

HEARING RESUMES ON TUESDAY 31 JULY 2012 AT 9.30 AM**DAVID HARDING (RE-SWORN)****5 CROSS-EXAMINATION CONTINUES: MR RENNIE**

Q. Mr Harding do you have your briefs of evidence available to you?

A. Yes sir.

Q. If you turn to the supplementary brief and paragraph 8.

WITNESS REFERRED TO SUPPLEMENTARY BRIEF OF EVIDENCE

10 Q. There you appear to say that Dr Reay instructed you not to discuss Dr Reay's calculations with Mr Henry. Do you see that?

A. Yes.

Q. Is that what you meant to say?

A. Yes.

15 Q. And where do you say Dr Reay's calculations came from as opposed to your own?

A. Oh, no, I didn't, I did, I had no calculations from Dr Reay. I think what I meant to say was that he didn't want me to discuss my concerns with, with John. I don't, I didn't see any calculations from Dr Reay for this building.

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Q. No indeed, and indeed there's no suggestion there were any is there?

A. I am saying I haven't seen any.

Q. No. And you've just put it on the basis of not discussing your concerns with Mr Henry. So are you saying you took a concern to Dr Reay and Dr Reay said don't discuss it with Mr Henry?

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A. No it was part of the brief when he was giving me the job. That was really he was giving me the calculations for the Landsborough House and –

Q. That's the template that we discussed yesterday?

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A. That's the template.

Q. Yes.

A. And the instruction was, "If you have any queries about this talk to me about it rather than John."

Q. So in fact the proposition was that discussing the template with Mr Henry was not something which Dr Reay recommended?

5 A. Well it wasn't recommended, he told me not to.

Q. But there was no prohibition in relation to your discussing the job itself with Mr Henry was there?

A. I took there to be a prohibition on not discussing anything with John Henry.

10 Q. Well Dr Reay disagrees as he has said and will say in evidence. Does that indicate a misunderstanding between you or a mistake on your part?

A. Well I'm going from my memory. I can't tell you which it was.

Q. Now I'm going to go to a couple of the details of the CTV building.

15 Firstly may we have please BUI.MAD249.0284.15?

WITNESS REFERRED TO SLIDE – PLAN

Q. It would be helpful if we could enlarge the top left-hand corner of that plan please. The first two segments of column cross-section. And you've no doubt looked at this before today have you Mr Harding?

20 A. Yes.

Q. And you will see in the right-hand segment a drawing of a beam column joint, that's correct?

A. I can't quite tell from that where section 2 is taken but...

Q. Would you like the larger plan back so you can see that?

25 A. Yes please. I still can't quite find section2.

Q. Well I don't think it's important which level you find it on. Do you accept that it shows a detail of a beam column joint?

A. Well, no I can't tell where that section's taken from that. There doesn't appear to be a section 2 anywhere on those elevations so I, I can't tell
30 you where it is.

JUSTICE COOPER:

Mr Rennie, I hope this doesn't upset some forensic purpose that you might have but my colleague, Commissioner Fenwick, tells me it's not a drawing of a beam column joint.

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MR RENNIE:

Well it may well upset a forensic purpose Sir, but perhaps you are –

JUSTICE COOPER:

10 Well advisedly or?

COMMISSIONER FENWICK:

It's a joint between column C18 I think and the wall DE at the top. So you can't really describe that as a beam.

15

MR RENNIE:

I understand your point Sir, and I apologise for the misinterpretation which of course is my responsibility.

CROSS-EXAMINATION CONTINUES: MR RENNIE

20 Q. This shows, this drawing in any event shows spirals at 250 pitch, do you see that?

A. It's disappeared.

Q. You'll need it back again, I'm sorry.

A. Yes that does show that.

25 Q. And I take it that is a pitch that you will have selected for this particular detail?

A. Yes that was what was in the calculations. As I've said, the calculations, we calculated what it would be for ductility and what it was without ductility and it was chosen to do it without ductility.

30 Q. And 250 millimetres was the spiral separation through the whole of the column?

A. It appears so, yes.

Q. Although in fact NZS3101 required the joints to have a separation not greater than 200 millimetres. Do you accept that?

A. Not without referring to the code but I –

Q. Can we have ENG.STA0016.70?

5 **WITNESS REFERRED TO SLIDE**

Q. And the relevant paragraph is 9.4.8 in the left-hand column three quarters of the way down?

A. You're talking about inner joints?

Q. Correct?

10 A. Yeah well I think the point is that that's talking about a ductile frame. We don't have a ductile frame here.

Q. Would you accept that the performance of the beam column joints which you designed was dependent on the spiral reinforcing being carried through the joint?

15 A. No. As I said before it's a pin, the column joint is a pin joint so there's no need for any joint reinforcement. There's no bending moment being taken through the joint so there's no requirement for shear to take the bending moment.

20 Q. Are you aware of a point in your calculations where you actually make the calculations on the pin basis?

A. Well as I said before, that's a standard detail which has been used many times in the office, to have precast beam base and the in situ column, and the whole reason for doing it that way is for simplicity of construction. If it wasn't being done that way you wouldn't be able to use precast beams so it was an essential part of the way of building the building using precast beams.

25 Q. So are you saying that you did not design the joint on the basis of a spiral reinforcing carried through it. You adopted what you considered to be a standard approach without calculations?

30 A. No, calculations were done, but what I'm saying is that it wasn't a part of a ductile frame, and if you have a continuous beam running through the joint the reinforcing you require is the beam reinforcement and that can

stop adjacent to the face of the joint. There's no need for beam column joint if you don't have a bending moment through the joint.

Q. But my question to you was whether you could show where in your calculations that calculation was done for a pin column?

5 A. Well I'm telling you that at the beginning when we had the brief for the job, the brief was that all of the lateral loads for the earthquake were taken by the walls, that the columns and beams were gravity elements only. As such the columns were designed as if they were pin ended columns and the beams were continuous to the joint. The, no bending
10 moment, no seismic moment was taken between the column and the beam.

Q. You've indicated that on a number of occasions you went to the construction site while the building was being constructed?

A. Yes.

15 Q. Was a part of that visit the inspection of the beam column joints at each level?

A. Yes.

0940

20 Q. Were you checking for the presence of spiral reinforcing in the beam column joints at that time?

A. No, because there's none shown on the drawing and none was intended to be put in.

Q. And so the absence of spiral reinforcing from the joint would not have concerned you?

25 A. No.

Q. Now you're aware that the Holmes Consulting Group reviewed this building in 1991.

WITNESS REFERRED TO BUI.MAD249.005.7

30 Q. And you've had the opportunity before today to read this report haven't you Mr Harding?

A. Yes.

Q. Now, to be clear, the report itself is dated January 1990. It appears that the drag bars were, in fact, installed in 1991. Speaking first of the 1990 period, were you contacted in relation to the preparation of this report?

A. No.

5 Q. In fact I think your evidence was that you've only seen it very recently.

A. Yes.

Q. Now the other contact that you've referred to in relation to these events was a call from Dr Reay, which we talked about yesterday, as to whether you had put additional ties or ties into the connection between the slab and the shear wall. Do you recall that?

10

A. Yes.

Q. Did you understand from that call that an issue had come up as to whether the slab was adequately secured to the shear wall?

A. The question was did we install drag bars, and I said no. There was no other discussion about what connection there was between the wall and the shear wall.

15

Q. Was it explained to you by Dr Reay that there was a report from the Holmes Consulting Group putting this in issue?

A. He said that they were reviewing it and they had asked the question. I wasn't aware that a report had been written at that time.

20

Q. And by they you're referring to Holmes Consulting reviewing the building.

A. I don't recall who was doing the review. I don't know that I was, I think you're right, I think Grant Wilkinson's name was mentioned at the time.

25

Q. Yes. It would be a matter of concern to you that there was some suggestion that you may have missed a detail or a structural requirement at that point.

A. Yes.

Q. Other than the phone call do you recall doing anything about it?

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A. No, I didn't do anything else about it other than the phone call.

Q. Independently of your knowledge the construction firm would have knowledge. Did you consider that?

A. The constructional firm would have knowledge?

Q. Would have knowledge of how the structure in that part was constructed.

A. Sorry I'm not sure what you're asking me here.

5 Q. I asked you whether you considered what knowledge the construction firm might have had?

A. Well I assume that they would have contacted either the foreman or the site construction manager to ask him a question but I'm not aware of whether Alan had that discussion or whether Holmes had that discussion.

10 Q. You were still working in association with that construction firm yourself at that time?

A. I was working, Gerald Shirtcliff and Tony Scott had formed a separate company at that time called Shirtcliff and Scott. Whether they were still operating in 1990, I guess they were, so I was aware that those guys were still around, yes.

15

Q. I think your indication was you were still designing for them at that stage.

A. I was working for them, yes.

Q. So would have been feasible to see what their records showed.

20 A. Well it wasn't my position to do that. If anyone was going to ask them what they did I was assuming that either Alan or Grant Wilkinson would have done that.

