-wall made of hollow brick masonry located at the rear of building susceptible to out-of-plane failure.	The building is used as a storage shed and corresponding Importance Level is IL1 as per NZS 1170. The building is accessed by DoC personnels only for the purpose of storing and retrieving the stored items.	A designated emergency assembly point is located immediately adjacent to the building on an empty plot beside the southern elevation of the garage. A footpath runs along the eastern (front) elevation of the building. Miyamoto has not determined the frequency of foot traffic but understands that it varies seasonally.

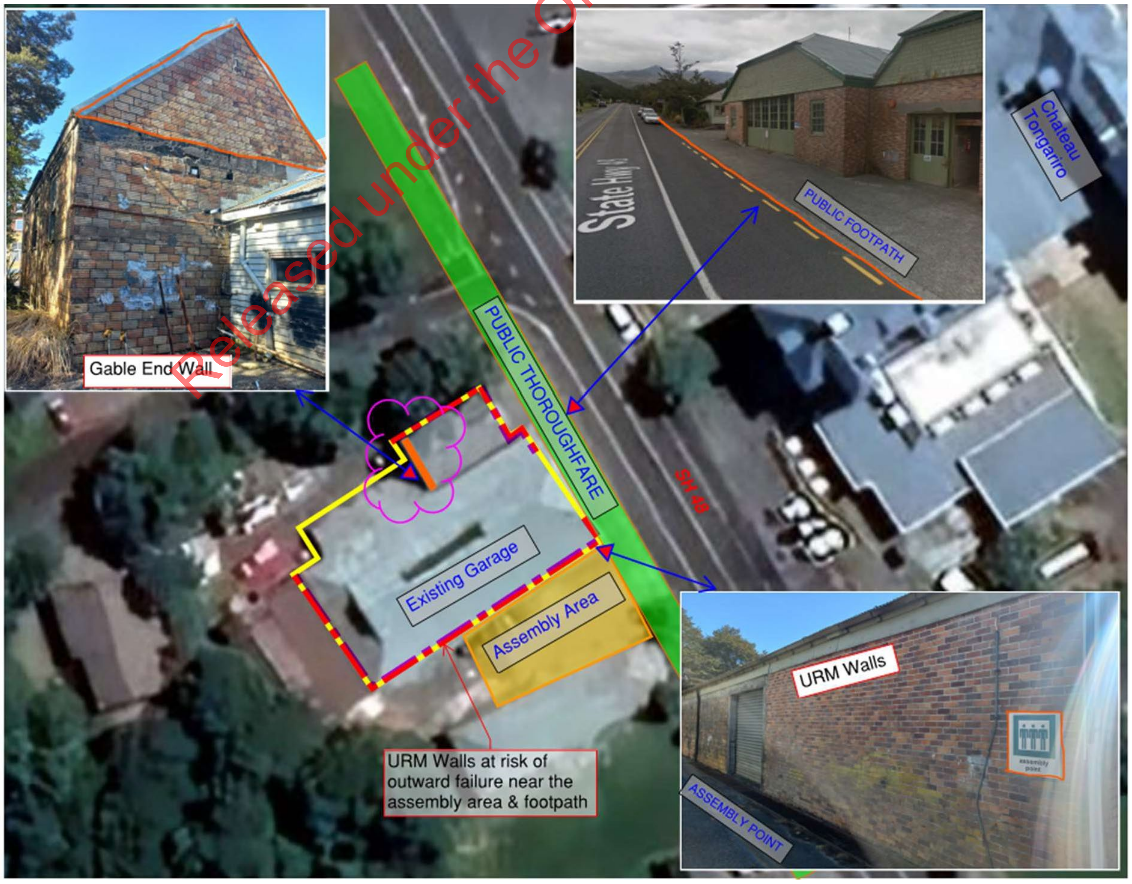


Figure 4 – Aerial view of building and surroundings with identification of structural elements and risk exposure

MBIE Guidelines for seismic assessment provides grading scheme to correlate the %NBS rating and the mode of failure of critical structural weaknesses to the risks. Based on that;

- ○ The building seismic rating is 15%NBS(IL2), and it achieves a seismic grading of **Grade E** which means it poses a **risk that is 25 times higher** as compared to the risk posed by a building with 100%NBS rating or higher.
- ○ Once the capacity of critical structural elements is exceeded during a seismic event, the manner in which they fail could potentially affect the primary gravity support system of the building.
- ○ The life safety implication of failure of critical structural elements could affect the occupants, the street foot traffic and the public thoroughfare.

By evaluating the risks, exposure and the implications of those risks in a qualitative manner, Miyamoto has established the current state-of-play and our recommendations are as follows;

- ☐ The entry into the building is *controlled* and the occupancy is *infrequent*. Therefore, the risk to the occupants of the building is considered low. No further actions are suggested in this regard as the exposure to the risk is limited. Note that any change in circumstances could change this evaluation.
- ☐ The main risk lies to the public around the building, particularly near the designated 'Assembly Point' on the South-East wall of the building (figure 4). We suggest removing the designated emergency point from adjacent to the building and relocating it away from the building somewhere safe.
- ☐ At the rear of the building on western elevation (figure 4 clouded area) where the Gable-end wall poses a potential risk of collapse, Miyamoto suggest placing localized cordons to deter public from accessing the area.
- ☐ The front façade walls of the building with solid brick masonry could potentially pose risk to public throughfare. Our preliminary assessment indicates that these walls are not rated less than 34%NB. A DSA with further investigations might change this outcome. Additionally, the frequency of foot traffic on this foot path is unknown to us, therefore Miyamoto have excluded this in our review until further investigations is done.
- ☐ We have not noted any risk in the building at the time of inspection which would mean the building is considered at an imminent risk of collapse in its current state under the ordinary course of events.

