South Waikato District Council Building

Detailed Seismic Assessment Report

3 Torphin Crescent, Tokoroa

South Waikato District Council

3 Torphin Crescent, Tokoroa

Detailed Seismic Assessment Report

September 2022

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Executive Summary

GDC Consultants Limited has been commissioned by South Waikato District Council to undertake a Detailed Seismic Assessment (DSA) for the South Waikato District Council building situated at 3 Torphin Crescent, Tokoroa.

The assessment has been undertaken in accordance with the guidelines "The Seismic Assessment of Existing Buildings-Technical Guidelines for Engineering Assessments". The DSA is a quantitative assessment method used to determine an earthquake rating in terms of "percentage of new building standard" (%NBS). These guidelines are also an integral part of the methodology published by the Ministry of Business, Innovation and Employment (MBIE) under section 133AV of the Building Act 2004, to identify earthquake-prone buildings.

The building was designed and originally built in 1987. The building is two storey, the structural system comprises of reinforced concrete shear walls and reinforced concrete frames in both directions.

The new building standards depend on the building "importance level" including the number of occupants. The client has advised that the maximum occupancy of the building is less than 300. The building is therefore classified as importance level 2 (normal structures) and has been assessed on that basis. The results of the assessment are summarised in Table 1 below.

Table 1 – Summary of Seismic Assessment

Building Component	Seismic Rating %NBS(IL2)
First floor concrete diaphragm	50%
Ground floor concrete walls	100%
First floor framing	100%
Stairs	100%

The rating of the building is governed by the lowest grade of structural members forming lateral load path. These are listed in Table 1 above:

The results of the DSA indicate that the earthquake rating of the South Waikato District Council is a minimum of 50%NBS (IL2). Buildings rated in excess of 33%NBS are not liable to be classified as "earthquake prone" under the earthquake prone buildings provisions of the Building Act. A building rating of 50%NBS is considered as "medium earthquake risk" (Class C) by the New Zealand Society for Earthquake Engineering grading scheme.

Table of Contents

1. Introduction

GDC Consultants Limited has been commissioned by South Waikato District Council to undertake a detailed seismic assessment (DSA) of the building located at 3 Torphin Crescent, Tokoroa (refer Figure 1 and 2).

Figure 1: Aerial photography showing South Waikato District Council building https://enterprise.mapimage.net/IntraMaps99)