Q. Now if we turn to the document at what is point 9 in terms of the document references. You will see that this states that the building was completed during 1987 and is currently untenanted. Do you see that?

25

A. Yes.

Q. So were you aware that the building had not yet been occupied by 1990?

A. No I had no knowledge of what the building was doing or who was in it.

30 Q. If we now turn over to point 11 and do you see four conclusions set out there. Now the first is simply an opinion about the building as it was in 1990. Second conclusion stated by Holmes Consulting was "the layout and design of the building is quite simple and straightforward and

generally complies with current design loading and materials codes.” Do you see that?

A. Yes.

5 Q. Does that correspond with the view that you had of the building or do you differ in some way?

A. No I'd agree with that.

10 Q. Now the next conclusion is “That a vital area of non-compliance with current design codes seen in the documents is in the tying of the floors to some of the shear walls” and then it goes on to talk about this being under review, you see that?

A. Yes.

Q. And that's what Dr Reay raised with you?

15 A. Yes, well he asked me whether, I think the question that he wanted answered was whether there was any additional, Grant was working from the documents and I think the question was “Is there anything additional to what's on the documents in the building”.

Q. Now in this building you've indicated that you designed it on the basis of a gravity structure with shear walls. That's correct?

A. Yeah a shear wall stabilised gravity frame I think is how it's described.

20 Q. Yes and a design on that basis is importantly dependent upon the connection of the slabs to the shear walls, isn't it?

A. Yes it is.

Q. And that's an issue which arises as a straightforward matter of design of no real complexity in itself, you would agree?

25 A. Yes.

Q. Not a matter which requires ETABS modelling or any other special investigation is it?

A. No it is not.

30 Q. And there can be no suggestion that there were any standard details that were simply applied to achieve the ties in this building to the shear walls, can there?

A. Well actually there were. I mean the connection between the wall and the shear wall is by virtue of the precast concrete beams sitting on the

ends of the two main shear walls and the bottom reinforcing of the beam passing through the vertical bars in the end of the shear wall and the top bars in the beam running continuously through between the top bars and the shear wall.

5 Q. And at the time you were satisfied you'd adequately designed and specified that?

A. Well that was how it had been done on the Landsborough House building and, at that stage, I believed it was adequate although, with further reflection, I accepted it could be improved.

10 Q. When you say that was how it was done on the Landsborough House building are you referring to the way in which the slabs in Landsborough House were tied to the shear walls in that building?

A. How the precast beams are connected to the shear wall.

Q. So did you go beyond –

15 A. And the slabs, I apologise, you're right, and the slabs.

Q. So did you go beyond using those calculations as a template to actually use them as the document for your reference for CTV?

A. No, no, I think somebody made that comment that I had adopted the calculations from the Landsborough House for this job but I hadn't
20 adopted any calculations from Landsborough House. It was merely a template.

Q. And you did your own calculations for this tie of the slabs to the shear wall?

A. Yes.

25 Q. That was not a matter that you needed to discuss with anybody was it because it was basic engineering?

A. Pretty much yes.

Q. Now if you go over to point 12 which is the summary of investigation, you have a look at the second paragraph, perhaps I should say in
30 fairness to you, in the first paragraph there's reference to review of the architectural drawings and some structural drawings from the architect, do you see that, and Mr Wilkie's evidence has been that he lost his records in the earthquake. So then they go on to say in paragraph 2

they were able to view the full design documentation, soils investigation and complete set of drawings, you see that?

A. Yes.

5 Q. And then it is said that the original design engineer was unavailable for comment. That would be a reference to you?

A. I assume so. I don't know why they're saying I was unavailable. Grant could have rung me but he hasn't done that.

Q. Well you say hasn't but I think you probably mean hadn't at that point.

A. He hadn't, yes, still hasn't, no-one's....

10 0950

Q. No one's discussed it with you?

A. Well no one from Holmes.

Q. Mr Banks was available for comment, that's what they're next saying?

A. It appears so yes.

15 Q. Do you recall whether Mr Banks discussed the position with you in 1990?

A. No, I had no discussion at all with Geoff Banks.

Q. Then there's reference to discussion with, or speaking to is probably a better way to put it, Mr Bluck of the Christchurch City Council, you see that?

20

A. Yeah.

Q. And then there's reference to an inspection, except at two levels were not accessible, you see that?

A. Yes.

25 Q. So that's the basis upon which Holmes reached their conclusions and also settled their description which you'll find on page 13. Go to 14 now please, this is the structural design aspects. 6.1, if we can enlarge 6.1. They state that from looking at the drawings and investigating the building it appears the gravity structure is sound and complies in all
30 respects with the appropriate design loading and materials code. Do you see that?

A. Yes.

Q. Is that consistent with the view that you held of the matter when you worked on this in 86 through 87?

A. Yes.

5 Q. And they then discuss the live load on the floor but that's not an issue here, and then we go to, or not an issue in relation to their investigation is what I mean, and then we go to lateral load resistance and you will have read this before?

A. I have.

10 Q. Now it's apparent from that that Holmes on what was a relatively short form review of this building, quite quickly identified the issue of connecting the floor diaphragm to the shear wall, you see that?

A. Yeah.

Q. They firstly considered that it was not a concern in relation to the coupled shear walls to the south of the building, see that?

15 A. I do.

Q. Now that was similarly a connection that you'd designed after recommending the inclusion of the south shear wall. That's correct?

20 A. Yeah, that's the reason we ran the gravity beams in the east-west direction so that the top reinforcement in those gravity beams would go right through that south shear wall.

Q. They describe the connections in the north face of the building as tenuous due to penetrations for services, lift shafts and the stairs as detailed in the drawing. Do you see that?

A. Yes.

25 Q. Can you account for them perceiving that in this relatively short form review but you're not perceiving that when you were designing it?

30 A. Well as I said when Grant was talking to Alan, when Alan rang me he said that they had looked at it because they had identified that defect in a number of their own buildings that Holmes had done and that I think they'd become aware that there's nothing specific in the code as you're working your way through it that the first, the drag bars, I still haven't seen anything particular in the code saying, using the terminology drag bars and that for that reason they had left it out of a few of their

buildings and they become aware of it as an issue so therefore whenever they were reviewing a building it was one of the first things they would look for.

5 Q. On your site inspections do you recall inspecting the construction of the slab to north shear wall connections?

A. I don't recall it this particularly.

Q. Would you accept that that was a critical element in the design of a construction?

10 A. I don't think any one element of it I could call more critical than another. I view pretty much everything on there as critical. I take equal interest in everything.

Q. On each occasion that you went to the site what's your estimate of the length of time you would have spent there?

15 A. Typically about half an hour per visit depending on how much concrete's being poured at the time. If it's a floor slab then probably longer, maybe an hour. If it's really only columns or a one lift of walls, perhaps half an hour.

Q. The point of your visit at a time of a concrete pour being to enable you to inspect the reinforcing structure before it is covered by concrete?

20 A. That's correct, yes –

Q. Now – keep going.

25 A. – and the form work to make sure that's adequate and in a lot of cases to make sure that the props are in place if you're doing a floor, that the props are sufficiently carried down to something that can support the weight.

Q. Now at the same time you would also have presented to you the test certificate for the concrete being poured. That's correct?

30 A. Not at that time. I mean the concrete hadn't been provided at that time so there was no certificate. All that you would have would be the docketts that had been left behind by the concrete supplier for the previous or some previous pours and they were usually kept in a folder in the foreman's office.

Q. And you would inspect those to see that the concrete which had been supplied met the specification you'd provided?

A. Yes.

Q. Do you ever remember any issue about concrete on this project?

5 A. No.

Q. Do you have any recollection of where the concrete came from?

A. No.

Q. There would have been several concrete suppliers in Christchurch at that time?

10 A. Yes.

Q. To your knowledge did they all hold appropriate certification?

A. Yes.

Q. Were you aware of any more general concern as to the quality of concrete supplied to building projects in Christchurch at that time?

15 A. No, I guess they were all very busy. I can't think of a particular concern regarding the supply at that time, it's a long time ago, but –

Q. Sure. But from that point of view it was one more matter to manage, not something you were on an alert about?

A. That's correct, yeah.

20 Q. And in relation to the construction company, how did you regard their ability to place concrete?

A. Well I had no experience with them before so I was learning as I went as to their abilities and I had no reason to doubt that they were competent to do the job.

25 Q. And in relation to the successor firm which as you've said two of them incorporated to carry on from the Williams company, you worked with them for a period of time?

A. Yes.

Q. And did you ever have concern about their placement of concrete?

30 A. No.

Q. Now yesterday we were discussing your aspirations when you joined Dr Reay's firm, you recall that?

A. Yes, yes.

Q. And I discussed with you reaching the status of associate and you responded that that wasn't the same as being made a director. You recall that?