5.4 Limitations of Life Safety Risk Review

- ☐ Our review is Qualitative in nature and based on the visual inspection of the building and information about its current usage as provided by the client.
- ☐ This is not a detailed review and does not aim to be prescriptive in discussing all risks, and is limited to risk from only critical structural elements identified in our ISA based on our limited knowledge of the building.
- ☐ Our review has been related to seismic risks only. We have not considered other risks such as performance under extreme weather events, flooding, fire safety and egress as part of this review.
- ☐ No assessment has been made to determine whether the structure complies with the New Zealand building codes or other standards, guidelines, legislation, plans, etc.
- ☐ Although we have visited the building, we have not carried out a detailed inspection of each structural element.

Limitations

This report is subject to the following limitations:

- This report has been prepared by Miyamoto for the Client for the purpose/s agreed with the Client (Purpose). Miyamoto accepts no responsibility for the validity, appropriateness, sufficiency or consequences of the Client using the report for purposes other than for the purpose.
- This report is not intended for general publication or circulation. This report is not to be reproduced by the Client except in relation to the Purpose, without Miyamoto's prior written permission. Miyamoto disclaims all risk and all responsibility to any third party.
- This report is provided based on the various assumptions contained in the report.
- Miyamoto's professional services are performed using a degree of care and skill reasonably exercised by reputable consultants providing the same or similar services as at the date of this report.
- The building assessments are based on visual building inspections only on the structural aspects, with no, or limited, intrusive inspections except as otherwise stated. Major structural elements have been reviewed where possible; however, this does not prove that latent defects do not exist. Minor structural repairs that may be required, as per general maintenance obligations, are outside the scope of this review. No material testing has been undertaken unless otherwise noted in the report. This report specifically excludes assessment or advice relating to hazardous materials, such as asbestos and weather tightness of the building envelope.
- Verification of structural elements is based on the information and drawings provided by the Client and available from archives and on our site inspection. The assumptions in this report are based on such information and drawings. Information or drawings not known to Miyamoto at the time of completing this report, which provide further and/or different detail, may affect these assumptions and the findings of the report.
- Where the Client provides information to Miyamoto, including design calculations and drawings of the as-built structure, or where the report indicates that we have obtained and/or relied upon information provided from a third party, Miyamoto has not made any independent verification of this information except as expressly stated in the report. Miyamoto assumes no responsibility for any inaccuracies in, or omissions to, that information.
- A change in circumstances, facts, information after the report has been provided may affect the adequacy or accuracy of the report and its findings. Miyamoto is not responsible for the adequacy or accuracy of the report as a result of any such changes.

Appendix A. Abbreviations

CSW – Critical Structural Weakness

DSA – Detailed Seismic Assessment

EPB – Earthquake Prone Building – refers to the definition in the Building Act 2004 i.e. < 33%NBS (some sources consider buildings to be EPB <34%)

ESA – Equivalent Static Analysis

IEP – Initial Evaluation Procedure.

LFRS – Lateral Force-Resisting System

NBS – New Building Standard – i.e., the standard that would apply to a new building at the site. This includes loading to the full requirements of the Standard.

NZS – New Zealand Standard

NZSEE – New Zealand Society for Earthquake Engineering

%NBS – Percentage of New Building Standard

pESA – Pseudo Equivalent Static Analysis

RC – Reinforced Concrete

RSA – Response Spectrum Analysis

SLS – Serviceability Limit State

ULS – Ultimate Limit State

Appendix B. Site Photos

	
East (front) Elevation – Solid brick 3 wythe wall	*Interior of the building*
	
Damage to hollow brick masonry wall	*Timber roof trusses*
	
South Elevation – Hollow brick 2 wythe wall	*West Elevation – Gable roof end wall spalling on bond beam with exposed reinforcement*

Appendix C. Initial Evaluation Procedure

This assessment was carried out using the approved IEP spreadsheet which is part of the NZSEE publication" The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. The spreadsheet is a useful tool that considers the nominal strength/ductility of the building in both directions, building height & function, ground conditions, proximity to earthquake faults and other buildings among other factors and produces an estimate of the percentage of New Building Standard and thus a quantification of the overall seismic risk. The current seismic assessment guideline is the successor of the "New Zealand Society for Earthquake Engineer's building assessment guideline, 2006." The *%NBS* was calculated using the following relationship:

$$\%NBS = \frac{Capacity}{Demand} \times 100\%NBS$$

To define the New Building Standard, the earthquake-loading standard NZS 1170.5:2004 Earthquake Actions was utilised.

<u>Factor F:</u>

From 1970s, New Zealand introduced the modern earthquake design philosophies into standards and there is an expectation that building have been designed for seismic loads. We have considered in our analysis and compensated the base line NBS score with a factor ("F") introduced in the IEP assessment process to reflect our personal engineering opinion or confidence in the final building rating.

This factor can decrease or increased the building rating and is entirely based on the engineering opinion and professional judgement of the assessor and therefore it is a requirement of the IEP that the factors that have led to the decision for the F factor are appropriately recorded.

The guidelines set a general factor of 1.0 and this factor should be less than 1.0 to reflect deficiencies not accounted in the standardized IEP process or to highlight that a detailed assessment of the building as a whole or of some specific parts is recommended.

