

- Q. Mr Harding's evidence, in terms of design is that you gave him the architectural drawings, you discussed what I have just discussed and left him to attend to the calculations using the template, John Henry's template from Landsborough House. Is that correct?
- 5 A. He brought, as I've said before, he brought the drawing to me, showed me what it was. I questioned him briefly on the aspect of the southern shear wall being included and that was the total of the conversation. He was the one who took responsibility for doing this, undertaking this project and he undertook that he had the ability and knowledge to do it.
- 10 Q. We'll come back to that. If Mr Harding is correct, Dr Reay, in these factors to which I have just referred and his evidence is accepted the only logical conclusion is that this was your design and not his. Do you agree with that?
- A. No I don't.
- 15 Q. As I recall in earlier evidence, Dr Reay, you have referred to Mr Harding's, if the Commission finds that Mr Harding had shortcomings. Can you recall that?
- 1040
- A. I can't recall in relation to the context that comment was made.
- 20 Q. I think the context was if there are shortcomings that your firm will stand by Mr Harding. Is that correct?
- A. I don't recall using those words in that context.
- Q. Let me develop the issue of shortcomings Dr Reay because in Mr Harding's view in the saga there were two particular shortcomings in his view that flow back to you. The first of these is what I'm going to call the Henry saga. My understanding Dr Reay that John Henry in respect of the Landsborough House building, he had a concern whether the gravity load system would be adequately protected by the shear walls. Is that correct?
- 25
- A. That was part of his design process, to review that.
- 30 Q. And that was his concern. That's his evidence, that's what his evidence is.
- A. I believe he said that.

Q. And as a consequence of that concern he discussed the matter with Professor Paulay. That's correct?

A. I believe so, yes.

5 Q. And in turn he discussed the matter, that's John Henry, with you. Is that correct?

A. John Henry discussed it with me.

Q. Yes. But when David Harding came to you, and by now John Henry had left your firm, you never discussed John Henry's concerns with Dr Harding did you?

10 A. I don't recall discussing it with him.

Q. And had you discussed John Henry's concerns with Mr Harding it's highly probable that Mr Harding would have made further enquiry and we may not have been here today. What do you say to that Dr Reay?

15 A. I think that if it had been discussed and the outcome had been discussed then what you say would not, not be correct.

Q. I have put that under the first heading of a shortcoming on your part. What do you say to that?

A. Well I can't say for certain that I didn't discuss it with Mr Harding. I can only say that I don't recall discussing it with him.

20 Q. I come back to this second shortcoming that Mr Harding is of the view that followed and this goes back to your belief that Mr Harding was experienced to carry out this work on a standalone basis. That now Dr Reay flies in the face of all the evidence. Surely you must accept that now?

25 A. At the time I was, I had no reason to doubt that he was not capable of undertaking the work. I had no reason to doubt that he was, that he would not follow the code. He was experienced. He had in fact been appointed to a senior level in the practice and he became an associate part way through this process.

30

JUSTICE COOPER:

Q. Dr Reay in fairness you've delivered yourself with a double negative. You've said you had no reason to doubt that he was not competent.

A. Oh, thank you. I had no reason to doubt his competence.

CROSS-EXAMINATION CONTINUES: MR KIRKLAND

- 5 Q. Well I put it to you Dr Reay there were many reasons to doubt his competence. Let me just go through these. When he was at Hardie & Anderson you knew the type of work that Mr Harding was undertaking: domestic buildings, foundations, single-storey commercial work. You had that knowledge.
- A. When I was there at Hardie & Anderson I designed many buildings including a six-storey building.
- 10 Q. But you had knowledge of the work that David Harding was doing when he was there.
- A. Not direct knowledge, only based on my personal experience of working at Hardie & Anderson.
- 15 Q. When he came to your firm for the first time, structural elements, domestic buildings, two-storey commercial buildings, you knew obviously what he was doing when he was with you.
- A. Yes and at no time did he give me any cause for concern in undertaking that work in terms of the codes and the work that he organised with the draftsmen.
- 20 Q. And when he was with the Waimairi District Council you knew what he was doing there.
- A. I knew that he was in a management role and that he had done some structural work there.
- 25 Q. You would have known the business of the Waimairi District Council was not designing high-rise buildings. A fairly basic point to put to you but that's a fact isn't it Dr Reay?
- A. Yes I knew they weren't doing that.
- Q. And you knew that Mr Harding was in the main undertaking civil engineering work as opposed to structural work. You knew that.
- A. Well I only know what he has said at the hearing. I can't recall what he actually told me when we discussed his working for the company.
- 30 Q. And the structural work as I would recall it at the Waimairi Council was mainly bridge maintenance, designing of bridges and I think the hydroslide at Jellie Park. You knew that.

A. Yes and that would have included the use of codes such as the loading code and the concrete code.

5 Q. So those are three factors that I put to you as a starting point Dr Reay that you knew that David Harding was not experienced. We'll just stop at that point. What do you say?

A. I still say that he was experienced. He had had 10 years since he'd been registered. He'd worked at Hardie & Anderson where other, where he has already mentioned that he, for example, worked on strengthening projects which were for at least three-storey buildings.

10 Q. Let me carry on. You knew Mr Harding was not experienced in high-rise buildings, in designing them?

A. I knew that he hadn't designed a six-storey building at the time he came to the company.

15 Q. In particular torsionally eccentric buildings, he had no experience in those. That's a fact.

A. That was new to him on that particular building.

Q. That's point 4. Point 5 is that he had no experience in any detail of using ETABS. You knew that.

20 A. Yes he had it before he did the CTV building though because he used it on another building.

Q. That's on the West Park building.

A. Yes.

Q. A concentric building.

25 A. Not totally concentric. One still designs buildings for anomaly eccentricities even if they are concentric.

30 Q. Well let's move to point 6 because as I recall, and I can find it if I need to, that in John Henry's evidence he says in particular with torsionally eccentric buildings it takes some time to become experienced, in particular in analysing the outputs of the computer program. That's correct isn't it?

A. That's what he said but I have disagreed with that in principle because even a concentric building has eccentricity which requires that analysis.

Q. And I think the sixth point, if I've got to that, is that John Henry also says that you need some experience under your belt in high-rise buildings to

become proficient, as I recall at least three buildings in his evidence. Is that correct?

A. That's what he said.

Q. And what do you say about that?

5 A. I don't agree with that. You have a choice when you're involved in these project and your choices include putting your hand up and saying, I can't understand this. I'm not familiar enough with it, and asking for assistance or alternatively saying I cannot continue to proceed with this project.

10

1050

Q. I think the seventh point Dr Reay, and I think the most telling of all, is that when you encouraged David Harding to come across to you his evidence was that you were expanding the practice into high-rise
15 buildings and you had a competent engineer that would mentor David Harding, this is John Henry, and good draftsmen, but the fact of the matter - David Harding and John Henry never spent one day together in your office. Is that correct?

A. That's correct but that was clear before David Harding agreed to come
20 to the company to work.

Q. And more of a reason on the basis you've lost John Henry to spend some time mentoring and reviewing David Harding's work.

A. David Harding was more familiar with the concrete code and the loadings code than I was.

25 Q. Adding together David Harding's self-evaluation of his ability when he came to you to design high-rise buildings and competence in the use of ETABS together with the seven points that I have referred to you Dr Harding, sorry Dr Reay, it appears to me and in particular to Mr Harding that there can be no escape from the logical conclusion that
30 you should have been reviewing his work and mentoring him. Your response to that?

A. I don't agree with that. If in fact at the time when he was considering whether he did, took on the CTV building or not he had said what you

have just said I would not have agreed to him undertaking it and it would not have been undertaken within ARCE.

Q. I have no doubt whatsoever Dr Reay that this has been a very low point in your life, in your professional life, but have you got any idea because
5 of your distancing yourself from Mr Harding what he is going through at the moment mentally and emotionally?

A. I can understand what he is going through but I'm not distancing myself as you say.

Q. Do you feel you owe Mr Harding an apology for what's happened
10 Dr Reay?

A. I haven't thought of it in that context.

Q. Thank you.

CROSS-EXAMINATION: MR MILLS – NIL

CROSS-EXAMINATION: MR ELLIOTT

15 Q. Dr Reay do you have a copy of the schedule that I provided to your lawyers yesterday to give you?

A. Yes.

Q. And that's a document headed "Schedule of Non-Compliance" – I should emphasise this is alleged non-compliance. So you received that
20 yesterday did you?

A. I have the list.

Q. Did you receive that yesterday?

A. Yes.

Q. And you were here during Mr Harding's evidence yesterday afternoon
25 and today weren't you?

A. Yes most of it.

Q. So that you've heard me questioning him about the schedule already and you heard his answers. Is that right?

A. Yes most of them.

30 Q. And do you agree that you have in front of you there two green folders available to you if you, if you need them, one of which contains the relevant codes and the other which contains Mr Harding's calculations

and stamped drawings. Would you like to check that or do you accept that they are there in front of you?

A. No that's fine.

5 Q. Thank you. The, I'm going to take you through the schedule in the same way as with Mr Harding the purpose being to give you an opportunity to comment on the evidence that's comes out before the Royal Commission. As I said to him I won't necessarily seek to debate each point but just to give you the opportunity to say what you'd like to say.

10 Now before I do that just one or two questions about the brief of evidence that you've read out today. The first is that you say that there is no certainty as to the documentation used for the permit application and arrive at a point where you say it's not possible to definitively state whether the building documentation complied. You do agree don't you
15 that we have drawings with the Council permit stamp on them don't we?

A. Yes we do.

Q. And so the Royal Commission can use those to determine compliance with the code at the time of permit can't it?

A. Well we don't know that that were all the documents that were issued.

20 Q. So are you saying you think there were other permitted drawings?

A. Well the difficulty is that at that time and probably to sometime subsequently we would never know what documents the Council formally issued to a builder.

25 Q. You have copies of drawings without any Council stamp on them don't you?

A. Yes.

30 Q. And when you gave evidence last time I asked you to check them and to satisfy yourself there is no difference between those two sets of drawings in relation to the diaphragm connection, the detailing of the columns and beam column connections and that is the case isn't it? There is no difference?

A. There's no difference that I can find.

Q. So you can point to no other documentation evidencing differences in relation to those parts of the building? Differences to what the permitted drawings have?

5 A. No I can't, all I'm making the point is that the documents were not issued to us, they were issued to the builder and we don't know what other documents may have been issued by the Council at that time.

JUSTICE COOPER:

10 Q. In the set of drawings which we have and which has the Council stamp on them there's an index which takes us from sheet 1 to sheet 39. Are you familiar with that?

A. Yes I am.

Q. And we've got sheets 1 to 39, each of them with a Council stamp on them. You've seen those?

15 A. Yes.

Q. And you've studied them?

A. Yes.

Q. So is there some omission in these drawings that you can refer us to?

A. No –

20 Q. Something that's not covered in your opinion?

A. At that time if the Council wanted further information they may have asked a question and the detail may have been provided to them in answer to that question. I don't know whether that happened on this job and that detail would then be issued to the builder.

25 Q. But the Council stamp on the plans dated the 30th of September is also on the index which shows drawings S1 to S39. So you're talking about some amendment are you after the permit has been issued?

30 A. No. They could have had a drawing, construction detail of some sort that they also put the stamp on and issued and it wouldn't be in the index. I can't say that that happened but I can't say that it didn't happen.

Q. Well what evidence is there that it happened?

A. Only that occasionally at that time that was the way they handled the permit process.

Q. So it happened in some other cases. Is that what you're saying?

A. Yes.

CROSS-EXAMINATION CONTINUES: MR ELLIOTT

5 Q. You go onto say Dr Reay in that same brief that you've identified two areas of possible non-compliance but they are areas of actual non-compliance aren't they?

A. Well I haven't established that they are definitely but I consider that they are possible non-compliances.

Q. Just explain your reasons for your view about the non-compliance of the diaphragm connection.

10 A. The fact that there is, there was no significant connection between two of the shear walls and the floor.

1100

15 Q. The Department of Building and Housing report addressed design, construction and standards issues, including reference to beam column joints and diaphragm connection didn't it?

A. (no audible answer 11:00:15)

Q. Do you recall that?

A. I can recall the diaphragm connections; I can't recall anything in depth on the beam column joints.

20 Q. I think at that point of release of that report you were critical of the report and called it "potentially flawed" do you recall that?

A. Yes in some aspects it was.

25 Q. Is there some reason why you couldn't have come out at that time and identified these two areas of non-compliance which you've only now identified?

A. We only had two weeks total to review it and we did the best we could in that time.

30 Q. Is there some reason why you haven't come forward before this point and pointed out to the Commission that this is your view about non-compliance?

A. I have been following the hearing and it is as I've said, it's because of that that I have noted these things. I didn't specifically look for them prior to that.

Q. Doesn't it evidence a general reluctance on your part to admit that you've done anything wrong?

A. I don't agree with that.

5 Q. Just turn to the schedule please, in front of you, this is the schedule I prepared.

WITNESS REFERRED TO DOCUMENT – SCHEDULE

10 Q. Now you've, as I say you've had an opportunity to hear the questioning of Mr Harding so you know what these are addressing. Firstly, symmetry. Is it your position, do you accept that the walls were not symmetrical in the east-west direction?

A. They were not symmetrical.

15 Q. They were not. Now you're aware that clause 3.1.1 of NZS 4203 says, "The main elements of a building that resists seismic forces shall as far as practicable be located symmetrically about the centre of mass." Mr Harding says the reason it was not practicable to make them symmetrical was architectural reasons. Do you agree with that?

A. That would've been one of the reasons I would imagine.

Q. Can you point to any engineering reason that made it impracticable for them to be located symmetrically about the centre of mass?

20 A. Well the walls were actually located symmetrically. It's the stiffness of the walls that varied. But that clause talks about the actual location of the wall.

Q. I'm sorry, I thought you'd agreed the walls were not located symmetrically?

25 A. Well they are –

Q. (inaudible 11:03:16)

A. – located symmetrically but the stiffness of them is different.

30 Q. Well just confine yourself to the question of whether they were located symmetrically about the centre of mass, to which you've agreed I think that they were not, is that right?

A. They were actually located approximately symmetrically in location.

Q. We just need to understand your position doctor. So you're saying, are you, that these walls in your view were or were not located symmetrically about the centre of mass?

A. They were located symmetrically but because the stiffness of them varied it produced an unsymmetric system, but that's different to the actual description that you're referring me to.

5 **JUSTICE COOPER:**

Q. It seems to me Mr Elliott's asking you a question which you're not answering, at least precisely anyway, and it may be a misunderstanding. The question is whether the walls were located symmetrically about the centre of mass, and you answered that by saying they were located symmetrically, but you leave out about the centre of mass. Now that's something that needs to be tidied up?

10

A. Right, they were located symmetrically about the centre of mass.

CROSS-EXAMINATION CONTINUES: MR ELLIOTT

Q. That's your position in relation –

15

A. Well they were.

Q. I see, all right, we just need to understand it. Now the next point is centre of stiffness of the designated primary seismic resisting elements significantly eccentric to the centre of mass. You agree or not?

A. Yes I agree that that centre of stiffness was eccentric to the centre of mass.

20

Q. The next page, page 2, the first topic there is shear reinforcing of columns.

A. Just before we move on, there wasn't an absolute requirement in the code that they were symmetric. And the code provided the requirements to design them as an asymmetric system.

25

Q. Well we best have a look at it then. ENG.STA.0018.38?

WITNESS REFERRED TO SLIDE

Q. Top right-hand corner please? I'm just going to enlarge that for you doctor so that we can see it, top right-hand corner 3.1.1.

30

A. Yes I can see that.

Q. That is what the code says?

A. Yes.

Q. Well that seems to say, "They shall be located symmetrically about the centre of mass."

A. As near as practicable.

Q. Yes.

5 A. And then other aspects of the code cover the situation where they are not symmetric.

Q. Are those other sections you're referring to in the commentary to NZS 4203?

10 A. Yes and within the design of the rest of the design elements of the codes.

Q. NZS –

A. Fundamentally it is not an absolute code requirement.

15 Q. Over to page 2, the shear reinforcing of columns. This will be well familiar to you because this was in the original Hyland Smith report, reference to clause 7.3.4.3 and 7.3.5.4 NZS 3101. What's your position in relation to those matters?

WITNESS REFERRED TO DOCUMENT

A. Shear reinforcing is only required if the certain conditions of the code aren't met.

20 Q. So –

A. So it's a function of the design of the columns as to whether that's, that requirement is required or not.

Q. Your position is that there was no breach of the code in relation to those provisions, is that right?

25 A. I believe not in terms of most of the columns.

Q. What about the other columns apart from the most? That was clumsy. Are there some columns which you think did breach those provisions of the code?

A. They may have.

30 Q. They may have?

A. They may have.

Q. Have you come here prepared to give an answer definitively on that?

A. Not definitively at the moment, no.

Q. Which columns are you referring to?

A. Well it depends on the method of analysis that's used to determine whether the columns comply and for example if you take the latest Hyland figures there's some columns on line 1 think in there about level 5, there's four that don't appear to comply by his design and his standards that he's adopted.

5

Q. Doctor I think you're coming back yet again later in the week. Would you please look into this matter and come back with a definitive answer then about whether you say that there was non-compliance in those respects or not?

10 A. I can't give a definitive answer because it depends on the basis on which you do that analysis.

JUSTICE COOPER:

Q. Well, do you not have a preferred basis yourself?

15 A. Not at the moment I don't.

Q. Well, Mr Elliott, your, well let me ask you this further question Dr Reay, how long would it take you to have a preferred method of assessing that issue?

A. Well I've listened to diverse opinions on it and I don't believe I have the expertise to determine which is the right answer for this.

20

JUSTICE COOPER:

So this is a matter on which he doesn't, he prefers not to express a view, I would've thought that was sufficient for your present purposes?

25

MR ELLIOTT:

Yes Your Honour.

1110

CROSS-EXAMINATION CONTINUES: MR ELLIOTT

30 Q. I take it, it would follow you didn't have the expertise to design the columns in that respect back in 1986?

A. Well I didn't undertake the design of columns in that circumstances then, so I'm unable to say whether I did or didn't.

- Q. The next point is the anchorage of the spirals on columns. There's a provision in the code, you see it there, requiring anchorage and Mr Smith gave evidence that there was no indication in the drawings of anchorage. I think Mr Harding accepted that but said that he would rely upon the contractor. What's your position on that? Do you accept that the drawings showed no indication of anchorage and therefore on their face did not comply with that clause?
- 5
- A. I would agree with Mr Harding that you wouldn't expect to see that on the drawings. You would use the standards. But perhaps the most important point is, if you go to the site at Burwood the reinforcing does have the return.
- 10
- Q. I'm sorry, the?
- A. The reinforcing does have the return that is required.
- Q. I see so you've –
- 15 A. It's evident there now.
- Q. – you've seen examples of that?
- A. Yes.
- Q. Did you take any photographs?
- A. Yes I did when I was there, well I've taken them twice of that because I noted it particularly, but I can send the photo through of it.
- 20
- Q. The next point is adequacy of the R6 at 250 spirals in the regions of the cranked splices of the columns. You're familiar with the area I'm talking about there, cranked splice region?
- A. Yes.
- 25
- Q. And Mr Smith's position was the spirals of R6 at 250 were insufficient to meet the requirement of the code set out there in the schedule. Do you accept that?
- A. No I don't understand his, that statement. The spiral was at 250 pitch, which means that the line of the spiral would've been within 150 millimetres of the change in angle of the bar. On site you can still see some of the lapse and the bars are not actually cranked.
- 30
- Q. Again do you have photographs of that?
- A. I, yes I probably do, but if I don't I can get them, it's still evident there.

Q. Page 3 relates to the ductility of the columns and there were various positions in relation to why the columns should have been designed with the seismic detailing provisions from NZS 3101. Now firstly I'll deal with number 1, capacity design. Do you agree that capacity design applied to the design of the CTV building?

5

A. Not to the frames, no. Based, if they were based on elastic design and capacity design for those frames was not (inaudible 11:13:36)

Q. I'll just show you ENG.STA.0016.24.

WITNESS REFERRED TO SLIDE

10 Q. Highlight 3.5.1.1A please. Do you recognise this clause?

A. Yes but that frame is not designed as a ductile structure. It's designed under a different section of the code.

Q. Well we could enlarge the clause so we can see A, B and C please? Well they're the three design methods set out?

15 A. Yes.

Q. Which do you say applied to the CTV?

A. It's the version C.

Q. How do you reconcile that with Mr Harding's selection of a structural type factor of S equals 1 and S equals .8?

20 A. Well they relate to the shear walls which were designed for ductility.

Q. I see. So you would say the shear walls fall under category A and the columns fall under C, is that your position?

A. That's my understanding, yes.

25 Q. So when it says, "Ductile structures shall be subject to capacity design," in sub clause A, what you are saying is the ductile structures meant in this case the north core and south walls?

A. Yes that was a ductile structure.

Q. You were aware in 1986 of what capacity design was weren't you?

A. Yes.

30 Q. Professor Mander gave evidence that this was a concept introduced in the 1960s, did you, do you agree with that?

A. I wouldn't be certain about that.

Q. What did you do to ensure that Mr Harding understood what capacity design was before embarking upon the design of the CTV building?

- A. My understanding was Mr Harding would've learnt about capacity design when he was at university.
- Q. Is that an assumption you made or did you ask him?
- A. I didn't ask him but it was taught.
- 5 Q. Would you agree that the capacity design of this building would have required not just consideration of the north and south walls but consideration of the diaphragms connecting those walls so the structure as a whole should've been considered?
- A. No the code does not require that.
- 10 Q. Don't you agree that it's artificial if not completely meaningless to just design two separate walls using capacity design and ignore what's happening in between them?
- A. No the code was clear as to what loads were to be designed for and it was not, there was no requirement to design the, what you're talking
- 15 about, the capacity design.
- Q. How were the loads supposed to get to the walls?
- A. Through the structural system.
- Q. Through the diaphragms, correct?
- A. Yes.
- 20 Q. And through the diaphragm connections to the walls. So it's meaningless to exclude the diaphragms from consideration of capacity design –
- A. No because the code required the diaphragm to be designed for parts and portions.
- 25 Q. And you say that overrode considerations of capacity design do you?
- A. Well there was no requirement to use capacity design for that part at that time.
- Q. Well the wording refers to "structure" doesn't it? That's pretty clear?
- A. Yes but the diaphragm isn't a ductile structure.
- 30 Q. But the structure, which is supposed to be capacity designed must include the walls connected by the diaphragms, otherwise you're just considering two walls as elements –
- A. No that's wrong.
- Q. – behaving on their own?

