# HUP2-T0-Seismic Assessments
# WCC Housing Detailed Seismic Assessments

146 Daniell Street – DANI– Detailed Seismic Assessment

**Wellington City Council**

Reference 525885

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# Document control record

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# Executive Summary

## Scope and Basis of Assessment

Aurecon have been engaged by the Wellington City Council (WCC) to provide a Detailed Seismic Assessment (DSA) for the building located at the 146 Daniell Street Newtown, Wellington. The building is known as the **Daniell Street Block I Building**.

The DSA was generally completed in accordance *The Seismic Assessment of Existing Buildings – Technical Guidelines for Engineering Assessments*, dated July 2017 (**Red Book**), including the *updated Section C5 – Concrete Buildings – Proposed Revision to the Engineering Assessment Guidelines*, dated November 2018 (the **Yellow Chapter**). These are collectively noted as the **Guidelines**.

The Building is considered to be an **Importance Level 2 (IL2)** structure, located on a **Site Subsoil Class B** site as defined by NZS 1170.5:2004

## Results Summary

The seismic rating of a building is generally limited by the lowest scoring element; therefore, the Building achieves an earthquake rating of **15%*NBS*(IL2)** in accordance with the **Guidelines**. This rating of **15%*NBS*** is based on the Critical Structural Weakness (**CSW**) of the perimeter external reinforcement concrete chimney overturning capacity to resist out-of-plane parts seismic loading. The chimney is anticipated to fall away from the building, potentially posing a hazard to pedestrians during a design-level earthquake. However, the chimney is not expected to be a hazard for people inside the building during such an event.

The Building also contains other distinct elements that are classified as structural weaknesses (**SW**). A **SW** is an aspect of the building structure and/or the foundation soils that scores less than 100%*NBS* and a **CSW** is the lowest scoring structural weakness.

While the %*NBS* of the building may be low, it is importance to recognise that this structure is a light timber-framed building. Such buildings, characterised by their construction, often exhibit superior performance in the face of significant earthquake shaking, particularly in terms of life safety. The anticipated performance of this building in a design-level earthquake is expected to surpass the implications of its %*NBS* rating, indicating a higher level of resilience and life safety compared to heavier structures.

The Table below presents a summary of the results based on the **Guidelines.**

**Table: Summary of Elements - %*NBS* scores**

| Element: | %*NBS*(IL2): | Commentary: |
|---|---|---|
| Timber framed brace walls with plasterboard sheathing – Longitudinal Direction | 35-55% | ▪ The timber framed walls have insufficient in-plane capacity in the longitudinal direction at the ground level. The bracing was assessed using a ductility of 3.5 and Sp=0.5. The range of %NBS is due to the unknown plasterboard fixing spacing. The lower bound range is derived by assuming the plasterboard fixing at 300mm centres and the resistance from external weatherboard, and the upper bound %NBS is determined based on the plasterboard fixing at 150mm centres and external weatherboard.<br>▪ The out-of-plane seismic load from the unreinforced block party walls must be resisted by the walls in the longitudinal direction. And the total length of timber framed brace wall in the longitudinal direction is relatively short compared to the walls in the transverse direction.<br>▪ The timber framed walls in the longitudinal direction at the first level scores at 100%*NBS*(IL2). |

| | | |
|---|---|---|
| Timber framed brace walls with plasterboard sheathing – Transverse Direction | 100% | ▪ The timber framed wall scores 100%*NBS* in transverse direction using a ductility of 3.5 and Sp=0.5.<br>▪ The unreinforced block party walls in this direction bear their own seismic inertia load, including some timber floor loading determined by tributary width. As a result, the seismic load of the party walls in this direction does not transfer to the adjacent timber frame walls. |
| Timber Diaphragms: | 40% | ▪ The flexible timber diaphragms score 40%*NBS* in the longitudinal and transverse direction. The diaphragm must transfer the out-of-plane seismic load from the party walls to the timber braced plasterboard walls. |
| Roof | 100% | ▪ The diaphragm scores 100%*NBS* in the longitudinal and transverse direction. |
| Unreinforced Block Party Wall | 60% | ▪ The unreinforced block party wall lacks the capacity to resist out-of-plane seismic loading. However, the timber studs on either side of the walls can vertically span between levels, preventing the walls from falling out-of-plane. The timber studs achieve a 60%*NBS* score based on their flexural capacity.<br>▪ Additionally, we observe, based on the existing drawings, that there is no apparent positive connection from the party walls to the diaphragm. Instead, the walls are expected to bear on the timber joists and diaphragm to transfer their load.<br>▪ The unreinforced block party walls are governed by toe crushing when subjected to in-plane loading and achieve a score of 100%*NBS*. |
| RC Chimneys | 15% | ▪ The perimeter external reinforcement concrete (RC) chimney overturning capacity to resist out-of-plane parts seismic loading.<br>▪ The chimney is expected to overturn away from the building, potentially posing a hazard to pedestrians during a design-level earthquake. However, it is not anticipated to be a hazard for individuals inside the building during such an event. The chimney is not positively tied back to the timber structure and functions as a stand-alone structure.<br>▪ The internal RC chimneys have sufficient capacity to resist out-of-plane seismic loading. The existing drawings indicate that the original internal RC chimneys are positively connected to the party walls with reinforced bars. The internal chimneys are expected to bear on the timber joists and diaphragm to transfer their load. |
| Foundations: | 100% | ▪ The foundations can resist the soil bearing pressure demands and scores >100%*NBS*(IL2).<br>▪ The building is constructed on concrete perimeter walls with a sub-floor height of less than 600mm. According to the Guidelines, buildings with a sub-floor height of 600 mm or less are unlikely to present a life safety hazard if they come off their foundations, although significant damage may result. |

| | | |
|---|---|---|
| Stairs | N/A | ▪ The stairs are timber-framed boxed stairs. The existing structural drawings do not contain sufficient information to seismically assess the stairs.<br>▪ However, according to the Guidelines, internal stairs constructed of timber are unlikely to lead to a significant life safety hazard due to loss of egress. |

We note that the non-structural building elements is not part of this DSA. However, a desktop study of the available documentation did not identify any large plant, ceilings, and partitions that would raise concern.

## Recommendations

We recommend retrofitting the building to achieve a minimum seismic rating greater than 34%NBS (IL2). Our review indicates that seismic strengthening, to attain a rating exceeding 34%NBS (IL2), would involve, but not be limited to:

- Removing the external chimney.

Upon the removal of the external chimney, the building would still have a seismic rating below 67%NBS. Despite this rating, it's important to note that lightweight timber buildings demonstrate superior performance in significant earthquake shaking, particularly in terms of life safety. Therefore, in our opinion, no further actions are critically required to strengthen the building once the external chimney is removed.

However, if the Wellington City Council wishes to enhance the building's seismic resilience, we recommend a seismic retrofit to achieve a minimum rating of 67%NBS (IL2). This retrofit should include:

- Replacing lining materials for existing walls in specific locations with modern plasterboard linings and fixings.
- Installing additional anchors to connect internal party walls to the timber diaphragm.
- Installing additional anchors to connect the building to the existing foundations.

We further recommend that, in designing any seismic retrofit, the building owner should also consider the proposed increase in seismic hazard levels in Wellington. This would insulate the building against further future reductions in the seismic rating.

Finally, we recommend undertaking onsite investigations to confirm that the structure and the northern retaining wall are not positively connected.

# Contents

# 1 Introduction

## 1.1 Scope of Assessment

### 1.1.1 General

Aurecon have been engaged by the Wellington City Council (WCC) to provide a Detailed Seismic Assessment (DSA) for seven accommodation buildings located on Daniell Street, Newton, Wellington. Refer to Figure 1-1 for the site's location and layout.

The buildings include:

1. 140 Daniell Street - DANF
2. 142 Daniell Street - DANG
3. 144 Daniell Street - DANH
4. **146 Daniell Street - DANI**
5. 148 Daniell Street - DANJ
6. 175 Daniell Street - DANK
7. 175 Daniell Street – DANL

This DSA report is for the **146 Daniell Street - DANI** (Building I). Figure 1-2 shows a photo of the building.

On an unknown date, the northern unit of the building was removed and replaced with a car park and retaining wall (Figure 1-3). For this DSA, we assumed that the structure and retaining wall are not positively connected and that the structure does not resist any soil loading. Further investigations are required to confirm this assumption.

The DSA focuses on life safety issues as the primary objective. This means that the earthquake scores or rating is based primarily on life safety considerations rather than damage to the building or its contents unless this might lead to damage to adjacent property. The earthquake rating assigned is, therefore, not reflective of serviceability performance.