Similarly, the factor could be more than 1.0 to reflect that the building has higher capacity then evaluated above and set limits on this compensating factor are as follows:

- No limit on factor less than 1.0
- Up to 2.5 for buildings up to three storeys high
- Up to 1.5 for buildings more than three storey high.

Appendix D. IEP Spreadsheet Output and Supplementary Calculations

Initial Evaluation Procedure (IEP) Assessment - Completed for

WARNING!! *This initial evaluation has been carried out solely as an initial seismic assessment of the building following the procedure set out in the "The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. This spreadsheet must be read in conjunction with the limitations set out in the accompanying report, and should not be relied on by any party for any other purpose. Detailed inspections and engineering calculations, or engineering judgements based on them, have not been undertaken, and these may lead to a different result or seismic grade.*

Street Number & Name:	State Highway 48, Mt Ruapehu 3951	**Job No.:**	220138
AKA:	Chateau Tongariro Garage	**By:**	SL
Name of building:	Old fire station building	**Date:**	14/09/2023
City:	Whakapapa, Mt Ruapehu	**Revision No.:**	1

Table IEP-1 Initial Evaluation Procedure Step 1

Step 1 - General Information

1.1 Photos (attach sufficient to describe building)

NOTE: THERE ARE MORE PHOTOS ON PAGE 1a ATTACHED

1.2 Sketches (plans etc, show items of interest)

NOTE: THERE ARE MORE SKETCHES ON PAGE 1a ATTACHED

1.3 List relevant features (Note: only 10 lines of text will print in this box. If further text required use Page 1a)

The garage building was constructed Circa. 1929 around the same time as the main Chateau building. The garage is a single storey structure comprised of standalone masonry walls (solid brick) and masonry infill walls (hollow brick) with timber roof trusses supporting a currugated metal roof.

1.4 Note information sources Tick as appropriate

Visual Inspection of Exterior	☑	**Specifications**	☐
Visual Inspection of Interior	☑	**Geotechnical Reports**	☐
Drawings (note type)	☐	**Other (list)**	☐

No structural drawings were available for the garage building in the Ruapehu District Council property file.

Initial Evaluation Procedure (IEP) Assessment - Completed for

Street Number & Name:	**State Highway 48, Mt Ruapehu 3951**	**Job No.:**	**220138**
AKA:	**Chateau Tongariro Garage**	**By:**	**SL**
Name of building:	**Old fire station building**	**Date:**	**14/09/2023**
City:	**Whakapapa, Mt Ruapehu**	**Revision No.:**	**1**

Table IEP-2 Initial Evaluation Procedure Step 2

Step 2 - Determination of *(%NBS)* b

(Baseline *(%NBS)* for particular building - refer Section B5)

2.1 Determine nominal *(%NBS) = (%NBS)* nom

a) Building Strengthening Data

	Longitudinal	**Transverse**
Tick if building is known to have been strengthened in this direction	☐	☐
If strengthened, enter percentage of code the building has been strengthened to	N/A	N/A

b) Year of Design/Strengthening, Building Type and Seismic Zone

	Longitudinal	Transverse
Pre 1935	●	●
1935-1965	○	○
1965-1976	○	○
1976-1984	○	○
1984-1992	○	○
1992-2004	○	○
2004-2011	○	○
Post Aug 2011	○	○
Building Type:	Others	Others
Seismic Zone:	**Not applicable**	**Not applicable**

c) Soil Type

	Longitudinal	Transverse
From NZS1170.5:2004, Cl 3.1.3 :	C Shallow Soil	C Shallow Soil
From NZS4203:1992, Cl 4.6.2.2 : **(for 1992 to 2004 and only if known)**	**Not applicable**	**Not applicable**

d) Estimate Period, *T*

Comment:

Masonry walls in both the transverse and longitudinal directions. One storey structure.

		Longitudinal	Transverse	
h_n =		6.5	6.5	m
A_c =		1.00	1.00	m^2
Moment Resisting Concrete Frames:	$T = \max\{0.09h_n^{0.75}, 0.4\}$	○	○	
Moment Resisting Steel Frames:	$T = \max\{0.14h_n^{0.75}, 0.4\}$	○	○	
Eccentrically Braced Steel Frames:	$T = \max\{0.08h_n^{0.75}, 0.4\}$	○	○	
All Other Frame Structures:	$T = \max\{0.06h_n^{0.75}, 0.4\}$	○	○	
Concrete Shear Walls	$T = \max\{0.09h_n^{0.75}/A^{0.5}, 0.4\}$	○	○	
Masonry Shear Walls:	$T \leq 0.4$sec	●	●	
User Defined (input Period):		○	○	
	T:	0.40	0.40	

Where h_n = height in metres from the base of the structure to the uppermost seismic weight or mass.

			Longitudinal	Transverse
e) Factor A:	Strengthening factor determined using result from (a) above (set to 1.0 if not strengthened)	**Factor A:**	1.00	1.00
f) Factor B:	Determined from NZSEE Guidelines Figure 3A.1 using results (a) to (e) above	**Factor B:**	0.04	0.04
g) Factor C:	For reinforced concrete buildings designed between 1976-84 Factor C = 1.2, otherwise take as 1.0.	**Factor C:**	1.00	1.00
h) Factor D:	For buildings designed prior to 1935 Factor D = 0.8 except for Wellington and Napier (1931-1935) where Factor D may be taken as 1.0, otherwise take as 1.0.	**Factor D:**	0.80	0.80
***(%NBS)* nom = AxBxCxD**		***(%NBS)* nom**	3%	3%