A. It's, the ductility is in the wall itself.

Q. Well, as I've mentioned, when you received the report from DBH you put out a press release in which you said, "The report's findings were not conclusive and in many areas may be flawed." That's right isn't it?

5 A. I recall that.

Q. And so I think you then engaged Professor Mander, didn't you?

A. I beg your pardon?

Q. You then engaged Professor Mander?

A. Subsequently yes.

10 Q. And I take it that you considered his evidence would assist the Commission?

A. Yes.

Q. And you considered in fact his involvement was necessary, given those perceived flaws in the DBH report, is that right?

15 A. No I didn't look at it like that.

Q. I'm just going to give you a passage of evidence Professor Mander gave about capacity design. TRANS.201020724.101.

WITNESS REFERRED TO SLIDE

1120

20 Q. Just highlight from line 26. This and the next page relates to questions to Professor Mander about what the consequences would be if capacity design applied to the structure and you'll see there the wording to the structure is exactly as per the clause I've just quoted. So would you please read that and then we'll read part of the next page as well. And
25 the next page, lines 1 to 16 please. Do you accept what Professor Mander says?

A. No I don't agree with it and I'd have to consider it within the context of the various questions that have been asked. It certainly be, that applies to the primary structural system, if that's what was being referred to, but
30 it doesn't apply to the gravity frame system and the previous page mentioned about resisting load, the columns resisting seismic loads, in fact really the gravity frame system has deflections imposed on it as part of the response of the ductile system and it's those deflections that have to be taken account of.

Q. All right, so just to take it step by step and to be clear. This questioning to Professor Mander about what the consequences would be if capacity design applied to this building you don't accept the evidence he's given there, that's right?

5 A. The capacity design does not apply to the gravity frames if they are based on elastic design.

Q. Well he's saying it does you see. So you disagree with that?

A. Well if that's what you say he's saying, I disagree.

10 **COMMISSIONER FENWICK:**

Q. Excuse me can we just sort out this capacity design with the walls and floor slabs and we'll assume the columns go for the ride and they may or may not be elastic but when you're looking at the strength of the walls you're assuming that plastic hinges are going to form in the walls, generate in the south wall, is that correct?.

15

A. Yes.

Q. Going to deform inelastically. Now to force that member or to allow that member to develop its plastic hinges you've got to transfer certain forces from the floor slab into the wall haven't you?

20

A. Yes.

Q. Now when you're doing capacity design, when you're doing design you design for strength conservatively on the basis that you're using lower characteristic strengths. They weren't talked about in those times but the reinforcement stress and grade 275 reinforcement that usually had a strength of about 20 percent higher than that. The 380 reinforcement likewise the strength was appreciably higher than 380 megapascals on average, is that correct?

25

A. Yes.

Q. The concrete was ordered at 25 megapascals with 35 megapascals, whatever it is, usually that concrete strength, which you assume of 35 or 25 or whatever it was in the design but usually it was quite a lot higher than that wasn't it?

30

A. We would have expected it to be yes.

- Q. Nineteen out of 20 times (inaudible 11.24.16) you expect to be higher. So the actual strength of that wall was appreciably higher than it was assumed in design wasn't it? The design, the actual average strength was higher than the design strength.
- 5 A. Yes potentially.
- Q. And do you get strain hardening of the reinforcement which you didn't allow for in the design, is that correct, when you did your analysis?
- A. That's correct yes.
- Q. So in capacity design you have to say if you're going to form a plastic hinge there the forces you'd need to transfer need to be based on the likely maximum possible strength of that wall don't they, not the design strength?
- 10 A. Yes that's correct.
- Q. So in terms of capacity design then the connections between the floor slabs and the wall must be capable safely of developing the high, the maximum possible strength known as the over-strength of the wall, that's correct isn't it?
- 15 A. Well yes except that the Code referred to using parts and portions at that time.
- Q. Referred to both and I agree the Code was a little bit vague there. It said you should work it out by parts and portions or by over-strength and you use whichever was the smaller, that's correct isn't it?
- 20 A. Yes I think that's what it said.
- Q. Yes, didn't make much sense though did it?
- 25 A. Well in hindsight, no.

CROSS-EXAMINATION CONTINUES: MR ELLIOTT

- Q. And the fact that it didn't make much sense is reflected in the way the building behaved on the 22nd of February which is that the north wall remained upright, everything in between collapsed and the south wall seems to have collapsed on top. That reflects the design of this building doesn't it?
- 30 A. It may not reflect the issue that we've been discussing at all.
- Q. What, that the wall was stronger than the parts in between?

A. I'm not certain but I suspect that the south wall may have had sufficient strength to meet the capacity requirement, the north wall wouldn't have.

5 Q. Next on page 4 another ground which has emerged in the evidence as a basis for the columns being required to be designed for ductility is that they were a risk to life. Now before asking you about that I just want to refer you to Bylaw 105. Are you aware of what Bylaw 105 is?

A. Having been here yesterday I am.

Q. Were you aware of what Bylaw 105 was back in 1986?

A. I wouldn't recall.

10 Q. So I don't suppose you could recall whether you checked whether Mr Harding was aware of it or whether, indeed, anyone in your office was aware of it?

A. We would have had a copy of it.

Q. Kept prominently or gathering dust?

15 A. It's 26 years ago, I can't answer that. The Bylaw essentially encompasses the New Zealand Building Codes. So if you follow the New Zealand Building Codes you're effectively following the Bylaw as I understand it.

20 Q. Right, but it's the Bylaw that set out the legal requirements, did you understand that at the time?

A. Well yes I was familiar with the fact that the Council chose what New Zealand standards it adopted.

WITNESS REFERRED TO ENG.CCC.0044A.86

25 Q. Highlight all of 11.1.5 and 11.1.6 please. Would you like to read that to yourself Doctor.

HEARING ADJOURNS: 11.29 AM

HEARING RESUMES: 11.47 AM**CROSS-EXAMINATION CONTINUES: MR ELLIOTT**

5 Q. Dr Reay you have those words in front of you, 11.1.5, and in particular referring you to Clause D of the Bylaw. My question is did you have those words in your mind in 1986 when designing buildings?

A. I would imagine so.

Q. And would you have taken steps to ensure that Mr Harding had those words at the forefront of his mind?

10 A. Well under 11.1.6 complying with the New Zealand Standard is complying with those requirements.

Q. So I'm going to suggest to you that if the objective set out in 11.1.5(d) was your objective then it must have followed the columns of the CTV building should have been designed with seismic detailing as per
15 NZS3101, do you accept that?

A. No that's not right.

Q. Do you accept that the failure of the columns was a risk to life which, therefore, necessitated them to be required to possess ductility as per the seismic detailing provisions of the Code.

20 A. The way the Code is written and the way we follow it it should happen that the columns aren't the critical element in terms of the risk to life and you could design those columns for ductility but the end result could be that there is a greater tendency for the cover concrete to fall off when they're subject to yielding than if they were built as they had been drawn
25 and that's been illustrated in buildings such as the Westpac Building in Christchurch where I think they were designed for and were confined but the cover concrete spalled off in large sections. Now in the case of these columns, they're not that large, they wouldn't have carried the load. So the solution that you're proposing is not necessarily going to
30 solve the problem that you see. But fundamentally 11.1.6 is the basis for complying with 11.1.5.

- 5 Q. The next issue on your schedule in front of you on page 4, this is another ground for the assertion that the columns should have been designed for ductility, is in relation to the application of Clause 3.5.14.3 of NZS3101, that's the secondary elements clause. Would you like to see that or you're familiar with it?
- A. Well the columns were not designed as part of the primary force resisting system.
- 10 Q. So you don't accept that they formed part of the primary force resisting system and should therefore not have been classified as secondary elements?
- A. No the basis, the basis of the design is that they were secondary elements.
- 15 Q. Over the page the other reason for which the columns should not have been treated as secondary elements there is that they were necessary for the survival of the building as a whole under seismically induced lateral loading. Do you accept that for that reason they could not have been treated as secondary elements by the designers?
- A. No that's not a basis for that. The definition of the secondary elements is more particular than that particular clause and it identifies that in the definitions.
- 20 Q. You're aware that the definition of primary elements in NZS4203:1984 included beams and columns.
- A. Yes, but in the in the Concrete Code it says, in the Concrete Code, that the use of the basis for secondary elements is more particular. It takes preference over it.
- 25 Q. The next ground on which it has been argued that the columns should have been designed for ductility is point 4 here in the schedule. If they were secondary elements the drift limits, that would be delta point, were exceeded, various people have said that and what's your position on that?
- 30 A. Well in designing a building like this you have options and if, for example, I mentioned the Hyland Drift Analysis which has been presented. There was four, one level of columns on line 1 at level 5 I think that didn't comply on the basis that he analysed them and you

know you have a choice at that point. You can put more reinforcing in and maintain the principle of elastic behaviour by simply reinforcing them appropriately and if there's only a few columns that's probably what you would do. If you found that when you analysed them that 90 percent of the columns were not performing adequately you would either

5 revise your base design or you would change the whole lateral load system or you would change the gravity system. So there is no one answer like is being put forward here.

Q. I just need to understand your position so that we know it so that

10 compliant or non-compliant, I'm sorry should the columns have been ductile or not? The assertion some have made is they should have been ductile because V-Delta was exceeded. They were not elastic beyond V-Delta.

A. No what I've said is that you didn't have to make the columns ductile.

15 You could actually design them to remain elastic.

Q. Next page, page 6. Now at this point in relation to beam column connections requiring to be designed for ductility, if it was the case that the columns were required to be designed for ductility, which I think you've said no on every count, but if that was the case would you accept

20 that it would follow that the beam column connections should also have been designed with those seismic detailing provisions as well?

A. It's my understanding that if the columns were to be designed for full ductility then the joint would be designed for capacity design, that's my understanding. I don't quite understand how a joint could be designed

25 for ductility itself.

Q. I appreciate that's probably my clumsy wording, what I meant there was the seismic detailing provisions, you know the seismic and non-seismic provisions in NZS3101 for beam column connections, so I'm referring there to the seismic provisions at that part of the Code.

30 A. I think that if you decide that you're going to use the seismic provisions for the design of that frame then you end up designing a total frame for those provisions not just making the columns ductile.

Q. Yes. The next issue is the minimum transverse reinforcement requirements for beam column connections not being met and there's

reference there to three clauses from NZS3101 and Mr Smith's position was that the R6 at 250mm spacing spiralling was insufficient to meet those requirements. What's your position on that?

5 A. Yes well I have said that I think that it is quite likely that the 250 didn't meet the 200 Code requirement, I've already said that.

Q. Over the page, page 7, I think the first one we've already dealt with, you've dealt with that in your evidence, that's correct isn't it, 9.4.8, that's an area of non-compliance that you've agreed?

A. Yes I've commented on that.

10 Q. Thank you. The next issue is diaphragm, we're talking about the diaphragm as opposed to the diaphragm connection.

1157

15 A. Yes just going back to that 200 versus 250. It could well have been installed on the site at 200 because of the fact you couldn't actually build it as drawn but as others have said the difference between the 200 and 250 isn't actually the issue. It's, it's more complex than that.

Q. But you accept the drawings had 250 on them?

A. Yes I certainly do.

20 Q. Thank you. The diaphragm, firstly do you accept that the 664 mesh did not meet the code provisions set out there?

A. If you take it at face value as there it may appear that way but if you actually allow for the effect of all the laps that are put in as a result of using mesh I think it could, because it comes close to meeting it, I think it would then meet the code requirement.

25 Q. The next point is the use of parts and portions forces in the design of the diaphragms. Do you accept that the forces set out in the parts and portions section were not used for the design of the diaphragms and should have been?

A. I haven't followed the calculations to that degree to answer that.

30 Q. Over the page on page 8 there was some evidence in which Mr Harding responded to questions from Commissioner Fenwick about not following the requirements of capacity design in relation to the diaphragms. I think you've already accepted that, well you say capacity design didn't apply to the diaphragms.

A. Well parts and portions applied to the diaphragm.

Q. The next issue is diaphragm connection to the north core. Now we're talking here about the calculation of the required force, the load that the connection must be required to be capable of sustaining. Firstly, do you
5 accept that Mr Harding has used forces derived from the equivalent static method and not the parts and portions section of the code in determining what those forces would be, should be?

A. Well I don't know. I can only go by what he said. I can't, I haven't studied that.

10 Q. Do you accept that at the very least the forces specified by the parts and portions section of the code should have been used in relation to the calculations of loadings for the diaphragm connections?

A. That's the basis on which they should be designed.

Q. And would you accept that if capacity design considerations were
15 applied then the loadings necessitated could be even greater than those specified by the parts and portions provision of the code?

A. Well I haven't considered that but it's possible.

Q. At page 9, we may need to, there'll be some more evidence on this, this week I think we're dealing with drag bars but you accept do you that
20 even following installation of the drag bars the building remained non-compliant with the code in the east-west direction as Dr O'Leary says?

A. No I can't accept that at this time. Dr O'Leary was a relatively brief analysis that excluded some of the mesh reinforcing so you'd have to
25 analysis it more fully before you could come to a conclusion such as that.

Q. Do you accept what Dr Jacobs said which is the drag bars should have extended to the slab back to line 3?

A. I, no I don't accept that because they only, they only had to be designed for the specific load and the specific connection forces and my
30 understanding is that those were able to be transmitted within the distance or within the length that the bars were.

Q. The next issue is spandrel panel separation. I think you had actually responded to this with Mr Mills before. You accept that there was no

seismic gap specified, noted in the drawings in relation to the spandrel panel separation don't you?

A. It wasn't called a seismic gap but a gap was specified.

5 Q. Turning to page 10 Dr Reay these are issues which I've categorised as best practice. Professor Priestley –

A. Could you perhaps provide me a definition of best practice because I don't know what it is?

10 Q. Well what I've done is just to extract what various people have said and I'm putting it to you and, and you can say whether you agree that that is best practice and whether it complied. So firstly in relation –

A. Well I have difficulty with that. When there's no definition how do I answer that question.

Q. Well as I say –

15 **JUSTICE COOPER:**

Q. Well your position, if you want to leave it on this basis, appears to be that you have no idea what best practice is. Is that your evidence?

A. Well it's defined by Nigel Priestley, or Professor Priestley I should say, I think, that it's the state of accepted knowledge at the time of design.

20 Q. All right. Well that's your understanding of the term?

A. Well that's what, that's what he says in his –

Q. I was just trying to elicit from you what your view is.

A. Well that then, that then to me would mean that that's the code because that's the accepted knowledge at the time of design.

25 Q. So if code requirements are met that's best practice, that's your stance?

A. Well that's my understanding.

Q. All right. So over to you as to whether you take that further. I'm not suggesting you shouldn't but –

30 **MR ELLIOTT:**

Well it's a simple process Your Honour for the sake of completeness.

CROSS-EXAMINATION CONTINUES: MR ELLIOTT

- 5 Q. Specifically Dr Reay Professor Priestley has said that there was a lack of adequate connection between the floor slabs and the north core. I think you accept that as non-compliant with code and, therefore, also non-compliant with best practice?
- A. Yes it is potentially non-compliant with the code. I haven't actually analysed it to see what the effect of it is.
- 10 Q. We won't deal with eccentricity. Over the page, page 11. The first issue in the Hyland Smith report, robustness, was stated to mean the ability of the structure to sustain damage without causing progressive damage to the building as a whole and they say the secondary beam and column frames lacked the level of robustness expected of frames designed to cope with cyclic drift of earthquakes and the seismic provisions of the code would have improved robustness. Do you accept that? Firstly, do you accept that robustness as they've defined it was a best practice requirement at the time?
- 15 A. Well again there's no definition of robustness. It was a word that was bandied around you might say but fundamentally if you complied with the code then the structure should have been robust.
- 20 Q. Based on the definition of robustness they've given there do you accept that the secondary beam and column frames lacked the level of robustness as they say?
- A. No not in terms of the code, no.
- 25 Q. Do you accept on the next issue that the building lacked redundancy in that if the columns or beam column connections failed whole or partial collapse would result?
- A. Well that's true of most buildings so I don't quite understand how that's been put in that term so I can't, can't really agree with, with it other than that's inevitable with every building.
- 30 Q. You've heard the evidence that Mr Harding gave, my questions to him earlier on about columns and the reference to the Park and Paulay extract. You were here for that weren't you?
- A. Yes.

Q. So Professor Priestley there is saying lack of ductile detailing is a failure to comply with best practice, in this case best practice evidenced by the publication of a text some 10 years before the design of the building. So do you accept that best practice would have required ductile detailing of the columns?

5

A. Well I've explained that in fact I don't think it would have helped to have detailed those columns for ductile behaviour without changing the whole frame. So I don't really agree with that and the issue here I think is that you can, I mean Park and Priestley were leaders and they've described the book as the Bible, was absolutely correct, but they were both part of this code committee in 1982 which was long after the book was produced and if in fact that aspect was critical I would have thought that they would have insisted on it being in the code. So I don't quite, I'm concerned about, you know, the issue but I can't quite see how that feeds into design at that time. Given their involvement with the code committee.

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1207

Q. Over the page, page 12, I think this is more or less the same point, but excessive spacing of transverse reinforcement according to Professor Priestley was too inadequate to achieve ductility. I suppose you've answered that point, or do you have more to say?

20

A. No, no, no I don't.

Q. What about the assertion that excessive cover to reinforcement of columns, there was, sorry, there was excessive covered reinforcement of columns resulting in inadequate compression strength of concrete core in the event of spalling of the covered concrete?

25

A. Well, yes, I've said that that would be the case if it was, if the cover concrete was removed, but the columns complied with the code as I understand it at the time, in terms of load capacity.

30

Q. So do you or do you not accept that that was a failure to comply with best practice?

A. No I don't accept that.

- Q. Professor Priestley points to the lack of transverse reinforcement in the beam column joints as a failure to comply with best practice. Do you accept that?
- 5 A. The beam column joints, where they don't meet the code, aren't to best practice by the code criteria, if they don't.
- Q. And the issue of poor connectivity between pre-cast beams and columns. Do you accept that there was poor connectivity between pre-cast beams and columns?
- 10 A. Well no the connectivity was there with the reinforcing steel as David Harding's explained so that if connectivity means ensuring that the beams on each side of the column don't move apart, then in fact that was provided for.
- 15 Q. And finally on page 13, you've heard evidence from Mr Harding I think about this disparity in structural type factors, the selection of structural type factors at the north, the north and south, which Mr Smith said could lead to disparities in performance with the yielding of the south wall before the north with plastic performance at the south and elastic performance at the north and potential impacts on inter-storey drift. What's your comment on that?
- 20 A. Well again, if you comply with the code, there is no issue with it. And by way for example the Landsborough House building was exactly the same. It had one line of wall that was a yielding wall and the opposing wall would've remained pretty much elastic. There was no, in principle, in terms of response there isn't a lot of difference between the two
- 25 buildings and the systems. So I don't, that in itself is not, not a problem in terms of the code provided it you design appropriately for it.

RE-EXAMINATION: MR PALMER – NIL

QUESTIONS FROM COMMISSIONER FENWICK- NIL

QUESTIONS FROM COMMISSIONER CARTER:

- 30 Q. Dr Reay, just in regard to the method of actions of this building in which it was designed with a gravity internal frame and with seismic walls. I

understand that that method of design, I think Mr Henry gave evidence to the fact design was also being used by other firms. Are you familiar with that?

5 A. Yes, yes it was in Christchurch and Mr Henry said also that it had been used in Wellington but I don't think he gave an example.

Q. I think your office had experience in at least three buildings –

A. Yes.

Q. – prior to this building and using that method?

A. Yes they were all designed by Mr Henry, the three.

10 Q. So in regard to familiarity with these various clauses in the code, this concrete code which we've just been hearing and with the fit or lack of fit with what was being said in 4203. Were you not following that personally, how that, the logic for the use of the codes was being interpreted by you might say the practices in Christchurch, or were you
15 leaving that to others?

A. I wasn't personally following it closely, no. Initially I relied on Mr Henry to undertake the work in that manner.

Q. So that's the basis of your comment that Mr Harding would know more about the codes than you?

20 A. Well yes, that's right and he had been to that course, that three day course of Park, Paulay et cetera in the middle of the time he was designing this building.

QUESTIONS FROM JUSTICE COOPER:

25 Q. Dr Reay, Mr Henry gave evidence that when you employed him you told him that you had a couple of multi-storey buildings in the pipeline and that he understood that his expertise was wanted because of that. Is that something you agree with or not?

A. His general expertise was, at that time I wouldn't have been thinking specifically about this design methodology.

30 Q. But multi-storey buildings that were not to be concrete block buildings was not something with which your firm had dealt previously?

A. Well no, the Ibis House building, the eight storey one was the seismic system was essentially based on concrete frame design.

- Q. So Mr Henry said that Ibis House and one other he mentioned, Ka –
A. Kamahi.
- Q. – Kamahi Towers were concrete block structures, is that not correct?
A. The Kamahi building was a concrete block structure but Ibis House,
5 while it had some concrete wall, concrete block walls in it, the
fundamental east-west design of the lateral load resisting system was
based on reinforced concrete.
- Q. And were you the designer of that building?
A. I was responsible for it, yes.
- 10 Q. And how many storeys was that?
A. That was eight storeys.
- Q. Now the buildings which relied on the shear walls, I think you've said
there were three before the CTV building, all of them were designed by
Mr Henry, is that right?
- 15 A. Yes three were, yes.
- Q. Aged Concern, Bradley Nuttall and Landsborough, is that right?
A. Yes.
- Q. Now you weren't involved in the design of those buildings, you left it to
Mr Henry?
- 20 A. Well I was involved to the extent that I was the lead consultant for those
three jobs. So I was involved with Mr Henry in term of liaising with him
as I was with the architects or et cetera for those. So I was, to some
degree I was involved in understanding what the basis was of what, of
how they were being designed.
- 25 Q. So that would've included, presumably, knowledge of how those
designs could be made to comply with the relevant standards at the
time?
- A. Well I understood the principle that they were being, the structures were
being designed for.
- 30 Q. Right, so did that include satisfying yourself that they could be lawfully
built in terms of the applicable standards at the time, including the
concrete code?
- A. No I relied on Mr Henry for that.