A. Yes.

5 Q. Now in fact at the time there was no company that you could be made a director of was there?

A. I don't recall what the set up of the company was at that time.

Q. The documentation that you routinely signed out was in the name of Alan Reay Consulting engineer. Do you recall that?

10 A. No I don't recall what was the name at that time.

Q. And the evidence which has been given to the Commission is that Dr Reay practised on his own account in that style until 1988 when a company was incorporated. Are you saying you were not aware of that?

15 A. I'm saying I don't recall what the incorporation was at the time I was working there.

Q. Do you accept that if there wasn't a company before 1988 you couldn't have become a director before 1988?

A. There was never any suggestion that I would become a director or a partner.

20 Q. But that was an aspiration you had.

A. Not necessarily. My aspiration at that time was to gain experience in multi-storey buildings and to get back into being a consulting engineer after having worked in the public service for a while and not doing structural design for a long time.

25 Q. Now one of the first buildings which you worked on was the medical building, you recall that?

A. That's the one I worked on while I was working out my notice at Waimairi.

Q. Yes. And the architect for that was a Mr Dally.

30 A. Maybe, I don't recall.

Q. Do you not recall meetings with Mr Dally in relation to that project?

A. I wouldn't – I don't, no, no.

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Q. It's clear from the evidence I put to you yesterday that Williams Construction, particularly its manager, Mr Scott, believed that they had dealings only with you in relation to that project after the first meeting with Dr Reay. You recall that?

5 A. I remember seeing Tony's evidence, yes.

Q. And, similarly, that went on to be the case with such projects as the Shangri-La project didn't it?

10 A. Yeah well as I've said to you I think Tony's mistaken as regards the CTV because I, I haven't visited Williams' office, I, I haven't had meetings with him at the preliminary time. Certainly once we got past the CTV building and I had met Tony and Gerald, then I was involved with Tony and he would ring me when he had a design build project and he was wanting to get some feeling for what the structural cost would be. He would ring me directly to ask me and I would give him information from
15 which he could do preliminary costings.

Q. And you've accepted in relation to the CTV building that you must have met with Mr Tapper although you don't recall that?

20 A. No I don't accept I would have met with Mr Tapper. I don't, I don't recall any meetings with Mr Tapper. The only meeting it appears that I had was after the building was completed and there was that question from Bryan Bluck regarding whether the exposed steel on the floor slab needed to be fire rated. I think from memory it was something to do with whether Mr Bluck thought that it should have had Kafko or something sprayed upon it and I reviewed the file to find that it didn't need that and
25 I appear to have met with Mr Tapper at that time but that was, that was following construction of the building.

Q. So in fact the interfaces that you aspired to with architects, client and counsel were actually taking place weren't they?

30 A. No they weren't, not at the time of the CTV. It wasn't until when I was doing the, the Shangri-La and I'd been there a while that I had any contact with, yes, with, with Tony particularly. I certainly did have meetings with, with clients. As I said if it was a, if it was a residential building or something small I'd talk to the draftsmen and they'd just want

a steel beam or what have you that – certainly I'm not, not saying I didn't have that kind of contact .

Q. You're not suggesting that anybody other than you managed these relationships during the design and build stages of these buildings are you?

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A. Which buildings are we talking about?

Q. The buildings through 1985/86.

A. I'm saying that with a lot of the big buildings in that time I had no initial contact with the client or the builder and that includes the CTV building.

10 Q. Initial contact but I'm talking about the design and construction phase.

A. Well there was no reason to have any contact with the builder during the, during the design phase but I did have contact with him during the construction phase.

15 Q. There'd be every reason to have contact in the CTV building because the client was the construction company.

A. So I understand but I didn't have that contact at that time.

Q. So are you saying that you designed that building in isolation from the construction company?

A. Yes.

20 **CROSS-EXAMINATION: MR REID**

Q. Mr Harding I'm counsel for the Christchurch City Council. I just have a few questions for you. Most of the areas that have been covered by my learned friend are matters that I was going to deal with so I have a limited number of questions and you're coming back next week to deal with compliance so there'll be more questions then. So, firstly, just in relation to your role at Waimairi where you were employed for some time, you were the head of a division there, is that correct?

25

A. Yes.

Q. Yes and that was mainly in relation to civil engineering works, bridges and so on. Is that right?

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A. Yes.

Q. But was there a review component as well in relation to that work?

- A. A review component in –
- Q. Yes.
- A. In regard to what, buildings?
- Q. Yes.
- 5 A. No.
- Q. Yes were you involved though in annual checks of buildings?
- A. No.
- Q. So in the work you were doing there did that require you to have an understanding of the codes at the time, the various codes that you were
- 10 dealing with?
- A. Building, buildings codes?
- Q. Yes.
- A. No.
- Q. What codes were you required to have an understanding of?
- 15 A. Well it was, it was National Roads Board standards for buildings and, sorry for roads, pavement construction, as I perhaps mentioned yesterday with regard to subdivision at the time that filling was going on, on land prior to being subdivided which was setting traps for, for the engineer to build buildings on it and I was concerned that the Council
- 20 wasn't complying with the codes for compaction and filling for residential subdivisions so I was familiar with that particular code.
- Q. Right and during your time there were you, were you a registered engineer?
- A. Yes.
- 25 Q. Yes and your, that would have entailed you having, there were training requirements that went with that. Is that correct?
- A. Absolutely, yeah, what are they called, continuing professional development, yes.
- Q. And did they in part relate to the content of the codes?
- 30 A. They related to, to National Roads Board standards. In no way to buildings codes. It was, as I probably mentioned I went along to a few pavement seminars which would talk about pavement management and

deflection measurement, overlay design, such things as that which I was involved in doing, you know, pavement correction, stabilisation of roads.

5 Q. Yes. So as I understand the questions that you, the answers that you gave to my learned friend your, the main lack of experience that you had when you addressed, when you first went to Alan Reay was in relation to computer modelling and multi-storey buildings. Is that right?

10 A. Multi-storey buildings and dynamic computer modelling as opposed to static modelling of a structure. I mean there were certainly building, at that time there were very early programmes becoming available for, for static design of buildings and I, I wouldn't, I wasn't familiar with that but I was aware that they existed. I hadn't used them.

Q. No but you were experienced though in carrying out hand calculations of, for example, deflections. Is that correct?

A. Certainly.

15 Q. So you felt quite confident about the application of the code, codes in relation to deflection issues as they pertained to design issues?

20 A. As they, as they pertained to gravity loading and, and normal design of single storey and two-storey structures, yes, so far as they can be calculated by – I think the program that was, that was available at that time was called Frame 80. A very, very basic program. One of the first programs by which you could actually calculate deflections. Up till then a lot of the times you didn't calculate deflections because it was, took about five times longer to calculate the deflection than it did to calculate the actual loading. So you tended not to calculate deflections. You would, you would rather adopt the standard span upon depth ratios and if you stayed within those standard ratios you assumed that deflections were okay.

25 Q. So you described the CTV building as a shear wall stabilised structure with a gravity frame. Is that correct?

30 A. Yeah I think John Henry invented that, that description which I feel is quite appropriate.

Q. Yes but you were well, you were well versed in those kinds of buildings?

A. No not at all.

Q. You, you had an understanding though of that general approach?

A. I could understand the concept for certain.

Q. Yes and was that an approach that was generally used within the engineering profession at the time?

5 A. I couldn't tell you. Until I joined Alan's office I had no concept of what was generally used. It was all, all new to me.

Q. Well when you came to design the CTV building, and your approach to it was this shear wall stabilised gravity frame, so in coming to your determination that that was an appropriate way to proceed, the ETABS analysis was critical wasn't it?

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A. Yes.

Q. Yes. And you had little experience with that I think you've said. You relied on the university's computer analysis, is that correct?

15 A. Well until I joined his firm I, I had no experience with ETABS at all, so obviously such experience as I had was gained from, from Alan's office.

Q. Yes, did you provide the ETABS analysis to the Council?

A. I can't tell you that. I don't know what was provided to the Council.

Q. Do you agree with me though that from the perspective of the Council it would've been virtually impossible for a reviewing engineer to second guess the contents of that analysis?

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A. I don't know what you mean by "second guess". I mean it comes back to what extent of checking a local authority would do. As I've mentioned, at the time when I was working at Waimairi the head of the buildings department, if you like, was a building inspector, Ted Hughes, and he had two graduate engineers. It was traditional at that stage that graduate engineers would do the job because it was seen as a not particularly rewarding and the sort of job that some unfortunate graduate was prepared to do that other people wouldn't want to do.

25

30 Q. Well neither Waimairi nor Christchurch City Council had computers in their office at the time did they?

A. I can't tell you that. Waimairi did have a computer but it wasn't, I don't know what it was used for. I think that whether the structural checking engineers used it or not I have no idea.

5 Q. It wasn't customary, was it, for a checking engineer to redo an ETABS analysis?

A. Oh, absolutely not. I would very much doubt it. I don't think even today you would find a structural checking engineer redoing an analysis but I may be, obviously if you're doing a peer review today you would probably redo it, but I wouldn't expect that a Council checking engineer
10 would redo it.