WARNING!! *This initial evaluation has been carried out solely as an initial seismic assessment of the building following the procedure set out in "The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. This spreadsheet must be read in conjunction with the limitations set out in the accompanying report, and should not be relied on by any party for any other purpose. Detailed inspections and engineering calculations, or engineering judgements based on them, have not been undertaken, and these may lead to a different result or seismic grade.*

Initial Evaluation Procedure (IEP) Assessment - Completed for

Street Number & Name:	State Highway 48, Mt Ruapehu 3951	**Job No.:**	220138
AKA:	Chateau Tongariro Garage	**By:**	SL
Name of building:	Old fire station building	**Date:**	14/09/2023
City:	Whakapapa, Mt Ruapehu	**Revision No.:**	1

Table IEP-2 Initial Evaluation Procedure Step 2 continued

2.2 Near Fault Scaling Factor, Factor E

If $T \leq$ 1.5sec, Factor E = 1

		Longitudinal	**Transverse**
a) Near Fault Factor, *N(T,D)* (from NZS1170.5:2004, Cl 3.1.6)	**N(T,D):**	1	1
b) Factor E = 1/N(T,D)	**Factor E:**	1.00	1.00

2.3 Hazard Scaling Factor, Factor F

a) Hazard Factor, *Z*, for site

Location: Turangi **Refer right for user-defined locations**

Z = 0.27 (from NZS1170.5:2004, Table 3.3)

Z_{1992} = 1.08 (NZS4203:1992 Zone Factor from accompanying Figure 3.5(b))

Z_{2004} = 0.27 (from NZS1170.5:2004, Table 3.3)

b) Factor F

For pre 1992 = $1/Z$

For 1992-2011 = Z_{1992}/Z

For post 2011 = Z_{2004}/Z

	Longitudinal	Transverse
Factor F:	3.70	3.70

2.4 Return Period Scaling Factor, Factor G

a) Design Importance Level, I

(Set to 1 if not known. For buildings designed prior to 1965 and known to be designed as a public building set to 1.25. For buildings designed 1965-1976 and known to be designed as a public building set to 1.33 for Zone A or 1.2 for Zone B. For 1976-1984 set I value.)

b) Design Risk Factor, R_o

(set to 1.0 if other than 1976-2004, or not known)

c) Return Period Factor, R

(from NZS1170.0:2004 Building Importance Level) *Choose Importance Level*

d) Factor G = IR_o/R

	Longitudinal	Transverse
I =	1	1
R_o =	1	1
Choose Importance Level	○ 1 ● 2 ○ 3 ○ 4	○ 1 ● 2 ○ 3 ○ 4
R =	1.0	1.0
Factor G:	1.00	1.00

2.5 Ductility Scaling Factor, Factor H

a) Available Displacement Ductility Within Existing Structure

Comment:

Masonry Structure

b) Factor H

For pre 1976 (maximum of 2) = k_m

For 1976 onwards = 1

(where kμ is NZS1170.5:2004 Inelastic Spectrum Scaling Factor, from accompanying Table 3.3)

	Longitudinal	Transverse
m =	1.00	1.00
	k_m	k_m
For pre 1976 (maximum of 2) =	1.00	1.00
For 1976 onwards =	1	1
Factor H:	1.00	1.00

2.6 Structural Performance Scaling Factor, Factor I

a) Structural Performance Factor, S_p

(from accompanying Figure 3.4)

Tick if light timber-framed construction in this direction

b) Structural Performance Scaling Factor = $1/S_p$

Note Factor B values for 1992 to 2004 have been multiplied by 0.67 to account for Sp in this period

	Longitudinal	Transverse
Tick if light timber-framed construction in this direction	☐	☐
S_p =	1.00	1.00
Factor I:	1.00	1.00

	Longitudinal	Transverse
2.7 Baseline *%NBS* for Building, *(%NBS)*$_b$ (equals ***(%NBS)***$_{nom}$ x E x F x G x H x I)	**11%**	**11%**

WARNING!! *This initial evaluation has been carried out solely as an initial seismic assessment of the building following the procedure set out in "The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. This spreadsheet must be read in conjunction with the limitations set out in the accompanying report, and should not be relied on by any party for any other purpose. Detailed inspections and engineering calculations, or engineering judgements based on them, have not been undertaken, and these may lead to a different result or seismic grade.*

Initial Evaluation Procedure (IEP) Assessment - Completed for

Street Number & Name:	State Highway 48, Mt Ruapehu 3951	**Job No.:**	220138
AKA:	Chateau Tongariro Garage	**By:**	SL
Name of building:	Old fire station building	**Date:**	14/09/2023
City:	Whakapapa, Mt Ruapehu	**Revision No.:**	1

Table IEP-3 Initial Evaluation Procedure Step 3

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

a) Longitudinal Direction

potential CSWs **Effect on Structural Performance** **Factors**

(Choose a value - Do not interpolate)

3.1 Plan Irregularity

Effect on Structural Performance ○ *Severe* ○ *Significant* ● *Insignificant* **Factor A** 1.0

No plan irregularity. Leanto building considered separately.

3.2 Vertical Irregularity

Effect on Structural Performance ○ *Severe* ○ *Significant* ● *Insignificant* **Factor B** 1.0

no vertical irregularity

3.3 Short Columns

Effect on Structural Performance ○ *Severe* ○ *Significant* ● *Insignificant* **Factor C** 1.0

No short column effect.

