



16 September 2011

Dr David Hopkins  
Department of Building Housing  
PO Box 10729  
Wellington 6143

Email: David.hopkins@dbh.govt.nz

TECHNICAL INVESTIGATION INTO THE PERFORMANCE OF THE PGC, FORSYTH  
BARR AND HOTEL GRAND CHANCELLOR BUILDINGS

Dear David

Thank you for the opportunity to provide comment on the Department of Building  
and Housing (DBH) technical investigation reports in relation to Pyne Gould  
Corporation (PGC), Forsyth Barr, and Hotel Grand Chancellor buildings.

We have reviewed the following information provided:

Investigation into Collapse of the Forsyth Barr Building Stairs on 22<sup>nd</sup> February  
2011  
Prepared for Department of Building and Housing (DBH)  
By Beca Carter Hollings & Ferner Ltd (Beca)  
26<sup>th</sup> August 2011

Report on the Structural Performance of the Hotel Grand Chancellor in the  
Earthquake of 22 February 2011  
Prepared By: Dunning Thornton Consultants Ltd  
For: The Department of Building & Housing  
Provisional Final: 26 August 2011

Investigation into the Collapse of the Pyne Gould Corporation Building on  
22<sup>nd</sup> February 2011  
Prepared for Department of Building and Housing (DBH)  
By Beca Carter Hollings & Ferner Ltd (Beca)  
26<sup>th</sup> August 2011

Structural Performance of Christchurch CBD Buildings in the 22 February  
2011 Aftershock, Stage 1 Report, covering: Pyne Gould Corporation Building,  
Hotel Grand Chancellor, Forsyth Barr Building.  
29 August 2011

Auckland

Telephone

+64 9 965 4789

Facsimile

+64 9 965 4780

Internet Address

[www.holmesgroup.com](http://www.holmesgroup.com)

Level 1

39 Market Place

PO Box 90745

Viaduct Basin

Auckland 1010

New Zealand

Offices in

Hamilton

Wellington

Christchurch

Queenstown

San Francisco



Report of Expert Panel, appointed by the New Zealand Department of Building and Housing.

1.0	Introduction	Not received/reviewed
2.0	Objective/Scope/Terms of Reference	Not received/reviewed
3.0	Approach	Not received/reviewed
4.0	Context	Not received/reviewed
5.0	Pyne Gould Corporation Building	Reviewed
6.0	Hotel Grand Chancellor Building	Reviewed
7.0	Forsyth Barr Building	Reviewed
8.0	Principal Findings and Recom'dations	Not received/reviewed

List of Report Appendices

Appendix A.	Panel Members' Biographies	Not received/reviewed
Appendix B.	Information Obtained	Not received/reviewed

We have structured our response to provide:

- General comments relating to all of the above reports.
- Specific comments on the reports on PGC, Forsyth Barr and Hotel Grand Chancellor buildings.
- Comments on the Stage 1 Report of the Expert Panel.



### General Comments

The language used in the PGC, Forsyth Barr and Hotel Grand Chancellor Building Technical Reports is generally technical, professional, objective and fact based. However, there are a couple of instances where subjective and/or emotive or negative language is used, in particular in the Hotel Grand Chancellor report.

Specific concerning examples of this are listed in the specific sections of this letter covering the respective building reports.

We recommend the language used in the reports should be consistent, and err on being professional, objective and fact-based.

The DBH's decision to remove any reference to the name of specific Engineers and/or specific engineering company's is appreciated, as this allows the reports to focus on the technical issues, and the learnings that will benefit all future design and construction processes. All reports are consistent on this matter, however both the PGC and Forsyth Barr reports Section 3.3 has the following final paragraph.

*Where we have directly quoted from others, we have italicised the quotation. At the request of DBH, names of companies and authors have been removed from most reproduced material.*

We believe the second sentence of this paragraph should be deleted as it could be unfavourably interpreted that there was some element of cover up behind the decision/request and also unnecessarily brings this to the attention of any reader.

We also note that the author of the Hotel Grand Chancellor Report didn't see the need to make a similar statement.

According we request that the paragraph be shortened to the following:

*Where we have directly quoted from others, we have italicised the quotation.*

## Beca Responses to HCG's Letter to DBH of 16 September 2011

### 1 With Reference to HCG Page 3

HCG : "According we request that the paragraph be shortened to the following:

*Where we have directly quoted from others, we have italicised the quotation."*

Beca sees no reason to change our original statement in either report. We have reported a factual reason for why, quite obviously, the names have been blanked out, particularly in reproduced drawings. Not to give a reason would look like Beca has initiated a cover-up.

No action contemplated.



## **Specific comments on Pyne Gould Corporation, Hotel Grand Chancellor and the Forsyth Barr buildings**

### **Pyne Gould Corporation Building Report:**

Generally the report reads well. We concur with the recommendations and believe the reviewers reached a conclusion that we feel fairly reflects our understanding of the building and its behaviour in each of the earthquakes. However, we do have a number of specific comments as follows:

#### **Section 5.2.2, Observed Building Performance, Page 25, Evidence from Public Witnesses**

This section reads as follows:

*A number of members of the public contacted the Department of Building and Housing after the collapse with respect to concerns they had after the September earthquake. They included occupants of the adjacent Ernst & Young building, tenants of the PGC building, and unrelated observers.*

*The general theme was that they had noticed damage to the building after the 4<sup>th</sup> September earthquake. We have interacted with them by telephone and e-mail.*

*One of the respondents marked up a pre-collapse photo supplied by Beca with arrows showing where damage had been observed on the East face as seen from Manchester Street. The interfaces between the floor slabs and the top and the bottom of the external concrete columns at the upper levels were indicated.*

*Others identified non-structural damage to external window frames which was also reported by the owner's structural engineer's post-earthquake report.*

It appears inconsistent for a technical report to have reference to hearsay, and/or reference to anecdotal comment from non experts that is after the fact and was never referred to the owner's structural engineer at the time of the earthquakes.

We request that this section be deleted in total, or at least as a minimum be reworded to remove all hearsay and non technical expert unsubstantiated anecdotal statements, particularly in paragraph 2 and 3, or highly qualified along the lines of "It should be noted that evidence or photographs was not available to substantiate any of the Public Witnesses statements."

