| **Quality Assurance Statement** | | |
|---|---|---|
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| | **Approved for issue by:**<br>Omar Hilli | ................................ |

# Rangitikei District Council

# Earthquake Performance Assessment / Workshop Building

## Contents

# 1 Introduction

## 1.1 Report Structure

Rangitikei District Council (RDC) requested MWH to undertake an earthquake performance assessment of six council buildings, these include:

1. The office complex which consists of four buildings:
    a. Main building – currently housing reception and CEO offices.
    b. Annex building – connected to the main building via a walkway.
    c. Assets building – currently housing the Assets team
    d. Workshop and archives building.
2. The library building
3. The civil defense building

This report is for the Workshop and Archives Building.

## 1.2 Current legislation

The Building Act 2004 has repealed the Building Act 1991 and introduced a number of changes one of which is to reduce the risk of death or injury that may result from the effects of a significant earthquake on buildings *that represent a higher than normal risk in earthquake.*

In relation to the above mentioned, the Building Act now focuses particularly on buildings of high risk. These buildings are referred in the legislation as *Earthquake Prone Buildings* hereafter referred to as EPB. To make these buildings deemed as earthquake prone safer to use in the future, the Building Act 2004 introduced provisions to improve the likelihood of existing buildings withstanding earthquakes

The expression EPB is now regarded as applying to any building (excluding some residential buildings) that is not capable of meeting the nominal performance objectives and requirements in relation to seismic strength of 33% of "New Building Standard" (NBS). 33% of NBS corresponds to approximately 20 times the risk of a building reaching a similar condition to that which a new building would reach in a full design earthquake.

Current legislation requires that buildings that are assessed as being earthquake prone under the Building Act be strengthened. It was made the responsibility of each individual Territorial Authority to develop their own formal policy on earthquake-prone buildings through consultation with building owners, consultants and the public. Such policy was to addresses the identification process for earthquake prone buildings, a timetable for carrying out required strengthening works and specifies the required level of strengthening for EPBs.

## 1.3 Review of Rangitikei District Council Policy for Earthquake - Prone Buildings

The Rangitikei District Council has developed a policy for EPBs based on the provisions of the building act requirements.

The policy addresses the following issues:

- The approach that the Council will take in performing its functions under the Act;
- Council's priorities in performing those functions;
- How the policy will apply to heritage buildings.

The developed policy reflects the Council's desire to reduce the earthquake risk over time in a way that is socially and economically acceptable to its ratepayers and citizens, and which recognises the heritage value of its heritage stock and limited resources available to the Council.

### 1.3.1 Rangitikei District Council (RDC) Approach

The approach the Council will take (as identified in the policy) will be to:

- Review its building stock to identify buildings that fall within the scope of EPBs under the Building Act 2004.
- Assess broadly the performance of those buildings in relation to the new building standard and, in particular, to the standard defined for EPBs. This broad assessment will be done at the Council's cost, based on priorities.
- Determine and compile from this broad assessment a list of buildings that are earthquake-prone in terms of the Building Act 2004
- Advise owner(s) of these buildings of the results of the Council's broad assessment and invite them, within a limited time frame, to meet with and/or obtain further details from the Council on future requirements.
- Give written notices to all owner(s) of EPBs once the deadline for contacting Council has passed and, subject to the results of discussions, to carry out work to reduce or remove the danger or demolish the building within a specified timeframe.
- Allow owners a right of appeal as defined in the Building Act 2004, which can include applying for a determination under section 177.

### 1.3.2 Assessment Process

The process the Council will follow in identifying-earthquake prone buildings will be to:

- Undertake an initial desktop review of Council files to assess which buildings could be earthquake-prone (at Council cost).
- Follow this with a brief visual inspection of each building where necessary.
- Carry out an initial evaluation of performance in an earthquake based on information obtained by using the New Zealand Society of Earthquake Engineers (NZSEE) Initial Evaluation Method process (at councils cost).
- Require building owners to do a detailed assessment on buildings identified as earthquake-prone in the initial evaluation, unless otherwise agreed in discussion following the initial evaluation (at Owner cost).
- Assemble a list of earthquake-prone buildings according to the results of the assessments (at Councils cost).
- Categorise the earthquake-prone buildings according to use and importance as follows:

    -Buildings with special post-disaster functions as defined in AS/NZS 1170.0:2002, Importance Level 4.

    -Buildings that contain people in crowds or contents of high value to the community (including all Council-owned buildings) - not listed in 1 above as defined in AS/NZS 1170.0:2002, Importance Level 3.

    -Buildings with a heritage classification under the historic places act 1993.

### 1.3.3 Assessment criteria

The council will use the NZSEE recommendations as its preferred basis for defining technical requirements and criteria. These recommendations are designed to be used in conjunction with AS/NZS1170 Loadings Standard, NZS3101 Concrete Structures Standard, NZS3404 Steel Structures Standard and other materials standards.

The NZSEE document "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes" which we will adopt for assessing the Council Offices Building, concentrates on matters relating to life safety; that is to say, performance at the ultimate limit state. MWH New Zealand Ltd emphasises, that the assessment procedure adopted is mainly concerned with the identification and elimination of possible undesirable collapse modes that could affect either part of a building or the entire structure. Damage to the building itself in an earthquake event is of secondary consideration. ***Earthquake prone buildings strengthened using the recommendations and procedures outlined by the NZSEE could be damaged beyond repair by a significant earthquake. It is therefore critical that Rangitikei DC acknowledges this fact and factors this into its decision making.***

### 1.3.4 Taking action on earthquake-prone buildings

Before exercising its powers under section 124 and 125 of the Act, the Council will seek, within a defined timeframe, to discuss options for action with owner(s) with a view to obtaining from the owner(s) a mutually acceptable approach for dealing with the danger, leading to receipt of a formal proposal from the owner(s) for strengthening or removal. In the event that discussions do not yield a mutually acceptable approach and proposal, the Council will serve a formal notice on the owner(s) to strengthen or demolish the building.

RDC requires buildings identified as earthquake-prone to be strengthened only to the minimum level of 33% NBS. NZSEE recommends strengthening to 67% NBS and RDC will encourage owners to upgrade to greater than the minimum.

### 1.3.5 Priorities

The Council has prioritised both the identification and the requirement to strengthen or demolish buildings as follows.

Figures that follow in brackets indicate the latest date for identification and notification and the maximum time for strengthening or demolition respectively. Times required for strengthening, or demolition, commence on the date of issue of formal notice. Specific times will be assigned for action according to assessment of structural performance and the value of concerns.