Q. Now why didn't you familiarise yourself with the code provisions? Can you recall?

A. Well I was fully committed on other work and it was Mr Henry's role to undertake that particular work in the senior position that he'd been employed in.

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1217

Q. It seems to me that as a prospective employee Mr Henry would have presented as a more experienced person than Mr Harding when it came to the design of multi-storey office buildings. Am I right in that?

10 A. Well, Mr Henry had actually had less experience post-engineering registration than Mr Harding.

Q. In relation to multi-storey buildings?

A. No just in general.

Q. No well my question was in relation to multi-storey office buildings?

15 A. Oh, well Mr Henry certainly had more experience than Mr Harding.

Q. What was the subject of your PhD thesis?

A. It was small amplitude vibration.

Q. Of?

A. Of concrete buildings in particular the physics chemistry building at the University and the zoology building.

20

Q. You have said on a number of times in giving evidence that Mr Harding knew more about the concrete code than you did?

A. Yes.

Q. Now what's the basis for that assertion?

25 A. He, when he was with me designed the more significant buildings that were undertaking.

Q. Name them please?

A. Broadway, there is a list been provided.

Q. Oh, that list?

30 A. Yes and Broadway is on it as one example. I think he's mentioned in his previous employment with me the Farmers building in Blenheim which was quite a large structure.

Q. What, was that a warehouse or?

A. No that was a commercial building, two storeys.

Q. I wonder if counsel assisting can help me with the number of that list?

A. Mr Harding had also designed that four storey building for the DBH at the time he was joining –

Q. The DHB perhaps?

5 A. Sorry DHB, yeah.

Q. Let's see if I can find that list. Just bear with Mr Dr Reay I am looking for the list that you referred to.

JUSTICE COOPER:

10 Mr Palmer can you help us with the number of that list?

MR PALMER:

I have got a copy of it Sir but not the number.

15 **JUSTICE COOPER:**

Q. All right, well this looks like it, so. So Broadway is a two storey commercial building at 62 Riccarton Road on which Mr Harding worked for, between December 1985 and October 1986 and you say he had full responsibility for the design of that building?

20 A. Yes that is correct.

Q. And you say that as a result of his involvement in the buildings in this list which I better read into the record, BUI.MAD249.0555.3. That is what created his greater familiarity with the concrete code than you had, is that right?

25 A. Well that and other, I mean that – other buildings that he designed whilst he was with my practise previously and based on him attending a ductile frame seminar that, when he was with us in the first case and then attending the three day seminar with Park and Paulay in the middle of designing the CTV building.

30 Q. So what provisions of the code do you say that he was more familiar with than you were?

A. Well most of my work had related to single level precast concrete factories and at that time also I was heavily involved in cold form steel design and that was where my emphasis was.

Q. Yes.

QUESTIONS ARISING: MR REID – NIL

QUESTIONS ARISING: MS DAINES – NIL

QUESTIONS ARISING: MR KIRKLAND

5 Q. Dr Reay you are not seriously contending and putting before this Commission that the attendants of a three day seminar was sufficient to close the gap in terms of Mr Harding's lack of experience in (1) high rise torsionally eccentric buildings and (2) ETABS?

A. It would close –

10 Q. Is that what you are putting to the –

A. (inaudible 12:24:03).

Q. Yes, your comment on that?

A. It would close the gap in terms of Mr Harding being able to say I can complete this design or I can't.

15 **QUESTIONS ARISING: MESSRS ELLIOTT AND PALMER – NIL**

QUESTIONS ARISING: MR MILLS

Q. There is just one issue Dr Reay which I thought I should follow up with you which arose out of the cross-examination by Mr Kirkland and it has been touched on I think again just in some answers to His Honour. You recall Mr Kirkland was putting to you a series of reasons why you should have appreciated that Mr Harding was insufficiently experienced to take on this job without supervision. You will no doubt recall the various propositions he put to you. You recall him asking you that series of questions?

20

25 A. I recall him asking me those questions.

Q. The note that I made of one of your responses to that I think pretty much at the end of the seven points that he put to you and it may not be entirely accurate so I will ask you to tell me whether it is sufficiently accurate that Mr Harding had a choice when he was engaged in this

project: you put your hand up and say you can't do it or you do it. Is that sufficiently capturing the point that you were making that it was over to Mr Harding, he either got on with it and did it or he put his hand up and said, I can't do it, or I need help to do it?

5 A. Well that was the point I was making.

Q. Yes.

A. It was his responsibility in that he didn't – no one made him do the job.

Q. Yes.

A. He wanted to and it was his responsibility to say whether he could do it
10 or not.

Q. And you made a similar comment in response to one of His Honour's questions about Mr Henry where my note of your response was that Mr Henry's role was to undertake in the senior position in which he had been employed, it was his job to get on and just undertake the work on
15 Landsborough House. Again that accurately captures your position about someone in a senior position and their responsibility to get their head down and get on with the work?

A. No again if Mr Henry had said, this building shouldn't be designed this way or I can't design it this way, then it would not have been designed
20 that way.

Q. Yes. But the expectation is, people in senior positions have the responsibility and the ability and if they don't they have to put up their hand and say, I don't?

A. Well that's part of being a registered engineer.

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Q. Now we've been over some of this before but I just need to tick this off with you again. Mr Harding, and again you repeated it in the course of your evidence today, he'd come with the prospect of an associate appointment and, indeed, you've said today he was actually appointed
30 as an associate part way through doing the CTV work. That's correct isn't it?

A. That's what I understand.

Q. Well it's what you've actually said I think that you said that he was appointed and associate.

A. Mmm well that's my understanding. I don't have a written record of that actually happening.

5 Q. Do you accept or do you agree that that prospect of being appointed as an associate and the reality of him being appointed an associate was because he got on with the CTV job in particular, got his head down and appeared, any rate, to be performing what he'd been asked to do?

A. No it wouldn't have been necessarily related to the CTV job. Mr Harding had undertaken other work prior to the CTV job.

10 Q. Wasn't that the most significant job that he'd undertaken on his own during his time with you?

A. Well of course he hadn't completed it then so if one's going to make an assessment of his performance based on that you would wait until it was finished. So I can't –

15 Q. Let me ask that again. Was this not the most significant job that he'd undertaken on his own during the time that he'd been with you?

A. I don't, in total it was probably no more significant than the previous nine storey building that he had done. They were different buildings with different challenges.

Q. You're referring there to Westpark are you?

20 A. Yes to Westpark.

Q. Right well it's already a matter of evidence of the extent to which that was picked up from Mr Henry so I won't pursue that again but really the point I want to get you to respond to relates to this issue about the environment in which he was operating, Mr Harding. If he had repeatedly put up his hand to you and said I can't do this, I'm outside my level of experience, I'm out of my depth. Would that have adversely affected the decision to make him an associate?

25

A. Not at all.

Q. Not at all?

30 A. Nope.

Q. I see, all right, thank you.

CROSS-EXAMINATION: MS DAINES, MR KIRKLAND, MR ELLIOTT – NIL

RE-EXAMINATION: MR PALMER

Q. During that sequence of questioning Mr Mills put to you as the alternative to David Harding saying that he would not do it that you would just leave him to it, those were Mr Mills' words not yours. By
5 leaving him to it, what would that mean to you in terms of any ongoing issues that might have arisen if you were aware of them?

A. Well he would proceed with the work that he considered he was capable of doing.

Q. And if he raised an issue with you that if he got halfway through it and
10 said I've got a problem what would your response have been?

A. My response would have been either to suggest that he approach someone else, depending on what the problem was would depend on who he approached and if it appeared that he was struggling with the job overall then we would have pulled the plug on the job. We wouldn't
15 have proceeded with it.

QUESTIONS FROM COMMISSIONERS FENWICK AND CARTER – NIL**QUESTIONS FROM JUSTICE COOPER – NIL****WITNESS EXCUSED**

MR RAYMOND CALLS**ALUN TREVOR WILKIE (AFFIRMS)**

Q. Mr Wilkie your full name is Alun Trevor Wilkie?

A. It is.

5 Q. And you are a registered architect living here in Christchurch?

A. I am.

Q. And you've been a registered architect for 36 years.

A. I have.

10 Q. You are currently a director and shareholder of Wilkie Bruce Registered Architects Limited.

A. I am.

Q. But at the time of the construction of the building at 249 Madras Street you were trading as Alun Wilkie Associates Limited and you were the sole director and shareholder of that company.

15 A. Yes.

Q. You have previously been asked to prepare and have provided to this Commission a brief of evidence in which you set out your initial involvement and responded to all of the questions which, as at that date, had been put to you by counsel assisting the Commission, Mr Mills QC.

20 A. Yes.

Q. And that brief was signed and filed on or about 10 May 2012.

A. Yes.

MR RAYMOND:

25 Sir, I've discussed this with Mr Zarifeh I understand it's been read –

JUSTICE COOPER:

We've read it yes.

MR RAYMOND:

30 I wasn't intending to read it again, Sir, if you're happy with that.

JUSTICE COOPER:

Yes. He needs to confirm that it's true and correct I suppose.

EXAMINATION CONTINUES: MR RAYMOND

Q. You have a copy of the brief of evidence there Mr Wilkie?

A. Yes.

Q. And if you turn to the final page you'll see that's your normal signature?

5 A. Yes.

Q. And dated 10 May 2012.

A. Yes.

Q. And can you confirm for the Commission please that it is a true and correct record of your evidence?

10 A. I confirm that.

Q. Now since that time counsel assisting the Commission has been in contact with me, as you know, and raised two or three other issues which they wish you to comment further on if you can and they relate to three issues. Firstly your recollection of dealings with the engineer on the project, firstly in the initial stages and, secondly, during the project. You're aware of that enquiry?

15

A. Yes.

Q. Secondly, who the decision maker was, in your view, on certain structural elements for the building.

20 A. Yes.

Q. And, finally, any further evidence you can give on the design of the south shear wall and any input you may have had in relation to that.

A. Yes.

Q. So I'm just going to address each one of those briefly if we can. So turning firstly to your recollection of your dealings with people on the initial stages of the project. You've already provided evidence in your brief in relation to who instructed you and your recollection of that. Since that time have you had an opportunity to read the transcripts of evidence for the Commission from Mike Brooks and Tony Scott?

25

30 A. Yes I have.

Q. And in relation to their evidence on the early design phase what comment do you have in relation to what they said?

A. Generally I concur with both the transcripts of Scott and Brooks as to the earlier design phases of the project.

Q. So in terms of the engineers your initial meetings with the engineers, can you recall, in particular, who you would have met with?

A. My recollection was that I would have met with David Harding. I can't specifically recall meeting with Alan Reay.

5 Q. And during the course of the project itself can you recall meeting with either of those engineers?

A. I think, similarly, once that initial design phase of a project is completed there is less contact or working contact with other consultants so I must assume that the same pattern would have followed with any subsequent
10 meetings.

1237

Q. Can you in fact recall any?

A. I'm struggling to recall the nature of the meetings and the programme of meetings through that design phase.

15 Q. Just on that and this issue of your recollection which you have, to be fair, struggled with on some matters, would you agree with me that there are broadly speaking two elements to a building project from your perspective?

A. I've always thought that there are, there are two parts to the design
20 process.

Q. What are they?

A. Well firstly you have what I call the content of the project which is the building itself and that encompasses obviously the design process through to completion at the end. So it's the bricks and the mortar of the
25 project. But the second part is what I describe as the process of the building which is not directly to do with the bricks and the mortar but it is, the process covers aspects like timelines, personnel involved, the building consent process, the more abstract, the more generic parts of, of the building process.

30 Q. So on the question of your recollection of the project for the CTV building, do you draw a distinction between content and process?

A. I do, yes, yes I do.

Q. So is your recollection on content clear?

A. I believe so. The part that relates to the design and the plans and what have you. Yes I have a good recollection of that aspect.

Q. And what about process?

5 A. Many aspects of that I have struggled with, recollecting, and perhaps in reading some of the transcripts which I have done only in the last two days, because of my absence, a lot of the process parts of the project have refreshed my memory but I have felt that because of the significant number of people and companies involved in the building of the building and at various stages, I have felt that's possibly one of the reasons why
10 I have struggled remembering some of the parties because it transpires there have been so many of them through the early design process from developers to builders, the building companies changing a number of times. So I have struggled with aspects of my recollection, yes.

15 Q. So on the question of content you're clear on what your design responsibilities were for the project?

A. Yes I am.

20 Q. So that leads us to the second question posed for you and that relates to who may have decided on the structural elements of the building. Are you able to assist with that? Who was responsible for the structural elements?

A. The engineer is, is responsible for all structural design aspects.

Q. And more specifically are you able to identify, and if you're not that's fine, which engineer you're referring to in particular?

25 A. Well going back to the earlier question I must assume that it would have been David Harding that had been involved as, what I would describe as the project engineer.

30 Q. The third question related to a specific element of the building, the south shear wall, and you will recall that whilst you were overseas in June this year you received an enquiry from Mr Zarifeh, as counsel assisting, through me, to ask you a specific question about some evidence that Mr Harding had provided to the Commission.

A. Yes, yes I did, yes.

MR RAYMOND:

Sir for convenience I actually have that email exchange and I'll read it into the record if you wish, it just deals with that third point reasonably quickly – copies if the registrar wants to hand them around.

5

MR ZARIFEH ADDRESSES JUSTICE COOPER**JUSTICE COOPER:**

Mr Zarifeh says they're already in the record. Do we have a number
10 Mr Zarifeh?

MR ZARIFEH:

0452.1.

15 **MR RAYMOND:**

Other counsel might find it convenient to have a copy if they wish, it's here.

EXAMINATION CONTINUES: MR RAYMOND

Q. So firstly on the 13th of June, Mr Zarifeh referred me to a passage from it
looks like paragraph 18 of Mr Harding's evidence where he said, "I recall
20 discussing this with Alan and I recommended that we should add in an
additional shear wall on the south face of the building to help to resist
the torsional rotation of the building. Alan [and it's spelt A-L-A-N so it's
not a reference to you Alan Reay] Alan was concerned that a wall in this
location was not present on the Contours building so the addition of this
25 wall on the CTV building may not be acceptable to the client. I believe
Alan then discussed this with the owner and the architect and it was
agreed by them and relayed to me that this wall could be added if it
were limited in size such that it would be concealed behind the external
egress stair on the south wall. This required the south wall to be
30 constructed as a coupled shear wall with holes in the centre of the wall
at each floor level to facilitate egress to the stair landings. This wall was
added to the seismic model of the building and the wall thicknesses
were adjusted again including the additional south wall. By this means

the building was made stiff enough to reduce the inter-storey deflection to below the limits set out in the Building Code,” and then the question was asked, “Can you advise if Mr Wilkie can confirm that the discussion referred to, you responded, and you have that email in front of you.

5 Mr Wilkie perhaps you could read your response please?

A. “Once again I cannot recall this type of detail regarding length of shear walls et cetera and do not recall any client conversations of this nature. When designing any buildings where people work it is desirable to have as many windows as possible commensurate with the structural requirements. As I stated in my statement the length of the shear walls, 10 their configuration et cetera is always for the engineer to determine. The owner/architect or anyone else is not in a position to prescribe what length structural walls should be. I cannot add anything further regarding this issue.”

15 Q. That was your view as at 15 June 2012. With the further passage of time and reflecting further on the evidence and in particular events back at the relevant period are you able to add anything further on the south shear wall issue, in particular a meeting which Mr Harding suggests you may have been at with the client?

20 A. I certainly can't add anything with respect to the structural nature of that wall.

Q. And is there any spark of memory in relation to a meeting on particular, on that issue?

A. My only comment might be that I believe I was always aware that a solid 25 wall was required on the south side to provide the requisite fire protection for the external stair. So there was always, in my view, a wall, as I say a solid wall, a solid fire-rated wall along the south wall of the building from the outset. That was the nature of the fire design of the building. But I can't comment and can't recall at what stage that wall 30 either became a shear wall or was a shear wall from the outset. I can't actually recollect that.

CROSS-EXAMINATION: MS DAINES, MR PALMER – NIL

CROSS-EXAMINATION: MR ZARIFEH

Q. A couple of questions Mr Wilkie. Mr Brooks and Mr Scott said that the original architectural drawings would have been on an A4. Is that your recollection?

5 A. That would be very unusual to produce drawings of a building of this size on A4 so I doubt that's correct.

Q. I think they were talking about preliminary drawings. Would that have been done?

A. Even preliminary drawings would normally be done at a larger scale. So
10 for a building of this size as a minimum I would have thought they would be on A2 size for them to be meaningful to present to a client and/or commence any initial costing and/or town planning checking process.

1247

Q. Well leaving aside the size, you would've had contact with Brooks and
15 as a result of that you would've drawn up some architectural drawings at the start, is that what you recall?

A. It's only through the reading of the evidence to date that I was reminded or made aware of my meetings or a meeting with Mr Brooks at the outset, but at this point I cannot recall that initial instruction process.

20 Q. So you can't recall, in relation to the south wall as you said, what you initially drew on the first architectural drawings in terms of that wall?

A. Other than the requirement to provide a secondary means of fire protection which required a wall of some sort, I can't recall what might've been on those early sketches.

25 Q. The sketches that we've got which were obtained from the Council, the architectural drawings sorry, have a coupled wall. So the south wall is separated into two walls that are joined.

A. Sorry the?

Q. A coupled shear wall, are you aware of that, have you seen the
30 architectural drawings?

A. Oh, yes, yes, no I have the drawings, yes.

Q. You don't know when that wall became a coupled shear wall?

A. Well the term "coupled" is quite technical and it's very much an engineering term. My understanding is that it's linking one wall with the

interaction of another wall so it's highly unlikely that that term "coupled wall" would've been used in an early design part of the process where we are trying to establish the overall plan of the building and getting it costed and checking compliance against planning. They're probably not matters that would've been transgressed at that early phase.

5

Q. Right I understand, but you think that there would've been some kind of wall in front of the stairwell which would've always been there, the fire escape?

A. As I recall that would've been fundamental to the concept. Also if I may add, because the building was relatively close to a legal boundary the fire code at the time, chapter 5, NZS 1900 clearly limits the amount of unprotected window opening facing a boundary at a given distance, so it was always a requirement to have some form of solid element along that building, although not necessarily concrete, it did need to be a four hour fire rated element.

10

Q. The building to the west that was very close to the CTV building we've heard, but that was a solid block wall for the first three floors?

A. Correct, yes.

Q. We're talking about the south, the Cashel Street frontage.

20

A. The south wall, yes, correct, facing Cashel Street one.

Q. Mr Harding's evidence was that the coupled shear wall was not originally on the architectural drawings and that he did an ETABS analysis. Have you heard of ETABS?

A. No.

25

Q. Or ERSA, it's a computer modelling program that structural engineers use and after he had started doing runs on that program he realised that it needed a south shear wall, okay, that was his evidence?

A. I can't confirm that.

30

Q. No, no, I'm just telling you, and he, his evidence was that he went and discussed it with Alan Reay and he thought that Alan Reay had gone off and discussed it either with the architect or the owner or both and then he says Alan Reay comes back –

JUSTICE COOPER:

Mr Zarifeh we just need to adjourn very briefly and we will be back directly.

HEARING ADJOURNS: 12.51 PM

HEARING RESUMES: 12.53 PM

JUSTICE COOPER:

We were partway through a question Mr Zarifeh but perhaps you'd better start
5 it again?

CROSS-EXAMINATION CONTINUES: MR ZARIFEH

Q. Mr Wilkie what I was putting to you was what Mr Harding has said which
was that the south shear coupled wall was not in the original
architectural drawings. That he realised that it needed a coupled shear
10 wall or a shear wall of some description on the south, that the north core
shear wall was insufficient and he says he discussed that with
Alan Reay. Alan Reay, he thought, had gone back to the client or the
architect or both and come back to him and said, "Okay, you can put it
in but it's got to be as short as possible," in other words not to be the
15 whole length of the south wall or anything like that. Can you re – I take
it you can't remember any conversation like that?

OBJECTION: MR PALMER (12:54:52)

MR PALMER:

20 That's not what is recorded in the evidence.

JUSTICE COOPER:

What is?

25 **MR PALMER:**

That Dr Reay said it had to be as short as possible. The sequence that my
friend is reading from is the evidence that's already been put to this witness in
relation to David Harding's evidence and I don't think there was ever any
comment that Dr Reay said that it had to be as short as possible.

30

JUSTICE COOPER:

Mr Zarifeh?

MR ZARIFEH:

5 I'm putting Mr Harding's evidence, not Dr Reay's.

MR PALMER:

Reading this evidence Sir –

10 **JUSTICE COOPER:**

Well what evidence are you reading?

MR PALMER:

Well this evidence was previously put by my friend Mr Raymond and Mr –

15

JUSTICE COOPER:

No, no, Mr Zarifeh as I understand is referring to evidence that Mr Harding gave at an earlier stage in the hearing.

20 **MR PALMER:**

Well if it's from paragraph 18 of his evidence –

JUSTICE COOPER:

Of, Mr Harding?

25

MR PALMER:

Mr Harding's evidence, it doesn't say what Mr Zarifeh's saying it says.

JUSTICE COOPER:

30 Mr Zarifeh?

MR ZARIFEH:

Well for the purposes, my purposes I'm happy to put 18 to him.

CROSS-EXAMINATION CONTINUES: MR ZARIFEH

- 5 Q. This is from Mr Harding's written brief, "To the effect that the wall could be added if it were limited in size such that it would be concealed behind the external egress stair on the south wall." Now you don't recall any conversation with Dr Reay or the owners about the south wall?
- A. No I do not.
- Q. Is that something that you would've expected to have been consulted in if there was to be a change in the architectural plans?
- 10 A. Um, I may have been, not involved but it may have been a question I might put back to the client, "Can we add a wall of this nature," but I'm quite confused by the background because of what I have said regarding the requirement to have a wall there in the first place to protect the stairwell, so I am somewhat perplexed about the whole thrust of this additional wall or the implication that may be an additional
- 15 wall. I'm, I can't understand that and I certainly can't recall the nature of any conversation with any party regarding this –
- 1257
- Q. I understand that but you are not saying the wall that would have been behind the stairwell, or the stairway in the first place, in your first
- 20 drawings, was a shear wall or a coupled shear wall?
- A. I can't say that it was, no.
- Q. Why would you have put that in though if that was in your original drawings?
- A. Why would I have put what in?
- 25 Q. Why would you have put a coupled shear wall on the south?
- A. Well I am not the engineer. I wouldn't have added any shear wall to any building.
- Q. Right, so you would have taken – it would have been on advice from the engineer to put that element in?
- 30 A. If it was a structural requirement to have a shear wall of whatever length in that position, that would have been added to the plan, if it was indeed added, or it would have been there from the outset. It is the same with the column centres or other structural elements.

