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BQBHIKKU Ranchhod Trust No. 2
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8 November 2023

Dear Ishwer

2 Cobham Court, Porirua – Seismic Review of Structure

BQBHIKKU Ranchhod Trust No. 2 has commissioned Beca Ltd (Beca) to review our Detailed Seismic Assessment (DSA) undertaken in 2012 for 2 Cobham Court, Porirua, and incorporate subsequent changes that have occurred in the seismic assessment guidelines. This letter presents the findings of our review.

Scope of this Review

The scope of work that was undertaken by Beca was a review of the structural aspects of 2 Cobham Court, Porirua, as follows:

- Review of the seismic assessment and structural drawings.
- Undertake a review of the building focusing on aspects that have changed between the 2006 Guidelines entitled "*Assessment and Improvement of the Structural Performance of Buildings in Earthquake*", which was the basis of our 2012 DSA, and the July 2017 Guidelines entitled "*The Seismic Assessment of Existing Buildings*" and the November 2018 draft amendments to Chapter C5.
- Our assessment relied on the results from the previous structural analysis of the building as a whole to provide the expected building deflections. We subjected these results and parameters to a high-level review and determined that they were of an appropriate order.
- Provide a brief letter-style report indicating our findings as outlined below.

Documents Received

We received the following documents for use in our review:

- Original structural drawings from 1988.
- Beca DSA Report: 2 Cobham Court, Porirua – Detailed Seismic Assessment, dated 18 October 2012.

Building Description

The structure is a two-storey building constructed with reinforced concrete and reinforced concrete blocks, supported by strip and pad footings. On the first floor, there's an in-situ reinforced concrete slab at the front, and precast hollow core floor units with reinforced concrete topping at the rear. The roof is lightweight and is composed of steel rafters and timber purlins. The visual inspection indicates that it lacks bracing.

The structure employs several mechanisms to withstand lateral forces from earthquake motion. In the longitudinal direction, seismic shaking is countered by reinforced concrete block shear walls that extend

along both sides of the building. In the transverse direction, the original section of the building uses the strong room's shear walls on the ground floor and relies on the cantilever effect of the reinforced concrete columns on the first floor to resist lateral loads. In the rear part of the structure, added reinforced concrete frames in 1988 provide lateral resistance in the transverse direction.

The first-floor diaphragm is assumed to evenly distribute the load to the various ground-floor mechanisms that resist forces. Due to the absence of roof bracing, the steel rafters in the roof are required to bear the load by acting about their weaker axis.

Beca's Original Seismic Assessment

We undertook a detailed seismic assessment in 2012. The assessment was undertaken in accordance with the requirements of New Zealand Society for Earthquake Engineering (NZSEE) documented entitled *Assessment and Improvement of the Structural Performance of Buildings in Earthquake*, dated 2006. The assessment stated that the building would achieve a rating *of 70%NBS*(IL2) based on the cantilever capacity of the first floor reinforced concrete columns.

Beca's Current Assessment

We have followed the guidelines to evaluate the ability of the primary structural reinforced concrete moment frames and gravity frames to withstand lateral displacements. Additionally, we examined other essential details specific to this type of building construction and its age.

We assessed the overall inter-storey drifts and displacement ductility demands to be relatively high in the transverse direction. Higher drifts typically result in larger damage to the building in a large earthquake, especially to the frames and precast flooring units.

Our target seismic assessment identified the following potential structural weaknesses:

- Loss of seating of the hollowcore flooring units from the RC beams supporting them.
- Negative and positive moment failure of the precast hollowcore flooring.
- Web Cracking of the precast hollowcore flooring.

Seismic Assessment of the Precast Hollowcore Flooring

A seismic assessment of the precast hollowcore flooring systems has been undertaken in accordance with the guideline document "*The Seismic Assessment of Existing Buildings"* (the Guidelines), dated July 2017 and the draft amendments to Chapter C5 dated November 2018. Please see Table 1 for the Precast Flooring Units *%NBS* (IL2) and Table 2 for a summary of the precast flooring failure modes.

Table 1: Precast Flooring Units *%NBS* (IL2)

Subassembly Element	*%NBS* (IL2)	Comments
Precast Flooring Units	**50**	▪ Under these guidelines, the *%NBS* of the precast units is given by the failure mode that has the lowest inter-storey drift capacity. The failure modes are described below in Table 2. ▪ Inter-storey drift is the amount of relative lateral displacement from one level to another level in an earthquake. ▪ The precast units seating on the RC beams and web cracking governs the *%NBS* of the precast units.

Table 2: Precast Flooring Units Failure Modes

Precast Unit Failure Mode	Comments
Precast Unit Seating Loss Failure	■ Localised damage at the ends of each of the primary beams adjacent to the columns called plastic hinges is expected in a severe earthquake. As the RC beams develop plastic hinges due to repeated earthquake shaking cycles, they grow in length, rotate, and concrete cover spalling may occur. ■ The frame is expected to grow about its mid-point in each direction as the beams grow in length, but the floor system does not. ■ The consequence of the growth in beam length relative to the slab is that the corner columns and beams may be pushed out and away from the corner of the floor. ■ After beam elongation, beam rotation, and spalling of the concrete cover, the 50mm seating specified in the building drawings is considered insufficient to meet full code requirements.
Negative Moment Failure	■ A negative moment failure could occur when a large crack forms on the topside of the unit away from the precast unit seating.
Positive Moment Failure	■ A positive moment failure could occur when a large crack forms on the underside of the unit away from precast unit seating. ■ Once the crack forms, beam growth and rotation may force the crack wider. The 50mm seating specified in the building drawings is considered insufficient to meet full code requirements after the crack is forced wider.
Web Cracking	■ Web cracking in the Hollowcore alpha slab units could occur in a severe earthquake. ■ An alpha slab is the precast unit that runs directly parallel to a seismic frame. ■ In severe shaking, horizontal web cracking of the units may be expected in the alpha slab units, potentially causing the bottom portion of the precast unit to separate from the upper part of the unit.