The order is as indicated below:

1. Buildings with special post-disaster functions as defined in *AS/NZS 1170.0:2002* Importance Level 4 (June 2008, 5 years).
2. Buildings that contain people in crowds or contents community as defined in AS/NZS 1170.0:2002, Importance Level 3 **including Council buildings** (June 2009, 10 years).
3. Buildings registered by the New Zealand Historic Places Trust under the Historic Places Act 1993 (June 2011, 15 years).
4. Buildings with an Importance Level of less than 3 as defined in AS/NZS1170.0:2002 (June 2011, 20 years).

***The council Workshop Building is therefore required to be assessed by June 2009 and strengthened (if needed) within a maximum period of 10 years following identification and notification.***

## 2 General Description of Workshop Building

MWH NZ Ltd undertook a site inspection on 15 November 2007 to visually inspect and to undertake a limited scope measure up the workshop / archives building at the High Street council complex. The approximate as built dimensions for this building are outlined in the appended sketches. The building is made up of two distinct structures; the original workshop and a lean to addition that was constructed at a latter date.

It is believed that the original workshop was constructed circa 1952 (as advised by RDC). In 1982 it was extended by adding an 11m x 4.32m lean to structure. The extension of the original workshop also included the construction of a relatively large pit. RDC later converted this addition and a portion of the original workshop (rear end) into an archives storage. The workshop / archives building as it stands now is a 414.8m² single storey structure. The lean forms 47.52m² of that total area.

MWH was only able to obtain (through RDC) the construction details for the 1982 addition. The original workshop construction details could not be located. However, we were able to determine the following through a visual inspection of the existing building:

- It is a single level reinforced concrete structure comprising of 150mm thick walls and regularly spaced reinforced concrete columns.
- The building includes a gantry crane that spans the full width of the building. Support for the gantry rails is through two reinforced concrete beams on each side wall just above the roller door openings (refer to cross section 2 / appendix).
- The roof comprises regularly spaced triangular timber trusses, purlins and corrugated steel with intermittent translucent panels.
- The wall and column foundations are likely to be a continuous reinforced ground beam probably with an internal outstand (L shaped ground beam).
- The concrete floor slab is likely to be unreinforced or with nominal reinforcement to control shrinkage and cracking.
- No obvious signs of deterioration or damage from past seismic activity were visually identified.
- There was no trolley / hoist arrangement on the gantry beam which suggests that crane is not in use. We could not visually ascertain the lift capacity of the crane (no maximum lift signage posted).

The 1982 addition is a series 20 reinforced masonry (blockwork) wall building with light weight roof construction comprising timber trusses, timber purlins and corrugated steel cladding. The construction details indicate that walls are supported on a continuous 500mm x 500mm reinforced concrete perimeter ground beam. The floor slab is 150mm thick and reinforced with a 665 mesh. The blockwalls have D12 @ 600 vertical and D12 @ 800 horizontal reinforcement.

At this stage for the purpose of this structural evaluation and due to lack of specific geotechnical ground information, we have assumed that the subsoil underlying the council buildings (High Street complex) is susceptible to liquefaction.

Soil liquefaction and related ground failures are associated with earthquakes. It refers to the loss of strength in saturated, cohesionless soils due to the build up of pore water pressures during dynamic loading. We recommend that a limited scope geotechnical investigation be undertaken at a later stage to verify ground conditions.

# 3 Outline of Evaluation Procedure Adopted

## 3.1 Building Act Definitions

The definition of an earthquake-prone building (EPB) is set out in Section 122 of the Building Act and in its associated Regulations.

Quoting from the Act;

***122 Meaning of earthquake-prone building***
*(1) A building is earthquake prone for the purposes of this Act if, having regard to its condition and to the ground on which it is built, and because of its construction, the building –*

> *(a) will have its ultimate capacity exceeded in a moderate earthquake (as defined in the regulations): and*
> *(b) would be likely to collapse causing –*
>
> *(i) injury or death to persons in the building or to persons on any other property; or*
> *(ii) damage to any other property*
> *(2) Subsection (1) does not apply to a building that is used wholly or mainly for residential purposes unless the building-*
> *(a) comprises 2 or more storeys: and*
> *(b) contains 3 or more household units.*

And from the Regulations;

***7. Earthquake-prone buildings: moderate earthquake defined-***
For the purpose of section 122 (meaning of earthquake-prone building) of the Act, moderate earthquake means, in relation to a building, an earthquake that would generate shaking at the site of the building that is of the same duration as, but that is one-third as strong as, the earthquake shaking (determined by normal measures of acceleration, velocity, and displacement) that would be used to design a new building at that site.

It is worth mentioning that buildings that pass the one-third criterion, but which still represent a significant risk (below 67% NBS) require no action legally. However it is NZSEE view that any building below 67%NBS should be regarded as a questionable earthquake risk and therefore still an Earthquake Risk. In such a case it will be a client's preference as to strengthen a building or otherwise.

## 3.2 NZSEE Assessment Procedure

The structural evaluation process adopted for assessing EPBs (developed by NZSEE) comprises two stages as follows:

**Initial Evaluation Process (IEP)**
The initial evaluation procedure (IEP) is intended to be a coarse screening to identify potentially high risk (or earthquake-prone) buildings. The results obtained in the IEP may be used to:

☐ identify buildings that warrant a detailed assessment of their structural performance
☐ provide a preliminary score for a comparative risk grading of buildings
☐ provide a means of determining priorities for improvement of structural performance.

The objective of the IEP is to identify, with an acceptable level of confidence, all high risk buildings. At the same time the process must not catch an unacceptable number of buildings that would, on detailed evaluation be outside the high risk category.

**Detailed Assessment of Earthquake Performance**
The NZSEE assessment procedure states that where an initial evaluation indicates that the building is likely to be high risk (earthquake-prone), it is desirable that a detailed assessment is carried out as set out in NZSEE Guidelines. This will provide a more specific and convincing evaluation on which a final decision can be made on whether or not the building is to be classified as high risk.

# 4 Findings

Based on the IEP undertaken, we believe that the workshop & archives building is earthquake-prone failing the threshold Percentage of New Building Standard (%NBS) of 33 in both the longitudinal and transverse directions. At this stage and without undertaking a detailed assessment of the building, we believe that the shape of the original building which included a cutout (now the archives storage area / lean to addition) introduces a degree of plan irregularity which in turn translates into an overall structural weakness of the building. Furthermore, the building extension (lean to) being of masonry construction in comparison to the original reinforced concrete walls, may introduce a slight additional structural weakness to the building as a whole, due to the potential performance incompatibility of the two different construction materials under the influence of lateral loads (such as earthquake loads).