Q. No, and so to the extent that the ETABS analysis included inputs and methodology that was determined by the design engineer. That would have been impenetrable, I suggest, to the Council reviewing engineer?

A. No I don't think impenetrable. I think one of the skills that you get as
15 being a checking engineer is to just flick through the drawings and from a first view you can tell a lot as to whether the building, whether all the information is there and get a feeling for how it's being done, and if there are any, if you've seen a number of buildings of the same type you know what to look for. If you've already done a building of a similar type in the
20 past and you have had an argument about a particular element, or you know, you've found a defect or something missing on that drawing or that kind of building when you've done it in the past, that's obviously the first thing you'll go to when you're doing your checking. So it's more a case of looking for obvious mistakes and then checking through the
25 calculations to make sure that the system that is there is logical and sensible.

Q. Yes, and in this case the way that you approached the columns, the beams and the beam column joints was to detail them as gravity elements wasn't it?

30 A. Yes.

Q. And so whether that was permissible or not wasn't able to be determined by simply looking at the plans themselves, do you agree with that?

- A. No I think that it certainly would be possible to tell and I think that there'd been a number of, as I've said it's a fairly standard detail and that had been used on a lot of buildings that Alan Reay had done. I believe probably even that Broadway building, just ordinary two storey buildings.
- 5 Those were the kinds of building where that kind of detail was developed so it would've been used a lot of times and I think Graeme Tapper or any checking engineer would be able to look at a detail and pretty much see straight away whether it was a ductile frame building or whether it was a shear wall building. I don't see that as
- 10 being particularly difficult.
- Q. Yes, but your view was that it complied and it remains that it complied isn't it?
- A. Well as I again said, you know, if you have the same building and you put it to three different councils and have three different reviewing
- 15 engineers, you'll get three different lists of perceived problems or questions and if you have the same, I mean anyone who's designed a standard house will tell you that. They'll put the same house to three different councils in three different areas, they'll get three different lists of queries. Well if you go through the list of queries you get from the
- 20 first guy and answer them all and get it approved you believe at that time that it complies. If you submit that same plan to another council in another area there will be other things on their list which they are looking at because they happen to be looking at different things, or they're more familiar with a certain code than somebody else. So you go through the same process. You, if you've had a standard drawing
- 25 you will modify it so that it includes the requirements made from the previous checker, and if the next guy comes along with another list of things you modify it as required to suit him. So each time, once you've been through that process, you and the checker believe that it is a
- 30 complying building.
- Q. Yes and at the end of the day that's what's important?
- A. Of course it is.

Q. You had to form the view, or at least your office had to form the view that the building complied with the code?

5 A. Certainly. Well I mean we, you always believe that it does. The idea, when you put it in for the consent you believe that it complies, but anyone who's ever applied for a building consent knows that you get a list of queries back and that list of queries, in essence, are things which the council believes do not comply for whatever reason, and it's a case of working through that list until you both agree that what's on the drawing complies.

10 Q. Yes, now I understand in your evidence previously that you take the view from a review of the Tapper letter, that's the 27th of August 1986, that the plans that were provided prior to that letter must've been to some extent incomplete. Is that correct?

15 A. When I look at that Tapper letter with the type of things that were on there, that's the view, that's the impression I get, yes.

Q. Yes. But is it your view that having reviewed the plans that are available and that were signed by you, that those plans are complete?

20 A. Yes. I mean Graeme wouldn't have approved them until the things which he had identified had been done, and I wouldn't be surprised if there were other things. I mean, if Wayne hadn't yet finished the drawings and they'd been whipped out from under his pencil before he finished them, there would be all sorts of things which would be required to be completed before we would be, before I would sign the drawings. I would have to be happy that they were done and obviously having signed those drawings I would've made sure that anything that

25 Graeme Tapper required had also been done.

Q. Yes, and is that the significance of you signing them, that you took the view at the time that the building, that the plans complied with the codes?

30 A. Yes, that I believed that they were complete. That it wasn't, they were the set which I would expect that if they weren't signed, if you found a set of plans on the site which weren't signed, if by some mistake and this has happened before when they've done that they've submitted a

partly finished set of plans to the Council, and then later on re-submitted an amended set which are complete, through some mistake of bureaucracy that the original set of plans may end up with the stamp on them on the builder's site. So before you would, one of the first things you do when you first go on the site is to make sure that the plans which the builder has which are stamped are in fact the latest set of drawings, and the only way you can know that is to sign them. Usually once they've been signed, beyond that time, any amendment you make to the drawing you put an A or a B or whatever on it and you put a cloud around the alteration.

5 Q. Are you suggesting that there was any, you're not suggesting though are you that there was any amendment to these plans post them being signed by you and stamped?

10 A. I have no way of knowing. I mean the only way I would know that would be to have a look at a photocopy or a copy of the latest plans which were held in Dr Reay's office. And I have no access to those. I've only seen –

JUSTICE COOPER:

20 Q. But you've just told us there's a standard way by which amendments are marked on the plans haven't you?

A. Yes Sir.

Q. By way of the cloud –

A. Yes Sir.

25 Q. – the circular line?

A. That's correct.

1020

Q. Now there's no such marking on any of these plans is there?

30 A. No there is not but what I'm saying is they, those copies may be copies of the consent plans, I don't know, or they, the original tracings or, that are in Alan's office may or may not be the same as those consent plans.

- Q. Well you supervised or you attended this job whilst it was being constructed. Presumably you were working off the plans that had been approved, were you?
- 5 A. Yes sir. But which those plans were I cannot be certain. They probably aren't.
- Q. Well were there two sets of plans with your signature on them?
- A. No, the tracings have my signature put on them when I'm satisfied that they are complete and ready to submit to the Council and are suitable to have a building consent.
- 10 Q. Right and that happened before construction began presumably.
- A. That happened before construction began but during construction issues can arise or there can be alterations to the design and any alteration which is made at that time is made on the original tracing which is an existing plan which has my signature already on it and any
- 15 alterations which are then made to the plan subsequent to that building consent will be marked with an A or a B or a cloud.
- Q. Are you saying that only happens on one set of plans, namely the plans that are kept at the Council premises?
- A. No that happens on the original drawing which is in the engineer's
- 20 office. If the Council asks for an as built set of plans or if they ask for a revised set at the completion of the building which would show any alterations or amendments then the engineer at the end of the job, after all of the amendments that have been made have been completed and they are shown on the plan, would give the Council a copy of those
- 25 finally amended plans.
- Q. Well is there any evidence that you can point to that these plans were changed once they'd been permitted by the Council?
- A. No because I, the only evidence I have in front of me are plans which have been sent to me by the, by Dr Reay recently. I don't know.
- 30 Q. Well did they have the Council's stamp on them?
- A. I don't have them with me now but they may well have. No the ones I have here don't have the Council stamp on them.

CROSS-EXAMINATION CONTINUES: MR REID**WITNESS REFERRED TO BUI.MAD249.02841**

Q. You see those plans.

A. I see the cover sheet.

5 Q. Yes. Perhaps you could just be shown the first few pages, BUI.3 perhaps, .4, .5 and those are the plans that you referred to earlier.

A. Yeah those appear to be photocopies from the Council's record of the consented plans.

10 Q. So they're the ones that have your signature in the box headed approved.

A. That's correct.

Q. In the bottom right-hand corner and they also have the Council stamp 30th of September '86 don't they?

A. Yes.

15 Q. Have you had a look through those plans?

A. Yes, well I've looked through the earlier set which I was sent by Dr Reay by email but they're obviously a set taken from Alan's records as opposed to a set photocopied from the Council's set but I haven't looked to see if there were any particular differences.

20 Q. Well in any event you're saying though, aren't you, that the set that is signed and stamped are the consented ones and they're the ones that you approved –

A. Yes.

25 Q. – and that you would have taken the view at the time were complying with the codes.

A. Yes.

Q. All right well I think your counsel said in opening that you were surprised and disappointed that no design certificate had been provided or at least hadn't seen one. Is that correct?

30 A. Well I guess I was surprised at how little documentation was available from Dr Reay's office by way of correspondence and that would include the design certificate.

Q. You would have expected though that there would have been a design certificate supplied for this building.

A. Yes.

5 Q. And does the fact that a design certificate would normally have been provided is that consistent with the fact that you've signed the documents as approved?

10 A. No what, what my recollection of the normal procedure is that I would sign the drawings when I was happy that what had been put on them by the draughtsmen was complete and that all of the things which I had asked for had been put on the drawing. By way of the design certificate that's something which is withheld until you know that the drawings are complete and, in some cases, it's also withheld until the client's paid the bill but I don't, I'm just saying that, I'm not, any reason to suggest that that happened here but normally that's out of my hands – the signing of the design certificate and when and where and to whom it's submitted was not something that I'd traditionally be involved with.