#### **Section 5.3.2 Observed Building Performance, Page 28, Evidence from Public Witnesses.**

This section reads as follows:

## 2 With Reference to HCG Page 4

HCG: We request that this section be deleted in total, or at least as a minimum be reworded to remove all hearsay and non technical expert unsubstantiated anecdotal statements, particularly in paragraph 2 and 3, or highly qualified along the lines of "*It should be noted that evidence or photographs was not available to substantiate any of the Public Witnesses statements.*".

DBH's scope for our investigation clearly requires Beca to consider and report on witness statements. We have not reported hearsay.

No action contemplated.



*Occupants of the Ernst Young building have advised that they noticed increasing damage (believed to be cracking of concrete) over the period from Boxing Day until the 22<sup>nd</sup> February 2011. The locations of the damage they observed have been identified as being at the bottom of some of the columns above Level One.*

*An occupant of the PGC building has stated that the building became more responsive (in a new way) to aftershocks in January and February than it had been before the September earthquake.*

Again, it appears inconsistent for a technical report to have reference to hearsay, and/or reference to anecdotal subjective comments from non experts that is after the fact and was never referred to the owner's structural engineer at the time of the earthquakes.

Paragraph 1 is unsubstantiated and gives the impression that the building was deteriorating between Boxing Day, and 22 February. This information was never conveyed to the owner's structural engineer in this time period, nor observed by the owners structural engineers during site visits.

We request that this section be deleted in total, or at least as a minimum be reworded to remove all hearsay and non expert unsubstantiated anecdotal statements, particularly in paragraph 2 and 3, or highly qualified along the lines of "It should be noted evidence or photographs were not available to substantiate any of the Public Witnesses statements....".

We note that the inclusion of these statements, even if qualified, may give rise to a public impression that is incorrect. The wording would be likely to be used by media given its nature, and as such, should be treated with strong caution.

#### Section 10 Conclusions, 10.1 Reasons for Collapse, Page 43

Paragraph 1 reads as follows:

*The engineers' site reports do not identify any structural damage at the tops and bottoms of the perimeter reinforced concrete columns. At least one witness has reported seeing such damage from a distance.*

The second sentence is unsubstantiated hearsay and contradictory to the detailed close up inspection done by the owners structural engineers at the time, accordingly we request that this sentence be deleted, or at least qualified as unsubstantiated.

Paragraph 3 reads as follows:

*The balance of probability is that the damage observed by the public before the 22<sup>nd</sup> February 2011 was due to relative (inter-storey) horizontal motion between floors – possibly from a small torsional response of the building which would have been greatest at the perimeter. The perimeter concrete columns were detailed to be no more than props (in current design terms),*

### 3 With Reference to HCG Page 5 and Top of Page 6

HCG: Again, it appears inconsistent for a technical report to have reference to hearsay, and/or reference to anecdotal subjective comments from non experts that is after the fact and was never referred to the owner's structural engineer at the time of the earthquakes.

Paragraph 1 is unsubstantiated and gives the impression that the building was deteriorating between Boxing Day, and 22 February. This information was never conveyed to the owner's structural engineer in this time period, nor observed by the owners structural engineers during site visits.

.....

We request that this section be deleted in total, or at least as a minimum be reworded to remove all hearsay and non expert unsubstantiated anecdotal statements, particularly in paragraph 2 and 3, or highly qualified along the lines of "*It should be noted evidence or photographs were not available to substantiate any of the Public Witnesses statements....*".

and

The second sentence is unsubstantiated hearsay and contradictory to the detailed closeup inspection done by the owners structural engineers at the time, accordingly we request that this sentence be deleted, or at least qualified as unsubstantiated.

Beca has not reported hearsay, and has correctly reported contradictory witness accounts. Whether or not information was conveyed at the time to the owner's engineers is immaterial to our investigation. We have no evidence of the owner's engineers having undertaken a "closeup inspection" of all elements. Our Paragraph 3 with its "Balance of probability" statement is a fair summary. We could more strongly discount the evidence conveyed to us by the person who identified damage from Manchester Street, although it was reportedly on the east face rather than the west face visible from the Ernst Young building.

Will review wording re credibility of evidence and slightly modify if necessary. Witness reports will be retained, as will "balance of probability" statement.





*and would have exhibited some cracking without significant degradation of their propping capability (which had been previously found to be small enough to justify additional steel props being installed).*

This paragraph is highly subjective and by inclusion adds credibility to the factually unsubstantiated non expert witness view as noted in Sections 5.2.2 and 5.2.3 above.

We request that this paragraph be deleted, or at least highly qualified as unsubstantiated.

Paragraph 4 reads as follows:

*It is possible that the damage/cracking that occurred in the 4<sup>th</sup> September and Boxing Day earthquakes could have made the building perceptibly more responsive in the larger aftershocks experienced by occupants up the 22<sup>nd</sup> February 2011. However, the cracks in the shear-core (after September) are unlikely to have led to an appreciable loss in horizontal stiffness, as the severity of the aftershock shaking was unlikely to have been sufficient to reopen the cracks.*

As noted above the public witness account on this topic is highly subjective and similarly this paragraph is likewise highly subjective in its attempt to explain the public witnesses comments. Accordingly we request that this paragraph be removed.

We note that the inclusion of these statements, even if qualified, may give rise to a public impression that is incorrect. The wording would be likely to be used by media given its nature, and as such, should be treated with strong caution.

Paragraph 6 reads as follows:

*In our opinion, the collapse was primarily due to four factors:*

1. *A compression or buckling failure in the east wall of the unconfined shear-core immediately above Level One.*
2. *The inability of the columns and joints in the perimeter frame to sustain the resulting horizontal displacements.*
3. *The inability of the slab to wall connection to sustain the imposed rotations, shears and tensions resulting from the forced displacement of the shear-core.*
4. *The shaking experienced on 22<sup>nd</sup> February was several times larger than the loads the building was designed to resist.*

The intensity of the 22 February earthquake is the driver behind the damage that has occurred to this building and many others as well and we believe that it is the starting point for all subsequent discussion, accordingly the we request that this paragraph be reordered as follows, i.e. item 4 becomes the first item and all subsequent item drops one number:

#### 4 With Reference to HCG Page 6

HGC: Paragraph 4 reads as follows:

*It is possible that the damage/cracking that occurred in the 4th September and Boxing Day earthquakes could have made the building perceptibly more responsive in the larger aftershocks experienced by occupants up the 22nd February 2011. However, the cracks in the shear-core (after September) are unlikely to have led to an appreciable loss in horizontal stiffness, as the severity of the aftershock shaking was unlikely to have been sufficient to reopen the cracks.*

As noted above the public witness account on this topic is highly subjective and similarly this paragraph is likewise highly subjective in its attempt to explain the public witnesses comments. Accordingly we request that this paragraph be removed.

