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Report

Detailed Seismic Assessment – Clutha District Council Main Buildings and Community Halls

Appendix A

Balclutha Information and Service Building

Prepared for Clutha District Council

Prepared by Beca Ltd (Beca)

17 March 2017

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Revision History

Revision Nº	Prepared By	Description	Date
A	Peter Chen	Draft for client comment	17 March 2017
B	Tristan Hanbury-Webber	Update following further site investigation	17 March 2017

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Document Acceptance

Action	Name	Signed	Date
Prepared by	Peter Chen Tristan Hanbury-Webber		19 August 2016 17 March 2017
Reviewed by	Tristan Hanbury-Webber Peter Chen		19 August 2016 17 March 2017
Approved by	Jonathan Barnett		17 March 2017
on behalf of	Beca Ltd		

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1 Building Description

1.1 General

Summary information about the building is presented in the following table. Reference Information used to undertake this seismic assessment is listed in section '1.3 Sources of Information'.

Table 1 - Building Summary Information

Item	Details	Comment
Building name	Balclutha Service Centre	
Street Address	4 Clyde Street, Balclutha	
Age	Approximately 60 years	
Description / Building Occupancy	Single storey for public use.	
Importance Level	Importance Level 2	This building is considered a 'Normal Structure'. This building is not intended to contain people in crowds or contents of high value.
Building Footprint / Floor Area	Approximately 440m^2	Longitudinal (East-West) and transverse (North-South) building lengths measuring 28.7m and 23.4m respectively.
No. of storeys / basements	Single storey, no basement	
Gravity structural system	Unreinforced concrete block walls with reinforced concrete bond beams, reinforced concrete lintels, timber roof framing and timber floor.	
Lateral structural system	Unreinforced concrete block walls with reinforced concrete bond beams, flexible roof diaphragm.	
Foundation system	Concrete strip footings beneath concrete block walls, concrete piles.	
Stair system	No stairs	
Other notable features	Unreinforced masonry parapet above main entrance.	
Past seismic strengthening	N/A	Service area altered in 1994.
Construction information	Architectural drawings from 1954, structural drawings of the service area alteration from 1994.	
Likely Design Loading Standards	Unknown	
Heritage Status	This building is not included in the New Zealand Heritage List.	CDC to advise Beca if this building should be on the New Zealand Heritage List.
Other		

See Site Visit Report (chapter 2) for additional descriptions and photographs.

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1.2 Inspections and Assumptions

See Site Visit Report (chapter 2) for a summary of the investigations undertaken on-site.

The following assumptions were made for the Detailed Seismic Assessment.

- Site subsoil class D (deep or soft soil)
- From site investigation, reinforcement in the masonry walls could not be detected
- For unreinforced masonry: ductility factor, μ = 1.0, structural performance factor, S_p = 1.0.
- Masonry properties: brick hardness = medium, mortar hardness = medium, probable brick compressive strength, f'b = 26 MPa, probable mortar strength 2MPa.
- A site investigation was conducted on the ceiling diaphragm and based on its construction it is unlikely that a sufficient diaphragm exists in the ceiling and the roof structure is expected to behave as a flexible diaphragm.

1.3 Sources of Information

We based our analysis on the following sources of information

- Site visit.
- Drawings supplied to us by CDC
- Initial Evaluation Procedure (IEP) undertaken by Opus dated November 2014

1.4 Structural Systems

Refer to Figure 1 for a floor plan with annotated building directions.

The gravity load resisting system for Balclutha Information and Service building is identified to be:

- Roof level gravity loads are transferred through timber roof framing which span onto the unreinforced masonry walls and reinforced concrete lintels. Gravity loads are transferred to the ground through concrete strip footings.
- Floor level gravity loads are supported by a timber floor structure consisting of floor joists and bearers. The floor bears span onto concrete piles.