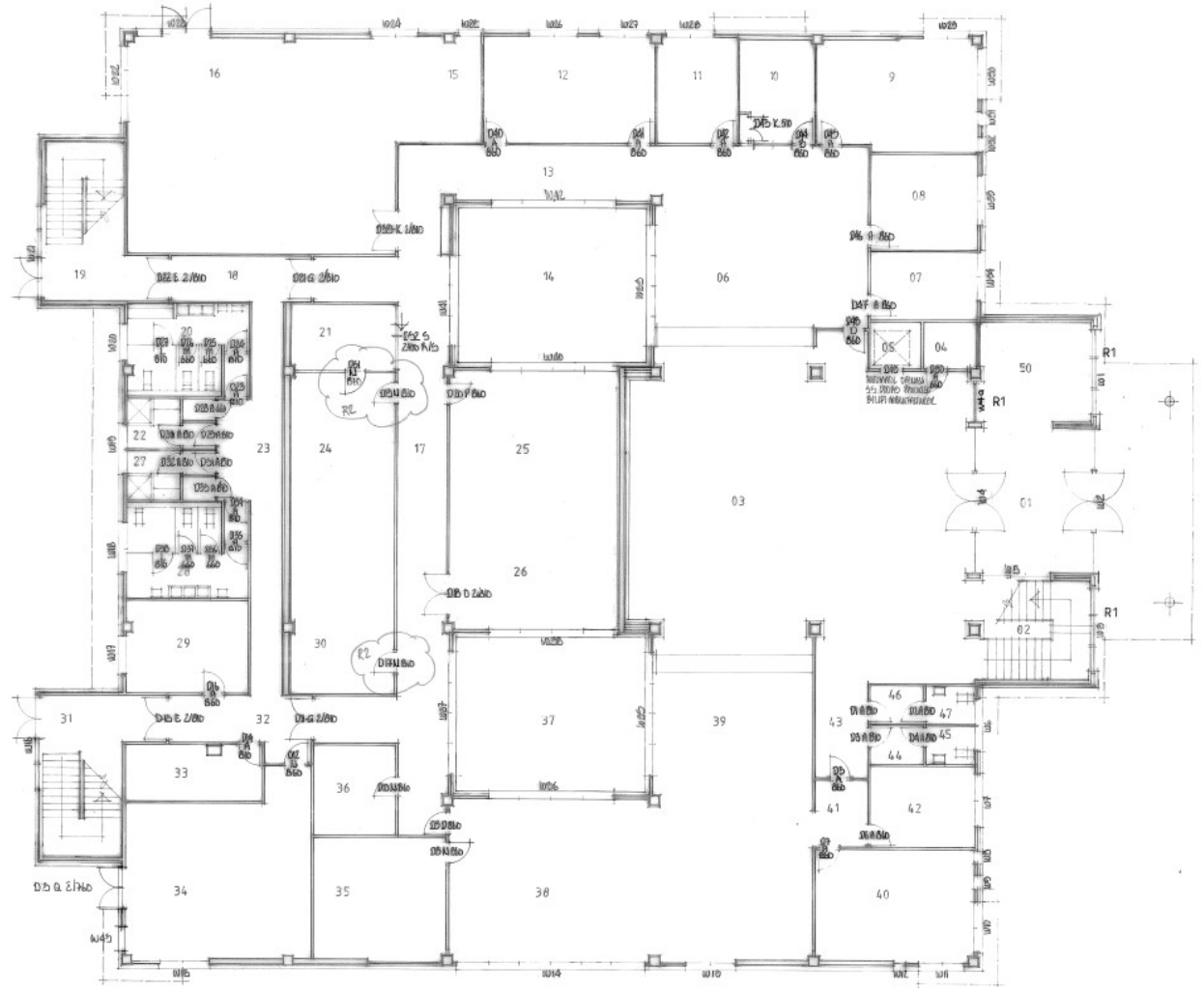

Figure 2: Floor plan

This assessment has been undertaken in accordance the guidelines document "The Seismic Assessment of Existing Buildings-Technical Guidelines for Engineering Assessments", dated 2017 published by the New Zealand Society for Earthquake Engineering (NZSEE). The DSA is a quantitative assessment method used to determine an earthquake rating in terms of "percentage new building standard" (%NBS). These guidelines are also an integral part of the EPB methodology produced by the Ministry of Business, Innovation and Employment (MBIE) under section 133AV of the Building Act 2004 to identify earthquake-prone buildings.

2. Relevant Regulations

The Earthquake Prone Buildings Amendment Act (section 133AB) defines an earthquake-prone building as one that:

> "having regard to the condition of the building or part and to the ground on which the building is built, and because of the construction of the building or part –

(a) the building or part will have its ultimate capacity exceeded in a moderate earthquake and

(b) if the building or part were to collapse, the collapse would be likely to cause –

(i) injury or death to persons in or near the building or on any other property; or

(ii) damage to any other property".

The Act also notes that this definition does not apply to buildings used wholly or mainly for residential purposes unless that building comprises 2 or more storeys and contains 3 or more household units.

The building regulations define a moderate earthquake as:

"In relation to a building, an earthquake that would generate shaking at the site of the building that is of the same durations 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 the site."

3. Available Information

The original drawings from 1987 were available at the time of assessing the building. The following sources of information was used in the assessment:

- Visual, non-intrusive site inspections to confirm as-built details were completed by Alin Poanta in July 2022.
- Selected scanning of walls, beams, columns and floor to confirm the reinforcement of structural elements. Scan results are shown in Appendix C.