15 Q. No from your perspective the only two reasons why a design certificate might not have been supplied were either that the account hadn't been paid by the client or that there were some outstanding requests. Is that correct?

20 A. Or that Alan hadn't yet checked and reviewed the drawings. Normally before he would sign them he would have a look at the drawings and make sure that he was happy that they were okay. Obviously he didn't want them to be going out the office unnecessarily without being checked. So normally you would check the drawings before you would issue the design certificate.

25 Q. Just dealing with your perspective on the design certificate though, there was no reason from your perspective why one wouldn't have been supplied.

30 A. I can't think of any reason why one wouldn't have been supplied, no.

JUSTICE COOPER:

Q. So are you saying you wouldn't have signed it?

A. Well I can only go from my memory of that many years ago. I would be very surprised if at that stage I was signing design certificates, but if I saw one in front of me that I had I would say I'm mistaken but my expectation at that time and my understanding of how the office worked
5 I'd be very surprised if I had done it.

Q. So if the design certificate were provided for the CTV building you would have expected Dr Reay to sign it having checked the plans, is that what you're telling us?

A. That's my recollection of how things worked, yes.

10 **CROSS-EXAMINATION CONTINUES: MR REID**
WITNESS REFERRED TO WIT.NICHOLS.0001.10

Q. Now this is a document, you probably haven't seen this before, Mr Harding, it's attached to a brief of evidence prepared by Peter Nichols who, at one stage, was employed by the Council and it is a document
15 that he says are some guidelines that were prepared by Bryan Bluck in the period prior to your work at Alan Reay. So it's dealing with a slightly earlier period, the early 80s as opposed to the mid 80s. But it sets out, according to Mr Nicholls, the approach that the Council took in general terms to reviewing structural engineering designs at around that time.

20 So I'd just like to refer you to item 3 and Mr Bluck there says that you, referring to structural checking engineers at the Council, are entitled to rely on the recognised expertise of a professional designer who is prepared to certify under his signature that a specific design for a conventional or innovative structure or detail complies in all respects
25 with the intent of the provisions of NZS 1900 Chapter 8. See that?

A. Yes.

Q. Now NZS 1900 Chapter 8 I think is one of the predecessor design codes, structural codes, is that correct?

A. I believe so.

30 1030

Q. Yes, and was that your understanding of the general way that the Council would approach these sorts of matters, the review of plans?

5 A. I can't comment on that, I really don't know what the process that the Council would adopt would be. I mean if you were prepared to accept a design certificate then there would be no reason for the Council to even look at the drawings. They would only check that the design certificate had been signed, but obviously that's not sufficient and it certainly wouldn't have been sufficient for Graeme Tapper.

10 Q. All right. I just want to go back for a moment to your answers about the way that the building was detailed and the ETABS analysis, as I'm not sure that we were quite on the same page with that series of questions. So what I was suggesting to you is that the design of the building as you designed it with gravity frames and structural shear walls, that was dependent, that approach was dependent on the outcome of the ETABS analysis. Do you agree with that?

15 A. No, I think you need to determine what the concept is for the building before you even fill in the analysis. If you've made the decision already that the columns and beams aren't going to be part of the lateral load resisting system, there's no reason for you to include those columns and beams in the input for the analysis. It simplifies the input, speeds up the program, simplifies the output. So basically the whole benefit of separating the two of them is that you don't have to model the columns and beams in the ETABS analysis.

20 Q. But being able to detail the columns, the beams and the beam column joints as gravity was dependent on meeting the require – the drift requirements of the code wasn't it?

25 A. No, I don't believe so, the drift requirements of the code are determined by the strength of the shear walls, the location of the shear walls, the foundations to the shear walls, the columns and beams have no effect on the drift of the building in – according, well go back a stage. Obviously there is some strength in the columns and beams of the gravity frame, but by designing the shear walls alone to take the lateral load and to calculate the lateral drift based on the strength and stiffness of those shear walls, by adding in the gravity frame if you are seen to be adding additional structure that can only reduce the lateral drift, so that

30

by neglecting the columns and beams and the natural frame you're being overly conservative, you're getting a figure for the drift of the building which is higher than it will actually be once you've put the gravity frames in. So long as those gravity frames are protected to the extent that they can't come to any harm, when the building deflects by the – what – by the amount it moves from, then it doesn't cause a problem. There's an effect that they call a P Delta effect, if you have a column and you get too much lateral sway then the load on that column is not concentric and there can be an induced bending moment on the column. So obviously if the deflection is excessive then that could be a concern but the object – the whole reason for putting the shear walls in is to limit the deflection so that that does not become a problem.

5
10
Q. All right, so you're saying are you that the purpose of the ETABS analysis was to determine that the shear walls were sufficiently strong?

15 A. Yes, sufficiently strong and particularly sufficiently stiff, strong enough so that they will take the loads specified, stiff enough that they won't deflect excessively.

Q. And so whether that was the case, whether the shear walls were sufficiently strong to comply with the code, as it was dependent on the ETABS analysis, correct?

20 A. Yes.

Q. And not something I suggest that could have been realistically reviewed by a Council checking engineer?

25 A. No, normally you would review the calculations to make sure that they made sense. Again as I say one of the first things you would do is look at it and see if in your opinion the arrangement of the shear walls made sense. I mean it's one of the basic criteria that you have a mechanism in place that can resist the loads you're talking about, so if you have a building with a single wall obviously there's no mechanism that can resist torsion so if you have two walls some distance apart then you have a mechanism by which you can resist torsion and that's the sort of thing you would be looking for as a first check when you're doing the check, the review.

30

Q. Yes, but from your perspective on the basis that you took the view the building complied, it was no surprise to you that Council found no difficulties with that general structure?

5 A. Well the difficulties they had were on the letter and I didn't perceive that letter as being anything particularly onerous. They were all items which could be comfortably satisfied.

CROSS-EXAMINATION: MR MILLS

10 Q. Just let me clear away a couple of fairly minor matters before I ask you some more detailed questions. First of all what have you been doing as a structural – in the structural engineering field since you left Alan Reay's firm?

A. I have my own company, Structural Engineering Design.

Q. And you've been doing that ever since you left Alan Reay's firm have you?

15 A. Yes.

Q. And the type of work that that firm involves?

A. Mainly low rise buildings, precast concrete buildings and a couple of five storey, one five storey and one four storey building.

Q. But that's a minority I take it of what you've been doing?

20 A. Well as I say only two buildings out of 4000 odd projects.

Q. Yes, so the responses that you've been giving to both Mr Rennie and counsel from the Christchurch City Council that you've just been getting questions from, about the design issues, the way in which buildings perform, you've fairly confident views about the design of the CTV building, that's all really based on experience that you picked up before you left Alan Reay Consultants is it?

25 A. Certainly in regards to ETABS and multi-storey buildings yes.

30 Q. Now I should also just make it clear that I'm not going to ask you questions about the permitting process and about Mr Tapper's letter, because that's going to come up at a later session. I don't want it to be thought of it being overlooked, but they're not going to be dealt with now.

5 Now I'm going to ask you the same question that I asked Dr Reay when he first gave evidence and the question was essentially along these lines. Is it your position that the CTV building was a well designed building that simply happened to collapse because it faced unexpectedly high vertical forces for which it was neither designed nor required to be designed?

A. That's essentially true yes.

Q. On both parts of that question?

10 A. Yes.

Q. And in going through the preparation to give your evidence and in thinking about the issues that have been raised with you in the last day or so, you've not changed your views at all on either part of that question?

15 A. No, each time I see new evidence I go through it to see if there's something in there that's new that would change my view, and I find that most things I see confirms the view.

Q. So you don't have any concerns in relying on the impact of vertical accelerations that the collapse that occurred might have been contributed to by design deficiencies in that building?

20 1040

A. Well the evidence I see, when I say evidence I, I'm not speaking of documents, I'm speaking of what the building's telling me. When I look at the, what I've read of evidence from the people who were in the building, of the forensic people who were looking at columns and beams and various different parts of the structure after the collapse, I'm relying upon the information in that evidence as to the condition of the building and so forth rather than having seen it myself which I haven't. But based on what I'm reading I, that, that's my view. That it was over and above the, the code that the load – the vertical loadings were over and above the code and that that was the reason why it failed.

30 Q. And nothing to do with anything wrong with the building?

5 A. No I, I think that the fact that it, the first earthquake which was essentially horizontal loadings which is essentially the kind of loading that, that the code requires that you design it for, I believe that it was designed to take those loads and I, I believe that the fact that it survived
10 the first earthquake apparently without significant damage but I, I'm not making that statement but just from – David Coatsworth is a very experienced engineer and I know he's been struggling as well to think, maybe I missed something, but having seen reviews of the design and as I say the evidence of how it did fail I, I think it survived the initial
15 earthquake with those horizontal loads as specified by the code in fairly good condition and that that was an indication that it was in fact designed to take the loads in the code. I think the fact that the second earthquake was different and as I say the epicentre was closer, that there was instead of just horizontal loads on the building there were horizontal and vertical loads and that it was the vertical loads that, that caused the collapse.