The lateral load resisting systems for Balclutha Information and Service building are identified to be:

- Seismic loads in the Balclutha Information and Service Centre are predominantly resisted by unreinforced masonry walls in both the North-South and East-West directions. Reinforced concrete bond beams are feature above all masonry walls.
- Seismic loads from the roof are transfer to the masonry walls through the timber roof structure as a flexible diaphragm.

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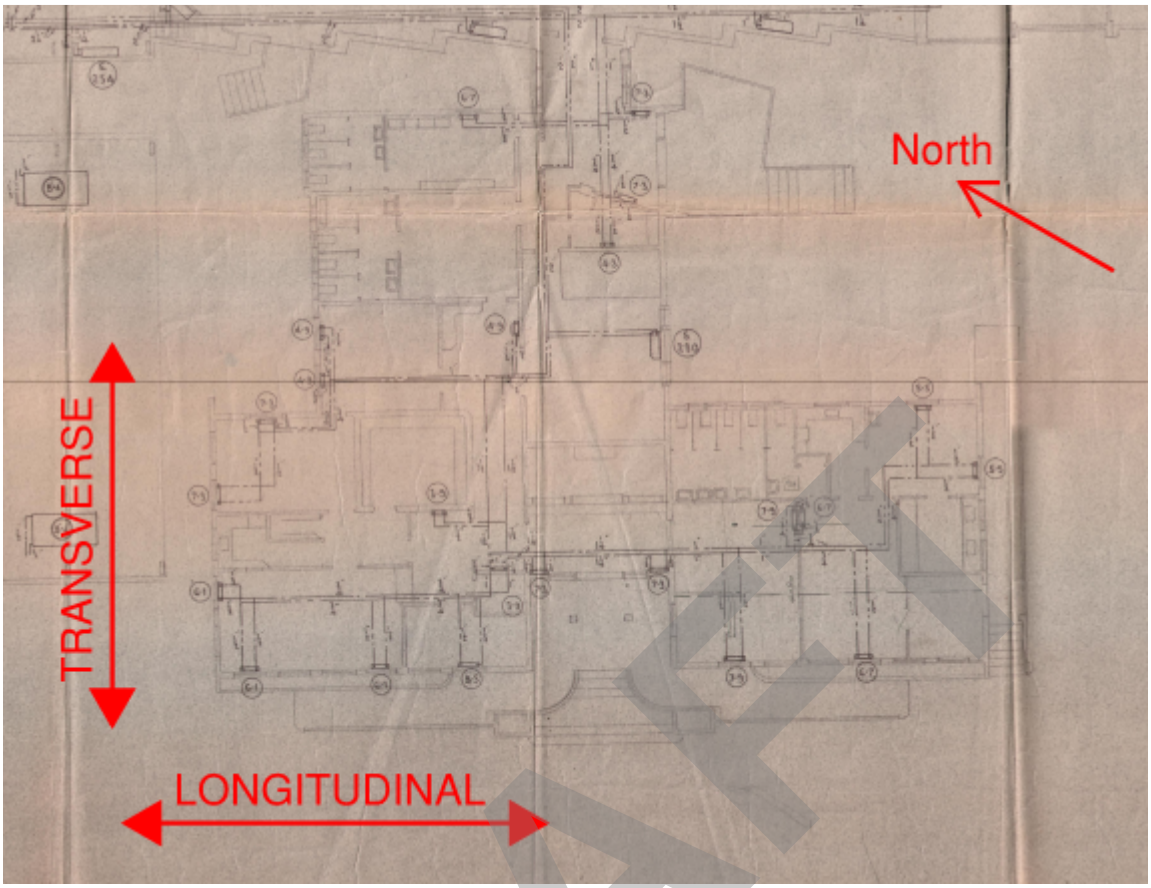

Figure 1 – Balclutha Information and Service Centre, Floor Plan

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2 Site Visit Report

Area of site visited:	Subfloor, building internal/external, ceiling space	**Purpose of visit:**	Collect information for Detailed Seismic Assessment (DSA)
Date/Time of visit:	30/05/2016 at 9:00a.m. 26/07/2016 at 2:00p.m. 21/11/2016 at 11:45am	**Weather:**	Fine
Beca personnel:	Doug Weston (30/5/16) Peter Chen (26/7/16) Tristan Hanbury-Webber (21/11/16)		**Error! Unknown document property name.**

Health and Safety:
Health and Safety Procedures followed.

