

**CERA**   
**Canterbury Earthquake  
Recovery Authority**

12 December 2012

Gavin Holley  
Chief Operations Officer  
Church Property Trustees  
PO Box 4438  
Christchurch

Dear Gavin

**Christchurch Cathedral**

Thank you for your letter of 20 November 2012.

As requested, CERA has reviewed the Great Christchurch Buildings Trust's (GCBT) alternative method of maximum retention of the Christ Church Cathedral (Cathedral) prepared by an Independent Panel of Structural Engineers (the Panel). Our Engineer's report is enclosed.

Yours sincerely



Baden Ewart  
**General Manager Operations**

# memo

**To:** Baden Ewart – General Manager Operations

**From:** John O'Hagan, Structural Engineer – Significant Buildings Unit

**Reviewed:**

**Date:** 11 December 2012

**Subject:** SB198 – Christ Church Anglican Cathedral – GCBT Proposal

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Baden,

As requested by the Church Property Trustees (CPT) I have reviewed the Great Christchurch Buildings Trust's (GCBT) alternative method of maximum retention of the Christ Church Cathedral (Cathedral) prepared by an Independent Panel of Structural Engineers (the Panel), copy enclosed, and provide comment.

CERA has also been asked to reconsider CERA's views of the three options proposed by the Church Property Trust (CPT) as outlined in our letter dated 23 February 2012, in light of any relevant new information.

## **Summary of the Panel's Scope**

The Panel's review scope was summarised in 8 questions put to them by the GCBT. The Panel's report concluded:

1. The proposed deconstruction allows for future reinstatement of the Cathedral in its current form.
2. From an engineering point of view the Cathedral does not have to be deconstructed as proposed and other make safe options could be adopted for initial stabilization followed by permanent repairs/strengthening.
3. Maximum retention options previously developed by Holmes Consulting Group could be further developed.
4. The Cathedral cannot be left in its current state.
5. The key health and safety issues are life safety of construction workers, general public safety, protection of adjacent property, and establishment of a strengthened/replacement structure.
6. There are relevant technical skills in New Zealand to reinstate the Cathedral but would refer to best international experience and practice.
7. Innovative application of technologies and construction methods would be required for a maximum retention option or reinstatement.
8. The Cathedral reinstatement or maximum retention option could meet or exceed 100% of the New Building Standard (%NBS) at importance level 3.

## **Additional Response from the Panel**

The maximum retention option proposed by the Panel is only a broad concept proposal. The Panel has not reviewed the costings for the concept and notes that it would take 8 weeks to develop the concept in sufficient detail for a cost estimate to then be prepared.

The Panel compared the merits and issues for both the deconstruction option and the maximum retention option. In the Panel's opinion:

1. The maximum retention option would keep the form and fabric of the current building largely intact;
2. The health and safety plan for the maximum retention method needs to be approved by CERA;
3. The potential for removing heritage artifacts undamaged is improved using the maximum retention option;
4. A faster overall programme would be possible under the maximum retention option.

In my opinion:

1. The maximum retention options would take longer to satisfy the section 38 notice;
2. The structure will retain a higher seismic risk for longer during the maximum retention works;
3. The Panel claims a faster overall programme under the maximum retention option, however I believe that the programme has not been addressed in detail and the actual programme is unknown until the detailed design work has been developed and a contractor has offered comment;
4. The maximum retention option offered by the Panel does not address the capacity or strengthening of the foundations.

## **Maximum Retention Option Proposed by the Panel**

The Panel addresses the maximum retention option in three sections:

1. Short term access and stability

### Proposal

This process would adopt mining and tunneling methods where a shaft is shored and strengthened and progress is made in to the Cathedral. Workers do not have to leave this safe haven.

The shaft is propelled forward into the building between the nave columns. Workers can advance into the nave with the aisle and nave column frames.

External bracing to the transept gable mullions, the apse buttresses and some of the south wall buttresses could be carried out at the same time as the internal work. Ratchet-straps and/or turfers are proposed to be installed across existing cracks where possible.

### Comment

The proposal does not address how the aisle and nave column frames are erected within the Cathedral without workers leaving the protection of the safe haven. The size and weight of the structural steel frames would make

man handling of these frames difficult and I consider that workers would be required to leave the safe havens for an unacceptable length of time necessary to erect the frames within the Cathedral.

The installation of the ratchet-straps and turfers would have to be done from the exterior of the structure for health and safety reasons.

## 2. Health and Safety

### Proposal

The Panel acknowledges that a comprehensive health and safety plan must be in place, and identifies some potential hazards and conceptual mitigation measures.

### Comment

In my opinion the Panel does not address health and safety in any detail. The report states the requirement to develop a method such that the life safety hazards during the work are not at a higher level than on a typical construction site. It must be noted that this is not a "typical" construction site and that we are dealing with a severely compromised building that could collapse in part, or full, in a less than moderate earthquake. The mitigation measures proposed need to be developed further and details of the fabrication and installation of the shields, frames, and safe havens are required. I reiterate the concern raised on other occasions that personal experience has shown that it is difficult to move in a significant earthquake event. Because of this, I consider that the provision of safe havens would do little to mitigate the risk to tradesmen working outside of these safe havens, but within the building.