3.4 Pounding Potential

(Estimate D1 and D2 and set D = the lower of the two, or 1.0 if no potential for pounding, or consequences are considered to be minimal)

a) Factor D1: - Pounding Effect

Note:
Values given assume the building has a frame structure. For stiff buildings (eg shear walls), the effect of pounding may be reduced by taking the coefficient to the right of the value applicable to frame buildings.

Factor D1 For Longitudinal Direction: 1.

Table for Selection of Factor D1	Severe	Significant	Insignificant
Separation	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Alignment of Floors within 20% of Storey Height	○ 1	○ 1	● 1
Alignment of Floors not within 20% of Storey Height	○ 0.4	○ 0.7	○ 0.8

Single standing building.

b) Factor D2: - Height Difference Effect

Factor D2 For Longitudinal Direction: 1.

Table for Selection of Factor D2	Severe	Significant	Insignificant
	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Height Difference > 4 Storeys	○ 0.4	○ 0.7	○ 1
Height Difference 2 to 4 Storeys	○ 0.7	○ 0.9	○ 1
Height Difference < 2 Storeys	○ 1	○ 1	● 1

Single standing building.

Factor D 1.0

3.5 Site Characteristics - *Stability, landslide threat, liquefaction etc as it affects the structural performance from a life-safety perspective*

Effect on Structural Performance ○ *Severe* ○ *Significant* ● *Insignificant* **Factor E** 1.0

No site characteristics were noted and considered an hazard from a life-safety perspective.

3.6 Other Factors - *for allowance of all other relevant characterstics of the building*

For ≤ 3 storeys - Maximum value 2.5
otherwise - Maximum value 1.5.
No minimum.

Factor F 1.0

Record rationale for choice of Factor F:

-Reasonable condition of concrete bounding frame (beam columns), apart from some spalling of cover exposing the reinforcement.
-The two wythe hollow brick masonry is weak, with one wythe sitting outside the bounding frame and unlikely to add

3.7 Performance Achievement Ratio (PAR)
(equals **A x B x C x D x E x F**)

PAR

Longitudinal **1.00**

WARNING!! *This initial evaluation has been carried out solely as an initial seismic assessment of the building following the procedure set out in "The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. This spreadsheet must be read in conjunction with the limitations set out in the accompanying report, and should not be relied on by any party for any other purpose. Detailed inspections and engineering calculations, or engineering judgements based on them, have not been undertaken, and these may lead to a different result or seismic grade.*

Initial Evaluation Procedure (IEP) Assessment - Completed for

Street Number & Name:	State Highway 48, Mt Ruapehu 3951	**Job No.:**	220138
AKA:	Chateau Tongariro Garage	**By:**	SL
Name of building:	Old fire station building	**Date:**	14/09/2023
City:	Whakapapa, Mt Ruapehu	**Revision No.:**	1

Table IEP-3 Initial Evaluation Procedure Step 3

Step 3 - Assessment of Performance Achievement Ratio (PAR)

(Refer Appendix B - Section B3.2)

b) Transverse Direction

Factors

potential CSWs

Effect on Structural Performance
(Choose a value - Do not interpolate)

3.1 Plan Irregularity

Effect on Structural Performance ○ *Severe* ○ *Significant* ● *Insignificant* **Factor A** 1.0

No plan irregularity. Leanto building considered separately.

3.2 Vertical Irregularity

Effect on Structural Performance ○ *Severe* ○ *Significant* ● *Insignificant* **Factor B** 1.0

no vertical irregularity

3.3 Short Columns

Effect on Structural Performance ○ *Severe* ○ *Significant* ● *Insignificant* **Factor C** 1.0

No short column effect.

3.4 Pounding Potential

(Estimate D1 and D2 and set D = the lower of the two, or 1.0 if no potential for pounding, or consequences are considered to be minimal)

a) Factor D1: - Pounding Effect

> ***Note:***
> ***Values given assume the building has a frame structure. For stiff buildings (eg shear walls), the effect of pounding may be reduced by taking the coefficient to the right of the value applicable to frame buildings.***

Factor D1 For Transverse Direction: 1.0

Table for Selection of Factor D1	Severe	Significant	Insignificant
Separation	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Alignment of Floors within 20% of Storey Height	○ 1	○ 1	● 1
Alignment of Floors not within 20% of Storey Height	○ 0.4	○ 0.7	○ 0.8

Single standing building.

b) Factor D2: - Height Difference Effect

Factor D2 For Transverse Direction: 1.0

Table for Selection of Factor D2	Severe	Significant	Insignificant
	0<Sep<.005H	.005<Sep<.01H	Sep>.01H
Height Difference > 4 Storeys	○ 0.4	○ 0.7	○ 1
Height Difference 2 to 4 Storeys	○ 0.7	○ 0.9	○ 1
Height Difference < 2 Storeys	○ 1	○ 1	● 1

Single standing building.

Factor D 1.0

3.5 Site Characteristics - *Stability, landslide threat, liquefaction etc as it affects the structural performance from a life-safety perspective*

Effect on Structural Performance ○ *Severe* ○ *Significant* ● *Insignificant* **Factor E** 1.0

No site characteristics were noted and considered an hazard from a life-safety perspective.

3.6 Other Factors - *for allowance of all other relevant characterstics of the building*

For ≤ 3 storeys - Maximum value 2.5
otherwise - Maximum value 1.5.
No minimum.

Factor F 0.80

Record rationale for choice of Factor F:

-State of Masonry. Weak bricks in most parts with damage and large cracking.
-Lack of any meaningful diaphragm action between supporting walls due to long span of flexible timber trusses preventing any transverse frame action.