Site Description
Original architectural drawings available. Built in 1951, the building is a single storey concrete block URM structure with a lightweight timber framed roof. The building has concrete strip footing beneath URM walls and concrete piles to support the timber floor system. The main entrance into the Balclutha Town Hall is through the Balclutha Information and Service Centre.

Location	Observation
Roof space	Timber boards on roof will provide some lateral stability. Insulation in the roof. Concrete roof on Strong room is visible; ceiling and roof is partially supported on strong room. Gable ends are timber framed.
Sub-floor space	Approximately 1.2m clear ground under floor. Concrete block walls continue down past the finished floor level and sit on concrete strip footings at ground level. Concrete piles support the timber framed floor and timber Tongue and Groove flooring. One of the concrete piles views had settled and was no longer attached or supporting the timber bearer.
Interior	Reinforced concrete beams/lintels throughout.
Walls	Strong room is reinforced concrete block masonry. Other Concrete block walls are unreinforced. Cracking can typically be seen through exterior plaster and through painted concrete blocks.
Window surrounds	300 thick reinforced (grid) window surrounds do not appear to have any cracking, whereas the other windows surrounds (which are likely to be concrete block URM that is plastered) have extensive cracking.
Entire building	A second site visit was undertaken by Peter Chen on 26/07/2016 to collect additional information for the DSA. Layout of the interior and exterior concrete block walls were recorded and confirmed against existing drawings. Thickness of interior and strong room walls were measured. Roof space was accessed to examine the ceiling diaphragm and its connections to the concrete block walls and reinforced concrete beams.
Entire building	A third site visit was undertaken by Tristan Hanbury-Webber on 21/11/16. The following items are noted: • All walls in Service Centre are unfilled and unreinforced. All have bond beams. • Bond beam at top is generally reinforced with 4 bars (D20 or D25 – very heavy). Stirrups at 250-500 crs. • RC columns have 3 vertical bars. • Bond beams are connected to the ceilings with ribbon plates 'bolted' with R12 cast in rods bent through holes in ribbon at 600mm-800mm crs (normally 800mm). As only load in ribbon plates is shear the bent bar will reach shear capacity of bolt (timber will fail first). • Sarking is screwed with at least 1 screw per board (small portion where the screws have missed the board proves this). Assume only 1 screw per board. • Columns out the front have 4 bars (size unclear, >=12mm). The beam at the top assumed to have the same reinforcing.

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- The ‘grid’ windows have two bars, to columns and beams, assume D12..
- Strong room D12 at 200 crs EW and roof of strong room has D12 at 250 crs.
- Lintels above doors have single bar with ‘stirrups’ at 400 crs. Maybe the stirrups go up to the bond beam or there may be another bar above roof space.

Attachments

Photo 1: View of Balclutha Information and Service Centre

Photo 2: View of timber board roof; the concrete ‘wall’ to the left is part of the war memorial at the entrance

Photo 3: View of timber framed gable end, strong room concrete roof, and timber roof framing

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Photo 4: View inside main entrance

Figure 5: View of concrete block wall with reinforced concrete bond beam and concrete beam spanning overhead; the door leads to the council chambers

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Photo 6: View of 300 thick reinforced concrete window surrounds in the council chambers

Figure 7: View of concrete block wall with reinforced concrete bond beam; note that the 'deep rectangle' in the wall is the end of a reinforced concrete beam that spans 'into the photo'

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3 Results of Seismic Assessment

3.1 Assessment Methodology

Bracing lines were assumed and the corresponding seismic weight was calculated for each bracing line. The seismic horizontal loading was determined by multiplying the seismic weights by the horizontal design action coefficient determined using the Equivalent Static Method considering the type of lateral structural system. Hand calculations were undertaken to calculate the capacities of the various lateral load resisting systems which were then compared to the demands. For unreinforced masonry structures, capacities of wall elements were derived in accordance with NZSEE document titled "Assessment and Improvement of the Structural Performance of Building in Earthquakes, Section 10 Revision Seismic Assessment of Unreinforced Masonry Buildings" dated April 2015. Out-of-plane checks of the parapet and walls were done based on the methodologies outlined in this document.