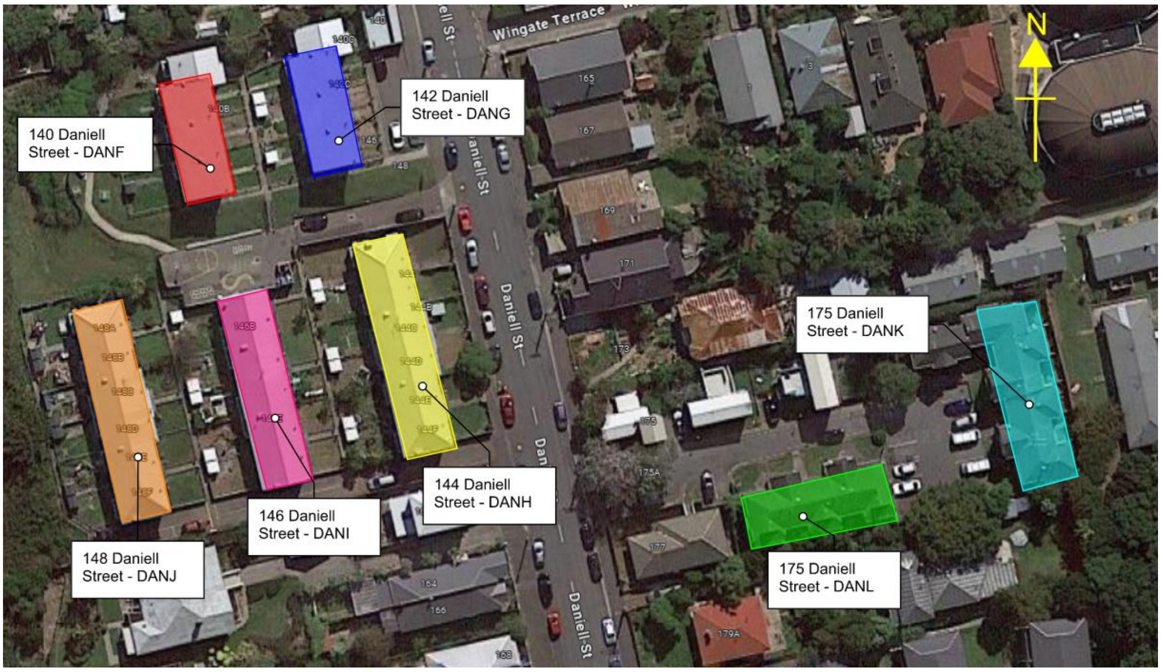



**Figure 1-1. Structures included in the Daniell Street DSAs (Source: Google Earth)**


**Figure 1-2. Photo of the Building**

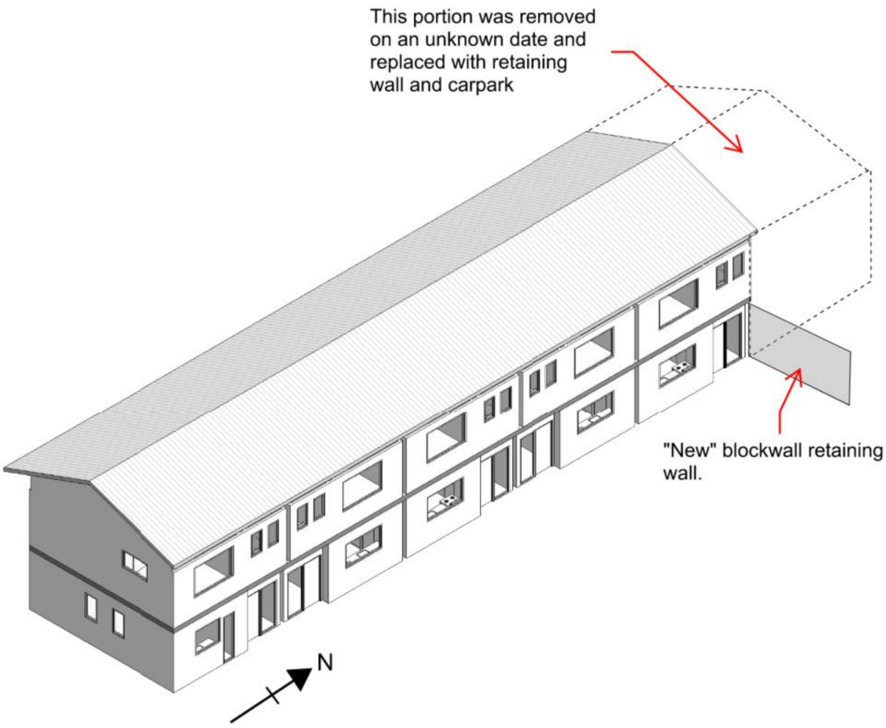



**Figure 1-3. 3D View of Building**

### 1.1.2 Scope

The purpose of this assessment is to complete Detailed Seismic Assessment (DSA) generally in accordance *The Seismic Assessment of Existing Buildings – Technical Guidelines for Engineering Assessments*, dated July 2017 (**Red Book**), including the *updated Section C5 – Concrete Buildings – Proposed Revision to the Engineering Assessment Guidelines*, dated November 2018 (the **Yellow Chapter**). These are collectively noted as the **Guidelines**. The assessment will provide a %*NBS* score for building elements that may pose a life hazard during an earthquake and provide an overall seismic %NBS rating to the building.

### 1.1.3 Importance Level

The building has been assessed as an **Importance Level 2 (IL2)** building and a design life of 50 years, in accordance with the New Zealand Building Code. A return period factor 'R' of 1.0 has therefore been used in accordance with NZS1170.5.

### 1.1.4 Site and subsoil class

Based on our review of the published geology and historic ground investigations, we are using the NZS 1170.5:2004 **site subsoil classification of B** for this site.

Geotechnical hazards such as liquefaction, landslide and lateral spreading are outside the scope of this assessment.

### 1.1.5 Hazard Zone Factor

The hazard zone factor Z determines the "seismic risk" area in accordance with NZS1170.5. There are different hazard zones factors depending on the buildings located in New Zealand. From NZS1170.5, we have used a hazard factor of **Z=0.40** for Wellington.

## 1.2 Regulatory Environment and Design Standards

The DSA was generally completed in accordance with the **Guidelines**. The Guidelines support seismic assessments undertaken for building regulatory requirements set by the Building Act 2004 as amended by the Earthquake-prone Buildings Amendment Act 2016. The Building Act 2004 sets out the framework for identifying and managing earthquake-prone buildings including that:

- Territorial Authorities (TAs) must identify potentially earthquake-prone buildings.
- Building owners of potentially earthquake-prone buildings must commission an engineering assessment.
- TAs must use this information to determine whether or not a building or part is earthquake prone.

## 1.3 Assessment Methodology

The Guidelines provide solutions and methods for the assessment of existing buildings and give guidance for strengthening methodologies that are considered acceptable. We have undertaken a stepped analysis approach to assess this building. Due to the buildings straightforward design, we conducted hand calculations using a force-based method for this assessment.

## 1.4 Building Description

Summary information about the building is presented in Table 1-1.

**Table 1-1. Building summary information**

| Element: | Details |
|---|---|
| Building Name | ▪ Daniell Street Block I Building |
| Street Address | ▪ 146 Daniell Street, Newtown |
| Age | ▪ 1952 |
| Description / Building Occupancy | ▪ Accommodation with 5 units |
| Importance Level | ▪ IL2 |
| Building Footprint / Floor Area | ▪ Approx. 210m2 per floor |
| No. of storeys / basements | ▪ 2 Stories |
| Structural system | ▪ Timber framed building with unreinforced block party walls between the tenancies |
| Earthquake resisting system | ▪ Longitudinal Direction - Timber framed brace walls with plasterboard sheathing<br>▪ Transverse direction - Timber framed brace walls with plasterboard sheathing and unreinforced block party walls |
| Foundation System | ▪ RC shallow foundations with local pads foundations and ground beams |
| Stair's system | ▪ Timber stairs with fixed-fixed connections |
| Other notable features | ▪ N/A |
| Past seismic retrofit/strengthening | ▪ N/A |
| Construction information | ▪ Original structural drawings |
| Likely Design Standards | ▪ N/A |
| Heritage Status | ▪ N/A |
| Seismic Risk Area | ▪ High |
| Priority building status | ▪ N/A |
| Other | ▪ N/A |

## 1.5 Geotech Site Conditions

Based on our review of the published geology and historic ground investigations, we are using the NZS 1170.5:2004 **site subsoil classification of B** for this site.

Geotechnical hazards such as liquefaction, landslide and lateral spreading are outside the scope of this assessment.