- Q. If it was there from the outset, would that have been on the engineer's advice then?
- A. Sorry if the wall had?
- Q. If it had been there from the outset would that be on the engineer's advice?
- 5 A. Not necessarily. It would if it was a shear wall from the outset –
- Q. That is what I am talking about.
- A. – but if it was a fire rated required wall I may well have said that we require that wall to limit the fire exposure to the adjoining boundary.
- 10 Q. I understand that, what I am asking is, if it was then converted at some stage to a coupled shear wall, that presumably would be on the advice of the engineer?
- A. Correct.
- Q. But you can't recall that advice?
- 15 A. No I can't.
- Q. Or even that change?
- A. Well I am not aware that it was a change but if it was a change I can't recall it no.
- Q. Would it have been possible to have that coupled shear wall somewhere else along the south face of the building?
- 20 A. Well that is a question for the engineers in terms of the balance of the structure I suppose but the requirement that I would have had from an architectural perspective was to get some solid wall along there to meet the fire requirement so it didn't actually, it wasn't of a concern exactly where along that south wall the fire rated wall or I just call it a solid wall, was actually required. You only need to meet the percentage for the wall as a whole so that wall could have been –
- 25 Q. Could have been –
- A. – could be broke into two parts, two smaller walls or it could have been just windows, you know, punched within a bigger wall.
- 30 Q. Right, and you are saying from an architectural point of view it could have been longer, as long as the stairway/well was in front of it?
- A. I said in my evidence that it is desirable to have a maximum length or square metreage of windows simply 'cos it is an office building therefore

you normally would not have longer walls than you needed to, for instance along the back boundary it was 100% of the length of the wall was solid on the lower level.

5 Q. And so are you saying, I know you can't recall any conversation but if you had been consulted, you may well have had that kind of input?

A. What kind of input?

Q. About the windows and the maximum –

10 A. Well I'm really saying that I did have input with respect to, or I would have input with respect to the length of the windows because that was a chapter 5 fire requirement calculation that I would have carried out.

Q. Now, you – as I understand it, you recall meeting with David Harding?

A. I can recall yes.

Q. When was that in relation to the project?

A. From the nature of the transcripts, 1986.

15 Q. No but in relation to your involvement, was it the initial stages or during construction or when?

20 A. No it would have been from the outset, virtually from the outset of the project because you can't, an architect can't advance a design for more than a single storey or probably at most a two storey building at the sketch plan stage without input from the structural engineer so it would have had to have been really from the outset.

Q. And you can't recall Dr Reay being involved in that meeting or meetings?

A. No I can't.

25 Q. Mr Scott, you will recall talked about attending a meeting with David Harding and Dr Reay. He didn't say you were there but you can't recall going to any meetings where both gentlemen were there?

A. No, I can't and I cannot recall the venue for any such meetings either, no I can't.

30 Q. You can't recall the venue for any meetings you had you mean?

A. Generally not, I have worked hard to think back but the – no I can't.

Q. Just on the structural elements, things like the round columns, the pre-cast beams, do you recall who had input into those features and –

A. Yes I do recall.

Q. Who was that?

A. The – as I have said in my evidence that the design of the structure and by that I mean the structure is comprised of foundations, columns, walls and floors and to a degree the roof structure, it was entirely the realm of the structural engineer. However, if there are options available to how part of those elements might appear, for instance can a wall be constructed as a pre-cast wall versus an in situ poured concrete wall, the architect might say, well I prefer say like the Town Hall, I prefer the finish of a pre-cast element. So there are definitely what I would call important cosmetic or architectural inputs into aspects of the structural design process. A case in point for this project would be my preference for a round shaped column as an architectural element and they were expressed on the exterior of the building. It is the external geometry of the column that I may have and probably did have input on, in this particular project because indeed it followed another project, the Contours building had round columns as well but the design of the structural capacity and the contribution that the columns make to the structural frame or the seismic or other dead loading of the building is the structural engineer's domain.

20 Q. So you recall having input about the round columns, not the size of them though?

A. Not the size of them.

Q. The diameter?

A. I – no the architect plays no part in the sizing of structural elements.

25 Q. And there has been mention of the Contours building already –

A. Yeah.

Q. Do you recall discussion about features that would be similar to the Contours building?

A. Mr Brooks in his evidence refers to I believe in instructing or requesting that the building at 249 Madras Street might follow the appearance of that building and I do not disagree with that.

30 Q. Because that was one you designed?

A. Yes I did design the Contours building, yes.

Q. And with pre-cast beams that were used in the CTV building, do you recall any input about that?

5 A. Not really I can only surmise from reading the evidence that pre-cast beams might have been chosen because they give a better architectural appearance, particularly on the soffit on the underside because they are a precast element so you are able to guarantee the architectural appearance much more so than beams poured in place or in situ.

Q. Right but you can't recall having discussions about those?

10 A. Not particularly but they could well have followed the Contours building that – I can't recall if they were precast or in situ, they most likely were pre-cast beams there as well.

Q. And finally the Hi-Bond floor that was used, the floor slab with metal deck underneath, did you have any input into that, that feature?

15 A. No that's generally – floor systems like that are generally a cost, you know a costing option or it may relate to time or craneage or some other construction methodology. They would rarely fall into the range of decision made by the architect. In this case no I could not recall the building construction system until I read the evidence – sorry the floor construction system until I read the evidence.

20 1307

Q. Right, and just to be clear did you say they fall within the range of the architect?

25 A. No, no, generally within could be a combination of the contractor preferring a particular approach but most likely it would be a costing decision. It was an option available to the contractor and/or engineer. They may favour one system over another so there's nothing in my lay view, if I can say, peculiar to adopting one system over another with regard to a flooring system.

30 **CROSS-EXAMINATION: MESSRS ELLIOTT, KIRKLAND AND RAYMOND – NIL**

QUESTIONS FROM COMMISSIONER FENWICK – NIL

QUESTIONS FROM COMMISSIONER CARTER:

Q. Yes I would just like to follow through the start-up phase of this job. We think we understand from Mr Scott that he became quite prominent in the way the organising of the job and he contacted you and so forth. Mr Brooks said that he conceived the general idea of the building and as he termed it a back of the envelope sort of proposition. So I'm just trying to track through from my experience the way an architect and engineer gradually build up a working situation. So there was a developer involved here and the contractor proposed to the developer to undertake a certain project for him and that was generally accepted as a possibility so the contractor organised some drawings to show to the developer just in an initial sense. So I understand that you would have been the person that produced that outline drawing to show to a developer what his building might be, is that correct?

A. Yes I was.

Q. So at that stage you would not necessarily have started to deal with the finer detail of the architectural design such as the fire rating, provision of means of egress and that sort of thing which you'd really start on once you knew the project was starting to perhaps get a little bit of momentum. Would that be reasonable?

A. Not entirely. I think even at the sketch plan stage, the early concept stage, an experienced architect has got to be very aware of the ultimate fire and egress requirements, floor to floor heights, the need to have space available for air conditioning etc so there are many elements of the second phase, the working drawing phase, that you must incorporate into that first stage, particularly when the first stage is an important costing phase that Mr Scott, in this instance, was involved in for the developer. You can't, it wouldn't be either fair or appropriate to add complex elements later in a project that you hadn't really considered in that early sketch design phase.

Q. I'm just trying to reconcile the evidence that Mr Harding was very clear about was that the first drawing he got to work with didn't have a wall on

the south face and there was, from a structural point of view he was quite specific that he did a design, complicated design, using computer systems at the University of Canterbury without a wall in that position and he found that that would not work from a structural capability point of view so he added a wall in. So I'm finding it very difficult to understand how an engineer would start a design of that degree of effort on the, with the understanding that there was a wall there when there wasn't a wall there on the design that he worked to. So somewhere there was a drawing, likely to be a drawing that didn't show a wall in the position where the south shear wall was finally built. Can you help us in understanding that possibility? I'm not, was there a possibility that there was as drawing which he didn't realise was a, or saw as a non-structural element, maybe the firewall that you're saying and therefore wasn't incorporating it into the structure and then came to the decision that that wall would have to become more a part of the structure?

A. Well like you, Sir, I am confused by the statement that Mr Harding has made because my recollection of the design of the building is very clear in my mind and I know that I would have required, I needed some form of solid wall along that south side to meet a very important design criteria for me, which is the fire rating requirements of that building. So the notion that a wall has been or a structural wall, let's say, has been added into the design process, albeit early on, I don't understand.

Q. So you would then, by the same logic, you would then have put a fire rated wall on the west side of the building going up the first three levels and, again, we understood that was a later addition. So was the, did you put a firewall on the west wall?

A. The west wall was always a solid firewall because it was right on the boundary, unlike the south wall that was set back from memory approximately three metres. The west wall was always a solid wall. It adjoined another building and above that other building then there were, as permitted, small fire windows for the entry of light on the west side above the roof line of that building.

Q. So in your mind your first drawing you would have produced would have shown the west wall as solid up to the first three levels the height of the adjoining building.

5 A. Oh absolutely and if I can just perhaps reinforce when the current Building Code was initiated, circa 1992, the fire engineering profession as it became was effectively initiated prior to that the fire code requirements, generally speaking, there was no such profession as a fire engineer and it did fall, generally speaking, on the architect, quite often in consultation with a structural engineer but for the architect to be 10 very conversant with the Fire Code. It was one of the main technical design requirements for the design of a building, particularly a building that's in a city proximate to boundaries, legal boundaries, so I can say with a high degree of confidence that the design in the ratio of windows to solid walls was an intrinsic part of the design that I needed to 15 establish early on just as I did with many other inner city office buildings that I was designing prior and after this.

QUESTIONS FROM JUSTICE COOPER - NIL

WITNESS EXCUSED

COURT ADJOURNS: 1.15 PM

20

25

HEARING RESUMES: 2.15 PM**MR PALMER CALLS****ALEXANDER SHANE FAIRMAID (SWORN)**

- 5 Q. Is your full name Alexander Shane Fairmaid?
A. Yes it is.
Q. Do you reside in Christchurch where you are a Project Manager working in the commercial and residential development area?
A. Yes I do.
- 10 Q. Have you been 30 years in the building industry?
A. Yes.
Q. And were you contacted by counsel for the Commission on the 3rd of August to discuss any recollections you may have had about work in Dr Reay's office and on designing the CTV building?
15 A. Yes I was.
Q. And did you provide assistance to them and then over the weekend that followed read your way into the evidence that had been presented on those design issues?
A. Yes that's correct.
- 20 Q. And in that process have you either read or listened to the evidence of Terry Horn and Wayne Strachan?
A. Yes I have.
Q. As I understand it you worked as a draughtsman for Alan Reay Consulting Engineer, that's ARCE, from 1981 until 1986, is that correct?
25 A. That's correct.
Q. Did you leave ARCE in 1986 to become a project manager working in the commercial and residential development area?
A. That's correct.
Q. And have you been in that role for the past 25 years?
30 A. That's correct.
Q. For 14 years did you work for Arrow International?
A. Yes.

Q. And in 2004 did you found your own project management and development company called Momentum Projects Limited?

A. That's correct.

Q. Are you still operating in that business?

5 A. Yes.

Q. Do you have with you a copy of your statement of evidence dated the 8th of August?

A. Yes I do.

10 **JUSTICE COOPER:**

Now there's a problem here because I've got one dated the 7th of August. My colleagues have got the one dated the 8th of August but not me.

MR PALMER:

15 You can have my copy, Sir, if you'd –

JUSTICE COOPER:

They're different I take it?

20 **MR PALMER:**

Yes there is a difference. There were several statements prepared and there was one by the Commission and then one dated the 7th but there has been some evidence redacted and consequently the correct version is that dated the 8th of August. Now I've got a spare copy, Sir, and I'm happy.

25

JUSTICE COOPER:

So the others are no longer germane.

MR PALMER:

30 They're no longer relevant. You'll be pleased to know that the latest version is the shortest version.

JUSTICE COOPER:

Well no the first statement was the shortest.

MR PALMER:

That's true, Sir, but perhaps –

5 **JUSTICE COOPER:**

You're saying that the third statement is shorter than the second statement.

MR PALMER:

That's correct. the first was the shortest but the third has, perhaps, got more
10 interest in it. It's WIT.FAIRMAID.0003.2 Sir.

JUSTICE COOPER:

Yes, I infer they've become more accurate as they've progressed.

15 **MR PALMER:**

We would hope, Sir.

EXAMINATION CONTINUES: MR PALMER

20 Q. So Mr Fairmaid could you please read your evidence starting at
paragraph 4.

WITNESS READS BRIEF OF EVIDENCE

A. Certainly. I have been asked by Mr Palmer of Buddle Findlay to give
evidence on my recollections of
25 (a) the observations of the ARCE work environment,
(b) working on the CTV building and
(c) how Dr Reay operated in that environment.

At the Commission's request I have provided previous statements of
evidence to counsel assisting the Royal Commission, that evidence is
essentially incorporated into this statement.

30

Observations of ARCE work environment.

In the later time that I worked for ARCE we worked in a small medium-
sized open plan office with Alan's office the only private office. Alan's

office, whilst private, it was behind a full glass wall with a glass door that was invariably open for discussions as required. It was a very professional and well ordered office environment. We were able to operate in a very effective manner.

5 I found Alan to be a good employer whom I respected. He was always very approachable and enjoyed the process of debating design solutions with the team. This would sometimes play out at smoko breaks when there were sound debates on the merits of different engineering solutions.

10 He did have quite different views on professional, he did have quite firm views on professional engineering design issues and was prepared to defend those views.

As employees we were always encouraged to participate and produce quality documentation, generally above industry standard, for which
15 Alan's office had a reputation for doing. I believe the office culture was such that we all worked hard to achieve high professional standards and I thoroughly enjoyed and valued my time there.

Since ARCE and then ARCL have been in business they would have designed a very large number of buildings in Christchurch, possibly
20 more than any other structural engineering firm in Christchurch.

Work on the CTV building.

I do recall the CTV building passing through the office and that it was one of the more basic and non-descript multi-storey buildings
25 undertaken by the office at that time. It was not part of the ARCE design innovation systems.

As noted in previous evidence I recall that Dave Harding was the ARCE engineer who designed the CTV building.

I have been informed that Wayne Strachan has given evidence that he
30 did most of the draughting on the CTV structural plans but that ARCE timesheets for 1986 show that instead it was Terry Horn who did most of the draughting and that I also accrued approximately 130 hours on the project. As noted on previous occasions I have no recall of having worked on the project. My specialist area was in the pre-cast panels

and structural steel detailing and so I can only assume that if I did anything on the project then it may have been in these areas.

Terry Horn and I were both senior draughtsmen but we had different experience bases and Terry was more senior to me. I note from
5 timesheets that Terry charged out at \$35 per hour and I was at \$30 per hour. Terry came from a background in documenting reinforcement concrete frame structures such as the CTV building whereas I worked
10 much more on the pre-cast panel and warehouse type structures, so it was usual for Terry to undertake the multi-storey projects and for me to document the industrial projects such as warehouses. So it did not surprise me to see Terry's timesheet indicating that he'd undertaken significant work on the project. However I was a little surprised to see I committed 130 hours. However, as noted previously, it is not out of the question.

15 Observations of Dr Reay.

In my 25 year career as a project manager I have worked with many of this country's top structural engineers and I still regard Dr Reay as one of the best I've worked with. Alan always demonstrated significant
20 passion about engineering innovation and he built a strong market reputation as an engineer that could deliver innovative solutions. Perhaps the most well known innovations that Dr Reay has been associated with is the tilt slab and pre-cast panel techniques that he championed into the Christchurch market in the early 1970s for which
25 he has won numerous engineering awards.

He had a strong client base and during my time with Alan we experienced many clients returning time and time again to request new projects under the direction of Alan's office.

Q. Mr Fairmaid I don't want to stop you but if you could just slow down
30 slightly. Third line at paragraph 15.

JUSTICE COOPER ADDRESSES MR PALMER

EXAMINATION CONTINUES: MR PALMER

WITNESS CONTINUES READING BRIEF OF EVIDENCE

A. Clearly the market liked Alan's approach to engineering. I also recall Alan noting once to me that as a student he'd spend time in the weekends going around construction sites to look at how engineering solutions were being delivered. He was also extremely dedicated and interested in not only the engineering but also the buildability of solutions. Alan was a very practical engineer and, in my view, that was one of the key reasons that Alan held a good base of builder/developer clients who would commission Alan to design their own development warehouses and commercial building solutions.

5
10 1425

Alan understood construction very well, not only from an engineering perspective, but also from a practical construction perspective.

I also recall many years after leaving ARCL I met one of Alan's clients in Dunedin. He was by then essentially retired and lived a less busy life on his own farm in North Canterbury. I recall that day he clearly indicated to me that the reason that he and his family were able to buy the farm was because of the work that, "The Doctor," had done for him over the years. In this, in context this was used as a term of respect. In my experience Alan was a very good engineer and one that was respected by his peers, his clients and contractors alike.

15
20
25 I have been told that Mr Horn recalls that Alan referred to Graham Tapper by a nickname he used for him being "Colonel Tapper". This is the first time I have heard of this. It was not a name I recall Alan using in my presence. My recollection of Alan was that he could have quite a focused manner with people in defending his point of view and that he was very articulate and professional in discussing issues. He was no slouch when it came to debating engineering solution and this no doubt may have been unnerving for people who were perhaps not as researched as Alan was.

30 I have also been told that Mr Horn has an awareness it was Dr Reay's practice to resolve issues with Graham Tapper by going over his head to the city engineer Bryan Bluck. I do recall Alan mentioning Bryan Bluck's name and I think it is fair to conclude that Alan did from time to time talk directly to Bryan Bluck. I cannot recall Graham

Tapper's name being mentioned, however that is not to say that lower level Council engineers would not have had to deal with Alan as well on occasions.

5 I have also been told that Mr Horn has said that Dr Reay was referred to by some clients and colleagues as, "The Doctor," and that he believed this was the reference to the perception of the importance he seemed to have attached to his doctorate. I would not necessarily disagree with Terry's comment that he was referred to by some clients and colleagues as, "The Doctor," but this should not be at all surprising as of course
10 Alan held a doctorate in civil engineering. I never heard it used as or associated with a derogatory comment in regard to Alan Reay, quite the contrary. I only ever heard it as a term of respect.

15 Further comment since hearing the evidence of Terry Horn and Wayne Strachan.

In closing my evidence and since listening to the evidence of Terry Horn and Wayne Strachan and news reports of it on Monday the 6th of August I wish to give some additional evidence which I prepared on the 7th of August.

20 I wish to clarify that I was a senior draughtsman working for Alan Reay and had been for a number of years. Whilst I was trained by Wayne Strachan I had already spent a number of years working as the lead draughtsman on projects where I reported directly to Alan Reay.

Wayne Strachan's evidence was that if he did not complete the draughting then it was my work as he trained me and the drawings looked like the style of his or my drawings. Wayne also trained other draughtspeople in the office either directly or indirectly and so it could have been other draughtspeople as well that documented the project. Gail whose surname I cannot recall, Tayna Bruce and Terry Horn were
25 all other draughtspeople that apparently recorded time to the project.
30

I was told by the Commission's lawyers that Terry accrued approximately 140–150 hours on the project according to the timesheets. Terry indicates in his evidence that he only documented the foundations. In reviewing the plans with the Commission's lawyers last

week it appeared that the building was founded on a shallow reinforced concrete foundation with no basement. I estimate that to document foundations of the complexity and scale of the CTV building would have taken between 20 and 30 hours so in my view Terry Horn must have had further involvement in the documentation than he indicates in his evidence.

Terry Horn indicates in his evidence that he documented a number of other high rise buildings for Alan Reay prior to the CTV project. This is consistent with my recollection of his experience and his role at Alan Reay's.

Terry Horn was by far the most experienced draughtsman when it came to high rise buildings and he was the draughtsman that recorded the most time of any draughts people on the project.

If I did spend time on the project it would be extremely unlikely that I took a leading role in the documentation as I had not documented any other high rise structures for Alan Reay.

In my opinion based on reading the timesheets that Dave Harding was the lead engineer, (he accrued the most time) and I along with Gail and Tanya Bruce were called in to work under Terry and Dave to complete the documentation to meet timeframes. That seems logical from all of the evidence that I have read.

Regardless of who documented the building it is quite clear to me that none of the draughtpeople that accrued time to the project had any design responsibility on the CTV building. That role would always have fallen with the registered engineer who designed and who ultimately signed off the engineering design for building consent.

CROSS-EXAMINATION: MR REID – NIL

CROSS-EXAMINATION: MR KIRKLAND

Q. Mr Fairmaid, in paragraph 10 you refer to the CTV building you describe it as, one of the more basic and non-descript multi-storey buildings. Can you just expand on what you mean by that, I don't understand that?

A. Well it was a relatively consistent in its floor plan. The ground floor plan was consistent with the top level and there was very little change from in between.

5 Q. Can I have WIT.REAY.555.20 please. When it refers to the second draughtsperson moving to the right and 133 hours I assume that is you Mr Fairmaid is it? I think you referred to 130 in your evidence?

10 A. I can't be sure on that but I was told by the Commission's lawyers that I had done, I think 131 hours on the job. I've seen the full set of timesheets and I haven't been able to add up all of the hours but I've essentially taken it as correct that I did 131 hours on the job.

Q. You see the evidence of John Henry and corroborated by Mr Harding is that Dr Reay was, what would be the correct word, were autocratic and ran a well controlled office. Would you agree with that?

15 A. I think he ran a very effective office. As stated in my evidence I think Alan had quite defined views on engineering but he was always approachable.

20 Q. Because, as I read all the evidence and trying to summarise it just over lunch, I think it has got, David Harding says Wayne Strachan did the majority of the draughting. Wayne Strachan say it was him who did the majority of the draughting yet this document records only 2.75 hours for Wayne Strachan. Dr Reay says Terry Horn did most of the draughting. Your time sheet say you did 130 or 133 if you are the draughtsperson referred to. Terry Horn says that he documented the foundations and you refer to 20 to 30 hours. That all adds up to an awful lot of confusion
25 over who did what, do you agree with that?