Q. And the fact that no other building in Christchurch collapsed in the way that this building did, that hasn't given you any hesitation about the building that you designed?

20 A. Well again I've had a look at this thing of, of which buildings are more susceptible to vertical acceleration and which aren't and I, I mentioned last time that the, the load factors on vertical loads have been reducing over time, they've gone, you know, I think (inaudible 10:42:48) said 1.5 and 1.8 down to 1.4 and 1.7, now to 1.2 and 1.5. so the vertical loads
25 which buildings are being designed for are, are less than they were. If we were designing that same building today potentially the columns would have been smaller than they were. I think the fact that when you get vertical acceleration, if you have, if your building is designed as a ductile frame then you have a building which by necessity the columns are massive. They are bigger than the beams. The columns are
30 designed so that they're last, the last thing to fail and by doing that, by designing the columns to take a very big bending moment and a very big shear load they automatically become capable of taking a very big

vertical acceleration and you've, if you were, for example, say it was, and this is, in terms of resilience and recommendations for future design and suggestions in a code as to what we should be doing to make sure it doesn't happen again, my suggestion would be to design a building with an additional load case which is perhaps two times dead plus one times load, one times live, plus an earthquake and you will find that a lot of buildings which are relatively light, that won't be a critical design case because if you've got a timber frame building where the, the dead load's only .35, you double it and you get .7, it's still going to be less than the normal 1.4 dead – 1.2 dead, 1.5 live.

Q. Let's come back to the building you actually designed rather than –

A. Which is what I, which, what I'm leading to is that if you have a building such as this one which has a dead load in the floor of 4 kpa and a live load of 2.5 you double that dead load of 4 and add it to your 2.5 you've made a significant difference to the vertical load on those elements and if that had been a design load case of that building those columns would have been a lot bigger.

Q. So let's come back to the question I asked you which is whether the fact that this was the only building in Christchurch that collapsed in the way that it did has caused you to consider further whether that might indicate some weaknesses in this building that weren't present in other buildings.

A. That's what I'm trying to say to you that –

Q. Well what's the answer, yes or no?

A. Yeah, no it's not a yes or no answer I'm sorry. The answer is that all buildings are different and the relationship between the dead load and the live load is different.

JUSTICE COOPER:

Q. Well, well just a minute Mr Harding it is a question which is to be answered properly. It does require a yes or no answer, albeit with some subsequent explanation if you want to give it. The question that has been asked twice now is whether the fact that this building collapsed in the earthquake has given you, has caused you to question whether

there were any inadequacies in the design. That's the question Mr Mills has asked you?

A. It definitely has –

Q. Sorry?

5 A. Yes, yes Sir it has caused me much time in considering whether there was any inadequacy in the design.

Q. All right. Thank you.

CROSS-EXAMINATION CONTINUES: MR MILLS

10 Q. And did you as a result of that deep thought and consideration reach a conclusion on whether there were any inadequacies in the design and, again, if you can tell me first yes or no and then elaborate that would be helpful.

A. Well I think you're, you're, say that, repeat the question please.

15 Q. I said as a result of that deep thought and contemplation have you reached a conclusion on whether there were any inadequacies in the design that may have contributed to that complete collapse?

A. Yes I have considered that.

Q. And have you identified any inadequacies as a result?

A. No.

20 Q. Thank you. All right I want to now move onto another issue and to some extent what I want to do with, in dealing with these questions is simply to be quite sure that I do fully understand, and the Commission itself has a clear understanding, of the, of where you stand on a number of these issues. Most of them have been covered off in questions by my learned
25 friend Mr Rennie. I just want to try and pull these threads together to be sure we've got a very clear and unequivocal position. So first of all I want to ask you some questions about the evidence you've given under cross-examination, principally about the culture at Alan Reay's firm when you were there. And I'm going to put a series of points to you and,
30 again, if we can get yes or no and then some modification if need be that would help.

So first of all the practice within that office during the time you were there was to build no greater than necessary in terms of the strength of the buildings?

A. Yes.

5 Q. You could not design above the code requirements or, to use the colourful language you used, you would get your hand smacked?

A. Yes.

Q. Dr Reay made his reputation by making buildings no stronger or more expensive than necessary in your view?

10 A. Yes.

Q. If you did design a building stronger than Dr Reay considered necessary you would be asked to justify that?

A. Yes.

15 Q. And if you couldn't justify it then you would go back to whatever the requirement was that Dr Reay considered appropriate?

A. Yes.

Q. And the result of that was that you came to understand that the culture was one where if you weren't going to be able to justify any structural element you learned to leave it out?

20 A. Yes.

Q. And is the result of that that the culture looked at in the round was to treat the code as a maximum not a minimum?

A. No. When you say as a maximum you're implying that we may build below the code and -

25 1050

Q. No, no, I'm not putting it clearly enough then. I'm asking you was the culture one that said if it was Code compliant that was the only issue, in other words the Code was all that you had to build to. It was not a minimum requirement.

30 A. The Code was a minimum requirement.

Q. And you were, the culture was that you didn't build beyond the Code.

A. Not if you, no that's correct.

Q. You made a reference, at least this is the note I made of the references I was listening yesterday, that sometimes you would need to go beyond acceptable knowledge and find other ways of doing things.

5 A. Well not, it's, I wouldn't say beyond acceptable knowledge but certainly to find other ways of doing things yes.

Q. And in that sense the culture was one of testing limits.

A. Oh I don't think it's testing limits I think it's innovation. I think it's trying to find different ways of doing things that are more efficient to achieve a similar end.

10 Q. And when you were working on the CTV building was that the culture you had absorbed and were applying in designing that building?

A. Yes.

15 Q. Now reference has been made by, among others, Professor Mander, who was called as an expert witness on behalf of Alan Reay's firm, about liberal versus conservative interpretations of the Code. Taking that language where did you think the culture in Alan Reay's firm sat? was it a firm that took a conservative view of the Code or a liberal one that was looking for ways to minimise the Code requirements?

20 A. I'm not sure what Professor Mander was referring to when he talks about liberal. I mean I've never, there's never been any suggestion at any time that we should go below what the Code requires. The idea is to work around the Code if you like, so if the Code, no it's not even working around it. It's finding different ways of complying with the Code. I don't think I can say it any differently than that.

25 Q. You agree with me that there are areas of the Code where what's required may not always be clear cut?

A. Oh very much so.

Q. And where differences of view might be held by structural engineers?

A. Yes.

30 Q. Now it's in that sense in which Professor Mander was using the distinction between liberal and conservative approaches to the Code. Was the culture that you experienced during your time at Alan Reay's firm one where if there was room for varying interpretations of the Code

that the interpretation that minimised cost and minimised the nature of the detailing that was required that would be the preferred route?

A. Yes I think that could apply to all engineers.

5 Q. I'm not asking about all engineers I'm just asking you about your experience at Alan Reay's firm and I take it you're saying it applied there?

A. Yes.

10 Q. Now you were, of course, at Alan Reay's firm twice. Do I take it that the elements of culture that you've just described were the same the first time you were there as they were the second time you were there?

A. Yes.

Q. So can I take it from that that when you decided to go back to Alan Reay's firm that you knew the culture you were going to?

A. Yes.

15 Q. And can I also take it that that says that you were sufficiently comfortable with that culture to go back to it?

A. Yes.

20 Q. Now you've said in your evidence that at the point at which you were contacted by Dr Reay to see if you would come back to the firm that I think, in general terms, you had concluded that the future you saw for yourself at that time at Waimairi was not one that you found attractive?

A. Yes.

Q. And as a result of that you were receptive to finding a way to shift your professional direction.

25 A. Yes.

Q. So the approach then from Alan Reay fell on receptive ears, I suppose, did it?

30 A. Yes. I think his evidence says that he heard from a common acquaintance, I don't know who that may have been, that I was looking to change.

Q. You have said, I think, that in going to the firm and in responding positively to this invitation you were going because you wanted to get experience in multi-level building design.

A. Yes.

Q. And experience with using ETABS.

A. Yes.

5 Q. Now I'm going to suggest to you that the bigger lure was the lure of becoming an associate in that firm.

A. No I dispute that. I think that was a, the idea of being an associate gave me the impression that I was more likely to be involved in preliminary design and concept design, which is what I had left the previous time because I was just a backroom number muncher, and I expected that if I
10 was to be an associate it was more likely to change and I'd have more input to the preliminary design and the concept design. That was my main reason.

Q. If Dr Reay had approached you and said there's an opening in the firm with potentially an associate position opening up for you to work on cutting edge tilt slab building design would you have said yes?
15

A. No.

Q. You wouldn't?

A. No.

Q. All right and I'm going to bring up a document and as always I'm hoping
20 it's the right document.

WITNESS REFERRED TO BUI.MAD249.0413.RED.2

Q. If this turns out not to be right I will come back to it later. It seems to have frozen so I'm just going to get a hard copy from Ms Jamieson. I'll deal with it that way. Now do you recall that during the run up to this
25 hearing that on a number of occasions there were letters sent to either you or to your legal counsel from the Royal Commission or, more accurately, from counsel assisting seeking information?