## 1.6 Previous Assessments

No previous assessment has been completed for this building.

## 1.7 Structural System Description

### 1.7.1 Vertical Lateral Resisting Elements

The primary lateral resisting system in the longitudinal consists of:

- Timber framed brace walls with plasterboard sheathing.

The primary lateral resisting system in the transverse direction consists of:

- Timber framed brace walls with plasterboard sheathing.
- Unreinforced block party walls.

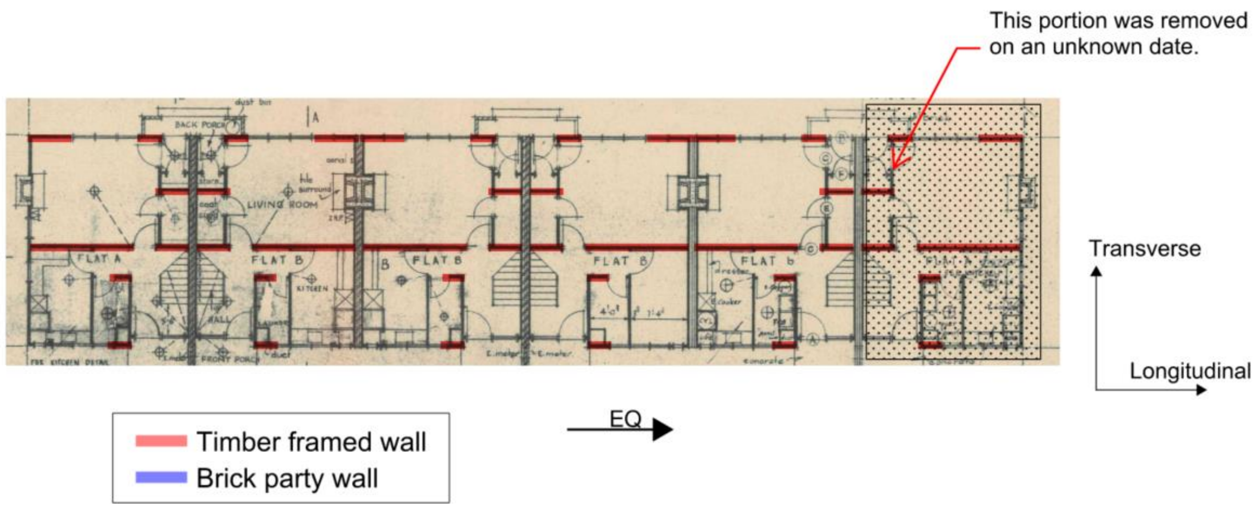



**Figure 1-4. Lateral Load Resisting Elements in the Longitudinal Direction**

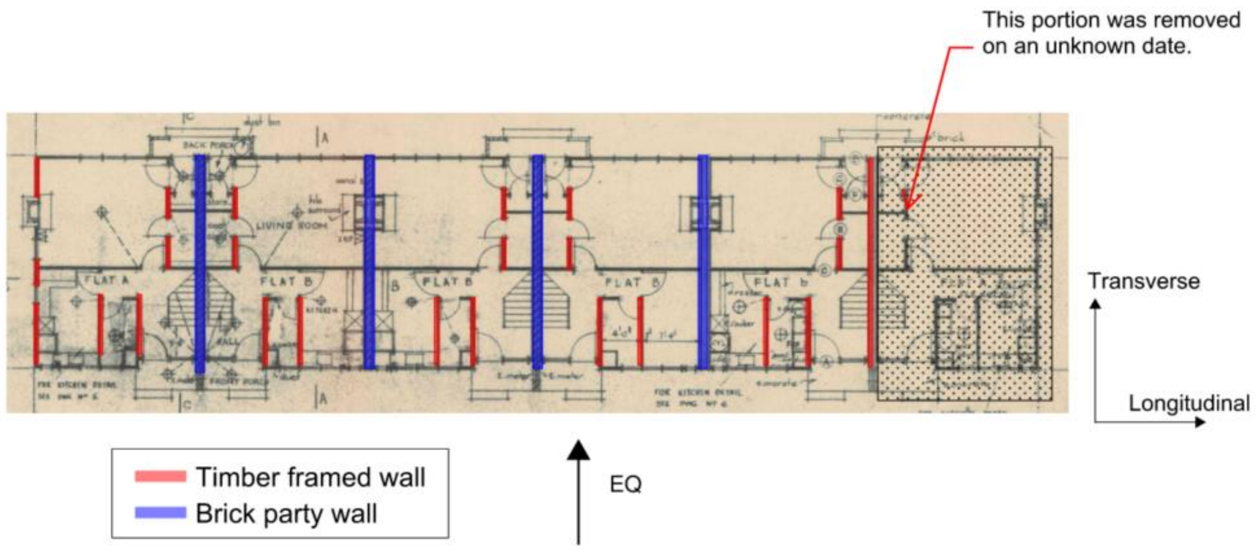



**Figure 1-5. Lateral Load Resisting Elements in the Transverse Direction**

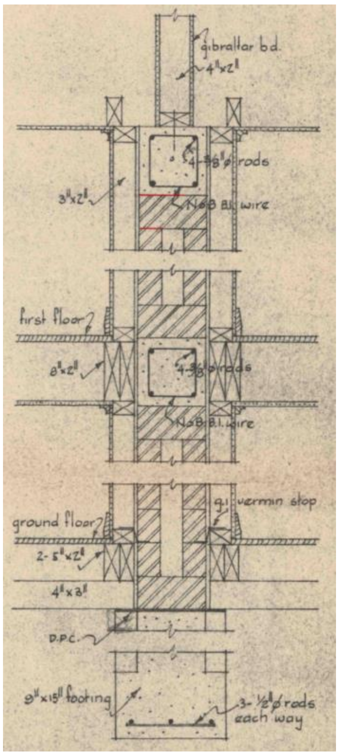



Figure 1-6 RC Party Wall Elevation

### 1.7.2 Horizontal Lateral Resisting Elements

The horizontal lateral load resisting system on the ground level, level 1 and the roof consist of transverse timber sheathing board. This type of diaphragm consists of 25 mm thick boards, approximately 100-200 mm wide, nailed in a single layer at right angles to the cross members such as joists in a floor or rafters in a roof.

The sheathing serves the dual purpose of supporting gravity loads and resisting shear forces in the diaphragm. We have assumed that the sheathing has been nailed with 60 mm long, 3.15 mm diameter jolt head nails, with two nails per sheathing board at each support. Shear forces perpendicular to the direction of the sheathing are resisted by the nail couple and some major axis bending of the sheathing boards. Shear forces parallel to the direction of the sheathing are transferred through the nails in the supporting joists or framing members below the sheathing joints, which then work in weak axis bending.

The diaphragm functions as a flexible component, distributing seismic loads to the primary lateral resisting elements according to its tributary area.

## 1.8 Foundations

The building is supported by RC strip footings at internal 300x300 piers.  The strip footings vary in width from 150–190mm. The foundations are reinforced with a single layer of bottom reinforcement, no top steel or steel stirrups have been placed in the strip footings. The strip footings serve to distribute gravity and vertical seismic forces to the soil below.

Refer to Figure 1-7 for below the typical strip footing detail and Figure 1-8 for a typical strip footing section.