OBJECTION: MR PALMER (14:33:40)

MR PALMER:

30 Sir, what my friend is putting to this witness is wrong given the subsequent evidence of Mr Strachan, there has been a correct to his brief. My friend may not be aware of it because he hasn't been in the room but it is certainly not

correct that the position put by my friend is indeed the evidence now settled or it certainly as it has come out.

JUSTICE COOPER:

5 Yes Mr Strachan has given different evidence now has he.

MR PALMER:

He has.

10 **JUSTICE COOPER:**

But I can't remember the detail of it.

MR PALMER:

I don't have it in front of me but I think in essence he accepted that he did
15 considerably more hours than those that he – sorry, than the draughting, sorry
the draughting was done by Mr Horn.

JUSTICE COOPER:

Yes but Mr Horn doesn't accept that.

20

MR PALMER:

No but certainly he doesn't accept that he did as many hours as original
postulated.

1435

25

JUSTICE COOPER:

Q. Well let's just find Mr Strachan's evidence. Mr Strachan's amended brief
is to the effect that Mr Fairmaid did the drawing. Is that the correction
you were keen to have made?

30 A. Yes.

Q. So Mr Strachan in his second brief, having looked at the timesheets is
that Mr Fairmaid did the drawings and that he knows that because of the
record of the timesheet and because Mr Fairmaid had a style of
draughting which was that of Mr Strachan, Mr Strachan having taught

him how to draught. Now I think if you could start your question again on that basis you may still end up in a similar position.

MR KIRKLAND:

- 5 I think it is probably better Sir that I withdraw the question because ultimately it's something the Commission has to grapple with. I don't think I can take it much further.

CROSS-EXAMINATION CONTINUES: MR KIRKLAND

- 10 Q. Mr Fairmaid, in paragraph 15 you refer to Alan to design their own development warehouses and commercial building solutions, referring to builders and developers. I think Mr Harding's evidence was that an engineer or a draughtsman would get his hand slapped, I think that's the expression that he used, if there were elements incorporated that were unnecessary. In other words you could design, the philosophy of the office was if you could design to ensure that the end product complied with the code of the day, that was the practice of the office. Your comment on that?
- 15

- A. Well I don't think that it's unusual for engineers to be required to design to code and I don't think it would've been any different in Alan Reay's office or any other office. There was a requirement to design to code.
- 20

- Q. And if you have a large clientele of builders/developers I suspect there'd be cost pressures brought to bear as well. Your comment on that?

- A. Costs are always a determining factor in the design and solution, absolutely.

- 25 Q. And just finally, it just probably caught my curiosity when you spoke about the clients you met in Dunedin and he was able to buy a farm. I assume what you're really meaning he was able to buy a farm out of the capital gain that he made from selling buildings?

- A. He was a successful developer, yes.

30 **CROSS-EXAMINATION: MR ZARIFEH**

- Q. Mr Fairmaid you mentioned in the first statement that you made to the Commission, which we've got, I take it that what's recorded in that statement's true and correct?
- A. Yes. And it's the statement of?
- 5 Q. 4 August.
- A. Correct, yep.
- Q. Mr Fairmaid, just on this issue of who actually did the draughtswork on the CTV building. I think Mr Horn, Mr Strachan and yourself, when you were first asked if you'd done the draughtswork, all of you, each of you
- 10 said no, you had no recollection of it, and I take it that's still your evidence?
- A. Well I don't have recollection of working on the project but, you know, it was 26-odd years ago.
- Q. Yes it's not a criticism I just wanted to know if that was the case still?
- 15 A. And as I've said on my evidence, I don't think it's out of the question that, you know, if there was 131 hours noted on the, in the timesheets, it's likely that I did do some work on it.
- Q. And you say in paragraph 26 that you had not done any draughtswork for high rise buildings before?
- 20 A. No.
- Q. So that would've been your first job on a high rise building?
- A. Yes.
- Q. And you said in your first statement, the 4th of August statement, that it would be unusual for you to work with Terry Horn?
- 25 A. Yes.
- Q. So you can't remember Terry Horn working on the building either can you?
- A. No.
- Q. Do you think that the timesheets are accurate?
- 30 A. Well I have put some thought into that and, I mean as I say I haven't actually, I mean the documents that I got sent through were amalgam of a whole lot of projects and I haven't added them all up, but the only thing I'll say to that is they look consistent with what I recall of the

timesheets of the time, in terms of their form. So, yep, I think they, you know, I think they probably are accurate.

Q. Were you sent your original timesheets?

A. Yes. I was sent the amalgam of the total projects done at that time.

5 Q. So you were sent the document that obviously someone, presumably in the office, has taken your original timesheet and other people's and transferred it onto another document, correct?

A. Correct. Well, I mean that's what I'm assuming, yes.

10 Q. Because even when you looked at the drawings for the CTV you still couldn't recognise, you couldn't recall yourself having had anything to do with it could you?

A. Well, I mean the thing about the drawings is it's very difficult to actually ascertain who did the documentation 'cos they're all traced, and they, they are traced in what I might call the Alan Reay office style, so they don't give you any indication as to who, who did them, but they are done in that office obviously by, by draughtspeople, and I mean I have no reason to sort of question the timesheets to any great extent. They make sense to me in that the draughtsman that was the most experienced accrued the most time for the project, and as I've said in my evidence, there are aspects of the CTV building that I could've well documented having had experience in those areas before, and I refer as per my evidence to the panel detailing which I was quite experienced at detailing, and also structural steel.

15

20

Q. Because if the timesheets are right then your hours, I think, are the second highest after Terry Horn's at 133?

25

A. Mmm.

Q. But in terms of any independent recollection you can't help us?

A. I'm sorry I can't no.

Q. That's all right. And you say that you recall the CTV building passing through the office?

30

A. Mmm.

Q. Can you actually recall anything about how the project came to the office or?

A. Well funnily enough, what I can recall is the architectural documentation. I remember that and I remember, you know, I wonder whether I was involved in the stairs documentation 'cos I can remember the stairs. You know, this is the south wall stairs, the fire stairs. But, yeah, I remember the architectural documentation more than I remember the structural documentation and whether that's just because they were unique or perhaps bespoke as opposed to the structural documentation which you do in all, you know, day in day out.

5

Q. Would the 133 hours, though, against your name equate to you just doing the stairs?

10

A. Well, no. I, no, not at all, I mean but as I've said, there could well have been other elements of that design that I could have done quite without any trouble, given my experience.

Q. But in terms of your recollection you can't help us then with the relationship between Alan Reay and David Harding in terms of the CTV building, can you recall any of those issues?

15

1445

A. As I've said to the Commission my recollection is that Dave Harding was the design engineer on the project and, and that's based on what I recall from the office at the time.

20

Q. Okay, so you're aware that he was involved in the design work for the CTV? David Harding?

A. When the event occurred on the 22nd of February my immediate thoughts were to the engineer who designed it. I, I was aware that it was an Alan Reay office project.

25

Q. You said that you, in paragraph 7 that you, you talk about the door being, his door being open, invariably for discussions. Alan Reay was always approachable and enjoyed the process of debating design solutions with the team, right? So – and you said this is sometimes played out at smoko breaks?

30

A. Mhm.

Q. So are you talking about, you're obviously talking about the time you were there?

A. Yes.

- Q. And that would include 1986, '87, when the CTV was designed?
- A. Eighty-six, I left at the end of '86.
- Q. Sorry, '86 when the CTV building was designed?
- A. Mhm.
- 5 Q. I was just trying to get a feel for what you're saying there, when you say design solutions were discussed or debated. That's obviously amongst engineers and draughtsperson, persons?
- A. Mhm.
- Q. And was that happening on a regular basis?
- 10 A. Yes, yes, well I mean it's I suppose being an engineering office that's the subject that is to the fore in, in down time you know.
- Q. Right. And presumably David Harding would be part of the team back in '86?
- A. Most definitely.
- 15 Q. Right, and so if someone was involved in a design or a project that would get discussed at smoko breaks or during the day in the office?
- A. Sorry, I don't understand that.
- Q. If someone was, he was involved in a building say, such as the CTV, are you saying that that would get discussed at smoko breaks and during the day in the office?
- 20 A. Well that, that sort of thing, mhm.
- Q. Right, you can't remember any specific discussions about CTV?
- A. No.
- Q. You said in that same paragraph that Alan Reay had quite firm views on professional engineering design issues?
- 25 A. Yes.
- Q. And he was prepared to defend those views?
- A. Yes.
- Q. Is that, you're talking about the debate within the office or debate with people outside the office as well?
- 30 A. Well I guess my main recollection would have been office internal but I've no reason to doubt that he was fairly adept at discussing things out of the office as well when it came to engineering solutions he was a very highly qualified engineer.

Q. And as you say he had these strong views?

A. Yes.

Q. Okay, you remember coming into the Commission office on the 3rd of August the Friday, speaking to Sarah Jamieson?

5 A. Mhm.

Q. Just looking at some of the notes she made of the conversation with you did you tell her that Alan Reay was always pushing boundaries?

A. I don't recall that.

10 Q. Right well if you'd said that what do you think you would have meant by that?

A. He was an innovative engineer.

Q. Right.

A. And he was known in the industry as an innovative engineer and certainly that's my recollection of, of Alan Reay as an engineer.

15 Q. So pushing the boundaries of design?

A. As I say I, I, not sure I put it in those terms, I, I'm quite comfortable that he was an innovative engineer and was prepared to you know challenge solutions yes.

20 Q. And I think you actually said that, I'm looking at another note she said other engineers didn't push boundaries as much as he would. They were more conservative as opposed to innovative and he was always challenging accepted design solutions?

25 A. Well I think you know to put that in context I, I think that Alan was an innovator in the pre-cast and tilt up panel area particularly and he achieved you know innovations and development in that area before other engineers so in that regard yes.

Q. All right but I thought you're talking generally though in terms of him being innovative and pushing boundaries?

30 A. Well that's an example of where he was innovative. I, I, you know I mean I think Alan Reay had his areas of expertise and that was one of them. I think you know certainly in the office there was a lot of work done in the cold formed steel area as well you know Fletcher Brownbuilt solutions and he, I understand, was at the forefront of developing those solutions, engineering solutions.

- Q. And you said in paragraph 8 that employees were always encouraged to produce quality documentation?
- A. Yes.
- Q. How was, how did he ensure that that occurred, was he checking it and supervising?
- 5 A. The, the documentation was always checked off by, by the engineers. But really Alan took a certain pride I think in terms of turning out quality documentation and you know obviously when I worked there that was, I didn't perhaps appreciate just how, how true that was but having left you know and been in, in practice as a project manager for a number of years it certainly reinforced my view that the documentation that we turned out of that office was of a high standard.
- 10 Q. Well you said in paragraph 8 that it was generally above industry standard?
- 15 A. Correct, yeah, and, and what I'm referring to there in particular is that there was more attention to doing shop drawings at Alan Reay's office so pre-cast componentry and structural steel componentry was detailed to a higher degree and that enabled builders to be more accurate about what they were doing in terms of delivery of those components.
- 20 Q. Right. You said a moment ago that or you agreed that he, or you said, I think you, might have been your words that he designed to code. What do you mean by that, do you mean that he would meet the code but no more because that would cost more?
- A. I think he was required to design to code just like other en- other engineer is required to design to code that's all I'm saying.
- 25 Q. Okay but what was put to you is that Mr Harding's evidence that you weren't to put in anything extra that wasn't strictly required for code because presumably there'd be a cost element in that. I took your comment about designing to code to be an acceptance of that?
- 30 A. In my experience that's not unusual.
- Q. No, no, I'm just talking about Alan Reay?
- A. Mhm.
- Q. You agree with that then?

A. I, I don't think he was any different to any other engineer that I worked with in that regard.

Q. Okay but in terms of your experience with him you agree that that was the case?

5 A. Mhm.

JUSTICE COOPER:

Q. That's yes is it?

A. Yes.

CROSS-EXAMINATION CONTINUES: MR ZARIFEH

10 Q. I just want to ask you about your comments about Dr Reay's dealings with the Council. You said that you do recall Alan mentioning Bryan Bluck's name?

A. Yes.

15 Q. And I think it fair to conclude that Alan did from time to time talk directly to Bryan Bluck?

A. Yes.

Q. What basis have you concluded that on?

A. General discussion in the office.

Q. With Alan Reay?

20 A. With Alan Reay. I worked very closely with Alan Reay for a number of years.

Q. Are you still close to him?

A. No not really not, not, I mean I think the last time I saw him would have been about the year 2000 other than here at this hearing.

25 Q. Okay but going back to the conversations that you recall back then you remember him talking about Bryan Bluck and meeting with him.

A. Yes. Yes, I do recall Bryan Bluck's name and it would have been, and I recall Alan mentioning his name.

1455

30 Q. So it wouldn't have been uncommon for Alan Reay to speak or meet with Bryan Bluck in your experience?

A. I'm unclear as to what transactions he had with Bryan Bluck but all I can say –

Q. I'm not asking about them I'm just saying it would not be uncommon for him to speak or meet with him from what you recall of his conversations to you?

5

A. Well my evidence says that I would conclude that from time to time he had communications with Bryan Bluck.

Q. And again I'm looking at some notes that Ms Jamieson made of what you said. You said Alan Reay was always down at the Council getting things sorted. Was that part of his role to get things sorted?

10

A. Well, I mean, you've got to remember that in the time that I worked at Alan Reay's he was the principal engineer and also the design engineer at Alan Reay's –

15 **JUSTICE COOPER:**

Q. Mr Fairmaid you're not actually helping us much by coming out with the explanation before you answer the question. Now the question was whether he was often down at the Council sorting things out?

A. In his role as design engineer he would obviously attend to those things yes.

20

CROSS-EXAMINATION CONTINUES: MR ZARIFEH

Q. Right and back then he was the sole principal of the firm wasn't he?

A. For part of my time at Alan Reay's, yes.

Q. So he would be responsible for what was going on in the firm?

25

A. Yes.

Q. And presumably he took that responsibility seriously from what you could see?

A. Yes most definitely.

Q. So if there were issues such as permit issues or issues with the Council he might well be required to go down and sort them out?

30

A. If he was the design engineer, yes.

Q. What if he's the principal of the firm but say David Harding was the design engineer for a project?

A. I don't have any recollection or understanding of that.

Q. Is that something you would be involved with or not?

A. No.

5 **JUSTICE COOPER:**

Q. Can I just ask you said that for part of the time that you were there Dr Reay was the only principal. Who was the other principal and over what period?

10 A. Well at my, in my time at Alan Reay's I think that he might have been the only principal but that he employed, and this is just my recollection, but he employed John Henry as a design engineer and Dave Harding. John was -

Q. So when you said to, I thought you made a specific qualification when you were answering Mr Zarifeh's question to point out that he had only
15 been the sole principal for part of the time?

A. Dr Reay?

Q. Yeah.

A. No sorry, no, well he was obviously the principal of the company for all the time that I was there –

20 Q. Yes but was anybody else in that role as you rather implied?

A. There were other engineers working for Alan Reay during my time at Alan Reay's. One of them was John Henry and the other was Dave Harding.

Q. All right, well I thought by use of the word principal Mr Zarifeh had
25 intended to connate somebody with an ownership interest in the firm.

A. I'm unaware of those matters.

CROSS-EXAMINATION CONTINUES: MR ZARIFEH

Q. I had, Sir, but I missed that answer but anyway he was owner of the business as far as you're aware?

30 A. As far as I was aware.

Q. And just looking again at these notes Ms Jamieson made you said that Alan Reay used to put pressure on the Council. Is that, were you

referring there to discussions or going and sorting things out at the Council?

A. He dealt with Council on design solutions yes.

Q. And you talked before about him having quite firm views.

5 A. Yes.

Q. And defending those views.

A. Yes.

Q. And is that what you mean by that that –

10 A. I don't recall my comment that he put pressure on Council. He would deal with Council in terms of building consent issues at my time with Alan Reay.

Q. And would he deal with them firmly?

A. Well he was an innovative engineer so, particularly in the areas that I worked –

15

JUSTICE COOPER:

Q. Well there you go again. Did he deal with them firmly is the question, could you answer that?

20 A. No I, as I say I wasn't involved in those discussions so I don't, I couldn't really comment but I know that he dealt with issues with the Council.

CROSS-EXAMINATION CONTINUES: MR ZARIFEH

Q. And you know that from what?

25 A. Because he was the principal engineer or the design engineer working on the solutions that went through his office. Now this is when he was a design engineer.

Q. So are you just assuming that he dealt with the Council?

A. No I know that he dealt with Council.

Q. And how do you know is my question?

30 A. Because of, I worked very closely with Alan and those sorts of matters were discussed. He wasn't the only person that dealt with Council but...

Q. No I'm not suggesting he was but when he did deal with the Council he was quite firm in the way that he dealt with them. That would be your recollection wouldn't it?

A. Well as I say I wasn't closely involved in those discussions obviously but he had firm views on engineering solutions.

Q. And can you help us at all with any dealings with Council in relation to the CTV building? Were you aware of anyone specifically dealing with the Council on that?

A. No.

Q. From what you have described about Alan Reay and what you knew of him back then would it surprise you to know that we've had evidence in this hearing of David Harding having really no experience in multi-rise, designing multi-rise buildings before he came to Alan Reay's office and yet being given the CTV building to design and work on effectively without any supervision or review? Would that surprise you?

A. It would surprise me if Mr Harding was an inexperienced engineer, yes.

Q. Not something you'd expect to happen.

15 A. Not if he was inexperienced no.

CROSS-EXAMINATION: MR ELLIOTT – NIL

RE-EXAMINATION: MR PALMER

Q. When you said it would surprise you what were you referring to there?

A. It would surprise me if Mr Harding was given a project like the CTV building if he wasn't an experienced engineer.

Q. Did you know –

A. If he was given with no supervision.

Q. Did you know what his experience was?

A. No I did not.

25

QUESTIONS FROM COMMISSIONER FENWICK:

Q. The 1980s, mid period you were working there, it was a pretty exciting time wasn't it in terms of structural development.

A. Busy.

30 Q. Busy and exciting?

A. Um....

Q. You're at Alan Reay's firm who's developed this and carried it to perfection this tilt up construction, taking off in Christchurch, spreading to Auckland, evolving a lot of innovative developments wasn't it?

A. Yes it did.

5 Q. I mean how do you pick up the panels, quite elaborate process of working it out wasn't there, really exciting?

A. Very much so, very much so.

Q. Working out how they fit together, quite tricky problems aren't they?

A. He was at the forefront of all that.

10 Q. Yes it would require quite detailed drawings to see things fitted in and you'd need to do this wouldn't you?

A. Yes.

Q. And you'd do the drawings and then, of course, the engineer would have to come along and study those drawings to see how they fitted in and perhaps say oh now we can move this a bit to get it to fit. Quite a lot of detailed engineering and detailed draughting involved isn't there?

15

A. Yes there is yep.

Q. So Alan Reay would have actually worked with you pretty closely in fairly close contact because of this need for innovation and detail on this new form of construction wouldn't he?

20

A. I worked closely with Alan yes.

Q. Yes and this was in quite sharp contrast by Alan Reay's own admission that he did not do this with David Harding or the draughtspeople who were working on the multi-storey building.

25 A. It seems that, it seems that he didn't spend a lot of time on that project and certainly as I've done my evidence Dave Harding was my immediate thought as to the engineer on the project.

1505

30 Q. Yes, so the experience you had, working closely and developing these very exciting tilt up structures and panel structures and also the new developments in the steelwork were very different from what other teams in there on the multi-storey building were experiencing by Alan Reay's own admission. He had very little detail, didn't study the drawings, he didn't study the calculations in any depth at all apart from

making sure that there was a south wall in there that could resist the action so, the actual time you had you were working very close with Alan Reay but do you accept that you would have a very different feeling about that because of that close involvement and that very exciting period of working out the details?

5

A. Yes but the only clarification I'd make to that is that my role was quite different to Dave Harding. Dave Harding was an engineer and I was a draughtsman so –

Q. Yes.

10

A. – by, by that –

Q. You were a draughtsman who were working very closely with Alan Reay?

A. Yes.

15

Q. That's correct, right, so you would develop a close working relationship. You would've been sorting out problems closely together, my guess is every few days you'd be taking something along and saying, "Now how do we fit this in," or he would be wanting to see how things fitted in?

A. Yes but could I just clarify though that there were teams working at Alan Reay's and I worked on Alan Reay's, predominantly on the area that he sort of built his reputation around and that was commercial and re –

20

Q. Yes.

A. – warehousing.

Q. That's right and there was a lot of –

25

A. There was another team that worked on the high rise and they worked closely together as well.

Q. Yes and there's a lot going on, you had a large number of tenant, people coming back. The system was expanding and it was a really exciting area which kept the two of you working pretty solidly at this with the innovation and so on. That's correct isn't it?

30

A. There was a lot of work on, yes.

Q. Yes, and so the office was working, there was two parts. You and Alan Reay and possibly other people working there would've been discussing how things fitted together and working closely and that was

not probably the case with the other half of the firm while Alan Reay would not have had, or by his own admission did not have an involvement to any appreciable extent other than perhaps sorting out problems with Council?

5 A. Well even to the point of sorting out problems with the Council, there were teams that worked in the office and there was a design engineer working on the high rise stuff, and then there was another team working on the low rise stuff and you know, that, that, the engineers would be responsible for delivering those solutions right through to, to built form.

10 Q. Yes, we also have from the other (inaudible 15:08:17) different views on how Alan Reay's firm worked and so on in there. All I'm saying is your experience was different from the other people we've been talking to who were involved on the high rise, but I think you have explained that, thank you very much.

15 **QUESTIONS FROM COMMISSIONER CARTER:**

Q. You've had a chance to have a good look at the CTV building that we now have had presented to the Commission?

A. The plan?

Q. The plans?

20 A. The structural plans I've overviewed, yes.

Q. We noted that, and then I think it came in evidence from Mr Horn, that there were two different styles of draughting evidence on those plans. The drawing of the foundations was styled differently to the drawings of the superstructure, particularly the columns in that the columns were detailed more like shop drawings. The column was set aside on the drawing of the floor plan and just the column was shown, no beams shown adjoining to it. Whereas Mr Horn described that his style of draughting was to put the beams and the columns on the one, on the one drawing so that you could see the column steel and the reinforcing steel on the same, on the same diagram. So that you could see how they connected together, and he, Mr Horn gave his evidence that he thought that indicated there were two styles of draughting being exhibited there. Have a look at the foundation drawings, they do appear

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to be drawn by a different style than the superstructure drawings. Have you noticed that?