3.7 Performance Achievement Ratio (PAR)
(equals **A x B x C x D x E x F**)

PAR

Transverse **0.80**

WARNING!! *This initial evaluation has been carried out solely as an initial seismic assessment of the building following the procedure set out in "The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. This spreadsheet must be read in conjunction with the limitations set out in the accompanying report, and should not be relied on by any party for any other purpose. Detailed inspections and engineering calculations, or engineering judgements based on them, have not been undertaken, and these may lead to a different result or seismic grade.*

Initial Evaluation Procedure (IEP) Assessment - Completed for

Street Number & Name:	State Highway 48, Mt Ruapehu 3951	**Job No.:**	220138
AKA:	Chateau Tongariro Garage	**By:**	SL
Name of building:	Old fire station building	**Date:**	14/09/2023
City:	Whakapapa, Mt Ruapehu	**Revision No.:**	1

Table IEP-4 Initial Evaluation Procedure Steps 4, 5, 6 and 7

Step 4 - Percentage of New Building Standard *(%NBS)*

		Longitudinal	Transverse
4.1	**Assessed Baseline *%NBS (%NBS)*** $_b$ (from Table IEP - 1)	11%	11%
4.2	**Performance Achievement Ratio (PAR)** (from Table IEP - 2)	1.00	0.80
4.3	**PAR x Baseline *(%NBS)*** $_b$	15%	15%
4.4	**Percentage New Building Standard *(%NBS)* - Seismic Rating** (Use lower of two values from Step 4.3)		15%

Step 5 - Is *%NBS* < 34? YES

Step 6 - Potentially Earthquake Risk (is *%NBS* < 67)? YES

Step 7 - Provisional Grading for Seismic Risk based on IEP

Seismic Grade E

Additional Comments (items of note affecting IEP based seismic rating)

No additional notes. The rating is in line with the expected behaviour of the building, considering the year of construction and the materials used.

Relationship between Grade and *%NBS* :

Grade:	**A+**	**A**	**B**	**C**	**D**	**E**
%NBS:	**> 100**	**100 to 80**	**79 to 67**	**66 to 34**	**< 34 to 20**	**< 20**

WARNING!! *This initial evaluation has been carried out solely as an initial seismic assessment of the building following the procedure set out in "The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. This spreadsheet must be read in conjunction with the limitations set out in the accompanying report, and should not be relied on by any party for any other purpose. Detailed inspections and engineering calculations, or engineering judgements based on them, have not been undertaken, and these may lead to a different result or seismic grade.*

Initial Evaluation Procedure (IEP) Assessment - Completed for

Street Number & Name:	State Highway 48, Mt Ruapehu 3951	**Job No.:**	220138
AKA:	Chateau Tongariro Garage	**By:**	SL
Name of building:	Old fire station building	**Date:**	14/09/2023
City:	Whakapapa, Mt Ruapehu	**Revision No.:**	1

Table IEP-5 Initial Evaluation Procedure Step 8

Step 8 - Identification of potential Severe Structural Weaknesses (SSWs) that could result in significant risk to a significant number of occupants

8.1	Number of storeys above ground level	1
8.2	Presence of heavy concrete floors and/or concrete roof? (Y/N)	N

Potential Severe Structural Weaknesses (SSWs):

Note: Options that are greyed out are not applicable and need not be considered.

Occupancy not considered to be significant - no further consideration required

Risk not considered to be significant - no further consideration required

The following potential Severe Structural Weaknesses (SSWs) have been identified in the building that could result in significant risk to a significant number of occupants:

1. None identified

2. Weak or soft storey (except top storey)

3. Brittle columns and/or beam-column joints the deformations of which are not constrained by other structural elements

4. Flat slab buildings with lateral capacity reliant on low ductility slab-to-column connections

5. No identifiable connection between primary structure and diaphragms

6. Ledge and gap stairs

IEP Assessment Confirmed by ______________ **Signature**

Umair Siddiqui **Name**

1150494 **CPEng. No**

WARNING!! *This initial evaluation has been carried out solely as an initial seismic assessment of the building following the procedure set out in "The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. This spreadsheet must be read in conjunction with the limitations set out in the accompanying report, and should not be relied on by any party for any other purpose. Detailed inspections and engineering calculations, or engineering judgements based on them, have not been undertaken, and these may lead to a different result or seismic grade.*

Initial Evaluation Procedure (IEP) Assessment - Completed for

Page 1a

Street Number & Name:	State Highway 48, Mt Ruapehu 3951	**Job No.:**	220138
AKA:	Chateau Tongariro Garage	**By:**	SL
Name of building:	Old fire station building	**Date:**	14/09/2023
City:	Whakapapa, Mt Ruapehu	**Revision No.:**	1

Table IEP-1a Additional Photos and Sketches

Add any additional photographs, notes or sketches required below:

Note: print this page separately

See App B

WARNING!! *This initial evaluation has been carried out solely as an initial seismic assessment of the building following the procedure set out "The Seismic Assessment of Existing Buildings" Technical Guidelines for Engineering Assessments, July 2017. This spreadsheet must be read in conjunction with the limitations set out in the accompanying report, and should not be relied on by any party for any other purpose. Detailed inspections and engineering calculations, or engineering judgements based on them, have not been undertaken, and these may lead to a different result or seismic grade.*

miyamoto.