Beca has been encouraged by the panel to state our opinion. We have made fair comment, and do not believe that it is highly subjective..

No action contemplated.

HGC : Request to re-order the list after: " In our opinion, the collapse was primarily due to four factors:"

The first item in the list is the one we are most sure about. The last one is the most general of the reasons. The order of the points is not important in the context of our investigation.

Will re-order as requested simply as a sign of goodwill.



Section 11 Recommendations

11.1 Recommendations to the DBH in Relation to Building Investigation, Design, Construction or Approvals, Page 45.

Paragraph 2 reads as follows:

*This building appeared to have been designed to the Standards of the day and be well-constructed. Nevertheless, it contained details that meant it was particularly vulnerable.*

The actual age of the building is an integral part of the report on the performance of the PGC and according we request that paragraph 2 be amended as follows:

*This building, which was designed and constructed in the 1960's, appeared to have been designed to the Standards of the day and be well-constructed. Nevertheless, it contained details, (typical of 1960's practice), that meant it was particularly vulnerable.*

## 5 With Reference to HCG Page 7

HGC: Paragraph 2 reads as follows:

*This building appeared to have been designed to the Standards of the day and be well-constructed. Nevertheless, it contained details that meant it was particularly vulnerable.*

The actual age of the building is an integral part of the report on the performance of the PGC and according we request that paragraph 2 be amended as follows:

This building, which was designed and constructed in the 1960's, appeared to have been designed to the Standards of the day and be well-constructed. Nevertheless, it contained details, (typical of 1960's practice), that meant it was particularly vulnerable.

Beca does not want to go as far as saying "(typical of 1960's practice)" as we have not studied that aspect. We have no objection to the inclusion of "which was designed and constructed in the 1960s".

Beca will add "which was designed and constructed in the 1960s".



### **Hotel Grand Chancellor Report:**

Generally the report reads well. We concur with the recommendations and believe the reviewers reached a conclusion that we feel fairly reflects our understanding of the building and its behaviour in each of the earthquakes. However, we do have a number of specific comments as follows:

#### **Executive Summary, Page 4.**

The first paragraph reads as follows:

*In the short but violent Lyttelton aftershock of 22 February 2011, the Christchurch Hotel Grand Chancellor building suffered major structural damage and came close to catastrophic collapse when a key supporting shear wall collapsed in a brittle manner.*

The second half of this paragraph is highly subjective and is not supported by any analysis in the report or by any other fact based research or knowledge. We request that this paragraph be reworded as follows:

*In the short but violent Lyttelton aftershock of 22 February 2011, the Christchurch Hotel Grand Chancellor building suffered major structural damage. The extent of the damage suffered by the building was increased by the failure of a key supporting shear wall which collapsed in a brittle manner.*

#### **Section 6.5 Cantilever Transfer Beam 8D-E, page 20.**

The section reads as follows:

*Parallel to the level 12-14 cantilever beams on grids 5 and 6 is a further cantilever beam on grid 8. This beam is also a full floor-to-floor depth between levels 12 and 14 and is an extension of the main spine shear wall on grid 8. This beam supports the hanging column at E8 which, as described in 6.4, experienced a major increase in load as the south-eastern corner of the tower dropped. As the hanger load increased a lap failure initiated in the lapped beam stirrups and the bars slipped by up to 80mm. **This mechanism appears to have come close to catastrophic collapse.** [Refer App. B page 14 and App. C Photographs 15 and 16].*

The highlighted sentence is subjective and emotive in its use of the word “catastrophic” and is not in keeping with what is generally a good objective technical report. Additionally it has the potential to be (mis)used by the media and accordingly we request that the word “catastrophic” be deleted.



Section 6.7 Level 2 Slab South-East Corner, Page 20.

The use of the word “spectacularly” in this paragraph is highly emotive and not in keeping with what is generally a good objective technical report. We request that the word “spectacularly” be deleted from this paragraph.

Section 8.1 Wall D5-6 Failure, page 23.

The opening paragraph to this section reads as follows:

*Initial inspections and assessment of the building's form following the earthquake suggested that the initiation of the major structural failure commenced with the failure and subsequent shortening of the D5-6 shear wall. As discussed in section 7.1 the failure is a transverse-diagonal, brittle rupture that obviously occurred abruptly and suddenly with little sign of progressive flexural yielding or concrete crushing. Subsequent assessment and analysis suggests that the failure occurred when the wall was subjected to extremely high axial compressive loads with little available ductility or confinement outside of the short end zones, at each end of the wall. With displacements requiring a curvature ductility at the base of the wall, of which there was little available, and with no confinement **and a tendency towards buckling due to excessive slenderness**, the wall failed abruptly, out-of-plane. The factors affecting this assessment are as follows:-*

The use of the word “excessive” in this paragraph is highly emotive and not in keeping with what is generally a good objective technical report. We request that the word “excessive” be deleted and the final sentence be reworded as follows. Also we are unsure as to why the word “and” is bolded in this sentence as it unnecessarily draws the readers attention to this word, and again request that this word is unbolded :

*“.....and a tendency towards buckling due to the slenderness of the wall being less than ideal, .....”*

Section 9 Conclusions, Page 28:

The opening paragraph reads as follows:

*The Grand Chancellor appears to have been generally well designed. The upper tower seismic frames, with offset beam hinge locations were state-of-the-art for the time of its design and appeared to perform well. The shear walls typically also appeared to perform well, as did the precast concrete façade panels. However, the structure contained a critical structural vulnerability resulting from the fact that the capacity of the D5-6 shear wall could be exceeded by the demand actions (that could be expected during code-level shaking) to the extent that a brittle and abrupt failure could occur. **If it had not been for some redundancy and resilience within other areas of the structure which provided alternative load paths and halted the failure, a catastrophic collapse may have occurred. Had the earthquake been of longer duration, then the collapse may have continued.***



The last two sentences of this paragraph are negative in their tone and/or subjective – there is no analytical evidence presented in the report to demonstrate or prove that the building might have suffered “a catastrophic collapse” or knowledge based research or fact around what might have happened had the earthquake gone on longer.