We therefore recommend that RDC undertakes the second stage detailed assessment which will identify to a higher degree of confidence the %NBS for the building in question. The detailed assessment will also address in more detail the interaction between the original reinforced concrete structure and the latter masonry construction addition (lean to part of the building). Please note that the detailed assessment is intended to provide a means of more accurate evaluation of performance. It will allow us to look in more detail at the characteristics of the building, its response to earthquake shaking, the demands it places on structural elements, and the capacity of such elements to meet those demands by maintaining structural integrity under imposed actions and displacements.

However MWH would like to point out that in order to undertake this assessment successfully more precise information regarding the building dimensions, building materials, condition of structural elements, structural design and ground conditions will need to be obtained or gathered.

# 5 Building Cost Estimates

RDC have requested that we undertake an evaluation of the indicative costs associated with:

- Constructing a new building, and
- Seismically improving the existing building to 33% NBS.

Due to the fact that neither an architectural layout / details for a new building have been developed nor that the required seismic strengthening of the building have yet been identified and designed, our cost estimates will be very indicative and perhaps to an accuracy of no more than +/- 35%.

**Option A -New Building:**
For this option, we have assumed the following:

1. New building to be single level
2. Industrial type building construction. We suggest, at this stage, steel portal frames and corrugated steel roof cladding. Side walls can either be corrugated steel (more cost effective) or reinforced masonry up to say 1.2m and steel cladding above (more robust from a vehicle impact point of view)
3. No gantry crane
4. No pits in ground slab
5. No foundation subsoil problems (nominal ground preparation)
6. Standard finishes
7. No HVAC
8. Nominal lighting
9. Includes basic small office area, toilet and amenities.
10. Basic internal plumbing to toilet and amenities
11. No unusual building shape (rectangular shaped building)
12. Minor local infrastructure upgrades only
13. Building plan dimensions similar to the building (approximately 415m$^2$).
14. Construction is undertaken by 2009.
15. Estimate has been based on information outlined in Rawlinsons New Zealand Construction Handbook 2006 edition. A 2% costs inflation has been incorporated in the estimate.

16. Costs exclude

    - ➢ Land & demolition
    - ➢ Covered ways, access roads and parking areas
    - ➢ Subdivisional partitions
    - ➢ Special requirements by RDC
    - ➢ Fire suppression systems
    - ➢ External services (including plumbing) more than 3.0m from the outside face of the building
    - ➢ Data and telephone services
    - ➢ External works other than those immediately adjacent to the building
    - ➢ Loose Furniture, Fittings or Equipment
    - ➢ Professional fees, such as architect, engineer, quantity surveyor

- Legal fees
- Staff and furniture temporary or permanent relocation
- Goods and Services Tax (GST)

Based on the above we estimate the cost associated with the construction of a new building to be in the region of:

- Option 1: $318,000 for a totally steel clad building and
- Option 2: $348,000 for building with a 1.2m high external blockwork wall then steel cladding above.

Both costs exclude GST.

We estimate the professional fees at this stage for this option (architect, structural eng., mechanical Eng., electrical Eng. and quantity surveyor) to be in the region of $36,000 (excluding costs associated with any geotechnical investigation(s) and site survey). ,

Allowing for minor unknowns and the undertaking of testing / investigative work (15%), the total estimated cost of replacement for option 1 is therefore about $407,000 and for option 2 $441,000, (both excluding GST).

Please note that the costs associated with a geotechnical investigation may be deducted from the above estimate if RDC undertakes a one off comprehensive site investigation at the High street complex.

**Option B -Seismic upgrade of existing building:**
For this option we have assumed the following:

1. Minor foundation upgrades
2. Minimal demolition
3. Structural elements including roof timber framing in acceptable condition
4. Acceptable ground conditions / no major concerns with subsoil
5. Bracing walls with steel members (such as flat or round bars) as a potentially acceptable seismic upgrade option
6. Estimate has been based on information outlined in Rawlinsons New Zealand Construction Handbook 2006 edition. A 2% costs inflation has been incorporated in the estimate. Since the seismic upgrades have not yet been identified, we have assumed the rates for standard office building upgrades/renovation works.

7. Costs exclude:

    - Staff and furniture relocation during works
    - Architectural upgrades to building
    - Upgrade to services
    - Layout modifications
    - Major unforeseen structural problems with the existing structure
    - Professional fees, such as architect, engineer, quantity surveyor
    - Geotechnical investigation that may be needed to determine ground conditions
    - Goods and Services Tax (GST)

Based on the above we estimate the cost associated with seismically upgrading the existing main offices building to a nominal 33% NBS to be in the region of $96,000. It should be noted that upgrading the strength to greater than 33% NBS will most likely result in additional costs.

It should be noted that costs for strengthening the building exclude all upgrade costs associated with building improvements such as ventilation upgrades etc.

We estimate at this stage the structural engineering fees for the development of the seismic upgrade design (including the undertaking of the detailed assessment of the building structure which is critical for any upgrades design), carrying out a site survey but excluding any costs associated with obtaining documents, the undertaking of destructive / non-destructive investigative tests and a geotechnical investigation to be in the region of $19,000 (plus GST).

Allowing for minor unknowns and the undertaking of testing / investigative work (15%), the estimate to strengthen the building to meet 33% NBS is around $133,000 (excluding GST).

As before please note that the costs associated with a geotechnical investigation may be deducted from the above estimate if RDC undertakes a one off comprehensive site investigation at the High street complex.

## 6 Summary

1. The original workshop building was built in circa 1952. An extension in the form of a lean to was then added in 1982. The extension is now being used by RDC as archives storage.
2. The Initial Evaluation Assessment has determined that the asset building is earthquake prone and does not meet the minimum legal requirement of having the seismic strength equivalent to 33% of a new building. We therefore recommend that RDC undertakes a detailed structural assessment of the building.
3. Section 122 of the Building Act and RDC's earthquake policy both only require the building to be upgraded to 33% of the new building standard (NBS). It should be noted that a building at 33% of the NBS has a risk of failure 20 times higher than a building constructed to full NBS.
4. Earthquake strengthening a building means that it has been strengthened to improve the risk of loss of life. It may be damaged beyond repair in a significant earthquake.
5. Strengthening the building to meet the 33% NBS is estimated to be $133,000 (excluding GST). The cost of strengthening the building excludes all upgrade costs such as improved functionality and ventilation.
6. An equivalent new 415m$^2$ industrial type totally steel clad building will cost approximately $407,000 $441,000 for a building with a 1.2m high external blockwork wall then steel cladding above. (Including engineering costs, the undertaking of a geotechnical investigation and a site survey but excluding GST).
7. Cost estimates are indicative and may have an accuracy of no more than +/- 35%.

