



22 December 2011

Dr David Hopkins  
Department of Building & Housing  
PO Box 10729  
**WELLINGTON**

**Email: David.Hopkins@dbh.govt.nz**

Dear Dr Hopkins

### **Canterbury Television Building Investigation – Draft Reports**

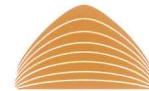
I refer to the letter dated 7 December 2011 from the Department's Deputy Chief Executive, Building Quality, David Kelly, enclosing copies of the draft consultants' report and relevant chapter of the Expert Panel Report (collectively "**draft reports**") in relation to the Canterbury Television Building ("**CTV Building**"). We received the letter and draft reports on 8 December 2011.

The letter advised that the draft reports were provided to Alan Reay Consultants Limited ("**ARCL**") so as to provide an opportunity to advise the Department of any relevant information omitted from the draft reports, whether any draft report requires clarification, or of any other matters relevant to the terms of reference for the investigation which might affect the content of the draft reports. The letter advised that responses must be received by the Department by 5.00 pm on 22 December 2011.

The two engineers referenced in the initial letter from Mr Kelly to ARCL dated 29 November 2011 (Messrs Harding and Banks) were, at different times, separately involved with the CTV Building, and were employed by ARCL. Neither has been with ARCL for many years. Any response either may wish to make in their personal capacity is a matter for them and they have not been involved in this response.

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ARCL has since February 2011 taken a professional interest in understanding the reasons for the failure of the CTV Building and has assisted in that investigation whenever called upon. In addition, we have carried out such investigations and research as we have been able to, but that has been severely limited by difficulties in obtaining access to the required information.

We understand a professional engineering investigation to involve open and collaborative inquiry, with the objective of identifying causation, not apportioning credit or blame. We have felt (and still feel) that this has not been the approach which has been taken by the Department. This has in our assessment led to incomplete, and in places inaccurate, draft reports. This response is provided in accordance with our commitment to open investigation.

We note that its terms of reference record the Department's investigation into the performance of the CTV Building and other buildings in Christchurch in the 22 February 2011 earthquake is an important task and it is vital to get it right.

In particular, it is obvious from the draft reports that the collapse of the CTV Building has been the subject of extensive analysis, testing, expert advice and assessment over the past ten months. It is also relevant that the Department's original reporting deadline of 31 July 2011 has now been extended by almost 5 months (and possibly longer) to enable assembly of information and analysis. In contrast, ARCL is provided at a late stage with a period of two weeks within which to carry out its own assessments and analysis in order to respond to the draft reports. With respect, the period of time provided to ARCL to provide a response on the draft reports is unreasonably short. Nonetheless, in the time available, ARCL has done what it can to review and analyse the draft reports, take expert advice and prepare this response. If more time were available, a considerably more detailed response could have been provided. We ask that this response be received in that context.

#### **Response to draft reports**

By way of response to the content of the draft reports dated 5 and 7 December 2011, we **enclose** a spreadsheet that sets out specific responses to various aspects of the draft reports. Many issues are noted in the spreadsheet. Some are significant and others are less so. Many identify that there is further work to be undertaken, both in respect of factual research and in respect of suggested testing and analysis.

The extent of the impact of these issues is such that we believe that it would be highly undesirable to publish the draft reports in their present form. The work which still needs to be done is likely to lead to both requirements for revision, and the ability to state more clearly the main findings which can be made. There will be great interest in the reports, and in that respect it is critical that the first airing of them is in a form which is an accurate reference for the profession and for the future. While these reports have immediate application in New Zealand they will be of international importance and used as a reference for many years to come.





A comparison may be drawn with the long established and internationally accepted air accident investigation process. The draft report in such an investigation becomes the basis for detailed further work before the final report is completed and the findings made public. There is usually substantial modification in that process.

It is also relevant that the draft reports, when finalised, will be scrutinised at the Royal Commission hearings. The Commission has publically stated that the results of the technical investigation will be contestable in the Commission's hearings process. However, for several obvious reasons every effort should be made to get the results of the Department's investigation right before they are finalised and published, rather than suffer undue challenge and criticism at the Commission's hearing.