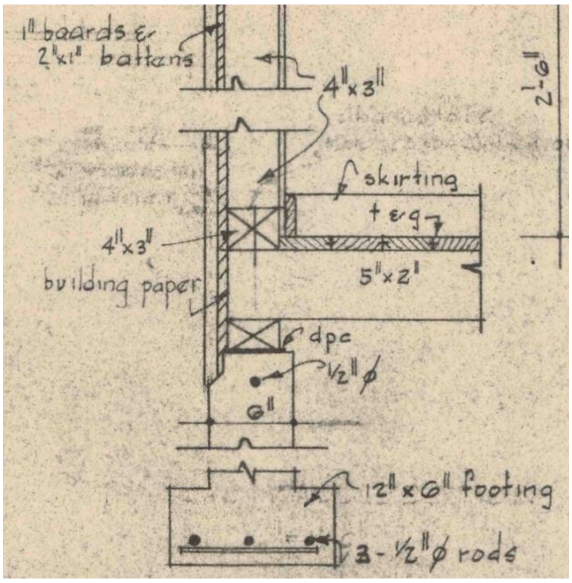



**Figure 1-7. Typical Strip Footing Detail**

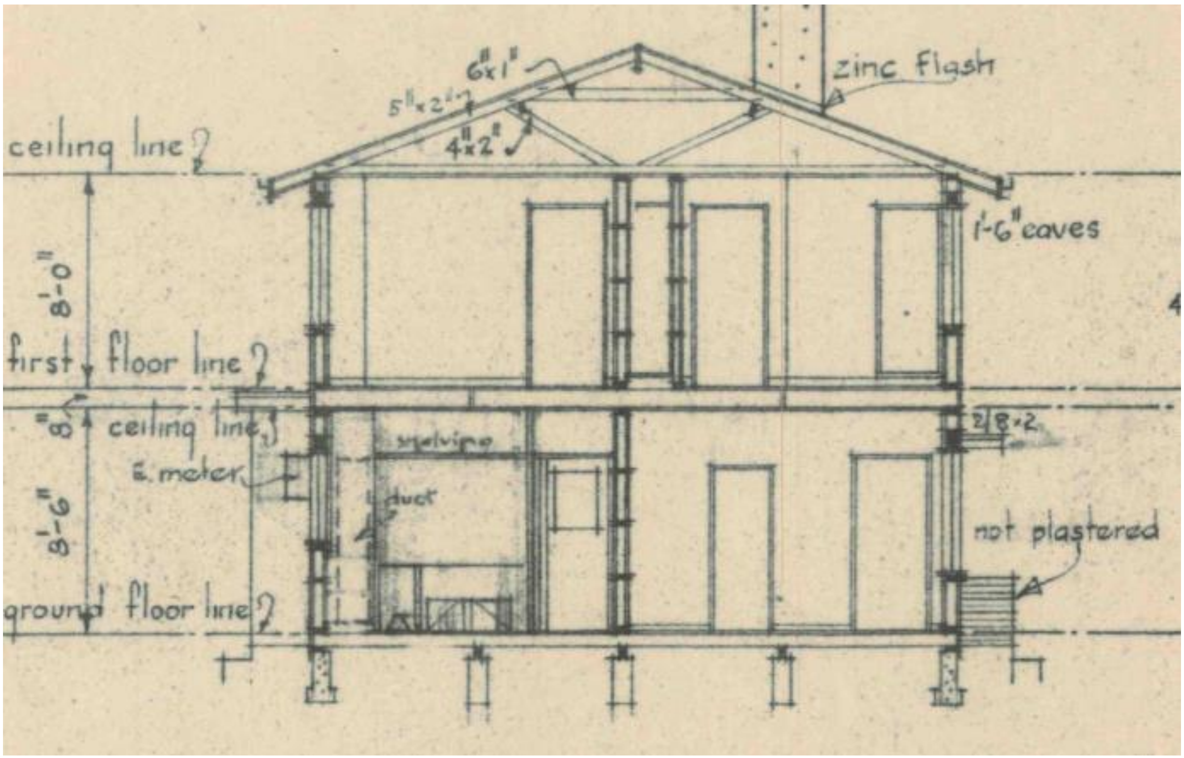



**Figure 1-8. Typical Strip Footing Section**

# 2 Assessment Results

## 2.1 Assessment Results Summary

The results of the DSA indicate that the Building's earthquake rating to be **25%*NBS*(IL2**) in accordance with the **Guidelines**. The earthquake rating is based on the lowest scoring element shown in **Table 2-1.**

**Table 2-1 Summary of Elements - %NBS scores**

| Element: | %*NBS*(IL2): | Commentary: |
|---|---|---|
| Timber framed brace walls with plasterboard sheathing – Longitudinal Direction | 35-55% | ▪ The timber framed walls have insufficient in-plane capacity in the longitudinal direction at the ground level. The bracing was assessed using a ductility of 3.5 and Sp=0.5. The range of %NBS is due to the unknown plasterboard fixing spacing. The lower bound range is derived by assuming the plasterboard fixing at 300mm centres and the resistance from external weatherboard, and the upper bound %NBS is determined based on the plasterboard fixing at 150mm centres and external weatherboard.<br>▪ The out-of-plane seismic load from the unreinforced block party walls must be resisted by the walls in the longitudinal direction. And the total length of timber framed brace wall in the longitudinal direction is relatively short compared to the walls in the transverse direction.<br>▪ The timber framed walls in the longitudinal direction at the first level scores at 100%*NBS*(IL2). |
| Timber framed brace walls with plasterboard sheathing – Transverse Direction | 100% | ▪ The timber framed wall scores 100%*NBS* in transverse direction using a ductility of 3.5 and Sp=0.5.<br>▪ The unreinforced block party walls in this direction bear their own seismic inertia load, including some timber floor loading determined by tributary width. As a result, the seismic load of the party walls in this direction does not transfer to the adjacent timber frame walls. |
| Timber Diaphragms: | 40% | ▪ The flexible timber diaphragms score 40%*NBS* in the longitudinal and transverse direction. The diaphragm must transfer the out-of-plane seismic load from the party walls to the timber braced plasterboard walls. |
| Roof | 100% | ▪ The diaphragm scores 100%*NBS* in the longitudinal and transverse direction. |
| Unreinforced Block Party Wall | 60% | ▪ The unreinforced block party wall lacks the capacity to resist out-of-plane seismic loading. However, the timber studs on either side of the walls can vertically span between levels, preventing the walls from falling out-of-plane. The timber studs achieve a 60%*NBS* score based on their flexural capacity.<br>▪ Additionally, we observe, based on the existing drawings, that there is no apparent positive connection from the party walls to the diaphragm. Instead, the walls are expected to bear on the timber joists and diaphragm to transfer their load.<br>▪ The unreinforced block party walls are governed by toe crushing when subjected to in-plane loading and achieve a score of 100%*NBS*. |

| | | |
|---|---|---|
| RC Chimneys | 15% | ▪ The perimeter external reinforcement concrete (RC) chimney overturning capacity to resist out-of-plane parts seismic loading.<br>▪ The chimney is expected to overturn away from the building, potentially posing a hazard to pedestrians during a design-level earthquake. However, it is not anticipated to be a hazard for individuals inside the building during such an event. The chimney is not positively tied back to the timber structure and functions as a stand-alone structure.<br>▪ The internal RC chimneys have sufficient capacity to resist out-of-plane seismic loading. The existing drawings indicate that the original internal RC chimneys are positively connected to the party walls with reinforced bars. The internal chimneys are expected to bear on the timber joists and diaphragm to transfer their load. |
| Foundations: | 100% | ▪ The foundations can resist the soil bearing pressure demands and scores >100%*NBS*(IL2).<br>▪ The building is constructed on concrete perimeter walls with a sub-floor height of less than 600mm. According to the Guidelines, buildings with a sub-floor height of 600 mm or less are unlikely to present a life safety hazard if they come off their foundations, although significant damage may result. |
| Stairs | N/A | ▪ The stairs are timber-framed boxed stairs. The existing structural drawings do not contain sufficient information to seismically assess the stairs.<br>▪ However, according to the Guidelines, internal stairs constructed of timber are unlikely to lead to a significant life safety hazard due to loss of egress. |

## 2.2 Structural Weaknesses

A structural weakness (**SW**) is an aspect of the building structure and/or the foundation that scores less than 100%*NBS*(IL2). The Critical Structural Weakness (**CSW**) is the lowest scoring structural weakness determined in the assessment. Based on the results of the DSA, the CSW for this building is:

- External RC Chimneys

See below for the other structural weaknesses for the elements considered in this DSA:

- Timber framed brace walls with plasterboard sheathing – Longitudinal Direction
- Unreinforced Block Party Wall
- Level 1 and Roof diaphragms

## 2.3 Severe Structural Weaknesses

A Severe Structural Weakness (SSW) is a defined structural weakness that is potentially associated with catastrophic collapse and for which the capacity may not be reliably assessed based on current knowledge.

There are no SSWs identified for this building.

# 3 Secondary Elements

## 3.1 Stairs

The stairs are timber-framed boxed stairs. The existing structural drawings do not contain sufficient information to seismically assess the stairs.

However, according to the Guidelines, internal stairs constructed of timber are unlikely to lead to a significant life safety hazard due to loss of egress. Refer to Figure 3-1 that shows the locations of the stairs.