A. I haven't drawn that strong a conclusion from that, from looking at the drawings.

5 Q. Okay, so you have no, you can't help us on that?

A. Well I don't think it's –

Q. Because it could indicate who the draughtsman was?

A. Well, correct, but I've looked at the drawings and, you know, they just look to me pretty much like the Alan Reay style really. The foundations might look slightly different but they were all, they were all traced so they were traced in Alan Reay's style.

10

Q. But wouldn't Mr Horn's drawings be to the Alan Reay style?

A. Well, possibly but I do know that Alan was quite articulate or quite specific about the way the documents were traced, and that, and he was one of the few offices that actually traced –

15

Q. We're talking about drawing now, not tracing, we're talking about the actual way the drawing was put down because the tracer would just copy what the draughtsman had shown on his drawing.

A. Well I didn't draw quite the same conclusions that Terry did in that regard.

20

QUESTIONS FROM JUSTICE COOPER:

Q. Well, I'm interested that you just agreed to the proposition that Commissioner Carter put to you because I thought you'd said something different. Let me ask you this. I understood you to say in evidence earlier that there was a house style, an Alan Reay style with respect to tracing whereas I'd understood from earlier evidence that a tracer would trace the plans as they'd been draughted, which is the evidence you've just given to Commissioner Carter. Now which it is?

25

A. Well the tracers would trace the documentation to a style that Alan Reay liked.

30

Q. So if the draughtsman –

A. I, I wouldn't say that that is what happened all the time, but I certainly know that that was perhaps Alan's desire, but whether that happened all the time it's unclear, I couldn't comment.

5 Q. Well in addition to the point that Commissioner Carter raised, Mr Horn said that he could recognise structural drawings as not his drawings because of two features. One where there was an arrow Mr Horn would draw the head of the arrow with no tail. He told us that that was his style. So you just got the arrow head against the feature that it was referring to. And secondly, he would leave the arrow head clear,
10 whereas in the structural drawings for this building the arrow head was as to one half of it, darkened, shaded. And those features of these plans were the basis upon which he said, "Well that's not my work." Are you saying that the practice in the office was for the tracers to remove such individual indications of style in favour of a house style?

15 A. I think there was a preference for a house style. Whether it appeared all the time I couldn't be clear.

Q. But would it be the draughtspeople who were required to implement the house style or the tracers? Or can't you remember?

20 A. I think that it possibly was simpler to get the tracers to try to implement some of that presentation type detail. The draughtsmen were required to document. I mean I think the whole purpose of having tracers was (a), quality of presentation, but (b) so that the draughtsmen could get on and move more quickly.

25 Q. Are you saying today that you were involved in draughting the plans for this building or not?

A. I'm saying that I, I don't have recollection of it but that I, it's not inconceivable that I did have an involvement in the draughting of the CTV building. I do recall the project going through the office.

1515

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QUESTIONS FROM COMMISSIONER CARTER:

Q. So how would you draw a column in reinforcing steel compared to the other description I gave you of a beam and column conjunction on the

same drawing versus just the column putting in only the steel that was in the column?

A. To be quite honest it was 26 years ago and I just can't recall how I documented those sorts of things.

5 Q. So you would see in your present work though as a project manager working on construction jobs you would see different standards of draughting coming through? Different styles of draughting?

A. To be quite honest it's actually changed a lot since CAD came along so the standards have actually become a lot more consistent throughout
10 the industry.

QUESTIONS FROM JUSTICE COOPER:

Q. In paragraph 22 of your statement you referred to Mr Strachan's evidence that if he hadn't done the drawings it was your work as he trained you and the drawings looked like the style of his or my drawings.

15 Do you recall saying that?

A. I was referring to Wayne's comments.

Q. Yes. I see. And then you say, "Wayne also trained other draughtspeople in the office, either directly or indirectly so it could have been other draughtspeople as well that documented the project"?

20 A. Correct.

Q. You don't mention there this rule that the tracers had to observe to convert people's plans into the house style?

A. Well I think it's probably too strong a term to say rule but I think there was a desire to have a consistency about the way the documentation
25 was presented coming out of the office.

Q. Right.

QUESTIONS FROM COMMISSIONER CARTER:

30 Q. But a tracer puts a piece of translucent material over the top of a drawing that a draughtsman has prepared and then traces it. So I'm, I'm at a loss to know how the tracer then starts to convert that into some other style because they would not be copying the work that's underneath the paper that they're working on.

- A. Obviously they don't change the format of the plans or what is actually but they might change the way wording is you know –
- Q. The lettering –
- A. The let- yes.
- 5 Q. And the way –
- A. And the way, how it gets closed off or not closed off.
- Q. Oh yes.
- A. Or that sort of thing.
- Q. And so –
- 10 A. To provide a consistency -
- Q. Yes and that –
- A. – but certainly they wouldn't change the you know the actual format of the drawing.
- Q. The drawing beneath?
- 15 A. Not at all.
- Q. And I was trying to direct your attention to the drawing beneath the two different ways -
- A. Mhm.
- Q. – in which you could show beam column arrangements on a drawing and both of which –
- 20 A. Well –
- Q. – I know are used in the, in the practice of preparing engineering drawings so...
- A. Mhm. Well I've looked at the CTV column plans and they you know I, they really just look like you know standard Alan Reay plans to me.
- 25 Q. So your work was mostly directed towards the pre-cast industry and the tilt up and the steel industry where indeed the manufacturer needs shop drawings because they're making a single component. They're not putting the whole, whole building together. They are actually making a precast slab, wall, floor unit or something and just providing it with the, with the information that is shown on the drawing of that element. They don't really in the manufacturing side unless they're given a different responsibility they just have to make that, that piece –
- 30 A. Element.

Q. – of, that element?

A. Yep.

Q. So indeed it makes sense for a manufacturer to have shop drawings which he, he or she, uses to produce an, an actual product that they're contracted to provide so in, in, in – it's understandable to me that in work which was largely off site manufactured such or manufactured in single components that more of a shop drawing approach was taken whereas if you're building a, a multi-storey building out of interconnected beams, beams and columns where there's a lot of in situ casting and the steel has to be threaded through there's a sense in actually showing both those elements of work on the same drawing so that the actual builder can actually understand what it is that he's, he's now putting together, assembling if you like. So there's a logic behind both styles and I think you've said that the office was doing both pre, pre-assembly, pre-cast business and also was now doing some multi-storey building business which Terry Horne was the more experienced draughtsman at doing?

A. Correct.

Q. So I just was trying to lead you towards thinking if that gave you a clue as to where the drawing work was, was located in the office?

A. Yeah, I have looked at the plans and I, I don't feel I can draw any strong conclusions other than perhaps the foundations as to who documented them.

Q. And that would be?

A. I think Terry as he said documented the foundation. It looks like Terry documented the foundations to me.

QUESTIONS FROM JUSTICE COOPER:

Q. So the reason this is occupying sometime Mr Fairmaid with us is that the, we'd had the draughtspeople from the office or many of them come along and each of them give evidence to the effect, and you're part of this, that they find the timesheet record difficult to accept so we have to factor in the possibility that for whatever reason whether it's in the resolution, whether in the drawing together of the information in the

timesheets or for some other reason that summary of what they say might be wrong?

A. Right well –

5 Q. And your, your position is still, as I read it, that you – if, if, if the timesheets the record of the timesheets is correct then you accept you were involved?

A. Correct.

Q. But that's the only basis on which you accept you were involved, is that fair?

10 A. Yes, yeah, I, I cannot recall specifically working on the project.

Q. Yeah.

A. I can recall the architectural documentation.

Q. Yeah.

15 A. But you know the fact that I can recall the architectural documentation and the fact that I can recall it going through the office, the fact that there is timesheets indicate I did work on the project would seem to indicate that I did work on the project, I'm happy to accept that, I don't see, you know, you've just got to draw that conclusion and when you look at the other hours on the timesheets it, it is also consistent with my
20 recollection of you know for instance you know Dave Harding being the engineer on the project.

Q. Well you remember that but you don't remember working with him?

A. No. No I don't.

25 Q. Right so this brings me to another point because to Commission Fenwick you state –

A. Can I just clarify that point just a little excuse me, the reason I may not have remembers working with Dave that closely is because I might have been working on areas that were you know the steel, the roof steel and the panels and the stairs and that sort of thing which are sort of more
30 non-structural. I know they're structural but they are areas that don't require as much structural input because that's where my experience was. Sorry.

Q. You said to Commission Fenwick that there were different teams in the office, you and Dr Reay were in one team?

- A. Yes.
- Q. You recall saying that?
- A. Yes.
- Q. Who was in Mr Harding's team?
- 5 A. Well the high rise team being Terry was the draughtsman that was more experienced in high rise and that's what he did.
- Q. So in so far as engineers were concerned it was only Mr Harding?
- A. But – well and John Henry when he was there.
- Q. Yes all right.

10 **QUESTIONS ARISING - NIL**

JUSTICE COOPER ADDRESSES MR FAIRMAID

WITNESS EXCUSED

**MR ZARIFEH ADDRESSES JUSTICE COOPER – ORDER OF WITNESSES
MR PALMER ADDRESSES JUSTICE COOPER – AVAILABILITY OF
DR BRADLEY**

HEARING ADJOURNS: 3.36 PM

5

HEARING RESUMES: 3.46 PM**MR PALMER CALLS****DOUGLAS HAAVIK (SWORN)**

- 5 Q Mr Haavik. Is your full name Douglas Jon Haavik?
- A Yes, it is.
- Q And you reside in Orange, California, USA?
- A That's correct.
- Q And are you a consulting engineer specialising in concrete and concrete
10 materials?
- A That's correct.
- Q Have you read the code for expert witnesses set out in the High Court Rules?
- A I have, and have agreed to abide by it.
- 15 Q Now, you've prepared a brief of evidence, haven't you? It's dated 30th May 2012.
- A Yes.
- Q And it summarises work that you and others that you have directed – Dr David Rothstein and Mr Orville (or Bud) Werner have done, doesn't it?
- 20 A That's correct.
- Q And that brief is taken as read, but you've prepared a PowerPoint presentation in relation to the work that you have done in relation to concrete examination.
- A Yes.
- 25 Q Could you please present that PowerPoint presentation to the Commission?
- A I will. After... before getting into the PowerPoint slides I wanted to go ahead and detail just a little bit the timeline of my participation in these investigations.
- 30 In early January Dr Robyn Shepherd called me by telephone from New Zealand and described the situation on the CTV Building investigation from his point of view and asked if I was available and would be interested in providing materials consulting services on behalf of Alan

Reay Consulting Limited. I responded that I would. Nothing happened for about a month, but then Mr Willie Palmer and Ms Kelly Patterson made arrangements for a discussion. They agreed to engage my services, shipped a package of documents. I reviewed that and on
5 February 20th made a recommended programme of tests to them.

We continued on with conference calls through March, accompanied by various emails agreed to go ahead and do the programme, and on March 20th and 21st cores were drilled in New Zealand out at Burwood Landfill by Douglas Latham and Christopher Urmson. They did a fine
10 job. They shipped the cores to Colorado to a petrographer by the name of Dr David Rothstein. He's a PhD in geology. A petrographer is a person who is trained to look at concrete as an artificial stone. They typically have a degree in geology or come into the profession by a geological type of connection. Dr Rothstein has a PhD in geology from
15 the University of California, Los Angeles, and operates a petrographic laboratory in Boulder, Colorado where we had the specimens shipped.

I travelled to Colorado on April 27th 2012. Dr Rothstein and I and Mr Werner looked over the samples there and prepared a plan to go ahead and test the samples.

20 A month later we, a report was issued in California which is described in the brief. And on August 7th, Tuesday a week ago, I arrived in Christchurch, New Zealand to present this information to the Commission.

25 With that background I'll just go ahead, go with the forensic examination with the PowerPoint proof.

The objective here was to determine in-situ concrete compressive strength using undamaged cores. The effort was to determine, very specifically, the core strength of concrete that you would get at a time prior to the Darwood [*sic*] earthquake. The problem that had been
30 described to me was that in the Hyland-Smith report there were core strengths reported which seemed to be very low and the Hyland-Smith report had concluded that the concrete was not of proper strength when delivered to the job site. I am sure others will correct me in the questioning periods if they think that that statement is incorrect.

Now what we did as I expressed in the timeline was Mr Latham and Mr Urmson sampled cores on March 20th and 21st in New Zealand. They then shipped the cores to Colorado and I put method 2(a), 2(b) and 2(c) because these all kind of ran a little bit concurrently depending on what we were doing and so we prepared – we looked over the cores initially for damage, prepared a plan for, to determine how we could test the cores with the largest diameters and the longest lengths. Mr Latham's work was to take cores that were 150 millimetres diameter, if we can get WIT.HAAVIK.001.35 on the screen we can show that now.

5

10

We are bringing up an example here of the documentation Mr Latham and Mr Urmson did while they were sampling the cores and the interesting thing is we prepared our programme in mid to late February, started implementing it in March and then in early to mid April I received a copy of Dr MacKechnie's peer review which outlined a programme very similar to the one we were implementing as the recommended effort to go ahead and take core samples and test them. So here on the screens you can see how Mr Urmson and Latham had gone ahead. They in essence had people saw sections out of the column, set the column upright and then core drill down the middle of it to provide a cylinder that is parallel to the direction of concrete placement. This is important for reasons I will go to a little bit later. The three holes over to the left side of the photo here are apparently cores taken for the Hyland-Smith report.

15

20

For completeness, if we can put sheet 36 on up here. Each of these pieces of documentation had two sheets so that was the sample there and they took enough photographs so that we could reasonably see what was doing. The bottom photo shows what the column looked like after the core was drilled out of it.

25

30

If we can go back to the Powerpoint presentation. So in Colorado we examined the cores as I've said then we prepared samples for compression and petrography. We evaluated the samples using ultrasonic pulse velocity, petrography and visual inspections. I won't go into the details of the specimen preparation. Those are in our report or I can be asked questions if there is further interest in that afterwards but there

was one thing that really struck me when we first – if you can call up number 76 please. When I first started to look at the samples and I commented on this with the other investigators and that is the cores, the concrete with the Christchurch greywacke tends to have flat and elongated particles so in the top photo you see here I think most of you can see a relative kind of slant of the aggregate particles flowing in a lower direction down towards the bottom.

JUSTICE COOPER:

10 There is a mouse there or there should be if you want to –

EXAMINATION CONTINUES: MR PALMER

A. Is that, okay, yes I have got the arrow on there now and you can just see that the particles tend to assume an orientation along this sort of a direction and I feel that is important because if you are going ahead and testing the concrete vertically on those flat particles that would tend to give a higher strength than if you had cored that area horizontally and the flat particles all stood up like columns. From a structural point of view they would tend to buckle and give a lower strength. In 50 years of experience around the concrete industry I have never seen a concrete with cores that gave this sort of an appearance.

20 Number 66 please. Now this is a different cylinder and we can see that this cylinder shows a much less pronounced tendency towards this orientation phenomenon that I have been talking about. I included these two because I felt that phenomenon was important and wanted to make sure the Commission was informed of that.

25 Number 87 please. Unfortunately I am playing with the mouse here, okay, now along here we can see there's a crack in this particular specimen and there were cracks in some of the specimens and that is why we needed to carefully evaluate the samples we were using and re-core them. We had been hoping to be able to test 150 millimetre diameter cores but we were actually only able to test 99 millimetre diameter cores which is still substantially larger in diameter than the 69

millimetre diameter cores typically tested for the Hyland-Smith report.

5 If we can go to 154. This is just the main sheet of the Olsen Engineering report which Olsen Engineering is an internationally known non-destructive testing firm which is based in the Denver metropolitan area and we got them to use ultrasonic pulse velocity which basically puts pulse waves through the concrete and determines the velocity that these waves can go ahead and do and they verified these samples we were proposing to compression test were all sound. So we have the petrography and the ultrasonic pulse velocity inspections.

10 If we can go back to the Powerpoint presentation please. So we went ahead and evaluated the cores for damage, prepared the samples, evaluated the samples using ultrasonic pulse velocity petrography and visual inspections. We compression tested the cores, determined in densities and absorptions in the laboratory in Colorado and produced reports both in California and Colorado.

15 The findings, we ended up with. We had compression test results and concrete sample correlation and petrography.

1603

20 If we could have the compressive strength comparison visual up here. We have both of them here now, that's fine. The compressive strength comparison shows up here on the bottom and it's arranged from the highest strength we got – 75.1MPa – to the lowest strength – 28.4MPa. This also shows a column, this is just three columns from the table at the end of my report and where the Hyland Smith report had tested the same columns we have their average compressive strength in the middle column and then in each case our test results were higher than the Hyland average compressive strengths by anywhere from 2.7 percent on up to a high of 55.8 percent. It's relatively variable but that's what we got. Also I prepared the concrete sample correlation video showing an orienting and rank corrected compressive strengths, densities and absorption to show the relative consistency of the different samples. Each particular colour is the same sample number so as you go along here on C4B you see they're in the top two columns. C4T the

yellow ones are all in the top two columns. The lower ones of some of them vary a little bit more but the lowest ones is the R3 sample which happens to be the only air entrained sample in the whole collection and why there is some air entrainment in the structure and not, I can only
5 assume they were placing at lower temperatures than we're concerned about the possibility of freezing before the concrete had gained a lot of strength. Just a couple of minor comments on the petrography –

JUSTICE COOPER:

- 10 Q. Did you say freezing?
A. Yes, freezing of concrete. If approaching zero degrees celsius while the concrete is fresh. It is important to not freeze the concrete and air entrainment prevents freezing of concrete by providing very tiny air bubbles that water can expand into. Much like avoiding freezing in an
15 automobile engine block.
Q. But I mean this depends on ambient air temperature does it?
A. Correct and wind factor too. We know it's chillier when the wind blows.

EXAMINATION CONTINUES: MR PALMER

- A. The petrography, just to summarise in a couple of sentences. I would
20 describe Dr Rothstein's report of the concrete is it is distinguished by its uniformity. That is he didn't see very much difference in all of the concrete with a few exceptions. The R3 cylinder being air entrained but Dr Rothstein commented it's well consolidated with no large entrapped voids or bleed voids observed. There's no evidence of fire damage in
25 these cores, which one would expect since they were from within the confinement of the columns. Dr Rothstein found a few cores that contained occasional micro-cracks, very few, with some ettringite that he deems to indicate that the cracks are old and were not done in the process of our coring and handling to get them to Colorado and tested.
30 That concludes my presentation. If we want to handle questions now or during the hot tub that's fine.

CROSS-EXAMINATION: MESSRS ALLAN, ZARIFEH, ELLIOTT – NIL

QUESTIONS FROM COMMISSIONERS FENWICK & CARTER – NIL**QUESTIONS FROM JUSTICE COOPER – NIL****JUSTICE COOPER:**

5 I've had a note from the transcribers or perhaps from Ms Walton saying that the first five minutes of recording were missed and then she says, "It's just introduction. What do you want to do?" The transcript should record that Mr Haavik was called and sworn and then he addressed his slides which, yes he gave us what he described as the timeline of the project. I wonder whether
10 the easiest thing might not be for him simply to repeat what he told us about that or is it in the report.

MR PALMER:

It's not really there, Sir, I think it's better that he repeat that.

15

JUSTICE COOPER:

Yes because then he moved onto the slides which are BUI.MAD249.0589.1 and following. Just give us the timeline again please. We've had this technical hitch Mr Palmer.

20

MR PALMER:

Given the identities that he refers to in his timeline, Sir, it might be worth recording that he's worked, he's directed the work of Dr David Rothstein and also Mr Orville Bud Werner in the work that he's produced as part of his
25 evidence.

JUSTICE COOPER:

Would you mind Mr Haavik?

MR HAAVIK:

30 That's fine. The timeline of my activities in the project are in early January Dr Robyn Shepherd called me from New Zealand and described the situation of preparing for the hearings here and the problem of the Hyland Smith report

finding lower strength concrete and because he and I had worked before after the Los Angeles North Ridge earthquake in 1994 on similar sorts of projects he invited me to become a participant in it subject to my availability which I, of course, accepted. In early to mid-February Mr Willie Palmer and Ms Kelly
5 Patterson telephoned me and we discussed the project a bit. I submitted my CV to them and was engaged. They shipped a package and I reviewed it and on February 20th 2012, by telephone, I recommended a programme of tests to them. Subsequently, with their approval, I ended up engaging Dr David
10 Rothstein and Mr Orville Bud Werner to do the petrography and the concrete testing in Colorado and we made a plan to do the coring on March 7th. That was when our discussion was. The coring was actually done by Douglas Latham and Christopher Urmson on March 20th and 21st out at the Burwood landfill. In mid-April I received a copy of Dr MacKechnie's peer review regarding the concrete materials aspects of the Hyland Smith report and was
15 pleased to see that his recommendations for a forensic investigation largely paralleled the plan we had already put in motion. Dr Rothstein, Mr Werner and I met April 27th 2012 in Colorado to personally review all of the cores and select how we were going to re-core, cut and do the tests and examinations on it. On May 29th 2012 our report was issued to Buddle Findlay from
20 California and I arrived August 7th, a week ago, in Christchurch, New Zealand.
1613

JUSTICE COOPER:

Right, thank you very much for repeating that.

25 **JUSTICE COOPER ADDRESSES THE PANEL – SEATING**

JAMES MACKECHNIE (AFFIRMED)

ROBERT GAIMSTER (AFFIRMED)

JOHN MANDER (AFFIRMED)

CLARK HYLAND (AFFIRMED)

5 **BRENDON BRADLEY (AFFIRMED)**

JUSTICE COOPER ADDRESSES THE PANEL – MICROPHONES

JUSTICE COOPER:

10 My function is in broad terms there's a measure of agreement amongst many of you that the reported concrete strengths in the Hyland Smith report are likely to have, or have in fact understated the strength that was actually present in the concrete in the CTV building. Am I right in that? Yes. So it may however be helpful if we just hear from you each a summary of your position.

15 Can we start with you Dr MacKechnie?

DR MACKECHNIE:

Yeah, my summary would be that there were issues with the concrete testing in the way that it was sampled. To some degree in the lack of completeness in the test recording and that basically impacted on the reliability of the final
20 numbers that were presented in that report.

JUSTICE COOPER:

Mr Gaimster?