3.2 Seismic Risk and Performance Levels

From our assessment, the Balclutha Information and Service building is likely to achieve approximately **20%NBS** as it relates to life safety issues. The building has been assessed as an IL2 building. Therefore, it is a **Grade D** building, following the definition of the New Zealand Society of Earthquake Engineering (NZSEE) building grading scheme, which could be regarded as exposing the occupants to a **high** seismic risk. Please see Section 6 of the main report for a table describing the relevance of these building grades.

The New Building Standard requires an IL2 building to have a low probability of collapse in a 1 in 500-year "design level" earthquake (i.e. an earthquake with a probability of exceedance of approximately 10% over the assumed 50 year design life of a building).

3.3 Results of Detailed Seismic Assessment

The results of our quantitative detailed seismic assessment (DSA) indicate the building's seismic rating to be **20%NBS**.

Table 2 presents the evaluated seismic performance in terms of *%NBS* of the individual structural systems in each loading direction.

Table 2 - Summary of Building Seismic Performance

System	Direction	Seismic Performance in *%NBS*	Notes
Unreinforced Masonry Walls	In-plane strength (Longitudinal)	20%NBS	In-plane strength of unreinforced masonry walls governed by the capacities of west and south URM walls. Parapet assumed to be restrained at ceiling level and 1.2m high from this level.
	In-plane strength (Transverse)	25%NBS	
	Out-of-plane strength (Both directions)	60%NBS	
	Out-of-plane strength (Entrance parapet)	50%NBS	
Reinforced Concrete walls (Strong room)	In-plane strength (Both directions)	100%NBS	

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The seismic rating of Balclutha Information and Service centre is limited by the in-plane strength of the south unreinforced masonry wall. These walls are along the front of the building and feature several windows which reduces its capacity. Toe crushing of the window frames was found to be the limiting mechanism of the walls. It has been assumed that the window framing is constructed from unreinforced masonry blocks as reinforcement was not detected during site investigations with reinforcing scanner.

The seismic performance of several unreinforced masonry walls were found to be less than 34%NBS or 67%NBS. Refer to Figure 2 in Section 4 showing the location of these walls. Majority of walls in the building were found to be greater than 67%NBS.

The ceiling diaphragm was investigated on site and based on its construction it is unlikely that a sufficient diaphragm exists in the ceiling thus it would be likely that its seismic performance is less than 34%NBS and would require strengthening. However the edge timber in the ceiling is connected to the bond beams with D12 bar at 600-800 crs.

3.4 Comparison of the Initial and Detailed Seismic Assessment Findings

The results from the previous Initial Evaluation Procedure (IEP) by Opus and this Detailed Seismic Assessment (DSA) are summarised in Table 3.

The critical weakness determined in the IEP was the capacity of the URM elements of the building. The DSA agrees with critical weakness of the building however the DSA determined a lower overall seismic performance.

Table 3 – Summary of Building Seismic Performance determined by Initial and Seismic Assessments

Building Segment	Initial Evaluation Procedure (IEP)	Detailed Seismic Assessment (DSA)
Overall	30%NBS	20%NBS

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4 Seismic Strengthening and/or further intrusive investigations

4.1 Retrofit and Strengthening Options

We have developed high level seismic strengthening concepts to address all elements below 67%NBS and all CSW as requested by the Client. These concepts have been developed with the intention to maximise the use of existing structure, minimise cost, and minimise business interruption, where possible.