We request that last two sentences of this paragraph be reworded as follows to be in keeping with what is generally a good objective technical report:

*Due to some redundancy and resilience within the other areas of the structure which provided alternative load paths, the building collapse was prevented in the 22 February earthquake.*

Note: the comment in the Technical Report with respect to earthquake length (last sentence) has been deleted. It is entirely subjective to say what a longer duration earthquake might have been like, or how that building might of performed in such a situation.

Section 9 Conclusions, Page 29 Bullet Point 2:

This bullet point reads as follows:

*Wall slenderness did meet code requirements, for the levels of axial load*

The word “not” appears to have been omitted from this sentence.

Appendix A: List of Reference Material:

We note that section 3.0 of the report list the original calculations as part of the material that was reviewed but this Appendix does not. Were the original calculations reviewed?

Appendix C Photos:

The title to Photo 11 and 13 read, respectively:

*Photo 11 – Similar to Shearwall Failure - Not HGC*

*Photo 13 – Similar to Shearwall Failure - Not HGC*

We request that ‘HGC’ be expanded in full to ‘Hotel Grand Chancellor’ to avoid any confusion with the acronym for Holmes Consulting Group which HCG, which is further confused by Photo 11 being of the shearwall in the building in which Holmes was a tenant.

**Forsyth Barr Report:**

Generally the report reads well. We concur with the recommendations and believe the reviewers reached a conclusion that we feel fairly reflects our understanding of the building and its behaviour in each of the earthquakes. However, we do have a number of specific comments as follows:

**Executive Summary, Page 1**

Paragraph 5 reads as follows:

*A building designed in 1988 could be expected to be designed to essentially the same standard as a similar building in 2010.*

We believe that this paragraph is factually incorrect and accordingly misleading. The Forsyth Barr Building was designed to the 1984 NZ Loadings Standard. This standard has been revised in 1992, 2003, 2004 and 2008.

The Forsyth Barr building was designed to the 1982 concrete material standard applicable in 1986-88. This concrete material standard has subsequently been revised in 1995 and 2006.

The progression of changes included in these revisions are very material as they impact on analysis techniques and material and element properties to be used, and acceptable minimum limits for determining inter-storey drifts and hence separations.

Accordingly we request that this paragraph be deleted. If not, we request that it be changed to be factually correct, and to be relevant to the materials used. We are available to assist should you wish to do the latter.

**Executive Summary, Reason for the collapse, page 3:**

The magnitude and intensity of the 22 February is of critical importance and should be mentioned in this section. Accordingly we request that a similar statement that used in the PGC report (page 43, item 4 of that report) be added as the first bullet under this heading, i.e.,

*The shaking experienced on 22 February was several times larger than the building was designed to resist.*

**Executive Summary, Commentary, Page 4:**

Bullet point 6 reads as follows:



## 6 With Reference to HCG Page 11

HGC: Paragraph 5 reads as follows:

*A building designed in 1988 could be expected to be designed to essentially the same standard as a similar building in 2010.*

We believe that this paragraph is factually incorrect and accordingly misleading. The Forsyth Barr Building was designed to the 1984 NZ Loadings Standard. This standard has been revised in 1992, 2003, 2004 and 2008.

The Forsyth Barr building was designed to the 1982 concrete material standard applicable in 1986-88. This concrete material standard has subsequently been revised in 1995 and 2006.

The progression of changes included in these revisions are very material as they impact on analysis techniques and material and element properties to be used, and acceptable minimum limits for determining inter-storey drifts and hence separations.

Accordingly we request that this paragraph be deleted. If not, we request that it be changed to be factually correct, and to be relevant to the materials used. We are available to assist should you wish to do the latter.

Our statement is neither factually incorrect nor misleading, as the changes in the Standards noted are relatively minor with respect to the overall seismic performance of the building. While some requirements went up, others were reduced (as noted in HCG's report on 29<sup>th</sup> November 2010). We believe that it is important to report to the public that buildings of this era are essentially modern. We acknowledge that our use of the word "standard" might be confused with "Standard", and we will re-phrase our statement to achieve our original intent. In other parts of the report we explain the changes over time with respect to the stair seismic gap requirements.

Beca to re-phrase statement to achieve our original intent.



*The owner's structural engineers inspected the building after the 4<sup>th</sup> September and 26<sup>th</sup> December earthquakes, and advised the owner that it was **safe** to occupy.*

We request that this be reworded to replace the word 'safe' with the word 'acceptable'. This would then be consistent with a similar comment in the PGC report, i.e., final bullet point under the Commentary section, page 3 of the PGC report.

Accordingly this bullet would read:

*The owner's structural engineers inspected the building after the 4<sup>th</sup> September and 26<sup>th</sup> December earthquakes, and advised the owner that it was **acceptable** to occupy.*

Executive Summary, Recommendation, Page 4.

The first bullet point reads as follows:

***Known** alternatives to the seismic gap detail used in this building should be used on all new buildings, and for replacing the stairs in this building. These alternatives minimise significantly any likelihood of the stairs collapsing because of insufficient allowance for inter-storey drift.*

The use of the word 'known' as the first word in the bullet could be unfavourably interpreted as alternatives were known at the time. Accordingly we request that this bullet be reworded as follows:

***Alternatives, now known,** to the seismic gap detail used in this building should be used on all new buildings, and for replacing the stairs in this building. These alternatives minimise significantly any likelihood of the stairs collapsing because of insufficient allowance for inter-storey drift.*

The second bullet reads as follows:

*The seismic gaps in the upper levels of the Forsyth Barr building, where the stairs are still intact, should be measured for effective width, and the presence of any obstructions such as construction detritus of other material recorded.*

This bullet point talks about measuring the seismic gaps and checking for detritus in the gap. We assume this is because there is an assumption that these stairs may remain.

The intention of the Building Owner is to remove these stairs and replace all stair flights with a stair that incorporates a separation detail that meets current code separation detail requirements at ULS, times 2.

## 7 With Reference to HCG Page 12

HGC: *The owner's structural engineers inspected the building after the 4th September and 26<sup>th</sup> December earthquakes, and advised the owner that it was safe to occupy.*

Beca agrees that "safe" should be changed. We have not been able to confirm our reference to an inspection after the Boxing Day earthquake..

Report to be revised to reflect this.