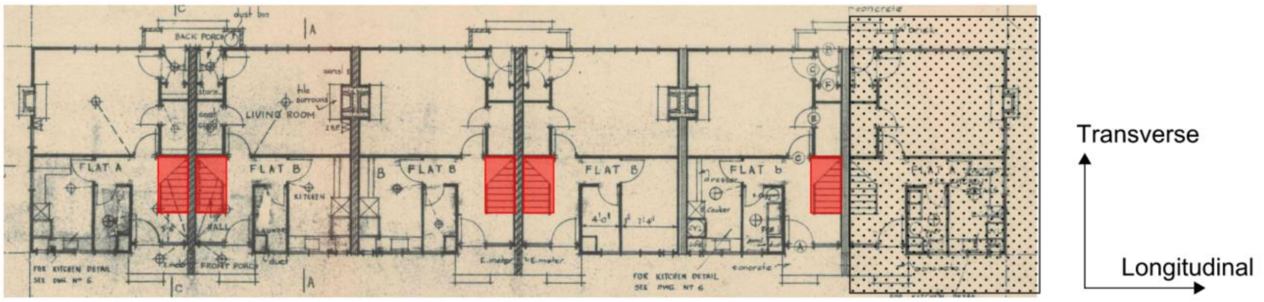



**Figure 3-1. Stair Locations**

## 3.2 Chimney

The perimeter external reinforcement concrete chimney overturning capacity to resist out-of-plane parts seismic loading. The perimeter chimney is not positively connected to the main structure. The chimney is anticipated to fall away from the building, potentially posing a hazard to pedestrians during a design-level earthquake. However, the chimney is not expected to be a hazard for people inside the building during such an event. The chimney is not positively tied back to the timber structure and functions as a stand-alone structure. The external chimney failure mode is shown in Figure 3-3.

The internal RC chimneys have sufficient capacity to resist out-of-plane seismic loading. The internal chimneys are expected to bear on the timber joists and diaphragm to transfer their load.

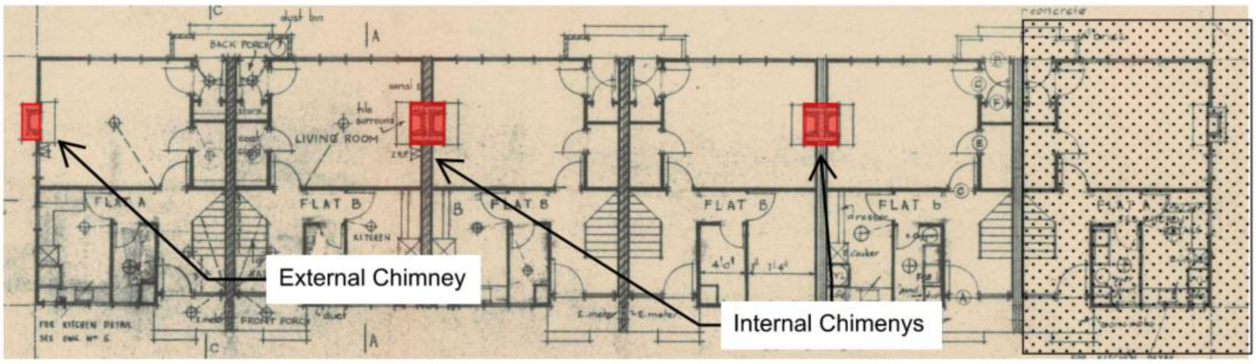



**Figure 3-2. Chimney Locations**

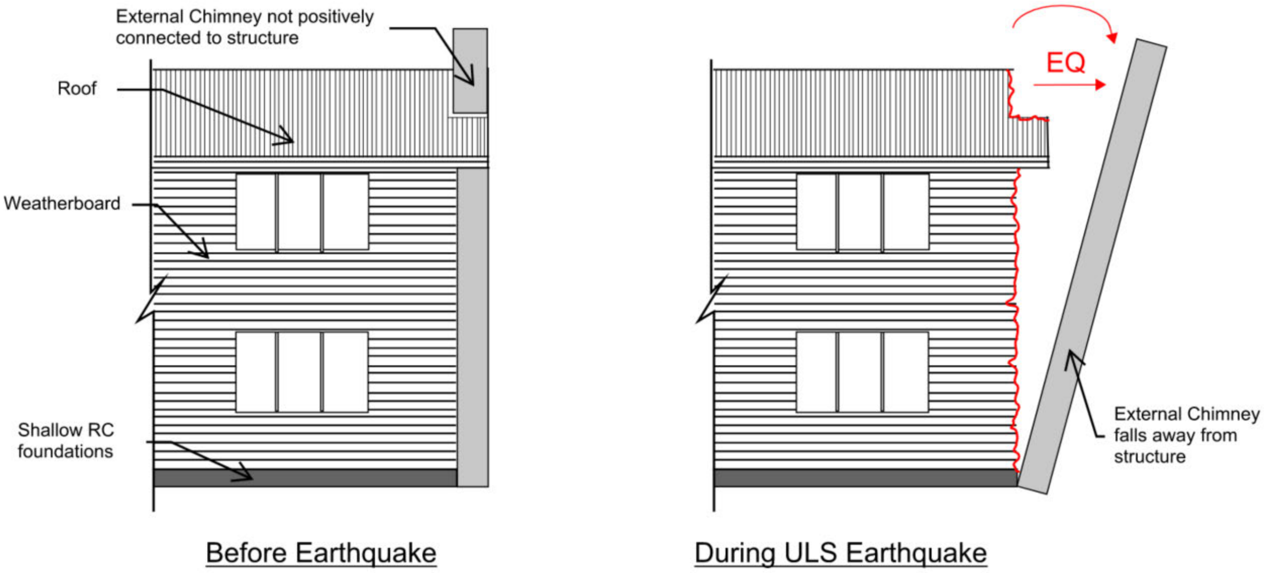



**Figure 3-3 External Chimney Failure Mode**

# 4 Non-Structural Elements

From our recent experience in evaluating similar buildings in Christchurch and Wellington, non-structural building elements (façade glass, ceilings, internal walls, overhead services etc.) constitute a significant portion of the repair/reinstatement cost following an earthquake. In a moderate seismic event, non-structural element damage may contribute heavily to downtime and repair costs and therefore the performance of these non-structural elements following a moderate seismic event could affect business continuity.

While assessment of these non-structural elements is not part of this DSA scope, a desktop study of the available documentation did not identify any large plant, ceilings, and partitions that would raise concern.

# 5 Risks from Adjacent Buildings

There are no risks from adjacent buildings.

# 6 Assessed Seismic Risk

The Building achieves an earthquake rating of **15%*NBS*(IL2)** in accordance with the **Guidelines**. This rating of **15%*NBS*** is based on the Critical Structural Weakness (**CSW**) of the perimeter external reinforcement concrete chimneys overturning capacity to resist out-of-plane parts seismic loading. We note that this risk will be to people outside of the building, rather than building occupants.

Therefore, this is a Grade E building following the NZSEE grading scheme. A grade E building imposes a risk > 25 times greater than a new building. Refer to Table 6-1 that shows the relative seismic risk compared to a new building.

**Table 6-1 Relative seismic risk**

| Seismic Grade | *%NBS*(IL2) | Approx. risk relative to a similar new building | Relative life-safety risk description |
|---|---|---|---|
| A+ | >100 | <1 | low risk |
| A | 80 to 100 | 1 to 2 times | low risk |
| B | 67 to 80 | 2 to 5 times | low to medium risk |
| C | 33 to 67 | 5 to 10 times | medium risk |
| D | 20 to 33 | 10 to 25 times | high risk |
| E | <20 | more than 25 times | very high risk |

A building with an earthquake rating less than 34%*NBS*, with the assessment undertaken utilising the Red Book, fulfils one of the requirements for the Territorial Authority to consider it to be an Earthquake-Prone Building (EPB) in terms of the Building Act 2004. A building rating less than 67%*NBS* is considered as an Earthquake Risk Building (ERB).

The Building is therefore categorised as an Earthquake-Risk Building and meets the criteria that could categorise it as an Earthquake Prone Building by Wellington City Council as the Territorial Authority. We note that our assessment used the **Yellow Chapter**. An assessment using the **Red Book** would likely result in similar scores to the **Yellow Chapter**.

# 7 Future Code Changes

## 7.1 Hazard Zone Factor

The results of the updated National Seismic Hazard Model (NSHM) were released in October 2022. The previous update to the NSHM was in 2010. Since then, the science behind estimating earthquake rates and understanding and complexity of ground motion modelling have significantly advanced.

The NZSM provides the basis for setting the seismic demands in the design code NZS1170.5. Although the results are not a design standard or design loadings standard, they provide an indication of how the code may reflect the updated seismic hazard in future revisions. A possible outcome of this review will be an increase in the hazard zone factor, Z, for the Wellington region. This factor is used to determine the seismic risk for the area and hence the design standard for new buildings.

A future increase in the Hazard Factor will lead to an increase in the design level for new buildings in Wellington and potentially increase the standard required for existing buildings to achieve 100%NBS when assessed against that new standard.