In addition to the content of the spreadsheet, we summarise below the key areas of concern to ARCL in relation to the content of the draft reports. These issues have a high level of significance to the conclusions of the draft reports.

- *The draft reports omit important reference material*

In the context of the general comments made above regarding the importance of the reports to be issued by the Department, including as a reference paper for future research both in New Zealand and internationally, there are significant omissions. The omissions include reference material that is relied upon in the draft reports but not provided and not otherwise available in the public domain. They also include data sets that, if provided, might allow verification of the conclusions reached in the report.

By way of example, reference is made to a CompuSoft non-linear analysis report that has been prepared but not referenced as suggested (see CTV Building Collapse Investigation draft report at page 180). Another example is the reference to a Tonkin & Taylor Report by T Sinclair (see page 105 of the same draft report) which appears to be relied upon for conclusions made but is not provided. Further, the owner's inspecting engineer's report as at 6 October 2010, shortly after the initial 4 September earthquake, is referred to (see CTV Building Collapse Investigation draft report at page 37) but it has not been provided. These and other reports have not been noted as being attached to the draft reports. They should be attached.

Obviously, ARCL has not been provided with these and other reports and is unable to properly review the analysis and conclusions that rely upon those reports, some of which include draft findings detrimental to ARCL in relation to design.

- *Concrete strength*

The draft reports indicate that an analysis on the main columns has been performed which found some of the columns to be as low as 11MPa (the level should be at least 35MPa or more for the column in question). At levels of 11MPa and less concrete can break away if a relatively small force is applied to it. This is particularly so when concrete is curing and of course a hardened concrete test reading of 11MPa suggests that curing concrete strengths during the construction period would have been lower still.



Accordingly, it is considered unlikely that the in situ strength would have been this low (or lower). Two factors require specific comment:

- *The effect of the fire on concrete strength:*

In stating the relatively low concrete strengths upon testing, we note that the draft reports make no comment about possible effects of the fire which broke out amongst the building remains shortly after the collapse, other than that sample tests were taken in a way that attempted to minimise the influence of fire on the testing. It is difficult to imagine how the effect of the fire could have been minimised to the extent it had no influence and no allowance is made for any such influence. We understand a permanent chemical change occurs in concrete with heat, commencing at 300 degrees Celsius. Significant changes in strength occur and at 500 degrees Celsius concrete can be expected to lose half its strength on cooling. (Please see pages 466 & 467 of the extract from Mindess Young and Darwin referred to in the spreadsheet, **enclosed**.) The fire would almost certainly have exceeded this temperature and probably have been far higher.

Information provided to ARCL from one of the recovery contractors who were on site throughout most of the rescue operation, fire and material removal, but who we understand were not interviewed by the Department, is to the effect that the majority of the CTV Building remains were affected by the fire which extended throughout the building remains and continued for days. It is surprising to note that there is no comment in the draft reports about the effect of the fire on the concrete strength and any conclusions about concrete strength should be qualified accordingly. Further analysis of the concrete strength should be undertaken in the context of recognising the limitations of the previous testing because of the effects of fire.

- *Sampling and testing issues:*

Given that the concrete was affected by the earthquake, subsequent collapse and then demolition and storage, there was scope for the strength of samples taken to be tainted by issues such as micro-cracking. Without knowing the influence of each of these factors, as well as the fire, on the test results such results must be viewed with caution. However, there is no attempt in the draft reports to analyse the influence of such factors.

Aggravating the limitations of the samples taken, as noted above, the Schmidt hammer testing method used is likely to have created increased statistical uncertainty as does the back-dated inferences as to 28 day concrete strength through testing samples over twenty five years old and subjected to earthquakes, fire and other damage.





In addition there appears to have been no testing of the composition of the cement in the concrete which could have provided a useful data set.

As a consequence of the failure of the draft reports to properly consider the effect of the fire and sampling and testing inadequacies, it is not appropriate to make the conclusions that have been made about concrete strength in the draft reports. These inadequacies have a consequential effect on the analytical work discussed below.

- *Design assumptions and analysis*

Computer simulations of the effect of the earthquake have been carried out using seismic records from sites 500 metres and further away. It is not possible to be certain that the simulations emulate the localised effects of the earthquake imposed on the CTV Building. There appears to have been no attempt to correlate the seismic data used to run the computer simulations with the conditions actually experienced on the CTV Building site.