Title:	Tongariro Chateau - URM Garage Building	Job No.	220138
		Page No.	
Description:	South wall - typical bay	Date	28/09/23
		Author:	SL
		Reviewer:	
		Revision:	

Out of plane adequacy of simple supported masonry walls

Description

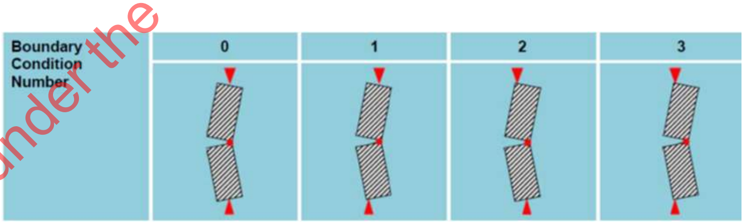
What does this work sheet do?

This spread sheet calculates the adequacy of out of plane capacity of URM walls spaning vertically between adjacent floors using an inelastic displacement-based approach (10.8.5.2 NZSEE)

Assumptions:

Assumption 1	Calculation is for unit length of wall
Assumption 2	Wall section is rectangular in both vertical and horizontal direction with no openning
Assumption 3	For calculation of demand force on fixings ductility and risk factor of wall is assumed 1 (R_p=1,μ_P=1)

Building Information		Unit	Discription
Zone factor (z):	0.27		*Clause 3.1.4 NZS 1170.5*
Return period (R)	1		*Clause 3.1.4 NZS 1170.5*
N(T,N)	1		*Clause 3.1.4 NZS 1170.5*
$C_h(0)$ on soil type	1.12		*For soil type A insert **1** , type C: **1.33** and for type D& E: **1.12***
Total height (h_n)	2.5	*m*	*Height form base to upper most seismic weight (usually top floor)*
Wall's height (h_i)	2.5	*m*	*Average height of top and bottom floors that the wall is vertically spanning between*
Drift	0.025		*If inter story drift is expected to be less than 1% insert **0** otherwise **0.025** (ULS limit)*
Masonry wall's information			
Brick Density:	16900	*N/m³*	*Material Strengths assumed similar to Chateau Tongariro Hotel - Glenburn Bricks*
Boundary conditio	0		*Select based on position of load coming form above and base support*
R_p	1		*Table 8.1*
P	0	*N/m*	*G,Q No weight as its an infill*
h	2.5	*m*	*Height (from top to bot of the wall)*
t_{nom}	0.17	*m*	*Thickness*
W	7182.5	*N*	
t_{eff}	0.1658	*m*	
e_b	0	*m*	
e_p	0	*m*	
b	483.02	Nm/m	
a	8978.1	Nm/m	
Δ_i	0.0673	*m*	
Δ_m	0.0404	*m*	*Out of plane displacement capacity of URM wall*
J	393.07	*kg.m²/m*	
T_p	0.8516	*sec*	
γ	1.4552		
C(0)	0.3024	*g*	
C_{Hi}	1.4167		
$C_p(T_p)$	0.77	*g*	*From spectrum (next page) insert the spectral ordinate corresponding to T_p*
$C_p(T_p)R_p$	0.77	OK	*Checks Rp.Cp(Tp)<3.6*
D_{ph}	0.2019	*m*	*Out of plane displacement demand*
%NBS	20.0	*%*	*Final result showing URM wall adequacy based on %NBS*
Out of plane fixing - Not applicable			
A	1	*m or m²*	*Enter the tributary area of wall being held by a fixing consider two adjacent story*
$C_p(0.75)$	1.1	*g*	*From spectrum (next page) insert the spectral ordinate corresponding to **0.75** sec*
C_m	0.1326	*g*	
$C_{m\text{-}min}$	0.1326	*g*	*Seismic coefficient of load on fixing*
F_{dem}	0.381	*kN*	*Out of plane demand force on fixing*
F_{cap}	5	*kN*	*Enter the capacity calculated based on 10.8.4 NZSEE*
%NBS	1312.5	*%*	*Final result showing the fixing adequacy based on %NBS*



Note the fixings were observed to be corroded and unlikely to contribute in tying wythes

miyamoto.

Title:	Tongariro Chateau - URM Garage Building	Job No.	220138
		Page No.	
Description:	East (Front) wall north corner - 3 bricks thick	Date	28/09/23
		Author:	SL
		Reviewer:	
		Revision:	

Out of plane adequacy of simple supported masonry walls

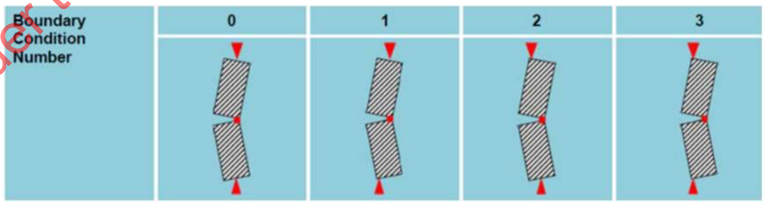
Description

What does this work sheet do?