## 7.2 Basin Edge Effects

The 2016 Kaikōura earthquake exposed the concept of the "basin edge effects." The basin edge efforts cause amplification of ground shaking due to the presence of soft soils in the sedimentary basin and cause larger peak ground accelerations than expected.  The edge efforts are currently not incorporated in the Earthquake actions design code NZS 1170.5.

The basin edge effects have the potential to significantly increase the design standard for new buildings in particular locations in Wellington and potentially may increase the standard required for existing buildings to achieve 100%NBS (IL2) when assessed against that new standard. The "basin edge effects" is currently being discussed and reviewed by industry experts with no fixed timeframe when it will be introduced into the design standards.

The building is not expected to be affected by these effects.

## 7.3 Seismic Guidelines

Section C5 – Concrete Buildings – Proposed Revision to the Engineering Assessment Guidelines (**Yellow Chapter**), dated November 2018, provides the latest engineering knowledge on aspects involved in the assessment of concrete buildings, and to reflect what engineers learned from the Kaikōura earthquake.

However, its impact to the industry to still being assessed before it can be incorporated into regulation. Therefore, some aspects of the Guidelines may potentially change and hence affect the standard required for existing buildings to achieve 100%NBS (IL2).

This Building is primary a timber building and therefore is not expected to be affected by changes to the Yellow Chapter.

# 8 Seismic Concept Strengthening

We recommend retrofitting the building to achieve a minimum seismic rating greater than 34%NBS (IL2). Our review indicates that seismic strengthening, to attain a rating exceeding 34%NBS (IL2), would involve, but not be limited to:

- Removing the external chimney.

Upon the removal of the external chimney, the building would still have a seismic rating below 67%NBS, based on the capacity of the longitudinal wall at 45%*NBS*(IL2).

Although this building rates less than 67%*NBS*(IL2), it is importance to recognise that this structure is a light timber-framed building. Such buildings, characterised by their construction, often exhibit superior performance in the face of significant earthquake shaking, particularly in terms of life safety. The anticipated performance of this building in a design-level earthquake is expected to surpass the implications of its %*NBS* rating, indicating a higher level of resilience and life safety compared to heavier structures. Therefore, in our opinion, no further actions are required to strengthen the building once the external chimney is removed.

However, if the Wellington City Council wishes to enhance the building's seismic resilience, we recommend a seismic retrofit to achieve a minimum rating of 67%NBS (IL2). The strengthening options recommended are only of a schematic level detail and a detailed design will be required for Building Consent and construction documents. It is noted that the schematic design presented is one structural solution and there may be other solutions for the building.

This retrofit should include:

- Replacing lining materials for existing walls in specific locations with modern plasterboard linings and fixings.
- Installing additional anchors to connect internal party walls to the timber diaphragm.
- Installing additional anchors to connect the building to the existing foundations.

We further recommend that, in designing any seismic retrofit, the building owner should also consider the proposed increase in seismic hazard levels in Wellington. This would insulate the building against further future reductions in the seismic rating.

Finally, we recommend undertaking onsite investigations to confirm that the structure and the northern retaining wall are not positively connected.

# 9 Conclusions and Recommendations

## 9.1 Conclusion

The seismic rating of a building is generally limited by the lowest scoring element; therefore, the Building achieves an earthquake rating of **25%*NBS*(IL2)** in accordance with the **Guidelines**. This rating of **25%*NBS*** is based on the Critical Structural Weakness (**CSW**) of the perimeter external reinforcement concrete chimney overturning capacity to resist out-of-plane parts seismic loading.

## 9.2 Recommendations

We recommend retrofitting the building to achieve a minimum seismic rating greater than 34%NBS (IL2). Our review indicates that seismic strengthening, to attain a rating exceeding 34%NBS (IL2), would involve, removing the external chimney.

Upon the removal of the external chimney, the building would still have a seismic rating below 67%NBS. Despite this rating, it's important to note that lightweight timber buildings demonstrate superior performance in significant earthquake shaking, particularly in terms of life safety. Therefore, in our opinion, no further actions are required to strengthen the building once the external chimney is removed.

However, if the Wellington City Council wishes to enhance the building's seismic resilience, we recommend a seismic retrofit to achieve a minimum rating of 67%NBS (IL2).

# 10 Explanatory Notes

- The information contained in this report has been prepared by Aurecon at the request of Wellington City Council and is exclusively for Wellington City Council's use and reliance. It is not possible to make a proper assessment of this review without a clear understanding of the terms of engagement under which it has been prepared, including the scope of the instructions and directions given to and the assumptions made by Aurecon. The report will not address issues which would need to be considered for another party if that party's particular circumstances, requirements and experience were known and, further, may make assumptions about matters of which a third party is not aware. Aurecon accepts no responsibility or liability to any third party for any loss or damage whatsoever arising out of the use of or reliance on this report by that party or any party other than our Client.
- This report contains the professional opinion of Aurecon as to the matters set out herein, in the light of the information available to it during preparation, using its professional judgment and acting in accordance with the standard of care and skill usually exercised by professional engineers providing similar services in similar circumstances. Aurecon is not able to give any warranty or guarantee that all possible damage, defects, conditions or qualities have been identified.
- The report is based on information that has been provided to Aurecon from other sources or by other parties. The report has been prepared strictly on the basis that the information that has been provided is accurate, complete and adequate, except where otherwise identified during site investigation inspections. To the extent that any information is inaccurate, incomplete or inadequate, Aurecon takes no responsibility and disclaims all liability whatsoever for any loss or damage that results from any conclusions based on information that has been provided to Aurecon.
- The inspections of the building discussed in this report have been undertaken to inspect the structure and confirm the adequacy of the existing drawings. This report does not address building defects. Where site inspections were undertaken, they were restricted to visual inspections with intent to determine existing building main structural elements only.
- We have not undertaken a review of secondary elements such as ceilings, building services, plant and partitions.

A

# Appendix A - Sources of Information

# Sources of Information

The building layout, member sizes, detailing and material grades have been taken from available design drawings and calculations. A site inspection of the exterior was carried out to confirm that the drawings and documentation was generally in accordance with the as-built configuration. The following drawing documentation was available at the time of the assessment:

- Existing Structural drawings titled "*New Flats Daniell Street" by Wellington City Corporation City Engineers Department Architectural Branch dated 1952.*

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

- A - Assessment Objectives and Principles July 2017
- B - Initial Seismic Assessment July 2017
- C1 – General Issues July 2017
- C2 – Assessment Procedures and Analysis Techniques July 2017
- C3 – Earthquake Demands July 2017
- C4 – Geotechnical Considerations July 2017
- C5 -Technical Proposal to Revise C5 November 2018
- C9 – Timber Buildings July 2017
- C10 – Secondary Structural and Non-Structural Elements July 2017

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

- AS/NZS 1170.0 – Structural design actions – Part 0: General Principles 2002
- AS/NZS 1170.1 – Structural Design actions – Part 1: Permanent, imposed and other actions 2002
- NZS 1170.5 – Structural Design actions 2004

# B

## Appendix B – Initial Assessment

C

# Appendix C – Photographs from Inspection

# 1 SEISMIC ASSESSMENT – INITIAL REVIEW FORM

The purpose of this document is to provide a record of agreed initial parameters for a seismic assessment project.

**Building Name:**

140-142 Daniell Street, Newtown

| **Structural Description:** Describe the building | |
|---|---|
| Building Age/Year Constructed | 1952 |
| Previously strengthened? Y/N | N |
| Location | 146 Daniell Street, Newtown |
| No. levels | 2 |
| Plan Area (sq.m.) | 255m2 |
| Structural Form | Timber framed building with brick/unreinforced masonry party walls between the tenancies |
| Roof Type | Timber Board |
| Floor Type | Timber Board |
| Foundation Type | RC shallow foundations with local pads foundations and ground beams |
| Stair Type (Precast, Steel, etc) | Timber stairs with fixed-fixed connections |
| Seismic Gaps (mm)/Pounding | N/A |
| Appendages/Parapets/Canopies | N/A |
| Precast Walls (reo type) | N/A |
| Veneers Present | N/A |

| **Lateral Load-Resisting Mechanism (in each direction - confirm with drawings):** Describe the lateral load resisting system in each direction | |
|---|---|
| Longitudinal: | Timber framed brace walls with plasterboard sheathing |
| Transverse: | Timber framed brace walls with plasterboard sheathing and brick/unreinforced masonry party walls |

**Assessment Methodology**
List components and proposed analysis method e.g. eqv Static, pushover, modal analysis, rocking, force based, displacement based, part and portions, tributary area, flexible/rigid diaphragms

**Type of analysis method:**

We have undertaken a stepped analysis approach to assess this building. Due to the buildings straightforward design, we conducted hand calculations using a force-based method for this assessment.