## 3. Seismic strengthening concepts

### Proposal

The Panel acknowledges the existing structure is complex and to bring it to a 100% New Building Standard for an importance category 3 building will require significant analysis and physical work. The Panel discusses, in broad conceptual terms, strengthening options many of which have already been prepared, costed and ultimately dismissed by the CPT and their engineering experts (Holmes Consulting Group).

### Comment

In my opinion the Panel has offered a basic conceptual proposal for maximum retention that has not been through the requisite detailed analysis and design steps necessary to develop the required construction details to determine whether it is in fact a practical, feasible, buildable, and affordable option.

The concept has not been developed to a level that can be adequately costed so a true comparison with three options developed by Holmes Consulting Group, for the CPT, cannot be made. While I acknowledge this is purely an engineering based review I believe that costs are also a significant consideration when making the decision.

## **Summary of the GCBT Proposal**

In my opinion the GCBT proposal does not offer anything fundamentally different than what has already been proposed by Holmes Consulting Group in Option 1 - the maximum retention option, and considered by CERA previously. In my opinion the Holmes Consulting Group's proposal for the maximum retention option was developed in more detail than the GCBT proposal to the extent that costings were done on the basis of the Holmes concept design work.

The safety of workers in or around dangerous earthquake damaged buildings is one of the key CERA considerations when reviewing plans to satisfy section 38 notices and whether internal access to buildings will be permitted. While the GCBT proposal identifies the use of safe havens my interpretation of the proposal is that workers will be required to exit these safe havens for a considerable time to erect the steel braces and frames required in the nave and aisles. I do not consider this building and associated works as a typical construction project, and we are dealing with a severely compromised building that could collapse in part, or full, in a less than moderate earthquake. Therefore the proposed method would need to be developed to a detailed construction level, and the use of the safe havens would need to be addressed in detail to satisfy CERA's requirements to ensure a safe working environment within this extensively damaged and dangerous building.

The GCBT proposal refers to grout injection into rock-fill voids and insertion of reinforcing through known cracks. In a number of locations around the exterior of the Cathedral the masonry elements have significant displacements which would become permanently displaced when grouted. In my opinion any method of trying to jack the masonry back in to the original position would be difficult due to the likelihood that the rubble infill would have also dislodged. Trying to push the masonry back in to position is likely to further damage the external masonry.

The GCBT proposal claims that the Cathedral would be strengthened to 100%NBS. While this may theoretically be the case it is my opinion that the strengthened building will not have the same actual strength as a new structure as a newly designed structure will likely have greater ductility and reserve capacity than a strengthened structure. Also the proposal does not address the foundation aspects of strengthening the building except to note "new concrete aisle-wall columns (buttresses) and foundations (similarly for the apse buttresses)". In my opinion, addressing foundations will be technically and practically difficult to do and what is provided is inadequate.

## **Conclusion**

I have reviewed the GCBT's structural engineering review report prepared by its Panel. In my opinion the report submitted by the GCBT for consideration is only a broad concept report and fails to address significant matters as discussed above. In my opinion the Panel's report does not describe a method for maximum retention which addresses the requirements of the section 38 to remove the hazards posed by this earthquake damaged dangerous building. The proposal would need to be significantly developed to a workable solution before CERA is able to consider it as satisfying the section 38. I also believe that there would be significant costs associated with the proposal that would need to be investigated.

## Existing Church Property Trust Proposed Options

CERA outlined and discussed the three options that were put forward by the CPT in a letter dated 23 February 2012. These were:

### Option 1: Maximum Retention.

#### Proposal

This involves the construction of braced structural steel shoring towers within the building, vertical steel mullions on the outside of the north and south gables and additional roof bracing. The installation of the internal make safe works would require the use of 'safe havens' in order to minimize health and safety risks to construction personnel. This option also involves a significant amount of demolition/deconstruction of damaged masonry.

#### Comment

I consider this option to be the basis of the proposal put forward by the GCBT. I have reservations about the effectiveness of temporary supports to restrain severely damaged masonry in a less than moderate earthquake event.

I consider that the building in its present condition poses a high risk to tradesmen erecting and carrying out proposed temporary strengthening works within it.

### Option 2: Minimum Shoring

#### Proposal

This involves the controlled demolition/deconstruction of the structure to sill level.

#### Comment

Controlled deconstruction is a feasible option and I still consider it can be done safely.

### Option 3: Intermediate Scheme

#### Proposal

A combination of Options 1 and 2, with deconstruction of the nave and retention and strengthening east from the crossing.

#### Comment

The controlled deconstruction of the nave, aisle, and west end of the building is a feasible option and could be done safely. The retention and strengthening east from the crossing is possible but has high risk to tradesmen erecting and carrying out proposed temporary strengthening works. However I believe these risks could be mitigated when the detailed methodologies for the work are considered.

In summary I have not fundamentally changed my opinion on the options put forward by the CPT and as outlined above. There has been no new information since February 2012 which has led to a change in approach.

END



John O'Hagan  
Structural Engineer  
Significant Buildings Unit

*Noted and agreed.*



Baden Ewart – General Manager Operations

Date: *11 December 2012*