It would have been very helpful for a seismic monitor to have been placed on the CTV site for the months since the earthquake so that actual site seismic readings could be better correlated with those from remote sites that have been used for the simulations.

The computer simulations were run on SAP2000 software. There are more sophisticated software programmes available that can allow greater flexibility of input parameters and assumptions and hence can produce more robust results. ARCL is aware that the software company that ran the simulations referred to in the draft reports does have one of these more complex programmes.

Another of the Department's consultant's utilised such a programme (called "PERFORM") on the investigation into the collapse of the PGC building.

It is not clear why a more complex programme has not been used for the CTV Building investigation, especially when the length of time taken to complete the draft reports is considered.

There are many uncertain factors relevant to the assumptions made in the simulations of the earthquake strength and behaviour of the CTV Building during the 22 February earthquake. While assumptions have been made, the basis for many has not been specified in the draft reports. This has prevented a full review of the modelling outputs dependent on such assumptions.

As a consequence of these inadequacies in both the correlation of the seismic data used and selection of simulation methodology, it is not appropriate to make the conclusions that have been made in the draft reports about the behaviour of the CTV Building in the 22 February earthquake.



- *Practices and standards*

The terms of reference for its investigation and report require the Department to take into account "the design codes, construction methods, and building controls in force at the time the buildings were designed and constructed and changes over time as they applied to these buildings".

When discussing the Council approved design and construction in 1986, the draft reports refer to guidelines and standards that post-date such design and construction. These later guidelines and standards cannot be the correct basis for any assessment of the original design and construction. The specific standards, bylaws and Council interpretations that were in effect at the time of Council approval of design and construction must be referenced.

In addition, practices of the day were different to how they now are. The Council engineer responsible for the Council approval process at the time (Mr Bluck) was a very able engineer.

At the time of construction, the CTV Building would have been of specific interest to the Council and Mr Bluck. Mr Bluck would challenge engineers over their designs and would occasionally over-rule engineers where he felt he was right to do so. The Council was in effect the peer reviewing authority at the time. This contrasts with modern practice where most councils now require provision of an independent peer review. ARCL also considers that an insufficient distinction is drawn between engineering design issues (i.e. was the design in accordance with the Code at the time?) and standards issues (i.e. were the standards of the day sufficient?).

It is significant that neither Holmes Consulting Group Limited (Consulting Engineer B), nor the Council, considered that the columns were an issue at the time of their reviews. Both were experienced in the design and review of buildings of this type. In particular there was a near contemporaneous assessment by Holmes Consulting Group, which constituted a full design review of the CTV Building in the context of the design standards of the day (as at 1991). This report does not seem to be have been given the weight expected for such a significant independent and contemporaneous design review.

It is unreasonable to support conclusions in the draft reports on the basis of guidelines and standards that were not enacted when the building design was consented or the building constructed. The draft reports' conclusions also suffer from failure to take into account the practical and legal influences that the Council officers, interpretations and practices had on the design and construction process at the time.

- *Further issues*

- While specific analytical techniques were used, different techniques may lead to different conclusions. The analysis in the draft reports is stated as indicating the diaphragm to shear wall ties failed first, but this was not evident from the investigators' assessment of the physical failure. This indicates that the specific assumptions and analysis in the draft reports does not reflect the actual behaviour.