# 7 Recommendations

It is recommended that no decision be made on the future of the asset building until the other RDC buildings on High Street (the office complex site have been evaluated for earthquake performance (initial assessment), health and safety aspects, ventilation, compliance with regulations and consent obligations.

# Appendix A Photos

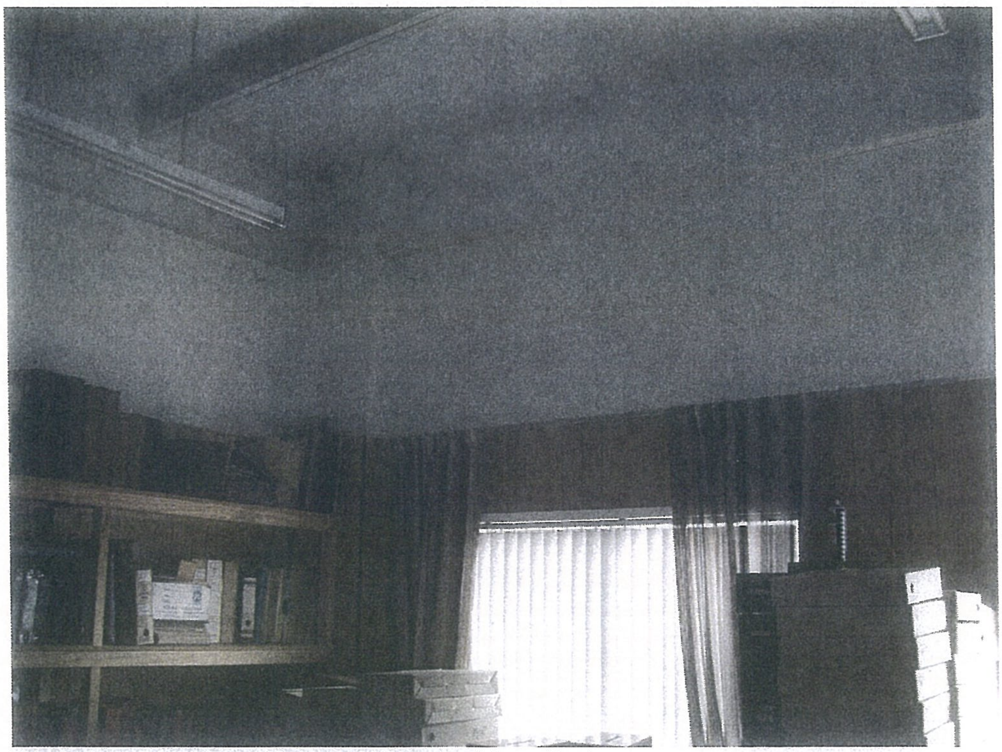
Workshop / Archives Building / Side View Facing The Asset Building

Workshop / Archives Building / Side View Facing High Street

Workshop / Archives / End View

Workshop / Archives / End View Showing Lean To Addition

Workshop / Archives / Internal View Showing Workshop End



Workshop / Archives / Internal View Archives End

# Appendix A Building Details

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DATE 20
REVIEWED/CHECKED BY
DATE 20
REF/DWGS
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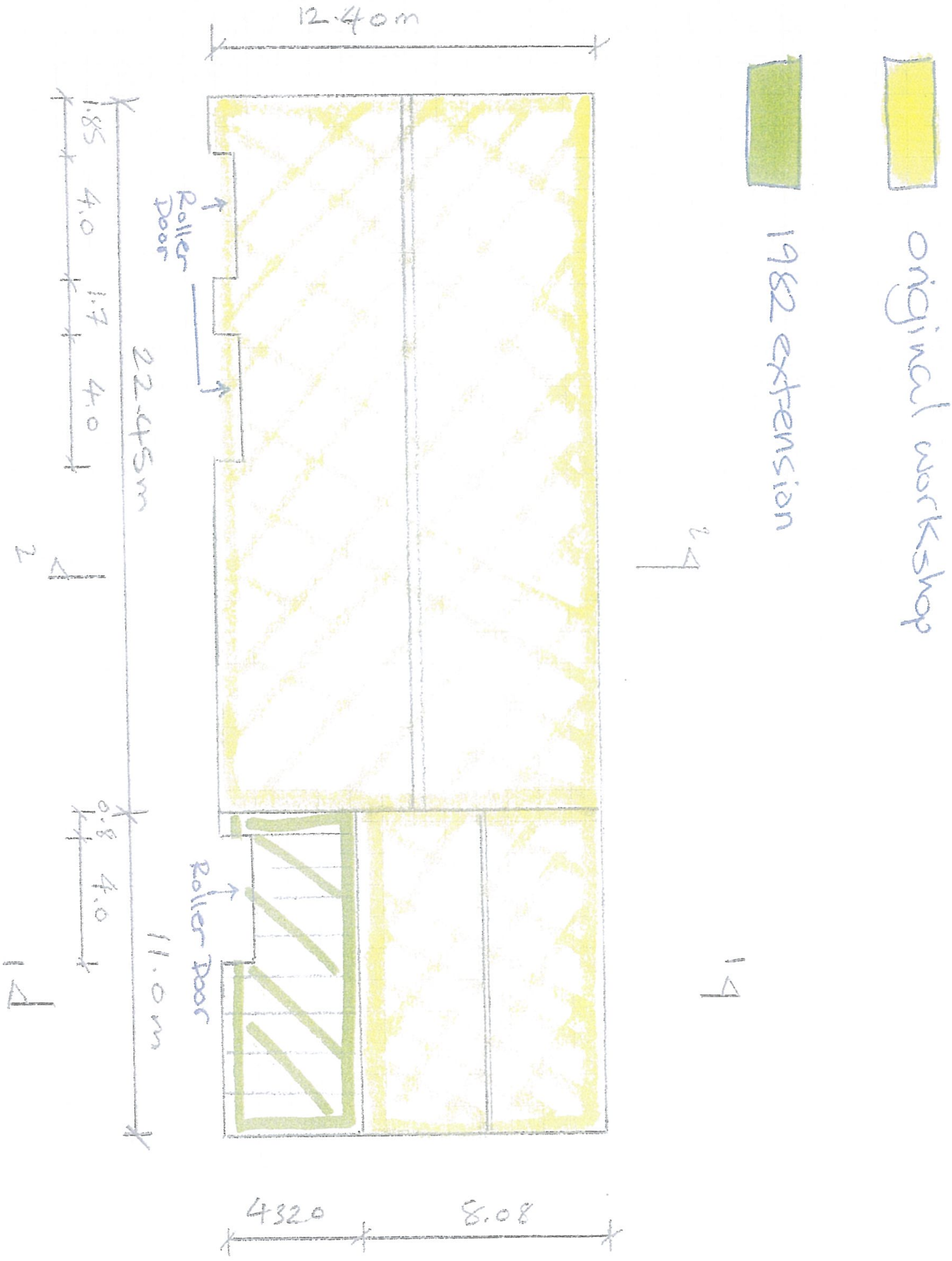

