NEW ZEALAND POLICE
Ngā Pirihimana o Aotearoa

2017

CTV Investigation

Report for Crown Solicitor

New Zealand Police

New Zealand POLICE
Nga Pirihimana O Aotearoa

CTV Building
249 Madras Street, Christchurch

CRIMINAL INVESTIGATION
Report for the Crown Solicitor

TO

Raymond Donnelly & Co.
Crown Solicitors
CHRISTCHURCH

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26 May 2017

CTV – Criminal Investigation – Crown Report

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1 INTERACTIVE INVESTIGATION REPORT

This report covers the background of the CTV building construction, the lifespan of the building and the various investigations carried out following the February 2011 earthquake.

The report sets out the methodology of not only the Police criminal investigation, but a range of inquiries by agencies and critically the findings of the Canterbury Earthquake Royal Commission (CERC). This report outlines the key issues and outcomes reached as at the date of this report.

The documents supporting this report across all sources (number in the tens of thousands) and are the key pillars of evidence from that created, seized, examined and referred to.

The size and complexity of the investigation file, the areas of interest that have been identified are as a result of interview or at the direction of experts engaged by the NZ Police. A number of documents, interviews and evidential material has been obtained, but not all of these have been referred to as they are not considered to have relevance to the cause of the collapse.

This report is designed as a snapshot of the investigation. It refers the reader to a number of key documents, across a number of investigative themes. This document provides a broad introduction to the CTV building; the investigation, the issues and themes identified as important to the investigation, expert conclusions in respect of the cause of the collapse and how it relates to the issue of gross negligence.

The key themes identified by the investigation to date are that of management, supervision / review, competency and engineer responsibility. These are relevant issues to consider when assessing the evidence in light of Dr Reay and Mr Harding's involvement in the concept, design and construction of the CTV building. The Police and Beca have obtained a number of statements from engineers who were practising in the 1980s to obtain an overview of the standard of the day principles that were utilised by the engineering profession. It is against that objective standard that much of the evidence has been reviewed.

The start point for the criminal investigation is:

- **The BECA Expert Engineering Opinion Report** into the collapse of the CTV building. It is this report that provides the technical expert evidence for the investigation and identifies the cause of the collapse. This report goes into considerable detail around the structural design of the building and the short comings identified in regards to areas of non-compliance, along with significant issues with regards to lack of supervision and review of the designer. Beca provides an expert opinion on matters relating to design and construction which allows Police to determine the question of gross negligence and criminal culpability.

Additional reports produced by:

- **The Department of Building and Housing (DBH)** and

- **The Canterbury Earthquakes Royal Commission (CERC)** will also provide the reader with detailed appreciation of factors involved and the technical aspects of the building from design to collapse. CERC provided the basis for evidence of the key themes for the police investigation.

All of the documents are attached by **Folder (1 or 2) and Tab numbers** to this report for convenience. Documents referred to by ***footnote reference only***, are available by accessing the electronic police investigation file.

Investigative Themes / Intelligence Product[1]

For each investigative theme that has been identified and formed part of the focus of the investigation, a summary has been prepared in this report that identifies the relevant points. Many of these points of interest refer to footnotes to documents that canvas the theme in more detail.

- All of the crucial witnesses who can give important commentary to these themes are identified.

- All investigative themes have multiple witnesses who can provide relevant information on the topic. The only issue that does not have direct evidence available is on the issue of the supervision / oversight that Reay did or did not provide to Harding during the design of the CTV building. [redacted]

- Of all of the witnesses listed, not all have been interviewed to date.

- Each transcript of interview has been summarised, as many transcripts go to several hundred pages.

- Key Documentary exhibits referred to by witnesses are also linked as they are referred to.

- Intelligence product - The investigation analyst has produced an i2 chart that lists all the key investigative themes, witnesses and exhibits as an aide memoir for the design / construction and lifespan through to failure of the CTV building. That product should be used in conjunction with this report. In many senses it provides a schematic representation of how a proposed criminal trial might progress.

Photographs and Videos

Many thousands of images and videos were collected during the course of the earthquake and emergency services response. These total many hours of viewing. Some have matters of interest, most are post 22 February 2011 and are of little significance to the investigation into the cause of the structural collapse. For this reason only a small number of still images have been included electronically on this file. Viewing of any image or video not on file can be arranged if required. Many were tendered during the Coronial Hearings for the CTV building in order to make official findings regarding the cause of death for the 115 people in the building and also Emergency Services Coronial Hearings in 2012.

[1] FOLDER 2 - TAB 6

Legal Opinion

The report has been drafted by the investigation team and reviewed by the CTV investigation lawyer, [redacted], who has been responsible for researching and linking to the criminal investigation the evidence from the Canterbury Earthquake Royal Commission of Inquiry (CERC), as well as assessing the relevancy of evidence obtained from witnesses. [redacted] has also prepared **Summary of Evidence**[2] documents for Dr Alan Reay and Mr David Harding[3]. At the time of writing these are considered to be evolving documents.

Given the complex and unique nature of this investigation, the writer has included check points at relevant junctures in order to provide an overview of the evidence obtained to date, areas that may require further investigation and how the evidence available is relevant to the investigation. Some of the points simply raise an issue that will need to be discussed with the Crown Solicitor at a later stage.

CTV Investigation Team

The CTV investigation team has comprised of:

- Officer in Charge: Detective Superintendent Peter Read
- District Manager CIB Detective Inspector Corrie Parnell
- Officer in Charge Investigation: Detective Inspector Darryl Sweeney
- 2ic: Detective Sergeant Grant Collins
- General Inquiries [redacted]
- Investigation Team: [redacted]

Electronic Investigation File

The complete electronic investigation file will be provided to the Crown. The 2ic of the CTV investigation, Detective Sergeant Grant Collins (or [redacted] who holds responsibility for the file) can guide the reader through the police file and links to outside sources.

Disclosure is currently being prepared using a separate software program.

2 EXECUTIVE SUMMARY

This report relates to the criminal investigation by Police into the circumstances surrounding the structural failure and collapse of the building known as the Canterbury Television (CTV) building, formerly situated at 249 Madras Street, Christchurch. The collapse followed a magnitude 6.3 earthquake at 12.51pm on 22 February 2011 and claimed the lives of 115 people.

[2] FOLDER 1 – TAB 3 (SOE REAY – will continue to be updated)
[3] FOLDER 1 – TAB 4 (SOE HARDING – will continue to be updated)

The origins of the building came about in late 1985 as a result of a speculative property development project by Prime West Limited. The company owned land at the corner of Madras Street and Cashel Street, Christchurch. The primary objective was to build a six storey office building that had maximum lettable space with ground floor parking. Prime West worked in collaboration with Williams Construction on this design build project and it was Michael Brooks of Williams who drew a rough sketch of what he envisaged the building to be; a square box with large floor spaces. His idea of the lifts and services being located on the outside of the building came a short time later.

Alan Reay Consultant Engineer was chosen as the structural engineering firm for this design build. Alan Reay, as sole director and principal of this firm, allocated the structural design work to David Harding. Harding was the only other engineer employed by Reay but had a background primarily in civil engineering. He had recently returned to Reay's firm to gain experience in multi-storey design, something he had not done previously.

Construction of the building began in late 1986 with a completion date in 1988, shortly after the share market crash in October 1987. The building did not sell and did not attract any tenants until late 1991.

The building had numerous changes in tenants over the years, and eventually became known as the CTV building after the Christchurch based television company took over the bottom two floors in the early 2000s.

At the time of the February earthquake it was home to CTV, an English language school (King's Education), a medical clinic (The Clinic) and counselling services (Relationship Services). There were a total of 149 people inside the building when the earthquake struck.

This report details the Police investigation into the development of this building, from conception to construction. It also details events around 1990 / 1991 when an issue was identified regarding the lack of connection between the north shear wall and the floor slabs. The report outlines the key roles and responsibilities of the people involved in each stage.

The Police investigation has been heavily reliant on the expert opinion of Beca as to the cause of the building's collapse. Beca have also considered the roles, particularly of Reay and Harding, and provided an opinion regarding their respective actions and omissions. Whilst the question of whether Reay and Harding were under a duty pursuant to the Crimes Act 1961 is a legal question, Beca's investigation has informed the investigation as to standard of the day practice, the applicable codes and bylaws and the design and construction methodology.

Beca conclude that both Reay and Harding's actions and omissions were a major departure from the accepted practice of the day. Furthermore, both Reay and Harding omitted to discharge their duties in their respective ways and the omission for each was a substantial and operating cause of the deaths.

Beca were asked to consider whether any of the individuals who also had (or should have had) significant involvement omitted to discharge their duty, whether the omission was a substantial and operating cause of the deaths and whether the omission was a major departure from the expected standard. Beca's findings were that Graeme Tapper and Bryan Bluck from the Christchurch City Council did not meet all three criteria, nor did Geoff Banks (who designed the retrofit of the drag bars in 1991). Bill Jones (construction foreman) and Gerald Shirtcliff (construction manager) likewise did not satisfy all three criteria required to establish the criminal offence of manslaughter.

Police have not completed the inquiry as at the date of this report's submission to the Crown. The comprehensive inquiries and investigation conducted thus far have provided a reasonably clear indication of the evidence expected for a particular area of inquiry. For example, an important issue at CERC was the strength of the concrete. Inquiries undertaken strongly suggest that the concrete was supplied by [redacted] and that it was not understrength at the time of construction. Inquiries need to be completed for that area but the strong indication is that the concrete strength was not a contributing factor in the collapse.

The legal analysis undertaken by Police concludes that Alan Reay and David Harding were under a legal duty pursuant to either section 156 or section 157 Crimes Act 1961. Both duties appear to be equally applicable and based on the expert opinion of Beca, it was the flawed structural design of the building which was the cause of the building's failure to survive the 22 February 2011 earthquake. The design by Harding was not supervised or moderated in any way by his employer, Reay and for that reason Beca conclude that Reay also failed to discharge his duty.

Police are of the opinion that there is both evidential sufficiency and public interest in filing charges of manslaughter for both Reay and Harding. The charge of criminal nuisance was not considered an appropriate charge in this case due to the requirement to prove recklessness and also the charge not reflecting the seriousness of the circumstances. The question of whether there is a reasonable prospect of conviction is one that Police believe is answered in the affirmative as there is an evidential basis upon which to proceed. The issue for the jury will be whether they are satisfied with the findings of Beca as to the cause of the collapse and also whether Reay and Harding's conduct represented a major departure from the standard of care. It is not the prosecution's role to usurp the role of the jury in that regard.

There are a number of inquiries to be finalised. However, Police are of the view that there is sufficient information available, particularly from the Beca Engineering Opinion Report and the Peer Reviews by [redacted], to enable a decision to be made as to whether a prosecution should be commenced.

Police recommend that charges of manslaughter be filed against Alan Reay and David Harding for the 115 deaths at the CTV building on 22 February 2011.

3 SUMMARY OF INVESTIGATIONS

In the wake of the February 2011 earthquake, a number of investigations were carried out by various agencies. The investigations of relevance to the collapse of the CTV building are listed at the bottom of this section, along with a brief outline of the scope of the inquiry, the duration of the inquiry and the outcome or result.

The timelines for each investigation are important to observe, because although it has been some six years since the CTV building collapse, there have been a number of complex investigations and hearings conducted along the way, with expert findings released at the conclusion of each investigation. Each inquiry was necessary in its own right and every outcome has in turn determined the subsequent course of action. It was not until August 2014 that NZ Police received the mandate to embark on a comprehensive criminal investigation, collating all of the evidence obtained up until that point, assessing the facts and commencing further inquiries.

The CTV Investigation has involved a combination of investigative work through Police interviews, inquiries, research and search warrants as well as project management of obtaining expert opinion from Beca. Analysis of the investigation through different phases has been ongoing and decisions have been made as to whether continue with a particular phase

or to commence in another area. This is a large and complex investigation which has required input from the expert witnesses regarding engineering practices and principles.

In critical areas the investigation team has been heavily reliant on expert opinion by Beca in order to progress the inquiry, and that expert opinion was finalised in May 2016.

It is important to note that while the CTV Investigation has been progressing, the team have also investigated 25 other sites around the city where deaths occurred from building collapse in February 2011. Each site has been assessed for criminal liability, resulting in four separate individuals investigated for manslaughter at sites where major departures appear to have occurred. Of those cases, one has been resolved and the three remaining files await the legal opinion of the Crown.

A list of the different investigations and the timeline is as follows:

- **Missing Persons / Coronial Investigations** (Operation Earthquake) - NZ Police
  - **February 2011 to November 2011**

- **Coronial Hearings** - Office of the Coroner
  - All Deaths (including - 115 CTV deaths)
  - **May 2011 to December 2011**
  - Coronial Inquest - CTV Emergency Services Response ([redacted] and others)
  - **October 2012 to November 2012**

- **Department of Building and Housing Report – DBH**[4]
  - Hyland – Smith Report (CTV)
  - Expert Panel Report
  - **March 2011 to February 2012**
  - **Report released 9 February 2012**

- **Canterbury Earthquakes Royal Commission of Inquiry** – CERC
  - **October 2011 to September 2012**
  - Final Report, Part 3, Volume 6, Canterbury Television (CTV)[5]
  - **Report released 10 December 2012**
  - Commission findings critical of designer David Harding and principal consultant Alan Reay

- **Police Legal Review**
  - [redacted] of Legal Section, Police National Headquarters (PNHQ), [redacted]
  - Review CERC findings and assess criminal liability of individuals
  - **February 2013 – December 2013**

- **BECA Investigation – Phase One**
  - Engaged by Police to provide independent expert engineering opinion
  - **February 2014 – August 2014**
  - **Preliminary Engineering Opinion Report released 29 August 2014**

- **CTV Criminal Investigation** – NZ Police
  - Investigation team formed, phase assessment, further inquiries

[4] FOLDER 1 – TAB 2
[5] FOLDER 2 – TAB 5

- **August 2014 - current**
- **June 2016 -** Police - Crown Investigation report submitted:
  - Crown Solicitor assessment of investigation commences:
- Crown Solicitor directs further peer reviews
  - [redacted]
  - [redacted]

- **Other Sites Investigation** – NZ Police
  - 25 building sites assessed and investigated
  - 4 completed for assessment (manslaughter) by the Crown Solicitor
    1. [redacted], *Christchurch*
    2. [redacted] *Christchurch*
    3. [redacted], *Christchurch*
    4. [redacted], *Christchurch*
  - **October 2014 - current**

- **BECA Investigation – Phase Two**
  - Further investigation and additional computer modelling (NLTHA) and Physical Testing – University of Auckland (UoA)
  - **September 2014 – April 2016**
  - **Final Engineering Opinion Report released July 2016**
  - **Ground report released December 2016**

For more detail around these inquiries, the following section of this report includes an overview of each investigation as part of the overall background of events that led up to the commencement of the criminal investigation by Police.

4 CTV BUILDING HISTORY

Section 4 provides a brief summary of the individuals involved in the lifespan of the CTV building, from conception to construction, including tenancies and alterations prior to 2010. This section also looks at the chronology of events leading up to and post collapse, beginning with the September 2010 earthquake, building assessments and what more detail of the investigations and inquiries carried out in the wake of the 115 deaths.

4.1 Concept, Design, Permit and Construction

In early 1986, Williams Construction Limited (contractor) was invited by Prime West Corporation Limited (developer) to submit a design-build proposal for an office building at 249 Madras Street, Christchurch. The building project was 'speculative' in that there were no tenants for the building and the contract did not include fit-out. It was simply named 'Office Building – 249 Madras Street'. More detail on the origins of the project and the people involved can be found in CERC Volume 6, section 2.1.3.

Neil Blair, director of Prime West and Michael Brooks of Williams Construction met over lunch to discuss the prospect of doing a project together. Brooks drew a basic box on the back of a lunchtime menu card representing the idea of six storey building with maximum lettable space and ground floor car parking. Blair said that he then left Brooks to work out the details and present the cost analysis to him at a later stage. Brooks said that he came up with the idea to have the services core put on the outside of the building (the north wall complex) a short time after that initial meeting.

Alun Wilkie (of Alun Wilkie Associates) architect, was engaged to draw up plans[6]. Once this process was underway, Alan Reay, operating as a sole practitioner under the name Alan M. Reay Consulting Engineer (ARCE), was engaged as the structural engineer for the building. David Harding, employed by Dr Reay as a structural engineer, was allocated the role of designing the building.

4.1.1 Concept

The architectural design of the CTV building was based on the design of a four storey building at 299 Durham Street, known as the Contours building. Wilkie had designed the Contours building and liked using the same methodology across his designs. The design included the services core offset to the north (Brooks' idea), circular columns, precast concrete spandrel panels, glazing set back behind the perimeter columns and the layout of the internal columns.

Once the architectural sketch had been done, ARCE were invited to be the structural engineering firm, based on an established relationship between ARCE and Williams Construction developed during the construction of the Aged Peoples Welfare building, situated at 64 Cashel Street. Williams Construction liked the presentation, content and standard of drawings and the fact that ARCE would also provide preliminary drawings for costing purposes free of charge. It was also felt by Williams' that Reay 'understood a developer's desire for maximising lettable space'.

Once the preliminary price calculations and the concept design had been worked up, Reay gave the job of producing the structural design to David Harding.

4.1.2 David Harding

Harding began his career in engineering at [redacted], working there from 1973 to 1977. His work included the design of domestic buildings and foundations, site levelling surveys and storm water design. Harding also did the structural design of single storey factories, offices, warehouses and school buildings, as well as structural strengthening of brick buildings and full scale testing of fibreglass structures.

He then joined ARCE in 1978 and at that time undertook the design of structural elements of residential buildings and industrial and commercial buildings of one or two storeys, particularly of precast concrete construction. Harding left ARCE in May 1980 to gain experience in civil engineering.

Harding was subsequently employed at the Waimairi District Council as its design engineer. In that role he was responsible for the design office and supervised six staff. He was mainly involved in civil engineering, including the design of roundabouts and roads, but undertook some structural engineering related to annual surveys and maintenance of bridges. Harding carried out preliminary investigation of, and then designed, the hydroslide and associated platforms and swimming pools for the Jellie Park swimming pool complex.

Further detail of Harding's experience and role at ARCE is given later in this report in Section 6.

[6] [redacted] – Structural & Architectural Drawings (A3 booklet) **attached**

4.1.3 John Henry

While Harding was employed at Waimairi Council, John Henry was employed by ARCE for around a year between 1984 and 1985. Henry graduated in 1979 before joining [redacted] where he was involved in the design of a number of multi-storey buildings and trained in the use of the dynamic analysis computer program, ETABS.

The ETABS program is particularly relevant to the design of the CTV Building. The origins of the program and use of ETABS by structural designers in NZ in the 1980s, and the reliance of ETABS in the design of the CTV Building are covered later in this report.

Reay employed Henry primarily to undertake the design of medium height multi-storey buildings, which ARCE had started to take on at that time. The 1980s were described as a very busy time for structural design and construction in New Zealand, with a shortage of intermediate engineers with structural design experience.

During his time at ARCE, Henry designed Landsborough House, as well as completing the detailed design work for the Aged Peoples Welfare building. Henry was also involved to a limited extent in the design of Bradley Nuttall House, which largely replicated the Landsborough House design, and he started work on the design of Westpark Tower. Henry left ARCE in late 1985.

These buildings are relevant to the investigation. When Harding resumed his employment with ARCE in late 1985, he was either involved in the latter part of the design process for some (Westpark is an example) or in the case of Landsborough House, was provided with the calculations and ETABS data of John Henry's designs which were intended to be a template for Harding to follow.

It was supposedly this 'experience' in multi-storey design that gave Reay the confidence to allocate the structural design of the CTV Building to Harding. However, a closer look at Harding's actual role in those designs compared with what Henry had already done would suggest that Harding was not provided with any opportunity to develop a design himself, but had instead had the majority of the work already done for him by Henry. There was therefore little foundation for Reay to have concluded that Harding had the capability or experience to design a multi-storey building without any oversight or review. Even if he had some experience, it is clear that some degree of oversight and review was required. This is discussed further in section 6.3.

4.1.4 Harding's second period of employment with ARCE

After Henry left ARCE, Reay approached Harding and asked if he would be interested in returning to ARCE. According to Harding's evidence at CERC, the position offered the opportunity to design medium height multi-storey buildings. Harding was dissatisfied at the Council and was looking for a change of direction. Despite having no previous experience in multi-storey design, he accepted the offer and commenced a second period of employment with ARCE in November 1985.

4.1.5 Design

David Harding started work on the basic structural design in March 1986. Preliminary architectural drawings were provided to Harding and he was asked to provide three alternative designs for the purposes of pricing to the contractor. The main difference between the three designs was the floor composition and it was ultimately determined

that a Hi-Bond floor would be utilised. This meant that a shallow concrete foundation could be used rather than the piles that had originally been suggested.

Reay assigned Harding the task of doing the whole design of the building and gave him the Landsborough House file, which included calculations and ETABS outputs of that building. It was intended that Harding use this design as a 'method template' for modelling the CTV building.

Harding proceeded with a design based on an off-set shear 'core' (lift, stairs, toilets) on the north side, referred to as the north wall complex (NWC). The design was intended to function as a 'shear wall protected gravity load system'. This means that the side-to-side movement (lateral) of an earthquake would be resisted by reinforced concrete walls connected to the foundations. In theory, this seismic protection meant that the 400mm circular columns only needed to support the weight of the CTV building, in other words the 'gravity load'.

Pre-cast concrete beams ran from east to west, supporting reinforced concrete floor slabs poured over metal decking, a product known as 'Dimond Hi-Bond'. CERC Volume 6, Section 1.2 contains a more in-depth description of the design along with drawings and photographs.

Harding gave evidence at CERC that using the Landsborough House modelling data as a template, he performed the ETABS analysis for the CTV design on a computer at the University of Canterbury. He checked the outcome of the tests and interpreted that the amount of sideways movement in the columns (inter-storey deflections) exceeded the limits of the building code. He attempted to reduce the deflection by making the walls thicker but this was unsuccessful.

In order to solve this problem Harding added a shear wall on the south side of the building, but was restricted in the overall length of the wall by the layout of the concept design. Harding gave evidence at CERC that when he discussed the need for the south shear wall with Reay, it was clear that this wall was unsatisfactory as Reay said the client wanted maximised floor space and unobstructed views. Harding utilised an existing wall behind external fire escape stairs on the south side of the building and made it into a structural shear wall to resist the lateral load and reduce the inter-storey deflections to within the code limits. This wall was offset rather than directly opposite the NWC and much narrower than the opposite wall.

Once this was done, Harding completed the structural detailing in regards to the amount of reinforcing steel required in the columns, beams and floor connections. All of the details of his design were transferred onto the structural drawings by ARCE draughtsmen.

4.1.6 Draughtsmen

The role of the ARCE draughtsmen in producing the final structural drawings of the CTV building will be covered in more detail later in this report, as well as the obligations and expectations of draughtsmen in the 1980s. However, without duplicating that chapter, the acts or omissions of the ARCE draughtsmen are not in question for the purpose of this investigation.

Identifying deficiencies in a design based on drawing details, such as the amount of reinforcing in a beam-column joint, is not within the scope of responsibility or capability for a draughtsman. They have no formal structural engineering training and are not privy to the structural calculations or computer modelling results on which the engineer

has based the design. Their role is to draw the detail as specified by the design engineer.

4.1.7 Permit

An application for building permit was made to the Christchurch City Council (CCC) on 17 July 1986 by the architect on behalf of Williams Construction. CCC Assistant Building Engineer Graeme Tapper (deceased) reviewed the application and identified deficiencies with the structural drawings submitted for permit.

Tapper notified ARCE by way of a letter dated 27 August 1986, that the application was held up pending receipt of further calculations to support the design. Communication over these issues took place between ARCE and the CCC. Records show that additional documentation was supplied to CCC by ARCE under a 'document transfer form' dated 5 September 1986. Mr Tapper, despite his earlier objections, approved the structural design of the building and issued the permit on 10 September 1986.

It was standard in the 1980s for permit applications to be staggered so that a permit could be granted for the foundations whilst the structural design was still being finalised by the engineer. A significant feature in this permit application was that the design-build project was contingent on the granting of a building permit for the entire structure. The contract had been agreed that it was "no job, no fee" and that failure to gain a permit would mean no money had to be paid for any of the work done till that point.

4.1.8 Construction

Construction commenced in October 1986 and was carried out by Williams Construction Limited, under first [redacted] and a short time later, construction manager Gerald Shirtcliff and foreman William (Bill) Jones. In late 1986, Williams Construction was the subject of a takeover, and Union Construction Limited (with Michael Brooks, Tony Scott and Gerald Shirtcliff as directors) commenced trade on 1 May 1987. Union Construction, by agreement with the new owners at Williams Construction, completed the building by the early part of 1988. Not long after the completion of the building, both Prime West and Union Construction became insolvent and ceased to operate.

[redacted] of Williams Construction was clear in his interview with Police that there was no shortage of money during the construction of the building. Invoices were paid on time and any issues would have been easily remedied during construction. It was only towards the end of construction that issues arose, but that was mainly to do with the change of culture at Williams Construction rather than any shortfall in workmanship.

Following the stock market crash of 19 October 1987, the building remained vacant for some time as the receivers for Prime West, KPMG Peat Marwick, struggled to find a potential purchaser for the property.

4.2 Drag bar retro-fit

On 24 January 1990, Holmes Consulting Group (HCG) was engaged by Canterbury Regional Council (CRC), a potential purchaser of the building, to prepare a pre-purchase review as part of their due diligence. HCG liaised with Alan Reay and Geoff Banks, structural engineer by then employed by Reay. Harding had by this stage resigned from ARCE. The main finding

of the HCG review was the identification of non-compliance in the connections between the floor slabs and the North Wall Complex (NWC).

CRC did not purchase the building and instructed HCG to cease their work and review of the building on 31 January 1990. Consequently a full review by HCG was not completed, although a draft report was submitted by HCG outlining what they had discovered along with a possible solution and estimation of cost. This was to show their client the work they had undertaken, essentially to justify the invoice rather than provide information on a building that was not going to be purchased.

Only the report was forwarded to Alan Reay Consultants Limited (ARCL) with no cover page identifying that it was a draft report. There were no calculations or draft solution drawings attached to the report sent to ARCL, where Banks believed that it was a complete review identifying only one issue regarding the connection of the slabs and the NWC.

The building was eventually purchased by Madras Equities Limited in December 1990 who remained the owners until February 2011. ARCL carried out the engineering design of drag bars to address the area of non-compliance identified in the draft HCG report and these were installed in October 1991, just prior to the building's first tenants, ANZ bank, moving in on 1 November 1991.

Of significance is that no building permit was obtained from the CCC before the drag bars were installed in October 1991. Under the CCC Building Bylaw 1990, a permit was required before that work commenced. Whether this is a major departure and whether it was a substantial and operating cause of the deaths is discussed in the legal analysis section of this report.

The HCG report and the actions of ARCL are discussed in further detail later in this report.

4.3 CTV Building 1991 - 2010

Madras Equities retained ownership of the building up until 22 February 2011, leasing various floors of the building to corporate tenants over that time. Those tenants included companies and organisations involved in finance, education, fitness, medical and counselling services.

One of those tenants was Canterbury Television (CTV) who leased levels one and two as television studios and production offices in 2000. The building became known from that time as the CTV building.

Between the time of original construction and 4 September 2010 the CCC issued a number of permits and consents (including resource consents) for work on the CTV building. In most cases, the approved work would have had no impact on the structural performance of the building in an earthquake.

A full list of the known tenants and associated building permits, consents and change of use applications are found in a list that details the life of the building at 249 Madras Street[7]. The notable alterations are described here:

4.3.1 Canopy 1988

On 21 December 1987, an application was made to CCC for the addition of a canopy to be erected as a cover between the pedestrian access to the NWC and the footpath

[7] FOLDER 2 - TAB 7

on Madras Street. The applicant was the construction foreman, Bill Jones on behalf of the client, Prime West. The designers are listed as Alun Wilkie and Alan Reay.

The canopy was constructed of concrete columns and pads, with a steel frame and a glass roof. The design of the canopy was done by David Harding, and it appears to have been omitted from the original design as an oversight. The addition of the canopy did not affect the overall seismic performance of the building as it was a non-structural element and an exterior fixture only.

4.3.2 ANZ Fit-Out 1991

Significant alterations were made to the CTV building prior to ANZ moving into the premises in November 1991. The interior fit-out of levels one to six were extensive, at a cost of $422,000.00 and configured to suit the needs of ANZ. The application was made by architects Warren and Mahoney on 9 September 1991.

As part of the ANZ work, a separate permit application was submitted on 20 September 1991 by Wilkie and Bruce Architects (Alun Wilkie's firm) to CCC for changes to the ground floor layout. The changes involved the installation of concrete block walls which converted part of the level one car parking area into ANZ ground floor office space.

The design of the concrete block wall was carried out by Geoff Banks of ARCL, and the drawings submitted to CCC as part of the permit application. Like the addition of the exterior canopy, the concrete block walls were a non-structural element with no effect on seismic response.

4.3.3 CHTV Fit-Out 2000

On 28 April 2000, an application for building consent was made to CCC by [redacted] for interior fit-out for Levels 1 and 2, new internal stair and new exterior canopy. The fit-out was for local television company CHTV, which later became NowTV before merging with Canterbury TV in 2003 and becoming CTV.

The building consent application included cutting a penetration in the floor of level 2 so that an internal stairwell could be installed. In addition, holes were to be drilled near the east end of the south shear wall. A building consent for the internal stairwell penetration was issued by the CCC on 10 May 2000.

The effect of the stair penetration on the overall strength of the building is discussed later in this report. In short, experts have concluded that the penetration would not have affected the seismic performance of the building.

4.3.4 Going Places 2001

On 16 May 2001, [redacted] submitted an application to CCC for building consent, described as a new fit-out for Level 3. The application stated that this was a 'change of use' for Going Places, a language school.

Change of use applications required CCC to check that provisions of the code for fire, protection of other property, sanitary facilities, structural and fire-rating behaviour, and access and facilities for the disabled were complied with.

A Senior Structural Engineer from CCC carried out those checks and completed a 'Structural Checklist' on 22 May 2001. Building consent was granted 20 June 2001.

4.3.5 Significance of the Permit applications

As mentioned earlier, the full list of alterations, fit-outs and change of use applications over the lifespan of the building is contained in the attached link. The notable applications have been included as they either apply to significant structural changes to the building, for example the penetration for the internal stairs or the installation of the concrete block wall in the car park, or complying with council regulations, for example change of use.

These applications take on further significance later in this report as two critical non-permitted actions are closely examined - the installation of the drag bars in October 1991 and the Kings Education tenancy in 2008.

4.4 Earthquakes and Building Inspections September 2010 – February 2011

Prior to 2010 it was widely believed that Christchurch was situated in an 'intermediate seismicity zone' some distance from the Alpine fault line, on the western side of the South Island, through to Hawke's Bay and the East Cape Peninsula.

In May 2005, the Institute of Geological & Nuclear Sciences (GNS) prepared a report for the CCC titled 'Estimated damage and casualties from earthquakes affecting Christchurch' (SEI.GNS.0006)[8].

That report, authored by [redacted], stated that although Christchurch was some distance from the 'zone of high activity', known earthquake sources were present within the region and are large enough and close enough to cause significant damage throughout the city.

Early on the morning of Saturday, 4 September 2010, Canterbury was shaken by a large and unexpected earthquake. That 7.1M_w seismic event triggered a long sequence of 'aftershocks' that included Boxing Day 2010, 22 February 2011 and 13 June 2011.

The Royal Commission conducted investigations into the nature and characteristics of these earthquakes. Section 2 of Volume 1 covers the CERC findings on the nature and severity of the Canterbury earthquakes, CERC Volume 1, Section 2[9].

For the purpose of this report, the events of 4 September 2010, 26 December 2010 and 22 February 2011 are covered briefly as they relate to Civil Defence and Local Authority (CCC) emergency management processes implemented during a state of local emergency, including the inspection of damaged buildings.

4.4.1 Earthquake - 4 September 2010

At 4.36am on 4 September 2010, a previously unknown fault line, running east-west from Greendale to Rolleston, ruptured violently without warning after lying undisturbed under gravels for at least 16,000 years.

The epicentre of the magnitude 7.1M_w earthquake was 40 kilometres west of Christchurch city, southeast of Darfield. The earthquake is known as the Darfield earthquake or the September earthquake.

[8] FOLDER 2 – TAB 8
[9] FOLDER 2 – TAB 10

According to GNS, the Darfield quake produced the strongest earthquake ground-shaking ever recorded in New Zealand at that time, with peak ground movement near the epicentre at 1.25 acceleration due to gravity (g), or 1.25g.

Although there were no fatalities, significant structural damage occurred to buildings and homes across the city, with older buildings suffering the worst damage, particularly unreinforced masonry (URM) structures which pre-dated modern building codes.

4.4.2 CCC Rapid Assessment Process

On the morning of 4 September, a state of local emergency was declared under section 68 of the Civil Defence Emergency Management Act 2002.

Christchurch City Council (CCC) activated its response plan and established an Emergency Operations Centre (EOC). The EOC operated continuously from 5.30 am on 4 September until 12 pm on 17 September 2010.

CCC implemented the New Zealand Society Earthquake Engineering (NZSEE) Guideline for Building Safety Evaluation during a State of Emergency. The NZSEE Guidelines, developed in 2009, identify a process for the rapid assessment of properties and a classification system to triage the extent of damage suffered by buildings within the Central Business District (CBD).

The process and associated documentation (Level 1 and Level 2 Assessment Forms; Red, Yellow, Green placards) are further explained in the CCC *Report into Building Safety Evaluation Process In the Central Business District following the 4 September 2010 Earthquake* (ENG.CCC.0002F)[10].

4.4.3 CTV Building post 4 September 2010

The location of the CTV building on the corner of Madras Street and Cashel Street was within the designated CBD zone, and therefore the building was inspected under the CCC Rapid Assessment process.

Those inspections and subsequent inspections by an independent engineer engaged by the building owner received considerable focus during the Royal Commission hearings. A comprehensive summary of the evidence in regards to those building inspections and the relevant findings can be found in Section 3 of Volume 6. (CERC Volume 6, Section 3)

Police have interviewed all of the individuals who carried out inspections of the building after 4 September 2010. Their interview transcripts can be found in the Police file.

4.4.4 Rapid Assessments CTV Building

A Level 1 Rapid Assessment of the CTV building was conducted on the afternoon of 5 September 2010. The inspection team consisted four individuals, including a Chartered Professional Engineer (CPEng) and a CCC Building Consent Officer.

As a result of that exterior inspection, the building was allocated a green placard with the estimated overall building damage recorded as “None”, and no restriction placed on use or occupancy. However the wording on the green placard encouraged the

[10] FOLDER 2 - TAB 9

owner to "obtain a detailed structural engineering assessment of the building as soon as possible."

The second CCC assessment occurred on 7 September 2010 and was submitted as a Level 2 Rapid Assessment, although two factors precluded that assessment constituting an approved Level 2 check. Firstly, a Level 2 Rapid Assessment requires that the inspection be carried out by an engineer, and secondly that the engineer have access to the whole building during the inspection. None of the three CCC employees deployed from the EOC on 7 September to perform this Level 2 check on the building were qualified engineers. As evident from the CERC evidence, there was general confusion as to the scope and purpose of the second assessment.

Despite having no engineer present in their party and some floors being inaccessible, the building was checked internally by the CCC staff and a Level 2 form was submitted. The green placard was confirmed as a result of that assessment.

The Level 2 assessment was the subject of some criticism at CERC, particularly with regards to the absence of an engineer, lack of clear instructions from the EOC, lack of training and the allocation of a green placard (CERC Volume 6 Section 3.4.4).

Despite the shortcomings of this inspection, the Commission heard submissions from counsel that there was no evidence that the three CCC employees, who were doing their best under emergency conditions, had missed anything of significance in their assessment.

The Commission also considered that the subsequent inspection carried out by engineer David Coatsworth later that month, which was a more detailed assessment not only superseded the Level 2 Rapid Assessment but likewise *"found no particular cause for concern"* and the green placard remained.

4.4.5 Engineer's Assessment

After the 7 September inspection by CCC officials, the building manager John Drew approached engineer David Coatsworth to carry out an inspection of the building. At the time Coatsworth was a Chartered Professional Engineer (CPEng) and senior associate at CPG New Zealand Ltd (CPG) with over 40 years' experience in structural and civil engineering.

Coatsworth inspected the CTV Building on 29 September 2010 along with Mr Pagan, a quantity surveyor, and Drew.

A 'visual-based' inspection took place, taking four hours to complete. Coatsworth took 109 photographs, made notes and sketches and spoke with other occupants of the building who pointed out areas of damage. As was his normal practice, Coatsworth discussed his preliminary conclusions with colleagues at CPG and other specialists in relevant fields, namely Dene Cook of Firth Concrete and Professor Des Bull of the University of Canterbury who has considerable expertise in reinforced concrete.

Coatsworth returned to the building on 6 October to complete some elevation sketches of the north wall complex and to recheck the width of the cracking observed in those walls. Coatsworth did not have access to the original design drawings or calculations whilst completing his assessment. This, however, was not unusual as most assessments were based on the damage visible upon inspection.

His findings and conclusions were provided in an earthquake damage report[11] dated 6 October 2010 and emailed to Drew on 8 October 2010.

In Coatsworth's view, although the building showed noticeable damage to non-structural elements such as linings and finishing, as well as some minor structural damage, there was no evidence of structural failure.

The last involvement that Coatsworth had with the CTV building occurred on 19 October 2010 when he was asked to conduct another check following an aftershock of 5.0. Other than two cracks that might have been slightly larger, he saw no additional damage to the building and emailed Drew that day and advised him that the building remained structurally sound.

In considering Coatsworth's approach in using a damage-based assessment, CERC found that Coatsworth's method was consistent with all of the engineers who gave evidence to the Commission and was in keeping with international best practice, as stated in evidence by Brian Kehoe.

CERC did not consider that Mr Coatsworth could be criticised for his inspections of the building. The Commission concluded that:

> *"As we have said, the damage-based inspection carried out by Mr Coatsworth was consistent with the approach of most, if not all, engineers in the aftermath of the September earthquake. It was not common, or considered necessary, for engineers to analyse the structural drawings of a building when carrying out this type of assessment if the observed damage did not indicate a need to do so. We deal with the issue of structural drawings in the following section. However we are of the view that, in terms of the damage-based inspections that were being conducted after the September earthquake, the inspection carried out by Mr Coatsworth was thorough and competent. Indeed, of all the inspections we considered in evidence over the course of the Inquiry, Mr Coatsworth's was the most thorough." (CERC Vol 6, section 3.5.2 page 138 para 7)*

4.4.6 Earthquake – 26 December 2010

On Boxing Day 2010 a sequence of aftershocks struck the CBD. Although relatively small in magnitude ($4.6M_W$ - $4.7M_L$) the epicentre was within the CBD and shallow in depth, ranging between 3.7 – 7km.