A. Yes.

1100

30 Q. One of those information requests, which is the one that I had been trying to bring up, is dated, or one of the answers is dated 20 May 2012 and in that you responded to some questions that had been put to you

about the call from Dr Reay making an offer to you and you say this, and it is signed by you although it came via your lawyers

You say this, "I recall Alan Reay personally calling me and making the offer but I do not recall what precipitated this call. I was not specifically
5 looking for the opportunity to design multi-storey buildings prior to that telephone call. However Alan was clearly advising me that the position which he was offering would specifically involve the design of such buildings. He advised me that since I left the firm in 1980 he had specifically targeted the multi-storey building market which he felt had
10 previously been dominated by Holmes Wood Poole and Johnston," and so on.

So Mr Harding I'm going to ask you again, is that not a more accurate description of what happened here, that there was an opening in the firm which held out the offer of becoming an associate but in order to
15 take up that and have that opportunity you had to engage in multi-level building design?

A. No, that's not – that's not what I've said and I don't believe – that's certainly not what I intended to say. I haven't got it in front of me but I don't believe that's what I said either.

20 Q. Well let me read it to you again, and hopefully it will come up at some point again. "I was not specifically looking for the opportunity to design multi-storey buildings prior to that telephone call."

A. Yes I accept that.

25 Q. So do I take it that, or do you accept that what was being offered you was a potential associate-ship in the firm?

A. As I said, that was an aside, that was not the main reason for going there. That was, I've explained that the reason I went was, as – what I've said in the evidence as I recall you calling it, was that I was offered the opportunity to go and learn how to do multi-storey buildings. If he
30 had offered me the opportunity and said that I'd be doing the same thing I was doing before or as you say, cutting edge tilt panel then it wouldn't have interested me at all.

Q. All right. Was the idea of becoming an associate in the firm an attractive proposition?

A. It wasn't a major concern, as I say the attractiveness of it was by virtue of the fact that having more contact with the clients. That was the more attractive proposition.

5

Q. All right, then let me ask you again, was the proposition of becoming an associate in the firm an attractive proposition?

A. Yes.

Q. In order to become an associate in that firm or to have a prospect of it, on the basis of the offer that was put to you, you would have to learn to do multi-level building design wouldn't you?

10

A. I mean the – I don't know –

Q. Well that's the offer that was being made to you wasn't it?

A. The offer was the opportunity to do multi-level building design. That was the reason I went.

15

Q. And you were aware weren't you because Dr Reay as I understand told you this, that an opening had come up because the previous designer who had been doing this had left.

A. Was going to leave.

20

Q. Was going to leave.

A. I don't know if he had left at that time.

Q. All right, was going to leave. That's what he told you wasn't it?

A. Yes.

Q. So there was a gap and a need in the firm for someone to do multi-level building design, wasn't there?

25

A. Yes.

Q. And you were being invited to come into the firm to fill that gap?

A. Yes.

Q. And the success you had in filling that gap would be likely would it not to determine whether or not you became an associate in the firm?

30

A. I don't – you'd have to ask Alan that, I don't know.

Q. Well what did you think at the time?

A. Well I don't think that becoming an associate was contingent on filling that gap. It was an independent issue.

Q. But do you think that your success in filling that gap would be what would determine whether or not you became an associate?

5 A. No, because I think at that stage Alan was fully aware of what I was capable of doing and what I had done, I mean he wouldn't have made that offer on the telephone if he hadn't already been aware of what my capabilities and abilities were, it was not contingent on anything I may have done once I rejoined the firm. It was based on his current
10 understanding of my capacity and my knowledge.

Q. The principal reason he wanted you and the principal substance of that phone call was that a person who had been doing multi-level design work was or was about to leave the firm and he needed a replacement?

A. Yes.

15 Q. And he told you that he had targeted the multi-level market and he had multi-level work coming through the firm?

A. Yes.

Q. And he was asking you to come and pick up that gap that had been created and work in that field, wasn't he?

20 A. Yes.

Q. Now am I right that the culture in that firm that you were familiar with was one that demanded fairly high levels of performance?

A. Yes.

25 Q. It was one where it required initiative from the people who worked there?

A. No, I don't think that's necessarily the case.

Q. Did it require people who worked there to be self-starters?

A. No I don't think it did that either.

Q. Did it offer a lot of hand holding in your previous experience?

30 A. No.

Q. Now when you came into that culture for the second time, you said that when you came to deal with the CTV building, that you were expecting guidance from Alan Reay. Is that correct?

A. Not necessarily him personally but the impression I had was that there was experience within his firm so how that came to me I had no way of knowing at that time.

5 Q. Weren't you told that the person who had been doing that work was about to leave?

A. Yes.

Q. So where did you think the experience was going to come from once that person left?

A. From Alan.

10 Q. Thank you. So it was Dr Reay where you were looking for that experience to come from?

A. Yes.

Q. And it was Dr Reay that you –

15 A. Oh, sorry, I mean from Dr Reay and from any other accumulated knowledge in the office. It may have been from the draftsmen, from the people who had built these buildings before. There would be knowledge to be gained from their experience in building as well, because in a lot of cases, if a draftsman has built something before he knows what to look for. When he's doing the carcass drawings he knows that details are

20 required of a number of different elements for that building and if you haven't provided them he'll prompt you and say, well you still haven't given me this or you still haven't given me that and it's as much the experience of the draftsman is not in any way to be underestimated.

25 A. Now you've said repeatedly in your evidence-in-chief and under cross-examination that you would not have taken on the CTV building if you had been in business on your own account?

A. That's true.

Q. And that you were relying on the fact that Dr Reay was playing a supervisory role. Is that correct?

30 A. I wouldn't necessarily – it depends how you use the word supervisory.

Q. Well how would you use it?

A. I think for him to review the design and to be available to answer questions and to discuss issues as they may arise but really, the word is

review I think, that if he sees something happening that for some reason doesn't look right he'd be there to say, "Well have you thought about this?" or, "Why've you done it like that?" or, "Those results don't perhaps look like they're working out properly, maybe you've got some glitch in the input that's giving you wrong answers." Cast his eye over it and say, "Well, yeah, you should've used this factor here or that factor there." It's really a case of review I think is the word.

1110

Q. And as between Dr Reay and the structural draughtsmen in the firm, who were mostly looking to, to give you the support and guidance that you say you needed?

A. I'm not, it applies to, whoever he believed was experienced, that he was, I mean I would work with whoever he gave me to work with.

Q. So you were principally looking to Dr Reay to guide you into safe hands?

A. No, I think I'm using the word "review". You're treating it as if it's supervision, as if he's watching every single thing and I can't do anything without him. The point is when you're designing something for the first time you don't know what you don't know. You think you have the ability. You think you have the competence but you need somebody who's done it before to be able to say, "Well yes but you haven't actually looked at this," or, "There's a component here that you are missing."

Q. And I take it –

A. Because you haven't done it before you're not aware of that so that's where the review process comes in.

Q. But I take it that you did think that you were up to doing this and did have the confidence to do it, subject to what you have just described as that oversight?

A. Yes.

Q. Now in terms of being given guidance from Dr Reay about how to go about this, you have said and it may be disputed by Dr Reay, I'm not sure where we'll get to on this, but you have said that he directed you to

the calculations that Mr Henry had done for Landsborough House and you were to treat that as a design model for CTV?

A. Yes as a template.

5 Q. As a template. So he was giving you guidance I take it, by giving you that?

A. Yes.

Q. And in what he gave you he also gave you the input and output data that ETABS work that Mr Henry had done on Landsborough House?

10 A. Yes. I believe so. I, you know, as I say my memory is, I'd have to be guided by documentation if it was put before me. If it was different to how I recall it, but yes that's how I recall it.

Q. You are adamant, as I understand it, that in doing the ETABS analysis on CTV that you were following input and output data that had been done by Mr Henry for Landsborough?

15 A. No I, it's the method.

Q. Yes?

A. But yes I believe so.

20 Q. And that would only, given that you didn't know the run of the office, am I right that that could only have come into your hands by Dr Reay directing you to it?

A. Yes I believe that that's, I can't see any other way it would've happened at this time.

Q. Yes. Did you know at this point that the work on Landsborough that you were being given as a template had been done by Mr John Henry?

25 A. Yes.

Q. Did you have any existing knowledge about his competence in the field of multi-level shear core building design?

A. Not prior to joining Alan's firm, no.

30 Q. And was anything said to you when you joined the firm about his levels of competence?

A. I don't recall anything particular but I, you can quickly draw a conclusion by looking at their, at the work that he had done. It was quite evident that he was very competent.