HGC: The first bullet point reads as follows:

*Known alternatives to the seismic gap detail used in this building should be used on all new buildings, and for replacing the stairs in this building. These alternatives minimise significantly any likelihood of the stairs collapsing because of insufficient allowance for interstorey drift.*

The use of the word 'known' as the first word in the bullet could be unfavourably interpreted as alternatives were known at the time. Accordingly we request that this bullet be reworded as follows:

*Alternatives, now known, to the seismic gap detail used in this building should be used on all new buildings, and for replacing the stairs in this building. These alternatives minimise significantly any likelihood of the stairs collapsing because of insufficient allowance for interstorey drift.*

The second bullet reads as follows:

*The seismic gaps in the upper levels of the Forsyth Barr building, where the stairs are still intact, should be measured for effective width, and the presence of any obstructions such as construction detritus of other material recorded.*

Beca believes that there were alternatives to this stair detail being used by other designers at the time. Therefore, the use of "known" and the implication are correct.

We have since visited the stairs in the upper level.

No change to report recommended, except for update on our recent site visit.



Accordingly the author of this report may like to reword this bullet point, or amend the report to reflect that all existing stairs are going to be replaced with a stair that meets the current separation detail requirements.

4 Building Description, 4.1 Outline Description, Page 9

Paragraph 6 reads as follows:

*A building designed in 1988 could be expected to be designed to essentially the same standard as a similar building in 2010.*

As per our comments above under “Executive Summary page 1” we request that this paragraph be removed.

Section 5.2.2 Observed Building Performance, page 24:

This section reads as follows:

*Minor structural damage was observed after the 4<sup>th</sup> September 2010 earthquake, including some cracking and deformation of a few flights of stairs. The Level 1 rapid assessment undertaken within a few days of the earthquake under the authority of Civil Defence resulted in the building being initially placarded Red (Unsafe). This was later revised by the Level 2 assessment undertaken by Beca (the building manager’s engineer), first to Yellow (Restricted Access) and, following further investigation of the stairs (breaking open of the timber-framed bulkheads under the worst flights and checking the seating of the lower landings – which indicated no significant movement) and propping of a vehicle ramp in the podium, to Green (Inspected). The assessments are reproduced in Appendix A2.*

*Subsequently, the owner’s structural engineer undertook an inspection of the building, and prepared instructions for the repair of cracked structural elements. The instructions relating to the stairs were general ones for epoxy grout injection to the crack width.*

*Building occupants interviewed have stated that repairs to earthquake damage to floor coverings on the stairs were underway in the period between the September 2010 and February 2011 earthquakes.*

We have a number of comments here:

1. To be consistent with the policy to remove names of Engineers, or that of an Engineering Company, from the DBH Technical Reports, the name of ‘Beca’ should be removed from paragraph 1 as they were acting for the building manager at this stage. Our involvement with this building didn’t start until 15 October 2010.
2. Paragraph 2 appears factually incorrect, in that when we were engaged by Pace Project Management on behalf of the Building Owner, we were advised by

## 8 With Reference to HCG Pages 13&14

HGC: This section reads as follows:

*Minor structural damage was observed after the 4<sup>th</sup> September 2010 earthquake, including some cracking and deformation of a few flights of stairs. The Level 1 rapid assessment undertaken within a few days of the earthquake under the authority of Civil Defence resulted in the building being initially placarded Red (Unsafe). This was later revised by the Level 2 assessment undertaken by Beca (the building manager's engineer), first to Yellow (Restricted Access) and, following further investigation of the stairs (breaking open of the timber-framed bulkheads under the worst flights and checking the seating of the lower landings – which indicated no significant movement) and propping of a vehicle ramp in the podium, to Green (Inspected). The assessments are reproduced in Appendix A2.*

*Subsequently, the owner's structural engineer undertook an inspection of the building, and prepared instructions for the repair of cracked structural elements. The instructions relating to the stairs were general ones for epoxy grout injection to the crack width.*

*Building occupants interviewed have stated that repairs to earthquake damage to floor coverings on the stairs were underway in the period between the September 2010 and February 2011 earthquakes.*

We have a number of comments here:

1. To be consistent with the policy to remove names of Engineers, or that of an Engineering Company, from the DBH Technical Reports, the name of 'Beca' should be removed from paragraph 1 as they were acting for the building manager at this stage. Our involvement with this building didn't start until 15 October 2010.

"Beca" has been deliberately left in our report to ensure that we are seen to be open, as investigators, about our previous involvement.

No change to report recommended.

2. Paragraph 2 appears factually incorrect, in that when we were engaged by Pace Project Management on behalf of the Building Owner, we were advised by Pace Project Management that the stairs were not part of our scope of work as they had been addressed by the Beca as part of their initial engagement, accordingly our report of 29 November (included in Appendix A2.2 of the Technical Report) does not address the stairs at all, and in fact during our initial site visits the stair repair work was already underway.

Please amend existing wording, or add this clarification.

The Introduction to HCG's report of 29 November 2010 says that they were engaged by the owner to complete a full structural review following the Darfield Earthquake. The Scope of Work does not document that the stairs were excluded. HCG have supplied a copy of a Site Report dated 17 September 2010 reporting an inspection of a repair to a ramp beam.

We will change the report to include receipt of advice from HCG that their report does not convey the verbal exclusion they were given by the owner's project managers.

3. Given that the stair repair work had been instructed prior to our involvement we would have thought that there would at least have been a repair methodology/specification issued for

this work and that the same would have been part of the Technical Report prepared by Beca.

Beca did not instruct any repair work to the stairs per se. We provided our client, the property manager Colliers, with a standard *Christchurch Eq RAPID Assessment Form – Level 2*, and a copy of this is included in our report. We were advised on about the 25 September 2010 that no further services were required from Beca as the building owner was instructing others to undertake further investigations. Our file note of 6<sup>th</sup> September 2010 recommends *Cleaning of loose debris from the seismic separations at the base of all stairs, and The scissor stairs are available for normal use after health and safety issues have been addressed*. We are searching our archives for evidence of when/whether this was transmitted to our client.

No change to our report.

4. One final point - given the role of Beca between 5 September and 15 October particularly as relates to the stairs, it appears that there may be a conflict of interest issue here, unless there was another independent Engineer involved in the repair work that was carried out on the scissor stairs prior to our involvement from 15 October 2010. If that was the case then this probably should be clarified in the Technical Report

If the above is correct then the Building History table of page 12 of the Technical Report, as reproduced below, may need to be expanded to include a section after the 15<sup>th</sup> September 2010 Level 2 Rapid Assessment to address what actually was done with respect to the stairs.