A Civil Defence emergency was not declared. From 27 December, CCC sent teams out to commercial parts of the CBD to carry out Level 1 Rapid Assessments, in conjunction with USAR teams who conducted 'rapid visual surveys' of buildings.

On 27 December a CCC team carried out a Level 1 Rapid Assessment based on an external examination of the CTV structure. A more detailed account of that assessment can be found in CERC (CERC Vol 6, section 3.6.2) but the outcome was the allocation of a green "Inspected" placard, with no recommendation for further action.

The following day Drew tried to contact Coatsworth but discovered the CPG offices were closed for the holidays. He intended to ask Coatsworth to return and inspect the building and confirm that there was no additional damage. Drew did not follow up but

[11] FOLDER 2 – TAB 11

decided to focus on the 'next phase', which was to arrange for the concrete repairs recommended by Coatsworth in his report.

On the morning of 5 January 2011, [redacted], a manager at Relationship Services on level 6, contacted the CCC to request an inspection of the building. She was concerned about cracks in a column in the foyer on level 6.

On either 6 or 7 January 2011, [redacted] had a telephone discussion with Drew. Whilst the exact content of the call is disputed, it is apparent that engineering inspections were discussed and that [redacted] formed the belief that these inspections included the one carried out after Boxing Day.

The result was that [redacted] called CCC back on 7 January 2011 and withdrew her request for a CCC inspection, advising CCC that the building had already been checked by an engineer.

From this point onwards, Drew concentrated his efforts into facilitating the repairs identified by Coatsworth. He arranged for representatives from two concrete repair firms to visit the site and prepare quotes for repair. Neither representative identified any particular concerns about the damage they viewed during those visits.

The other significant decision Drew made was to relocate his medical practice 'The Clinic' from premises in Gloucester Street, which had been given a red placard after Boxing Day, to level 5 of the CTV Building.

The move by the medical clinic was completed by 10 January 2011.

4.5 The February Earthquake

The most destructive of the earthquakes to strike Christchurch occurred at 12:51pm on 22 February 2011 on what is now commonly referred to as the Port Hills Fault. Of magnitude 6.2Mw, the rupture occurred on a north-east/south-west oriented fault at a shallow depth, reaching to within one kilometre of the surface.

The resulting ground motions were extremely high. Vertical accelerations reached 2.2g, with horizontal accelerations of 1.7g in the Heathcote Valley near the epicentre and up to 0.8g in the CBD. Both horizontal and vertical accelerations are important for the performance of structures.

The existence of this fault was unknown before the February earthquake, but there had been some aftershock activity in this area prior to the 22 February event.

The nature and intensity of the February earthquake are described in greater detail in Volume 1, section 2 of the CERC Final Report (CERC Volume 1, Section 2.7.1.3).

The effect of the February earthquake on the CTV building was sudden and catastrophic. It collapsed rapidly and almost completely, effectively "pancaking". It was the only modern (post 1976) building to fail in this manner in Christchurch.

The police have engaged [redacted] from the Institute of Geological and Nuclear Sciences Limited (GNS Science) who will provide the overview of the Canterbury earthquake sequence.

4.5.1 Rescue and Recovery

At 12.51pm on 22 February, there were 151 people occupying the building. With the exception of level 3, which was vacant at the time, the occupants were spread throughout the remainder of the building, with the majority on level 4 according to the table below:

Level	Organisation	Occupants	Survivors	Deceased	Survival Rate
6	Relationship Services	19	18	1	94.7%
5	The Clinic	21	2	19	9.5%
4	Kings Education	94	15	79	16.0%
3	Vacant	0	0	0	-
2	CTV	16	0	16	0%
1	CTV	1	1	0	100%
	TOTALS	**151**	**36**	**115**	**23.8%**

A more detailed analysis of the building occupancy, including the names of the victims and survivors, floor plans and approximate locations of each individual at the moment of collapse can be found here CTV Level 1, CTV Level 2, Kings Education, The Clinic and Relationship Services.[12]

The rescue effort began immediately after the collapse. Civilian pedestrians and passing motorists climbed onto and into the rubble in an effort to locate and extract survivors.

A small group of Police Officers were on the scene within minutes, led by Sergeant Michael Brooklands. As reports about the scale of collapse were transmitted to the Police Communications Centre, more Police and emergency services began to arrive at the scene and coordinate rescue efforts.

The nature of the collapse meant that there were very few gaps or voids in the rubble into which rescuers could crawl to look for survivors. Heavy concrete floors, beams and columns lay on top of each other with very little space between them.

Within minutes fire broke out under the rubble in the vicinity of the lift shaft (NWC), which was the only part of the structure left standing. The fire took hold and spread throughout the site, the heat and smoke making rescue attempts difficult and dangerous.

Communication problems and extreme demand on NZ Fire Service resources meant that the first fire appliance did not arrive at the scene until 40 minutes after the fire started. That appliance, with a crew of four, was the only fire truck in attendance for some time. There were issues with water pressure and a helicopter with monsoon

[12] FOLDER 2 – TAB 12

bucket was also employed at the site but the fire continued to burn for most of the afternoon and evening. The fire was a contributing cause of death at the site. But for the fire, it is highly probable that the survivor numbers would have increased.

The remainder of the afternoon saw a concerted rescue effort by civilians, construction workers and emergency staff working together to search for and remove victims from the rubble. In all, 34 people were able to escape or were rescued from the site.

Demolition contractors used heavy excavators and concrete cutting tools to try and remove, shift or create gaps in the floor slabs in order to create access under the rubble.

As the gravity of the situation at the CTV site became clear, Urban Search and Rescue (USAR) teams assembled that evening at nearby Latimer Square and took over the coordination of the rescue effort. Emergency services adopted the Coordinated Incident Management System (CIMS) model.

All civilian volunteers and emergency staff without protective equipment were removed from the site on the evening of 22 February 2011.

Within a few days of the earthquake, the three New Zealand taskforces were supplemented by teams from Australia, the United States, United Kingdom, China, Japan, Taiwan and Singapore.

The last survivor was pulled from the building in the early hours of 23 February. Following protocol USAR teams were initially stood down from the CTV site at about 2pm that afternoon. [redacted]

With regards to any future criminal trial, it is anticipated at this stage that evidence on the Rescue and Recovery phase could effectively be provided by 8 – 10 key witnesses, providing the backdrop to the scale of the collapse and the enormity of the challenge facing the rescuers.

4.7 Coronial Inquests – 115 Deaths

Staff from the Ministry of Justice Coronial Services arrived in Canterbury within hours of the disaster to coordinate with the relevant agencies based at Burnham Military Camp and establish a DVI (Disaster Victim Identification) process for dealing with the 185 earthquake deceased.

In due course, Coronial Inquest hearings were heard for all those who died in the 22 February 2011 earthquake. It was the CIB that designed and implemented a unique system for the sudden death inquiries, coronial file format and subsequent hearings. This process was signed off by the Chief Coroner, Judge Neil McLean.

Future discussions would be required with any potential defence lawyer about acceptance of death and identity for each deceased at the CTV site. The investigation team hold the DVI files for all 115 victims along with the Coronial evidence. Forensic Pathologist [redacted], is currently being consulted as to the best mode of providing this evidence.

[13] [redacted]

4.7.1 Coronial Hearings

The first of these hearings commenced on 16 May 2011 at the Riccarton Racecourse and was heard before the Chief Coroner. Mr Chris Lange of the Crown Solicitor's Office represented Police.

That initial hearing concerned nine victims believed to be deceased as a result of the CTV collapse but whose remains had not yet been found. The Chief Coroner's aim was to hear the best circumstantial evidence available to the point that the deaths could be registered and Death Certificates obtained.

Continuing forensic work throughout 2011 resulted in positive identification of eight of the nine victims, with only Ms Rhea Sumalpong of the Philippines unaccounted for.

At the conclusion of that initial hearing on 18 May 2011, Judge McLean announced that Waikato Coroner Gordon Matenga would hear the next phase of the inquests which would focus on the remaining 106 victims of the CTV building.

That hearing was set down for 13 - 15 June 2011 at the Riccarton Racecourse. [redacted] (then Crime Manager, Canterbury Criminal Investigation Branch) gave evidence in respect of each of the victims and their circumstances.

Formal identification evidence as to the identity of each victim was presented, along with evidence and statements about the last known movements and whereabouts of the victim at the time the earthquake struck.

The June hearing was adjourned suddenly due to a magnitude 6.3M_L earthquake that occurred at 2.20pm on the opening afternoon. The inquest resumed on 29 August 2011 and the cases of the remaining CTV victims were heard.

During this inquest, questions were raised about a number of CTV victims who appeared to survive the initial collapse of the building and make cell phone contact with next of kin and emergency services, only to be subsequently located deceased.

Coroner Matenga ruled that the cases relating to the eight CTV victims be adjourned part-heard in order for the issues raised during the hearings to be further investigated.

4.7.2 CTV Emergency Response Coronial Hearings

Following a conference held on 30 April 2012 at Wigram Manor, Coroner Matenga directed that the inquiry would focus on the circumstances of the deaths of Dr Tamara Cvetanova and 7 others who died in the CTV Building.

The eight victims were all students at Kings Education on level 4:

- Dr Tamara Cvetanova
- Chang Lai
- Mary Louise Anne Bantillo Amantillo
- Emmabelle Anoba
- Rhea Mae Sumalpong
- Rika Hyuga
- Ezra Mae Sabayton Medalle

- Jessie Lloyd Albarracin Redoble

Pursuant to section 57 of the Corners Act 2006, the inquiry examined the emergency response, the role (if any) the response may have played in the deaths of Dr Cvetanova and others, and what knowledge could be gained to avoid the occurrence of deaths in similar circumstances in the future.

Matters being considered by the Royal Commission were specifically excluded from the inquiry.

The Coroner issued a direction to further limit the inquiry to the events at the CTV Building, although he did receive general evidence of the emergency response at the PGC Building and across the city to provide context.

This approach was agreed by Counsel involved in the inquiry. Coroner Matenga acknowledged that that this was in no way intended to diminish the enormity of the event. The February 2011 earthquake was of such magnitude that it spawned numerous incidents across the city and further afield to Sumner, Redcliffs and Lyttelton, each demanding its own emergency response.

However, in Coroner Matenga's view, the CTV site was the most prominent given the catastrophic building collapse, fire, entrapment and loss of life. No other site experienced this lethal combination.

The inquiry was not conducted to determine civil, criminal or disciplinary liability, as that falls outside the Coroner's jurisdiction to do so. The purpose of the inquiry, (given that the identities of deceased persons had previously been established), was to determine when and where each person died, the cause or causes of death and the circumstances of death.

A three week hearing commenced 29 October 2012 in Christchurch before Coroner Matenga.

Transcripts of this hearing are filed within the 10000 series; folder 29 October 2012, 30 October 2012 (1), 30 October 2012 (2), 31 October 2012, 1 November 2012, 2 November 2012, 5 November 2012, 6 November 2012, 7 November 2012, 8 November 2012, 9 November 2012, 3 December 2012, 4 December 2012, 5 December 2012, 6 December 2012 . At the conclusion of the hearing the Coroner reserved his findings which were not made public until 31 March 2014.

4.7.3 Coroner's Findings

The Coroner made a number of recommendations pursuant to section 57(3) of the Coroners Act 2006 in terms of how the emergency services worked together under the CIMS model and the need to clearly establish incident control, with the need for further training between Police, Fire Service, USAR and Defence Forces.

However, of particular relevance to this investigation, Coroner Matenga found that the search and rescue efforts at the CTV Building did not contribute to the deaths of the eight named victims. At paragraph 129, Coroner Matenga stated:

> *"My view is that the Police, USAR, firemen and members of the public were doing all they could in a difficult situation to effect rescues and save lives. The rescue efforts of those who worked at the CTV Building were outstanding, courageous and selfless and a number of people were saved because of it. The rescuers could not*

save everyone but they expended every effort and resource that was available to them in attempting to do so. More people, more resources, better communication and a better structure would, I am satisfied on the evidence, have improved the situation overall and may have improved the chances of saving more lives. However, I am not satisfied to the standard required that such improvements would have resulted in actually locating and saving the lives of Dr Cvetanova, Ezra Medalle, Jessie Redoble, Mary Amantillo, Emmabelle Anoba, Rika Hyuga, Chang Lai or Rhea Sumalpong, or created a reasonable prospect of locating and saving their lives.

Accordingly, I find that the search and rescue efforts did not contribute to the cause of deaths of Dr Cvetanova, Ezra Medalle, Jessie Redoble, Mary Amantillo, Emmabelle Anoba, Rika Hyuga, Chang Lai and Rhea Sumalpong."

A complete copy of the Coroner's findings in relation to the CTV emergency response[14].

4.8 Witnesses and Survivors – CTV collapse

Police inquiries identified a total of 36 people who survived the collapse of the CTV Building. The locations of the survivors at the time of the earthquake are listed in the table in **4.5.1**. For the purpose of this investigation, 'survivors' were physically inside the building at 12.51pm at the commencement of the shaking.

Many of the survivors were injured, some quite seriously, and were hospitalised or airlifted out of Christchurch before Police could formally interview them. Of the 36 survivors, 23 were interviewed at the time, either by way of DVD interview (16) or by formal statement (7).

Others who had been in the building earlier that day, but at the time of the earthquake were not physically in the building, are classified as witnesses, rather than survivors. Police identified a number of people who fit into that category. Interviews were conducted with these witnesses to document their observations of the collapse, if applicable, or else on the last known whereabouts of deceased persons within the building before 12.51pm.

Finally, in regards to witnesses, a number of people were in the immediate vicinity of the CTV building and witnessed the catastrophic manner of collapse from their vantage point. Others were not present during the earthquake but had some subsequent involvement with the site as part of the Rescue and Recovery effort.

Where possible, formal statements from 2011 have been reformatted into the latest Criminal Procedures Act version of statement and signed by the witness. Interview transcripts from 2011 are now accompanied by a signed declaration by the witness that they have read their interview transcript and that it is an accurate record.

4.9 Department of Building and Housing (DBH) Report

The New Zealand Government, through the Department of Building and Housing (DBH), responded to public concern about damage to major buildings and identified for investigation four large multi-storey buildings in the Christchurch CBD which experienced varying degrees of failure during the 22 February 2011 aftershock. The buildings included in the investigation are the:

[14] FOLDER 2 – TAB 13

- Canterbury Television Building (CTV)
- Pyne Gould Corporation Building (PGC)
- Hotel Grand Chancellor Building
- Forsyth Barr Building

The CTV building suffered catastrophic collapse, the PGC suffered partial collapse and the other two experienced significant failure of building components, including stairs, columns and walls.

4.9.1 The Hyland Smith Report

The technical investigation into the reasons for the collapse of the CTV building was undertaken by Dr Clark Hyland (Hyland Consultants Ltd) and Mr Ashley Smith (StructureSmith Ltd). The CTV Report, known as the 'Hyland Smith' report, was prepared under the oversight of the Expert Panel appointed by the DBH. The Hyland Smith report was reviewed and approved by the Expert Panel.

4.9.2 The DBH Report

The Expert Panel Report is known as the DBH Report.

The report was released to the public on 9 February 2012. It essentially found there were three aspects of design and construction of the CTV building that did not meet the standards of the day. The report itself was the subject of criticism by a number within the structural engineering profession though.

In several key areas, the Expert Panel was unable to reach agreement with conflicting opinions expressed by some members. Some of the findings, such as the testing of the concrete samples, were the subject of strenuous debate and the conclusion in the Hyland Smith report that the concrete was of low strength was discredited by experts in that field. The collapse sequence was also the subject of some debate with a number of differing views offered.

Many were of the view that the Hyland Smith report had overstepped its mandate and that conclusions made by the report writers were not within their terms of reference. Ultimately the Hyland Smith report was side-lined by the subsequent Royal Commission of Inquiry.

The Canterbury Earthquakes Royal Commission of Inquiry (CERC) took into account, but was not limited by, the findings of the DBH report.

[redacted]

4.10 Canterbury Earthquakes Royal Commission of Inquiry

On 14 March 2011, Cabinet agreed that a Royal Commission be established to inquire into and report on the causes of building failure that occurred as a result of the Canterbury Earthquakes since 2010.

The terms of reference and appointments for the Royal Commission were approved by Cabinet in April 2011. Hon Justice Mark Cooper was appointed as Chair, and Sir Ron Carter and Professor Richard Fenwick were appointed as Commissioners.

Assessment of these hearings has been undertaken by the CTV investigation Legal Advisor [redacted], who has completed a considerable volume of work. Much of this hearing has had to be converted to current Formal Statements for potential prosecution witnesses. Evidence obtained during subsequent Police interviews has also been incorporated into the Formal Statements obtained, together with any evidence that arose during the course of evidence in chief and cross-examination.

4.10.1 Terms of Reference

The Terms of Reference were to investigate:

- *The building failures in Christchurch within the bounds of the four avenues and specifically the Canterbury Television (CTV) Building, the Pyne Gould Corporation (PGC) Building, Forsyth Barr and the Hotel Grand Chancellor.*
- *The adequacy of current legal and best practice requirements for the design, construction and maintenance of buildings in central business districts in New Zealand.*
- *To make recommendations on measures desirable to prevent or minimise failure of buildings in earthquakes, the cost of those measures and the adequacy of the design, construction and maintenance insofar as those requirements apply to managing risks of building failures in earthquakes.*

Excluded from the Terms of Reference were:

- *Whether any questions of liability arise.*
- *Matters which relate to the design, planning and options for the rebuild.*
- *The role and response of any persons acting under the Civil Defence Emergency Management Act 2002 or providing any services or response after the 22 February aftershock.*

As mentioned in section 4.9.2 of this report, the Commission also took into account, but was not limited by, a technical investigation undertaken by the Department of Building and Housing (DBH).

4.10.2 CERC Hearings

The CERC hearings were held at St Teresa's church hall in Riccarton. The public hearings, which were live streamed as they happened, began with an opening ceremony held on 17 October 2011 and concluded on 12 September 2012.

As well as the CTV Building, the Commission examined a wide range of building related issues including:

- seismicity
- soils and ground conditions
- unreinforced masonry buildings (URM)
- CTV / PGC / Hotel Grand Chancellor / Forsyth Barr
- other buildings whose failure resulted in loss of life (Other Sites)

- new building technologies
- building management after earthquakes
- the engineering profession
- roles and responsibilities

Written transcripts of the evidence given and submissions made each day, witness statements, documentary exhibits, the Final Reports and more are available to the public online at www.canterbury.royalcommission.govt.nz.

4.10.3 CERC Final Report

CERC presented its findings to the Government in a three part series of final reports consisting of seven volumes in total. A brief outline of those reports and the respective links to the CERC volumes is below, but for the purpose of this investigation the CERC final report on the CTV Building is Part 3, Volume 6. The hard copy version is on the file.

Part One (Volumes 1, 2 and 3)

This report contains recommendations to inform early decision-making about the central city's recovery from the Canterbury earthquakes. It was delivered to the Governor-General on 29 June 2012 and released by the Government on 23 August 2012.

Part Two (Volume 4)

Part two of the final report consists of one volume (Volume 4) and contains recommendations about earthquake-prone buildings. It was delivered to the Governor-General on 10 October 2012 and released by the Government on 7 December 2012.

Part Three (Volumes 5, 6 and 7)

Part three of the final report is presented in three volumes. It includes the results of the investigation into the collapse of the CTV building (Volume 6) and other aspects of the Terms of Reference not addressed in other parts of the final report. Part Three (Volumes 5, 6 and 7) of the final report was delivered on 29 November 2012 and released by the Government on 10 December 2012.

4.10.4 CERC Findings

The CTV Building Final Report (Volume 6) released in December 2012 outlined a number of shortcomings in the design, permitting and construction phases of the CTV building, and CERC drew conclusions and made recommendations based on the evidence heard before the Commission.

An in-depth summary of those conclusions and recommendations can be read in Volume 6, Section 9, but of significance to this inquiry were the conclusions drawn by CERC in relation to Harding and Reay.

4.10.5 David Harding

The Royal Commission was critical of the role that design engineer Harding played in the design process. In summary, CERC found that he:

- Had no experience in designing multi-storey buildings;
- Worked unsupervised (and did not ask for supervision);
- Failed to carry out certain important calculations relating to floor deflections and tracking load paths;
- Failed to ensure the floors were adequately tied to the north shear wall.

The Commission's report stated (vol. 6, page 71):

> *"Prior to this time, Mr Harding had not designed a multi-storey building with a significantly eccentric configuration. However we have found that he did not seek assistance with the design from Dr Reay or anyone outside of ARCE. While Mr Harding's position at the hearing in 2012 was that he was not competent to design the CTV building without review of his work, we are satisfied that this was not the view he held in 1986, when he was confident that he could carry out the design…*
>
> *"We have found that there were a number of non-compliant aspects of the CTV building design. We have concluded that a primary reason for this was that Mr Harding was working beyond his competence in designing this building. He should have recognised this himself, given that the requirements of the design took him well beyond his previous experience."*

4.10.6 Dr Alan Reay

In relation to Reay, the Commission was critical of his involvement in the design process. As the principal of ARCE, he recruited Harding to replace previous engineer, John Henry. Henry was a competent engineer who was experienced in multi-storey buildings.

CERC found that, although Reay must have known that Harding did not have sufficient experience in the design of a multi-storied building such as this one, he essentially left Harding to work unsupervised on the CTV project**.** This was the subject of strong criticism in the Commission's report (vol. 6, page 71):

> *"We also consider that Dr Reay was aware of Mr Harding's lack of relevant experience and therefore should have realised that this design was pushing him beyond the limits of his competence. Dr Reay should not have left Mr Harding to work unsupervised on the design or without a system in place for reviewing the design, either by himself or someone else qualified to do so."*

5 LEGAL REVIEW

5.1 Legal Review by Police

In early 2013, following the release of the CERC findings, NZ Police commenced a legal review of the CTV case to determine whether or not any individual, including those criticised by the Royal Commission, could be criminally liable for the 115 deaths.

The initial stages of the inquiry were carried out by Detective Inspector David Long (now deceased) with the assistance of [redacted], a lawyer contracted to Police.

Also assisting with the technical aspects of the investigation at that time was [redacted], Senior Technical Advisor at the DBH.

[redacted] is a Chartered Professional Engineer (CPEng) with over 30 years' experience in structural and earthquake engineering. He was the Investigations Project Manager for the DBH investigations into the collapse of several high profile buildings in Christchurch following the February earthquake, including the CTV building. A list of [redacted] experience and qualifications can be viewed here ([redacted][15].

As part of the legal review Police identified the potential charges that could be filed under the Crimes Act 1961. Given that one of the potential charges is manslaughter, it was determined that proof of this charge would, to a large degree, depend on expert engineering opinion.

5.2 Beca engaged as Engineering Experts

In early 2014, the Police commissioned leading NZ engineering firm, Beca to provide an independent expert engineering opinion to assist their investigation into the potential criminal culpability of individuals following the collapse of the CTV building.

Beca, first established in New Zealand in 1918, has grown in size and undergone several name changes over the years, including Beca Carter Hollings & Ferner. Today, it has a substantial Asia Pacific footprint approaching 3,000 employees in nineteen offices across the world (source: http://www.beca.com/about_beca.aspx).

The engagement of Beca was formally requested by Detective Superintendent Peter Read by way of letter addressed to Beca's [redacted], dated 14 February 2014.

[redacted] has considerable engineering experience and his expertise is widely acknowledged within the engineering industry internationally. His curriculum vitae (CV) can be seen here [redacted][16]

The Police provided the terms of reference for the investigation and a list of individuals whose actions they required Beca to review in relation to the design, issuance of the building permit, construction and subsequent strengthening of the CTV building.

A full copy of the letter, which includes the terms of reference and list of individuals, can be found in the attached Engineering Expert Opinion Briefing Document[17].

5.2.1 Terms of Reference - Beca

The initial section of the letter covers the relevant provisions of the Crimes Act 1961 as it applies to individuals (as opposed to a corporate body) and sets out the standard of proof required for a criminal prosecution. The document explains some key terms, including 'legal duty', 'acts and omissions' and 'major departure.'

Any prosecution of an individual(s) for manslaughter would be based on a breach of a duty imposed by the Crimes Act, and sets out section 156 along with the four elements of that charge that would have to be proved by the prosecution. A more detailed discussion of the relevant legislation can be found later in this report in section 7 - Legislation.

15 [redacted]
16
17

In considering whether this charge could be proved against any individual, the letter explains the elements which would require an expert engineering opinion in order to assess whether it can be proved beyond reasonable doubt that:

- *any individual omitted to discharge this duty*
- *any such omission caused the deaths*
- *any such established omission was a major departure from the expected standard*

The legal terms of major departure and causation are discussed further before the briefing document outlines that Police required Beca to provide expert engineering opinion, essentially to address these three issues:

- *Was there an omission by any individual to discharge the duty?*
- *Was the omission a substantial and operating cause of the deaths?*
- *If so, was that omission a major departure from the expected standard?*

Beca were directed by the Police to take into account the findings of the DBH report and the CERC Final Report conclusions. These reports considered a number of matters which Beca were directed to also take into account in forming an opinion on these three issues. They include:

- *Practices in 1986 (including building codes of the day and their interpretation and technology available)*
- *The Christchurch City Council's permit approval process in 1986 (including the fact that Council engineers checked and approved permits)*
- *Can one be sure that the building would have collapsed in the way it did if the construction defects (e.g. failure to roughen, presence of bent–back bars, concrete strength) were not present?*
- *What effect does the fitting of the drag bars in 1991 have on the issue of whether the collapse was caused by design faults and/or construction faults?*
- *The February 2011 earthquake is acknowledged to have been approximately two times the design level earthquake contemplated by the 1986 building codes. The September 2010 earthquake is acknowledged to have been at that design level earthquake. What affect does that have on the standard a reasonable design engineer could have been expected to meet in 1986?*

5.2.2 Focus of Police Considerations

The Police identified that the focus of whether there was any criminal culpability would be narrowed to the acts and/or omissions of persons associated with the design and the construction of the CTV building.

5.2.3 List of Persons whose acts or omissions are in question

The following is a list of persons provided to Beca whose acts or omissions are in question regarding design and/or construction faults:

- Dr Alan Reay — Principal, ARCE
- David Harding — Structural Designer, ARCE
- Graeme Tapper — CCC Reviewing Engineer
- Bryan Bluck — CCC Chief Building Engineer

- Geoff Banks — Director, ARCL (1990-1991)
- Bill Jones — Foreman, Williams Construction
- Gerald Shirtcliff — Construction Manager, Williams

The letter provided Beca with further detail as to the role that each individual played in the design, permitting or construction of the building, along with the reasons why Police required Beca to carry out further technical inquiries in regards to their acts or omissions.

The document concluded by acknowledging that there may be other issues that have been identified that Beca recognised as requiring consideration, and that the list above was by no means exhaustive

Beca, under the expertise of [redacted], accepted the role of providing expert engineering opinion to Police and commenced their technical investigation in March 2014.

During the course of their review, Beca made use of the reports prepared as part of the Department of Building and Housing's investigation into the collapse of the building and also the submissions to and deliberations of CERC.

Beca kept the Police informed as their investigation progressed, including several 'challenge sessions' which involved Beca, Police and the Crown.

On 14 May 2014, Beca provided Police with a draft "CTV Building Opinion Report – Progress Report to Date"[18]

That report indicated that Beca, at that time, were well advanced in their investigation and had prepared a "provisional draft summary" of their findings which indicated to Police that both Harding and Reay had made omissions which were significant enough to warrant further investigation. Beca also recommended that further computer modelling, known as Non Linear Time History Analysis (NLTHA), of the CTV building's seismic response to the September, December and February earthquakes be carried out.

Based on the information contained within the progress report, Detective Superintendent Read approved further NLTHA testing by [redacted] as recommended by Beca.

5.3 Beca Engineering Opinion Report[19]

On 29 August 2014, Beca released to Police a draft version of their investigation, entitled CTV Building Collapse – Engineering Opinion Report. It was incomplete at that stage due to further testing required, but it formed a preliminary view from an expert perspective.

The Beca draft report, 157 pages in length, included an outline of their approach, a description of the roles of the identified individuals, a structural description of the building, observations from the earthquakes, a summary of Beca's opinion on the likely causes of catastrophic collapse of the building, whether or not the pancaking collapse was caused by omissions of the identified individuals to discharge their duties, and whether or not the omissions were a major departure from accepted practice of the day.

[18] [redacted]
[19] FOLDER 1 – TAB 1

Naturally the draft report is superseded by the release of the final CTV Building Collapse – Engineering Opinion Report on 15 July 2016. That report incorporates all of the above as well as covering the Physical Testing phase, which was carried out at the University of Auckland (UoA) in 2016.

The Physical Testing phase consisted of constructing three full-size test specimens to replicate the arrangement of an internal beam-column joint and ground floor column in three configurations; as-designed, as constructed and code compliant. The specimens were tested on a shake table at the UoA structural testing laboratory. Further information on the testing and a summary of the result and conclusions are provided in Appendix K.

It worth noting that the preliminary findings contained in the 2014 draft have not only remained consistent throughout the release of interim versions, but in some cases the results of further investigation and analysis has strengthened their conclusions, as reflected in the final conclusions by Beca.

5.4 Beca Foundation and Soils Investigation Report[20]

Included in the final Engineering Opinion Report were Beca's conclusions regarding the CTV foundations and the surrounding soils at 249 Madras Street. Based on all of the technical data and images available, Beca were satisfied that there was no evidence to suggest that the foundations sustained damage or that there was any significant ground deformation that would have affected foundation performance during the earthquake.

Having reached this conclusion, Beca felt justified on relying on the foundation and soil assumptions as a basis for all subsequent investigation into the cause of the collapse, including the computer modelling analysis and NLTHA data.

Following discussions with Police and the Crown, Beca carried out a physical examination and inspection of the foundations and the ground conditions at the site in August 2016 in order to:

- *determine whether the founding soil profile is generally in accordance with the original design assumptions and the assumptions on which our investigations (including our structural analyses) were based*
- *assess whether there was any material disturbance to the foundation soils caused by the earthquake, either directly, or by loading from the foundation system during the earthquake*
- *record the physical dimensions of the foundation structures and compare them with the construction drawings that were used as a basis of our analyses, record any observable damage or cracking in the foundation structural elements, and finally*
- *conclude if any of the observations made of the foundation and foundation soils would indicate a different response of the building during the 22 February 2011 earthquake from that in our 15 July 2016 opinion report.*

The excavation of the foundations and the soil testing by experts found no damage to the foundations and no sign of either soil deformation or liquefaction.

> *"We have therefore concluded that the results from this investigation do not provide justification for modifying the modelling input parameters adopted in our previous computer analyses. Therefore, the expected response of the building*

[20] FOLDER 2 – TAB 20

during the 22 February 2011 earthquake predicted in our 15 July 2016 opinion report is unchanged by the findings of this investigation."

The Beca Foundation and Soils Investigation Report, is also discussed later in this report, see section 6.6 Geotechnical.

5.5 Expert Peer Reviews

Following the release of Beca's Engineering Opinion Report on 15 July 2016 New Zealand Police, on the advice of the Crown, sought to have the Beca report peer reviewed by suitably qualified and recognised experts in multi-storey structural design.

Two such experts were identified and engaged by Police to carry out these reviews; [redacted] and [redacted].

The terms of engagement and the scope of work for both experts were set out in an engagement letter from Detective Superintendent Peter Read. The engagement letters can be found in the corresponding Appendices under the respective Peer Reviews.

5.5.1 [redacted].

According to his bio, [redacted] is a structural engineer with over 40 years of extensive experience in the design of buildings in seismically active regions. He has been actively involved in the development of provisions for the seismic design of buildings in the United States over the course of his career.

In summary [redacted] appears to strongly agree with Beca's findings, and he added some useful commentary under each of Beca's findings which corroborate those conclusions and support his views. There was one point on which [redacted] opinion differs from that of Beca, namely the collapse initiation and whether or not collapse would have occurred in the absence of the other identified design errors:

> *"We agree with Beca's finding regarding the location of collapse initiation, based on the results of analysis, testing and collapse propagation analysis that are fully consistent with this assessment. We also agree that design errors substantially contributed to the collapse. We agree that it is highly probable that failure would not have occurred absent the design errors, based on Beca's analyses and test results that indicate such and the substantial affect that the errors are estimated to have had on building response.*
>
> *However, because the experience and response of individual buildings to individual earthquakes cannot be precisely established by analysis and testing, we cannot concur that the collapse would not have occurred in the absence the identified errors. We base this conclusion on the relatively large dispersion that we see in assessing earthquake response and the lack of resilience in the building columns to accommodate excess demand. The lack of resilience afforded by poorly reinforced columns in combination with other aspects of the gravity force resisting system selection and detailing is in our opinion likely to be a substantial operating cause of why the CTV Building collapsed so completely when strongly shaken."*

[21] FOLDER 2 – TAB 21

In other words, it reads from his report that [redacted] does not completely agree with Beca's conclusion that without the other design errors (i.e. the poor connections to the NWC) that code compliant reinforcing through the beam-column joint would have prevented column failure, and therefore the building would have survived the earthquake, but he does agree it is highly probable.

Overall it can be said that [redacted] views align with Beca's findings, and in his Peer Review Report dated 25 October 2016, [redacted] concludes:

> *"Based on our review of Beca's report, including review of Appendices documenting analysis and testing efforts in more detail, it is our professional opinion that Beca has performed a comprehensive assessment of the cause of the CTV Building collapse and identified errors in the design and detailing of the structure that substantially contributed to the collapse.*
>
> *Based on our own professional experience, which is grounded in US practice, we concur with Beca's findings regarding duty and cause, except that we have reservations with regard to the duty as related to Mr. Harding."*

Notwithstanding the direction by Police in the engagement letter that the question of whether or not the defendant was under a duty was a legal question and did not require expert evidence, the reference to US practice illustrates the value of having the Engineering Opinion Report peer also reviewed by a New Zealand based expert, [redacted]

5.5.2 [redacted]

[redacted] graduated with B.E (Hons) in 1965 and PHD in engineering 1969. He formed [redacted] in 1974, and is currently the Director of [redacted] a civil and structural consultancy practice based in Auckland.

[redacted] has over 40 years of experience in the design of structures, primarily in Auckland. He specialised in tall multi-storey buildings such as ASB Building (34 storey) the Auckland Club (18 storey) and the Aotea Centre. In the 1980s his practice consisted of 2-3 engineers and 4-5 draughtsmen, a similar size to ARCE.

[redacted] is eminently qualified, being a Member of New Zealand Institute of Engineers, a Chartered Professional Engineer (CPEng) and a Member of International Professional Engineers. He gave expert evidence to the Canterbury Earthquakes Royal Commission into the collapse of the CTV building, and has previously given evidence as an expert in numerous structural engineering investigations.

In his conclusion, [redacted] stated[22]:

> *"I agree with the Beca report findings in relation to the responsibility of Mr Harding and Dr Reay plus the other people mentioned who were involved.*
>
> *I agree that the mistakes identified by Beca, including the failure to follow the code and standards of the time and the shortcomings in the design lead to the catastrophic collapse of the building with the loss of life.*

[22] FOLDER 2 – TAB 22

I consider that the report explored the various design shortcomings and mistakes thoroughly.

The item No 1 in Beca's Summary and Conclusions concentrated on the beam-column joint failure on line 2, level 2 as initiating the failure of the building. Much of the NLTH analysis and the full scale testing was undertaken to confirm this conclusion. I consider that this initial failure of the columns on line 2 was probable but that other areas of the structure would have likely failed as well."

6 CTV CRIMINAL INVESTIGATION

The criminal investigation commenced in August 2014 by way of a formal team briefing, followed by a period of reviewing all of the material collated up until that point, including the CERC findings, DBH report, Beca draft report as well as material gathered by Police Legal Section and Detective Inspector Long.

The team then identified the investigative phases which required further work, and prioritised these inquiries. Due to the size and complexity of the investigation, a visual "Investigation Map" was created which set out the different phases and lines of inquiry.

Depending on the priority of those inquiries, phases have been either well advanced, part completed or considered and held, pending the decision in regards to prosecution. The phases and lines of inquiry are discussed in this section, along with a summary of the outcomes or an outline of the proposed inquiries to be carried out if required.

6.1 Alan M Reay Consulting Engineer (ARCE)

The engineering design of the CTV building was undertaken by a Christchurch firm, Alan M Reay Consulting Engineer (ARCE) in 1986.

A major phase of the CTV investigation focused on this firm; its origins, how it evolved over the years, the personnel hierarchy and structure of the firm, particularly in the mid-1980s.

One of the key objectives of this phase was to establish the office management culture within ARCE during David Harding's second period of employment, between 1985 and 1988. In order to examine the CERC findings in relation to the relationship between Reay and Harding and draw any factual conclusions, it was important to identify as many people as possible who worked for Reay; either before, during or after 1986.

As the list of people grew in number, a decision was made on whether or not to make an approach to an individual. The main factors were the time frame of employment, the specific role of the person within the firm, and whether, if the person was still employed by Reay, this would pose a risk to the investigation if the line of questioning was to be relayed to Reay.

In total, 52 people were identified as having worked for ARCE since the firm began practicing in the early 1970s. The relevant periods identified by Police are in the 1980s (ARCE), in the early 1990s (ARCL) and the period around the CERC hearings when Reay gave evidence and it emerged documentary evidence may have been destroyed since the February 2011 earthquake. Twenty one individuals have been interviewed, with a further twenty one who may be interviewed following an assessment on relevance. Including Reay and Harding, there are eight people who either still work for Reay or are members of his family, and two of the list are now deceased.

The full list of ARCE personnel along with their period of employment and respective roles[23]. The key individuals are discussed below in groups.

6.1.1 Engineers

The first group covered in this section are the engineers employed by ARCE who played important roles prior to, during or after the design of the CTV building was carried out.

Dr Alan Reay

Dr Alan Reay studied at the University of Canterbury where he obtained a Bachelor of Engineering degree with First Class Honours in 1965 and a PhD in Civil Engineering in 1970. His PhD thesis was concerned with the dynamic characteristics of civil engineering structures.

After completing his education, Reay worked for two years as a structural engineer with [redacted] in Christchurch. Reay then started his own firm, Alan M Reay Consulting Engineer in 1971.

During the 1970s Reay built up his practice, working out of a converted house on the corner of Salisbury Street and Gracefield Avenue. During the early period of ARCE, Reay was the only structural engineer within the firm. He employed several other staff as draughtsmen, tracers and office support in those early years. An architect worked independently out of a room at the back of the premises, but he carried out much of Reay's architectural work.

At the end of 1985 the firm relocated to new premises situated on Kilmore Street. The move was due in-part to extra staff being employed in the mid-1980s as the firm continued to grow, taking on more projects.