4. Geotechnical Information

No site-specific geotechnical investigation or assessment including liquefaction assessment has been undertaken for this DSA. Hand auger logs taken at the site in 1986, a geological map and liquefaction hazard map are included in Appendix E. and

The New Zealand Geology Web Map indicates the soil type being variably welded, crystal-rich rhyolite ignimbrite having minor fall deposits. According to the auger logs the site is underlain with volcanic ash and weathered and unweathered ignimbrite described as fine sand ranging from dense to very dense. Groundwater was not encountered at depths in excess of 2m. The Waikato Regional Council hazard map indicates that the Tokoroa area has a low potential for liquefaction in strong ground shaking.

Based on our understanding of the underlying geology and previous geotechnical investigations in the Tokoroa area done by GDC Consultants, the subsoil classification for the site is Class C in accordance with NZS1170.5:2004 Clause 3.1.3.

5. Building Description

The building was designed and constructed circa 1987. It is two storey with a structural system comprising of reinforced concrete shear walls and reinforced concrete frames in both directions for the ground floor with a lightweight steel structure above the first floor concrete slab.

A floor plan is shown in Figure 2 and detailed descriptions of the building are presented in Table 2.

Table 2 – Building Description

Building part	Description
Number of Storeys	Two storey building
Approximate Gross Floor Area(m^2)	Ground Floor –1250 m^2
Construction Period	1987.
Current Use	Office facility
Importance Level (IL)	IL2. The normal occupancy for this building is less than 300.
Structural Alterations	Nil
Basement	None
Gravity Load Resisting System	Gravity Load Resisting System comprises the following elements: - Heavy-weight concrete tiles supported on timber batten and rafter sitting on steel columns and beams spanning between reinforced concrete columns. - Moment resisting reinforced concrete frames in both directions for the first floor. - Internal partition walls constructed of timber frame walls - First floor concrete slab supported by concrete shear walls and reinforced concrete frames on reinforced concrete foundations.

Lateral Load Resisting System	Lateral Loads Resisting System comprises the following elements: At the first floor, the lateral loads are resisted by moment resisting concrete frames transferring the loads to a concrete diaphragm. The loads are then resisted by concrete shear walls in both directions. The ground floor concrete frames are taking minimal lateral loads compared with concrete walls due to stiffness difference between the two elements. Concrete frames carry the vertical loads mainly.
Roof System	The roof comprises heavy-weight concrete tiles supported on timber batten and rafter sitting on steel columns and beams spanning between reinforced concrete columns.
Ground Floor System	Concrete slab-on-grade.
First floor	Precast double tee flooring system supported by the reinforced concrete frame
Foundation System	Foundations comprise of reinforced concrete ground beams under the concrete walls situated at 2.8m under the natural ground level and pad footings and reinforced concrete piles under the concrete frames.
Adjacent Buildings	There are no adjacent buildings.

6. Seismic Assessment Methodology

The detailed seismic assessments have been undertaken in accordance with the New Zealand Society for Earthquake Engineering (NZSEE) July 2017 guidelines for the "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes".

A building's seismic rating calculated as the percentage of new building standard (%NBS) where:

%NBS = (Seismic capacity/Seismic demand) x 100

Seismic capacities of the building components are calculated in accordance with procedures specified in the NZSEE guidelines.
Seismic demands or actions on these components is calculated in accordance with design standards for new buildings (AS/NZS 1170)

The following parameters from AS/NZS 1170 were used to calculate the seismic demand on the buildings:

- Building importance level 2
- Annual probability of exceedance for ultimate limit state 1 in 500 years
- Local seismic hazard factor, Z 0.21
- Building period, in both directions 0.4 sec
- Soil Class C

The following material properties were adopted from guidelines section C5:

- Probable yield stress of steel bars: 380MPa
- Probable compressive strength of concrete: 30MPa

Assessment calculations are provided in Appendix A. The following is a summary of the procedures adopted in the calculations.