As explained above, we did not instruct anyone to repair the stairs.

Table 4.1 (Major Changes to Building During its Life) will have last entry modified by splitting into two – distinguishing between stair floor repairs (overseen by Pace) and structural repairs to building (instructed by HCG).



Pace Project Management that the stairs were not part of our scope of work as they had been addressed by the Beca as part of their initial engagement, accordingly our report of 29 November (included in Appendix A2.2 of the Technical Report) does not address the stairs at all, and in fact during our initial site visits the stair repair work was already underway.

Please amend existing wording, or add this clarification.

3. Given that the stair repair work had been instructed prior to our involvement we would have thought that there would at least have been a repair methodology/specification issued for this work and that the same would have been part of the Technical Report prepared by Beca.
4. One final point - given the role of Beca between 5 September and 15 October particularly as relates to the stairs, it appears that there may be a conflict of interest issue here, unless there was another independent Engineer involved in the repair work that was carried out on the scissor stairs prior to our involvement from 15 October 2010. If that was the case then this probably should be clarified in the Technical Report

If the above is correct then the Building History table of page 12 of the Technical Report, as reproduced below, may need to be expanded to include a section after the 15<sup>th</sup> September 2010 Level 2 Rapid Assessment to address what actually was done with respect to the stairs.

#### 4.2 Building History

Table 4.1 summarises the major events in the building's life.

**Table 4.1 - Major Changes to Building During its Life**

Date	Event	Comment
1988	Designed as Robert Jones House	
1988	Constructed	Building Consent 1988
5 <sup>th</sup> Sept. 2010	Level 1 Rapid Assessment	Unsafe (Red)
5 <sup>th</sup> September 2010	Level 2 Rapid Assessment	Restricted Access (Yellow)
6 <sup>th</sup> September 2010	Level 2 Rapid Assessment after inspection of stairs and propping completed	Inspected (Green)
15 <sup>th</sup> September 2010	Level 2 Rapid Assessment after inspection of in-filled slab at floor level 7.	Confirmed as Inspected (Green)
October – February 2011	Repairs to a scope prepared by the building owner's engineers	



## 9. Conclusions, Page 43

The 6<sup>th</sup> Bullet Point reads as follows:

*The actual seismic gaps at the bottom landings of the stairs were too small for the earthquake shaking experienced on 22<sup>nd</sup> February 2011.*

We request this bullet be expanded to read:

*Although the actual seismic gaps at the bottom landings of the stairs met the code of the day in 1988 they were too small for the earthquake shaking experienced on 22<sup>nd</sup> February 2011.*

## Section 10.2 Comments on Implications of Future Standards and Practice

A question for the author:

Is the reference to NZS 4203:1976 in paragraph 3 of this section meant to be to NZS 4023:1984? Particularly as clause 3.8.4.2 (a) of NZS 4203:1984 refers to the requirement to provide double the calculated gaps/clearance for stairs.

## Section 11 Recommendations, Page 46:

The first bullet point reads as follows:

*Known alternatives to the seismic gap detail used in this building should be used on all new buildings, and for replacing the stairs in this building. These alternatives minimise significantly any likelihood of the stairs collapsing because of insufficient allowance for inter-storey drift.*

The use of the word 'known' as the first word in the bullet could be unfavourably interpreted as known at the time. Accordingly we request that this bullet be reworded as follows:

*Alternatives, now known, to the seismic gap detail used in this building should be used on all new buildings, and for replacing the stairs in this building. These alternatives minimise significantly any likelihood of the stairs collapsing because of insufficient allowance for inter-storey drift.*

The second bullet reads as follows:

*The seismic gaps in the upper levels of the Forsyth Barr building, where the stairs are still intact, should be measured for effective width, and the presence of any obstructions such as construction detritus of other material recorded.*



## 9 With Reference HCG Page 15

We request this bullet be expanded to read:

*Although the actual seismic gaps at the bottom landings of the stairs met the code of the day in 1988 they were too small for the earthquake shaking experienced on 22nd February 2011.*

Whereas the specified seismic gaps met the code of the day, we now know that the gaps as constructed almost certainly did not in all locations.

We will modify the body of our report and the conclusions to reflect our findings from 14<sup>th</sup> September 2011.

Is the reference to NZS 4203:1976 in paragraph 3 of this section meant to be to NZS 4023:1984? Particularly as clause 3.8.4.2 (a) of NZS 4203:1984 refers to the requirement to provide double the calculated gaps/clearance for stairs.

We will check the reference.

We will correct this reference if found necessary.

The first bullet point reads as follows:

*Known alternatives to the seismic gap detail used in this building should be used on all new buildings, and for replacing the stairs in this building. These alternatives minimise significantly any likelihood of the stairs collapsing because of insufficient allowance for interstorey drift.*

The use of the word 'known' as the first word in the bullet could be unfavourably interpreted as known at the time. Accordingly we request that this bullet be reworded as follows:

*Alternatives, now known, to the seismic gap detail used in this building should be used on all new buildings, and for replacing the stairs in this building. These alternatives minimise significantly any likelihood of the stairs collapsing because of insufficient allowance for interstorey drift.*

See our previous response (HCG Page 12)..

No change will be made.

The second bullet reads as follows:

The seismic gaps in the upper levels of the Forsyth Barr building, where the stairs are still intact, should be measured for effective width, and the presence of any obstructions such as construction detritus of other material recorded.

We will modify our report and conclusions to reflect our site inspection of 14<sup>th</sup> September 2011.



If this bullet is for the purposes of further investigation then this should be clarified. As stated earlier, it is the intention of the Building Owner to remove any remaining stairs and replace all flights with a stair that incorporates a separation detail that meets current code separation detail requirements at ULS, times 2.