- The effects of vertical displacement and acceleration were considered minor but they may have been major. The manner in which these impacted on the CTV Building, based on the analysis and assumptions noted above, may not have been adequately modelled. ARCL notes that vertical accelerations in one building in Madras Street exceeded 1G.
- In other buildings inspected by ARCL after the earthquake, some critical damage that has occurred would not have been predicted by the assumptions and analysis methods recorded in the draft reports.
- For the reasons already discussed in this response, the question as to the CTV Building's performance under the actual earthquake event is not properly considered in the draft reports, particularly given the assumptions made as to the relevant seismic site records. ARCL has obtained a seismic recording instrument to measure the actual seismic response at the site and is seeking CERA approval to conduct these tests.
- A number of comparisons and statements are not relevant and potentially misleading, for example:
  - There is reference to concrete strength specifications of 17.5MPa observed in the Amuri Courts building [see CTV Building Site Examination and Materials Tests draft report at page 72]. This building and concrete strength has no relationship to the CTV Building. The CTV Building contractor had no involvement with Amuri Courts. The Amuri Courts have a single level deck supported on columns quite unlike the CTV Building. Mentioning that the same engineer was involved in determining concrete strengths on both the Amuri Courts and CTV buildings is both irrelevant and potentially misleading.
  - The requirement for the concrete strengths to be on the drawings is not a Code requirement [see the so-called "omission" wrongly identified in the Expert Panel Report at page 48].
- The CTV Building had not been identified as an earthquake prone building at the time of the earthquake on 22 February 2011.
- The full effect of the 4 September and 26 December 2010 earthquakes are not properly accounted for in the analysis. The draft reports include a disclaimer that some damage and the resulting effects that may have occurred during previous earthquakes are not accounted for. While the draft reports acknowledge these effects, no proper allowance is made for their influence. Prior damage could be critical in terms of the assumptions that have been made.
- ARCL considers the issues of whether there were design and construction defects (which, for the reasons noted in this response, are not accepted) are overwhelmed by the most likely actual cause of the collapse of the CTV Building: The CTV Building was subjected to an earthquake on 22 February 2011 of such powerful force that it was well in excess of the loads expected under the Code the building was designed under.



- The strength of the above proposition may be emphasised by the Department's analytical work (if it can be relied upon) which demonstrated that under simulation of the 4 September 2010 earthquake the columns would have been subjected to a 1.1% drift (for example, see page 187 of the CTV Building Collapse Investigation draft report). This was substantially greater than the applicable Code design level drift. If the simulation is correct then it is highly relevant that the building columns did not fail during the actual earthquake conditions on 4 September 2010.

### Next steps

ARCL considers that the analysis undertaken by the Department and its experts as displayed in the draft reports does not justify the conclusions that have been made. ARCL considers that further data collection and analysis should be undertaken, including in the manners identified in these comments and spreadsheet, before any further attempt is made to formulate conclusions about the cause of the CTV Building collapse.

Accordingly, we seek your agreement that until the issues raised by ARCL in this letter and in the enclosed spreadsheet have been considered, pursued and resolved by the Department and its experts, it is not feasible (or in law, just) for conclusions about the CTV Building collapse to be made. It is contrary to the objectives of the investigation for the draft reports to be finalised and publically released.

In the context of the above, given the significance of the issues raised and their likely effect on the analysis and conclusions of the draft reports, we believe the draft reports should not be finalised or released without ARCL having been provided with a further opportunity to review and provide comment on any revised draft reports.

### Official Information Act request

On 4 October 2011, ARCL's solicitors wrote to the Department making a request for documents pursuant to the Official Information Act 1982. A copy of Buddle Findlay's letter is **enclosed**. It is disappointing that the request was refused. The grounds for refusal were stated as being: *"...the CTV Building is the subject of an ongoing investigation by the Department of Building and Housing. It is critical that in completing [the] investigation the Department complies with the principles of natural justice, and that no person or organisation is prejudiced or subjected to unfairness by the public release of information relating to the investigation, before it is complete."* ARCL's expectation was that the draft reports would reveal all the information it sought under the Official Information Act.

However, clearly the draft reports do not reveal all the information that ARCL sought in its Official Information Act request. There are references to data and other information that is not included in the draft reports. Having now seen the content of the draft reports and in light of the very short timeframe provided for a response, had ARCL had access to the information requested in the Official Information Act request, at the time it was requested, it may have been possible to raise many of the issues that are raised in this letter and the spreadsheet before the draft reports were advanced to their current stage.





Alan Reay Consultants

ARCL has asked its solicitors to prepare a further request pursuant to the Official Information Act 1982. A copy of ARCL's solicitor's letter is **enclosed**.

Please direct your reply to our further Official Information Act request to Buddle Findlay.

**Conclusion**

We look forward to hearing from you in relation to the responses set out above and in the attached spreadsheet.

Yours faithfully

A handwritten signature in blue ink, appearing to read 'Alan Reay', is written over a light blue horizontal line.

Dr Alan Reay  
On behalf of  
Alan Reay Consultants Ltd