Assessment of the reinforced concrete walls, frames and first floor diaphragm was based on methodology outlined in NZSEE Guidelines Section C2 Assessment Procedures and Analysis Techniques and Section C5-Seismic Assessment of Concrete Buildings.
According to NZSEE Guideline C2, equivalent elastic analysis is appropriate in circumstances where there is significant strength capacity to achieve the target %NBS, therefore the structure capacity was checked based on force-based assessment approach using Equivalent Static Method as outlined in NZS 1170.5: 2004.

The building has a lightweight structure on top of the first-floor concrete slab which presents a vertical irregularity by virtue of the change in storey mass and storey stiffness. This first floor structure was therefore analysed as a part. Since the ground floor structure comprises very stiff shear walls in both directions, a height amplification factor of 1.0 was adopted for this analysis.

A grillage method was adopted to obtain diaphragm design actions, in accordance with Section C5 Chapter C5.5.4 Concrete floor diaphragms and Appendix C5F. Inertia forces were derived in accordance with NZS 1170.5:2004 Chapter C5.7.A2.3 *The pseudo-equivalent static analysis – pESA.*

7. Results of Assessment

The results of the assessments are summarised in Table 3.

Building Component	Seismic Rating %NBS(IL2)
First floor concrete diaphragm	50%
Ground floor concrete walls	100%
First floor framing	100%

Table 3 – Summary of Seismic Assessment

The structural critical weakness (SCW) for the building is assessed to be the concrete diaphragm capacity to transfer the seismic forces to the shear walls. The diaphragm is rated at 50%NBS(IL2), all other components are rated at 100%NBS.

8. Options for improving the building's seismic capacity

The building's rating can be increased to up to 100%NBS by strengthening the first floor diaphragm. One option for achieving this is to install fibre reinforced polymer overlay and steel angles a shown in the conceptual sketches in Appendix C.

9. Conclusions

GDC Consultants Limited has completed a detailed seismic assessment (DSA) of the South Waikato District Council Building located at 3 Torphin Crescent, Tokoroa for South Waikato District Council.

This assessment has been undertaken in accordance the guidelines document "The Seismic Assessment of Existing Buildings-Technical Guidelines for Engineering Assessments", dated 2017 published by the New Zealand Society for Earthquake Engineering (NZSEE). The DSA is a quantitative assessment method used to determine an earthquake rating in terms of "percentage new building standard" (%NBS). These guidelines are also an integral part of the EPB methodology produced by the Ministry of Business, Innovation and Employment (MBIE) under section 133AV of the Building Act 2004 to identify earthquake-prone buildings.

The results of the DSA indicate that the earthquake rating of the South Waikato District Council building is a minimum of 50%NBS (IL2), with the critical weakness being the first floor concrete diaphragm. Buildings rated more than 33%NBS are not liable to be classified as "earthquake prone" under the earthquake prone buildings provisions of the Building Act. A building rating of

50%NBS is considered as “medium earthquake risk” (Class C) by the New Zealand Society for Earthquake Engineering grading scheme.

10. Limitations

This report is prepared with the limitations outlined below:

- This report is based on a visual inspection, intrusive investigation at discrete selected locations and a quantitative assessment of the building.
- Our professional judgement & services are performed using a degree of care, experience on similar structures as a reputable consultant practising in the field.
- This report is prepared for South Waikato District Council. Our responsibility in connection with this report is limited to the client to whom the report is addressed and to that client only. We disclaim all responsibility and will accept no liability to any other party without first obtaining the written consent of GDC and the author of the report. GDC reserves the right to alter, amend, explain or limit any further information given to any other party.
- Recommendations and opinions in this report are based on data obtained from the investigations and site observations.
- No liability is accepted by GDC or any employee or sub-consultant of this company with respect to its use by any other parties.
- This disclaimer shall apply notwithstanding that the report may be made available to other persons for an application for permission or approval to fulfil a legal requirement. This report shall not be used to interpret any form of financial transaction.

11. References

- NZSEE (July 2017). The Seismic Assessment of Existing Buildings-Technical Guidelines for Engineering Assessments.
- Standards New Zealand NZS1170:2004 Structural Design Actions
- SESOC Journal, Volume 27 Issue 1 April 2014, Floor Diaphragms