## Report of the Expert Panel

Sections 5.0 through 7.0, (being the only sections that we have been provided with for review) , generally read well and make recommendations and reach a conclusion that we feel fairly reflects our understanding of the 3 buildings and their behaviour in each of the earthquakes. However, we do have a number of specific comments as follows:

### 5.0 Pyne Gould Corporation Building:

#### 5.1 Summary

The summary reads as follows:

*The five-storey Pyne Gould Corporation (PGC) building located at 231-233 Cambridge Terrace, Christchurch suffered a catastrophic collapse on 22 February 2011 following the Magnitude 6.3 aftershock.*

*The building collapsed when the reinforced concrete walls of the core of the structure between Level 1 and Level 2 failed. Subsequently, the perimeter columns and/or joints between the columns and the beams and the connections between the floor slabs and the shear-core failed, causing the floors to collapse.*

*The principal reasons that the PGC building collapsed in response to the 22 February 2011 aftershock event were identified as being:*

- *That the intensity and characteristics of the ground shaking caused forces in the core wall of the building (between Level 1 and Level 2) that exceeded its capacity; and*
- *That the non-ductile design of the structure, typical of buildings designed in the early 1960s, lacked resilience once the building's strength had been exceeded and was unable to accommodate the shaking associated with the 22 February 2011 aftershock event.*

As the Summary Section is likely to be the section that most commentators and interested non technical people are likely to read, we request that the word “catastrophic” be amended and the paragraph be expanded as follows:

*The five-storey Pyne Gould Corporation (PGC) building located at 231-233 Cambridge Terrace, Christchurch suffered a major structural collapse on 22 February 2011 following the Magnitude 6.3 aftershock.*

*The building collapsed when the reinforced concrete walls of the core of the structure between Level 1 and Level 2 failed. Subsequently, the perimeter columns and/or joints between the columns and the beams and the connections between the floor slabs and the shear-core failed, causing the floors to collapse.*



*The structure, when built, met the 1963 design requirements of that time for the prescribed earthquake loads, both in terms of level of strength and the level of detailing provided.*

*The principal reasons that the PGC building collapsed in response to the 22 February 2011 aftershock event were identified as being:*

- *That the intensity and characteristics of the ground shaking caused forces in the core wall of the building (between Level 1 and Level 2) that exceeded its capacity; and*
- *That the non-ductile design of the structure, typical of buildings designed in the early 1960s, lacked resilience once the building's strength had been exceeded and was unable to accommodate the shaking associated with the 22 February 2011 aftershock event.*

The added paragraph is taken directly from the Beca Technical Report – see Page 2 **Original Design**, first bullet point.

#### 5.8 Effects of 4 September 2010 earthquake and the 26 December 2010 aftershock:

Paragraph 2 reads as follows:

*Witnesses have advised of damage observed after the 4 September earthquake. Some of this, but not all, has been correlated with known spalling from reinforcing corrosion and recorded damage.*

This paragraph relates to witnesses accounts from non-technical people noted in the Beca report. These accounts were not substantiated by evidence or photos and, as such, are hearsay.

It appears inconsistent for a technical report to have reference to hearsay, and/or reference to anecdotal subjective comments from non experts that is after the fact and was never referred to the owner's structural engineer at the time of the earthquakes.

The second sentence of this paragraph could mistakenly be interpreted as the structural engineer missed some of the damage when carrying out their review. This is not the case.

We request this paragraph be deleted as noted in our comments on the Beca report above, or as a minimum be qualified further as follows:

*Anecdotal accounts from non technical witnesses have recounted seeing damage observed after the 4 September earthquake. Some of this has been correlated with known spalling from reinforcing corrosion prior to 4 September 2010 and/or recorded damage after 4 September 2010, the remainder these accounts have not been able to be substantiated.*



## 6.0 Hotel Grand Chancellor Building:

### 6.1 Summary:

The first paragraph reads as follows:

*The Hotel Grand Chancellor complex located at 161 Cashel Street, Christchurch suffered major structural damage and came close to catastrophic failure following the Magnitude 6.3 aftershock on 22 February 2011 when a key supporting shear wall collapsed in brittle compression failure.*

The middle portion of this paragraph is highly subjective and is not supported by any analysis in the Technical Report or by any other fact based research or knowledge. We request that this paragraph be reworded as follows:

*The Hotel Grand Chancellor complex located at 161 Cashel Street, Christchurch suffered major structural damage following the Magnitude 6.3 aftershock on 22 February 2011. The extent of the damage suffered by the building was increased by the failure of a key supporting shear wall which collapsed in a brittle manner.*

This change would then match our requested change to the Technical Report on the same issue.

## 7.0 Forsyth Barr Building

### 7.1 Summary

The summary reads as follows:

*The 18-storey Forsyth Barr Building located on the south-east corner of Armagh and Colombo Streets, Christchurch, suffered an internal collapse of its stairs following the Magnitude 6.3 aftershock on 22 February 2011.*

*The stairs collapsed on one side of the stair well up to Level 13, and on the other up to Level 15. The stairs were designed in a "scissor" arrangement, and were the only means of emergency egress from the building.*

*The principal reasons that the stairs collapsed were:*

- *The intensity and characteristics of the shaking of the 22 February 2011 aftershock exceeded the design capacity of the stairs in terms of distance provided for the stairs to move on their supports in an earthquake (the seismic gap); and*
- *It is possible that the seismic gaps at the lower supports had been filled with material that restricted movement (including debris, mortar or polystyrene) which reduced their effectiveness.*



As the Summary Section is likely to be the section that most commentators and interested non technical people are likely to read we request that the section be expanded as follows:

*The 18-storey Forsyth Barr Building located on the south-east corner of Armagh and Colombo Streets, Christchurch, suffered an internal collapse of its stairs following the Magnitude 6.3 aftershock on 22 February 2011.*

*The stairs collapsed on one side of the stair well up to Level 13, and on the other up to Level 15. The stairs were designed in a “scissor” arrangement, and were the only means of emergency egress from the building.*

*The stairs as designed met the 1988 design requirements for the prescribed earthquake loads and required seismic gap.*

*The principal reasons that the stairs collapsed were:*

- The intensity and characteristics of the shaking of the 22 February 2011 aftershock exceeded the design capacity of the stairs in terms of distance provided for the stairs to move on their supports in an earthquake (the seismic gap); and*
- It is possible that the seismic gaps at the lower supports had been filled with material that restricted movement (including debris, mortar or polystyrene) which reduced their effectiveness.*

The added sentence is taken from the Beca Technical report.

#### Section 7.5 Design basis and code compliance, Page 41

The first paragraph reads as follows:

*There were no issues identified to indicate design non-compliance with respect to the code of the day. The seismic gap complied with the code of the day but would not satisfy current code requirements (by a factor of approximately two). In other respects a stair system within a building designed in 1988 could be expected to be designed to essentially the same standard as stairs in a similar building in 2010.*

The highlighted sentence is factually misleading as discussed in detail in under our commentary on the Forsyth Barr Technical report above and repeated here for clarity.