In 1988, Alan Reay Consultants Limited (ARCL) was incorporated. The company continued to grow in size throughout the 1990s until new premises were required by the end of the millennium. ARCL designed a new, purpose built office block situated at [redacted] which was constructed in 1999.

Following the February 2011 earthquake, the company experienced negative publicity in the form of media reporting on the CTV building linking Reay personally and Alan Reay Consultants Limited with the cause of the collapse through poor structural design and management processes.

On 20 January 2012 a new company, Alan Reay Consulting Group (ARCG), was formed. In December 2012 the CERC findings were made public. As already mentioned in this application, these findings were critical of the ARCE design, and critical of the roles played by Harding and Reay.

On 4 September 2013 Alan Reay Consulting Group (ARCG) announced it was re-branding itself as [redacted] Reay ceased to be a director on 5 September 2013, but he remains actively involved in the company to this day.

Reay's expertise - tilt slab design

The majority of Reay's work in the 1970s and early 1980s related to, and focused on, single level precast concrete factories and cold-formed

[23] FOLDER 2 – TAB 14

steel design. He developed systems for the design of precast concrete, on site cast structures and the use of cold-formed steel in the light industrial and farming sectors throughout New Zealand and parts of the South Pacific.

Many considered Reay "a very prominent designer" in the area of tilt-slab design. The systems he developed for those buildings were acknowledged as being very efficient with regard to the use of materials and ease of construction.

His expertise was recognised following the Cave Creek viewing platform collapse that occurred in 1995, resulting in the tragic deaths of 14 young students on the West Coast. Reay was engaged as an Expert Engineer and he gave expert evidence at the Commission of Inquiry hearings held in July and August 1996.

The Commission of Inquiry report stated:

> "*Dr Reay has high academic qualifications, is a learned theoretician with very sound practical skill and is conservative and careful in his approach. Very substantial weight can be attached to his evidence, which was of great assistance. In cross-examination he demonstrated all the hallmarks of the expert witness, giving careful consideration to questions, providing balanced answers and being prepared to acknowledge that another expert might hold a different opinion."*

Reay's work in developing the use of tilt-slab construction in New Zealand was recognised in 1997 when he was awarded the Engineering Achievement Award for outstanding design contributions that advance the application of tilt-up construction, by the Tilt-Up Concrete Association of America, the first time it was awarded outside of the United States.

However, those systems were not present in the CTV building and were not relevant to its design. Furthermore, Reay said in evidence to the Commission that he had never used the ETABS computer program.

Reay's lack of experience - multi-storey design

In contrast to his expertise in designing tilt-slab structures, by the mid-1980s Reay had relatively little experience in the design of complex multi-level shear-core buildings. During the CERC hearings, Reay provided a list of three multi-storey buildings that he had been responsible for prior to 1986:

- 6 storey concrete frame building, Liverpool Street [redacted], 1970)
- Ibis House, 8 storey, 183 Hereford Street (ARCE, 1974)
- Kamahi Towers, 8 storey, Carlton Mill Rd (ARCE, 1970s)

The Commission considered the examples provided by Reay and compared the design elements present against the CTV design. The outcome is discussed in more detail in section 2.1.2.1 of Volume 6, but essentially, of the three buildings listed, Ibis House (1974) was the only reinforced concrete framed building that could have provided Reay with any experience in the design of a multi-storey building at the time.

However, in terms of the actual design, the permitted drawings for Ibis House reveal that the design of the columns, beams, slabs and blockwork was done by [redacted], a structural engineer who worked for ARCE. The drawings show that Reay checked all of the structural drawings.

David Harding

As previously mentioned in section 4 of this report, David Harding had two periods of employment with ARCE; 1978 – 1980 and 1985 – 1988.

Harding graduated from the University of Canterbury with a Bachelor of Engineering (Civil) degree with Second Class Honours in 1973 and became a Registered Engineer in 1976. Like Reay, he was employed by [redacted] for four years after he completed his studies.

During his employment with [redacted], Harding was involved in the design of residential buildings and foundations, single-storey factories, offices, warehouses and school buildings and the structural strengthening of brick buildings.

After joining ARCE in 1978 he undertook the design of structural elements of residential buildings and industrial and commercial buildings of one or two storeys, particularly of precast concrete construction. He left ARCE in May 1980 to gain experience in civil engineering, taking the role of design engineer at the Waimairi District Council.

For the next five years at the council, Harding was mainly involved in civil engineering work but did undertake some structural engineering, including the annual survey and maintenance of bridges, and the design of the hydroslide and associated platforms at Jellie Park pool.

He was approached in the latter part of 1985 by Reay who had heard that Harding was looking to move on. In the intervening years since Harding's first stint at ARCE, Reay's firm had expanded into the multi-storey field and had designed several office buildings in the CBD (Landsborough, Aged Persons Welfare). Reay indicated to Harding that he had other projects in the pipeline and offered Harding the opportunity to gain experience in multi-storey design. This was in the wake of experienced structural engineer John Henry's resignation from ARCE, in about September 1985.

At the time of his second period of employment at ARCE, David Harding was 34 years of age. He had been a practicing engineer for thirteen years, a registered engineer for ten years, with no experience whatsoever of multi-storey design or ETABS.

John Henry

In mid-1984, John Henry took up a position as a structural engineer at ARCE.

He graduated from the University of Canterbury with a Bachelor of Engineering with First Class Honours in 1979 before joining [redacted], where he was involved in the design of multi-storey buildings and trained in the use of the dynamic analysis computer program, ETABS. He became a Registered Engineer in 1982.

A more detailed account of Henry's experience up until this point, including design projects and buildings he had been involved in, can be found in the relevant section of the CERC Report, Vol 6 section 2.1.

In short, despite having only practiced for six years, Henry was already an experienced and competent structural engineer by this time. He described his time with [redacted] as an excellent learning environment, and details the internal procedures and mentoring by experienced engineers like [redacted]. He was fully conversant with ETABS, and, importantly, knew that the program had limitations that had to be supplemented by further hand calculations, particularly in the case of eccentric buildings. Designers in the mid-1980s needed to have both experience using ETABS *and* an understanding of the design of multi-storey shear core buildings to ensure the deflections of a building had been determined accurately.

Henry, by his own admission, would describe his own design style as being fairly conservative. He preferred to build redundancy into his designs, rather than design to the extreme limits of the code.

This approach was markedly different to Alan Reay's design philosophy with tilt-slab structures; the cost efficient use of materials which met the code, but no more than was necessary.

Henry responded to an advertisement for a structural engineering position at Reay's firm and thought that it might be an opportunity for career advancement. He attended an interview with Reay, who was the only engineer in the firm at that time.

Reay indicated during the interview that there was a possibility Henry would become a partner at some future point. Reay also told him at this interview that he had some multi-storey buildings in the pipeline. Henry understood that his expertise was required for these projects as Reay had started to take on multi-storey buildings and wanted someone experienced in this area to design them.

Henry accepted the position. He said that at that point he expected to be working together with Reay, not on his own.

At the time of his employment at ARCE, Henry was 30 years of age. He had been a practicing engineer for six years, a registered engineer for two years, with all of his experience in multi-storey buildings in Christchurch and Wellington.

Formal Statement is in draft form but due to be signed by end May 2017[24].

[24] [redacted])

Geoff Banks

In late 1988, Geoff Banks took up a position of structural engineer with Alan Reay Consultants Limited (ARCL).

Banks graduated from the University of Canterbury in 1980 with a Bachelors Degree (1st Class Honours) in Civil Engineering. Upon leaving university Banks worked as a structural design engineer for [redacted]) from around 1982 to 1986.

During that time Banks designed low rise commercial and public buildings and a number of multi-storey buildings in the Auckland CBD. Much of that work was under the direction of [redacted], a senior director of the firm. Those buildings were mostly constructed using reinforced concrete frames, but some had shear cores. One of those buildings was the Stock Exchange Tower in Queen Street.

Banks left Holmes in 1987 to start a new practice, [redacted] with another engineer. [redacted] undertook the design of a number of low rise commercial buildings.

Alan Reay Consultants Limited (ARCL) was formed in 1988, providing a new corporate entity which continued the work of Alan M Reay Consulting Engineer, Reay's former practice. Banks was invited by Reay to join ARCL in late 1988, after [redacted] had worked as sub-consultant for him on the Duty Free building in Cathedral Square.

Banks was employed at the end of 1988 and became a director on 31 March 1989 and subsequently a shareholder. He remained at ARCL for 13 years until late 2002 when he left and formed [redacted]

At the time Banks started in 1988, ARCL was undertaking a range of work, but the dominant project type was low rise commercial and industrial buildings (one or two storeys high). Banks took over the construction monitoring on the Heatherlea apartment high-rise building in Deans Ave, designed by David Harding.

At the time of his employment at ARCE, Geoff Banks was 29 years of age. He had been a practicing engineer for eight years, a registered engineer for four years, with considerable experience in designing multi-storey buildings in Auckland.

Formal Statement due to be completed June 2017[25].

6.1.2 Structural Draughtsmen

Over this period in the mid-1980s, ARCE employed a number of draughtsmen who were responsible for preparing structural drawings. It appears that the draughtsmen were split into two distinct teams – the tilt-slab design team and the multi-storey team, with [redacted] being the only draughtsman who did the work for the multi-storey team.

[redacted]

[25] [redacted])

[redacted] worked for ARCE between 1979 and 1988. His main area of work during that period was tilt-up factories and he also worked on the design of kitset buildings for [redacted], one of Reay's main clients. He had been involved in the draughting of structural drawings for multi-level shear core buildings in Wellington and Palmerston North in his previous employment but had not been involved in draughting any buildings at ARCE prior to the CTV project coming into the office. He was not involved in the draughting of Landsborough House or any of the other multi-storey buildings designed by Henry while he was employed by ARCE.

Formal Statement due to be completed June 2017.

[redacted]

[redacted] came to ARCE from [redacted] in December 1984, having gained experience there in the draughting of multi-storey buildings. [redacted] knew [redacted] from [redacted] and essentially brokered [redacted] job offer at ARCE shortly after his arrival at the firm, recognising a need for an experienced multi-storey structural draughtsman. [redacted] worked with [redacted] on the Landsborough House project and did the structural draughting drawings for the Bradley Nuttall building. He left ARCL in 1995.

Formal Statement due to be completed June 2017.

[redacted]

[redacted] was employed by ARCE between 1981 and 1986. He referred to two teams operating within the ARCE office, one working on low-rise projects and the other working on multi-storey buildings. [redacted] worked primarily on the low-rise commercial projects and warehouses and worked closely with Reay on those. Prior to the CTV building he had not been involved with any of the other multi-storey buildings that [redacted] or Harding designed.

Formal Statement due to be completed June 2017.

[redacted]

[redacted] worked at ARCE as a draughtsman from August 1986 until just prior to the stock market crash, September or October 1987.

[redacted]

[redacted] began working at ARCE in January 1985. She still currently works for [redacted] and has not been spoken to as yet.

6.1.3 Tracers

In the 1980s ARCE employed several staff as tracers. A tracer was used to trace the drawings by putting translucent material over the top of the draughtsman's work. This was done to make the final drawings neater and to ensure consistency with the firm's drawing style. A copy of the traced drawings would then go back to the draughtsmen for checking and then the complete set would go to the engineer for review.

[redacted]

was employed at ARCE between June 1980 and May 1986. fulfilled a number of roles at the practice, one of those being a tracer. The other role had at ARCE was that of office administration. carried out general typing duties and prepared the wages each week, including the collation of timesheets.

Formal Statement due to be completed June 2017.

6.1.4 Office Support Staff

A number of people have fulfilled the role of receptionist, telephonist, typist and wages clerk over the years. Of interest are:

worked at ARCE between February 1986 and 1989. She worked as the office administration assistant and effectively took over from when she left on maternity leave. was one of the staff responsible for collecting the individual timesheets from staff and collating the register of hours against job codes over the course of the CTV design.

Formal Statement due to be completed June 2017.

was a receptionist at the Kilmore Street premises and carried out those roles, as above. was interviewed by Police and provided interesting background in regards to the culture and environment at ARCE and ARCL at that time. She also provides detail around taking telephone messages for Reay and the protocol she had to follow with regards to writing names and phone numbers in his diary when he was out. was a name she recognised from that time. described Reay's A4 diaries, which he couldn't live without.

Part of role was to convert historic hard copy job files from ARCE and ARCL, dating back to the 1970s, onto electronic storage to save space. This task took 10 years,

6.2 Standard of the Day (SOD) – 1980s

In determining whether an omission is a major departure from the standard of care expected from an individual, it was necessary to obtain the account of structural engineers who were practising in New Zealand in the 1980s. Both Beca and Police have conducted their own interviews with a number of engineers who were practising at the relevant time, with the focus expanding for the Police interviews.

The full summary of the Police Standard of the Day phase, which includes a list of the structural engineers, company information, qualifications and links to each individual SOD statement. Hard copies are attached to the file[26].

To date 28 engineers from the 1980s have been interviewed by Police.

6.2.1 Initial Beca Survey – Accepted Practice for 1980s

As part of their opinion as to whether an individual's actions and / or omissions amounted to a major departure from the standard expected of them, Beca set out to establish what the accepted practice of engineers engaged in such work was at the relevant time.

According to Beca, 'accepted practice' relates to both the technical design practices involved in designing a multi-storey reinforced concrete building to the relevant design codes, and also the management practices of a firm including technical direction, design guidance and design review and checking.

Beca were very aware of the challenges in asking individuals to recall things done 25-30 years ago, and the possibility of "beneficial hindsight" creeping in, or recollections based on 'what should have been', not what actually happened. There was also the fact that those who worked in larger firms may have been subject to different practices to those in smaller firms (like ARCE) where systems may not have been so well established.

In an effort to minimise beneficial hindsight and avoid the dominance of larger companies, a process was adopted whereby Beca surveyed a range of practitioners who were active at the time. The practitioners were from a variety of design firms throughout New Zealand, including Christchurch, and included those who were operating as senior engineers or principals of their companies.

<u>The survey focused on three specific areas:</u>

1. *Design practices in the mid-1980s, particularly in the area applicable to the design of the CTV building such as the interpretation and handling of secondary seismic structural elements.*

2. *Design practices in the early 1990s, particularly around practices for design of diaphragms and their connections.*

3. *Office practices around responsibilities, allocation of staff to projects, supervision of staff and design reviews.*

Beca identified eight individuals who were interviewed by Beca staff (refer to list). The initial Beca survey was split in to four parts, A - D.

Part A related to preliminary questions regarding the company that the individual worked for and their role during the mid-1980s. The questions cover the size and type of the company, a breakdown of employees by grouping (engineers, draughtsmen and support staff), the location and type of project work carried out, and the position and role of the individual at the time as well as their relative experience at that time.

[26] FOLDER 2 – TAB 15

Part B and Part C focused on the technical nature of design in regards to the initial concept stage and regularity in seismic structural systems.

Part D focused on questions which related to

- The allocation of staff to a particular project.
- What checking procedures or supervision were employed, and how would these change depending on experience?
- What reliance was placed on Council consent review process at that time?
- Where the individual believed that responsibilities as partner, director, owner or senior engineer regarding the technical output of the firm ended - in other words “did the buck stop with the director?”
- Were drawings reviewed before being issued and who was responsible for doing so?

In light of the fact that these were the only questions on review and supervision, an area that Police consider was a major departure by Reay during the CTV design and construction, the decision was made to identify and canvass a wider pool of appropriate candidates, and include an expanded section on review and supervision.

With the assistance of Beca, the original survey was amended and an updated Beca Questionnaire was formatted.

Police kept Part A entirely the same, which covered the size of the organisation and the type of work that the individual was doing during the 1980s. Part B of the new questionnaire absorbed four questions from the first Part D interview plus an additional eleven questions, taking it up to fifteen questions on the allocation, checking, supervision and review of projects in the 1980s.

Police then sought the assistance of Beca to identify additional engineers to interview in relation to the SOD. Those engineers are included on the list. Those individuals were contacted by Beca and then in turn, contacted by Police and the second questionnaire was sent out to each individual. This second phase included the initial eight canvassed by Beca in early 2014.

The questionnaire responses were positive in terms of being consistent and strong on the SOD themes across the group, but the answers tended to be concise and succinct. In order to clarify meaning and expand on answers, Police conducted face-to-face meetings with each engineer and full SOD statements were obtained from twelve of the group.

The balance of SOD statements have been taken in 2017. It is considered now that the investigation has identified the majority of experienced structural designers operating in New Zealand during that time.

Overall, Police believe that this phase provides a strong basis by which to measure Reay and Harding’s omissions and establish the major departure from the accepted practice of that time. Beca’s expert opinion, which relies in part on their own inquiries as to accepted practice, is strongly supported by the expanded SOD inquiries carried out by Police.

Outside of the list of SOD engineers, there are also interviews with other key structural engineers who were directly involved with CTV that include statements with regards to

the SOD. These engineers include [redacted]

Whilst this group were spoken to about their involvement in the building and therefore could be considered to have a potential conflict, it is of interest to note that this group align very closely to the wider peer group, strengthening the Police belief that the accepted practice does collectively reflect that of structural engineers working in New Zealand in the mid-1980s.

6.2.2 Common Themes

In terms of consistency, all of the SOD statements provide a clear picture of the accepted standard within the structural engineering profession with regards to the following broad themes:

- Concept – getting the initial concept "right"
- Allocating staff and determining competence
- Maintaining continual oversight and review – Director
- Checking process
- Role of engineers vs draughtsmen
- Reliance on council for structural review
- Construction monitoring
- Responsibility for the design – "the buck stops with the director"

It is strongly recommended that the SOD statements are read in their entirety. This provides the best appreciation of how closely aligned the responses are rather than a summary of the statements or a synopsis of each witness.

The practices in place in 1986 preceded the advent of formal quality assurance (QA) programs, such as ISO9001, that many design firms began to adopt in the 1990s. However, as several of the practitioners mentioned, just because the process was not formalised, called "ISO9001" or encompassed in a book or folder, did not mean that it didn't exist. All of the accepted practices, especially around checking and review, was well established within structural firms. It was led by the directors and senior staff and taught to the junior staff.

The profession as a whole, and the governing body (IPENZ) expected all members to uphold these standards. The culture was well embedded and adhered to prior to this. "*….the process was, for the most part, inherently understood rather than being formalised and written down".* [redacted]

The SOD phase will be discussed further at relevant sections of this report, beginning with the next chapter on Concept and Design, in order to compare the different approaches by both Harding and Reay and contrast these with the SOD benchmark for each topic, where applicable. This provides further support for the Beca opinion that major departures have occurred.

6.3 Concept and Design

This section covers a number of key stages which are critical to the case. Each stage can be considered a stepping stone in the overall evolution of the CTV building, from an idea on the

back of a menu card through to a full set of architectural and structural drawings with supporting calculations sent to council for permit approval.

Each stage in the process is broken down and examined for factual detail in regards to what happened at each stage, the degree of involvement by both Harding and Reay at each point in the process, followed by a comparison of these actions or omissions against the "standard of the day" for each stage.

6.3.1 The Origins of the CTV Building

The concept of the CTV Building came about as a result of a speculative property development deal by Prime West, who owned the block of land at 249 Madras Street. Neil Blair, Prime West, had previously worked with Michael Brooks of Williams Construction on other projects, and he asked Brooks to come up with a design-build office building in response to the high demand for office space in the CBD in the mid-1980s.

According to Brooks, he met with Blair in late 1984 or early 1985 at a Christchurch Hotel to discuss the project. Brooks sketched the floorplan of the building on the back of a menu. Whilst he no longer has the original sketch, Brooks replicated the concept during his Police interview.

Brooks' floorplan sketch featured a box which represented the maximum leasable space for an office block. The envelope calculated the return on leasable space based on overall dimensions of roughly 20m x 30m over six floors. The idea to have the services (lift shaft, toilet etc.) situated outside the building in the north core was Brooks' idea but he believes that this was a short time after that initial meeting at the hotel.

Blair liked the idea and together Prime West and Williams worked up the concept, based on Brooks' floorplan. Blair favoured the look of buildings that had been built by Industrial Holdings in Victoria Street and based his idea for the exterior design on those buildings.

The architect for the Contours Building, Alun Wilkie, was then engaged to work up architectural drawings of the project. According to Wilkie, he incorporated the same exterior look of Contours, including concrete spandrels, set back glazing and round columns, which Wilkie personally liked.

Having developed the idea to this stage, the next step was to engage a consultant engineer who could carry out the structural design of the building. Williams Construction had worked recently with Alan M Reay Consultant Engineer on the Aged Peoples Welfare building. ARCE was approached with the concept and invited to join as the structural engineer.

It is important at this point to note that although the concept of the building had been worked up by a number of people with varying degrees of experience in construction and or property development, none of those individuals had any structural engineering qualifications or expertise. The primary concern for the developer was obtaining maximum rental return on their office space and car parking.

6.3.2 Concept Stage

The client approached Reay in early 1986 to discuss the venture and the possibility of ARCE doing the structural design of the building for a fixed fee, payment conditional on the issuing of a building permit.

As the principal of the firm, Reay liaised with clients, handled negotiations regarding contracts and fees and discussed preliminary design concepts. The exact timing and location of the initial meeting(s) between Williams Construction and Reay are unknown, but once the engagement of ARCE as structural engineers was confirmed for the fixed fee of $50,000, a follow-up meeting was held at the ARCE premises in Kilmore Street in late February or early March 1986.

Project Development Manager for Williams Construction, Tony Scott and architect Alun Wilkie met with Reay. David Harding was then introduced as the engineer assigned to the project. Scott provided Harding with drawings of the concept prepared by Wilkie, and ARCE agreed to prepare preliminary calculations and structural drawings, including a suitable and cost effective flooring option. This involved Harding preparing three alternative options to present to the client.

In March 1986, Harding prepared the preliminary calculations and structural drawings, which were on A4 size paper. His design opted for the 'Hi-Bond' flooring system, which was familiar to Williams as the best option financially at that time.

In April 1986 Scott used Harding's calculations and A4 structural drawings, along with Wilkie's A2 architectural drawings, to cost the project at $2,450,000, which he submitted to Prime West.

SOD Comparison - Concept

One of the common themes from the SOD statements was the importance of the concept stage, or *"high level scheming".* This is the stage where the client, architect and structural engineer, usually the principal or a director of the company, arrive at a structural solution for the building. It is vital at this stage that a feasible concept be developed. Hand calculations are used to establish whether or not the concept is sound.

Once the initial concept is decided, the developed design stage starts. The principal or director briefs the "lead" structural engineer, usually an associate or senior engineer, on the concept and allocates them the responsibility of carrying out the structural design. The concept design is then firmed up, sometimes with changes made by the architect or client, with the director maintaining an active overview throughout this process.

This is the point at which the client would approve of the developed design, and the project would get the official "go ahead".

Although this was a "design build" project, there are notable similarities in the stages of the CTV building design with the stages described during the SOD phase. The developers' concept of the open floor plan with lift shaft and services off-set to the north was essentially adopted "as-is" by the structural engineering practice, in particular by the principal engineer who accepted the job, and the senior engineer responsible for the structural design.

Neither Reay nor Harding had sufficient experience or competence in multi-storey design to recognise the fundamental shortcomings of the concept as presented by Williams Construction. They did not appreciate the complexity of designing an eccentric shear wall protected gravity load building.

Landsborough - Concept

According to Henry, his first multi-storey project at ARCE was to design "Landsborough House". This involved an initial meeting with Reay and an architect, Dave Allen. Reay showed Henry preliminary concept drawings prepared by Allen that featured lifts and services at the northern end of the building and large, open floors with unobstructed views to the south, east and west.

Based on his experience at [redacted], Henry recognised that the concept was flawed and would never work. [redacted] Henry also realised that a) he would need to demonstrate to Reay that the concept would not work and b) he could not rely on Reay to provide competent oversight of multi-storey design.

Henry carried out calculations and some drawings which demonstrated to Reay that the concept of Landsborough House was flawed and needed to be re-worked. Henry was so concerned about the design as it had been proposed by Reay that he went to visit Professor Paulay at the University of Canterbury to discuss the issue of having the shear core on the exterior of the building and because he knew Reay didn't understand the problem with such a structure.

Professor Paulay gave Henry advice and Henry continued with his calculations to show Reay that the shear core needed to be inside the building. Reay was dismissive of Professor Paulay's concerns and Henry remembers feeling shocked about this. It was at that point that Henry realised that he was on his own in terms of having anyone in the office to seek multi-storey advice from.

As a compromise, Henry designed the shear core to be offset but with sufficient strength to meet the seismic requirements. It was on the edge of his comfort level but he was satisfied because he knew it would be Code compliant.

He had to do a week's worth of calculations and work to show Reay that the design as Reay had presented would not work and eventually Reay agreed.

Henry recalls Reay being reluctant to change the concept as the client was sold on the idea of unobstructed views, but he eventually accepted Henry's argument and a workable compromise was reached.

Even so, once the design was relatively far advanced, Reay would still continue to make decisions with the client and then relay them to Henry. One of those directions was to cut a hole in an internal wall for a door but Henry was put in a difficult position because this weakened the structure and required strength to be put in elsewhere. [redacted] Henry was never involved in the meetings with the client, something he had been immersed in whilst at [redacted]. This enabled him to stay abreast of what the client's needs were as well as having input from an engineering perspective.

With Reay maintaining all the client contact and making decisions without input from the design engineer, Henry felt that he was being relegated to being a "backroom designer". Henry was also not used to designing budget buildings which he felt Landsborough House was. Reay did not review his calculations and occasionally looked at the drawings but it appeared only to make suggestions on where pre-cast concrete panels could be used rather than any structural engineering review.

When Reay suggested that Henry sign the design certificate, Henry was surprised as in his previous experience only the principal or director of firm signed that document. The fact that only principals or directors of firms signed design certificates is almost unanimously supported by the evidence from the Standard of the Day engineers spoken to.

As the design certificate for Landsborough House has not been located on either the Council file or in ARCE's documents, it is unknown who signed the design certificate for this building. Henry remembers saying "no, no" to Reay and telling him that he should sign as owner of the firm.

6.3.3 Developed Design Stage

Through May and June 1986, the CTV project was very much in the developed design stage, with the structural model needing analysis and a final decision on the configuration of the shear core and walls.

6.3.3.1 Beca Investigation into the CTV Design

The Beca Report provides an excellent overview of their investigation into the developed design and detailed design stages of the CTV building. The Beca investigation looked closely at each stage of the design process and examined the respective roles of Harding and Reay, as lead engineer and principal. The investigation has been extremely thorough, and the Beca Report has been robustly challenged by Police and Crown as well. In addition, the Beca findings have undergone two peer reviews. The first by an internationally recognised expert in seismic structural engineering, [redacted] from [redacted] and the second by [redacted] of Auckland, an expert in structural design.

As part of their investigation, Beca set out to ensure that the standards, codes, principles and resources of 1986 were utilised as part of the examination. In order to understand and provide expert opinion on Harding's approach, Beca carried out their own analyses and calculations of Harding's design. They used the structure, as detailed on the original drawings, and techniques as close as possible to what was available and common at the time, and what is understood by Beca to have been used by Harding. This even included building a simple (by today's standards) model in ETABS which allowed Beca to provide comparisons with the results of Harding's analysis.

It is not the intention of this report to repeat entire sections of the Beca Report in relation to the CTV design, or re-state the conclusions as to the identified design shortcomings and expert opinion on the issue of whether or not theses omissions constitute a major departure.

The complete investigation into the CTV design process can be found in the relevant section of the Beca Report at section 7.

However, for the purposes of this report, several key parts of the detailed design stage are examined here and contrasted against both the SOD statement phase (benchmark) and the Landsborough case. These are:

- The ETABS analysis of the CTV building
- The addition of the South Shear Wall (SSW)
- The reinforcing in columns, beams and joints

- The connections between the floors and the North Wall Complex (NWC)

6.3.3.2 David Harding and ETABS

David Harding ran ETABS analysis on the University of Canterbury (UoC) School of Engineering computer in order to check the seismic performance of the CTV design. An invoice from UoC to ARCE, dated June 1986, included the ARCE job code for the CTV Building (2503) and the amount of $163.09 for computer time.

Prior to his second period of employment at ARCE, which commenced in late 1985, Harding had never used ETABS. Likewise Alan Reay had never used ETABS either, but he was aware of the 3D modelling program and knew it was important for seismic analysis of shear-core buildings, as Harding's predecessor John Henry had used ETABS for his design of ARCE multi-storey buildings Landsborough House, Aged Peoples Welfare and Westpark Towers.

When Henry left ARCE at the end of 1985, he had completed the preliminary design and calculations for Westpark Towers. The structure itself was octagonal in shape and featured an enclosed core in the centre of the building. According to Henry, he had begun preliminary ETABS analysis of Westpark by the time he left ARCE, but that analysis had not been completed. UoC invoices and ETABS printouts show that initial ETABS testing was done in early September 1985.

However, based on those preliminary results and his experience with multi-storey buildings Henry had no cause for concern in regards to the seismic performance of Westpark, given its symmetrical nature and almost circular shape about a central core.

When Harding started at ARCE for the second time, he was given the job of finishing Westpark Towers. ETABS records show that additional ETABS analysis was carried out on the Westpark design in February and March 1986. Supporting this is an invoice from J.M.T. Henry to ARCE, dated 27 March 1986 for $56.00 for *"Advice on running ETAB programme at University of Canterbury"* was marked *"File 2389".* This was the ARCE job code for Westpark Towers.

It was noted at CERC that Reay signed the design certificate for Westpark Towers in July 1986, whereas Harding began work on the CTV building in March 1986.

During the CERC hearings both Reay and Harding gave evidence that prior to his ETABS analysis of the CTV building in June 1986, Harding did have some experience with running the program, which he had gained as part of completing the Westpark Towers. Both men conceded that CTV was the first time that Harding had been entirely responsible for an ETABS analysis.

The invoice from Henry to ARCE supports Henry's recollection that he came back to ARCE as a consultant after he left to help Reay out with a couple of jobs that he had started, namely the Bromley Trickle Filter Covers and showing Harding how to run ETABS. The fee of $56.00 indicates to Henry that this advice would have taken one hour, which is sufficient to demonstrate an ETABS run on a straight forward symmetrical design like Westpark. It was not sufficient to train someone how to use ETABS completely on their own however

and it is worth noting that a preliminary run had been done on ETABS for this project by Henry.

However, the computing limitations facing a program like ETABS in 1986 meant that for eccentric designs like the CTV, with the off-set north wall complex (NWC) and no opposing shear wall (at that stage) on the south side, the ETABS results only related to the Centre of Mass (CoM). Further calculations were required by the engineer to determine the results at the far corners of the building, which always exceeded what was happening in the middle of the building.

Competent structural designers with experience in both multi-storey design and use of ETABS knew that the engineer had to calculate the corner deflections by hand. Harding and Reay were not experienced or competent in either, and therefore did not know about the ETABS limitations. Furthermore, the output from ETABS was heavily dependent on putting the correct figures in. It only worked if the calculations leading up to that point were correct.

The evidence that the design certificate for Westpark was signed some months after the commencement of the CTV project means that there is some doubt as to how Reay could have been satisfied that Harding had sufficient experience to do the work for the CTV project. Westpark had not yet concluded and Harding would only have spent a very short amount of time on that before beginning work on CTV.

6.3.3.3 ETABS analysis on CTV

As mentioned earlier in this section, the seismic structural system of the CTV building is referred to as a 'shear wall-protected gravity load system'. In layman's terms, the building relies on a primary seismic frame, namely the NWC and SSW which are rigidly connected to the floor slabs (diaphragms), to protect the secondary seismic system, which are the columns and beams which hold the building up (gravity load). The intention of Harding's design was that the secondary system was not required to do anything other than hold the weight of the building because the primary frame would protect the structure from seismic movement, including the effects of torsion (twisting) resulting from the eccentric layout of the NWC.

Reay had given Harding the ETABS outputs and the calculations for Landsborough House to use as a template for his CTV design. There was no evidence of any further assistance given in that regard for Harding to know what he was doing or the requirement for additional calculations beyond the ETABS analysis.

When Harding ran the initial ETABS analysis on the CTV design in June 1986, the results showed that the inter-storey deflections exceeded the limits of the code, NZS 4203:1984. In other words, for a building that was supposed to act as a shear wall protected gravity load system, the deflections between each floor showed that the gravity load system was having to do more than just hold the building up.

According to his evidence at CERC, Harding tried to remedy this problem by increasing the thickness of the walls of the NWC, but this did not reduce the inter-storey deflections below the limit in the Standard. After about the fourth

or fifth ETABS run, Harding told CERC that he spoke to Reay about his problem.

Harding's problem of excessive inter-storey deflections is significant to note at this point. The computer modelling program, for all its limitations in 1986, was still accurate enough to predict that the columns, designed only to handle gravity loads, would be vulnerable to lateral loads due to the torsional effects of the eccentric building layout (refer to the Beca physical testing and cause of collapse findings).

The difficulty that Harding experienced with ETABS is also relevant to the overall context of what was happening at this point, namely that he was working alone but under pressure to get the design completed in order that it could be submitted for council consent. [redacted] said in his statement to Police that he was "pushing" the application because it was only once the permit was granted that the job was officially going ahead. The "no job, no fee" situation meant that [redacted] was trying to get everything to the council in order to progress matters. [redacted] recalls that the structural drawings were late because Harding was doing computer work with them. This coincides with the period when Harding was reportedly having difficulty getting the ETABS analysis to work.

6.3.3.4 The South Shear Wall

CERC heard conflicting evidence from Harding and Reay about when the South Shear Wall (SSW) was added to the design. Regardless of when this occurred, the most obvious way to remedy the effects of torsion was to balance out the NWC with a similarly sized SSW directly opposite. However, Harding said that when he discussed the need for a SSW, he remembers Reay saying that the inclusion of a south wall may not meet the aesthetic required by the client as it would look different to the Contours building. This was somewhat unusual because it was not the client's preference to have the building look like the Contours building, rather it was the architect's style preference.

The solution was to make the small, non-structural wall behind the external stairs on the south side into a coupled shear wall. Harding incorporated this shear wall into his design and ran the ETABS analysis again. The results brought the inter-storey deflections to within the limits of the Standard, and critically Harding proceeded forward with his design.

Harding did not carry out any further calculations by hand to establish the corner deflections. He was unaware that he had to do this, and the material provided to him by Reay to use as a template did not include Henry's additional calculations. Neither Reay nor Harding had the necessary experience to appreciate the ETABS limitations and realise that further work was required at this point. Further calculations would have shown Harding that the inter-storey deflections at the corners of the building were still beyond the limits of the code, and therefore non-compliant.

6.3.3.5 Centre of Rotation

One of the key principles of multi-storey design is symmetry, resulting in a balanced structure that responded in a predicable manner under lateral load. Designers aim to get the Centre of Rotation (CoR), the point about which a building wants to rotate under lateral load, as close as possible to the Centre of Mass (CoM). Westpark Towers, with its octagonal shape and central core

is a good example of a symmetrical design with the CoR and CoM right in the middle.

In the case of the CTV building, ideally the NWC would be complemented by a matching SWC that balanced the building's response. If not a SWC, then the next best option would be a much longer SSW which was able to handle 50% of the seismic loading in the east-west (E-W) plane. In other words, each shear wall doing exactly half of the work, cancelling out torsion.

The problem that Harding faced but failed to fully comprehend was that by incorporating a shorter SSW which was off-centre to the east, whilst it did help to resist movement in the E-W direction, the amount of load it could handle was far less than the much stronger NWC, was off-centre, and therefore not symmetrical. These two factors created torsion and meant that the ever critical CoR was now outside the footprint of the building, somewhere to the west of the NWC (Diagram).

Standard of the Day – Eccentric Designs

The SOD commentary on the flawed concept is very consistent on this topic. A common theme across the board is "this is structural engineering 101". In other words, any structural designer with experience in the design of high-rise buildings would recognise the problem with such an eccentric design as Harding's, and would have the knowledge and skills to counteract the effect of torsion.

Lack of experience is no defence. The codes were very clear on the obligations of structural engineers to design seismically symmetrical structures. Structural engineer [redacted] gives expert evidence on this aspect of structural design and examines the non-compliance of the CTV design with Bylaw 105.

The IPENZ Code of Ethics 1986, Beca Report, Appendix C, pages 83-85, also puts the onus on the individual to realise their limitations and not work beyond them.

Rule 6: *"He shall not misrepresent his competence nor, without disclosing its limits, undertake work beyond it."*

Rule 8: *"However engaged, he shall at all times recognise his responsibilities to his employer or client, others associated with his work, the public interest and his profession."*

There are two things of note in this respect. Firstly, Harding knew he had no previous experience in multi-storey design and disclosed this to Reay before he returned to work at ARCE. Reay told him he could gain experience by working at the firm, and Harding then accepted the job. The second point is that when Harding had trouble with his ETABS results and the excessive deflections, Harding gave evidence at CERC that he went to Reay for assistance and guidance.

There is a question about Harding's ethical and professional responsibility here. He was upfront with Reay about his level of competence, and he duly sought assistance from the principal of the firm who was providing oversight for the project. But he also must have known that Reay, by his own admission, was himself not experienced or competent in this area. The issue is whether

there was an onus or obligation on Harding to ensure that he sought *technically competent oversight* from a suitable peer outside ARCE (see [redacted] SOD, para 87).

From the SOD statements, it does not appear that there was any expectation on a junior engineer to arrange their own mentoring or oversight. However, the counter-argument is that if Harding knew that he was undertaking work beyond his competence, then he should not have continued without some safety precautions such as oversight. Whether or not he recognised that Reay was not technically competent or proficient in this area is unclear, but from the evidence at CERC it appears that he believes he discharged his obligation by seeking out advice from Reay regarding the SSW.

Landsborough - Compromise

By way of comparison, after convincing Reay that the Landsborough concept was unfeasible, Henry submitted an alternative design which was essentially a compromise between Reay's commercial focus (maximised floor area) and Henry's conservative approach to multi-storey design and his desire for a central core. The alternative Henry design featured a shear core that was enclosed with a further wall and off-set to the north side of the building, but still within the building.

Even so, this was still an eccentric design and although the ETABS analysis showed that the structural model worked, Henry's hand calculations revealed that the inter-storey drifts at the corners were at, or near, the maximum limits in the code. Henry remained concerned at the configuration of the shear walls.

Based on the structurally flawed concept as presented to him by Reay, Henry realised that Reay was not suitably experienced in multi-storey design to provide technically competent oversight on his proposed design. Henry felt strongly that his design needed a second opinion, and he arranged for Professor Thomas Paulay, UoC, to look at his proposed design and comment on the possible effects of torsion.

Professor Paulay also had his concerns about the eccentricity of the design and he cautioned Henry about this issue. According to Henry's statement to Police, when he returned to the office and discussed the concerns with Reay, Reay was dismissive of Professor Paulay and his advice. At CERC Reay denied this, but Henry is very clear about Reay's reaction and it left him with the knowledge that he was isolated and alone when it came to multi-storey technical competence at ARCE.