Beca's Opinion

From our high-level review of the drawings and assessment reports, we find the following:

- The RC frames typically look substantial and well-detailed for the building's time and have many of the desirable details required for a modern building. We also note, that as the structure is a ductile reinforced concrete frame, it may be damaged beyond repair in a large earthquake, however it is expected to perform well from a life-safety point of view.
- From our high-level review, we generally agree with the potential structural weaknesses stated in our original DSA in 2012.

Based on the limiting elements stated above, and in the context of the scope of our current review, we believe that the building currently is likely to achieve an earthquake rating of circa *50%NBS* (IL2), limited by the precast hollowcore flooring.

Seismic Restraint of Non–Structural Items

From our recent experience in evaluating similar buildings in Christchurch and Wellington, non-structural building elements (façade glass, ceilings, internal walls, overhead services) constitute a significant portion of the repair/reinstatement cost following an earthquake. In a moderate seismic event, non-structural element damage will likely 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.

Also, during an earthquake, the safety of people can be put at risk due to non-structural items falling on them. These items should be adequately seismically restrained, where possible, to the NZS 4129:2009 'The Seismic Performance of Engineering Systems in Buildings'.

An assessment has not been made of the bracing of the ceilings, in-ceiling ducting, services, and plant. These issues are outside our scope but could be the subject of another investigation.

Future Code Changes

Based on the latest knowledge of faults and the subduction zone in and under the Wellington region, GNS Science (GNS) have indicated a likelihood that the seismic hazard level in Wellington is much higher than previously assessed and currently allowed for in the earthquake design code NZS 1170.5. The level of seismic hazard for a region is allowed for in the design code through the setting of the seismic hazard factor, Z. GNS have indicated that the current Z value that is defined for Wellington, including this site, may be significantly understated. A future increase in the Z factor in the design code will lead to an increase in the design standard for new buildings in Wellington, however the initial guidance from MBIE is that this increase won't apply to existing buildings.

Recommendations

We recommend, BQBHIKKU Ranchhod Trust No. 2 consider increasing the capacity and resilience of the building at 2 Cobham Court, Porirua. Some high-level options for seismic retrofit are noted below in Table 3.

Table 3: Recommendations

High Level Strengthening Options	Comments
Install steel catch brackets under each hollowcore unit	▪ This will increase the seating width for the precast unit. ▪ The brackets will also limit the possibility of a positive moment failure.
Install steel hangers at regular centres through the alpha slab units	▪ This will support the alpha slab unit if the webs of the hollowcore crack

Clarifications

- This review is of defined scope and is for reliance by BQBHIKKU Ranchhod Trust No. 2 only. Beca accepts no responsibility or liability to any third party for loss or damage whatsoever arising out of the use of or reliance on this review by that party or any party other than our Client.
- This seismic review is limited in nature and cannot be considered a full DSA.
- Beca's review is limited to the information provided to us. In the context of this review, Beca has not visited the building again or undertaken any independent calculations except for the seismic assessment of the precast flooring units. We have relied on the structural analyses including inputs used and assumptions made by the detailed seismic assessment in 2012 when undertaking the assessment. We have not sought to validate these inputs and assumptions other than to check they are of the appropriate order.

Overall Comments

Our 2012 DSA identified principal features of the structure which are likely to limit its seismic performance. Our recent review has focussed primarily on the precast hollowcore flooring.

Based on our recent review of the information provided to us, and in the context of the scope of our current review, we believe that the building currently is likely to achieve an earthquake rating of circa *50%NBS* (IL2). It must be noted that we have not carried out a full DSA: instead we have relied on our previous 2012 DSA, and we have focussed on the precast flooring which we believe is likely to govern the building's seismic rating.

We recommend, that BQBHIKKU Ranchhod Trust No. 2 install steel catch brackets under each hollowcore unit as a minimum, however, ultimately all retrofit items we have noted should be considered. Once the retrofit items are installed, we believe that the building might achieve an earthquake rating of 70*%NBS* (IL2).

We would be pleased to discuss our review in more depth if that would help you.

Yours sincerely

Matthew Lander

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on behalf of

Beca Limited

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DISCLOSURE STATEMENT

1. The following information has been supplied to Capital Commercial (2013) Limited ("Bayleys") to be made available for distribution on the vendor's behalf to potential purchasers to assist purchasers with their due diligence and to use at the purchaser's discretion.
2. Bayleys and the Vendor do not warrant the accuracy or completeness of the information and recommends that all recipients undertake their own due diligence, obtain their own reports to their satisfaction and seek independent advice prior to committing to purchaser.