The Forsyth Barr Building was designed to the 1984 NZ Loadings Standard. This standard has been revised in 1992, 2003, 2004 and 2008. The Forsyth Barr building was designed to the 1982 concrete material standard applicable in 1986-88.

This concrete material standard has subsequently been revised in 1995 and 2006.



The progression of changes included in these revisions are very material as they impact on analysis techniques, and acceptable minimum limits for determining inter-storey drifts and hence separations.

Accordingly we request that the highlighted sentence be deleted.

Section 7.7 Effects of 4 September 2010 earthquake and 26 December 2010 aftershock

Paragraph 3 reads as follows:

*Subsequently, the owner's structural engineer undertook an inspection of the building, and prepared instructions for the repair of cracked structural elements. Instructions had been given for any cracks over a certain size visible in the stairs to be repaired by injection of an epoxy grout. The repair scope did not specifically mention structural repairs to stairs.*

This paragraph appears factually incorrect, in that when we were engaged by Pace Project Management on behalf of the Building Owner, we were advised by Pace Project Management that the stairs were not part of our scope of work as they had been addressed by the Beca as part of their initial engagement. Accordingly our report of 29 November (included in Appendix A2.2 of the Technical Report on Forsyth Barr) does not address the stairs at all, and in fact during our initial site visits the stair repair work was already underway.

Given that the stair repair work had been instructed prior to our involvement we would have thought that there would at least have been a repair methodology/specification issued for this work and that the same would have been part of the Technical Report prepared by Beca.

One final point - given the role of Beca between 5 September and 15 October particularly as relates to the stairs, it appears that there may be a conflict of interest issue here, unless there was another independent Engineer involved in the repair work that was carried out on the scissor stairs prior to our involvement from 15 October 2010.

Paragraph 6 reads as follows:

*The owner's structural engineers inspected the building after the 4 September 2010 earthquake and the 26 December 2010 aftershock, and advised the owner that it was safe to occupy.*

As there is heightened public awareness around the word "safe" we request that it is replaced in this paragraph with the word "acceptable" to be consistent with language that is used in the Technical Reports.

A second point of clarification – there are 2 engineers involved here. After the 4 September 2010 earthquake Beca was engaged by the building manager to carry out



assessments, and then subsequently we were engaged from 15 October 2010 to carry out detailed remedial assessment and repair work, excluding the stairs as noted above.

To clarify this situation the word “owner’s” should be deleted.

Accordingly after both requested changes this paragraph would read:

*Structural engineers inspected the building after the 4 September 2010 earthquake and the 26 December 2010 aftershock, and advised the owner that it was acceptable to occupy.*

Section 7.9 Mode of collapse. Page 43:

Last bullet point reads as follows:

*Construction tolerances and the possibility that the seismic gap at the lower stair support had been filled (with debris or mortar), would have reduced the level of building horizontal displacement required to fail the stair. Analyses indicate that the collapse would have occurred even if the joints had been fully free to move.*

We request the last sentence of this bullet be expanded to aid clarity, as follows

*Construction tolerances and the possibility that the seismic gap at the lower stair support had been filled (with debris or mortar), would have reduced the level of building horizontal displacement required to fail the stair. **Even though the stair separation gaps as designed met the code of the day analyses indicate that the collapse would have occurred even if the joints had been fully free to move, because the gaps were too small for the displacements induced by the 22 February 2010 earthquake.***

Section 7.10 Probable reasons for collapse. page 45

Paragraph 2 reads as follows:

*The stair units were not designed to resist compression that would arise from the closing up of the seismic gap.*

We request that this paragraph be expanded as follows to aid clarity:

***The design codes at the time didn't require designers to assume that the seismic gap would close up beyond the specified gap under earthquake loading and accordingly the stair units were not designed to resist compression that would arise from the closing up of the seismic gap.***





Section 7.11 Conclusions, Page 45

The first sentence of the first paragraph reads as follows:

*The seismic gap at the lower stair support was too small for the aftershock event of 22 February 2011.*

We request that this sentence be expanded as follows to aid clarity:

*Although the seismic gap seismic gap lower end of the support met the code of the day it was too small for the aftershock event of 22 February 2011.*

Section 7.12 Recommendations, Site Inspections, page 46.

The first bullet point reads as follows:

***Alternatives to seismic gap detail***

*Known alternatives to the seismic gap detail used in this building should be used on all new buildings, and for replacing the stairs in this building. These alternatives minimise significantly any likelihood of the stair collapsing because of insufficient displacement allowance.*

The use of the word 'known' as the first word in the bullet could be unfavourably interpreted as known at the time. Accordingly we request that this bullet be reworded as follows:

***Alternatives to seismic gap detail***

*Alternatives now known, to the seismic gap detail used in this building should be used on all new buildings, and for replacing the stairs in this building. These alternatives minimise significantly any likelihood of the stair collapsing because of insufficient displacement allowance.*

The second bullet reads as follows:

***Site Inspections***

*Site inspections should be made to check the seismic gaps in the upper levels where the stairs are still intact. Effective widths should be measured and check of the seismic gap made for the presence on any obstructions such as debris, mortar, polystyrene or other material. The level of damage to the structure should be checked, especially in the region of Levels 13 and 14, to correlate the level of damage with the displacements used in the collapse analysis.*

As stated earlier under our comments on the Technical Report, it is the intention of the Building Owner to remove any remaining stairs and replace all flights with a stair that incorporates a separation detail that meets current code separation detail requirements at ULS, times 2.



Summary/Final Comments:

We understand that these reports have been sent to various parties beyond just us and that they are also given the opportunity to provide comment, some of which may result in material changes to the reports and hence may be material to our views, or require comment for us. Accordingly can we please have the opportunity to review the final report before it is released to the public.

Similarly, we have made numerous comments in this letter and trust that all of them will be actioned, however, if a decision is taken to not action any of them we request that an explanation be provided to us so that we can understand the logic/reason behind any such decision.

Should you have any queries on this matter please feel free to contact me on:

M: 0274 743 110.

P: (09) 965 4789

E: [bruceb@holmesgroup.com](mailto:bruceb@holmesgroup.com)

Yours sincerely

A handwritten signature in black ink that reads "Bruce Black". The signature is written in a cursive style with a horizontal line underneath.

Bruce Black  
MANAGING DIRECTOR