25

MR GAIMSTER:

Thank you Sir. I believe that Dr Hyland's conclusions are not valid concerning concrete strength and on the balance of probabilities the concrete used in the building was almost certainly of acceptable standard. I further believe
30 Dr Hyland's core methodology in terms of sampling and testing and his interpretation was simply insufficient and we should remember that the concrete he sampled had been subjected to two major seismic events, a significant fire, extreme stresses associated with a building collapse and it had also been bulldozed and cored and the coring process itself is quite intrusive,

and the concrete was likely to have been subject to cumulative stress and damage. The British standard says don't core from stressed areas. Also at the time the building was constructed we know that all the major ready mix concrete suppliers in Christchurch were part of the plank classification scheme, a quality scheme for ready mix concrete. We know that all three suppliers were supplying special grade concrete which means they were, had a high regimen in terms of quality control. In terms of the core methodology, it was somewhat flawed from sampling, testing, reporting even through to the interpretation. Now I can go into detail there or I could leave that.

10 1620

JUSTICE COOPER:

I just think we – if we could just have the summary of your position, those points are all made in your associations –

15

MR GAIMSTER:

They are indeed, yes.

JUSTICE COOPER:

20 Professor Mander, can I just say we've just had the opportunity to read very briefly your third statement of evidence and there may be some questions on that which we don't want to ask today because we haven't had time properly to consider it but can I just ask Dr Hyland have you seen this third statement of evidence of Professor Mander's?

25

DR HYLAND:

No I haven't had a chance to read it Sir.

JUSTICE COOPER:

30 You have got it but you haven't had a chance to read it.

MR HYLAND:

Yes.

JUSTICE COOPER:

So Professor Mander, could you just summarise your position for us?

PROFESSOR MANDER:

5 Well, you have heard from me before on this topic but I just like to endorse what my former two speakers have said because I totally agree with that but in very simple terms I would put my view this way. It didn't pass the smell test, it just didn't look right and one looks as, is very accustomed to looking at reports and documents and does a lot of editorial work for various different
10 organisations and when you flick through things you instantly get a feel and one of the things that immediately jumped out, big time, in my eyes was the fact that you have these bell curves which is not the right to plot it anyway and one of the bell curves which is ostensibly the concrete as measured at the site, was just totally off the mark, as far as I could tell and showing that there
15 were results with, you know, strengths down into the teens, well if that was true, I maintain you don't need to do any testing, you can just use your eyes and they will tell you that that is bad concrete. So that is my position and of course I have done a lot of analysis to corroborate that initial kneejerk feeling.

20 JUSTICE COOPER:

Yes, all right thank you. Dr Bradley?

DR BRADLEY:

I guess from my perspective Sir, rather than focusing on the methodology of
25 concrete specimen extraction and actually the testing, I principally looked at the interpretation of the numerical values from that testing and reconciliation of that with the specific specifications that the concrete was. So the analysis that I performed suggested that irrespective of the quality of the concrete specimen extraction testing the interpretation of the testing results and
30 comparison with specifications was inappropriate and as a result yielded an incorrect assertion that the concrete was below strength.

JUSTICE COOPER:

Right. Now, this brings us to you Dr Hyland so you have the floor.

DR HYLAND:

Excellent, okay thank you very much. Look we appreciate the work that
5 Mr Haavik has done and Dr Rothstein's analysis, the petrography and we
acknowledge we didn't do petrographic analysis at the time but we were
aware that this could be done at some point. I think Dr Rothstein's
petrography has highlighted some of the issues that we were concerned
10 about. One, being he has noted that there was apparently dirty aggregates in
his report. He also notes that there appears to be high sand content in one of
the figures he has got there. The issue of flat and elongated aggregates is
very interesting and I think this does give some explanation about a vertical
versus a transverse result. I don't think that gives us any comfort however in
terms of this concrete. It would indicate that this concrete has perhaps got
15 quite different properties in a transverse direction than in the, in a vertical
direction. In terms of a concrete that has to undergo shear and vertical
loading this, to say that the concrete is, you could use the upper strength as
your design strength when you know there is actually a transverse weakness I
think is a problem. The length of the particles or the aggregates I am not
20 aware of any controls that are in the current standard around the aggregates, I
am not sure if we have any long – an elongation or oblong issue that is dealt
with in the concrete aggregate standard but I think that is something that
would need to be looked at. The densities that came out of the testings by
CTL on behalf of Mr Haavik came up with very much the same sort of
25 densities that concerned us also. I am aware from discussions with Mr Jones
who performed the testing on my behalf, at Opus laboratories that a 25 MPa
concrete mix in Canterbury would typically have a density of 2380 kilograms
per cubic metre and that the Canterbury concretes have a very consistent
signature in terms of density in that the aggregates are very consistent
30 between Oamaru and Christchurch and he told me that he had, his
experience was that this was in the range of 20 kilograms a cubic metre.

JUSTICE COOPER:

We better tell Mr Haavik where Oamaru is I think?

DR HYLAND:

Oh, Oamaru is just down the road, about a 100 k is it or.

5

JUSTICE COOPER:

Who knows how far it is from Christchurch to Oamaru? 250 kilometres.

DR HYLAND:

10 So the issue is that if you have got a consistent aggregate content and the, we are using a 19 millimetre maximum aggregate size then the water content is going to be largely determined by the aggregate size. It is going to be reasonably consistent dependent on the, between one mix and another, so the cement ratio is then what changes the density and so in my discussions
15 with him he was of the view that we had, not only did we have low concrete strengths in a number of these columns but the densities were sort of corroborating evidence in his view that we were looking at something that wasn't what you would expect to be in these columns. We'd started with a test, going back on this, I mean I'd started with testing on the PGC building
20 and in the Forsyth Barr and we had found concrete strengths which didn't cause any alarm to us at all. There was strengths in these concretes that were, you know, up to two times the specified strength which was, commensurate with what we would be, you know, could be well, conditioned with aging of these concretes. When we came to this one the first test we did
25 was, on a level 6 column at the CTV site. My memory was we had something like, it came in with 26, 16 and maybe 25 MPa, for a 25 MPa concrete, and we were just sort of thinking this seems, we could tell it was level 6 but this seems to be right at the low end of what you would expect. I mean that would, you know if it was 25 MPa you'd be hoping you'd be getting something more than
30 that. So then the next step was to look at the remaining level 1 column which was C18 outside the core, there was a stub remaining and so we attempted some tests on that, did three cores on that, difficult to get the cores out of it, whole but the tests again indicated a low strength and not only a low strength but a low density. So it was then, so okay, let's go the next step and this was

in conjunction with the panel I believe we said, okay let's see if we can get some more tests on that, see if we can confirm if this is just an outlier but the following tests done by Opus in their own lab when they cored it and I think one of them was actually was a vertical core, was still low and we are still
5 getting a low densities so at that point the concerns were and we believed we needed to take this further, was do we have a problem with low concrete strengths in the CTV building that may have been a contributing cause to the collapse and I don't believe we were – we would have been remiss if we didn't pursue this further. So the decision was made to let's go to the Burwood
10 landfill where the columns were in a secure place and then see if we can extend the testing there and we did that. I guess I am making a bit of a long story here, you just want a short one, but in summary I believe, I have re-analysed the results using the data from Mr Haavik.

1630

15 We adjusted our results 8% for orientation based on the Great Britain Concrete Society recommendations, and when I've made that, when I've combined his results into our results the differences aren't that marked. We're still not getting a big change in the results, so our concerns are still that there is a problem with concrete. Perhaps there was a number of different mixes
20 brought onto site. Maybe there wasn't the control that was there. If we look at the densities of the concrete there's, we use a signature densities that we have it would indicate you could've had concretes of 20 MPa, 25 MPa, 30 MPa concrete on that job. So having, my position is that I believe the testing has added another dimension to it, and perhaps brought out the issue of an
25 isotropic performance of this concrete but it still doesn't allay our concerns that there may be an issue with concrete quality control in this building and perhaps in other buildings that should be further investigated.

JUSTICE COOPER:

30 Yes, so did I understand you right to say that Mr Haavik and Dr Rothstein's work resulted in similar densities to what you had found?

DR HYLAND:

Yes, yes in the cored, the cored samples they had very similar densities to those that Mr Jones found.

JUSTICE COOPER:

5 Is that accepted Mr Haavik?

MR HAAVIK:

I haven't looked extensively at Dr Hyland's densities but I see no reason that they should be that much different.

10

JUSTICE COOPER:

Does anybody else want to comment on that? Dr MacKechnie?

DR MACKECHNIE:

15 Yeah the densities of the two investigations are reasonably similar. If you look at the column densities of Hyland, you mentioned 2350 of that kind of order. That's pretty much what Haavik's work was getting between 2330 and 2390 which is pretty much what we'd expect for the grade of concrete as Dr Hyland said that would be its signature in terms of its density. So there's not much
20 difference. But I would just add that there's only three results that Hyland has got of all the cores that he took that I would suspect as having low density, that's below the design, the theoretical density of 2330.

DR HYLAND:

25 No, what we're saying is, if I can butt in there, level C18, level 1 C18 column had an average of 2336 kilograms per cubic metre. Now for a 20 MPa concrete you'd be expecting 2345. The level 6 C1 column had 2328 kilograms per cubic metre, again a 20 MPa would be 2345. The C4 column had 2423 kgs a cubic metre which is equivalent to about a 30 MPa concrete.
30 C12 2379 which is pretty much a 25, it's 2380. R6 2386 which is a 2380, 25 MPa. R7 2353 which is close to a 20 MPa is a 2345. R3 had the lowest at 2261 and that's less than a 17 and a half MPa.

MR GAIMSTER:

But R3 was an air entrained copy?

DR HYLAND:

It was an air entrained yes.

5

MR GAIMSTER:

And you'd expect that to be 100 kilograms per cubic metre lower?

DR HYLAND:

10 Well I'll take your advice on that. The C7 at 2374 which is approximately 25 MPa.

DR MACKECHNIE:

15 I would just dispute that correlation between density and strength. We don't find that with Christchurch aggregates. It can be, it can vary and 2350 is quite acceptable for 25 MPa concrete and we test thousands of samples.

JUSTICE COOPER:

So there's a real difference of opinion there it seems?

20

DR HYLAND:

There would be but I mean this is, you would agree that the main change would be the cement content between the different grades of cement. The aggregates don't really change much in Christchurch.

25

MR GAIMSTER:

30 I was just looking at, I'm not sure if I can raise this but there was a submission made by David Barnard who is the chairman of the NZRNCA about the plank classification scheme and he mentions density. Now David is, he would be in his seventies now. He's been in, he's a structural engineer and he's been in concrete technology all his life and he says on densities, "The concrete densities measured in the report were consistent with densities I know are appropriate for 25, 30 and 35 MPa strength concretes using Canterbury

aggregates.” Now Dr Hyland has mentioned column C18 several times. I just wondered if I could refer you to page 71 of the Hyland materials report?

JUSTICE COOPER:

5 The Hyland material book, can we have a number for that document please?
Mr Zarifeh will tell us immediately what it is.

MR GAIMSTER:

I'm looking for the Hyland examination of the materials?

10

JUSTICE COOPER:

They Hy – sorry, what are you looking for? Page?

MR GAIMSTER:

15 Seventy one.

JUSTICE COOPER:

Page 71 of, not it's not the collapse report I'm sorry, it's the materials report that we're looking for?

20

MR ZARIFEH:

Your Honour BUI.MAD249.0190.81.

MR HAAVIK:

25 Your Honour while we're waiting I'd just like to point out that on the visuals I had with the powerpoint presentation we showed Mr Urmson and Latham's coring results showing the same column sample with both the Hyland cores taken out of it and the cores in our study taken out of it, so it should be the, it should be essentially the same density. It's the same structural member.

30

COMMISSIONER FENWICK:

On that picture you showed us we could see the cores and we could see the lines marked round it. Now I assume that's where you cut, take the cores is it?

MR HAAVIK:

Our cores, they, the large picture they saw of the intact, showed of the intact column, that was before they sliced cuts out of between it, pulled samples out
5 of it like a tree trunk and then went ahead and drilled vertically.

COMMISSIONER FENWICK:

The point I wanted to make was whereabouts in the height of the column did
10 you take the core?

MR HAAVIK:

That particular column was taken at both ends. There were two samples
taken from it.

COMMISSIONER FENWICK:

So you got one from the top and one from the bottom?

MR HAAVIK:

Yeah, right, and it is, that visual actually is labelled top and bottom although
20 the cores –

COMMISSIONER FENWICK:

Normally expect the top to be weaker don't you?

MR HAAVIK:

Yes.

JUSTICE COOPER:

Mr Gaimster, this is the page you're looking for?
30

MR GAIMSTER:

Yes Sir. This is just an example. What Dr Hyland did was sample extract
cores from seven columns. C18 is quite an important one because they took
six cores from C18 and when you're doing core testing and interpretation you

really need at least between four and six cores per test location, depending on your core diameter. Now –

JUSTICE COOPER:

5 This is a column I've been told we should be calling it DE4.

DR HYLAND:

Yes you could call it that.

10 **JUSTICE COOPER:**

Just to translate it into engineers' language.

MR GAIMSTER:

The point I want to make on page 71 is the final sentence in the fifth
15 paragraph there clearly says that the remnant in question here is affected by
heat and collapse damage, and if we can now go to –

DR HYLAND:

I don't, we don't say it's, we say it may be affected, we're not saying that that's
20 affected the actual strength.

MR GAIMSTER:

Well if we go to then page 69?

25 **JUSTICE COOPER:**

So two pages earlier?

MR GAIMSTER:

Yep, we can just see a picture of that rather distressed looking C18 column,
30 I'm dragging this out a bit. If we then go to page –
1640

JUSTICE COOPER:

Well hang on, you've gone to – we should've gone to what is page 69 of –

MR GAIMSTER:

Sorry it's page 69.

JUSTICE COOPER:

5 No hang on, hang on, we've gone back to the collapse report.

MR GAIMSTER:

I'm looking at page, I'm looking at page 79, apologies.

JUSTICE COOPER:

10 Is this what you're after?

MR GAIMSTER:

Yep.

JUSTICE COOPER:

15 Figure, figure 47?

MR GAIMSTER:

Thanks the one.

20 **WITNESS REFERS TO FIGURE 47**

JUSTICE COOPER:

Thank you.

MR GAIMSTER:

25 So, just, just by way of example as I say C18's quite an important column in that a lot of cores were taken out of it, taken out of it, you can see in these photographs here that it does appear to be in some distress. If we could go to page 124 I think it will be.

JUSTICE COOPER:

Is that our number or the report number?

MR GAIMSTER:

5 I think it's your number.

JUSTICE COOPER:

Our number, the red number, 124.

MR GAIMSTER:

10 At the top.

JUSTICE COOPER:

Yep.

WITNESS REFERS TO PAGE 124

15

MR GAIMSTER:

Then we just have a picture of the remnant and the core that's been extracted from it and you can clearly see that that remnant has been, has got scorched marked in two places and we can also see there appears to be some kind of
20 macro crack just to the top right of, of that particular remnant and the point I'm making is, is that core and cores from C18 shouldn't have been included in the interpretation because you can just see it's not right, you can see there's something wrong with that remnant. I think it's been subject to ongoing distress from, from the collapse and from the fire and what you would do in
25 normal circumstances is that you would reject those results from the analysis and if you did that I think Mr MacKechnie did it, sorry, Dr MacKechnie did it and came up with an average core strength of 30 MPa. Now Sir if you'd asked me before the coring regime took place what you would expect from those results I would say around 30 would be indicative of, of concrete
30 supplied between 25 and 35 Mpa. So if you remove that from the analysis you would think –

JUSTICE COOPER:

You're saying this column's an outlier?

MR GAIMSTER:

5 I am indeed sir.

JUSTICE COOPER:

So is that the approach you take too Dr MacKechnie?

DR MACKECHNIE:

10 Yes, this one in particular I think there's no doubt that it wasn't suitable that the reason it was tested up in my understanding is it remained. They knew it was a ground floor column and they were, it was really important to try and get some grade 35 MPa concrete tested.

JUSTICE COOPER:

15 Yes.

DR MACKECHNIE:

And because it was still in situ they knew where it came from but that doesn't mean it was suitable for testing.

20

MR GAIMSTER:

And cores were only extracted from seven out of 132 columns, so not really a huge sample size.

JUSTICE COOPER:

25 Mhm. Professor Mander you were wanting to say something.

PROFESSOR MANDER:

If I could add, yes might I add if you, if you go to one of the pictures that you've seen from me before. It's WIT.MANDER.0001.63.

30 **WITNESS REFERS TO WIT.MANDER.0001.63**

Now these are three of the column specimens that I'm going to be talking about tomorrow. It's interesting that these were not tested by anybody and so that's why we, we chose to test these but you'll notice the two outer ones are kind of coloured purple are both from column C5 and ones at the top portion
5 you can see that written there and then there's the bottom portion and then the – now those are both in notionally good in order, that, there is some minor signs of damage but they're in notionally good order. C13 by contrast is demonstrably damaged but I might say not as damaged as this column that we've just seen and so you'll see tomorrow that C13 is somewhat weaker than
10 C5 and, the two C5 specimens there. Now we deliberately chose C13 to clearly make the point that damage makes a difference and it sure does.

JUSTICE COOPER:

Dr Hyland.

15 **DR HYLAND:**

Yes I mean first of all the, the C, the C18 column we, we, we took six cores on that and all of the, all of the results from that core were reasonably consistent and consistently low as well as the density being low at 2336 kilograms per cubic metre for what should have been the 35 MPa concrete, 35 MPa
20 concrete should have had a density in the order of hang on just a minute – somewhere between 2430 or something like that so the, the density is, is, is part of the equation and it is low, it is not what you'd expect from a 35 MPa concrete. Now it was taken from a column, a column that was damaged but each of the cores was competent core. It was inspected by a technician
25 who's experienced in this in a laboratory that's certified to do these tests according to the New Zealand standards. He did a visual examination on the cores. He saw no obvious cracking to the eye which is, which is the test.

JUSTICE COOPER:

We've just seen a photo of that haven't we with cracking?

30

DR HYLAND:

Yes but through the core itself that he tested there was not a crack, there was no macro cracking obvious. Now if you're using, if you're, if you're looking at low strength concretes like this the effect of micro cracking is, is going to be negligible. What we found with, with the petrographic examination that was being done is that even though the cores that were taken at the direction of Mr Haavik were in basically the same locations as the cores that I directed to be taken. No micro cracking was found in those cores. So the inference is that there was no obvious micro cracking in the cores that were taken for our testing. The influence of micro cracking I believe is not an issue so if we've got component cores and we're getting results which are low which are also consistent with low densities evidence is pointing to the fact that this is quite a valid test and there was a problem with the concrete in this particular location. Now the – while we only had how many, how many columns are there I can't remember was it eight that were cored. We, seven, we extended, we extended the, the testing to 26 columns using rebound hammer testing and so it is, there is a significant range of columns that were tested and out of those we had six that did not meet the minimum concrete strength specified at the time of construction we had, of 25 MPa and we had two that didn't meet the 35 MPa minimum. So the, the concern –

JUSTICE COOPER:

Was that four, was that four plus two or?

DR HYLAND:

No, six plus two, six that didn't meet the 25 and two that didn't meet the 35 where we knew where they were from. The, the size of the sample we took is significant. We did tests on 26 out of 123 columns and the columns were randomly selected. There was no, there was no deliberation about where to pick the columns, I, I just deliberately walked through, except that I deliberately walked systematically through the debris field, John Snook watched me do it, we did it together, pointed out where we could find columns and we, we extracted those and we put those out for testing and we, we also

left them there for legacy testing. So we, we've, we've got a significant sample there.

1650

If we look at, even the distribution of what we know is looking at it if you do
5 (inaudible 16.50.11) distribution we had three that we know that were level
one columns. Do a (inaudible 16.50.11) distribution that's about an 80
percent chance that we would get that out of that level of sample. We have
two level two columns. There's a 92 percent chance of having two columns
out of that out of level two there. The rest of the 25, even if you take the
10 average of that out of that you would say your column strength should be
higher, if you take the average of what you'd expect, you'd expect the average
to be higher than what we've got statistically.

JUSTICE COOPER:

15 Can we just leave the hammer testing on one side for the moment. Mr Haavik
is there anything you want to say about what Dr Hyland was saying in defence
of the core sampling that was done?

MR HAAVIK:

20 Well I think that we did a good job on core sampling. We ended up getting
higher strength tests and part of test results and we haven't gotten over into
the issue yet of the difference in diameters of the cores and that is going to
account for a significant increase in strength just based on testing a 69 inch
millimetre diameter cores compared to the 99 millimetre diameter cores that
25 were tested under my forensic examination.

JUSTICE COOPER:

Dr Hyland is that something that you tried to adjust for when you redid your
analysis?

30

DR HYLAND:

Yeah I mean I deliberately set out to try to get length and diameter ratios too
as the main criteria of the cores I did because that, my understanding is that
that is the way to get a most consistent result out of your concrete. If I look at

Neville page 564 he says three to four times aggregate diameters is generally accepted as being reasonable.

JUSTICE COOPER:

5 What are you referring to there, sir?

DR HYLAND:

A book by Professor Neville, 'Properties of Concrete', it's sort of the second bible if you like for consulting engineers around concrete. You've got the Park and Paulay and then you've got the Properties of Concrete. I had a look at
10 the Great Britain Concrete Society Technical Report 11, page 15 says that, it notes that no correction was required for core diameters for aggregates 19mm the size of 50 to 150mm diameter so they, as a learned society, did not believe there was significant difference. I had a look at a paper by McGregor
15 and Bartlett, September 1994, ACI materials and it says it couldn't find a strong issue in the size, in the diameter. It said the difference between a three inch and four inch, the three inch maybe 97 percent of the four inch, so 75mm to a 100mm core there may be a three percent difference but it's not a significant amount. The issue, however, I'll just finish, the issue, however,
20 the length of diameter is much more critical in that the recommendations of BS1881 in terms of length to diameter adjustments are different from the ACM C42 recommendations for length to diameter adjustments. Now Mr Jones, I understand, has used the BS1881 adjust which for a length of diameter of one, say if you've got a rather squat specimen you would use a correction
25 factor of 0.85, whereas I think the ASTM is at 0.9 or something like that. There is a difference there. So –

JUSTICE COOPER:

Do you think your approach is in accordance with those various authorities to
30 which you've referred?

DR HYLAND:

Yeah there's certainly a statement I read in the ACI recommendations on core testing that, let's see if I can find it, yes ACI 214.4R-7 Strength Correction

Factors are less accurate as the magnitude of the necessary correction increases because with smaller length of diameter this correct to core strength values do not have the same degree of certainty as strength obtained from specimens having L upon D equals to two.