Lack of formal checking – multi-storey projects

Henry said in his Police interview that there was no formal checking undertaken during his time at ARCE. He does not think that Reay ever looked at his Landsborough calculations and he got very little support from Reay during the design process. No effort was made by Reay to initiate any discussions, to review calculations or to check Henry's thinking or methods. There was no offer to have Henry's work reviewed by anyone else either.

Of the staff identified as having worked at ARCE or ARCL between 1979 and 1992, six were engineers (excluding Reay) as follows:

1978 – 1980 David Harding
1984 – 1985 John Henry
1985 – 1988 David Harding
1987 – 1991 [redacted]
1987 – 1987
1988 – 1992
1988 – 2002

Aside from Harding who appears twice, John Henry was the only experienced multi-storey designer who worked at the firm until the arrival of Banks in 1988. Banks became a director within a short time and was himself experienced in that type of design. [redacted] were all relatively new to engineering, either recent graduates or junior engineers at the time of their employment.

As Henry was involved in most of the multi-storey projects undertaken by ARCE in the mid-1980s during the property boom, he is best positioned (other than Harding) to comment on the lack of oversight provided by Reay to the design engineer during these high-rise jobs. Due in part to the share market crash in 1987 and their relative inexperience, [redacted] did not have any significant involvement (if any) in multi-storey work and can only comment on Reay's oversight on tilt-slab projects or commercial low-rise or residential work.

Henry's comments are supported by structural draughtsman [redacted]

"In terms of the multi-level work I did with [redacted] and other engineers, Dr Reay had very little involvement with that work. I do not think Dr Reay had any design input into those structures and we did not have meetings with him to discuss how something would work."

Signing of Drawings

[redacted]

Likewise the approach to Professor Paulay was initiated by Henry who said that whilst Reay did not stop him from going for advice, the impression he had from Reay was "if you must".

Henry was a competent and experienced structural engineer with a conservative approach to multi-storey design and a healthy respect for the seismic codes and limits. He realised that he did not have suitably competent oversight in Reay and no means by which to seek out advice or discuss solutions within ARCE. Henry, through his own initiative, ensured he had the

necessary oversight and a second opinion on a design that was pushing the limits and causing him concern.

However, this appeared to be a more unusual step as most practitioners surveyed for the SOD interviews said that it was rare to obtain external peer review. Henry was a very cautious and careful engineer who was concerned about Reay's inexperience in multi-storey design. He had the experience to recognise this, but Harding 'did not know what he did not know'. Harding therefore was unable to identify that Reay was agreeing to a deficient design from the outset.

It is not entirely clear what level of review Reay did for Henry's work. At CERC Henry gave evidence that he was sure Reay must have been looking at what he was doing, but this was never when Henry was around. He thought it must be happening because it should have been. Reay signed the design certificate for Westpark in July 1986 so presumably he had sufficient knowledge to certify that it complied with the codes. [redacted]

6.3.4 Detailed Design Phase

Once the ETABS data for the CTV building was within the code limits, the detailed design stage of the CTV building began. This is the transition of the developed design onto detailed drawings which show all aspects of the structure. The results of all of the structural and seismic calculations, preliminary drawings and the computer modelling tests are used to determine the minute detail of the design. This includes things like the dimensions of each element like columns, beams and shear walls, the strength of the concrete required for each, and detail such as the size, shape and amount of reinforcing steel needed for each column and beam, as well as their joints and connections with walls and floor slabs.

The engineer draws the detail for each element onto a drawing of the basic outline of the building, known as a carcase drawing, and gives these to the structural draughtsman to draw up accurately and to the correct scale.

6.3.4.1 Reinforcing

Despite all of the issues with torsion and inter-storey drift, Harding believed that he now had a fully functioning primary seismic frame that protected the secondary system from lateral load, and therefore he only needed to detail the columns as non-ductile members.

This assumption was grossly incorrect, and it was based on a number of errors and omissions that Harding had made up until this point, as catalogued in the Beca Report on Harding's failings with his design. In short, the cumulative effect of all Harding's failures to this point meant that he felt confident putting the minimum amount of steel reinforcing in the columns and the beam-column joints as he believed the code required.

A big part of Alan Reay's success in the area of tilt-slab design was his cost effective designs which incorporated no more material than necessary. This meant that low-rise commercial properties could be constructed at the lowest

possible cost, which suited his clients. Reay's philosophy with regards to materials like reinforcing steel was "enough to meet code and no more."

Draughtsman [redacted] supports this with his statement:

"I do not recall him ever questioning my competency or suggesting my work was not up to standard, but he would challenge me if he felt my drawings were over-detailed. Everything had to be efficient and repetitious…

...Staff were required to set out buildings to achieve as much efficiency as possible. They were to be no stronger or more expensive than what was required. This was achieved through using steel products near their design limits and repeating these elements many times within the project."

SOD Comparison - Reinforcing

While some structural engineering firms in the 1980s had a reputation for being 'cost effective' and 'pushing the limits of design', those firms were also considered by many of the SOD group as firms who were prepared to cut corners on behalf of certain clients who wanted things done as cheaply as possible.

The majority of the practitioners interviewed indicated that their preference, in regards to steel, was to incorporate some degree of redundancy into their designs, which meant detailing sufficient amount of correctly sized reinforcing steel to not only meet the Standard, but exceed it by a certain percentage, as a built-in safety margin.

Landsborough - Reinforcing

During the detailed design stage of Landsborough House, Henry became aware of Reay's cost effective approach to design, especially in regards to materials such as steel. Henry felt that although Reay maintained some degree of oversight in the design process, his actual focus was on what materials were being used in different areas and whether cheaper alternatives could be sourced, rather than on structural issues. Reay queried Henry on the size of some of his columns and the amount of steel detailed, directing that Henry use only what was required to meet the code and no more.

[redacted]

6.3.4.2 Comparison of other Christchurch buildings

Beca examined six other multi-storey buildings (above four storeys) designed and constructed in Christchurch in the mid-1980s. The structures were all similar in the fact that they were reinforced concrete shear wall designs like the CTV building.

The extent of Beca's examination of the other six buildings was limited to a general comparison of the structures; number of storeys, floor area and foundation details, as well as a comparison of the design specifications for the column and transverse joint steel.

The Beca building comparison phase methodology, the list of buildings and the results of the investigation can be found in section 7.5 of the Beca report. The Beca report sums the building comparison phase in this paragraph (page 62, paragraph 5)

> *"Notwithstanding the code specified minimum reinforcement requirements, we found no other examples of buildings in Christchurch of the period where designers were prepared to adopt the low levels of column and joint transverse reinforcement used in the CTV building."*

Consideration was given to Beca conducting a more thorough investigation of the structural designs of each building, in order to determine whether or not they were 'code compliant' but the joint consensus was against doing this.

One reason was the time consuming nature of carrying out full structural checks of each design, estimated to be about 60 - 80 hours work for each building. The other reason concerns the purpose of the comparison in the first place, and the clear outcome; all six buildings surveyed contained significantly more joint reinforcing steel than CTV, and all six survived the earthquakes, whereas the CTV building did not.

6.3.4.3 Connections between the floors and the NWC

The concept of a primary seismic structure which protects the secondary system relies on having strong connections between the shear walls, which resist the lateral loads, and the floor slabs, referred to as 'diaphragms'. Ensuring that the floors and walls are robustly tied together means that the connection forces must be adequately developed into both the floor slabs and the primary wall elements. In other words, having floors and walls connected by the right amount of steel reinforcing embedded well into both the slabs and wall and covered by concrete.

According to Beca's investigation into the practices of 1980s design firms, there were two ways to calculate how much steel was required between the floors and the walls. The two methods were known as the 'Parts and Portions' provisions of the loadings standard (NZS 4302:1984) and the 'Capacity Design' method (NZS 3101:1982).

In their report, Beca acknowledge that the exact method to be used for the calculation of actions in the connections of diaphragms to primary seismic elements *was "not well described in the codes of the day."*

In the end, as with many other parts of his design, David Harding made both incorrect assumptions and mathematical errors when determining the strength required between the floors and the walls of the NWC and the SSW.

In two sections of his calculations, Beca discovered that Harding went from 300kN (300,000N) to 30,000N (30kN) on the next stage of the calculation, inexplicably dropping a zero and reducing the force by a factor of 10.

Beca also found that in a number of areas Harding misinterpreted the codes and started to apply various 'period scaling factors' to his calculations, further reducing the value of the forces being calculated.

The net result of all of the cumulative errors and failings by Harding in designing the diaphragm connections meant that on the whole, the connections between both the NWC and the SSW were well under the strength required and were in both cases non-compliant. The connections between the NWC and the floors were only **60% of the minimum** required by the code, and the connections with the SSW were **less than half** of what was required by the minimum interpretation of the code at the upper levels of the building (i.e. 300kN instead of 700kN for level 6) (Page 53 Beca Report).

Standard of the Day Comparison - Method

The Beca report includes comparisons with what was accepted practice in regards to the approach by designers in determining which method to use when calculating the strength of the diaphragm connections, and when the application of the various scaling factors was justified.

The Beca findings in relation to the SOD for diaphragm connections can be found in the Beca report at page 59, para 1.

As mentioned earlier in this section, there was uncertainty in the 1980s over which method to use, Parts and Portions or the capacity design approach. Beca found that it was accepted practice at that time for structural engineers to use either one in their working.

Critically, Beca found that Harding failed to use either method. The Beca Report states: *"If Mr Harding had followed either approach, he would have calculated a significantly larger design connection force."* (refer to the Beca report, section 7.5.1, page 59, para 1).

In other words, as a result of his lack of competence and experience, Harding followed neither of the recommended methods. The poor diaphragm connections are significant to the CTV investigation, as they surface in the early 1990s with the Holmes Consulting Group (HCG) report which highlighted the deficiencies, and the subsequent attempt by ARCL to remedy the issue.

The non-compliant connections are also directly relevant to the results of the Beca physical testing phase, and the catastrophic effect this had on the performance of the non-ductile columns under laboratory conditions.

6.3.4.4 Draughting Process

The draughting process at ARCE in the mid-1980s involved the engineers drawing the detail, such as the reinforcing, on to carcase drawings of the

building footprint. Draughtsmen then used the hand drawn detail to draw up structural drawings to scale, with all of the detail included along with dimensions and layout.

At the time of the CTV project, there were a number of draughting staff in the ARCE office. The team were split between working on the ARCE low-rise projects like commercial tilt-slab warehouses and [redacted] barns and farm utility sheds, and the multi-storey side of the business, such as Landsborough House, APW, Bradley Nuttall, Westpark and CTV.

[redacted] and [redacted] worked predominantly in the low-rise team and spent quite a lot of their time dealing with Reay's tilt-slab drawings. [redacted] was employed in the wake of [redacted] appointment in mid-1985 for his structural draughting experience. Initially [redacted] drew all of [redacted] multi-storey designs, and said that Reay essentially left them to it.

However, by the time that Harding was working at ARCE in 1986 and designing the CTV building it does appear from the timesheets over that time that six of the draughting staff worked on the project, as per the following table:

	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
July	49.75	0	22.5	0	0	4.5
August	82.5	.75	97	89.5	22	87
September	8.75	2	13.25	27.5	.5	36.25
October	0	0	0	0	0	0
November	0	0	.25	0	0	0
TOTALS	141 hrs	2.75 hrs	133 hrs	117 hrs	22.5 hrs	127.75 hrs

All of those staff listed above, with the exception of [redacted] who is still employed by [redacted], have been interviewed by Police. The senior draughtsmen were [redacted]

[redacted] joined the ARCE draughting team in August. It appears from her recollection and that of others that she was asked to draw the exterior stairs for the CTV building once she arrived at the practice. According to the timesheet, she spent 89.5 hours in August and 27.5 hours in September on the CTV project.

[redacted] started at ARCE in December 1985 just as the firm moved premises to Kilmore Street. She was very junior at the firm and although she had a New Zealand Certificate (NZ Cert) in architectural draughting, [redacted] did tracing duties when she commenced at ARCE. She recorded 127 hours on the CTV building and did the majority of the tracing work.

Given the significant time delay between completing the drawings in 1986 and being questioned about the CTV job during the CERC hearings in 2011, it is not surprising perhaps that [redacted] all struggled to recall working on the building.

[redacted] were never called to give evidence by the Commission, partly because of their minor roles and in [redacted] case, she mistakenly denied any involvement at all at that time to counsel assisting. During her Police interview she conceded that she did do the tracing on the project. [redacted] has indicated that she will not sign a Formal Statement for Police and that if she is required to give evidence, Police will need to summons her. She has told Police that she has already given an affidavit to Dr Reay's counsel.

Regardless of the time spent by each draughtsman or tracer, it is important at this point to record that, in terms of their involvement in the design process and the question as to whether there is any culpability on their part for any failures or omissions, the CERC finding was very clear. CERC found that:

> *"There is no suggestion that any draughtsman had any responsibility for the structural design of the building or ensuring that it complied with the Bylaw and the relevant codes."*

By extension then, the ARCE tracers are also considered as part of the criminal investigation. The tracers were simply performing the task of transferring and finalising the drawings onto translucent material. They had no responsibility for checking or any structural detail of the building.

The Beca report did not consider any of the draughting or tracing team when offering an opinion as to whether any individuals omitted to discharge their duty and whether an omission was a substantial and operating cause of the deaths. Firstly, those individuals were not identified as part of the briefing document provided by Police. Secondly, Beca concur with the CERC conclusions and place no responsibility for design failings with the draughtsmen.

SOD Comparison - Draughtsmen

The SOD practitioners were all consistent in their view regarding the role of draughtsmen in structural design. Whilst good structural draughtsmen are an asset to any design team, and open communication is always encouraged between engineers and draughtsmen (particularly around questioning details and querying aspects of a design), there is absolutely no onus by structural engineers on a draughtsman to identify flaws in structural design based on drawings.

Some of the respondents talked about healthy competition between the two groups, and there were some experienced draughtsmen who liked to catch junior engineers out. If the draughtsmen did identify an omission or mistake in a design, then it was treated very much as a bonus and something that reflected poorly on the design engineer.

Good and effective internal checking procedures were in place to see that any such mistake was picked up by the senior engineer or director during the final review.

Anecdotally, some of the engineers indicated that if such an error slipped through from the designer and was picked up by the draughting team, then you certainly 'didn't want to be that engineer' as word would spread through the office and it would effectively be a black mark against that engineer's reputation. These comments illustrate the expectation in the engineering

profession that there would be no reliance on the draughting team as part of the checking or review process. The responsibility for checking lay entirely with the engineers.

6.3.5 CTV Building Design – Conclusion

As covered earlier in this section of the report, the Beca investigation into the overall design of the CTV building, and the omissions by both Harding and Reay, was extremely thorough and is well chronicled in section 7 of the Beca Report.

6.3.5.1 Major Departure by Harding

According to their report, Beca identified no less than **12 errors or failings** made by Harding while he was carrying out his design of the building, including a significant mathematical error. *"The resulting design of the building contained significant non-compliances with the codes of the day. This represents an omission by Harding to discharge his duty in relation to the design of the building."*

In particular, Beca's opinion is that *"Harding's design of the secondary seismic elements was a major departure from the accepted Standard of the Day."*

6.3.5.2 Major Departure by Reay

The Beca report concludes at section 7.6 that Reay's failings were:

> *"The design of CTV building was carried out by Alan M. Reay Consulting Engineer. Dr Reay was a sole practitioner and, therefore, as the person who received the commission and assigned the project team, was ultimately responsible for the structural design and construction observation of the building. Being ultimately responsible, he failed to ensure that adequate experience and review processes were applied to the design with the result that the building design did not meet the required codes and standards of the day. These were significant failings and represented an omission by Dr Reay to discharge his duty in relation to the design of the building. His approach to these responsibilities was a major departure from accepted practice of the time."*

6.4 Comparison with other ARCE Projects

In the course of the CTV investigation, a number of multi-storey design projects carried out by ARCE have been briefly examined by investigators. The examination involved a physical check of the contents of the files, not an analysis of the structural elements or engineering principles for each. Some of these projects have already been mentioned in other areas of this report, and they include the following key buildings:

- CTV Building 249 Madras Street
- Landsborough House 287 Durham Street
- Aged Peoples Welfare 64 Cashel Street
- The Bradley Nuttall Building 79 Cambridge Terrace
- Westpark Towers 56 Cashel Street
- The Contours Building 299 Durham Street
- Heatherlea Apartments 10 Ayr Street

- Mainstay Apartments 111 Hereford Street

The physical hard-copy CCC files relating to these properties have been obtained from the CCC pursuant to search warrant and are exhibited at the Central Police Station. The files contain all physical documents relating to the properties and retained by the council, including permit applications, architectural and structural drawings and design certificates, where applicable. The files have also been obtained in electronic format from the council.

Over the years, the CCC has changed the format in which property files are stored, with emphasis over the years given to alternative storage methods in an effort to reduce the need for physical space. Methods such as microfiche and converting files to floppy disc have been trialled, with various degrees of success.

Storage locations and procedures around granting access to the physical files has also changed a number of times over the last thirty or so years.

The end result is that there is no real consistency as to what order the files are kept in, what documents are retained, what documents are duplications and what is discarded. It appears that most of the documents are there, but it is difficult to know for certain. One example is the actual building permit form, visible on a copy of a CCC microfiche page on the electronic file but missing from the physical file, whereas the other documents featured on the microfiche page are present.

To avoid any further potential for any physical documents to be lost or go missing from the physical files, the files for the above properties were seized under search warrant from CCC and placed in secure storage with Police.

6.4.1 Comparison of Seized CCC Files

As well as safeguarding the files as exhibits, it is the intention of the investigation team at some future point to compare the CCC files on each property and prepare a table which lists the different key documents on file and who was responsible for producing or signing that document, and compare the chart with the CTV file.

Key documents include the permit applications, the CCC permits, drawings and calculations, correspondence between the structural designer and council, and the presence of any design certificates and who signed those.

This will enable the contents of the CTV file to be compared with what is on the council files for the other big ARCE projects.

6.4.2 Comparison of Archived ARCE Projects

In June 2015, Police executed search warrants at four addresses around Canterbury, including the current premises of Reay's firm, [redacted] A summary of this phase can be found later in this report (see section 6.14).

As well as documents relating to the CTV building, all ARCE and ARCL files relating to design projects undertaken by the firm for a ten year period between 1981 and 1991 (five years either side of CTV) were sought under the terms of the warrant. Due to the time delay, these archived files are believed to exist only in electronic format on external hard drive (HD).

Police sought ten years' worth of ARCE / ARCL files in order to examine the contents of each file and compiled a list of what type of documents were scanned and retained,

and what documents were destroyed. This may provide evidence as to who at ARCE produced key documents such as design certificates and who signed them. It is also of interest to Police to know how many files had their design certificates and other documents retained on the archive file, particularly as none was located on the CTV file.

The comparison of historic ARCE and ARCL files has not, at this stage, been commenced. This is due in large part to a wide reaching claim of privilege by Reay's lawyers on all hard copy and electronic data seized during the search warrant in June 2015.

The hardcopy files have been largely sorted (barring two remaining folders), and exhibits have been seized. All seized documents have been copied and included with all remaining material returned to Reay. The electronic search phase has been extremely slow, pending agreement by all parties about the best method to electronically sort and search the data without breaching the integrity of the privileged documents.

This electronic search is progressing, but a detailed examination and cataloguing of all the ARCE files over that ten year period will be put on hold until such time that a decision is made regarding prosecution. Ultimately it will require the intervention of the Courts to progress.

6.5 CCC Building Permits and Code Compliance

The issue of whether the CTV design, as it was submitted to the Christchurch City Council on 26 August 1986, should have been granted a building permit has been thoroughly examined during the CERC hearings in 2011 and as part of the Beca investigation.

Police have also carried out a number of inquiries with witnesses related to this phase. These interviews were conducted to substantiate the evidence given at CERC and to establish the working environment and culture within the CCC Building Permit office in the 1980s and early 1990s. A review of the Police 'CCC Building Permit' phase will be discussed at the end of this section.

Part of the CCC Building Permit phase aligns with the SOD section which deals *with 'Reliance on Local Council to Check Structural Design'.* Where applicable, a comparison with SOD responses is provided in this section against findings into the CCC process and procedures in the permit office.

The issue of '*Code Compliance'* relates to whether or not Harding's design complied with the relevant codes and bylaws of the day. Essentially Beca have answered this question, and the expert opinion on this is clear. The Beca Report states that "*the resulting design of the CTV building contained significant non-compliances with the codes of the day."*

The number of non-compliances have taken on more significance following the physical testing of the beam column joints at the University of Auckland. An example of this is the effect that the poor diaphragm connections, which were only **60%-65%** of code requirements, had on the overall performance of the non-complaint columns.

This section of the report will deal with the CCC Building Permit and Code Compliance in two parts.

6.5.1 CCC Building Permit

As mentioned above, the granting of the CCC building permit for the CTV building was thoroughly examined during the CERC hearings. The approach of the commission and the resulting evidence and findings are set out in section 2.2 of the Final Report, Volume 6.

It is not the intention of this report to re-summarise the CERC findings and go over all of the evidence heard at the hearings, but the relevant CERC section does provide excellent background as to the individuals involved in the process and the sequence of events.

This section will instead narrow the focus to the issuing of the permit as Beca were asked to investigate as part of the Terms of Reference letter, and in particular look at the acts or omissions of two key CCC structural checking staff in 1986, Chief Building Engineer Bryan Bluck and Assistant Building Engineer Graeme Tapper, both deceased.

6.5.1.1 Beca Investigation

Section 8 of the Beca Report outlines the objective of the investigation into the CCC building permit, which was to identify whether or not the individuals involved with the permitting process omitted to discharge their duty, and if so, whether or not the omissions were major departures from the accepted practice of the day.

As part of their investigation into the council and the respective roles played by Bluck and Tapper, Beca examined two main areas; the building permit process for CTV Building, and the capacity of CCC to review the structural design.

6.5.1.2 Building Permit Process

It may be useful to refer to the simple timeline of the building permit process:

Date	Action
17 July 1986	Application for building permit filed at CCC without structural drawings
26 August 1986	Structural drawings submitted to CCC
27 August 1986	Tapper reviews drawings, sends letter to ARCE requesting further information
5 Sept 1986	Revised sets of signed structural drawings and calculations submitted
10 Sept 1986	Tapper signs off on structural aspects of project
30 Sept 1986	Building permit granted by CCC

In terms of the process, Beca state that the above situation was fairly typical of the time. This is based on the experience of their own in-house inquiries as well as the accepted practice of the day as ascertained from practitioners. Submitting an application for building permit with incomplete structural

documentation, followed by further submissions of completed construction documents before the permit was granted, was not an unusual practice in 1986.

Part of the reason for this was due to the busy building market in the mid-1980s. Early submission of the application allowed the council to make a start on the non-structural matters (Town Planning, Egress, Drainage, Utilities) while the structural drawings were being completed, resulting in the minimisation of the overall time to gain a building permit.

SOD Comparison – Permit Process

This finding by Beca is certainly backed up strongly by the SOD inquiries carried out by the investigation team. Practitioners from that time spoke about the tight timeframes for design projects, and the building permit submission was often considered an inviolable milestone. It was common to file the application with only partially finished drawings accompanying the paperwork, almost as a means of getting the process rolling, on the proviso that further drawings and calculations would come.

Most firms knew the lead time required for local councils to process building permits and would submit their applications based on these timeframes, rather than waiting until all drawings were fully completed before filing the paperwork, further delaying the project and increasing costs.

Some of the structural engineers stated that they placed less importance on the drawings submitted to council for permit application than the drawings that were prepared, reviewed, checked (and sometimes signed) by the director before construction. That was considered the last chance in the design process in which errors or mistakes could be picked up before the contractor began construction on-site.

This mind-set also goes to the issue of 'reliance on council to review structural design', which is also covered by Beca in the next section, and well supported by the SOD interviews which will also be discussed.

6.5.1.3 Design Certificates

The other important point that Beca note at this point is the '*Guidelines for Structural Checking Engineers'* which was prepared by Bluck and circulated amongst the Building Permit office in the early to mid-1980s.[27]

Point 3 of the guidelines stated:

> *"You are entitled to rely upon the recognised expertise of a Professional Designer who is prepared to certify under his signature that a specific design for a conventional or innovative structure (or detail), complies in all respects with the intent of the provisions of NZS1900 Chapter 8."*

Beca note that the reference to the earlier standard NZS1900 dates the memorandum to before the mid-1980s, but is indicative of the approach likely to have been in place in 1986 at the CCC.

For all intents and purposes, this guideline refers to the council accepting 'Design Certificates' which are prepared and signed by suitably experienced

[27] [redacted]

registered engineers and accompany the permit application. No design certificate for the CTV building has ever been located.

The CERC Report draws an interesting point here in relation to the lack of design certificate. According to section 2.2.3.5, page 81 of the Final Report:

> *"There was no evidence that a design certificate was provided for this building and we are satisfied that none was. Clause 8.2.5 of Bylaw 105 required that either calculations or a design certificate be provided with the design. Tapper requested calculations, and the Bylaw would not have authorised a request for a design certificate in addition."*

However, the structural drawings submitted to CCC on 5 September 1986 which accompanied the calculations, in response to Tapper's letter, were signed by the Professional Designer (Harding) in the box marked 'Approved'. In certain respects this complies with CCC Structural Checking Guideline 3 above, which is ambiguous about the exact nature of the form by which to *"certify under his signature".*

SOD Comparison – Design Certificates

The practitioners' view on city councils across New Zealand accepting design certificates accords with the CERC conclusions. The structural engineers canvassed by Police believed that council checking staff did not have the time, resources, or technical competence in high-rise structural design to carry out effective structural checks, and it made sense for council to rely on the expertise of the design engineer and the in-house checking protocols of the firm.

In terms of signing the drawings, the SOD respondents stated that the signature in the 'Approved' box was usually reserved for the director or principal in charge of the project, although at times this could also be the lead engineer, if they were suitably experienced. All were clear on one thing; putting your signature to drawings meant that you were taking responsibility for the quality and detail of the design, and as such you had to be totally sure that everything was okay.

6.5.1.4 Capacity of CCC to Review the Structural Design

Beca looked at the CCC process, and in particular they reviewed the timeline of the CTV application process, as set out in the table above. It is apparent from this timeline that once the structural drawings were supplied to CCC on 5 September 1986, Tapper had 5 days to carry out a full structural review of the building before he signed off on 10 September 1986.

A check of the 1986 calendar shows that 5 September 1986 was a Friday. Given that two of the days available to Tapper included a weekend, Beca believe that it is unlikely that he could have dedicated all of his time over this period to the structural checking of the CTV building.

Beca make several important points at this stage, which are very relevant and well supported by the SOD interviews.

The first point concerns the time, or the lack thereof. According to Beca, the design of the CTV building was *'not straight forward'*, and this is certainly

evident from the all of the issues which were discussed in section 6.3 of this report. Beca believe that it would take a reviewing engineer some time to familiarise themselves with the structural configuration of the building, complete or check a structural analysis and confirm compliance with the standards and codes.

Even assuming that the drawings were dropped off first thing on Friday 5 September and Tapper signed off last thing on Wednesday 10 September, then excluding the weekend that allows four working days at the most. In reality, the total amount of time that Tapper had to review the design was less than that. Beca do not believe that this was nearly enough time for Tapper to be able to conduct a full structural review, as described.

The second point relates to the fact that Tapper did not have access to the same resources as Harding did. He could not carry out the modal analyses that had been done by Harding using ETABS. Harding spent in excess of 300 hours on his design (seven and a half weeks) running numerous computer tests and doing his calculations, and Tapper had perhaps three or four days at the most to carry out the full structural review.

Therefore, Beca believe that in order for Tapper to have completed the review over such a short period, he must have relied on Guideline 3 in Bluck's memorandum, and accepted Harding's signature on the drawings as certification that the design was compliant in all respects with the codes of the day.

There are additional considerations when evaluating the CCC's ability to carry out a review. The experience of the reviewing engineer is relevant as it was only those structural engineers experienced in multi-storey design who were able to easily identify the issue of the connection between the floors and the North Wall Complex. Tapper was a civil engineer who had worked on the Benmore Dam and other similar projects. There is no evidence to suggest that he had practised as a structural design engineer and therefore was familiar with the issues for those particular structures.

There was also the pragmatic reality that the 1980s were a very busy period in Christchurch and throughout NZ for building design and construction. The volume of building permits meant that there was simply insufficient time to evaluate a design to the same extent that a design engineer would have. This heightened the importance of Bluck's instruction that the signature of the design engineer was sufficient to rely on and that design certificates were heavily relied on by the CCC.

Some of the errors identified would have only been possible through an engineer undertaking his own calculations and computations, something that was not possible for a reviewing engineer at the Council.

6.5.1.5 Identification of Gross Omissions Expected

In relation to the CCC review process, Beca make the comment that:

> *"Notwithstanding the limited time available, we would have expected that any gross omissions in the structural design of the building would have been picked up during a review of the structural drawings by a structural engineer experienced in multi-storey design".*

This raises the question of Tapper's career experience in high-rise or multi-storey design. Even if Tapper had had any experience in multi-storey design, given his age and the fact that he was approaching retirement, Police believe that any work he may have been involved with is unlikely to have been current with the sort of design he was asked to review with CTV, namely a reinforced concrete shear wall protected gravity load system that Beca describe as "*not straight forward"*.

Tapper's lack of relevant technical experience aside, Beca's expectation that a review of the structural drawings would identify "*gross omissions"* does highlight several important issues at this stage.

The first is that several experienced designers did identify gross omissions in the design based on relatively brief 'desk top' reviews of the structural drawings, but this was well after the building had been constructed. A full discussion of the post-construction reviews and the possible legal obligations of those individuals who reviewed the CTV design can be read later in this report, section 6.10.

However, for the purpose of this section which deals with the expectation by Beca that the gross omissions would be detected, a brief summary of those reviews is included here.

HCG structural engineers John Hare and Grant Wilkinson quickly identified "a vital area of non-compliance with current design codes" when Hare discovered that *"connections to the walls at the North face of the building are tenuous, due to penetrations for services, lift shafts and the stairs, as detailed on the drawings."*

In his interview with Police, [redacted] stated that "*there were a couple of other things in there which weren't that great either, with the joints and the columns and so on."* However, [redacted] believed that in terms of [redacted] the poor diaphragm connections were *"the obvious glaring error."*

[redacted] described [redacted] the poor connections as *"it's a bit like looking at a car and saying, hey, it's only got three wheels….for an experienced engineer, I'd say it's pretty fundamental and obvious."*

[redacted] carried out a desk top review of the CTV building in 1997 or 1998. He estimates he spent about 4 hours looking at the structural drawings. In terms of the poor diaphragm connections, [redacted] spotted the problem almost straight away. He stated *"This is the only structure I have seen where the building is attached, if you like, to the face of the shear core. That face being interrupted by two lift shafts and by one stairwell and the only, reliable interconnection is about 30 odd bars in the stairwell area."*

From the Police perspective, there were three experienced structural designers with expertise in multi-storey design who identified major problems with the CTV design, simply from looking at the drawings.

This fact raises a second issue which, in the Police's opinion, relates directly back to Beca's expectations around picking up gross omissions. If Reay felt that he was not competent or experienced enough to carry out a technically competent structural review, then as the principal he needed to ensure that such a review was carried out by a suitably experienced structural engineer.

If this had occurred, it is assumed that the obvious flaws in the design would have been identified at an early stage or would have at least provided a reasonable opportunity for the errors to have been picked up.

SOD Comparison – Reliance on Council

There are several interlinked issues at play here, reliance on the council checking process and the importance of in-house checking and review, and the SOD provides robust and consistent opinion on what the accepted practice was for designers in 1986.

The first main point is that almost no reliance at all was placed in the ability of local council checking staff to review structural design. Police cannot say that absolutely no reliance was placed on the council review process because several of the practitioners interviewed admitted that the council did carry out reviews of their designs and that the council checking process did have a part to play in the process. However, that said, the vast majority of the SOD engineers were emphatic in their dismissal of the council structural reviews in the 1980s.

None of the SOD structural designers relied on the council to check their structural designs in lieu of any other structural reviews, either in-house or by another experienced designer if the respondent was part of a smaller firm or a sole practitioner. Although the council checking procedures were indeed part of the overall process, the SOD respondents stated that the reason for this lack of reliance on the fact that the council did not have the time, resources or staff experienced in structural design.

The second point to note from the SOD phase on this section is that all of the respondents interviewed said that it was not accepted practice for one person to carry out all aspects of the structural design of a building on their own without having the design and drawings checked in some way before going to the council. The council was never relied upon as the only other structural review before construction, even for sole practitioners.

The position of the SOD phase on this was absolutely clear; from the point of view of the structural engineering profession, the accepted standard of the day in the 1980s was that the obligation to ensure that a design was free of errors and complied with the relevant codes remained squarely with the design firm. Structural engineers placed no obligation on councils to review structural design and identify flaws.

6.5.1.6 Conclusion – Building Permit

In terms of whether or not Tapper omitted to discharge his duty, Beca found that there were essentially three failings in the structural review process:

- The light spiral reinforcing in the columns (R6 @ 250mm) was not typical of the time and warranted at least a comment from a reviewer**;**

- The beam-column joint reinforcement on the drawings was significantly less than the minimum required by the code, and less than other similar buildings constructed in Christchurch at the time (refer to Beca comparison of other buildings, Appendix G);

- The attachment of the floor slabs to the NWC was significantly deficient and obviously so. A review should have identified this issue that required comment from the designer.

Regardless of all of the background issues, which were explored more thoroughly in the CERC report, concerning the allegations that Reay became involved and convinced Bluck that the design was adequate, Beca is of the view that the failure to highlight the above deficiencies does represent an omission by both Bluck and Tapper to discharge their duties in relation to the CTV building permit.

However, Beca are unclear on how much experience Tapper had in multi-storey design and therefore if it was a reasonable expectation that he identify the issues, given the limited time spent reviewing the design. They also found that, based on the SOD responses, that verification of the design during the building permit phase should not have been expected by the designers of the CTV because of the limited time and resources available to the CCC.

Further inquiries are to be carried out by Police to establish Tapper's previous experience prior to joining the CCC.

In terms of Bluck and Tapper, Beca conclude that whilst they both omitted to discharge their duty in terms of the permitting of the building, their omissions did not represent a major departure from the accepted practice in 1986.

6.5.2 Code Compliance

Beca are very clear on the fact that David Harding's design of the CTV building did not comply with the codes and bylaws of the day.

Following on from the discussions around the roles and responsibilities of the CCC Building Permit team, the structural design firm and the SOD position on accepted practice in 1986, Police believe that the question around who was ultimately responsible for ensuring that the design complied with the codes of the day has been already been answered - the structural designer.

The wording of Point 3 of the CCC Structural Checking Guidelines as well as the wording of Design Certificates from the mid-1980s confirms the view that it was the design engineer who bore the responsibility to certifying that the design was compliant with the codes.

The critical section of the Point 3 wording is:

> "…*certify under his signature that a specific design for a conventional or innovative structure (or detail), complies in all respects with the intent of the provisions of NZS1900 Chapter 8."*

The wording of the standard Design Certificate template, as used by Members of the Association of Consulting Engineers New Zealand (ACENZ) in the relevant section states:

> *I further certify that the works defined above have been designed in accordance with sound and widely accepted engineering principles: that they have been designed to support the loads specified in [ ] and further that I have ascertained to the best of my ability that the stresses and*

combinations of stresses in the various materials of construction under the above loads will not exceed the maxima to ensure the safety and stability of the structure if erected in accordance with these plans and specifications. Various aspects of the design are in accord with the following relevant authorities: [ ]

To a large extent Beca provides the expert opinion regarding the engineering omissions of Harding and Reay and provide an opinion as to the role of the CCC in permitting. Supporting evidence is provided by the SOD phase, and in particular from [redacted], an experienced engineer who was part of the SOD interviews and who also gave expert evidence at the CERC hearings on Code Compliance.

The only outstanding issue is, notwithstanding the requirement that the design engineer certify or provide sufficient information to show that the design complied with the codes, what role the council had in satisfying themselves that the design was compliant. This issue is discussed further in the legal analysis of the parties. This will require analysis and review by the Crown Solicitor.

6.6 Geotechnical

As part of the original design of the CTV building, a Site Investigation Report was carried out on the ground at 249 Madras Street by local Christchurch company, Soils and Foundations (1973) Limited, who specialised in Geotechnical Engineering Services. The Site Investigation Report, dated 18 June 1986[28], is attached (soils and foundations report).

This report was used by ARCE to design the foundation of the CTV building, described as shallow spread footings.

CERC heard evidence about the Site Investigation Report and concluded that the "scope and methodology" of the investigations carried out in 1986 were typical for that time and appropriate for the expected development. (CERC Vol 6, section 5.5, page 193 & 194) Evidence was provided by [redacted] of [redacted], who carried out the Geological Report[29] relied upon by DBH and CERC (BUI.MAD249.0470 & BUI.MAD249.0083).

In 2013 [redacted] of the University of Canterbury suggested that softening of the soils could be a possible explanation for the large inter-storey drifts. [redacted] stated, in an affidavit sworn on 13 August 2013, that movement of the foundations, due to softening of the soils under the SSW, could be a *"possible and feasible cause for the building's collapse".* That affidavit was forwarded to [redacted], Chief Executive at MBIE, by Reay's legal counsel in October 2013 to bring to MBIE's attention a "*potential alternative explanation"* for the collapse.

Beca considered all of this material as part of their investigation, in particular in terms of whether the foundations were compliant with the code, and also with regards to how ground conditions during the February earthquake may have affected the performance of the foundations, and in turn the building as a whole.

It should be noted that as a result of further discussions with Beca, [redacted] subsequently agreed with the assumptions and conclusions reached by Beca in terms of the

[28] FOLDER 2 – TAB 16
[29] FOLDER 2 – TAB 17

ground conditions and indicated that he only intended to raise the issue of the softening of the soil as a possibility to be considered.

Beca found that Harding's design of the foundations of the NWC and the SSW were substantial, and the design for both met minimum code requirements. With regards to the ground investigation, Beca was of the opinion that there was no evidence to suggest that the foundations suffered any structural damage during the earthquake. This conclusion was included in their opinion report dated 15 July 2016.

On 1 August 2016 Beca, at the request of Police, coordinated an investigation of the foundations and the surrounding soil at the CTV site. This investigation was carried out over a week and the excavation work was carried out by [redacted]

The findings of that investigation can be found in the BECA Foundations and Soils Investigation Report, dated 16 December 2016. In summary, other than some minor cracking in two ground beams, no damage to the foundations was observed, the foundation dimensions were as expected and the positioning of the foundations found to be essentially level.