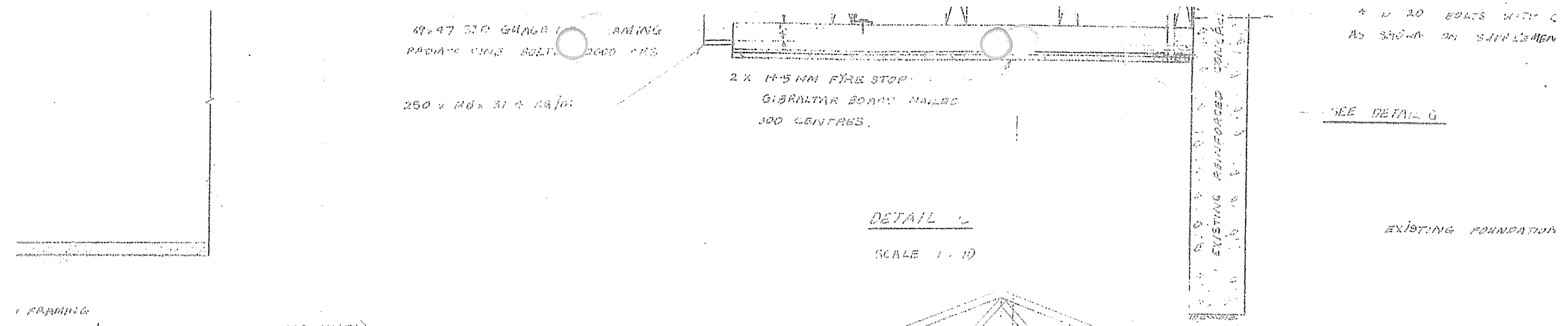

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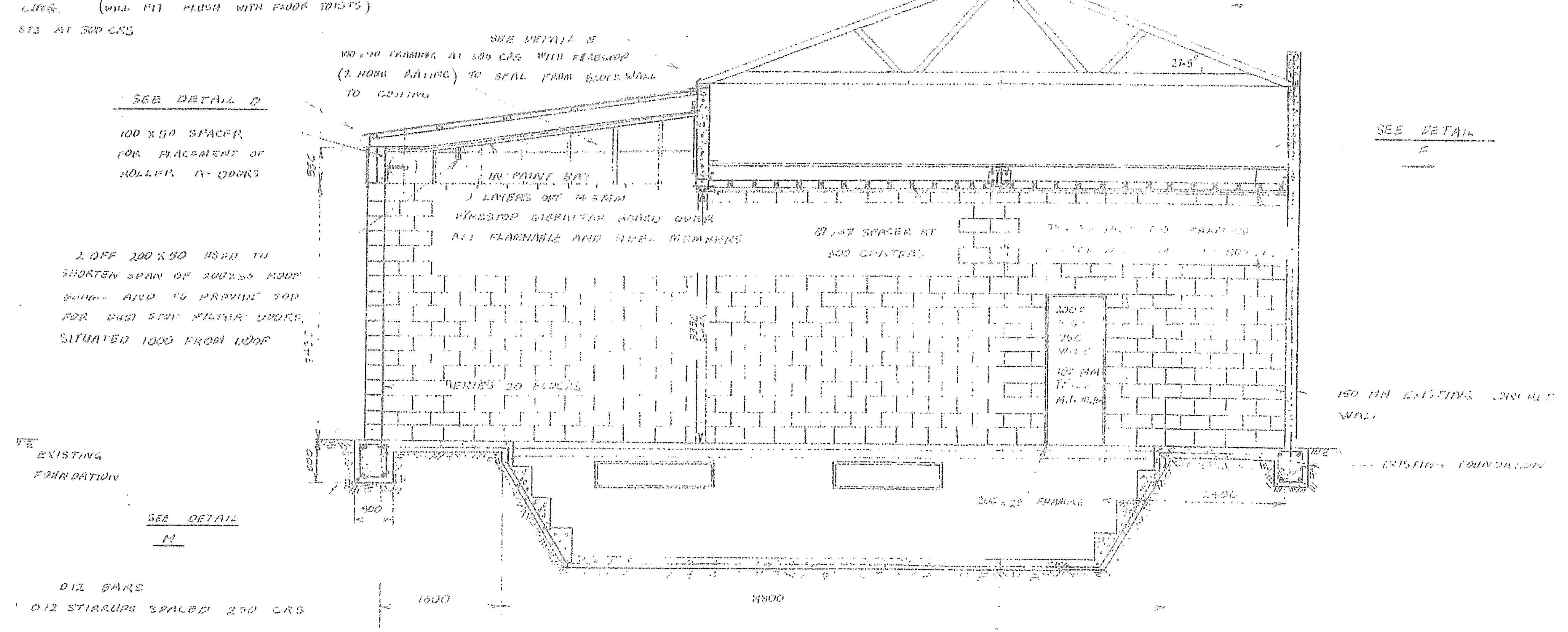