This spread sheet calculates the adequacy of out of plane capacity of URM walls spaning vertically between adjacent floors using an inelastic displacement-based approach (10.8.5.2 NZSEE)

Assumptions:

Assumption 1	Calculation is for unit length of wall
Assumption 2	Wall section is rectangular in both vertical and horizontal direction with no openning
Assumption 3	For calculation of demand force on fixings ductility and risk factor of wall is assumed 1 (R_p=1,μ_P=1)

Building Information		Unit	Discription
Zone factor (z):	0.27		*Clause 3.1.4 NZS 1170.5*
Return period (R):	1		*Clause 3.1.4 NZS 1170.5*
N(T,N)	1		*Clause 3.1.4 NZS 1170.5*
$C_h(0)$ on soil type	1.12		*For soil type A insert **1**, type C: **1.33** and for type D& E: **1.12***
Total height (h_n)	6.5	*m*	*Height form base to upper most seismic weight (usually top floor)*
Wall's height (h_i)	3	*m*	*Average height of top and bottom floors that the wall is vertically spanning between*
Drift	0.025		*If inter story drift is expected to be less than 1% insert **0** otherwise **0.025** (ULS limit)*
Masonry wall's information			
Brick Density:	18000	*N/m^3*	*Material Strengths assumed similar to Chateau Tongariro Hotel bricks*
Boundary condition:	0		*Select based on position of load coming form above and base support*
R_p	1		*Table 8.1*
P	4000	*N/m*	*G,Q*
h	3	*m*	*Height (from top to bot of the wall)*
t_{nom}	0.27	*m*	*Thickness*
W	14580	*N*	
t_{eff}	0.2614	*m*	
e_b	0	*m*	
e_p	0	*m*	
b	2677.8	*Nm/m*	
a	33870	*Nm/m*	
Δ_i	0.11859	*m*	
Δ_m	0.07116	*m*	*Out of plane displacement capacity of URM wall*
J	1201.78	*$kg.m^2/m$*	
T_p	0.76665	*sec*	
γ	1.39129		
C(0)	0.3024	*g*	
C_{Hi}	1.5		
$C_p(T_p)$	0.77	*g*	*From spectrum (next page) insert the spectral ordinate corresponding to T_p*
$C_p(T_p)R_p$	0.77	OK	*Checks Rp.Cp(Tp)<3.6*
D_{ph}	0.15647	*m*	*Out of plane displacement demand*
%NBS	45.5	%	*Final result showing URM wall adequacy based on %NBS* *Note that this doesn't consider existing damage if any*
Out of plane fixing - Not applicable			
A		*m or m^2*	*Enter the tributary area of wall being held by a fixing consider two adjacent story*
$C_p(0.75)$		*g*	*From spectrum (next page) insert the spectral ordinate corresponding to **0.75** sec*
C_m	0.26988	*g*	
C_{m-min}	#REF!	*g*	*Seismic coefficient of load on fixing*
F_{dem}	#REF!	*kN*	*Out of plane demand force on fixing*
F_{cap}		*kN*	*Enter the capacity calculated based on 10.8.4 NZSEE*
%NBS	#REF!	%	*Final result showing the fixing adequacy based on %NBS*

miyamoto.

Title:	Tongariro Chateau - URM Garage Building	Job No.	220138
		Page No.	
Description:	Gabled roof end wall (west elevation)	Date	25/09/23
		Author:	SL
		Reviewer:	
		Revision:	

Out of plane adequacy of cantilever masonry walls

Description

What does this work sheet do?

This spread sheet calculates the adequacy of out of plane capacity of URM walls cantilevering vertically from floors using using an inelastic displacement-based approach (10.8.5.2 NZSEE)

Assumptions

Assumption 1	Calculation is for unit length of wall
Assumption 2	Wall section is rectangulare in both vertical and horizontal with no openning
Assumption 3	For calculation of demand force on fixings ductility and risk factor of wall is: 1 (R_p=1,μ_p=1)

Building Information		Unit	Discription
Zone factor (z):	0.27		*Clause 3.1.4 NZS 1170.5*
Return period (R):	1		*Clause 3.1.4 NZS 1170.5*
N(T,N)	1		*Clause 3.1.4 NZS 1170.5*
$C_h(0)$ on soil type	1.12		*For soil type A insert* ***1***, *type C:* ***1.33*** *and for type D& E:* ***1.12***
Total height (h_n)	6.5	*m*	*Height form base to upper most seismic weight (usually top floor)*
Wall's height (h_i)	2.3	*m*	*Average height of top and bottom floors that the wall is vertically spanning bet ween*
Masonry wall's information			
Brick Density:	16900	*N/m³*	*Material Strengths assumed similar to Chateau Tongariro Hotel - Glenburn Bricks*
R_p	1		*Table 8.1*
h	3	*m*	*Height of the cantilever wall above the base*
t_{nom}	0.14	*m*	
W	7098	*N*	
t_{eff}	0.1372	*m*	
e_b	0.0686	*m*	
Δ_i	0.1372	*m*	
Δ_m	0.0412	*m*	*Displacement capacity of URM cantilever wall measured at top of the wall*
T_p	1.4011	*sec*	
γ	1.4969		
C(0)	0.3024	*g*	
C_{Hi}	1.3833		
$C_p(T_p)$	0.92	*g*	*From spectrum (next page) insert the spectral ordinate corresponding to* T_p
$C_p(T_p)R_p$	0.92	*OK*	*Checks Rp.Cp(Tp)<3.6*
D_{ph}	0.6718	*m*	*Displacement demand*
%NBS	**6.1**	*%*	*Final result showing URM wall adequacy based on %NBS*
Out of plane fixing - Not applicable			
A	3	*m²*	*Enter the maximum tributary area of wall being held by a fixing*
$C_p(0.75)$	0.82	*g*	*From spectrum (next page) insert the spectral ordinate corresponding to* ***0.75*** *sec*
C_m	0.0457	*g*	
C_{m-min}	0.0457	*g*	
F_{dem}	0.3246	*kN*	*Maximum base shear at the base of cantilever wall*
F_{cap}	0.2	*kN*	*Enter the capacity calculated based on 10.4.8 NZSEE*
%NBS	~~61.611~~	*%*	*Final result showing the fixing adequacy based on %NBS*

Note the fixings were observed to be corroded and unlikely to contribute in tying wythes