Only minor evidence of liquefaction was observed, in one trench near the SSW foundation beam. This did not trace to the surface and was unlikely to have impacted on the response or performance of the building. The groundwater level in August (mid-winter) was lower than previously inferred, and together with other factors suggests that in February 2011 (late summer) the groundwater level may have been lower than previously thought, which reduces the potential for liquefaction.

Beca concluded:

"The expected response of the building during the 22 February 2011 earthquake predicted in our 15 July 2016 opinion report is unchanged by the findings of this investigation."

6.7 Construction and Construction Monitoring

The construction of the CTV building by Williams Construction in 1987 has been thoroughly examined during CERC, and considered by Beca during their investigation. The relevant sections in relation to construction and construction monitoring are found in the DBH report (Section 5.12, page 52), the CERC report (Vol 6, section 2.3) and the Beca report (Section 9).

In short, the following is a list of potential construction defects identified as issues and investigated by Beca:

- Potentially low concrete strength in columns
- Un-roughened construction joints at the beam ends
- Bent-back bars in some beams
- No spiral reinforcement in beam-column joints
- Lack of separation between columns and spandrels
- Lack of separation between columns and western infill wall
- Missing bar between column C18 and NWC
- Offset column cage

Beca also looked at the effect that these following factors had on the construction:

- Experience of the contractor
- Adequacy of Construction Monitoring by Designer Engineer
- Adequacy of inspections by CCC [redacted]

The personnel whose omissions are under scrutiny in this section are:

- Bill Jones, Foreman
- Gerald Shirtcliff, Construction Manager
- David Harding, Design Engineer
- [redacted], CCC Inspector [redacted]

6.7.1 Construction Defects

In terms of significance to the overall investigation, a number of the above list of deficiencies were considered and negated by Beca as being relevant to the collapse. This includes concrete strength (also discussed in this report), the bent-back bars, the lack of separation between columns, spandrels and infill walls, the missing bar at C18 and the offset column cage issue.

According to Beca, the two main construction defects considered relevant to the investigation are the un-roughened beam joints and the lack of spiral reinforcing in the beam-column joints.

6.7.1.1 Un-Roughened Beam Joints

In Beca's view, the ends of the beams were required to be roughened under the code, and that this could have been carried out on-site if not done at the pre-cast yard. The lack of preparation was a construction defect and primarily the responsibility of the contractor, although Beca believe that the designer and/or the CCC inspectors should have picked up the defect whilst on site.

The un-roughened joints were included in the defects of the 'As Built' specimen tested during the Physical Testing program at UoA, along with the lack of spiral reinforcing.

Based on their analyses, Beca conclude that the poor preparation of the joints, whilst not in accordance with the design specifications and not accepted practice, **would not** have significantly increased the propensity for sudden pancaking collapse.

6.7.1.2. Lack of Spiral Reinforcing in Beam-Column Joint

As above, the omission was included in the faults of the 'As-Built' specimen tested under February conditions at the UoA test facility. It was clearly a construction defect, as the steel should have been placed as required on the drawings. If this was not possible then the contractor should have contacted the engineer.

Beca expected that this defect should have been identified by the designer during Construction Monitoring at the site.

However, as with the un-roughened joints (and the rest of the list of defects) ultimately the Beca conclude that in their opinion, the lack of reinforcing in the joint region did not significantly contribute to the collapse.

In fact, the Beca opinion substantiated the CERC finding that the lack of reinforcement as detailed (R6 @ 250mm) would have had little effect on preventing joint failure, as it was so minimal and light (and non-compliant) that its inclusion was ineffective. This was demonstrated in the testing results and the relative closeness of the failure limits for both the 'As-Designed' and the 'As-Built' specimen.

6.7.2 Construction Personnel

This area has not been addressed by the Police investigation to date. Chapter 9 of the BECA report identifies the key themes addressed. There are failures at the building site in particular "*adequacy of construction monitoring by the designer.*"

Beca identified that both Jones and Shirtcliff's omissions were **major departures** from the accepted practice of the day. It will be for the Crown Solicitor to determine on the available facts the relevance of this phase 'construction' to the overall failure. The investigation team have yet to identify standard of the day witnesses in terms of construction site management such as how a foreman, a clerk of works or a construction manager might be expected to manage activities on site.

Bill Jones provided a helpful overview of what took place whilst on site, stating that he would sometimes telephone Harding for the pours and Harding would either come to the site or give the 'go ahead' without him. His memory is that this was probably one of the least supervised sites he worked on and noted that there was no clerk of works which would often be the case on multi-storey buildings. He received no direction from Shirtcliff and rarely saw him on site. [redacted]

It is important to note that formal Quality Assurance did not come into the industry until 1989 with ISO9001, but the engineers interviewed stated that the culture was well embedded and adhered to prior to this. "*….the process was, for the most part, inherently understood rather than being formalised and written down*" according to [redacted] in his SOD formal statement.

Further work is required by the investigation team in order to establish what the expected standard of practice was for an engineer who had been contracted to do construction monitoring as Harding had been. Ultimately it was not for the foreman to identify gross omissions with design, but there were some responsibilities that fell within the domain of the design engineer and others that were the foreman's responsibility. It will be important to establish this with subsequent inquiries.

6.8 Concrete and Reinforcing

The objective of the concrete phase was to ascertain if the CTV building was constructed to the specified concrete strength using 'special' or 'high' grade concrete as defined in NZS 3109. CERC identified concrete strength as a construction issue, but for reasons outlined below these issues assumed less significance during the hearings following the evidence of Robert Gaimster, Dr James McKechnie, Dr Brendan Bradley and Douglas Haavik.

Identifying the concrete supply company to the CTV building was seen as a major part of the Police investigation to ascertain if they were a member of the New Zealand Ready Mix Association who specify concrete strength. The concrete supply company was not identified

by CERC. Police have identified [redacted] as the company who supplied the concrete to the CTV building.

6.8.1 Concrete Strength

The structural specification[30] for the CTV building required the site concrete shall be at 10 MPa (at 28 days) or better. All other concrete in the floors, walls and columns were to be special or high grade, supplied from an approved ready-mix plant, as defined in NZS 3109: Clause 6.2. According to the structural specifications for the CTV building, the following strengths were specified:

- Foundations beams and pads 20 MPa
- Columns at Level 1 35 MPa
- Columns at Level 2 30 MPa
- Columns at Level 3 25 MPa
- All other structural concrete 25 MPa

The Hyland Smith report identified the concrete strength as a construction issue. Material testing of salvaged columns found that the concrete was "significantly weaker than expected". Tests of twenty six column samples from levels one to six had a mean concrete strength of 29.6 MPa.

The Hyland Smith report also stated an expectation that the actual concrete strength would be 25% higher than the specified concrete strength due to "the conservative approach to achieving specified strengths, and the expected strength gain with age".

Consequently "low concrete strength in critical columns" (namely columns level 1-2) was listed as a factor that contributed (or may have contributed) to the collapse.

6.8.2 Concrete Experts

A number of experts at the CERC expressed disagreement with the Hyland Smith report conclusion about concrete strength. The principle criticisms included:

- core strengths being taken from areas of distressed concrete
- the limited number of cores taken to draw firm conclusions
- erroneous correlation of the Schmidt hammer testing against core strength
- the low aspect ratio of some cores
- testing perpendicular instead of parallel to the column length
- an inappropriate interpretation of results

6.8.3 Cement and Concrete Association of New Zealand (CCANZ)

The Cement and Concrete Association of New Zealand (CCANZ) which represents over 300 corporate and individual members and works toward fostering industry solutions as well as training and research initiatives in concrete related areas.

[30] FOLDER 2 – TAB 18

Robert Gaimster

Robert Gaimster is the Chief Executive of the CCANZ. A submission to CERC from CCANZ[31] was critical of the Hyland Smith report. In summary the submission stated the Hyland Smith reports concrete core testing methodology was not best practice for the following reasons:

- Testing objective not clarified
- Cores taken from distressed concrete
- Issues around core diameters, number and location
- Incorrect application of concrete aging
- Schmidt Hammer test – insufficient number and poor sample

The CCANZ summary concluded by stating the Hyland Smith reports conclusions in relation to the concrete column strength must therefore be questioned.

Robert Gaimster gave evidence and presented his submission on behalf of the CCANZ at the CERC on 15 August 2012[32] He was interviewed by [redacted] on 9 April 2015[33] .

[redacted] is the Chairman of the Plant Audit Scheme of the NZRMCA, who work alongside CCANZ. [redacted] has provided a statement in response to the DBH Report.

He checked the density measurements of the samples tested in the DBH report and concluded that the samples were at the expected densities for the design strengths specified in the plans. He reviewed Plant Audit Scheme records for all of the major ready mixed concrete suppliers in Christchurch in 1987 and determined that on average, the concrete that was supplied was between 5.5 and 7.5MPa over the design strength. [redacted] indicated that the test results that were obtained in the DBH report could be attributed to sampling distressed concrete and possible poor workmanship including the addition of water or excess air entrainment in the poured concrete. [redacted] pointed to the Schmidt Hammer test results obtained in the DBH report which showed that the strength of the concrete in the columns of the CTV Building was in the 31 – 50MPa range, in keeping with the specified design strengths.

6.8.4 Experts of interest - concrete

Dr James MacKechnie

CERC requested a peer review of the Hyland Smith report by Dr MacKechnie, a plant engineer at Allied Concrete and an Adjunct Senior Fellow of the Civil and Natural Resources Engineering Department of the University of Canterbury.

Dr MacKechnie criticised the testing processes and referred to incomplete or inconsistent reporting which limited the reliability of information. He went on to state

31 [redacted]
32
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that the conclusions drawn in the Hyland Smith report were not fully supported by the evidence and ignored accepted guidelines used to interpret core strengths.

Dr MacKechnie gave evidence at CERC on 15 August 2012[34]. He has not been interviewed by Police.

Dr Brendon Bradley

Dr Bradley was instructed by [redacted] on behalf of Alan Reay Consulting Limited (ARCL) to provide independent expert advice on a number of issues including a critique of the concrete modelling and statistical analysis of concrete test data presented in Hyland Smith report.

Dr Bradley principally looked at the interpretation of the Hyland Smith report and its reconciliation with the specifications for the concrete. He said that irrespective of testing and results the comparison with specifications was inappropriate and as a result yielded an incorrect assertion that the concrete was below strength.

Dr Bradley gave evidence at the CERC on 25, 26 July and 15 August 2012[35]). He has not been interviewed by Police as yet.

Mr Douglas Haavik

Douglas Haavik, a registered civil engineer in California who specialises in concrete materials, was engaged by [redacted] on behalf of ARCL to provide independent expert advice. The cost for this expert evidence was in excess of $250,000.

In an effort to better determine the concrete strength prior to the seismic events, a study of the concrete strength along with appropriate petrographic examination was commissioned by [redacted]. This work consisted of testing eight cores removed from the column remnants of the building along with petrography.

Haavik gave evidence at CERC on 15 August 2012[36].

Haavik noted that his core strengths were between 2-55 per cent higher (a large difference in range) than those of the Hyland Smith report. His report concluded that there is no reason to believe there was a systemic reduction in the strength of concrete supplied to the building and that if there was any such strength reduction, it would likely be attributable only to gross error for a specific load of concrete. This would itself be extremely unlikely.

6.8.5 CERC Findings

The CERC Report found that the concrete was likely to have been at or above the strength specified by the designer and that there was no reliable evidence to suggest the concrete was understrength in any columns.

6.8.6 Police Investigation

The objective of the concrete phase of the Police CTV investigation was to identify the concrete supplier and concrete placer of the CTV building. Establishing the identity of

34 [redacted]
35
36

these companies may locate eye witnesses and hard copy documentation relating to the CTV building.

CERC did not identify the concrete company who supplied the concrete to the CTV building site, nor the concrete placing company who worked on the CTV building site. Establishing the concrete company who supplied the concrete to the CTV building would confirm the concrete was supplied from an approved ready-mix plant, as defined in NZS 3109. Establishing the concrete placer working on the site of the CTV building would assist with both confirming the identity of the concrete supplier and gauging the quality of the concrete placing work, based on the experience and reputation of the placing company. The strength and performance of the concrete is dependent on a number of variables, including how well the concrete is placed and vibrated, removing the air.

The Concrete Phase was also another way to identify potential eye witnesses and hard copy documentation regarding the construction site at 249 Madras Street.

6.8.7 Concrete Supply Company

Inquiries at the Christchurch City Library identified ten potential concrete suppliers in Canterbury in 1986. Three of the companies were eliminated, as they were based in Ashburton and Rangiora. One further company was eliminated as they specialised in only small loads of concretes. That left six concrete supply companies who could have supplied concrete to the CTV building:

All of these ready mix concrete suppliers were graded under the NZ Ready Mixed Concrete Association's (NZRMCA) Plant Audit Scheme as suppliers of Special Grade concrete. Special Grade suppliers used separate scales to measure the cement and the aggregate that went into each batch of concrete. This meant that they were able to batch their concrete very accurately and produce concrete at the desired strength. Another key part of the audit scheme was ensuring that concrete was tested in accordance with the NZ Standard at the time. Effectively at the large concrete companies a daily sample of concrete would be tested for slump, yield, air entrainment, and compression strength at 28 days.

Representatives from all of the Ready Mix Concrete Suppliers have been contracted. All business records, including those from , have been destroyed.

6.8.8 Williams Construction

Inquiries with Williams Construction staff identified several potential concrete supply companies to the CTV building. The statement and documentation obtained from showed that had some connection with the CTV building.

[redacted] – [redacted]

[redacted] spoke to [redacted] on 20 February 2015. [redacted] was unsure who delivered the concrete to the CTV site but he did mention three concrete supply companies he recalled using. He mentioned [redacted] and said the main one was [redacted]

[redacted] – [redacted]

[redacted] interviewed [redacted] on 13 and 16 March 2015.

[redacted] states *"from my knowledge I think it was* [redacted]*"* (who supplied the concrete to CTV building). This statement was based mainly on a document[37] [redacted] provided to Police. The document is a letter written by [redacted], to [redacted], Williams Construction. The letter confirms concrete prices for Durham Tower and Manchester Street and added in handwriting are concrete prices for "Madras Street" and "Riccarton."

[redacted] provided Police with another document[38] showing quantity surveyor's workings outlining the financial status of the building at 31 January 1987. [redacted] believes the workings belong to [redacted] who handled all the financial aspects of Prime West at the time of the CTV building construction. These workings show [redacted] supplying 9.2 cubic metres of concrete between the 13 and 16 October 1986. This date range fits with the beginning of the foundation work at 249 Madras Street.

6.8.9 [redacted]

Police inquiries found strong evidence that [redacted] supplied the concrete to the CTV building and poured the concrete on site. Inquiries with CCANZ and documentary evidence seized from that organisation provides strong evidence that over the duration of construction at the CTV site, [redacted] was certified as 'special grade' by the New Zealand Ready Mixed Concrete Association.

[redacted]

[redacted] has been interviewed and a Formal Statement obtained. He indicated that he has no specific recollection of the company supplying concrete for the CTV building, but acknowledged that he did not go to all of the building sites that [redacted] supplied concrete to.

[redacted] does confirm that [redacted] was a member of the New Zealand Ready Mixed Concrete Association (NZRMCA) in 1986/1987. The NZRMCA were responsible for running plant audits and conducting QA testing, the results of which determined the grade of concrete the firm received.

[redacted] Batchers

[redacted] and [redacted] were two of three concrete batchers employed by [redacted] in the 1980s. The third was [redacted], now deceased.

[37] EXHIBIT 71000.1.
[38] EXHIBIT 71000.2.

[redacted] did not specifically recall batching concrete for the CTV Building, but acknowledged that he did remember batching for other major jobs, such as Durham Towers.

[redacted] also stated that he did not recall batching concrete for the CTV Building, but that he tended to remember jobs where there was some issue with the supply of concrete to the site.

[redacted] and [redacted] described the concrete batching process, the records that were kept, and the testing that was undertaken at [redacted].

[redacted] **Pump Operator**

[redacted], brother of [redacted] worked at [redacted] operating the Concrete Pump. He can recall pumping concrete at the Building site at 249 Madras Street, and in his statement he detailed a specific incident on the building site involving himself and the site Foreman [redacted]. [redacted] also stated that [redacted] was the concrete placer who had worked on the building.

[redacted] **Truck Drivers**

Eight concrete truck drivers who worked for [redacted] at the time the CTV building was constructed have been interviewed by Police and statements obtained. Of these, [redacted] and [redacted] both recalled delivering concrete for [redacted] to the building site at 249 Madras Street.

6.8.10 Concrete Placing Company

The placement of concrete is an important operation and particular care is necessary during this process. It involves a number of different phases from the time when concrete leaves the mixer and the finished structure: transport, pouring into formwork or a mould, vibration, maturing, form removal and curing. The concrete finishers will place the concrete either directly from the concrete chute, concrete pump, concrete skip or wheelbarrow. They screed the surface to ensure that it is smooth and level.

[redacted]

Whilst [redacted] cannot specifically recall [redacted] doing the concrete placing at CTV, he did state that [redacted] company used to do *all* the concrete floor placing for Williams Construction.

[redacted]

[redacted] recalls his company, [redacted], doing the concrete placing on the 249 Madras Street site, along with his employee [redacted]. The concrete placing included the five floors of the CTV building, and he recalls the floor being poured on metal Hi-Bond.

[redacted] remembers the foreman on the job being [redacted] who [redacted] knew well, and even remembers doing some concrete work on [redacted] house in Avonside. [redacted] remembers going to [redacted]' office to get job numbers so he could invoice Williams Construction. He recalls [redacted] having the construction program in his office and at the end of a job would give him the date for the next floor pour.

According to [redacted] spoke to him on site and told him if he ever had a problem with getting paid to go and see him in his office on Hereford Street. [redacted] remembers taking [redacted] up on that offer after late payment from Williams on an invoice. He left the CTV building site walked to Latimer Square turning left on Hereford Street.

Police inquiries confirm that Williams Construction office was at 176 Hereford Street in 1986.

[redacted] recalls [redacted] supplied the concrete to the CTV building and remembers [redacted] as the concrete pump operator. [redacted] stated [redacted] was supplying concrete to both Durham Towers and the CTV building at that time.

[redacted]

[redacted] was a concrete placer who worked for [redacted]. He has been spoken to by Police and a statement obtained. He recalls working on the CTV Building, and that the pump operator was [redacted] and that [redacted] trucks delivered the concrete to the site.

6.8.11 Plant Audit Scheme - concrete testing

As mentioned above, Concrete suppliers who were part of the NZRMCA were graded under the Plant Audit Scheme. A key part of the audit scheme was ensuring that concrete was tested in accordance with the NZ Standard at the time. Daily samples would be tested for slump, yield, air entrainment, and compression strength at 28 days.

[redacted]

[redacted] was an independent Concrete Plant Engineer used by [redacted] in the 1980s and 90s. He has made a statement describing the testing that he conducted on [redacted] in accordance with NZ Standard 3104. According to [redacted] managing Director [redacted] aimed to have the concrete that the company supplied at 1-2MPa over design strength, which he saw as a way of guaranteeing that their concrete was always the correct strength.

[redacted] recalled no issues with the quality and strength of the concrete produced by [redacted] during his tenure as Plant Engineer.

A statement obtained in February 2017. Sadly, [redacted] passed away at his home in Queenstown in March 2017.

6.8.12 Conclusion

Police have identified [redacted] as the concrete supply company and [redacted] as the concrete placing company to the CTV Building. The [redacted] pump operator, [redacted], two drivers [redacted] and [redacted], Concrete Placers [redacted] and [redacted] all recall working on the site.

Given the length of time since construction took place and general retention periods of most company records being around 10 years, locating documentary proof of the concrete supply to CTV was always going to be unlikely. However, circumstantial evidence from witnesses indicate that [redacted] supplied the concrete to the CTV

building, poured the concrete on site, and, at the time of construction, [redacted] was certified 'special grade' by the New Zealand Ready Mixed Concrete Association.

6.9 The Drag Bar Retrofit

The timing of the 1987 stock market crash and subsequent down-turn in the economy saw demand for office space in the Christchurch CBD dry up. The speculative CTV building project, with no tenants confirmed prior to the start of construction, sat vacant for three years until the ANZ moved into the premises in November 1991.

The other consequence of the market crash was that Prime West went into receivership, leaving the building in the hands of the receivers, KPMG Peat Marwick. In January 1990, the Canterbury Regional Council (CRC) made inquiries about the possible purchase of the CTV Building, and Holmes Consulting Group (HCG) were engaged to carry out the pre-purchase review of the building, as previously discussed in 6.5.

The section will briefly cover the circumstances of the HCG report and how it came about, as well as discussing the relevant issues arising from it. These issues include the way in which the HCG Report was interpreted by ARCL, the resulting remedial work and communications with CCC and the net effect that the drag-bars had on the seismic performance of the building in 2011. This section also deals with the acts or omissions made by Alan Reay and Geoff Banks with regards to the remedial work, and whether or not these were major departures from the expected standard.

6.9.1 The Holmes Consulting Group Report

On 24 January 1990, John Hare was working as an associate at Holmes Consulting Group. He was relatively experienced in multi-storey design and had recently returned to Christchurch after working in structural engineering overseas. His manager, Grant Wilkinson, a director at Holmes, was also a very experienced structural engineer at that time. Wilkinson gave Hare the job because Hare was suitably experienced to carry out the review, having recently completed a similar review of another building, and he was relatively free to pick up the CTV job at short notice.

Both Hare and Wilkinson gave evidence at CERC, and an excellent summary of the CERC evidence is found in Vol 6 section 2.4. Both witnesses have also been interviewed by Police. The transcripts are on file.

6.9.1.1 Due Diligence vs Peer Review

An important distinction to make at this point is to accurately categorise the HCG Report for what is was at the time; a *'technical review assignment'* on behalf of a potential purchaser carrying out due diligence, and not a 'full peer review' of the design.

A full peer review is a methodical and thorough look at all aspects of the structural design in order to determine whether the building complies with the relevant codes and bylaws. It can take some time to carry out and may include a team of engineers. A due diligence study is a more general look at the design in order to identify possible areas for concern. It is carried out over a shorter period of time and is usually done by one person.

The main differences between the two types of review would appear to be the amount of time spent carrying out the review, and the degree to which all of the details are checked and verified.

There are several other points to note here. The first is that it is far more common today to carry out full peer reviews of a structural design than it was in 1990. Even the manner in which an engineering firm would carry out a due diligence study or technical review today have changed, more in line with society's changing expectations towards professionals and legal and criminal accountability should something subsequently *'go wrong.'*

Another important point is the way in which engineers approach reviewing another engineers' work, which is governed by the IPENZ code of ethics. Police believe that expert evidence on these aspects, including the issue of whether or not engineers involved in any structural review of the CTV Building prior to February 2011 met or breached ethical guidelines, will be needed in the event of a prosecution. [redacted] Trevor Robertson, was considered an expert on engineering ethics and gave such evidence at CERC. Robertson would be a good starting point, and further clarification on these matters will be required, especially about the SOD for 'due diligence' reports carried out in 1990, as opposed to current accepted practice.

In any case, Police believe that it is very clear from the facts, particularly from the statements of both Wilkinson and Hare that the HCG report was never intended as a full peer review of Harding's design and only ever meant to be what Hare describes as a general look in order to identify any major problems with the building, something which is likely to make it dangerous, or something that may require a disproportionately high amount of maintenance or attention.

6.9.1.2 HCG Findings

Hare recalls being briefed on the job by Wilkinson, and he went about obtaining the architectural and structural drawings from the Architect, Alun Wilkie. Hare knew both Wilkie and Reay from previous projects and dealings, and he chose Wilkie to approach about accessing the drawings [redacted]

Hare reviewed the drawings and quickly identified a potential major issue with the diaphragm connections. [redacted]

[redacted] He briefed Wilkinson and then made two phone calls. Hare made an appointment to see Bryan Bluck at the CCC to get the background on the consenting issues. He also rang ARCL and advised Reay that he was doing a pre-purchase review and asked for an appointment to discuss the CTV design and to go through the file.

Hare said the meeting with Bluck was a bit of a non-event because Bluck's concern turned out to be about some fire escape stairs, and not a structural issue. Bluck did not mention Graeme Tapper, Alan Reay or David Harding and

the permit issues of early September 1986. [redacted]

Hare remembers visiting the ARCL offices and meeting briefly with Reay who introduced Geoff Banks, who was a director at the company. Banks gave evidence at CERC and his statements and transcripts are available at the CERC website. He has also been interviewed by Police (transcript)[39]. There is also a synopsis of Banks' synopsis of evidence[40].

Hare sat in an office and looked through the CTV file and ascertained that there was no further detail regarding the ties to the NWC on the file. He raised this with Banks who agreed that there did appear to be an issue and that there was no evidence on the file that anything had been done.

Either Reay or Banks said to Hare that the issue may have been dealt with at construction, and someone was going to get in touch with Harding to check. The Harding inquiry was negative, so Hare met again with Banks several days later on-site at the CTV building to carry out further examination with what Hare refers to as a *'bar meter'*, a metal detector used to find reinforcing steel in concrete. Banks found no extra sign of reinforcing to that indicated on the drawings.

Hare began writing the due diligence report [redacted]

6.9.1.3 Initial cost estimate – drag bars

Hare also completed some preliminary calculations for some retro-fitted 'drag bars' as a possible solution to the problem, and had these costed out by a Quantity Surveying firm used by HCG, Russell Drysdale Thomas (RDT). The reason that Hare did this was to provide the client with a ball-park figure for the cost of fixing the problem, rather than being a full and final analysis and design. The costs indicated by RDT for the fixing of the diaphragms to the NWC by way of two steel drag bars on five floors came out at $15,750.00 (including GST).

Wilkinson advised the client of the preliminary findings of the structural report and the estimated cost of repairs. Around 31 January 1990, HCG were advised by the client that they were no longer considering the building for purchase. Effectively this meant that HCG were to stop working on the job, as they were no longer getting paid for it.

Several things occurred at this point which are important in terms of the investigation and the question of:

- whether there were omissions by engineers Hare, Wilkinson, Banks or Reay in the course of designing and installing the drag bars, and if so,

39 [redacted]
40

- were these omissions a substantial and operating cause of the deaths, and if so,
- were these major departures from the expected standard of the day.

[redacted] Hare completed the rest of the structural report based on what he had discovered over the previous four days. [redacted]

Hare likened this as more like evidence of the work he had done to date, [redacted] He never intended the report to be a final version or relied upon for anything in terms of structural design or remedial repairs as a full review.

On 31 January 1990, Hare faxed the documents to Shultz Knight, who were acting on behalf of CRC in the process. Hare handwrote on a cover page *"Please see over a draft copy of our report, for your information and comment, Regards, John Hare"*. Hare says that, in hindsight, the report was not very well marked as 'Draft' or even checked or completed, and it was unsigned. Hare states that today, such a report would never leave the office without watermark stamps of "DRAFT" or similar on every page, because organisations are far more aware of how information can be disseminated once it leaves the firm, but before the days of word processors this was not possible.

Somehow John Hare's draft HCG Report and the accompanying drag bar design found its way to ARCL. Banks included the report, minus the cover page marked 'draft', as part of a sheaf of documents that he faxed on 2 February 1990 notifying insurance members of the potential problem and outlining a plan of action.

6.9.2 ARCL reliance on HCG Report

During the CERC hearings, the Commission heard evidence from both Reay and Banks that indicated that they placed some weight on the HCG Report, and in particular, some fairly generalised wording around the state of the building. One of the sentences referred to by counsel for ARCL during CERC was point 2 of Hare's conclusions; *"The layout and design of the building is quite simple and straight forward and generally complies with current design loading and material codes."*[41] .

Both Hare and Wilkinson were critical of this reliance by ARCL in 1990. Wilkinson believed that Hare's preliminary review was only a brief look at something that required a far more in-depth investigation. In terms of the actual drag-bars, Wilkinson told Police that further investigation would have shown that the drag bars needed to be far bigger and extend further into the floor slabs than the initial calculations indicated, and that he expected Hare would have determined this had he had more time.

Hare believes that a number of generic sounding paragraphs from the previous structural report, which related to a totally different building, may have stayed in the draft version, and that because he was no longer working on the job and never intended the report to go to the design firm (and be used to justify subsequent actions)

[41] FOLDER 2 – TAB 19

he didn't think too much more about the wording before it left the office, unmarked, unchecked and incomplete.

CERC were also critical of both Reay and Banks and the Final Report contains a summary of their findings:

> *"Notwithstanding the matters raised by counsel for Dr Reay and Mr Banks, we consider that it should have been apparent to them that the report was not a full review of the structural integrity of the building. Further, no enquiry was evidently made of HCG to ascertain the extent and implications of the qualifications stated in the report. Dr Reay knew of Mr Harding's inexperience at the time he designed the building. The identification of such a "fundamental" design error should have signalled the need for a more detailed review of the design, especially given that this was the first time he had looked at the structural drawings.*
>
> *Reliance on the HCG report meant that an opportunity was lost to conduct a full review of the building's design."*

6.9.3 Banks' Drag Bar design

Reay gave Banks the task of coming up with a solution to the problem identified by HCG. Banks, who replaced Harding at ARCL when Harding left in 1988, started out on the assumption that the rest of the building complied with current loading codes, as mentioned in the HCG Report. The Beca final report devotes section 10 to the Drag Bar retro-fit and Banks' calculations and final action.

In short, Banks took Hare's preliminary sketches and calculations and applied various deductions to the forces required under the codes of the day. This reduced both the size of the drag bars and the number of drag bars required, from all five upper levels to just levels 6, 5 and 4. This also reduced the overall cost of installing the drag bars.

Banks finalised his design and contacted John Hare at HCG on 14 February 1990 to discuss the specifics, especially in regards to the reductions he had applied to forces, resulting in the requirement for less steel than Hare originally estimated.

Both men remember this conversation, and Banks made a diary note about it, including the date. Banks recalls that he told Hare about his calculations and that Hare had agreed with him on the phone that the figures sounded right, and that there was only the need for bars on levels 4, 5 and 6.

Hare remembers it very differently, as he didn't know why Banks was calling him. This leads to the next area of this section – the ethical obligations.

6.9.4 Ethical Obligations

According to both Hare and Wilkinson, HCG had fully complied with all of their ethical responsibilities in this case. They contacted ARCL to advise them they were reviewing one of their buildings and then met with the Principal Consultant and a Director to review the drawings with them and highlight the area of concern.

In the minds of the HCG engineers, once ARCL had acknowledged that there was cause for concern and had indicated to HCG that they would carry out further investigation, then Hare and Wilkinson felt that the problem had reverted back to being the responsibility of the original design firm.

That view was endorsed at the CERC hearings by Trevor Robertson, a highly qualified structural engineer [redacted] Robertson gave expert evidence around the ethical obligations of engineers, especially in this case the *obligations of disclosure of knowledge about a structural weakness that has the potential to affect the safety of the users of a building or the public.*

Beca consider the roles played by Hare and Wilkinson in section 10.5.4 of the Beca Report, page 75. There is discussion about whether the statement in the HCG Report about *"the gravity structure is sound and complies in all respects…"* is a second opinion that Harding's design was compliant, apart from the diaphragms. However, Beca discount this and find that, given the short period of time available, the pre-purchase reviewer could not have been expected to uncover the issues around the lack of stiffness of the shear walls and the vulnerable gravity structure without doing significant analysis, especially after being told by the client to stop work.

Beca make the comment that *"it is noted that no one relied on the result of the review, except the then current owner and ARCL, who relied on the fact that the only error identified was the only one."*

6.9.5 Geoff Banks

In terms of the final design by Banks, Beca have detailed how Banks approached the problem and arrived at his final design. Without going back over what Beca discovered, the outcome of their investigation into Geoff Banks and his responsibilities for the design of the retro-fit drag bars is as follows:

- Banks elected to focus solely on the identified problem of the diaphragm connections and did not conduct a review of the entire structure. This was not a major departure from the accepted standard of the day in 1990.

- He made errors in his checks and his retro-fitted diaphragm connections still did not meet the code requirements. Beca found that in this regard, Banks omitted to discharge his duty in relation to fixing the identified problem, and that this omission was a major departure from the accepted practice of the day.

However, what is important for Banks is the result of the additional Non-Linear Time History Analyses (NLTHAs) that [redacted] ran jointly with Beca as part of their investigation. These analyses indicated that the response of an otherwise compliant building model (i.e. good connections to the NWC) was not greatly affected by whether the ties were modelled as retro-fitted or as fully compliant.

Beca make the comment that although the drag bars were obviously intended to improve the strength of the building and its seismic performance in the north – south direction, the installation of the bars may have actually worsened the torsional effect in the east – west direction, increasing the deflections on the columns. However, Beca believe that this did not have a significantly detrimental effect on the building overall.

Beca conclude from these results that the non-compliance of the drag bars **was not** a significant factor in the collapse of the building on 22 February 2011. This means that although Geoff Banks omitted to discharge his duty in terms of the strengthening work, and this omission was a major departure, the omission **was not** a substantial and operating cause of the deaths.

6.9.6 Installation

The next two areas of significance with regards to the drag bars are the time delay between designing the bars in February 1990 and installing them in October 1991, and the failure to apply for a building permit to install them.

In terms of delay, there was considerable discussion about this at CERC and conflicting evidence was heard from various parties about whether or not the lengthy time delay was satisfactory. The CERC findings aligned with ethics expert Trevor Robertson, who believed three to six months was all that was required to complete that job. Ultimately, in terms of the Beca and Police investigations, the result of the NLTHA on the drag bars and how they had little effect of the collapse means that this issue is merely noted at this stage.

6.9.7 No building permit for drag bars

Similarly then, but possibly of more significance is the failure by Banks and ARCL to apply for a building permit to add structural elements to an existing building. From a purely technical point of view, there seems little doubt that the situation did call for the council to be notified of the structural change by way of an application for building permit.

Geoff Banks gave evidence at CERC and has since confirmed in an interview with Police that he did not believe a building permit was required for the retro-fit work. He believed that HCG had informed the CCC of the issues they were investigating and also that any work undertaken was simply completing that which the original building permit had been issued for. He believed it was an omission from the original construction of the building that had been missed so any steps to complete that were already covered by the original permit.

Banks was very clear that he wanted to do the job properly, that he was not trying to hide anything from the CCC and that there was no instruction from Reay to do things as cheaply as possible. He believed that he was dealing with the issue to the best of his ability.

CERC heard evidence from Stephen McCarthy, then CCC Resource Consents and Buildings Policy Manager, who said that under CCC Building Bylaw 1990, clause 2.2.1, a permit was required before a person did erect or commence to erect any building, with the definition of erect meaning any alteration, repair or addition.

Even with argument from Reay and Banks that the wording was too 'widely framed', a second requirement under clause 2.16.1 meant: *"written approval was required from the City Engineer authorising a departure from the original permit drawings."*

CERC did not agree with ARCL's submissions on this point and found that the failure to apply for a permit meant that the inadequacy of the connections was not drawn to the attention of the CCC.

It is noteworthy that ARCL did not apply for a building permit for what can only be described as a significant structural repair. In contrast, the same firm applied for a number of other building permits in respect of the same building prior to the drag bars being put in.

These applications were discussed earlier in this report, in sections 4.3.1 and 4.3.2, and relate to the erection of a non-structural canopy in 1988 (Harding) and the ANZ Fit

Out (Banks) that occurred about a week before the installation of the drag bars in October 1991.

However, in light of the findings by Beca that the installation of the drag bars did not greatly affect the seismic response the building, the issues around time delay and failure to apply for a permit do not provide further evidence of culpability by Banks. He is effectively covered by the fact that his decision not to carry out a full structural review of Harding's design was not a major departure from the accepted standard of the day and the drag bars were not a substantial and operating cause of the collapse of the building in Beca's opinion.

In regards to the question of what might have happened if the CCC were notified of the problems with the diaphragm connections and the planned remedial works, it remains doubtful that the permit application would have triggered anything more than a perusal of the drawings and calculations, something that had already occurred at CCC resulting in the issuance of a permit.

The capacity and resources available to Bryan Bluck and his team at CCC had not improved significantly in the four years since the original permit process was carried out. Beca's own in-depth investigation into Harding's design, calculations and the results of his 3D modal analysis show that it would have required a full structural review by an experienced and competent structural designer to highlight the various failings by the original designer and the list of non-compliances detailed by Beca in their report, section 7.4 (page 52).

However, despite the apparent unlikelihood that CCC would have picked up the non-compliances if Banks had applied for the permit, the fact is that had the application been made, then the drawings and calculations for the remedial work would have been on the CCC file. The file was reviewed by a number of structural engineers over the course of the building's life and it is always possible that one of these practitioners (Falloon, CTV Fit Out 2000) would have noted the additions and have been prompted to investigate further.

However, in terms of this investigation, the possible outcomes had different actions occurred is nothing more than speculation.

According to the SOD phase interviews, the correct time for such a review to take place was at the time of design, as part of technically competent oversight provided by the principal or director responsible for the design project, and this further highlights Reay's omission to discharge his duty in 1986.

6.10 Seismology

Police believe that there are several 'earthquake related' issues within this section that will require further consideration and additional inquiry work, should a prosecution against any individual be commenced. Some of these issues have been raised by CERC and as part of Beca's investigation, and some are merely issues that *could* be raised by defence, and therefore need to be followed up in order that these can be addressed or negated, should they be raised.

Thought could also be given to identifying, most probably through inquiries with the Institute of Geological and Nuclear Sciences Limited (GNS Science) and the Universities of Canterbury and Auckland, a suitably qualified seismic expert (or experts) who would effectively be the 'earthquake expert(s)' and give authoritative evidence during trial that would address some of

the issues. Dr Brendon Bradley of the University of Canterbury is one example of a seismic expert. Dr Bradley gave expert evidence on ground motions at the CERC hearings in 2012.

The main seismic issues are:

- The 'size' of the February earthquake
- Cumulative effect of multiple earthquakes (September 2010 – February 2011)
- Vertical acceleration versus horizontal acceleration and effect on CTV collapse
- The choice of strong-motion recording station for CTV (CCCC)

Section 11 of the Beca Report investigates these issues in more detail, but a summary of each issue and the expert conclusion are set out below.

6.10.1 Size of the earthquake

The characteristics of the February earthquake are dealt with as part of the CERC Final Report, Volume 1 section 2, as well as Dr Bradley's evidence at the CTV hearing, discussed in Volume 6, section 5.4.4.

Notwithstanding the voluminous material on the February earthquake, it is generally accepted that the seismic event on 22 February 2011 was bigger than the loadings code specified in 1986, but that the shaking was of relatively short duration.

The possible issue likely to be raised at trial would essentially be that the size of the earthquake exceeded the limits in the code by such a degree that it was impossible to design a building to withstand the earthquake.