Conceptual Seismic Strengthening Scheme to 67%NBS

- Strengthen the URM window frames and all walls assessed to be less than 67%NBS by any of following:
  - Replace URM window framing and URM walls with reinforced masonry block walls.
  - Place additional reinforced masonry block walls in critical brace lines.
  - Strengthen walls by adding structural steel frames.
  - Install a stiff diaphragm in the roof space to re-distribute seismic load to stronger walls.
- Strengthen out-of-plane capacity of entrance parapet by any of the following:
  - Remove URM parapet.
  - Replace URM parapet with reinforced masonry block.
  - Install strongbacks behind URM parapet.
- Strengthen the ceiling diaphragm of the building by any of the following:
  - Re-line the ceiling with GIB.
  - Install roof bracing inside the roof space.

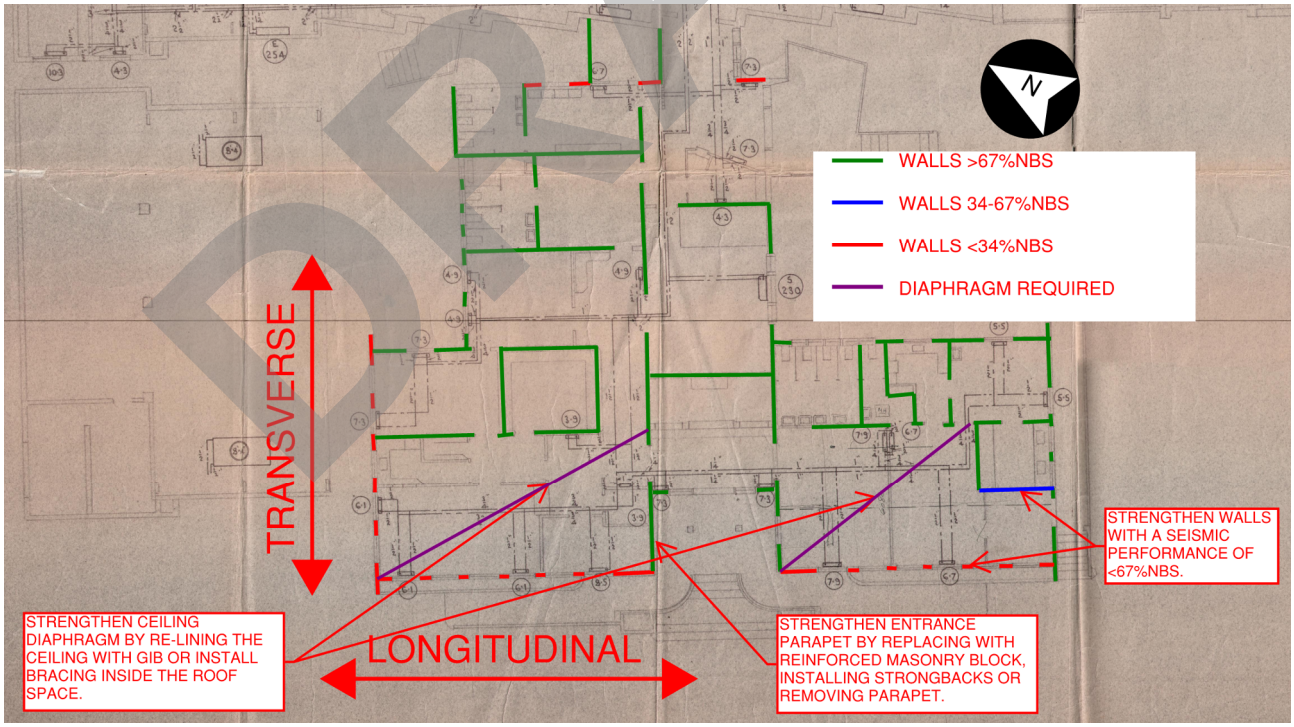

Figure 2 – Balclutha Information and Service Centre, 67%NBS Strengthening Scheme.

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5 Next Steps

We recommend Clutha District Council consider carrying out the following steps in relation to Balclutha Information and Service Centre:

- Further develop high level strengthening schemes as given in Section 4.

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