**Analysis method of diaphragms:**

The diaphragm acceleration demands were determined by the pESA method as recommended in NZS1170.5 C5.7.2. Capacities used Table C9.3 from the Guidelines.

| Initial Assessment of Ductility<br>List the components of the structural system and the expected ductility to be achieved from them, eg plain round bar reinforced concrete moment frame ductility 1 – 1.25 or rocking | |
|---|---|
| ▪ Timber Walls | ▪ μ = 3.5 Sp=0.5 |
| ▪ RC walls in-plane | ▪ μ = 1.25 Sp=0.9 |
| ▪ RC walls out-of- plane | ▪ μ = 1.25 |
| ▪ RC Diaphragms | ▪ μ = 1.25 Sp=0.9 |
| ▪ RC foundations | ▪ μ = 1.25 Sp=0.9 |

| Assessment Loadings:<br>Loads to be used as part of assessment: | |
|---|---|
| **Seismic Loadings** | |
| Building Importance Level: | 2 |
| Site Subsoil Class: | B |
| Annual Probability of Exceedance: | 1/500 years |
| Return Period Factor, Ru: | 1 |
| Near Fault Factor, N(T,D): | 1 |
| Hazard Factor, Z: | 0.4 |
| Code of the Day: | N/A |
| Sp | 0.7 – 0.9 |
| Design Working Life (yrs): | 50 |
| **Dead Loads/Superimposed Dead Loads** | |
| SDL | 0.2kPa |
| | |
| | |
| | |
| **Live Loads:** | |
| Self-contained dwellings | 1.5 kPa |
| | |
| | |
| | |
| **Deflection Criteria** | |
| ULS Deflection Limit (%) | 2.5% |
| Reason for Limit | Code limit |

| Material Properties:<br>**Material**<br>Rename material as appropriate | | Design Strength (MPa) | Strength Mod Factor | Assessment Strength (MPa) |
|---|---|---|---|---|
| Reinforcement | Plain or Deformed bars? | Plain | | |
| | High Tensile (HT) | | | N/A |

| | | | | |
|---|---|---|---|---|
| | Medium Tensile (MT) | | | N/A |
| | Mild Steel (MS) | - | - | 324MPa |
| Concrete | Foundations | | | 30MPa |
| | Slab on Grade | | | N/A |
| | Precast Panels or Shear Walls | | | N/A |
| | Columns | | | N/A |
| | Beams | | | 30MPa |
| Structural Steel | Beams | | | N/A |
| | Columns | | | N/A |
| | CHS | | | N/A |
| | Plate | | | N/A |
| | Other members | | | N/A |
| Bolts | | | | N/A |
| Weld Strength | | | | N/A |

| **Stiffness Reduction Factors in ETABS software:** | |
|---|---|
| Columns Lower floors | N/A |
| Columns Upper floors | N/A |
| Beams | N/A |
| Walls | N/A |
| Diaphragms | N/A |

| **Foundation Assessment Criteria:** | |
|---|---|
| Geotechnical Report Available? | No |
| Foundation type: | Shallow RC Foundations |
| Soil type: | B |
| Geotechnical Investigation: | No |
| Ult. Bearing Pressure: | 150kPa (assumed) |
| Sliding Resistance: | Friction |

**Pending Code/Guideline Changes to Take into Account :**

Are there any upcoming code changes to take into account?

No

**Kick-off Meeting:**

Record minutes of the kick off meeting here, including key actions for people

| Task / Note | Actioned By Who? |
|---|---|
| N/A | |

## Additional Project-Specific Issues to take into account

E.g. Beam elongation, non-ductile mesh connection, minimal flexural steel, fracture issues, eccentric floor plate, bar anchoring, insufficient seating, unusual site characteristics, poor detailing

N/A

## Additional Project-Site Investigation Scope

N/A

D

# Appendix D – Assessment Summary

# Assessment Inputs

## Dead, Superimposed Dead Loads and Live Loads.

See Table below for the Dead, Superimposed dead loads and Live Loads used in the assessment. The self-weight of the walls, frame members and slabs are calculated by hand. The design live loads were adopted as indicated as per structural drawings and in accordance with NZS1170.1 loading.

**Table: Dead, Superimposed dead loads and Live Loads used in the assessment**

| Load Type | Load |
|---|---|
| Dead Load | Calculated by hand |
| Super Imposed Dead Load | 0.2 kPa |
| Live Load | 1.5kPa |

## Seismic Weight

The seismic mass was calculated based on the NZS 1170.5:2004 loading combination W = G + ΨEQu, where ΨE = 0.0 for roof. Where applicable, an area reduction factor was also applied to the live load in accordance with clause 3.4.2 of AS/NZS 1170.1:2002.

## Wind Loads

Consideration of wind loads is outside the scope of this assessment.

## Seismic loading

The seismic loads were determined in accordance with NZS1170.5 with the following parameters.

**Table: Seismic parameters for building assessments**

| Parameter | Value |
|---|---|
| Design Working Life | 50 |
| Importance level | 2 |
| Site Subsoil Classification | B |
| Hazard Factor (Z) | 0.4 |

## Material Properties

The following material properties and corresponding characteristic and probable strengths were used as per the Assessment Guideline Tables C5.3, C5.4 and Section C6. No material specification regarding the concrete and steel used at the time was found in the structural drawings. No physical materials testing has been undertaken to validate the assumed material properties.

**Table: Material properties**

| Item | Characteristic Design Strength (MPa) | Assessment (Probable) Strength (MPa) |
|---|---|---|
| Reinforcing Steel – Beams | 275 MPa | 324 MPa |
| Concrete | 20 MPa | 30 MPa |
| Structural Steel | 300 MPa | 345 MPa |

# Assessment Summary

| **1. Building Information** | |
|---|---|
| Building Name/ Description: | Daniell Street Block I Building |
| Street Address | 146 Daniell Street, Newtown |
| Territorial Authority | Wellington City Council |
| No. of Storeys | 2 |
| Area of Typical Floor (approx.) | Approx. 210m$^2$ per floor |
| Year of Design (approx.) | 1952 |
| NZ Standards designed to | N/A |
| Structural System including Foundations | ▪ Longitudinal Direction - Timber framed brace walls with plasterboard sheathing<br>▪ Transverse direction - Timber framed brace walls with plasterboard sheathing and brick/unreinforced masonry party walls |
| Does the building comprise a shared structural form or shares structural elements with any other adjacent titles? | No |
| Key features of ground profile and identified geohazards | The site subsoil classification, in terms of NZS1170.5:2004 Clause 3.1.3, is Class B. |
| Previous strengthening and/ or significant alteration | N/A |
| Heritage Issues/ Status | N/A |
| Other Relevant Information | N/A |

| **2. Assessment Information** | |
|---|---|
| Consulting Practice | Aurecon NZ Ltd |
| CPEng Responsible, including:<br>• Name<br>• CPEng number<br>• A statement of suitable skills and experience in the seismic assessment of existing buildings | ▪ s(7)(2)(a) [redacted]<br>▪ [redacted]<br>▪ 21 years' experience as a structural engineer with significant experience in the seismic assessment of existing buildings |
| Documentation reviewed, including:<br>• date/ version of drawings/ calculations<br>• previous seismic assessments | ▪ Existing Structural drawings titled "*Hanson Street Flats development Stage 3*" dated 1965 |
| Geotechnical Report(s) | NA |
| Date(s) Building Inspected and extent of inspection | 01/2024<br>Visual external, no material test or intrusive investigation has been carried out. |

| | |
|---|---|
| Description of any structural testing undertaken and results summary | N/A |
| Previous Assessment Reports | NA |
| Other Relevant Information | N/A |