In their report, Beca believe that the higher intensity but short duration of the February earthquake makes comparison with the design loadings in the code difficult, but that "*it would not be unreasonable to consider it to be a severe earthquake but not as severe as the design loading as a cursory inspection of the elastic spectral response might suggest."* Beca report, section 11.3.2 page 80.

In other words, Beca believe that although it was a big earthquake (severe) it was short enough to allow buildings designed to the relevant codes to survive, because they had sufficient resilience to meet the *"seismic performance objectives"* of the loadings code of the day. These are summarised by Beca (11.3.3, page 80) as:

- Able to resist minor to moderate intensity earthquakes without damage, and
- Able to resist major earthquakes without collapse, but with structural as well as non-structural damage expected.

Beca provide some very good commentary (11.3.3, page 80) around the objectives of the loading codes and the expectation, both here in New Zealand and internationally, that buildings will survive, without collapse, earthquakes *much* larger than stated in the codes.

Two very important facts are relied upon by Beca in reaching their conclusion that the size of the February earthquake, on its own, was **not** a substantial and operating cause of the collapse.

The first is that the CTV building did not even meet the minimum code requirements in several critical areas, and the NLTHA and physical testing results show that had the building complied with these minimum requirements, it would not have collapsed.

Secondly, no other building in Christchurch collapsed in such a catastrophic manner, with all of the floors pancaking on top of each other as they did. A study of all the shear wall buildings constructed in Christchurch between 1984 and 1989 (Appendix G, Beca report) confirms that the CTV building was the only one of its kind to suffer any form of collapse.

The others remained standing, although they all sustained some form of damage, as per the performance objectives (above). The other six buildings in that group had sufficient reinforcing in the beam-column joints in accordance with the code, whereas the CTV building did not.

6.10.2 Cumulative effect of multiple earthquakes

The sequence of earthquakes that began on 4 September 2010 is well established and discussions of the dates and magnitudes can be found in the background summary section of this report (section 4.4). For more analysis of those earthquakes and their individual characteristics, refer to the Beca report, Appendix I.

The high number of earthquakes and aftershocks experienced across Canterbury over that period has naturally posed the question as to whether those combined events caused any significant structural damage to the CTV building prior to February, and if so, did this cumulative effect contribute to the structural failure resulting in the collapse.

One view held by the general public is that modern buildings are designed to withstand a major earthquake, and then they need to be demolished and re-built. This viewpoint, although incorrect, shows that the cumulative effect does cause concern to many and can be anticipated to arise at trial.

The expert conclusion on this issue is that, although confirmation that CTV was not significantly damaged by any of the earthquakes prior to February 2011 is not possible, significant structural damage was unlikely.

The basis for this expert opinion is that:

- The inspections of CTV over this period, as covered in section 4.4 of this report, revealed **no** sign of any structural damage likely to cause yielding of the reinforcing steel;
- The NLTHA showed **no significant** difference in the seismic performance of the CTV model under February conditions, with or without September and December being run before hand;
- The Physical Testing showed that under the maximum movement experienced in Christchurch during September, there was **no** visible signs of damage in the replica ground floor column;
- The combined duration of all three earthquakes was **less** than that expected for the design earthquake in the code.

Ultimately Beca conclude that the cumulative effects of the earthquakes was not a substantial cause of the CTV collapse.

Police believe that this statement leaves the issue somewhat open, as it has been established by Beca's investigation that the building was not properly designed.

Consideration could be given to have Beca, or another suitable expert, carry out further investigation in order to adduce further evidence on the lack of both visible and internal structural damage to the critical columns, based on the Beca photographs of the 'as-built' specimen (Figure K20 & K21, page K24) along with added commentary of the expected 'elastic' response of Harding's non-ductile columns over low cycles.

In other words, the stiff columns, with their minimum steel constraint and lack of joint reinforcement, could be expected to deflect to the low September maximum (one third of the February maximum) and return to their neutral position numerous times, without suffering damage (either internal or visible) or affecting the stiffness of the column or its ability to resist future movement.

6.10.3 Vertical vs Horizontal Acceleration

The February earthquake produced some high numbers in terms of vertical acceleration at different points across the city, and these were well publicised in the media following the event. At the CCCC ground site, which is the closest to the CTV building, the peak vertical acceleration was 1.6g.

On its own, that level of vertical acceleration posed no threat to the structure of the CTV building, which had axial load capacity far in excess of that figure. The danger would occur where vertical acceleration happens simultaneously with horizontal movement, placing both lateral load and axial load on the columns at the same time, resulting in probable failure and collapse.

Beca have analysed the sequence of the earthquake movements, and in particular the timing of the vertical movement with regards to the peak horizontal acceleration of 0.48g, at the CCCC site.

Beca are of the opinion that the vertical accelerations were high but the NLTHAs indicate that these occurred earlier than the strongest horizontal shaking, and so therefore the high vertical acceleration was unlikely to have significantly influenced the collapse.

Much like the size of the earthquake, the issue with the high vertical acceleration is more likely to be raised as a "smoke screen" than a viable defence, as the rest of the high-rise buildings across the city were subjected to the same or similar vertical acceleration levels and did not collapse in a catastrophic manner. However, this will require further investigation and expert evidence in order to address this, should a prosecution take place.

6.10.4 Strong-Motion Recording Station CCCC

Of the four possible strong-motion recording stations in the vicinity of the CBD, the closest ground station to the CTV building is the Cathedral College site, "CCCC". This site is 750 metres south east of the CTV, with the next two closest sites being 1300 metres and the last 1850 metres to the west. A map showing the site locations and distances to CTV can be found in the Beca Report.[42]

[42] FOLDER 1 – TAB 1 (Appendix I of Beca Report)

Beca chose to use the ground motion data obtained from the CCCC site for the investigation and analysis of the CTV site, including the subsequent NLTHA tests and the physical testing program run at the UoA in early 2016.

The rationale for this choice is explained in Appendix J of the Beca Report, but the close proximity to CTV, the peak ground accelerations (PGAs) at CCCC being close to those estimated to have occurred at CTV and the evidence of surface liquefaction being the same, i.e. none to minimal, were the principal reasons.

Beca also take the recommendation of the Tonkin and Taylor Geological Report (section 6.2) that the most relevant station should be selected based on those ground conditions, rather than using some interpolation between multiple stations.

The likely issue to be raised is that seismic actions at CTV were different than CCCC, so how can the results of the NLTHAs and the physical testing be applied to what actually happened under different conditions 750 metres away.

During the search warrant at [redacted] in June 2015, Reay himself spoke in general terms about the different ground stations, the correct choice of site to use and the fact that ARCL attempted to put a strong-motion recording station at CTV to monitor aftershocks, so that this data could be compared with other sites in an effort to establish the difference between the sites. Reay bemoaned the fact that by the time the authorities had cleared the red tape and allowed the station to be installed, the strong aftershocks had all but stopped and it was all 'too late'.

Inquiries with Ōtākaro Limited now confirm that a recording station was installed at the CTV site. However, records are unclear on exactly when the station was installed and to whom data was disseminated and examined. At CERC Dr Brendan Bradley provided some commentary around this issue, which was effectively that by the time the ground station was installed the aftershocks had diminished to the point that prevented any extrapolation to the February event.

It is likely that further investigation and expert evidence will be required to cover off this issue.

6.11 Rapid Assessments and Building Inspections

Police reviewed the CERC findings in relation to all of the building inspections carried out by CCC and engineers in the period following the 4 September earthquake. All of the relevant witnesses from the Rapid Assessments and the engineering inspections were re-interviewed by the investigation team. These statements or transcripts are on file.

In terms of the timeline of events and what occurred post September, the situation is as set out in the background section of this report, 4.4.1. Nothing further of significance arose from the Rapid Assessment phase interviews.

Police believe that the biggest development to the Rapid Assessment phase since CERC occurred as a result of the Beca physical testing phase carried out in Auckland.

This area may require more in terms of expert opinion by Beca, but the Police believe, based on the conclusions of the physical testing phase and on observations of the specimens under test loading conditions, that there was very little sign of any physical damage to the columns, beams or joints after displacements equivalent to 4 September 2010. Also significant was that because the columns were not detailed for ductility, they showed very little sign of cracking

and suffered no significant structural weakness to the steel until the point of failure, which occurred suddenly and catastrophically.

The physical testing confirms the evidence given by the CCC assessors and in particular, engineer David Coatsworth that after 4 September 2010 there was minimal sign of any damage to the critical areas, and only hairline cracks were visible.

Police expect that further evidence to supplement Beca's own observations could be called from concrete and structural experts, such as Professor Bull (who was consulted by Coatsworth in regards to the best means of repair) around what physical signs of damage would be expected under the conditions post-September, and the effect (if any) that these relatively low cycles had on the resilience of the columns and beams.

[redacted]

[43] [redacted]

[redacted]

6.13 Search Warrants

Based on information received during the investigation [redacted] a search warrant application was drafted. Between 12 June 2015 and 14 June 2015, the CTV investigation team executed search warrants at:

- [redacted] –
- [redacted], Christchurch – Reay's temporary EQC accommodation
- [redacted], Christchurch – Reay's home (EQC repair)
- [redacted] – Reay's holiday home

[redacted] had provided information that electronic information was held at [redacted] that related to the CTV building collapse.

The team were aware that their search would likely locate privileged material between Reay and his counsel, particularly given the CERC hearings and the engagement of [redacted]. Consequently the likelihood for a Determination for a Claim of Privilege pursuant to Section 136(1)(a) – (c) of the Search and Surveillance Act was something the team bore in mind.

The application for the search warrant was drafted with the assistance of [redacted] – Raymond Donnelly and Co. (refer to documents [redacted]).

A carefully detailed execution phase was put in place by (then) Detective Senior Sergeant Sweeney so as not to interrupt the course of business at [redacted] This plan backed by an Operations Order. An Electronic Crime Lab (ECL) team attended the premises and cloned all devices.

Specialist Search and CIB staff were used for 3 days to clear all addresses. The search warrant was executed at 2pm Friday 12 June 2015. The team completed the search at 8pm Sunday 14 June 2015.

A significant amount of data was cloned from devices at [redacted]. Of interest, Reay, upon being contacted by police went straight to his home address in [redacted]. Police located back up discs (not dissimilar to those described) and computers were seized and cloned.

6.14 Exhibits

At this time (some 23 months later), the investigation team are still involved in negotiations to access all of the electronic data. An ECL charter was drafted at the request of [redacted].

The paper document assessment is complete. Two folders are being held by Police awaiting further assessment, identified as privileged material by [redacted] is an agreed independent lawyer).

The ECL / cloned data which to date has not been accessed. [redacted] has now agreed to progress the ECL request as at mid May 2016. The Crown Solicitor, Mr Zarifeh, is involved in discussions and as at the time of writing this report, the data has not yet been accessed by Police whilst awaiting the outcome of those discussions.

It is anticipated that the Police could locate the original CTV files that were *backed up* during the clean-up policy employed by [redacted] at the direction of Reay. This may provide further context around the design and build.

A full assessment of Exhibits / Relevance / ECL data assessment is a major phase yet to be completed.

6.15 Persons of Interest

As reported in section 5.2.3, a list of seven individuals was provided to Beca by Police as persons whose acts or omissions were in question regarding their respective roles in the design or construction of the CTV building.

- Dr Alan Reay — Principal, ARCE
- David Harding — Structural Designer, ARCE
- Graeme Tapper — CCC Reviewing Engineer
- Bryan Bluck — CCC Chief Building Engineer
- Geoff Banks — Director, ARCL (1990-1991)
- Bill Jones — Foreman, Williams Construction
- Gerald Shirtcliff — Construction Manager, Williams

Those seven individuals have all featured throughout this report, and their involvement (or lack of) in the failed design has been well established, both in this report and in the CERC Final Report and Beca Expert Opinion Report.

Experts have methodically examined the omissions of these individuals in discharging their duty, considered whether these omissions were a substantial and operating cause of the

[44] [redacted]

collapse, and then evaluated the evidence against the accepted practice of 1986 to ascertain the degree of departure, if any.

The following sections of this report now proceed to examine those issues with regards to each of the named individuals under consideration.

7 LEGISLATION AND LEGAL ANALYSIS OF EVIDENCE

The CTV Investigation is nearing completion, as at 1 May 2017, but has yet to be critiqued by the Crown Solicitor. Sufficient evidence has been obtained to enable Police to reach a preliminary view as to whether criminal charges should be filed against any of the individuals identified as potentially bearing criminal responsibility. Given the technical nature of the evidence, Police have obtained and relied on the expert opinion of Beca in respect of causation, whether there was a major departure from the standard of care and whether any individual omitted to discharge their legal duty.

The purpose of this section is to review the evidence and highlight the most relevant aspects to the Police case. Whilst it is acknowledged that some investigative phases are incomplete, the most critical evidence has been obtained and is reviewed. Police do not anticipate any significant departure from the evidence that has been obtained thus far.

In my view, there is sufficient evidence available to enable the Crown Solicitor to reach a view on whether charges should be filed. The Beca report as at 15 July 2016 is complete and the peer reviews conducted by [redacted] and [redacted] to a large extent confirm the findings of Beca in the most important respects.

It is proposed to firstly discuss the potential criminal charges that Police have considered, the specific element of whether an omission/s was a major departure from the standard of care with reference to the accepted practice of the day, to then discuss the evidence in relation to identifiable individuals whom Police investigated.

The legal analysis of those individuals' culpability is undertaken and where criminal responsibility is identified, an assessment is made against the Solicitor-General Prosecution Guidelines.

Further issues such as whether individual or representative charges are necessary, as well as what use can be made of the CERC evidence are discussed towards the end of this section.

7.1 Potential criminal charges

Manslaughter and criminal nuisance are the two potential charges which have been considered by the Police.

Manslaughter

The Crown would have to prove beyond reasonable doubt the following elements:

i. A homicide – the killing of one human being by another, directly or indirectly by any means whatsoever;

ii. That the homicide was culpable in that it consisted of the killing of a person by an omission without lawful excuse to perform or observe any legal duty (section 160(2)(b) Crimes Act 1961).

In my view, the legal duty which would be relied on would that under s156 Crimes Act 1961 which is a duty in respect of persons in charge of dangerous things:

> ***156 Duty of persons in charge of dangerous things***
> *Every one who has in his charge or under his control anything whatever, whether animate or inanimate, or who erects, makes, operates, or maintains anything whatever, which, in the absence of precaution or care, may endanger human life is under a legal duty to take reasonable precautions against and to use reasonable care to avoid such danger, and is criminally responsible for the consequences of omitting without lawful excuse to discharge that duty.*

I also considered that the duty as defined in section 157 may be appropriate:

> ***157 Duty to avoid omissions dangerous to life***
> *Every one who undertakes to do any act the omission to do which is or may be dangerous to life is under a legal duty to do that act, and is criminally responsible for the consequences of omitting without lawful excuse to discharge that duty.*

Section 150A Crimes Act 1961 provides that the omission to perform or observe a legal duty will only render a defendant criminally responsible if "*in the circumstances of a particular case, the omission was a major departure from the standard of care expected of a reasonable person to whom that legal duty applies in those circumstances*".

In order to prove manslaughter, the Crown would have to prove the following:

a. The defendant was under a duty; and
b. He omitted to discharge that duty; and
c. That the deaths were caused by that omission; and
d. That in the circumstances of the case, the omission was a major departure from the standard of care expected of a reasonable person to whom that duty applied.

Whether a person was under a legal duty is a question of law. This was not a question that could be answered by expert evidence from Beca, but rather is a point to be considered by Police and the Crown as to whether any identifiable individual was subject to a duty in the Crimes Act 1961. The difference in wording between sections 156 and 157 is that there is no reference to "reasonable" in s157. However, this does not pose any real difficulties as sections 150A provides the overarching definition of when a person will be criminally responsible and there is reference to the standard of care expected of a "reasonable" person.

The conclusion is that a high degree of negligence is required for both sections 156 and 157 and that will be major departure from the standard of reasonable care corresponding to gross negligence.

In my opinion, both Alan Reay and David Harding were under a legal duty as defined in section 156 Crimes Act 1961. In addition, they could be said to have been under a legal duty as defined in section 157. Section 157 imposes a legal duty, but only where the duty has been specifically "undertaken", whether express or implied. In many ways, the commentary and case law for each of these duties is interchangeable and equally relevant. Further examination of each element is assessed for each individual in the next section.

A person undertaking to design a multi-storey building is under a legal duty to use the reasonable care called for from an engineer holding himself out as undertaking that role. A

multi-storey building is an inanimate object which, in the absence of precaution or care, may endanger human life. The duty on an engineer is to take reasonable precautions against and to use reasonable care to avoid such danger.

The duty also extends to those who have sufficient authority in a situation. In this case, where a person had authority over the design engineer and structural design, there will be a duty – see *R v Crossan*[45] where the owner of the car was a passenger in the back seat. The car was driven in a dangerous manner and killed a young child as a result. Both the High Court and Court of Appeal confirmed that the owner of the vehicle had sufficient authority over the use of the vehicle to determine how and by whom it was driven. The owner, even though he was not driving, was charged and convicted of manslaughter.

As noted in *R v Myatt*[46], a higher standard of care is not required of a particular accused who is an expert at that activity. The test for negligence is an objective one. A failure to take reasonable precautions and to use reasonable care must be shown. What is reasonable is an objective test to be determined by what you consider would be the standard of skill and care which would be observed by a reasonable engineer in all the circumstances present at the time (see also *R v Yogasakaran*[47]).

The major departure test requires a high degree of negligence if a person is to be criminally responsible under section 160(2)(b) for manslaughter by negligent omission to perform or observe the legal duty in section 156. This accords with the common law standard of gross negligence. It was held in *Attorney-General's Reference (No 2 of 1999)*[48] that a defendant could properly be convicted of manslaughter by gross negligence in the absence of evidence to his state of mind. Whilst there might be cases in which the defendant's state of mind was relevant to the jury's consideration of the grossness and criminality of his conduct, evidence of his state of mind was not a prerequisite to a conviction. If a defendant knowingly ran a risk or was indifferent to an obvious risk of death, then that may be relevant to whether there was gross negligence.

That was the situation in *R v McKie*[49] where the High Court considered the case of a train driver who failed to check the track warrant to see where he should allow other trains to pass and ended up crashing into another train head-on causing the death of Mr White, the driver in the other train. The High Court reviewed the English Court of Appeal decision of *Prentice*[50] which also included *Adomako*, a case of medical manslaughter. Young J was of the view that the train driver's case could fit within a number of the categories detailed by Lord Taylor, but would probably fit more succinctly under category (d). This was where inattention or failure to advert to a serious risk which goes beyond 'mere inadvertence' in respect of an obvious and important matter which the defendant's duty demanded he should address.

Young J stated that whether the defendant's apparent negligence involved a major departure from the required standard of care would be for the jury to determine. The major departure test, in His Honour's view, equated with the English 'gross negligence' test.

The standard of care is not a standard of perfection. It is a threshold for measuring conduct based on what a reasonable and prudent professional would do under the same or similar circumstances.

[45] HC Invercargill T980970, 7 July 1998; CA310/98, 1 December 1998
[46] [1991] 1 NZLR 674
[47] [1990] 1 NZLR 399
[48] [2000] 3 All ER 182 (CA); [2000] QB 796
[49] 3 August 2000, High Court, Dunedin T13/00, Young J
[50] [1993] 4 All ER 935

Whether a charging document specified both legal duties, each in the alternative or simply one duty is unclear. This will be a question for the Crown to determine if a decision is made to proceed with a criminal prosecution.

The issue for the jury will be a question of fact and whether the conduct was grossly negligent and therefore criminal.

Criminal Nuisance

Section 145 Crimes Act 1961 provides:

> *(1) Every one commits criminal nuisance who does any unlawful act or omits to discharge any legal duty, such act or omission being one which he knew would endanger the lives, safety, or health of the public, or the life, safety, or health of any individual.*
>
> *(2) Every one who commits criminal nuisance is liable to imprisonment for a term not exceeding one year.*

To prove this charge, the Crown would have to prove the following:

a. That the defendant was under a legal duty (the legal duty as defined in sections 156 or 157); and

b. That the defendant omitted to discharge that duty; and

c. That the defendant knew that such an omission would endanger the lives, safety or health of the public or any individual.

The charge of criminal nuisance, although a far more minor charge than manslaughter, curiously imposes a higher threshold. The Court of Appeal in *R v Andersen* [2005] NZLR 774 held that section 145 should be regarded as creating an offence of recklessness. Therefore, there must be proof that the defendant knew that the omission would endanger life, safety or health. That knowledge must be actual knowledge, rather than "deemed knowledge" although knowledge may be readily inferred where the danger is obvious.

In my view, it is not in the public interest to consider a charge of criminal nuisance. It is a minor charge and one that presents evidential difficulties with the recklessness element. I am also of the view that it does not fairly reflect the seriousness of the circumstances and is therefore not an appropriate charge in this case.

7.2 Major Departure from the Standard of Care

Whilst the standard of the day (or as Beca referred to it in their report, the accepted practice of the day) phase has been addressed earlier in this report, there are a number of points made in that evidence which is relevant to the issue of whether the conduct in question was a major departure from the standard of care expected of a reasonable person to whom that duty applied.

In this case, the reasonable person to whom the duty under section 156 (or section 157) of the Crimes Act 1961 applied is the practising engineer in the 1980s when the CTV building was designed and constructed. The accepted standard of care is different depending on the role undertaken by each individual. For Reay, the standard of care relates to a principal of the day, particularly one in sole practise who has employed an engineer to undertaken work for him and the level of oversight expected from the principal. For Harding, the standard of care relates to an engineer who has undertaken to design a multi-storey building.

The most relevant points that came from the standard of the day interviews conducted by Police were:

[redacted]

- "Absolutely not" common to have one engineer assigned to the design and construction phase of a multi-storey building with no oversight from a senior engineer.
- Responsibility for oversight / supervision of the design engineer falls to the owner to ensure right qualified people are doing the design.

[redacted]

- Whilst working at [redacted], less experienced engineers would have to provide oral answers to questions posed by the senior engineers or associates about particular aspects of design. This was for the senior engineers / associates to assess the level of understanding. In [redacted] case, he had several years' experience on his CV but that did not include multi-storey design so he was kept under close watch initially by a senior engineer who mentored him until he was able to prove his ability and competence.
- Whilst at [redacted] where there were two engineers, they used to regularly discuss and review each other's work.

[redacted]

- The overall structural concept was decided by the director in charge and the junior / intermediate design engineers would then perform the modelling / analysis / design tasks necessary to validate the concept working within the assumptions and load-paths set by the director.
- The responsibility for judging the competency of employees lay with the director-in-charge.
- Checking and review involved a discussion / interrogation, some line by line review of calculations and review on a reasonably frequent basis.
- A significant number of years of engineering experience does not necessarily ensure competence in a complex field.
- It was the director's responsibility to arrange oversight / supervision of engineers. Formal external peer review was rare – usually only for extremely complex work.

[redacted]

- Age and length of service does not make a senior engineer.
- As a director, checks would be carried out on a daily basis and he had enough experience to know if something was wrong with a building. He would always follow projects from concept to construction.
- The preliminary design was very interactive between the engineer and director.
- The buck stops with the director – it was their role to sign the design certificate.

[redacted]

- Competence of an engineer was assessed by having discussions, looking at design drawings etc. If the engineer's competence was inadequate, then that person would get more supervision.
- Near the end of a set of drawings being completed, checking procedures generally included a detailed review by a very experienced engineer in the team.
- Oversight from a senior structural engineer for multi-storey construction was always viewed as necessary.

[redacted] provided probably the most relevant statement to Police as he owned a small practice employing two to three engineers in the 1980s. The relevant points from his standard of the day statement were:

- The small size of his practice meant that he could observe staff and determine their strengths and levels of competence.
- Before any drawing was released for consent, director would sit down with the draughtsmen and go through each drawing.
- [redacted] had a system where deadlines for completion of the design were met a week ahead of requirement – that week would be used to check over drawings in detail.
- As principal, [redacted] was involved in all aspects of the project. He carried out a set of hand calculations to ensure that he had was feasible and not a 'bad concept right from the beginning. This enabled effective review later on as well.
- Seldom worked in a completely new area of expertise. On one occasion, his firm engaged experts when the project exceeded their expertise and competence.
- Informal discussions during design progression and 'formal' checking at completion of the detailed design phase.
- [redacted] said that as sole director of his firm, the buck stopped with him.
- Whilst he welcomed council review, he did not rely on their checking to pick up mistakes.
- It was necessary for a design engineer to observe his own designs during construction.
- Engineers did not work on a project on their own and without oversight.

One question that was not asked of engineers, but is likely relevant to this case, is what would occur if there was insufficient expertise within the firm to provide effective oversight / review for a less experienced engineer? Most of the answers are predicated on the basis that the director or senior partners had sufficient knowledge to provide that oversight themselves, but does not specifically address the situation that Reay and Harding were in whereby Reay was not competent in structural design and ETABS, and therefore could not provide the mentoring and guidance that Harding required. It may be relevant to know what the accepted practice of the day would have been in that instance.

Beca's opinion is that Reay, as principal of ARCE should have carried out oversight of, reviewed or checked the design or arranged for another suitably experienced engineer to do so.

The standard of the day interviews provide Police with an independent and measured view of the accepted practice of engineers in the 1980s. Further interviews have been carried out with engineers who were practising in the 1980s and those statements are in the process of being reviewed and signed. The responses do not vary significantly from those already spoken to by the Police and Beca.

The other source of what the standard of care expected of a reasonable person is in this instance are those referred to by Beca in their report, namely the codes under the New Zealand Standards – NZS3101 and NZS4203. Those technical aspects have been addressed in the Beca report and the reader is referred there for more detail.

7.3 Identifiable Individuals

The purpose of this section is to review each of the individuals identified by Police as potentially bearing criminal culpability in relation to the collapse of the CTV building. As discussed earlier, the only appropriate charge in my view is that of manslaughter. Each of the

individual's actions / omissions are assessed against the statutory elements of that charge and considered in light of the expert engineering opinion from Beca. It is proposed to canvas the actions of each identified individual in chronological order as events occurred. It is not proposed to recite all of the conclusions by Beca, but to identify the most relevant points and to refer the reader to the Beca report where necessary.

[redacted]

In brief, Police allege that Reay was under a legal duty to allocate the task of designing a multi-storey building to a suitably qualified and experienced structural engineer. As part of that duty, Reay should have ensured that if he expected the engineer to work on his own, that there was appropriate levels of oversight, mentoring and review of that engineer's work. The completed design (calculations and drawings) should not have been allowed to leave the firm's office without having been through rigorous and effective review in order to certify that it complied with the codes of the day. Reay, as principal and sole practitioner, was ultimately responsible for accepting the commission, allocating the work to the engineer, ensuring adequate supervision and review, and was responsible for all the work that left his firm for a building permit.

In respect of Harding, Police allege that Harding undertook work that he was not suitably experienced to do and did not design a multi-storey building in accordance with the codes of the day. The serious errors made in the design of that building (as identified by Beca) led to the collapse during the 22 February 2011 earthquake. Harding was working beyond his competency and should not have agreed to undertake the work on his own without the appropriate level of input from another suitably experienced engineer.

Alan Reay

<u>Concept</u>

The idea for a six storey building with maximum lettable space and ground floor car parking originated when Michael Brooks and Neil Blair met to discuss the development of the 249 Madras Street site owned by Prime West. Neither of these men had any structural engineering experience. Once he had the architectural draft drawings from Alun Wilkie, Brooks approached Alan Reay Consulting Engineer (ARCE) to be the consultant structural engineer on the project.

Reay had no relevant experience in the design of multi-storey buildings and had never used ETABS. Whilst he was certainly well regarded as an engineer in the tilt slab industry, the engineering considerations with regards to those structures are very different to the considerations for a multi-storey shear core building according to all of the engineers spoken to by Beca and the Police.

As sole practitioner and director of the firm, it was Reay's role to determine whether the project should firstly be accepted, and secondly whether the concept was structurally sound.

The standard of the day interviews conducted by both Beca and Police indicate that it was the director or owner of the firm who determined whether the concept was viable structurally. [redacted] statement to Police was clear that it was the owner or senior partner's

role to conduct a thorough check on "buildability" and whether or not the detailing of the structural components made sense. A number of the engineers spoken to state that there had to be a compromise between the client's and architect's wishes and the engineering considerations to ensure that it was a safe, code compliant building.

There is no indication that Reay undertook any preliminary assessment through calculations or modelling for buildability, but simply accepted the project as it was and allocated it to Harding.

The evidence from [redacted] will be that when the project for Landsborough House was accepted by ARCE, Reay could not see the fundamental flaws with the design and this led [redacted] to conclude that Reay did not understand the basic principles of structural design for multi-storey buildings. [redacted] had to do a week's worth of calculations to convince Reay that the shear core needed to be located as close to the centre of the building as possible and even then Reay was not convinced. It appears that the same issue arose when Reay was commissioned as consultant structural engineer for the CTV project where the shear core would be located on the outside of the building according to the architectural drawings. What was a relatively simple building (in terms of being a box type structure) suddenly involved complex engineering principles that would have required an engineer with multi-storey design experience and an understanding of how a shear wall protected gravity load system worked.

Detailed structural design

Harding was an engineer with 13 years' experience but had no experience in the design of multi-storey structures. Reay was aware of this as Harding had worked for him from 1978 to 1980 (no multi-storey work involved) and had then left to join a District Council to gain civil engineering experience. There was no opportunity for the design of a multi-storey building at Waimairi District Council. It was clear from [redacted] SOD statement that "age and length of service does not make a senior engineer", a view endorsed by several SOD practitioners.

Harding was left to do the detailed structural design of the building on his own. According to [redacted] statement to Police, it was not common to have an engineer assigned to the design and construction phase of a multi-storey building with no oversight from a senior engineer. [redacted] view was "absolutely not".

It is clear that Reay did not have the relevant experience to know whether Harding was making serious errors or not. The detailed structural design was done, it seems, without any input from Reay. Harding's evidence at CERC was that once he had put his calculations through ETABS, he identified that a south shear wall was required and discussed this with Reay. He remembers that Reay said the inclusion of a south wall may not meet the aesthetic required by the client as it would look different to the Contours building which was Alun Wilkie's preference for design appearance.

Wilkie's evidence was that he remembers there always being a south wall on the architectural drawings. It seems likely that there was a short, slender wall there but that Harding had identified the need for a taller, larger one. Whatever the situation, Harding eventually designed an off-set south shear wall that resulted in an eccentric configuration for the building but Reay did not check to see that this was a structurally sound design that complied with the codes.

Oversight / Review / Supervision

In my view, it was incumbent on Reay to have assessed Harding's competence by undertaking a discussion during the development of the concept and by conducting regular checks of

Harding's drawings and calculations. The SOD interviews from Beca and Police are consistent that the owner / director / principal of a firm would keep an overview of each project.

The expert opinion from Beca in this regard is that the lack of oversight by Reay, or any form of review or checking by another experienced person, was contrary to the accepted practice of the time. Critically, Reay did not have the relevant experience to have known what he was checking, but there remained an overarching requirement to facilitate effective review. It was not reasonable for Reay to expect Harding to ask questions if needed and Beca concluded that this was not in accordance with the generally accepted and expected practice. The failure of Harding to ask questions did not absolve Reay of any responsibility to ensure the design was properly detailed.

Reay said in his evidence at CERC that had Harding told him he was struggling, he would have paid an external person to assist him or do some of the work. However, there is no indication that this was communicated as an option to Harding. Reay relied on his "open door" policy as stating that he had fulfilled his obligations as a director and that Harding should have told him about problems. In his view, Harding presented as confident in his work and Reay had no reason to doubt him. Reay placed significant emphasis on his work post-registration, Harding's age, experience in structural design (perceived by Reay), and management role in previous positions and he thought Harding understood how positions of responsibility worked. Reay never thought Harding was over-confident and believed he wanted to do the work.

[redacted], the timesheets seized during the search warrant reveal that he spent 3.5 hours on the project. This would have been insufficient to have conducted a proper review of Harding's work and would likely have been only the initial meetings with [redacted] and [redacted] to discuss the concept. Reay's evidence at CERC was that this timesheet was an accurate reflection of his involvement and he confirmed that he did not check or review any structural details for the building prior to the building permit being granted.

Beca observed that as the person who was commissioned by the client, Reay was responsible for the structural design and construction observation of the CTV building. Beca concluded that he failed to ensure that a suitable combination of an experienced designer, design review and oversight or checking process was implemented. The approach taken by Reay was a significant departure from the accepted and expected standard practice of the time.

The Institution of Professional Engineers Code of Ethics lists seventeen specific requirements to further Rule 18.2 of the Rules of the Institution of Profession Engineers New Zealand (IPENZ). As at February 1986, the relevant clauses in the code were:

> 1. *Each member shall exercise his professional and technical skill and judgement to the best of his ability and shall discharge his professional and technical responsibilities with integrity.*
>
> …
>
> 6. *He shall not misrepresent his competence nor, without disclosing its limits, undertake work beyond it.*
>
> …
>
> 8. *However engaged, he shall at all times recognise his responsibilities to his employer or client, others associated with his work, the public interest and his profession.*

I am of the view that the key is <u>effective</u> review. Simply looking at drawings or signing them off does not signify that they are compliant with the codes and standards in force at the time. Effective review meant that the reviewer was required to be sufficiently experienced and competent themselves in that particular area to know what they were checking. If they were not able to do so, then the responsibility for the director was to ensure that another suitably

qualified and experienced engineer was able to undertake that review and oversight. Notwithstanding that an employee may appear confident in their work, it is still the duty of the principal / director to ascertain whether there was a foundation for that confidence.

It was clear from the accepted practice of engineering practitioners that it was not the responsibility of the employee to ask for supervision; it was the director or associate's role to ensure that proper oversight and checks were being carried out. That is not to say that Harding should not have asked for assistance. Reay should have been conducting sufficient checks and reviews to know that Harding was not competent in designing a multi-storey building with a significantly eccentric configuration.

At CERC, Reay was adamant in making the following points:

- He had no involvement in the design of the building;
- He had no recollection of meeting with client & architect;
- He did not prepare the preliminary calculations and concept design;
- He did not arrange for preliminary architectural drawings to be amended;
- He did not tell Harding of the reasons for the building layout (i.e. premium leasable space);
- He was very vague about whether he gave Harding the Landsborough House calculations or whether Harding went and got those files himself;
- He did not have any input into the decisions regarding gravity & seismic resisting elements;
- The south shear wall was already on the architectural drawing when Reay discussed it with Harding;
- He did not direct the draughtsmen about the carcase drawings and did not review the drawings & calculations prior to submission to CCC for consent application;
- He did not tell Harding to design for an offset shear core.

The evidence given by Reay (and Harding) cannot be led at a criminal trial for reasons explained later in this section, so it is imperative for the investigation team to ascertain whether there is other evidence that will prove the lack of oversight and review.

The evidence obtained from the staff who worked for Reay is informative and will be crucial for showing what Reay's usual procedure was for each project and how he delegated responsibility. The draughtsmen who worked for Reay are largely complimentary of his leadership style as they were given a huge amount of responsibility and were able to draw up tilt-slab plans based on a formula he had provided to them. The contrast was for the engineers employed by Reay as they were often kept at arms-length distance from the client with Reay choosing to have all the client contact and then relaying important information to the engineer.

None of the staff talk about having any degree of supervision or oversight of their work and were largely left alone to get on with the project. This was, however, based on the formula that Reay was using for tilt-slab buildings.

When Reay elected to take on commissions for multi-storey buildings, he had to hire a structural design engineer and it was John Henry who brought that expertise to the firm. Because there were no draughtsman skilled in that particular area, [redacted] was also brought across from [redacted] to work with Henry. It emerged in the Police interview with draughtsman [redacted] that he had a reasonable amount of experience in multi-storey buildings from his previous employment, but it seems that he was not utilised for that at ARCE.

The engineers who have been employed by Reay have spoken to Police of Reay retaining control of projects and conducting the initial meetings and the continuing client relationship. [redacted] is particularly descriptive in this regard, stating that he never met any of the clients from the major projects he worked on. The CTV Building is in stark contrast to that and it appears that soon after the contract was agreed with Prime West and Williams Construction, Reay delegated all responsibility to Harding.

Whether this was because it was a fixed price contract or because the company in control was a construction company rather than ARCE is unknown. It does appear, however, that how Reay dealt with this project is very different to how he dealt with all the other projects that had come through his office.

It also appears from the Police interview and CERC evidence of Alun Wilkie, architect, that there was always a wall on the south of the building. Wilkie stated that this was required because of Fire Code provision mandating a four hour fire proof wall be present. Whether this was then used as a south shear wall is not something Wilkie can remember, but in any event, he states that this was a question for the structural design engineer, not the architect. Wilkie is very sure that the south wall was always present from the outset.

If the south wall needed to be wider or certain proportions for seismic considerations, then Wilkie said it was a matter for Harding to consider.

A further point that emerged in speaking with [redacted] and the draughtsmen employed by Reay is that efficiency was obtained by reusing the same design over and over again. Reay used the Landsborough House design for two further buildings whilst [redacted] was still employed, something that [redacted] did not think was ideal. Reay reportedly told [redacted] that he could "make money without having to do the work".

This is relevant to the issue of whether Reay gave Harding the Landsborough House calculations and told him to follow them for the CTV Building. [redacted] recognised some of the similarities from his design that had been copied across to the CTV's drawings but was horrified because they were such different designs [redacted]

Permitting

Reay's stated reliance on the Christchurch City Council to identify any errors or issues of non-compliance with the codes was at odds with the accepted practice of engineers in the 1980s. The response from practitioners who practised in the 1980s were unequivocal. The council, regardless of location throughout New Zealand, were not to be relied upon to conduct a full structural review of multi-storey buildings. They neither had the resources nor the experience to undertake those reviews. The building consent in this case was granted within three days of submission, a clear indication that a full review was not carried out. As [redacted] said in his statement to Police, there was no reliance placed on the council and it would have been embarrassing to have errors picked up there.

It was usual practice in the 1980s for there to be a staggered submission of drawings and calculations to the council for permitting. Foundation drawings and permit application were able to be submitted independently of the detailed structural design application in order to start the ground excavation and construction process. Drawings and calculations would be filed as they were ready and clearly work could not start without the permit being granted.

The interviews with engineers who practised in the 1980s were definite that no reliance was placed on the council to identify significant errors in structural design of a multi-storey building. Whilst some engineers said that the council checks were the final part of the process, they did not rely on the council engineers solely and in the absence of any other review by the partner or director of a firm. Reay's evidence to CERC that he did so was not in keeping with the accepted practice of the day.

This evidence of the SOD practice is more in keeping with the perceived role the council played in checking designs as opposed to what the legal obligations were for the council in granting a permit. The perception of the engineers did not abrogate the responsibility of the reviewing engineers in my view. There may have been some confusion for Beca as to what that evidence was intended to indicate, but in my view it was simply to illustrate that checking and signing off on a design was the responsibility of the principal or director of a firm.