Section 1 - 1

COUNTY COUNCIL

SCALE

MWH

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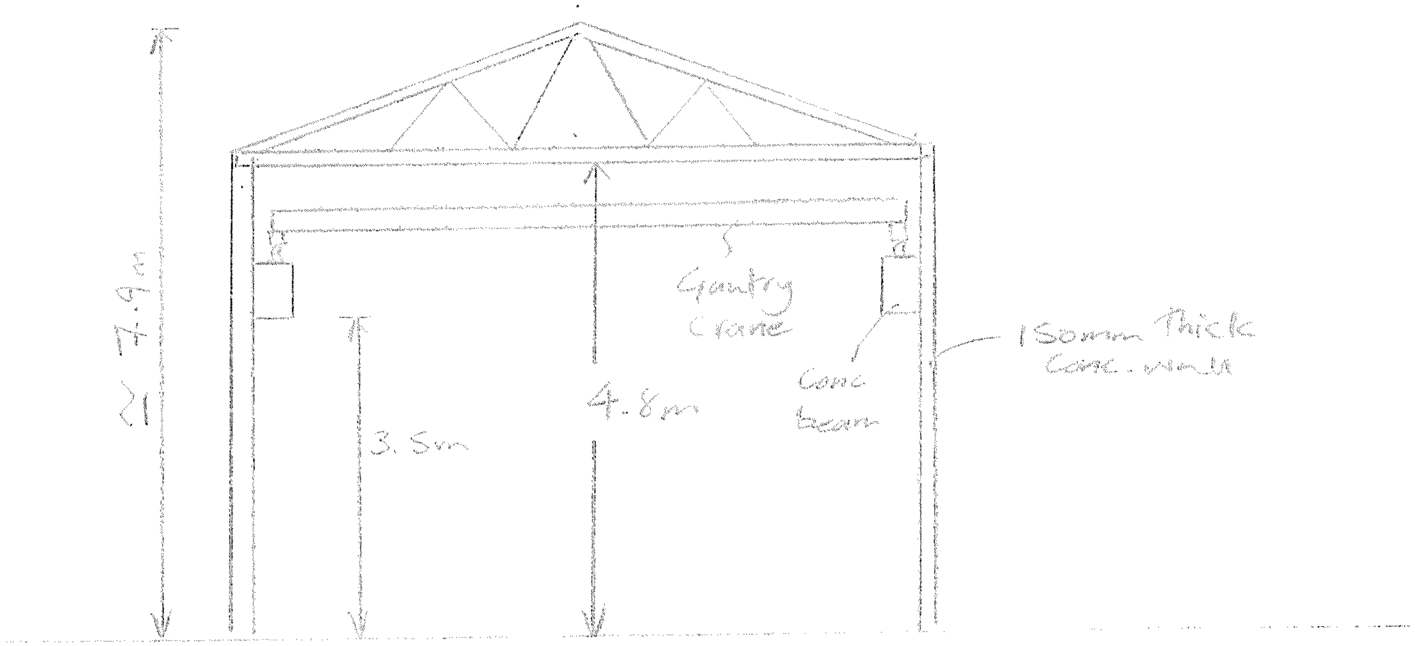
DATE 20
REVIEWED/CHECKED BY
DATE 20
REF/DWGS
SHEET OF



Section 2-2

# Appendix B Structural Evaluation Calculations

**Building Name** Rangitiki District Council / Workshop Building
**Location:** Marton

Ref.
By O. Hilli
Date Feb 2008

### *Step 1 - General Information contd...*

1.2 Refer to appendix for sketch of building plan

## 1.3 List of relevant features

1. Brick wall construction
2. Timber roof trusses
3. Built circa 1936 (as advised by Rangitikei District Council)

## 1.4 Note information sources

Visual Inspection of Exterior ☑
Visual Inspection of interior ☑
Drawings (note type) ☑ Extension only
Specifications ☐
Geotechnical Reports ☐
Other (list) ☐

**MWH** Initial Evaluation Procedure - Step 2

**Building Name** Rangitiki District Council / Workshop Building
**Location Marton**
**Direction considered:** **a) Longitudinal ~~b) Transverse~~**
(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

**Ref.**
**By** O. Hilli
**Date** Feb 2008

## *Step 2 - Determination of (%NBS)$_b$*

### 2.1 Determine nominal (%NBS) = (%NBS)$_{nom}$

a) Date of Design and Seismic Zone

Pre 1935 ☐
1935-1965 ☑
1965-1976 Seismic Zone; A ☐
B ☐
C ☐
1976-1992 Seismic Zone; A ☐
B ☐
C ☐
1992-2004 ☐

b) Soil Type

From NZS1170.5:2004, Cl 3.1.3
A or B Rock ☐
C Shallow Soil ☐
D Soft Soil ☑
E very Soft Soil ☐

From NZS4203:1992, Cl 4.6.2.2
(for 1992 to 2004 only and only if known)
a) Rigid ☐
b)Intermediate ☐

c) Estimate Period, T 0.22 Seconds

Can use the following:

$T=0.09h_n^{0.75}$ for moment resisting concrete frames
$T=0.14h_n^{0.75}$ for moment resisting steel frames
$T=0.08h_n^{0.75}$ for eccentrically braced steel frames
$T=0.06h_n^{0.75}$ for all other frame structures
$T=0.09h_n^{0.75}/A_c^{0.5}$ for concrete shear walls
$T \leq 0.4sec$ for masonry shear walls

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

$$A_c := \sum_i \left[ A_i \cdot \left( 0.2 + \frac{L_{wi}}{h_n} \right)^2 \right]$$

$A_i$ = cross-sectional shear area of the shear wall i in the first storey of the building, in m $^2$
$l_{wi}$ = length of shear wall i in the first storey in the direction parallel to the applied forces, in m with the restriction that $l_{wi}/h_n$ shall no exceed 0.9

d) (%NBS)$_{nom}$ determined from figure 3.3 of NZSEE Assessment and Improvement of the structural perfomance of buildings in earthquakes 3.0 (%NBS)$_{nom}$

**Note 1:** For buildings designed prior to 1965 and known to be designed as public buildings in accordance with the code of the time, multiply (%NBS) $_{nom}$ by 1.25. 1
For buildings designed 1965 - 1975 and known to be designed as public buildings in accordance with the code of the time, multiply by 1.33 - Zone A
1.2 - Zone B

**Note 2:** For reinforced concrete buildings designed between 1976 - 84 multiply (%NBS)$_{nom}$ by 1.2 ☐

**Note 3:** For buildings designed prior to 1935 multiply (%NBS) $_{nom}$ by 0.8 except for Wellington where the factor may be taken as 1. ☐ 3.0 (%NBS)$_{nom}$

## 2.2 Near Fault Scaling Factor, Factor A

If $T \leq 1.5\text{sec}$ Factor A = 1

a) Near Fault Factor, N(T,D) | 1
(from NZS 1170.5:2004, Cl 3.1.6)

b) Near Fault scaling factor = 1/N(T,D) **Factor A** | 1

## 2.3 Hazard Scaling Factor, Factor B

a) Hazard Factor, Z, for site | 0.3 Marton
(from NZS 1170.5:2004, Table 3.3

b) Hazard Scaling Factor

For pre 1992 = 1/Z

For 1992 onwards = $Z_{1992}/Z$

(Where $Z_{1992}$ is the NZS 4203:1992 Zone Factor from accompanying Figure 3.5(b)) **Factor B** | 3.33