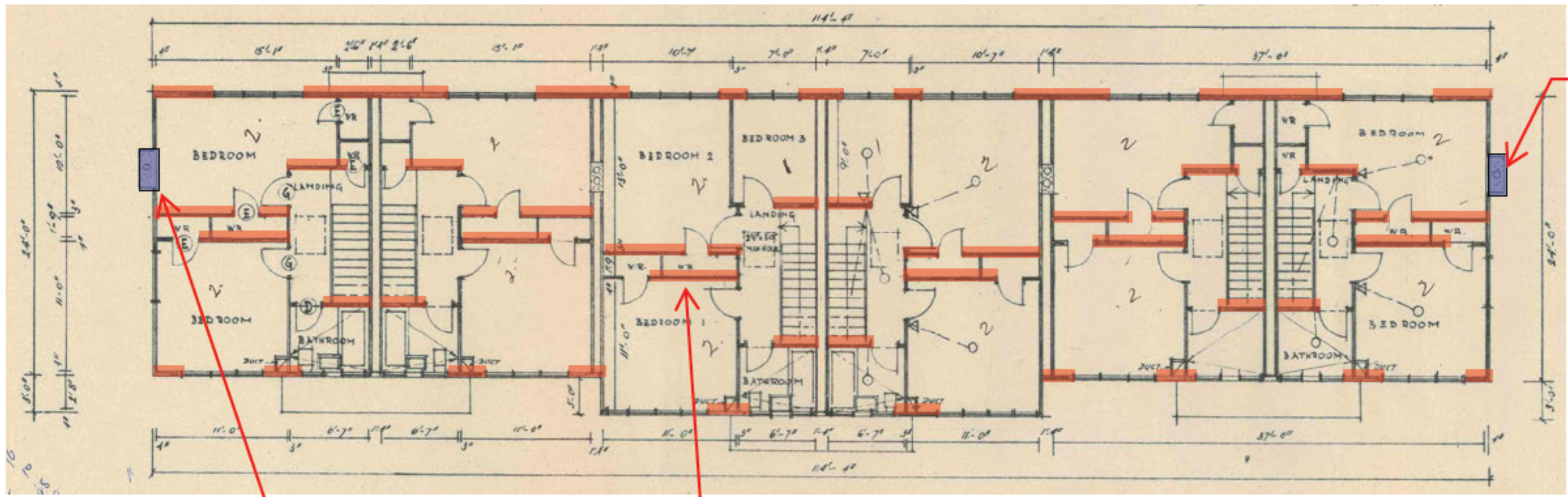
| 3. Summary of Engineering Assessment Methodology and Key Parameters Used | |
|---|---|
| Occupancy Type(s) and Importance Level | 2 |
| Site Subsoil Class | B |
| For a DSA:<br>Summary of how Part C was applied, including:<br>• the analysis methodology(s) used from C2<br>• other sections of Part C applied | Force-based Assessment<br>The Guidelines provide solutions and methods for the assessment of existing buildings and give guidance for strengthening methodologies that are considered acceptable. We have undertaken a stepped analysis approach to assess this building. Due to the buildings straightforward design, we conducted hand calculations using a force-based method for this assessment. |
| Other Relevant Information | N/A |

| 4. Assessment Outcomes | |
|---|---|
| Assessment Status | Final |
| Assessed %NBS Rating | 15% |
| For a DSA: | |
| Comment on the nature of Secondary Structural and Non-structural elements/ parts identified and assessed | Non-structural elements have not been assessed at this stage. |
| Describe the Governing Critical Structural Weakness | The perimeter external reinforcement concrete chimney overturning capacity to resist out-of-plane parts seismic loading. The chimney is anticipated to fall away from the building, potentially posing a hazard to pedestrians during a design-level earthquake. However, the chimney is not expected to be a hazard for people inside the building during such an event. |

| | | |
|---|---|---|
| If the results of this DSA are being used for earthquake prone decision purposes, <u>and</u> elements rating <34%NBS have been identified (including Parts): | <u>Engineering Statement of Structural Weaknesses and Location:</u><br>- External Chimney | <u>Mode of Failure and Physical Consequence Statement(s):</u><br>- The external chimney is anticipated to fall away from the building, potentially posing a hazard to pedestrians during a design-level earthquake. However, the chimney is not expected to be a hazard for people inside the building during such an event.<br>- The mode of failure of the whole building will be overloading of the plasterboard bracing walls in the longitudinal direction. This would manifest as excessive displacement of the wall element past levels considered acceptable but would be unlikely to result in loss of gravity load support or collapse at the 35-55% loading level. |
| Recommendations<br>(Optional for EPB purposes) | Strengthening should be undertaken to increase the structure's rating to a minimum of 67%NBS(IL2) if feasible. | |

# E

# Appendix E – Seismic Retrofit Concepts




Demolish external chimney

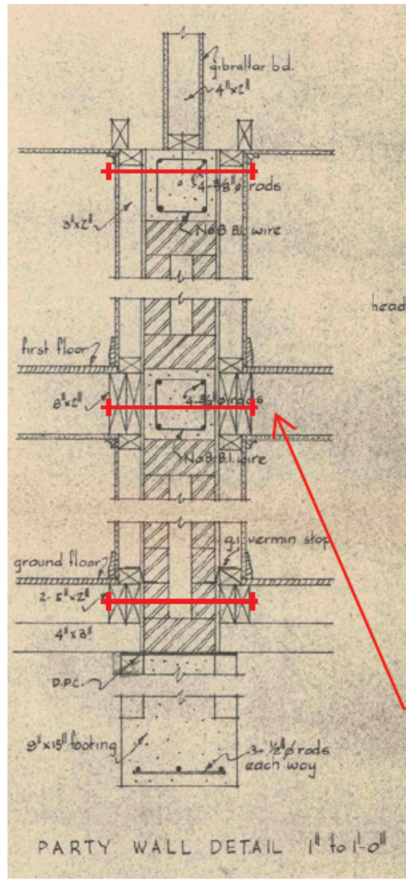
Transverse

Longitudinal

Replace lining materials with modern gib linings and fixings for ground level and level 1

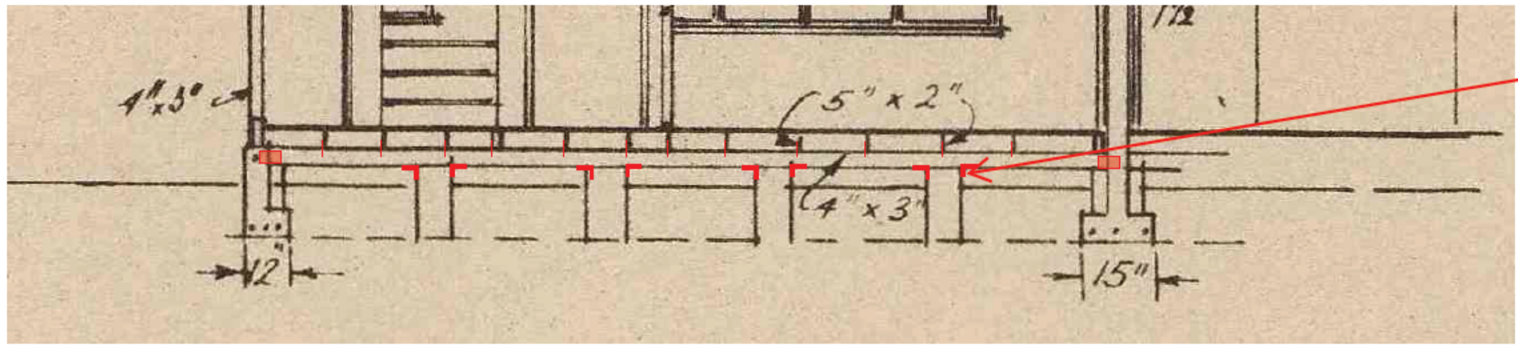
Demolish external chimney

## PLAN VIEW




Anchors to connect the internal party walls to the timber diaphragm.

## ELEVATION VIEW: RC PARTY WALL




Anchors that connect the building to the existing foundations.

## ELEVATION VIEW: FOUNDATIONS

**PRELIMINARY NOT FOR CONSTRUCTION**

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| CLIENT | REV | DATE | REVISION DETAILS | APPROVED | SCALE | SIZE |
|---|---|---|---|---|---|---|
| WCC | A | 02.02.24 | HIGH LEVEL CONCEPT FOR INFORMATION | | NTS | A3 |

DRAWN: s(7)(2)(a) s(7)(2)(a) s(7)(2)(a)

CONCEPT FOR INFORMATION

APPROVED: APPROVER DATE

PROJECT

TITLE

| DRAWING No. | PROJECT No. | WBS | TYPE | DISC - NUMBER | REV |
|---|---|---|---|---|---|
| | 523020 | 0000 | SK | STR-01 | A |

F

# Appendix F – Sample Building Plans

CONTRACT. NO. 1817.
DRAWING. NO. 3.


WELLINGTON CITY CORPORATION
CITY ENGINEER'S DEPARTMENT
ARCHITECTURAL BRANCH

NEW FLATS DANIELL STREET (18 UNITS IN 3 BLOCKS)

REF. NO. A52/520
CHECKED
APPROVED

TRACING NO. 11418.

| | | |
|---|---|---|
| FIELDWORK | | |
| DRAWN | R.H.B. revised F.O. 31.7.51 | amended F.O. |
| TRACED | " | |
| CHECKED | | |
| APPROVED | | |

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