A significant point in this project was that it was a design-build where the client would only pay the fixed price once the building permit had been granted. All of the meetings and work doing the conceptual and detailed design work would be for free if the permit were not granted by the council according to [redacted] statement to Police.

This provides some context as to why there was a sudden flurry of activity towards the end of the detailed design where a number of draughtsmen were involved to get the drawings done. [redacted], who had no previous experience in structural draughting, was asked by Reay to do the detailing of the external staircase on the south shear wall. There is no indication on the drawings or calculations that Reay reviewed either prior to the permit application being filed with the council. Reay gave evidence at CERC that he did not do so.

Alun Wilkie, the architect, filed the first application with incomplete drawings on 17 July 1986. Structural drawings were filed with the CCC on 26 August 1986. On 27 August 1986, Graeme Tapper, a deputy building engineer at the CCC, wrote a letter to ARCE requesting further information. A number of issues were identified, including the fact that the drawings were not signed as required by the Bylaw. A request was made for the calculations to be provided to support the design.

Tapper's letter of the 27th of August 1986 stated:

> *Please provide the calculations to support the design. We also require a foundation report and a specification which describes the required quality standards for materials and workmanship. Please note that CCC Bylaw 105 requires in Cl 28.1 that "all drawings computations and other data submitted shall be signed by the architect, engineer or designer responsible for their production and shall clearly identify him and his firm or organisation". There is no indication on the plans that they have been checked and approved for issue and construction.*
> *Please attend to the following matters:-*
> *…*
> *Sh 15 Incomplete notes. Ref Line 1 – Hi-Bond mesh reinforced encasting (sic) does not provide restraint to Hi-Bond for f.r.r purposes. Also floor connection to shear wall system. And general connection between floor slab and walls*
> *…*

In all, Tapper listed thirteen queries or points that required clarification or further information from ARCE, which both Peter Nichols and John Henry state is an unusually long list of matters that should have given Reay some cause for concern.

Tapper signed off on the structural design of the building on 10 September 1986, five days after Harding sent a document transfer form signed by himself together with a further set of structural drawings and two additional pages of calculations, which related to the fire rating of

the Hi-Bond structure. There is no indication from the CCC file that the query regarding the connection between the floor and the shear wall system was addressed by the provision of any further calculations or drawings.

5 September 1986 was a Friday, meaning that Tapper only had three working days, possibly four at most, to consider those additional documents. This was not sufficient for a full structural review of a multi-storey building according to the Beca expert opinion, particularly in light of the 300 or so hours that Harding had spent on the design. It is likely that Tapper would have required further time to identify many of the issues Beca found, particularly as he was not believed to be experienced in multi-storey design and did not have access to any of the resources available to design engineers such as ETABS.

After hearing evidence from Mrs Patricia Tapper and Peter Nichols, CERC concluded that Reay became involved in the permit process between 5 and 10 September 1986. It was found that Reay had likely attended a meeting with Bryan Bluck, chief engineer at the CCC and convinced him that Tapper's concerns about the building were unfounded.

This evidence is relevant in two respects:

1. Reay did not have sufficient expertise or knowledge of the design of this building to know that the concerns identified were unfounded; and
2. Reay's stated reliance on the council is diminished because if he relied on them to pick up errors, then tried to override the engineer when issues were identified, this meant that there was absolutely no effective review in place.

This evidence provides overall context of how Reay states that he satisfied himself that the work Harding was doing was to the relevant codes and that Harding was competent. Issues were identified which should have alerted Reay to the fact that Harding was not competent to be doing the structural design without any mentoring or guidance. Reay still did not arrange for any review or assistance for Harding and likely persuaded Bluck, who in turn directed Tapper to grant a permit.

This evidence simply provides further strength to the argument that Reay did not have the knowledge himself to be reviewing Harding's work because he did not realise the significance of what Tapper had identified, nor had he picked up the other serious errors. Furthermore, if Reay relied on the council to do checks then dismissed them when faults were found, it is clear that there was no "safety net" in place even according to his own standards.

Regardless of whether the interference or involvement by Reay with the council can be proved, it is still clear that Reay allowed the permit application to be made without identifying the serious deficiencies in the design. It may be that the evidence of Reay's likely involvement with the council is presented but not relied on to prove that he knew details about the building. The essential point is that he, as principal of ARCE, allowed a deficient design to be submitted to the council for permit application without checking it was structurally sound and correct.

The granting of the permit marked the point at which the design-build project would generate payment for work done by the architect, engineer and construction company.

As an aside, the evidence of Mrs Tapper and Nichols is hearsay and will need to be the subject of a hearsay application if it is to be introduced as evidence at trial. CERC undertook an assessment of the evidence against the Evidence Act 2006 criteria and determined that it would have been ruled admissible if challenged. I am of the view that it is reliable evidence that otherwise satisfies the statutory criteria. An assessment would need to be made by the

Crown of that evidence, what its purpose would be and whether it should be the subject of a pre-trial admissibility application.

Retrofit / drag bar installation

In my opinion, when Holmes Consulting Group (HCG) raised the issue of a possible lack of connection between the floor slabs and the north wall complex, this should have been a prompt for Reay to have reconsidered the building. He was the only person who possessed the knowledge that this was Harding's first multi-storey building where he was responsible for the design from start to finish.

Reay should also have been alert to the fact that issues had been identified with the connection to the north wall complex by the council in 1986, an issue now raised by HCG. Whilst it is not clear that Tapper specifically identified the lack of floor connection to the shear wall system, or simply requested the notes to understand the process, it was something that was identified by the council as requiring clarification. This has been discussed earlier in section 7 under "permitting".

I do not believe that there can be any suggestion that Reay tried to do the retrofit for the cheapest price possible as Geoff Banks was the engineer tasked with designing and arranging the installation of drag bars. Furthermore, I do not believe that there can be any suggestion that ARCL were negligent for the delay in installing the drag bars. Banks said at CERC and in his interview with Police that they were waiting on further information from HCG and from the ARCL's insurer before progressing. Once ARCL were aware that tenants would be moving in, prompt action was taken to arrange for the drag bars to be installed.

At this point, Banks was also a director and shareholder of ARCL. He assumed responsibility for the design and installation of the drag bars and it is arguable that Reay was entitled to rely on him to do that design without Reay's involvement.

I am of the view, however, that Banks' involvement was not an intervening act sufficient to relieve Reay of any duty in respect of this building. The issue identified by HCG simply reinforced that Reay should have provided competent oversight and mentoring for Harding in whatever form was required. A second opportunity presented for Reay to review the building and the issues that had arisen, but he did not do anything to satisfy himself that the building was of sound design.

Furthermore, the evidence from the engineers practising in the 1980s and 1990s was that even where there were two directors in a small firm, each would discuss a project with the other to ensure that their concept was sound and the design viable. It is arguable that this same obligation to have review and oversight of another's work continued even where it was a retrofit to an existing building, particularly in the case where one of the directors had been present when the firm had been commissioned in the original design.

David Harding

Concept

It appears that Harding was involved from the second meeting between the developers and ARCE. Michael Brooks recalls that he was introduced to Harding at that time and that Harding would be doing the detailed structural design. By this stage it also appears that the north wall complex was part of the proposed building structure. Harding did three preliminary drawings with different floor detailing for pricing purposes and the Hi-Bond flooring system was the option chosen.

[redacted] said to Police that it was his idea, a short time after meeting with [redacted] to have the shear wall located outside of the building in order to maximise the floor space inside the building and to enable sub-division by tenants if required. Reay, as director involved in the initial meeting with the clients, did not recognise the problem with having such an eccentric structure and therefore would have been unable to alert Harding to the potential pitfalls. [redacted], it is not known whether he thought that the concept as given to him by Reay was one that had been assessed for buildability. As noted by the SOD statements, it was usual for the director / principal to undertake hand calculations to check whether it was a good or bad concept from the outset. It is therefore not known whether Harding thought the project had also been given the "technical go-ahead" from the principal engineer.

Harding said at CERC that Reay gave him the Landsborough House calculations and ETABS outputs to use as a template and also told him not to contact John Henry, which Harding found strange. [redacted] The configuration for the CTV building was different to Landsborough House in any event, but Harding said that he did refer to the Landsborough House calculations when he was having trouble getting some aspects to work.

Detailed structural design

David Harding was hired as a senior engineer when he returned to ARCE for a second period of employment in late 1985. However, it is clear that he was not experienced in the design of multi-storey buildings, a fact that would have been known by Reay. Harding's first experience in multi-storey work was with Westpark, where the design and calculations had been all but completed by John Henry, his immediate predecessor at ARCE. This was also Harding's first experience with ETABS but it appears to have been largely uneventful as the numbers had already been generated by Henry. ETABS worked provided you inputted the correct numbers and Henry had already done that work.

John Henry returned to ARCE as a consultant to help Reay out with a couple of jobs that he had started before he left. This included showing Harding how to run ETABS for Westpark. An invoice for $56 was submitted to ARCE for this work and shows that Henry was still doing some of the work, albeit it showing Harding how to use ETABS for approximately an hour. This evidence fits somewhat uncomfortably with the earlier evidence that Reay told Harding not to contact Henry when designing the CTV building. Whether it was a desire to be commercially sensitive about current projects or a dislike of Henry, it does not entirely make sense given Reay was happy to have Henry back to do ETABS training for Harding and also help Reay with the design of the Bromley waste trickle filters.

At the time that the design-build project was brought to ARCE, Reay and Harding were the only two practising engineers at the firm. Reay was the principal and Harding an employee.

It was in the early stages of detailed design that Harding recognised that a south shear wall was required to 'balance' the seismic design load in both the north-south and east-west direction. In his evidence at CERC, Harding said that he went to Reay with this issue and his concerns were dismissed. Reay believed that the clients wanted a building with uninterrupted views and that a wall would not fit the aesthetic asked for. Harding therefore extended the external stairwell wall a short distance, but it was not long enough to provide the balance and strength required by the north wall.

Beca conclude in their expert engineering report that Harding made a significant error when he incorrectly calculated the building's natural periods of vibration in the east-west and north-south directions leading to under-calculation of the seismic design load. Furthermore, there was an incorrect reduction in the analysis results for design of the primary seismic elements by including an extra unjustified 0.8 factor, leading to a further lowering of the seismic design load compared with that required by the code. In combination with the first problem identified, the net effect was that the North Wall Complex (in the north-south direction) was 25% weaker and the South Shear Wall (in the east-west direction) 40% weaker than required by the code.

Regardless of whether the CERC evidence regarding Harding's conversation with Reay about the south wall is admissible or not, it is clear that the significant errors identified by Beca were not identified by Reay or Harding.

Harding was working beyond his competence and Reay was not sufficiently involved to recognise this. Had Reay had sufficient technical competence himself and been involved in the oversight and review of Harding's design, he would likely have identified the serious errors in Harding's work.

Reay said that Harding did not ask him for help or alert him to any of the difficulties that he was having with ETABS. At CERC, Reay said that he had an open door where staff could approach him if necessary and he saw Harding as a senior engineer who was confident with the work he was given. [redacted], Williams Construction, also described Harding as an engineer who had a confident personality and was confident in his work. Harding would explain the design to [redacted], who understood that Harding was senior in his role. Harding was the only person with whom [redacted] spoke about the CTV building.

Rather than reciting the whole list of serious errors made by Harding in the design of the building, the reader is referred to the Beca report for their detailed conclusions in that respect.

Beca conclude that Harding's general approach to the design was in line with the practices of the day. However, the lack of compliance of the design with the loadings and concrete codes was a major departure from generally accepted practice. In their expert opinion, Beca wrote that several of Harding's errors were either mistakes or simply due to inexperience, and do not relate to specific aspects of practice of the day. These include the overestimation of the building period in the east-west direction, the extra 0.8 factor when scaling base shears for design, the mathematical error when designing the diaphragm connections and the underestimation of the building deformations in the east-west direction. There were also omissions which did relate to specific aspects of practice of the day which are detailed at pages 57 – 58 of the report.

Harding's culpability is not that he did not ask for assistance from Reay, but that he made a number of serious errors which meant the building was not compliant with the code. Reay's culpability is that as principal and sole practitioner of Alan Reay Consulting Engineer, he accepted the commission, he allocated the job to an inexperienced and incompetent engineer, he did not check or review any of the work done on the project, he allowed that building design to leave his office and relied on the council to do a full structural review to identify issues.

Oversight / Review / Supervision

It is clear from the interviews with practitioners that the responsibility for arranging competent oversight, review and supervision was with the director or senior associate of the firm. It was not the responsibility of the less experienced engineer to organise this.

However, it is clear from the Code of Ethics listed above that there were rules which Harding was required to abide by, namely:

> 1. *Each member shall exercise his professional and technical skill and judgement to the best of his ability and shall discharge his professional and technical responsibilities with integrity.*
>
> …
>
> 6. *He shall not misrepresent his competence nor, without disclosing its limits, undertake work beyond it.*
>
> …
>
> 8. *However engaged, he shall at all times recognise his responsibilities to his employer or client, others associated with his work, the public interest and his profession.*

The obligation on Harding, therefore, was to recognise that he was working in an area where he was not technically competent or experienced. Regardless of whether he felt confident in his work, the obligation on Harding would have been to ensure that he was exercising professional and technical skill and judgement. He should also not have undertaken work beyond his experience or ability, or where he was, it appears from the accepted practice of the day reasonable to have alerted his employer to the difficulties he was having.

There is some confusion about whether he in fact did this and to what extent he told Reay that he was having issues with the configuration of the building and the south shear wall. The difficulty is that essentially it was "the blind leading the blind" because Reay did not have the technical skills to recognise any deficiencies or errors or to provide any meaningful assistance to Harding. John Henry recognised this immediately when speaking to Reay about Landsborough House, but Harding did not have that experience to identify the same. The result was that Harding made a number of serious errors working in isolation which resulted in a dangerous building being built.

Permitting

The first application for a permit was lodged with the CCC by the architect, Alun Wilkie on 17 July 1986. The structural drawings by Harding were taken in about a month later by [redacted] He said in his Police interview that he personally took them in because he was "pushing" the application. He did not see this as unusual because Williams Construction were the client. [redacted] recollection was that the structural drawings were late because they were "going through the computer process".

[redacted] had no communication from the CCC regarding issues with the permit. There were no conversations with Graeme Tapper and [redacted] was unaware of the letter Tapper sent to ARCE. [redacted] said that he was "astounded" when he found out about Tapper's letter after a TV programme in 2011 spoke of it. He said that there was money to fix the issues identified and that in his view, the issues raised by Tapper should have been referred back to Williams so that they could have put a few more 16mm rods in which would have connected the north shear wall to the floors and that would have been locked in with concrete.

At CERC, Harding could not recall responding to Tapper's letter which identified that the connection of the floors to the north wall complex was inadequate and non-compliant. However, he must have been aware of the letter because he responded to Tapper's request for signed structural drawings and calculations to support the design. Harding sent these documents, together with a document transfer form on 5 September 1986 which was a Friday. Unfortunately the further calculations and drawings did not address the substantive issues identified by Tapper.

Although much was made of the absence of a design certificate for the CTV building, it in fact was not required as the Bylaw 105 required either a design certificate or calculations, not both. Furthermore, Bluck had issued guidelines for structural checking engineers which stated that

the council were "*entitled to rely on the recognised expertise of a Professional Designer who is prepared to certify under his signature that a specific design for a conventional or innovative structure (or detail) complies in all respects with the intent of the provisions of NZS1900 Chapter 8*".

Harding signed the structural drawings and sent these, together with two pages of calculations to Tapper together with a document transfer form. It appears that Tapper relied on the signature on the drawings as certifying the design, something it seems he was entitled to do according to the guideline. Whether it was authorised by the Bylaw is something that needs consideration however.

In my view, it is relevant to note that ARCE were not being paid for any of the work done to date. ARCE's payment of a fixed fee for $50,000 was contingent on a building permit for the project being granted; "no job no fee" according to [redacted]. This gives some context to the situation that may have happened at ARCE, together with the "push" from [redacted] to get the permit in.

Given ARCE could not bill the client per hour for the work done, it would be natural to assume that Reay would not have wanted Harding to spend a huge amount of time on the building as the fee had already been agreed. There would have been a point at which the length of time spent on the project became uneconomical for ARCE. There was also the desire of the client to get the permit granted as soon as possible. The tension for Harding was that he was doing a multi-storey design for the first time and was also working to get it done reasonably quickly. He had already committed nearly 300 hours to the project by this stage.

The completed permit application was the critical point for ARCE and Harding and represented the point at which payment would be forthcoming and the project had the official "go-ahead". It does not appear that Harding had any further contact with Tapper beyond sending the drawings and calculations to him. It appears that Reay undertook to deal with the CCC directly on ARCE's behalf.

Christchurch City Council (CCC) employees – Bryan Bluck / Graeme Tapper

The role of Bryan Bluck and Graeme Tapper has been canvassed in the Beca report and earlier in this report. In my view, the most appropriate legal duty by which to assess their actions is in section 156 or 157 Crimes Act 1961. The council engineers were responsible for granting building permits without which a building could not be constructed.

The Local Government Act 1974 gave the authority for the enactment of the Christchurch City Bylaw 105 (1985) ("the Bylaw"). Part 2 of the Second Schedule of Bylaw 105 set out the legal requirements for a permit. Clause 2.2.1 provided that "no person shall erect or commence to erect any building without first obtaining a building permit from the engineer". Bluck was the engineer at the council who exercised this power Tapper was his deputy and did the day to day checking of building permit applications.

There were a number of clauses which specified the requirements to be satisfied by a design engineer submitting a permit application. These included that the plans, computations, descriptions and a number of other details which were to show with "sufficient clarity the exact nature and character of the proposed undertaking[51]" be provided. Another clause required that the drawings, computations and other data submitted were to be signed by the engineer or designer responsible for their production[52].

[51] Clause 2.6.1 of the Bylaw
[52] Clause 2.8

Clause 2.13 enabled the council engineer to withhold a permit where he considered that "deficient information" had been provided, or if he considered that the building "did not comply with the requirements of this Bylaw or any other relevant Acts, regulations or Bylaws". Clause 2.14 gave the council engineer the ability to issue a permit where he was satisfied that the "drawings and specifications" were "in accordance with the Bylaw and with other relevant Acts, Regulations and bylaws" and where he had no reason to believe that the "builder was not competent to carry out the work".

The CERC report concluded that as a result of Clause 2.14, the council engineer had a legal duty to do what was necessary to be satisfied that a building which was the subject of an application for a permit complied with the Bylaw in all respects. It was the CCC's duty to ensure that only buildings that complied with the Bylaw should be granted a building permit.

In my view, it is this requirement that the engineer *be satisfied* that imposes a legal duty. The duty in section 156 refers to a person who has in his charge or under his control anything whatever… which in the absence of precaution or care, may endanger human life, being under a legal duty to take reasonable precautions against and to use reasonable care to avoid such danger.

In my view, that imposed on both Bluck and Tapper the responsibility and duty of satisfying themselves that the building met the relevant codes and Bylaws. It was only once a building permit was issued that construction could proceed and the permit process was essentially the final opportunity to identify any gross omissions in the design. This was done through the provision of drawings, calculations, data and other information that was required by the engineer.

Bluck's guideline stated that council engineers were "*entitled to rely upon the recognized (sic) expertise of a Professional Designer who is prepared to certify under his signature that a specific design for a conventional or innovative structure (or detail), complies in all respects with the intent of the provisions of NZS 1900 Chapter 8*". In my view, the design engineer was still required to provide sufficient detail to satisfy the checking engineer. There was then an obligation for the engineer granting the permit to be satisfied, by taking reasonable care in assessing the detail, that the building was designed according to the code. The guideline could not have replaced that requirement as the Bylaw was clear in what the design engineer was required to do and in my view was simply an interpretation of the Bylaw, intended to give pragmatic effect to the role of the reviewing engineer at the council.

Tapper received the structural drawings from Harding on 26 August 1986 and within one day had identified a number of points that he spelt out in a letter addressed to "Alan M Reay Consulting Eng" on 27 August 1987. Tapper noted that "there is no indication on the plans that they have been checked and approved for issue and construction". He noted fourteen additional points that required clarification or further details. Evidence from Henry and Peter Nichols at CERC was that this was an "unusually large" number of important details that had been omitted from the drawings.

It appears from the evidence at CERC that an initial incomplete set of drawings was submitted to the CCC which was not unusual at the time. On 5 September 1986, Harding provided to the CCC "amended drawings as requested" and additional calculations (G76 and G77), together with a document transfer form. The calculations referred to the fire resistance rating issue of the Hi-Bond floor system which had apparently not been built in accordance with the permitted plans. This was raised in a letter from Bluck to Williams Construction dated 17 August 1986. The calculations forwarded to the CCC on 5 September addressed that Hi-Bond point, but did not meet the further request on 27 August by Tapper to "please provide the calculations to support the design".

Clause 9.2.5 of the Bylaw required that either calculations or a design certificate be provided with the design. Tapper requested calculations to support the design and the Bylaw would not have authorised a request for a design certificate in addition. This is based on the conjunctive nature of the statutory requirement.

Harding submitted signed drawings Friday and by the following Wednesday, 10 September 1986, Tapper had signed off the permit application on behalf of the structural unit of the CCC.

In Beca's opinion, the review of a seismic structural system comprising two shear walls of very different structural characteristics was not a straightforward exercise. Beca are of the view that the time available to Tapper would not have been sufficient for him to conduct a full structural review to confirm compliance with the structural standards. Tapper did not have the ability to conduct a modal analysis, nor did he have the calculations to enable him to check everything thoroughly.

In Beca's view, despite the concerns noted in his August 1986 letter, Tapper relied on Harding's signature on the structural drawings as certifying that the design was compliant with the relevant codes and a permit was granted for the building. It does not appear that any of the issues were addressed by Harding through the provision of the additional documentation, although Tapper failed to identify this.

In Beca's view, there were three issues which could be classified as failings in the structural review process by the CCC which related to the non-identification and/or acceptance of three significant deficiencies in the design:

1. The very light spiral reinforcing in the columns, although arguably not complying with the letter of NZS3101:1982 in many areas of the building, was not typical of the time and warranted at least a comment from a reviewer;
2. The beam column-joint reinforcement shown on the drawings was significantly less than the minimum required by NZS3101:1982, and significantly less than provided in other similar buildings constructed in Christchurch at the time;
3. The important attachment of the NWC to the floor slab at each floor was significantly under-designed and obviously so. A review of the structure should have identified that there was at least an issue with this detail that required comment from the designer.

Whilst Tapper did request further detail regarding the connection between the floor slab and the NWC, it is not clear that he had identified the fundamental flaw in that area. It also does not appear that Harding's documentation addressed that concern, so Tapper has granted a permit without the additional details sought. He appears to have simply relied on the 'certification' i.e. the signature of Harding on the structural drawings that everything was compliant.

Whilst it appears that he was entitled to do so according to the Bylaw in conjunction with Bluck's guidelines, in Beca's view, the errors were so immediately apparent that it should have been picked up by an engineer who was doing even a peripheral review.

This must be balanced against the pragmatic reality facing the CCC in 1986 where a significant number of building permits were being submitted, with the consequence that there was a great deal of pressure to get permits issued and the buildings built. Peter Nichols gave evidence at CERC that it was a demanding period and if there were any concerns by Bluck or one of his staff over a particular building permit application, Bluck would invite the designer in to meet with him and to discuss the design. This would usually result in the designer completing a

specifically worded design certificate. No such certificate has been found regarding the CTV building despite the concerns expressed by Tapper in his letter to ARCE.

[redacted] has told Police that he can recall on several occasions, [redacted], accompanying Alan Reay to the CCC to meet with Bryan Bluck over an aspect of a design that was causing concern. [redacted] does not recall specifically what the projects were, but he does recall that on each occasion it related to a problem that was holding up the issuing of a permit, which caused delay and increased costs which was what concerned Reay.

Nichols told CERC that when he worked as an engineer at the CCC, he had between a few hours to a few days to check large projects, depending on their size and complexity. There were no computers so the engineers were unable to undertake any modal analysis of a design. Any review by the council was looking for obvious errors or omissions rather than reviewing every number. This also has to be considered against the experience of Tapper himself. He was reportedly a civil engineer who had designed at least one major dam in New Zealand, but there is no evidence that he was himself experienced in multi-storey design. Tapper therefore may not have been sufficiently experienced to identify any gross omissions with a multi-storey design in a short time and did not appear to have the time in his role to undertake full structural reviews, even though he was renowned for being particular.

John Henry gave evidence at CERC and confirmed in his interview with Police, that during his time at the CCC, it was Bluck's position that the council were there to review and if a problem was spotted, then so long as a reasonable answer came back, the consent could be issued. Bluck believed the consultants were the experts and the responsibility for code compliance lay with those consultants. Bluck did not believe that the CCC engineers should be digging for detail or starting fights. Tapper was more rigorous and would frequently look to Henry for technical advice to support his position (suggesting that Tapper did not have the technical expertise himself in some areas or that Bluck did not pay much heed to what Tapper said). However, Bluck was the boss so ultimately he would have the final say and Tapper would have to follow that, even if he had misgivings according to Henry.

There was a shortage of intermediate engineers in New Zealand during this period of significant building activity as identified by some of the practitioners who provided SOD statements. This would have meant that the council was also potentially lacking the experience necessary to undertake adequate reviews of multi-storey buildings, the net result being that councils were reliant on engineers having checked their own designs and having had a robust review process in-house before submitting their permit applications. This was the overwhelming view of the SOD practitioners who all said that there was no expectation on the council to identify any errors in their design. It was almost embarrassing if that would occur.

CERC heard hearsay evidence from Patricia Tapper and Nichols that suggested that Reay had met with Bluck in person to discuss the CTV building design, specifically the concerns raised by Graeme Tapper[53]. This accords with Nichols' evidence that whilst he was at the CCC, Bluck would invite engineers in to discuss any issues and would ask them to complete a design certificate. Despite there being no design certificate located either on the CCC file or the ARCL file, it would appear that Reay did become involved. What is difficult to know is whether that involvement resulted in a permit being granted. It seems likely that it did, but further work may be required in this area.

Secondly, despite the request for further details and calculations, the CCC were prepared to rely on Harding's signature on structural drawings as certification that his design was compliant with the codes and Bylaw. It is arguable that this does not meet the requirement

[53] See later section for analysis of the hearsay evidence as presented to CERC

that the council engineer be satisfied that the design was compliant, particularly where the initial issues had not been addressed. There was no independent verification of this it seems with the CTV building.

There was evidence at CERC regarding the fractious relationship between Bluck and Tapper, with Bluck attempting to appease engineers and Tapper being very thorough, requesting answers when he thought there was an issue with a design. [redacted] Whether this resulted in Bluck directing Tapper to issue the permit because he had been convinced that the CTV building was a sound design by Reay is not certain. It is possible, with hearsay applications, to adduce evidence regarding this, the main purpose being to show that despite knowing nothing about the building Reay convinced the CCC that the design was structurally sound.

Whatever the situation, Tapper issued the building permit. It is clear that he should not have. If the evidence of Mrs Tapper and Nichols is adduced, it will simply show that Reay was more involved than he admitted to and will again show that Bluck was relying on the expertise of the professional engineer to certify that the design complied with the code. The meaning of "to certify" may require some further research and analysis at a later point.

In my opinion, Bluck and Tapper omitted to discharge their duty by failing to take reasonable precautions and care to satisfy themselves that the design of the CTV building was code compliant. The building design was not compliant with the Bylaw and the codes.

The reliance on the design engineer's signature on the structural drawings did not meet the Bylaw requirements in my view. There is no indication that a design certificate was provided and it seems that Tapper relied solely on Harding's signature on those drawings. This was not in keeping with the statutory requirement of either a design certificate or calculations. The calculations provided as a result of Tapper's letter related to fire safety of the Hi-Bond structure. There is no documentation available which demonstrates that Harding provided the information Tapper had requested.

The alternative is that Bluck met with Reay and took Reay's word for the structural integrity of the design and either he relied on that verbal assurance as certification or required a specially worded certificate from Reay. Either way, there is no indication of how the Bylaw requirements were satisfied in respect of this design. It is, however, difficult to know if further documentation was placed on the Council file as some of it may have gone missing during the earthquake simply due to being thrown around. It does appear that there was no design certificate initially as Tapper does not refer to one and requests the calculations, something that would not have been authorised if a design certificate was present.

The second limb is to consider whether the omission by Bluck and Tapper represented a major departure from the standard of care expected of a reasonable person. In Beca's opinion, having reviewed the SOD interviews, the omissions did not represent a major departure. However, in my view, this is a mixed legal and factual question and not one that can be answered solely by engineers stating what they thought the council would do.

The SOD conducted by Police correlate with the findings of Beca that there was no reliance placed on the council to undertake thorough reviews or identify any errors. None of the practitioners spoken to relied on the council to be their only form of checking or review. Given the limited time and resources available to the council, it was not reasonable to expect the council engineers to verify the design.

However, in my view this is not the test for major departure. I believe that the test for major departure in the case of the council reviewing engineers is whether they were entitled to defer to a signature on structural drawings as certification that the building was compliant with the

codes. Further, whether it was a major departure from the standard of care must surely be measuring the actions of the Christchurch City Council against the processes undertaken by other local authorities in issuing building permits and what reviewing engineers did to satisfy themselves that a building was compliant with the Bylaw and codes. Whilst the legislation gave the local authorities the power to regulate their own processes, it can't have anticipated that the council would relegate all responsibility solely to the design engineer with no expectation that the reviewing engineer simply check the documentation was present. This has to be balanced against the pragmatic reality that a full structural check was not possible, but something more than "rubber stamping" was desirable given that a permit could still be refused.

The role of the council engineer is essentially rendered invalid if you rely on the views of the SOD practitioners. Whilst they did not rely on the council to check their design, every design required a permit before it could be built. The other issue that arises when talking to practitioners regarding the building as constructed is that most said it had been granted a building permit so they were not concerned. It seems that the practitioners did not rely on the council to find fault with their design but equally said that if a permit had been issued, then they assumed the council were agreeing that the design was code compliant.

I am unclear how Beca have reached the conclusion that Bluck and Tapper's omission was not a major departure from the accepted practice because the accepted practice is defined in the Bylaw and there was clear deviation from that. There was insufficient information for either Bluck or Tapper to be satisfied that the building was compliant with the relevant codes and Bylaw. Bluck's guideline did not, in my view, replace the statutory requirements under the Bylaw. They were pragmatic solutions but there was still a continuing obligation on the council engineers to satisfy themselves by either a design certificate ***or*** calculations to support the design. Neither of these were present on the CTV file.

I do not believe that there was any expectation that the council conduct a full structural review of the design but simply signing drawings does not seem to fulfil the statutory criteria expected of a design engineer. It is clear that a full structural review would have taken between 300 and 600 hours according to the evidence of Grant Wilkinson at CERC.

This was not something the council reviewing engineers were able to undertake so there had to be a degree of reliance on the design engineer together with some investigation into the design philosophy from the CCC. Balancing this with the pragmatic reality that there were a large number of permits being sought in the 1980s and the lack of access to ETABS meant that the CCC did not have the capacity to conduct thorough reviews into every structural design application.

The Bylaw prescribed the law and the Codes set out a means of compliance. It is clear from Clause 11.1.5 of the Bylaw that there are two requirements when designing a building namely that collapse shall be avoided and the probability of injury or loss of life shall be minimised (emphasis added). Those are both mandatory requirements and the interpretation of those requirements is a matter of law. This clause was directed at the design engineer but it also imposes an obligation on the council as the issuer of the building permit to ensure that only safe structures are constructed.

It is useful to have evidence regarding the council processes and what practitioners did, particularly in light of the evidence Reay gave at CERC that he relied on the reviewing engineer to identify any errors. But in my view, that evidence does not assist in ascertaining whether the council in this instance omitted to discharge their duty and whether this is a major departure. However, if the Crown do not agree with my view that the legal question is different to the one posed by Beca, then the evidence of the practitioners regarding the council

processes shows that Reay was incorrect to place sole reliance on the council engineers to detect any errors or omissions.

Clause 2.6.1 specified that an application for a building permit was to be accompanied by:

> … detailed plans, elevations, cross-sections, and specifications which shall together furnish complete details of design, and the qualities and descriptions of construction materials and workmanship, and which shall be of sufficient clarify to show, to the satisfaction of the Engineer, the exact nature and character of the proposed undertaking and the provision made for full compliance with the requirements of this Bylaw and any other relevant bylaw in force at the time of the application.

Clause 2.6.2.1 also stated that there was a requirement to provide the following to the engineer:

> Such stress diagrams, computations, and other data as necessary to show that the design complies with all the requirements of this Bylaw and any other relevant bylaw in force.

This requirement was qualified by Clause 8.2.5 which referred to concrete buildings and stated:

> Design Certification
>
> The designer of any concrete element shall provide calculations which establish that the concrete element has been designed in accordance with the requirements of this Bylaw or alternatively certify in an approved manner that the design method conforms with the requirements of a recognised code of practice.

There was provision in Clause 2.13 for the reviewing engineer to withhold a permit if the proposed building did not comply with the requirements of the Bylaw or if deficient information had been provided. That suggests that more was required of the reviewing engineer in order to be satisfied that the design complied with the Bylaw than simply observing the presence of all documentation and a signature on the documents or design certificate.

The CCC's role was to ensure that only buildings compliant with the Bylaw were granted building permits. How that was achieved was a matter for the Local Authority to regulate, but it would appear that simply relying on the design engineer's certification that the building was compliant would be insufficient to meet the council's obligations. The CCC fulfilled a statutory role and it was their duty to ensure that an independent view was reached on whether the building was compliant or not.

It is recognised that a full structural review was not possible, particularly given that the CCC did not have access to a computer to do ETABS.

CERC referred to Clause 11.2.5.1 which provided:

> **11.2.5.1 Symmetry**
>
> The main elements of a Building that resist seismic forces shall, as nearly as is practicable, be located symmetrically about the centre of mass of the Building.
>
> **11.2.5.2 Ductility**
>
> (a) The Building as a whole and all of its elements that resist seismic forces or movements, or that in the cause of failure are a risk to life, shall be designed to possess ductility; provided that this shall not apply to small Buildings having a total floor area not exceeding 140m2 and having a total height not exceeding 9m.
>
> (b) Structural systems intended to dissipate seismic energy by ductile yielding shall have "adequate ductility".

(c) "Adequate ductility" in terms of clause (b) shall be considered to have been provided if all primary elements resisting seismic forces are detailed in accordance with special requirements for ductile detailing in the appropriate material Code.

CERC interpreted this clause to effectively be an "exhortation" to a designer to be cautious and conservative in the design of irregular and eccentric buildings. The clause is expressed in a mandatory way, but is qualified by the words "as nearly as is practicable". CERC took this to imply that there would be some designs in which symmetry could not be achieved. The report concluded that the clause should have raised a warning that a conservative approach was required in the analysis and design of the building and it is clear that such an approach was not taken.

CERC concluded that the CCC reviewing engineer should have identified a lack of symmetry in the design. However, given that Clause 11.2.5.1 was in the nature of an exhortation rather than an enforceable obligation, this would not have resulted in a permit being refused. Instead, CERC found that it should have resulted in the reviewing engineer satisfying himself that the issue had been considered and allowed for in the analysis. CERC accepted that apart from looking at the calculations to see if it had been considered, he would have had no way to check it further as the CCC did not have computers or software available. To make a detailed check would have required input from the University of Canterbury and a considerable time delay.

In CERC's view, all that could have been expected was for the reviewing engineer to make sure this issue was considered. In this case the calculations showed that it was.

The CCC relied on John O'Loughlin's evidence at CERC regarding the distinction between the design role of an engineer and the council's review role. In summary:

- The council's role involved checking at a general level that the designer had considered and dealt with compliance issues appropriately.
- There was only time to carry out as a review as compared to a full peer review.
- The council's structural checking section did not have the staffing resources that were available to consulting engineers, although the CCC's resourcing compared favourably with Dunedin and Wellington cities.
- The CCC did not have computers and software analysis systems or the ability to do an ETABS analysis.
- The CCC was processing a higher than average number of building permit applications at the time.
- Mr O'Loughlin commented that it must have stretched the capacity of the CCC staff to fully understand how the building was behaving. John Henry made a similar comment in answer to a question, while Dr O'Leary thought that the design of the building was not too difficult for the CCC to adequately perform its task of verifying compliance.
- It was accepted by Mr O'Loughlin that a CCC reviewing engineer should possibly have picked up the issue of inadequate reinforcement of the beam column joints. However, it was noted that there were four different drawings that a reviewing engineer would need to visualise and assemble in his mind to determine the particular arrangement of reinforcing in the beam column joint and it would have been difficult to visualise that arrangement.
- A reviewing engineer could not have been reasonably expected to pick up the error on S57 of the calculations where Harding dropped a zero.

- The CCC would need to rely on the designer having completed a competent ETABS analysis.

The question for Beca in respect of the Christchurch City Council staff is whether the deficiencies and errors were able to be detected in a short period of time and from a brief review of the design. It appears that the inadequate connections in the north-south direction were easy to identify whereas the east-west omission was more problematic. Other engineers gave evidence at CERC that they spotted the serious issues relatively quickly. John Hare of HCG recognised the issue quite quickly, whilst Murray Mitchell of Opus conducted a desktop review of the building and stated that it took him four hours to do the review, identifying the poor diaphragm connections almost immediately.

It appears Tapper did identify deficiencies in the design and requested further information from Harding to address his concerns. Whilst it is not entirely clear whether Tapper identified the lack of connection between the floor and the North Wall Complex to the extent that other engineers have since then, it is clear that points were raised that required clarification and further information.

The information provided by Harding did not address Tapper's concern (only related to the fire rating not any of the other substantive issues regarding the lack of connection) and I agree with CERC's conclusion that the permit for the building should not have been issued. The unknown is whether Reay personally satisfied the CCC that the building was compliant with the Codes and Bylaw or whether a design certificate was issued by Harding that has since been lost. On the basis of the hearsay evidence from Mrs Tapper and Nichols, it would appear that it was Reay's intervention that resulted in the building permit being issued despite Graeme Tapper's concerns.

The issue is therefore whether Tapper and Bluck's actions are an intervening act sufficient to relieve Harding and Reay of any legal duty / criminal responsibility or whether they would have been charged in addition to Harding and Reay. This will require some further consideration by the Crown. However, in my view, the actions of Tapper and Bluck in issuing the building permit were a contributing factor to the collapse, but not one that relieved Harding and Reay of any criminal responsibility. The ultimate responsibility for the errors and omissions rests with Harding as the design engineer and Reay as the principal of the firm that allowed the design to be submitted for a permit without any checking or oversight. In my opinion, as is discussed later in this report, Bluck and Tapper would likely have been charged together with Harding and Reay.