## 2.4 Return Period Scaling Factor, Factor C

a) Building Importance Level | 2
(from NZS1170.0:2004, Table 3.1 and 3.2)

b) Return Period Scaling Factor from accompanying Table 3.1 **Factor C** | 1

## 2.5 Ductility Scaling Factor, Factor D

a) Assessed Ductility of Existing Structure, $\mu$ | 2
(shall be less than the maximum given in accompanying Table 3.2)

b) Ductility Scaling Factor

For pre 1976 = $k_\mu$

For 1976 onwards = 1

(Where $k_\mu$ is NZS 1170.5:2004 Ductility Factor, from accompanying Table 3.3) **Factor D** | 1.57

## 2.6 Structural Performance Scaling Factor, Factor E

a) Structural Performance Factor, $S_p$ from accompanying Figure 3.4 | 0.7

b) Structural Performance Scaling Factor = $1/S_p$ **Factor E** | 1.43

## 2.7 Baseline %NBS for Building, $(\%NBS)_b$

(equals $(\%NBS)_{nom}$ x A x B x C x D x E ) | 22.43

= 3 x 1 x 3.33 x 1 x 1.57 x 1.43

= 22.43

MWH

# Initial Evaluation Procedure - Step 3

**Building Name** Rangitiki District Council / Workshop Building
**Location:** Marton
**Direction considered:** a) Longitudinal b) Transverse
(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

**Ref.**
**By** O. Hill
**Date** Feb 2008

## *Step 3 - Assessment of Performance Achievement Ratio (PAR)*

*(Refer to Appendix B - Section B3.2)*

**Critical Structural Weakness** | **Building Score** | **Effect on Structural Performance**

*(Choose a value - Do not interpolate)*

### 3.1 Plan Irregularity

*Effect on Structural Performance*

| | | Severe | Significant | Insignificant |
|---|---|---|---|---|
| Factor | A := 0.7 | 0.4 max | 0.7 | 1 |

*Comment*

### 3.2 Vertical Irregularity

*Effect on Structural Performance*

| | | Severe | Significant | Insignificant |
|---|---|---|---|---|
| Factor | B := 1 | 0.4 max | 0.7 | 1 |

*Comment*

### 3.3 Short Columns

*Effect on Structural Performance*

| | | Severe | Significant | Insignificant |
|---|---|---|---|---|
| Factor | C := 1 | 0.4 max | 0.7 | 1 |

*Comment*

### 3.4 Pounding Potential

(Estimate D1 and D2 and set D = the lower of the two, or = 1 if no potential for pounding)

a) Factor D1:- Pounding Effect

*Select appropriate value from Table*

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

Factor D1 := 1

| Table for Selection of Factor D1 | Severe | Significant | Insignificant |
|---|---|---|---|
| Separation | 0<Sep<.005H | .005H<Sep<.01H | .Sep>.01H |
| *Alignment of floors within 20% of story Height* | 0.7 | 0.8 | 1 |
| *Alignment of floors not within 20% of story height* | 0.4 | 0.7 | 0.8 |

b) Factor D2:- Height Difference Effect

*Select appropriate value from Table*

Factor D2 := 1

| Table for Selection of Factor D2 | Severe | Significant | Insignificant |
|---|---|---|---|
| | 0<Sep<.005H | .005H<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 |

Factor D := 1

### 3.5 Site Characteristics - (Stability, landslide threat, liquifaction etc)

*Effect on Structural Performance*

| | | Severe | Significant | Insignificant |
|---|---|---|---|---|
| Factor | E := 0.7 | 0.5 max | 0.7 | 1 |

### 3.6 Other Factors

Factor F := 1 For <= 3 storeys - maximum value 2.5,
otherwise - maximum value 1.5, No minimum

Record rationale for Factor F:

### 3.7 Performance Achievement Ratio (PAR)

PAR := A·B·C·D·E·F

PAR = 0.49

# MWH Initial Evaluation Procedure - Step 2

**Building Name** Rangitiki District Council / Workshop Building
**Location** Marton
**Direction considered:** ~~a) Longitudinal~~ **b) Transverse**
(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

**Ref.**
**By** O. Hilli
**Date** Feb 2008

## *Step 2 - Determination of (%NBS)$_b$*

### 2.1 Determine nominal (%NBS) = (%NBS)$_{nom}$

a) Date of Design and Seismic Zone

| | | |
|---|---|---|
| Pre 1935 | | ☐ |
| 1935-1965 | | ☑ |
| 1965-1976 | Seismic Zone; A | ☐ |
| | B | ☐ |
| | C | ☐ |
| 1976-1992 | Seismic Zone; A | ☐ |
| | B | ☐ |
| | C | ☐ |
| 1992-2004 | | ☐ |

b) Soil Type

| | | |
|---|---|---|
| From NZS1170.5:2004, Cl 3.1.3 | A or B Rock | ☐ |
| | C Shallow Soil | ☐ |
| | D Soft Soil | ☑ |
| | E very Soft Soil | ☐ |
| From NZS4203:1992, Cl 4.6.2.2 | a) Rigid | ☐ |
| (for 1992 to 2004 only and only if known) | b)Intermediate | ☐ |

c) Estimate Period, T 0.29 Seconds

Can use the following:

| | |
|---|---|
| $T=0.09h_n^{0.75}$ | for moment resisting concrete frames |
| $T=0.14h_n^{0.75}$ | for moment resisting steel frames |
| $T=0.08h_n^{0.75}$ | for eccentrically braced steel frames |
| $T=0.06h_n^{0.75}$ | for all other frame structures |
| $T=0.09h_n^{0.75}/A_c^{0.5}$ | for concrete shear walls |
| $T \leq 0.4\text{sec}$ | for masonry shear walls |

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

$$A_c := \sum_i \left[ A_i \cdot \left( 0.2 + \frac{L_{wi}}{h_n} \right)^2 \right]$$

$A_i$ = cross-sectional shear area of the shear wall i in the first storey of the building, in m $^2$
$l_{wi}$ = length of shear wall i in the first storey in the direction parallel to the applied forces, in m with the restriction that $l_{wi}/h_n$ shall no exceed 0.9

d) (%NBS)$_{nom}$ determined from figure 3.3 of NZSEE Assessment and Improvement of the structural performance of buildings in earthquakes 3.0 (%NBS)$_{nom}$

**Note 1:** For buildings designed prior to 1965 and known to be designed as public buildings in accordance with the code of the time, multiply (%NBS) $_{nom}$ by 1.25. ☐
For buildings designed 1965 - 1975 and known to be designed as public buildings in accordance with the code of the time, multiply by 1.33 - Zone A
1.2 - Zone B