5

JUSTICE COOPER:

I'm sorry I didn't catch that – as specimens that have been?

DR HYLAND:

10 Let's see, this, core strength values do not have the same degree of certainty as strength obtained from specimens having an L upon D of two. So the ACI was saying that you should be trying to avoid length diameter ratios getting down to one and I noted that in the testing done by Mr Haavik there was 133, three tests that were down below 1.14, there were two, there was one at 1.1
15 at 51, one at 1.61 and there were three that were close to the two, two values, whereas in our testing we had much fewer than that so the reality is you have to take those results but I believe we were taking, well I believe I took the correct approach to the, on the balance to go for the L upon D of two as much as possible.

20

MR GAIMSTER:

Sir, could I make a point?

JUSTICE COOPER:

25 Well I was going to come to you but I was going to give Mr Haavik an opportunity to respond which, I mean, we seem to have identified a real academic difference of approach here so Mr Haavik can you?

MR HAAVIK:

30 Unfortunately I didn't bring any of the technical papers on the studies of coring relative to the diameter of the cores but certain papers I think of, perhaps Dr MacKechnie and Mr Gaimster will back me up on this, have indicated that depending upon the core diameter there may be differences in strength of up, ranging up to about 30 percent, as I recall, and what we were attempting to do

was to at least get a 99mm/100mm diameter core because that is the current US standard of the diameter of core that is tested in fresh concrete operations. We worked very diligently to get the maximum core diameter and the maximum length we could out of the samples that we were able to obtain
5 and did not have any observable cracks in them either visually or under ultrasonic pulse velocity.

JUSTICE COOPER:

All right, Mr Gaimster.

10

MR GAIMSTER:

Thank you, Sir. I just want to go back to the point made by Dr Hyland concerning 70mm diameter cores. Dr Hyland did mention Adam Neville. Adam Neville is a concrete guru as I think Dr Hyland alluded to and he says in
15 his 1995 version of the Properties of Concrete that the effect of cracking on core strengths is greater for smaller diameter cores. Now going back to Dr Hyland also mentioned Concrete Society Technical Report 11 which is what the New Zealand Standard for Concrete Production points to at the moment because it's out of date and Concrete Society Technical Report 11 was
20 based, was replaced by a British Standard, BS6089 and what that says is that if you have 70mm cores, 70mm diameter cores, you need at least six samples per test location because of the variability associated with smaller diameter cores. Now that would mean from the seven columns that Dr Hyland tested he would have needed to get, by my reckoning, 39 samples. We have 19
25 samples. So we haven't got enough samples. So we should have no faith really in the testing results and the regime they're in.

JUSTICE COOPER:

Dr MacKechnie do you wish to add to this debate? Well will you?

30 1700

DR MACKECHNIE:

Yeah I will, I mean we are trying to get an aspect ratio of two, height to diameter, wherever possible, twice the height to the diameter. All of the

coring standards and concrete testing standards recommend 100mm diameter wherever possible. That's why the protocol that was used in the Haavik inspection is what I had also recommended that you go down the centre of the column because with the reinforcing cage as it was not only was it difficult to extract a core without extracting steel but the amount of vibration on the coring machine would be significant as it went through steel or nicked the side of bars and we don't know how much ridging there was on those cores because we have no record of the cores that were extracted on the first round but we do know there's a core barrel still stuck in one of the columns in Burwood landfill which would indicate that coring was, there was a lot of roughness in the coring process itself so if you had to chose which option I'd say the first thing is to get 100 diameter core to reduce variability. The second is try to get it as long as possible without it being cracked and when we say cracked it's not just macro cracks it would be micro cracking as well and to assure that you'd need to have petrography done to make sure that it wasn't damaged beyond which you can't see. It's no good saying it wasn't micro cracked looking at it because you can't see a micro crack. You need to put it under a microscope.

20 **JUSTICE COOPER:**

All right is there anything you wish to say Dr Bradley or is this outside your –

DR BRADLEY:

No it's fine, Sir, I can actually be present for about the first two hours tomorrow morning if that's suitable to the Commission.

JUSTICE COOPER:

Yes well our plan was to be talking about something else tomorrow morning. Well can we move on to the hammer testing, just quickly. There's criticism of the reliability of the hammer testing is that right?

DR MACKECHNIE:

Yeah there appears to be.

JUSTICE COOPER:

Well let's hear what that is Mr Gaimster.

MR GAIMSTER:

5 The Schmidt hammer's quite a useful tool but it's quite a blunt tool. It's normally used for in kind of quality control processes to just check on the approximate strength of a concrete section or concrete member. It's just measuring surface properties of the concrete. It's not measuring anything else and what Mr Hyland's done in this case is developed an erroneous relationship of Schmidt hammer result against core results and we know that some of those core results have been compromised through some of the issues that we've mentioned earlier. And again what the British and European standards say is actually valid to correlate Schmidt hammer with core result because the beauty of that is if you can do it accurately you don't have to take as many cores. So there is an advantage in doing it but you need nine pairs of results to do it with any certainty, and as I said a Schmidt hammer is a pretty blunt tool in any case, so that correlation is just not very reliable and in an investigation of this nature I would have thought there should have been more cores taken and then in establishing that relationship more pairs of results should have been used and at least nine, if not 15 or 18, to establish a valid relationship. So it's a useful tool. It's a bit of a blunt tool. You need lots of results for reliability and, in this case, the relationship that Dr Hyland established just wasn't reliable and, therefore, the remaining, don't know how many, core results or in-situ strengths Dr Hyland inferred from that, I think it was probably 20 odd, they're, in my opinion, they're just not right.

DR MACKECHNIE:

Yeah I've got concerns with the inferred hammer strengths. There were three different concrete mixes that were used on the project because the specification called for 25, 30 and 35 MPa concrete. Some was air entrained, some was non-air entrained. That will immediately affect the correlation that you get between the surface hardness and the expected strength of the column. Results unreliable with the long term exposure. You get carbonation on the surface, you get surface hardening. If you looked at the photos in Dr

Hyland's report you'll notice that the surfaces of the columns varied from being almost perfectly smooth as cast to being quite badly abraded, some even appeared to have fire damage on them when I inspected them at the Burwood landfill. All of those factors will influence the reliability of the results.

5 So it was, as Mr Gaimster said, it was an option to reduce the amount of coring. I don't think that was the right option. I think the scale and importance of this investigation meant that we should have cored as many of columns as we possibly could and not inferred from a secondary far less reliable instrument.

10

JUSTICE COOPER:

Mr Haavik is this an issue on which you can comment?

MR HAAVIK:

15 I can Your Honour. I own a Swiss hammer myself. I have used it on investigations and I would make the decision to not use it on this investigation. I basically endorse and appreciate the comments of Mr Gaimster and Dr MacKechnie and would only point out that I've been trying to figure out how many concrete mixes were used on this particular job because we have a Bill
20 Jones, the superintendent's evidence, that he drew concrete from three different concrete plants with possibly three different mix designs in the same place, potentially from each plant. That's nine concrete mixes and in hearing his evidence on the witness stand last week he noted that there were changes in mix designs to use manufactured aggregates in some cases. So how you
25 can make any sort of reasonable correlation with a Swiss hammer, even if you thought it was a good idea to try and use that technique I think it's just a pile of trouble and I endorse Dr MacKechnie's viewpoint that for this job the maximum amount of coring should have been done at the maximum sample diameter that could be reasonably obtained.

30

JUSTICE COOPER:

All right, Professor Mander.

PROFESSOR MANDER:

Just two small points, Sir. Firstly what I'll be talking about tomorrow covers this a little bit but the first point is a very simple one. The Schmidt hammer does not measure $f'(c)$, the concrete strength. It actually measures, is an indirect of the modulus of elasticity from which you can then back infer the concrete strength and that concept is well known but often forgotten and the point that I would like to make is that this concrete evidently has been damaged and with the damaging, well with the straining of concrete the modulus of elasticity reduces so, therefore, it's likely to give you different results. That will be a lesser indication than what you can get. The other point I will make is that the columns that were tested were 400mm diameter. During my own PhD thesis, and this comes up again tomorrow but during my own PhD thesis we tested a lot of columns of a similar size but they were actually 500mm diameters and in the process of doing that work we cracked a lot of cylinders over the age of the concrete and looked at an age growth curve and every time we cracked cylinders we would also do Schmidt hammer tests on the circular columns and the interesting thing is you cannot get very good results at all on a circular column and I think it's because you should graze them and then you are getting a rebound coming back and it is on a circular cross section and it gives you very random results.

1710

Now you get a lot of scatter with those results but you can never get a satisfactory resolution. If on the other hand you use the Schmidt hammer in a vertical orientation down the axes of the member you will get better results but then it is awkward to use so. And in other parts of my life I have used Schmidt hammers on the rare occasions. I really don't trust them very much but sometimes that is the only tool you have available to get some inference and so it is really only useful for an indicator. I don't think we should ever put much faith in it but the occasions where you will get better results is where the mass of concrete is truly large, so for example if you use it on a bridge, a big bridge pier cap going down the axis of it where it might be say, four feet by four feet in diameter, 30 feet long or thereabouts you will get more reliable results that correlate reasonably well with the specified, just on the guide of the side with the actual cylinder test.

JUSTICE COOPER:

Anything from you Dr Bradley? Dr Hyland?

DR HYLAND:

5 Yeah okay, I think first of all we need to put in context the Schmidt hammer
method was done in accordance with the OS10 standard, C805. There is a
method set down there for correlating your Schmidt hammer results to core
testing which was what was done. The Schmidt hammer testing was done by
technicians from a registered laboratory. The – so it is used as a comparative
10 tool to check.

JUSTICE COOPER:

But did you have sufficient number of these to actually embark upon the
process?

15

DR HYLAND:

Yes, according to the standard it was done correctly. The ACI 228.1R 16
says rebound hammer results would tend to have coefficient variation of 10%.
Whereas similar testing would have coefficient variation of 3% and coring a
20 coefficient variation of 5%. So there is greater variability in your Schmidt
hammer results but the average is not going to be a lot different if you have
done it correctly and what we are looking at in the sampling is what is the
averages that we are getting out of these results. So, it is expected you are
going to have more variability but you'd still expect your sample means to be
25 coming out reasonably close and given that these columns are available for
legacy testing we believe it's a good first step to go on in terms of determining
issues around these concretes and there is, all those columns are still there.
They are all still there and all the rest of them are still in that debris so more
comprehensive testing could be done using more coring but at the time it was
30 felt that we had got as far as we needed to for getting on with the job of
determining the collapse of the CTV building and raise the issue that there
seems to be some problems here. Whether they caused the collapse or not, is
not something I said. We have just said, they possibly could have been a

contributing factor and it is not something that we believe should be swept under the carpet. It needs due attention by the industry we believe.

JUSTICE COOPER:

5 Sorry?

DR HYLAND:

By the industry, we believe there should be some response from the industry to look at this.

10

JUSTICE COOPER:

Right, so can I just confer with my colleague.

COMMISSIONER FENWICK:

15 You have indicated that carbonation could have quite an influence 'cos it changes the character of the concrete of the surface. I assume that with 25 years the carbonation would have gone about 20 millimetres or so into the concrete, but the question I have got is perhaps did anyone test for that?

20 **DR MACKECHNIE:**

Not that I am aware of, there was some petrographic work by Dr Rothstein talking about carbonation but I am not sure that he actually measured it in his cores, and I guess he wouldn't be able to thinking about it because the core was taken down the centre of the column.

25

COMMISSIONER FENWICK:

So it wasn't going in from the surface?

DR MACKECHNIE:

30 No. So I am not sure, but yeah I would imagine at least 10 millimetres depth with that grade of concrete over 25 years so that would have cased and hardened it and all of the Schmidt hammer results if you compare them to what is on the instrument are quite high strengths and so that is where the

correlation is required 'cos you actually have to infer down the strengths based on that.

MR HAAVIK:

- 5 Dr Rothstein did stain carbonation panels and there is one for each of the samples photographed in his petrographic report but because these cores were buried so far into the columns there was no carbonation observed.

COMMISSIONER FENWICK:

- 10 Right thank you.

JUSTICE COOPER:

Dr Bradley, I have been trying to get you to answer a question but can you suggest a question that you would like to answer.

15

DR BRADLEY:

- Not unless you want me to Sir. I guess just to summarise my view is that there seems to be two issues here, one is related to the actual methodology of specimen extraction and one is actually the interpretation. And my focus was in the interpretation and despite the comments of Dr Hyland as to the brief
20 statistical analysis he has done I would argue that that which I have done is significantly more rigorous and the observations from that analysis suggests that there is no disparity between the actual samples taken and the specified design strength.

25

JUSTICE COOPER:

All right, well Dr Hyland do you wish to respond to that or is it covered in what you have already said?

30 **DR HYLAND:**

Well I have got some graphs and things we can put up tomorrow if you wanted which I could explain.

JUSTICE COOPER:

Just from a preliminary discussion I had with my colleagues I think we've probably, with what we have heard today and the evidence and submissions that have been received, we have probably heard all we feel the need to hear
5 on this subject, other than to have Dr Mander available tomorrow to discuss if we have questions, his third statement of evidence and we'd hear from you on that, at the time same time, but is there anything you particular want to say in relation to what Dr Bradley has just said.

10 DR HYLAND:

Yeah I mean I have looked at Dr Bradley's analysis and I believe the first part of it is, it shows that there is a good correlation with the test results between the hammer tests and the cores, that they seem to fit the curve with some variation, extra variation around the hammer results which would be expected.
15 The issue though is that we still have sample means, statistically checked which are less than what would be expected from this concrete in accordance with NZS3101, 3104:1983 and we can't get past that, I can't get past it. So maybe we need to sit down and go through the statistical analysis and work it through but we certainly can't just say well let's take some strong results and
20 do a statistical analysis without that. You need to look at the body of testing that's been done and see what we can infer from that.

MR BRADLEY:

I would simply say that the difference between specified and observed values
25 is relatively small, and given the small number of samples that that comparison's based on, that in a statistically rigorous sense the difference is not significant.

JUSTICE COOPER:

30 Well, unless anybody else has anything they particularly wish to bring to our attention or discuss in this forum our intention would be simply to adjourn until tomorrow at 9.30 but not for a continuation of the panel. That would be to hear from Professor Mander and anything that Dr Hyland might wish to say about Dr Mander's third statement of evidence.

1720

MR HAAVIK:

I'd like to just add one thing. Regarding these taking these cores and the
5 L over D ratios, there are a number of different standards that have been cited
today and basically what they all mostly end up saying is, take the largest core
diameter you can possibly, try and get a two over one aspect ratio but you can
legitimately test as low as a one to one, and do the best you can. And in this
10 particular case, given the materials available to work with, the forensic
investigations for concrete have been presented with an exceedingly difficult
task to get an adequate number of samples and a large enough population to
even identify what concrete mix designs are supposed to be represented by
these particular samples. It's a difficult problem and that's why our effort was
oriented towards trying to determine concrete strengths that were in place
15 before the Darfield earthquake.

QUESTIONS FROM MR PALMER - NIL

MR ALLAN:

Sir there is one matter I thought would have some validity in being raised in
20 this forum and that relates to the orientation of the cylindrical aggregate which
Mr Haavik has pointed out, and the potential that that orientation might have
for weakening concrete and in response to that issue Dr Hyland has made the
point that it should offer little comfort in structural members that might be
subject to shear forces as well as axial loads. And I'm not sure, and also
25 given the uniqueness of this feature of the concrete, I'm not sure that this
forum has closely perceived that.

JUSTICE COOPER:

We have discussed that. Dr Hyland did make that point. Now Mr Haavik, you
30 understand what's being said?

MR HAAVIK:

Yes.

JUSTICE COOPER:

What's your comment on that?

5 MR HAAVIK:

Well I only, I'm a materials engineer not a structural engineer so what I have done is produced concrete test results and left it to the structural engineers to determine how to best use them for their studies.

10 JUSTICE COOPER:

Yes, that might bring us back to you Professor Mander does it? If you care to comment?

PROFESSOR MANDER:

15 Yes I will surely comment. I don't believe that the shear mechanisms that the accepted mechanisms of shear and concrete rely a whole lot on classical transverse shear. That is a construct that may exist in our mind only and in the textbooks but not in reality. If you use the classical one, I'll spell out a formula here like QAI over IB type of formula doesn't work for, too well for
20 concrete, particularly after it's cracked. So concrete when it's cracked, the idea that's becoming more and more prevalent now is that one should really use some sort of truss type model where you have diagonal struts that take the concrete stresses and compression, and the concrete will crack in such a fashion that it will relax using sort of entropy principles into such an orientation
25 that it will more or less be on a fairly longitudinal direction. Now, what it means for the CTV building is that if you were to get cracking, because of the low level of transverse reinforcement, if you were to get a lot of shear cracking then those crack angles would be fairly flat to the longitudinal axis of the member, and so that the struts themselves would be fairly flat. And so this
30 orientation problem which has been identified by Mr Haavik may not be as, may not be so worrisome as one might first think in terms of just looking at shear in terms of what you would make in a cut in a section when you're doing a textbook type of analysis. So I think that's kind of my view. I really feel though that the orientation of the aggregate has had a significant bearing on

the concrete strength. That could well be one of the problems here there we're identifying.

MR GAIMSTER:

5 Sorry Sir, can I just ask one question of Mr Haavik?

JUSTICE COOPER:

Yes.

10 **MR GAIMSTER:**

How many of your samples did this phenomenon appear in?

MR HAAVIK:

I really didn't count them that way Mr Gaimster. This has been merely an
15 observation and it seemed like it was pretty regular through the samples. But
Dr Rothstein's photographs aren't as good as I would like them to be of the as
received samples.

JUSTICE COOPER:

20 Dr MacKechnie is this something you can shed light on?

DR MACKECHNIE:

I'd just like to say that it's, the mechanism that would make a oblong
aggregate particle and the Christchurch's aggregates aren't particularly
25 oblong anyway. I mean if you want poorly shaped aggregates we can get a
lot worse. But the mechanism that would line them all up in the direction that
you observed in that core is generally a flow dynamics of pumping or dropping
it into the columns, so that they are flowing in one direction and that tends to
cause a little bit of orientation. Now that's not going to occur everywhere in
30 the column. It might occur preferentially in the centre of the column and not
on the edges where you break up the flow as it drops into the shutter. So I'm
not sure that that prevalence is right through the structure, and certainly what
Dr Mander's going to be talking about tomorrow, the full scale column tests,
when we observed the failure of those there was no indication or no

observable orientation like that. It was random as you'd expect with aggregates in all directions and no particular alignment. So I'm not sure really about that.

5 **MR HAAVIK:**

I would like to go ahead and endorse Dr MacKechnie's discussion there and point out that I have visited Dr Mander's column samples out at the university a few days ago and noted the same sort of thing that Dr MacKechnie noted.

10 **JUSTICE COOPER:**

Do you want to respond to that Dr Hyland?

DR HYLAND:

No.

15 **HEARING ADJOURNS: 5.28 PM**

INDEX

DAVID HARDING (RE-SWORN)	1
CROSS-EXAMINATION: MR ALLAN – NIL	14
RE-EXAMINATION: MR KIRKLAND – NIL	14
QUESTIONS FROM COMMISSIONER FENWICK:.....	15
QUESTIONS FROM COMMISSIONER CARTER AND JUSTICE COOPER – NIL.....	18
ALAN MICHAEL REAY (SWORN)	19
EXHIBITS PRODUCED – HANDWRITING SAMPLES.....	22
CROSS-EXAMINATION: MESSRS ALLAN AND REID- NIL	22
CROSS-EXAMINATION: MR KIRKLAND	22
CROSS-EXAMINATION: MR MILLS – NIL	31
CROSS-EXAMINATION: MR ELLIOTT	31
RE-EXAMINATION: MR PALMER – NIL	54
QUESTIONS FROM COMMISSIONER FENWICK- NIL.....	54
QUESTIONS FROM COMMISSIONER CARTER:	54
QUESTIONS FROM JUSTICE COOPER:	55
QUESTIONS ARISING: MR REID – NIL.....	59
QUESTIONS ARISING: MS DAINES – NIL	59
QUESTIONS ARISING: MR KIRKLAND.....	59
QUESTIONS ARISING: MESSRS ELLIOTT AND PALMER – NIL.....	59
QUESTIONS ARISING: MR MILLS	59
CROSS-EXAMINATION: MS DAINES, MR KIRKLAND, MR ELLIOTT – NIL.....	61
RE-EXAMINATION: MR PALMER.....	62
QUESTIONS FROM COMMISSIONERS FENWICK AND CARTER – NIL	62
QUESTIONS FROM JUSTICE COOPER – NIL.....	62
ALUN TREVOR WILKIE (AFFIRMS)	63
CROSS-EXAMINATION: MS DAINES, MR PALMER – NIL	68
CROSS-EXAMINATION: MR ZARIFEH.....	69
CROSS-EXAMINATION: MESSRS ELLIOTT, KIRKLAND AND RAYMOND – NIL.....	78
QUESTIONS FROM COMMISSIONER FENWICK – NIL	78
QUESTIONS FROM COMMISSIONER CARTER:	79
QUESTIONS FROM JUSTICE COOPER - NIL	81
ALEXANDER SHANE FAIRMAID (SWORN)	82
CROSS-EXAMINATION: MR REID – NIL.....	89
CROSS-EXAMINATION: MR KIRKLAND	89
CROSS-EXAMINATION: MR ZARIFEH.....	92
CROSS-EXAMINATION: MR ELLIOTT – NIL	103
RE-EXAMINATION: MR PALMER.....	103
QUESTIONS FROM COMMISSIONER FENWICK:.....	103
QUESTIONS FROM COMMISSIONER CARTER:	106
QUESTIONS ARISING - NIL.....	113
DOUGLAS HAAVIK (SWORN)	115
CROSS-EXAMINATION: MESSRS ALLAN, ZARIFEH, ELLIOTT – NIL.....	120
QUESTIONS FROM COMMISSIONERS FENWICK & CARTER – NIL.....	121
QUESTIONS FROM JUSTICE COOPER – NIL.....	121
JAMES MACKECHNIE (AFFIRMED)	123
ROBERT GAIMSTER (AFFIRMED)	123

JOHN MANDER (AFFIRMED)	123
CLARK HYLAND (AFFIRMED).....	123
BRENDON BRADLEY (AFFIRMED).....	123
QUESTIONS FROM MR PALMER - NIL	151