Construction – Gerald Shirtcliff / Bill Jones

During the CERC hearing, the Hyland / Smith report identified a number of issues which could be described as construction defects. Beca refer to this report and in their expert opinion state that the construction defects identified represent omissions by Shirtcliff and Jones to discharge their duty in relation to the construction and inspection of the building. Beca also conclude that their actions are departures from expected practice of the day, although the identified construction defects on their own or together would not have contributed significantly to the collapse of the building.

Beca's findings remain that notwithstanding the construction of the building, it was the defective design and combination of those design defects that resulted in the catastrophic collapse of the building.

Gerald Shirtcliff's fraudulent engineering qualifications were somewhat of a red herring during the media coverage of the CERC hearings and distracted many away from the actual role he

was performing at the CTV site. The commercial agreement between Williams Construction and ARCE was that ARCE were responsible for construction monitoring. It was included in the contract and it was the expectation of Reay that Harding, as design engineer, would perform this role. Shirtcliff was rarely at the CTV building site during construction and Jones gave evidence at CERC that he rang Harding when any direction was required.

Jones had 30 years' experience as a foreman before the CTV job and had experience with a number of multi-level shear core buildings. He was on site initially for six weeks to oversee the topping of the lift slab to the closing in of the building. A new foreman took over from 20 August 1987 according to the CCC inspection record. Jones gave evidence that he remembered thinking the reinforcing in the columns and the size of the columns made this building "light" having regard to its height. He said that he never mentioned this to anyone in particular because he had learnt not to say anything unless asked.

Jones was responsible for contacting the engineer for inspections to be conducted at different points of the construction such as the inspection of the reinforcing steel. He remembers Harding doing inspections, sometimes with another young man but he did not know who this other person was. Shirtcliff did not spend much time on site at all. He gave no advice or any instruction to do with construction issues. There was less supervision of construction on this building than he was used to. There was no clerk of works who was generally invaluable to a foreman to help with technical matters.

Jones recalls no issues with the concrete strength and received dockets at each pour which he checked to see the specified strength. He would ring the engineer, Harding, for every pour except the columns.

Beca's expert opinion is that there is no basis to conclude that the concrete in the CTV building was significantly understrength. Inquiries by Police conclude that it was probably [redacted] who supplied the concrete. Bill Jones was known as a meticulous and experienced foreman who was unlikely to have allowed low strength concrete to be poured. The conclusion by Police and Beca is that low strength concrete is not an issue for the CTV building.

Please refer to pages 65 to 69 for Beca's detailed conclusions regarding the construction of the CTV building.

The testing and investigation undertaken by Beca rules out construction defects as a substantial and operating cause of the collapse of the CTV building. For that reason, Shirtcliff and Jones are not considered criminally responsible in this case.

Geoff Banks

In 1990, Banks was a director at ARCL and was an experienced structural engineer with expertise in multi-storey design. The first he knew of an issue with the CTV building was when John Hare of HCG came to ARCL to look at drawings. HCG's report was received a short time later identifying an issue with the connections of the structural floor diaphragm to the shear walls. This was described as a "vital area of non-compliance with the current design codes".

Banks was unaware that this was a draft report or that there were calculations for a proposed drag bar solution to accompany the report which had not been provided to ARCL. Banks said that Reay asked him to look at the issues raised and see whether ARCL agreed with HCG. As part of this, Reay contacted Harding and then relayed to Banks that there was "nothing really to add". Banks' investigation involved looking at the drawings and the calculations, where he noted that there was no significant tie or connection detailed. A bit of concrete was

dug out to see whether the issue had been addressed during construction and whilst some reinforcement was found, it was not sufficient to do the job that was needed.

Banks determined that he should err on the side of caution and assume that the issue had not been resolved during construction. Banks focused on this one issue because it was the only issue identified in the HCG report he received. Banks told Police in an interview that he did not have grave concerns about how the problem was being dealt with as HCG were involved, the original design engineer had been contacted and a solution was being designed. He took care to contact Grant Wilkinson at HCG to discuss his proposal for drag bars and how the loads would be distributed.

There was no suggestion that Reay told him to keep the matter quiet or to do things for as cheaply as possible. Banks contacted ARCL's insurer to alert them to the issue and when notice was received that the building had been sold, Banks and Reay agreed to contact the new owners to tell them about the connection issue and the remedial work required. Banks viewed this as a straightforward job. He acknowledged that he was unaware that this was Harding's first multi-storey design.

Whilst no building permit was applied for, Banks' rationale was that the building already had a permit and the work was part of the work required by the original permit. He saw it as completing that original construction work. He believed that HCG had notified the council and no issues were raised by them.

I am of the view that nothing sinister can be implied about the failure of Banks to obtain a building permit and there is no evidence to suggest that Reay told him not to contact the CCC. Whilst it may seem unusual given the range of permits applied for during the lifespan of the CTV building, including Banks' application for the ANZ fit-out which was the installation of a concrete block wall in 1991, there is nothing to suggest that they were trying to "hide" the issue from the CCC. The view from the CCC at CERC was that a building permit should have been applied for and Police agree with this conclusion.

The Beca report describes the steps taken by Banks to remedy the lack of connection between the floor slabs and the north wall complex (see pages 71-76) and it is not intended to rehearse those findings in detail. Ultimately Beca determined that Banks failed to identify that the connection of the floor slabs to the north wall complex for east-west loading was not compliant with the design codes and therefore also required remedial works. Furthermore, Banks failed to check the development of tension forces in the drag bars into the floors slabs. The drag bars only extended a short distance into the slab and Beca concluded that the design was flawed.

Beca's expert opinion is that Banks had a duty to ensure the connection of the floor slabs to the north wall complex was compliant with the codes of the day. In their opinion, Banks failed to do so and this represented an omission to discharge his duty in relation to the retrofit of the building. This duty would be that described in section 156 Crimes Act 1961.

In respect of whether Banks' actions were in keeping with the accepted practice of the day, Beca concluded that it was common for design firms to allocate one principal or director to be in charge of a project. Banks was an experienced structural engineer who had designed a number of multi-storey buildings. It was appropriate that he deal with the issue raised by HCG and that Reay maintain an oversight as Banks said he did.

Banks gave evidence at CERC and has subsequently confirmed with Police that he kept Reay regularly appraised of the issues as they arose. He and Reay discussed how they should proceed and kept in contact with the insurers, and later with the new owners of the building to inform them of the problem that HCG had raised. He said that if he had known this was

Harding's first multi-storey building that he had designed don his own, he might have approached it differently. Another factor he had taken into consideration was that there had been no problems with Westpark Tower which Harding had designed and Banks oversaw for construction. Banks saw no need for any further investigation into the CTV Building design.

Beca also concluded that it was acceptable practice of the day to calculate diaphragm connection forces for a building such as CTV using the parts and portions provisions from NZS4203:1984. Banks' actions in this regard were not considered a major departure from the accepted practice of the day. Beca also considered that it was accepted practice for the original design firm to have focused only on remedying the identified non-compliances and not on other aspects. As noted by Beca, the HCG report made a number of general statements including that the remaining key structural elements were "*well designed to the requirements of…"* or "*….complies in all respects with the appropriate design loading and materials codes*".

In Beca's opinion, based on the results of the non-linear time history analysis (NLTHA), the non-compliance of the retrofitted drag bars was not a significant factor in the collapse of the building.

7.4 Application of the facts to the legal elements

Dr Alan Reay

Of the two engineers working at ARCE in 1986, neither had sufficient experience or skill in multi-storey design to undertake the structural engineering for a six-storey building. Whilst it may seem inappropriate for Reay to have accepted the project in these circumstances, it was not unusual for firms to take on work in a previously unfamiliar area.

As seen from the SOD interview with [redacted], firms may be engaged to do undertake projects where there were aspects that were beyond their competence. The solution for [redacted] was to then arrange for the appropriate assistance and input from a relevantly qualified and competent external party, in that case a specialist firm from France. No assistance was sought from an appropriately qualified, competent source to mentor and guide Harding. The difference in those scenarios is that Reay accepted the commission with no "safety net".

It is a legal question whether Reay was under the duty as defined in s156 (and/or s157) Crimes Act 1961. In my opinion Reay was clearly under a duty to take reasonable precaution and care in ensuring his firm produced a multi-storey design that was not a danger to human life.

There are a number of factors which are relevant to the assessment of Reay's legal duty:

i. The design-build project was a commission accepted by Alan Reay Consulting Engineer and it was Reay's decision alone whether the firm should take on the structural engineering work for this multi-storey building. It was Reay's decision who the engineer responsible for the design would be.

ii. Contrary to the identified practice or standard of the day, Reay as director, did not determine Harding's ability to do the detailed design of a multi-storey building. Reay did not undertake any assessment of Harding's understanding of multi-storey structural design principles or identify where Harding may require assistance. Reay was not himself sufficiently experienced or competent in this area to make that assessment or know in what areas Harding would need guidance.

iii. As a sole practitioner and director of his firm, Reay was responsible for the work produced by Harding. All of the practitioners who provided statements to Police and Beca regarding the standard of the day agreed that "the buck stops with the

director". As stated by Beca in their expert opinion, Reay failed to ensure that the design and its documentation had appropriate levels of review before being issued. As noted by [redacted], the senior partner or business manager (in this case, the principal) was the final person to review the outputs for construction.

The evidence to prove that Reay did not perform his legal duty includes:

a) Reay accepted the commission from Williams Construction and Prime West;

b) He assigned the structural design responsibility to Harding alone;

c) 3.5 hours recorded on the timesheet for Reay against the CTV project;

d) No technical knowledge or expertise in the area of multi-storey design himself;

e) No indication on the drawings or calculations that Harding had assistance, oversight or independent checking from Reay or other suitably qualified person;

f) The flawed structural drawings and calculations were allowed to leave the ARCE office without identifying the significant errors;

g) Tapper's letter identified a number of issues with the design, which Reay, as a principal who was aware of the problems, did not ensure were rectified before construction commenced.

h) Reay gave evidence at CERC that he did not undertake any checks or reviews of the design.

In my opinion, Reay was under a legal duty and omitted to discharge that duty by failing to ensure that the CTV building design was designed to the codes of the day. Reay's omission resulted in a defective building design being issued and constructed. The subsequent catastrophic collapse as a result of those design defects caused the deaths of 115 people and Reay's omission was a major departure from the standard of care expected of a reasonable person to whom the duty applied.

In my opinion, Reay is criminally responsible for the deaths of the 115 people in the CTV building. The appropriate charge is that of manslaughter. This conclusion still requires evaluation against the Solicitor-General's Prosecution Guidelines (SGPG) which is in the following sections.

David Harding

David Harding had no relevant experience in the design of multi-storey buildings yet agreed to take on the role of structural design engineer for the CTV building. Whilst his general approach to the design was in line with the practices of the day according to Beca, the overall design was non-compliant with the loadings and concrete codes. This represented a major departure from accepted practice.

Harding was aware of his own limitations and gave evidence at CERC that he was "teaching himself" from Henry's Landsborough House calculations. He said that the calculations were clear and that he was "giving it a go". He further admitted that he struggled in the beginning, yet did not call out for oversight or supervision. There is no evidence to support any stated belief by Harding that Reay was regularly checking his work or providing any guidance with the design. Whilst he was described as an engineer who seemed "confident" in his work by Reay and [redacted], there was no basis for his confidence with this multi-storey design having never undertaken one previously.

The numerous errors made by Harding are outlined by Beca in their report and the conclusion is clear that it was these design errors that caused the collapse of the CTV building during the 22 February 2011 earthquake.

Harding's legal duty was to ensure that he took reasonable precaution and care to design a building that would not endanger life. He omitted to discharge that duty and that omission caused the deaths of 115 people in the CTV building. Harding's omission was a major departure from the standard of care expected of a reasonable person to whom the duty applied.

In my opinion, Harding is criminally responsible for the deaths of the 115 people in the CTV building. The appropriate charge is that of manslaughter. This conclusion still requires evaluation against the Solicitor-General's Prosecution Guidelines (SGPG) which is in the following sections.

Bryan Bluck / Graeme Tapper

As discussed earlier in this part of the report, the omissions by Bluck and Tapper were not assessed by Beca as being a major departure from the standard of care expected of a reasonable person.

However I disagree with Beca's reasoning regarding this and believe that the question they have posed in this regard was framed incorrectly. The standard of care and major departure question is not linked to whether Reay should have placed any reliance on the Council's checking procedure. The proper question is whether the CCC had a legal duty of care to examine a building permit application sufficiently in order to be satisfied that it met the codes and therefore the Bylaw.

Whether the Council were entitled to rely simply on a design certificate is the more appropriate question. In my view, a comparison between the Council practises in major centres in New Zealand would provide an indication of whether the Christchurch City Council procedures were a major departure from the standard of care.

This raises the question of whether Bluck and Tapper, if alive, would be charged in addition to Harding and Reay, or whether their omissions relieve Harding and Reay of criminal responsibility. Without a building permit, the CTV building would not have been constructed. This area requires further investigation and clarification in my view and is a legal question, not a question of fact in my opinion. It may be that Police and the Crown reach the same conclusion as Beca, but the rationale may be somewhat different.

In my view, the actions of Bluck and Tapper do not relieve Harding and Reay of criminal responsibility. The crux of this case is that Harding designed a building with a number of omissions and errors. It is those errors that resulted in the building collapse. Reay failed to ensure that the design had been carried out by a sufficiently qualified engineer and failed to check the design prior to issue for the building permit application.

In my opinion, Bluck and Tapper's actions would, had they both been alive today, seen them charged with manslaughter in addition to Harding and Reay. Their actions were less culpable than Harding and Reay, but I believe that their actions contributed to the collapse of the building. The ultimate responsibility, however, still remained with Harding and Reay.

Gerald Shirtcliff / Bill Jones

Given the conclusion by Beca that the construction defects were not a substantial and operating cause of the collapse of the building, it follows that no criminal responsibility can be attributed to the omissions by Shirtcliff and Jones.

The peer review reports of [redacted] confirm the conclusions of Beca that construction defects were not a substantial and operating cause of the collapse.

Geoff Banks

As with the other individuals who have been reviewed in this report, Banks was subject to the legal duty described in s156 Crimes Act 1961 (equally s157) in that he had a duty to ensure the connection of the floor slabs to the north wall complex were compliant with the codes of the day. This issue had been identified by HCG in their report, but it was the only issue identified in what was otherwise described as a building with "well designed" structural elements and otherwise "complies in all respects with the appropriate design loading and materials codes". Banks was unaware that this was a draft report or that HCG had been told to cease work on the pre-purchase review by their client.

In Beca's opinion, Banks was entitled to rely on that report and believe that there was only one significant issue. He was not obliged to conduct a full structural review in those circumstances, particularly as he was unaware that this was Harding's first multi-storey design.

Banks' role was to provide a structural solution for the issue identified by HCG in that there was insufficient connection of the floor slabs to the north wall complex. Because Banks failed to identify that the connection of the floor slabs to that wall for east-west loading was not compliant with the design codes, the remedial works did not cover that aspect. The remedial design which saw the drag bars extend only a short distance into the slab were also flawed and did render the connection code compliant.

As a result, Beca concluded that Banks therefore omitted to discharge his duty in respect of the retrofit of the building.

The answer to the question of Banks' criminal responsibility lies in the Beca finding that the non-compliance of the retrofitted drag bars were not a significant factor in the collapse of the building. It was therefore not a substantial and operating cause of the collapse of the building. Banks is therefore not criminally responsible for the collapse of the CTV building.

7.5 Cause of collapse

Police rely on the findings of Beca in their expert opinion regarding the cause of the collapse and the subsequent deaths. These are detailed at pages 89 and 90 of their report:

> *The primary cause for the catastrophic collapse, and the large number of fatalities, was the decision by the designer to assume that the primary gravity structure was fully protected by the primary seismic structure and did not need to be designed for seismic actions. The result was a gravity structure that was particularly vulnerable to earthquake shaking. It had little integrity and little resilience once the seismic deformations were imposed on it and once failure had initiated.*

Beca go on in their report to detail the significant errors made by the designer which resulted in the collapse of the building during the February 2011 earthquake. The reader is referred to that report for further details.

In essence, Beca conclude that the omissions of the design engineer, David Harding, was a substantial and operating cause of the deaths. The peer review reports provided by [redacted] and [redacted] confirm the conclusions reached by Beca.

7.6 Solicitor-General's Prosecution Guidelines

Evidential Test

The evidential test as outlined in the Solicitor-General's Prosecution Guidelines provides that the test for a prosecution to continue is met if:

> *The evidence which can be adduced in Court is sufficient to provide a reasonable prospect of conviction.*

The Guidelines state that a reasonable prospect of conviction exists if:

> *In relation to an identifiable individual, there is credible evidence which the prosecution can adduce before a Court and upon which evidence an impartial jury (or Judge), properly directed in accordance with the law, could reasonably be expected to be satisfied beyond reasonable doubt that the individual who is prosecuted has committed a criminal offence.*

A reasonable prospect of conviction exists if there is credible evidence upon which a jury could reasonably be expected to be satisfied of guilt beyond reasonable doubt. Credible evidence means evidence which is capable of belief. This requires an assessment of the quality of the evidence available.

The Guidelines provide that only evidence which is or reliably will be available, and legally admissible, can be taken into account in reaching a decision to prosecute. Part of the consideration by Police has been whether the witnesses spoken to will sign formal statements as well as adopt the statements they made at CERC. Whilst there may be a legal challenge to the search warrants for Reay's properties at a later stage (without merit in my view), at this point the evidence obtained there is relied on. These include timesheets, documents in relation to the original design of the CTV building as well as documents in respect of the drag bar installation in the 1990s. [redacted] there is no direct evidence from either on some aspects such as whether Harding asked Reay for help and what other discussions took place between them with no one else present. One example of evidence from CERC that may not be admissible (depending on the view of the Crown Solicitor regarding use of CERC evidence in a criminal trial) is the instruction that Harding says Reay gave him not to contact John Henry during the design of the CTV building.

The evidential test requires an objectively reasonable prospect of a conviction on the evidence. The apparent cogency and creditability of evidence is not a mathematical science, but rather a matter of judgment for the prosecutor. In forming that judgment, the prosecutor shall endeavour to anticipate and evaluate likely defences.

The evidential test requires that evidence available to the prosecutor be capable of reaching the high standard of proof required by the criminal law i.e. beyond reasonable doubt. A careful analysis is required of the law to identify what offence may have been committed and to

consider the evidence against each of the ingredients which establish the particular offence. This is relevant to the consideration of why the charge of manslaughter is being considered rather than criminal nuisance. In my opinion, it would not be possible to prove the element of recklessness required by criminal nuisance beyond reasonable doubt. For that reason, the charge has not been considered appropriate in this case.

Public Interest Test

Each aspect of the test must be separately considered and satisfied before a decision to prosecute can be taken. The evidential test must be satisfied before the public interest test is considered. The Guidelines mandate that the prosecutor is to analyse and evaluate all of the evidence and information in a thorough and critical manner.

It is not the rule that all offences for which there is sufficient evidence must be prosecuted. Prosecutors must exercise their discretion as to whether a prosecution is required in the public interest.

According to the Guidelines, there is a presumption that the public interest requires prosecution where there has been a contravention of the criminal law and this presumption provides the starting point for consideration of each individual case. The predominant consideration is the seriousness of the offence. The gravity of the maximum sentence and the anticipated penalty is likely to be a strong factor in determining the seriousness of the offence. The Guidelines go on to list some public interest considerations which may be relevant and require consideration by a prosecutor when determining where the public interest lies in any particular case. There may be additional considerations that are not listed in the Guidelines which need to be taken into account.

Application of the Solicitor-General Guidelines to this case

In my opinion, there is evidence which can be adduced in Court which is sufficient to provide a reasonable prospect of conviction. There is credible evidence from a number of sources, including the expert opinion of Beca, which can be adduced before a Court. Based on that evidence, an impartial jury properly directed in accordance with the law could reasonably be expected to be satisfied beyond reasonable doubt that the individual/s, in this case David Harding and Alan Reay, committed the criminal offence of manslaughter.

The only issue, in my view, in considering whether there is a reasonable prospect of conviction is the complexity of this case. It is not possible to have a Judge-alone trial and for that reason, the evidence will need to be presented in a way that is easily understood for the jury. There is a risk that it is so complex and essentially becomes a “battle of the experts” that the jury become confused, but the Police and Crown will have to ensure that the evidence is presented in such a way that it can be understood in layman’s terms. This may require innovative ways of presenting the evidence such as a day’s introduction to “Engineering 101”, physical mini replicas of the building, video demonstrations etc.

A reasonable prospect of conviction is somewhat problematic to assess because there is sufficient evidence in my view and there is public interest, but the complexity of it is apparent even from the discussions between Police and Beca. However, in my view, complexity is not a sufficient reason to not prosecute. Beca are sure of their views and are prepared to give evidence in support of their expert opinion report. [redacted] peer review supports the Beca report and in fact goes further in some regards in regards to the errors and omissions identified. This is a key reason why I am of the view that there is a reasonable prospect of conviction. It is no different to a case where cause of death is disputed and two medical experts give evidence as to their opinions. It will be for the jury to determine which evidence is more credible.

The public interest test is met, in my opinion, because of the seriousness of the offence (manslaughter) and the large number of deaths. In addition, both Harding and Reay created a serious risk of harm that eventuated in the deaths of people who thought they were working in a compliant building.

Whilst the delay between 22 February 2011 and current day is over six years, the criminal investigation was only commenced in August 2014 after a preliminary engineering report was obtained from Beca. Beca had been engaged after a legal review had been undertaken of the evidence obtained at the Royal Commission and the conclusions reached by that Inquiry. Police were unable to make any recommendations without the opinion from experts and the Beca report has been instrumental in that. The testing by the University of Auckland has also been necessary to determine the cause of the collapse, together with other methodologies. This has taken time and has been a considered and essential part of the process.

In my view, any suggestion or pre-trial application for dismissal based on undue delay will be easily answered by identifying the stages outlined above. There is no merit in this factor weighing against the public interest test.

In conclusion, I believe that the evidential sufficiency and the public interest tests are met in respect of both Harding and Reay based on the information available thus far.

7.7 Individual or representative charges

Section 20 of the Criminal Procedure Act 2011 provides that a charge may be representative provided certain criteria are satisfied. This section states:

> (1) A charge may be representative if-
>
> (a) multiple offences of the same type are alleged; and
>
> (b) the offences are alleged to have been committed in similar circumstances over a period of time; and
>
> (c) the nature and circumstances of the offences are such that the complainant cannot reasonably be expected to particularise dates or other details of the offences.
>
> (2) A charge may also be representative if-
>
> (a) multiple offences of the same type are alleged; and
>
> (b) the offences are alleged to have been committed in similar circumstances such that it is likely that the same plea would be entered by the defendant in relation to all the offences if they were charged separately; and
>
> (c) because of the number of offences alleged, if the offences were to be charged separately but tried together it would be unduly difficult for the court (including, in any jury trial, the jury) to manage the separate charges.

In my view, representative charges for manslaughter are appropriate in this case based on the statutory criteria in section 20(2) Criminal Procedure Act 2011. It would be unduly difficult for the court to manage 115 individual charging documents.

A further point for consideration is how a charge would be framed in terms of offence date. In my view, although the deficient design was done in 1986, the offence of manslaughter was only 'complete' on 22 February 2011 when the building collapsed killing 115 people.

It may have to be that the date is framed as on or about 22 February 2011 to account for those who died the following day.

7.8 Use of CERC evidence in a criminal trial

There were a significant number of people who gave evidence at CERC. CERC was established on 11 April 2011 and the hearing concluded in November 2012. In my view, the starting point for considering any evidence is the Evidence Act 2006 and the principle in s7 that all relevant evidence is admissible. Section 7(3) states that evidence is relevant in a proceeding if it has a tendency to prove or disprove anything that is of consequence to the determination of the proceeding.

However, a judge must exclude the evidence, even if relevant, if its probative value is outweighed by the risk that the evidence will have an unfairly prejudicial effect on the proceeding (s8(1)). This must take into account both the interests of the prosecution and the defence. The issue will be whether the evidence given at CERC, particularly by Reay and Harding, will have an unfairly prejudicial effect on the proceedings (not the parties) and should therefore be excluded.

Royal Commissions of Inquiry have coercive powers which means they can secure the attendance of all persons who could potentially assist their inquiries, ensure all witnesses provide a complete account and can allow evidence to be secured. Commissions also have the power to examine a person under oath. The main aim of a Royal Commission is to embark on a fact finding process rather than making findings of legal liability. The following sections are relevant[54]:

> **4B Evidence**
>
> (1) The Commission may receive as evidence any statement, document, information, or matter that in its opinion may assist it to deal effectively with the subject of the inquiry, whether or not it would be admissible in a Court of law.
>
> (2) The Commission may take evidence on oath, and for that purpose a member or officer of the Commission may administer an oath.
>
> (3) The Commission may permit a person appearing as a witness before it to give evidence by tendering a written statement, and if the Commission thinks fit, verifying it by oath.

The rules of evidence that operate in a traditional justice system and which regulate competency, compellability and hearsay are not strictly applicable in a Commission's proceedings. For this reason, there needs to be caution when determining whether evidence given at a Royal Commission can be used in criminal proceedings and for what purpose.

The Terms of Reference for the Canterbury Earthquake Royal Commission specifically stated that the Commission was not to inquire into, determine, or report in an interim or final way upon whether any questions of liability arose. Criminal liability was not discussed in any of the reports nor were any findings made in that regard.

Unlike in criminal proceedings, the Commission was able to have any document or record made available even if it would not have been admissible pursuant to the Evidence Act 2006. There was no need for search warrants, but simply a requirement that any person produce information or documents. Section 4C of the Commissions of Inquiry Act 1908 set the foundation for this power of investigation:

[54] Commissions of Inquiry Act 1908. The Inquiries Act 2013 only came into force on 28 August 2013 and the provisions there did not apply at CERC.

4C Powers of investigation

(1) For the purposes of the inquiry the Commission or any person authorised by it in writing to do so may-

(a) Inspect and examine any papers, documents, records, or things:

(b) Require any person to produce for examination any papers, documents, records, or things in that person's possession or under that person's control, and to allow copies of or extracts from any such papers, documents, or records to be made:

(c) Require any person to furnish, in a form approved by or acceptable to the Commission, any information or particulars that may be required by it, and any copies of or extracts from any such papers, documents, or records as aforesaid.

(2) The Commission may, if it thinks fit, require that any written information or particulars or any copies or extracts furnished under this section shall be verified by statutory declaration or otherwise as the Commission may require.

(3) For the purposes of the inquiry the Commission may of its own motion, or on application, order that any information or particulars, or a copy of the whole or any part of any paper, document or record, furnished or produced to it be supplied to any person appearing before the Commission, and in the order impose such terms and conditions as it thinks fit in respect of such supply and of the use that is to be made of the information, particulars, or copy.

(4) Every person shall have the same privileges in relation to the giving of information to the Commission, the answering of questions put by the Commission, and the production of papers, documents, records, and things to the Commission as witnesses have in Courts of law.

Section 9 provides that failure to produce the paper, document, record or thing ordered by the Commission is an offence.

However, the principle in a criminal trial is centred primarily on the issue of fairness and whether the evidence in whatever form (documents, calculations, records, drawings etc.) were obtained lawfully.

The purpose of the Search and Surveillance Act 2012 in s5 states:

> The purpose of this Act is to facilitate the monitoring or compliance with the law and the investigation and prosecution of offences in a manner that is consistent with human rights values by-
>
> (a) Modernising the law of search, seizure, and surveillance to take into account advances in technologies and to regulate the use of those technologies; and
>
> (b) Providing rules that recognise the importance of the rights and entitlements affirmed in other enactments, including the New Zealand Bill of Rights Act 1990, the Privacy Act 1993, and the Evidence Act 2006; and
>
> (c) Ensuring investigative tools are effective and adequate for law enforcement needs.

This is relevant because there is no such overarching purpose in the Commissions of Inquiry Act. An inquiry is inquisitorial by nature to provide answers and therefore not inherently subject to the same restrictions, protections or caveats that the criminal jurisdiction imposes.

The CTV investigation team has never assumed that they were entitled to rely on evidence that had been produced at CERC which may have been provided as a result of a request by CERC to do so. The investigation has been cautious to ensure that all evidence obtained was "best evidence" and in its original form as far as possible, obtained under search warrant that has been sanctioned by the court. Information requests from other agencies such as the

Christchurch City Council have been made under the Official Information Act 1982. In other instances, witnesses who have agreed to provide interviews to Police have often given Police documentary or other evidence voluntarily.

Section 4C(4) is a reference to s6 which states:

> **6 Protection of persons appearing**
> Every witness giving evidence, and every counsel or agent or other person appearing before the Commission, shall have the same privileges and immunities as witnesses and counsel in Courts of law.

Under this provision, the fundamental right of a witness to claim privilege against self-incrimination has not been abrogated in New Zealand. A witness giving evidence at a Commission would be able to claim that privilege if the situation arose and would have, it is presumed, been alerted to this by their legal counsel. The individuals the Police are currently investigating all had legal representation at CERC who would no doubt have cautioned them about the protection available to them as witnesses. From my examination of the evidence, I cannot see where any witness has given evidence that is self-incriminating, but some of the evidence given Reay and Harding is "unhelpful" to them.

The purpose of evidence given at CERC is different to the purpose of a Police interview or giving evidence at a criminal trial in which a person is a defendant or witness. The courts have generally been unsympathetic to the Crown using evidence in a criminal trial that has been obtained by coercive powers. Even compelling a witness to answer questions risks unfairness.

Whilst there is no suggestion that evidence was unfairly obtained at CERC, the question must be whether CERC has adversely impacted on a potential defendant's rights pursuant to:

- s25(a) - right to a fair and public hearing;
- s25(c) - right to be presumed innocent until proved guilty; and
- s25(d) - right not to be compelled to be a witness or to confess guilt of the New Zealand Bill of Rights Act 1990 ("NZBORA").

Section 23 NZBORA also provides the right to refrain from making any statement. No caution regarding self-incrimination was given before evidence was proffered at CERC and it unclear whether any of the witnesses knew they could claim that privilege. The issue the Crown may need to consider is whether Reay and Harding have essentially been forced to disclose aspects of or the whole of their defence by being compelled to answer questions at CERC.

The question for Police is whether the evidence given at CERC is admissible in a criminal trial. It can reasonably be anticipated that any evidence given at CERC by Reay or Harding will be the subject of robust pre-trial challenges in that they may not have anticipated that the evidence they gave would be considered in a criminal investigation against them. Importantly, the Police have not relied on the evidence given by Reay or Harding as providing the sole basis for evidential sufficiency, but have instead conducted an investigation by speaking to the original witnesses and obtaining either formal statements or indications of the evidence they would give at any subsequent criminal trial.

Were Reay or Harding to give evidence at a trial where they are defendants, then in my opinion their statements would be able to be used in cross-examination against them if they were to give inconsistent evidence. The same is true of any witness who gives evidence that is at odds with the evidence they gave at CERC in that they could be cross-examined on any inconsistencies. Any previous consistent statement is not admissible however by the

prosecution unless the criteria in sections 35(2) and (3) of the Evidence Act 2006 are met. Again, this will be subject to the usual rules of evidence regarding admissibility.

A witness spoken to by Police can adopt their CERC statement and confirm that it is still a true and accurate record of their evidence. In most instances, witnesses have taken the opportunity to expand on that evidence and provide a wider context to their statement. There is no issue with using that evidence provided it is specifically adopted and a formal statement is signed to confirm the evidence they would give. Obviously that evidence will need to be subject to the rules of the Evidence Act 2006. That means that any evidence with hearsay, that is subject to privilege etc. will be inadmissible unless the statutory criteria to include it is met.

If a witness, for example [redacted], was happy to speak with Police informally but did not want to sign his statement, in my view Police will be unable to use his CERC statement in evidence. He has to adopt that evidence and sign a formal statement, as a hearsay application is likely to be unsuccessful given section 18(1)(b) of the Evidence Act 2006 is not met.

It is likely that Dr Reay and Mr Harding will say that they have been deprived of the opportunity for a fair trial due to the extensive media coverage, the findings from CERC and the fact that they thought they were merely assisting a public inquiry as opposed to revealing evidence that may expose them to criminal charges, or that may reveal their defence.

IPENZ material – Reay and Harding

In August 2013 the Institution of Professional Engineers New Zealand (IPENZ) conducted disciplinary hearings into the actions of Reay and Harding after receiving a number of complaints following the release of the CERC findings, Volume 6. Both Reay and Harding appeared before the Investigating Committee, made up of a panel of three IPENZ members [redacted] and [redacted]. Both men had legal counsel present and were able to made submissions to the committee, as well as answer questions put to them.

The hearings were recorded and transcripts of those hearings form part of the 7,741 documents turned over to Police by IPENZ under Production Order in November 2014. Based on the line of questioning, it appears the committee were particularly interested in the interaction between Reay and Harding and the office dynamic at ARCE during the 1980s, and the content of the transcripts cover many of the key issues that are in question.

The existence of the Investigating Committee hearing transcripts of Reay and Harding, along with supporting documents produced at the hearings, and the potential evidential value of this material is worth noting and consideration as to whether it could be adduced at a trial.

Conclusion

In conclusion, the evidence given at CERC is important to consider and subject to the rules of the Evidence Act 2006, may in fact be admissible. This is likely to be in the situation where a witness has since died and a hearsay application will be appropriate, or in the situation where a witness gives evidence that is inconsistent with the evidence they gave at CERC. In that latter instance, the CERC evidence can be used to cross-examine them on their inconsistencies. In my view, the evidence given by a critical witness cannot be the basis upon which the Police proceed with criminal charges unless that witness is prepared to confirm that evidence and sign a formal statement to that effect. All evidence will need to be subject to the Evidence Act 2006 rules of admissibility.

7.9 Hearsay Evidence

The CERC report at 2.2.4.2.5 thoroughly explains the approach taken by the Commission to the hearsay evidence of Nichols and Mrs Tapper. CERC accepted the evidence of both witnesses about conversations they had had with other people since deceased.

Despite the fact that the Royal Commission had the power to admit this evidence as it considered appropriate pursuant to s4B(1) of the Commissions of Inquiry Act 1908, given the significance of the evidence it was considered appropriate to approach the evidence using the Evidence Act 2006.

The following is an excerpt from CERC:

> The fundamental principle is that all relevant evidence is admissible: section 7. This includes hearsay evidence. Evidence is relevant in a proceeding if it has a tendency to prove or disprove anything that is of consequence to the determination of the proceeding: section 7(3). Even if evidence is relevant a judge must still exclude it if its probative value is outweighed by the risk that the evidence would have an unfairly prejudicial effect on the proceeding: section 8(1). The other limbs of section 8 are not relevant here.
>
> Hearsay is dealt with specifically in sections 16, 17 and 18. Section 17 provides that a hearsay statement is not admissible except as provided for in subpart 1 of Part 2 of the Act. The general rule about the admissibility of hearsay statements is set out in section 18. A hearsay statement is admissible if the "circumstances" relating to the statement provide reasonable assurance that the statement is reliable: section 18(1)(a). The other provisions dealt with in section 18 are met here because both Mr Tapper and Mr Bluck are deceased.
>
> The meaning of the word "circumstances" as it is used in section 18 is defined in section 16. Relevant "circumstances" in considering whether they provide a reasonable assurance that the statement is reliable are:
>
> - the nature of the statement;
> - the contents of the statement;
> - the circumstances that relate to the making of the statement;
> - any circumstances that relate to the veracity of the person; and
> - any circumstances that relate to the accuracy of the observation of the person.

CERC concluded at 2.2.4.3 of their report that the evidence of both Mr Nichols and Mrs Tapper, about their conversations with Mr Bluck and Mr Tapper respectively, was credible and reliable. Insofar as their evidence was hearsay, CERC were satisfied that the circumstances relating to that evidence provided reasonable assurance that it was reliable, so that the general requirements for admissibility of hearsay evidence in a court of law … would be satisfied. Despite the considerable time that has passed since both conversations, both witnesses gave their evidence in a measured fashion, without apparent embellishment, and accepting that there were matters they could not remember. However, they were able to give details of the circumstances which made the conversations memorable for them.

Given that CERC undertook a thorough analysis of the hearsay evidence and ran it through the Evidence Act test, I believe that it is likely a pre-trial application for that same evidence to be admitted would be successful.

7.10 Trial Location

A further consideration for the Crown will be that of trial location. Section 14(1) of the Criminal Procedure Act 2011 ("CPA") states that a criminal proceeding in respect of an offence is commenced by filing a charging document in the District Court that is nearest to where the offence is alleged to have been committed or nearest to where the person filing the charging document believes the defendant can be found. In both instances that requires the charging document to be filed in Christchurch.

However, it seems pragmatic to consider whether the proceedings should be transferred to a different place as per s157 CPA. Section 157(2) provides:

> …
> (2) The High Court at a place, may on its own motion or on the application of the prosecutor or the defendant, transfer a proceeding to the High Court at a place or sitting other than that determined in accordance with section 72, 73, or 74, as the case may be, if the court is satisfied that it is in the interests of justice that the proceeding be heard at that other place or sitting.

The primary ground for considering a change of venue must be that an impartial jury would be difficult to obtain. The majority of Christchurch residents who were in the city on 22 February 2011 (or even during other less significant earthquakes) will have been affected in some way. The ongoing difficulties that some people have had with damaged houses, loss of employment, associations with people who died during the earthquake and other consequences as a result of the earthquakes mean that any Christchurch jury is likely to be prejudiced or be tainted by their own experiences. Everyone seems to have a theory on the earthquakes and the CTV building in Christchurch.

The media coverage of CERC is another factor that will likely influence the way Christchurch residents have perceived the role of Harding and Reay, something that may not be as significant for a jury pool in another city centre. The local prejudice will be difficult to overcome, particularly with lay citizens tending to hypothesise on matters based on their own experiences without heeding the expert evidence. For each anniversary of the 22 February earthquake, the media coverage usually turns to the CTV building and interviews some of the victims' families. This means that there is no real dissipation of the publicity and in my view, prejudice for the jury will more than likely still be apparent.

In order to have a sufficiently large jury pool, it will probably be necessary to consider Auckland, Wellington or Dunedin as possible trial locations.

I do not imagine that either Reay or Harding would seriously oppose an application to transfer the proceedings. If the prosecution intend to apply, then notice will need to be given in the trial callover memorandum and no later, unless the court extends or shortens that time in accordance with rule 1.7 of the Criminal Procedure Rules 2012.

8 RECOMMENDATIONS:

Based on the evidence available to date and the opinion expressed by Beca (and subsequent peer reviews) as to the cause of the CTV building collapse, it is recommended that:

1. A charging document be filed detailing an offence of manslaughter against Reay; and
2. A charging document be filed detailing an offence of manslaughter against Harding.

Detective Sergeant Grant COLLINS
2ic CTV Investigation

[redacted]

Detective Inspector Darryl SWEENEY
Investigation Manager