**Note 2:** For reinforced concrete buildings designed between 1976 - 84 multiply (%NBS)$_{nom}$ by 1.2 ☐

**Note 3:** For buildings designed prior to 1935 multiply (%NBS) $_{nom}$ by 0.8 except for Wellington where the factor may be taken as 1. ☐ 3.0 (%NBS)$_{nom}$

## 2.2 Near Fault Scaling Factor, Factor A

If $T \leq 1.5sec$ Factor A = 1

a) Near Fault Factor, N(T,D)
(from NZS 1170.5:2004, Cl 3.1.6)

b) Near Fault scaling factor = 1/N(T,D) **Factor A** 1

## 2.3 Hazard Scaling Factor, Factor B

a) Hazard Factor, Z, for site 0.3 Marton
(from NZS 1170.5:2004, Table 3.3

b) Hazard Scaling Factor

For pre 1992 = 1/Z

For 1992 onwards = $Z_{1992}/Z$

(Where $Z_{1992}$ is the NZS 4203:1992 Zone Factor from accompanying Figure 3.5(b)) **Factor B** 3.33

## 2.4 Return Period Scaling Factor, Factor C

a) Building Importance Level 2
(from NZS1170.0:2004, Table 3.1 and 3.2)

b) Return Period Scaling Factor from accompanying Table 3.1 **Factor C** 1

## 2.5 Ductility Scaling Factor, Factor D

a) Assessed Ductility of Existing Structure, $\mu$ 2
(shall be less than the maximum given in accompanying Table 3.2)

b) Ductility Scaling Factor

For pre 1976 = $k_{\mu}$

For 1976 onwards = 1

(Where $k_{\mu}$ is NZS 1170.5:2004 Ductility Factor, from accompanying Table 3.3) **Factor D** 1.57

## 2.6 Structural Performance Scaling Factor, Factor E

a) Structural Performance Factor, $S_p$ from accompanying Figure 3.4 0.7

b) Structural Performance Scaling Factor = $1/S_p$ **Factor E** 1.43

## 2.7 Baseline %NBS for Building, $(\%NBS)_b$

(equals $(\%NBS)_{nom}$ x A x B x C x D x E ) 22.43

**MWH**

# Initial Evaluation Procedure - Step 3

**Building Name** Rangitiki District Council / Workshop Building
**Location: Marton**
**Direction considered:** ~~a) Longitudinal b~~) **Transverse**
(Choose worse case if clear at start. Complete IEP-2 and IEP-3 for each if in doubt)

**Ref.**
**By** O. Hilli
**Date** Feb 2008

## *Step 3 - Assessment of Performance Achievement Ratio (PAR)*

*(Refer to Appendix B - Section B3.2)*

| **Critical Structural Weakness** | **Building Score** | **Effect on Structural Performance** | | |
|---|---|---|---|---|
| | | *(Choose a value - Do not interpolate)* | | |

### 3.1 Plan Irregularity

*Effect on Structural Performance*

*Comment*

| | | Severe | Significant | Insignificant |
|---|---|---|---|---|
| Factor | A := ....1.... | 0.4 max | 0.7 | [✓ 1] |

### 3.2 Vertical Irregularity

*Effect on Structural Performance*

*Comment*

| | | Severe | Significant | Insignificant |
|---|---|---|---|---|
| Factor | B := ....1.... | 0.4 max | 0.7 | [✓ 1] |

### 3.3 Short Columns

*Effect on Structural Performance*

*Comment*

| | | Severe | Significant | Insignificant |
|---|---|---|---|---|
| Factor | C := ....1.... | 0.4 max | 0.7 | [✓ 1] |

### 3.4 Pounding Potential

(Estimate D1 and D2 and set D = the lower of the two, or = 1 if no potential for pounding)

a) Factor D1:- Pounding Effect

*Select appropriate value from Table*

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

Factor D1 := ....1....

| Table for Selection of Factor D1 | Severe | Significant | Insignificant |
|---|---|---|---|
| Separation | 0<Sep<.005H | .005H<Sep<.01H | .Sep>.01H |
| *Alignment of floors within 20% of story Height* | 0.7 | 0.8 | 1 |
| *Alignment of floors not within 20% of story height* | 0.4 | 0.7 | 0.8 |

b) Factor D2:- Height Difference Effect

*Select appropriate value from Table*

Factor D2 := ....1....

| Table for Selection of Factor D2 | Severe | Significant | Insignificant |
|---|---|---|---|
| | 0<Sep<.005H | .005H<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 |

Factor D := ....1....

### 3.5 Site Characteristics - (Stability, landslide threat, liquifaction etc)

*Effect on Structural Performance*

| | | Severe | Significant | Insignificant |
|---|---|---|---|---|
| Factor | E := 0.7 | 0.5 max | [✓ 0.7] | 1 |

### 3.6 Other Factors

Factor F := 1 For <= 3 storeys - maximum value 2.5, otherwise - maximum value 1.5, No minimum

Record rationale for Factor F:

### 3.7 Performance Achievement Ratio (PAR)

PAR := A·B·C·D·E·F

PAR = 0.7

**Building Name** Rangitiki District Council / Workshop Building
**Location Marton**

**Ref**
**By** O. Hilli
**Date** Feb 2008

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

| | Longitudinal | Transverse |
|---|---|---|
| 4.1 Assessed Baseline $(\%NBS)_b$<br>(from Table IEP - 1) | 22.43 | 22.43 |
| 4.2 Performance Achievement Ratio (PAR)<br>(from Table IEP - 2) | 0.49 | 0.7 |
| 4.3 PAR x Baseline $(\%NBS)_b$ | 11 | 15.7 |
| 4.4 Percentage New Building Standard (%NBS)<br>(use lower of 2 values from step 4.3) | | 11 |

## *Step 5 - Potentially EQ Prone?*

(mark as appropriate)

| | |
|---|---|
| %NBS > 33 | No |
| %NBS < 33 | Yes |

## *Step 6 - Potentially EQ Risk*

(mark as appropriate)

| | |
|---|---|
| %NBS > 67 | No |
| %NBS < 67 | Yes |

## *Step 7 - Provisional Grading for seismic risk based on IEP*

Seismic Grade E

Evaluation Confirmed by... .................................... Signature

O. Hilli .................................... Name

Relationship between Seismic Grade and %NBS:

| Grade: | A+ | A | B | C | D | E |
|---|---|---|---|---|---|---|
| %NBS | > 100 | 100-80 | 80 - 67 | 67 - 33 | 33 - 20 | < 20 |