Q. So that was the view you formed when you looked at that material?

A. Yes.

Q. And as a result of that I take it you had a high level of confidence that if you followed what he had done there then you too could design a good building?

5

A. Yes.

Q. You've said in your evidence that you found the Landsborough House documentation that you were given clear and easy to follow, that's correct?

10 A. I wouldn't say easy but methodical. Nothing, none of it, easy compared to what I had seen from other engineers, put it that way.

Q. So within the engineering world, any rate, these were materials that were clear and easy to follow?

A. Clear to follow.

15 Q. Yes, but you were confident that you could follow them?

A. Well I was giving it a go. I, I did struggle I must say because, yeah, doing something at the beginning when you, when you're teaching yourself basically from somebody else's example and working backwards is not the best way to do it.

20 Q. So what you then proceeded to do on CTV, to what extent could it be described as following the dots that were laid out in the work that you'd been given from Landsborough?

A. Well, no I don't think you could call it following the dots.

Q. How would you describe it?

25 A. Oh, by looking at the method, at the, at the identification of which structural elements are doing the work and which parts are along for the ride. Which ones you need to include in your modelling and which you don't. What the relevant criteria are in terms of deflection perhaps or any number of other criteria such as shear and axial load.

30 Q. And am I right that in picking up the CTV job this was really the opportunity that you wanted to test yourself in doing multi-level building design?

A. Well I mean I, test myself?

Q. Prove yourself, if that helps?

A. No I wasn't out to prove myself in any way.

Q. Did you see this as a challenge that you wanted to take on?

A. Yes I did see it as a challenge, yes.

5 Q. That you wanted to take on?

A. Yes.

Q. Now you were asked some questions yesterday by His Honour about the exchanges or the involvement that you had with Dr Reay in the course of doing this design. Is it correct that the only specific issue that you recall taking to Dr Reay related to the need for a shear wall on the southern side?

A. That's the only one I can recall.

Q. Yes.

A. What I'm saying is that the rest of it was pretty much routine.

15 Q. Yes, and it was routine I take it because you felt that you knew what you were doing with the material that you had been given and with the draughtsmen that you were working with?

A. I believed so, yes.

Q. Yes. Because when you were asked yesterday about the time records and the accuracy of the time shown for Dr Reay on those time records, and the note I made of your response was that you referred in challenging the accuracy of that to the fact that Dr Reay would've had several meetings with owners and architects and each meeting would've been about three hours or so and so on. Do you remember saying that?

25 A. Yes.

Q. And noticeably absent from your response was any reference to the number of hours that you had spent in discussion with him yourself about the CTV building and I take it that's because you didn't?

A. No, I don't think anyone asked me how many hours I would, I mean I, you're asking me how many hours I spent doing a particular thing 26 years ago and I, I've no way of even estimating what that may have been.

1120

- Q. Well you were asked about the accuracy of the, I think three and a half hours that was recorded for Dr Reay's time in those timesheets and you said in response in saying they wouldn't be accurate. That he had several meetings with owners, with the owner, with the architect, each meeting would be about three hours and as a result his timesheet couldn't be right. Do you remember saying that?
- 5
- A. Yes.
- Q. You made no reference to time spent with you that would have made it not right?
- 10 A. Well that wasn't particularly intended. I mean I don't know how many hours he would have spent with me. How, how many 10 minutes a day sessions do you have to add up to how many hours. I've no, I can't think of a number. It's just, how long's a piece of string?
- Q. All right so let me try and get this firmed up. Was this a situation where as you've said you felt confident about what you were doing provided you had the right structural draftsman to work with and the right oversight?
- 15
- A. Yes.
- Q. And that oversight was there as a level of comfort to you?
- 20 A. Not just to me but –
- Q. Well was it to you, a level of comfort?
- A. Well as I said I wouldn't have even gone if I hadn't had the understanding that I was, that the work was being reviewed. The comfort was given by the fact that I knew he was keeping an eye on the, the work that the draftsmen were doing –
- 25
- Q. Yes.
- A. – and I took that to be that he was reviewing it and in that regard I took comfort from it, yes.
- Q. Yes. So the oversight that you understood Dr Reay was involved in was principally checking the work that was being done by the structural draftsmen on the CTV building?
- 30
- A. Well that's for him to say. That's, that was my interpretation of it.
- Q. Yes so that's what you're saying.

A. Well that was my understanding of the situation at the time.

Q. Yes.

A. It's not for me to, to deem whether he considers that adequate review.

5 Q. No and I'm not asking that. I'm asking about what you thought was going on at the time and what was giving you this level of comfort –

A. Yeah that was –

Q. – and I think you've answered that.

A. Yes.

10 Q. Now in addition to that Dr Reay has said that he was available to you if there were specific issues you wanted to raise with him. You agree with that?

A. Yes.

Q. And you're not disputing that he was available to you for specific issues?

15 A. Certainly.

Q. And the specific issue you remember is the issue around the southern shear wall.

A. Yes.

20 Q. Now when Dr Reay put you in charge of the design work for the CTV building I just want to confirm with you what at least in your view was the status of the design work that had already been done before it was given to you. With me? Now am I right that by the time it came to you the decision had already been made elsewhere that the, at least the architectural design of the building was to be based on the Contours building.

25

A. Yes.

Q. And that included a requirement for round exterior columns.

A. Yes.

30 Q. Do you know whether the Contours building also had round interior columns?

A. No I don't know. I assume that it would have but I, I don't know that answer, no.

Q. Where did the decision come from to make the interior columns in the CTV building round as well as the exterior columns?

5 A. Well normally they would all be the same because if the contractor who obviously had an input to the design, being a design build project, he wouldn't want to have two different kinds of form work. He would want to have, for a circular column he'd be making up steel form work in two halves that he could bolt together to form the column and he wouldn't want to have a lot of different sizes and shapes of form work. He would want to use the same form work as many times as he could.

10 Q. So is it your recollection that that decision on round columns both in the exterior and the interior was one that had been made before it came to you?

A. Yes.

15 Q. The layout of the floor plan and the location of the north shear wall outside of the floor plan of the building, was that already established when it came to you?

A. Yes.

Q. The east-west direction of the beams, that decision made before it came to you?

20 A. I don't recall that. I, yeah I don't, I don't recall that.

Q. You think it's possible you might have made that decision?

A. It's possible.

Q. Yes. The diameter of the columns, was that decision made before it came to you?

25 A. Yes.

Q. The decision to have exterior spandrels, that decision had already been made?

A. Yes.

30 Q. The mixture of precast and in situ concrete work, had that already been decided?

A. Yes.

Q. And the overall decision that this building would be a shear wall supported gravity frame building, had that decision already been made?

A. Yes.

Q. The decision to use Fletcher Brownbilt Hibond flooring, had that decision already been made?

A. Yes.

5 Q. Are there any other decisions that in your view had already been made before the design was handed over to you?

A. I think that that, the location of the walls as a separate shear core on the north side so that it looked the same, I think you, you inferred, implied that.

10 Q. Yes, yes.

A. That, apart, no I think that that's pretty much covered it.

Q. All right.

A. The fact that the, that we would be using this system of pre-cast beams and as, you know pre-casting as many items as possible as regards to beams was made.

15

Q. Yes.

A. Yeah.

Q. And that decision as far as you're aware would have been, would have reflected the expertise that Dr Reay had with pre-cast elements?

20 A. Exactly.

Q. And I take it, and I think you say this in your brief, that because of your inexperience with ETABS analysis that the fact that the shear wall supported gravity frame system made the ETABS analysis much simpler was also a bonus as far as you were concerned?

25 A. Yes.

Q. Now –

JUSTICE COOPER:

Mr Mills, Mr Carter just has a couple of further design issues that he's interested to know whether Mr Harding made the decision or it was made before the job got to him. Would this be the appropriate time?

30

MR MILLS:

(inaudible 11:28:15) Absolutely.

JUSTICE COOPER:

5 Yes.

COMMISSIONER CARTER:

10 Q. The question is in regard to the pre-cast beams that were running east-west, the amount of the seating that those were to have on the round column.

A. Very much a standard detail.

Q. That was a standard detail of a 50 millimetre support requirement?

A. Yes that, that was one of the, yes it was a standard detail. The –

15 JUSTICE COOPER:

Q. A standard Alan Reay detail?

20 A. Absolutely. I mean that, it wouldn't, the system wouldn't have worked unless it had been possible to do it like that. The general intention was to wrap the pre-cast beam around the column as much as possible so that it, it didn't require any form work on either side of the beam and that you'd pour the column up to a certain height, then you'd sit the precast beam on the column such that the two pieces of pre-cast beam would either meet around the side or if it was an end stand you'd, you'd have the beam continue and there'd be a hole in the precast beam for the vertical column bars to pass through.

25 Q. Rather than going to the detail the question really we're interested in is whether this was a matter that was essentially given to you –

A. Yes.

Q. – as the way it would be done.

30 A. The answer's yes sir.

COMMISSIONER CARTER:

Q. And do you know if that detail had been used on other structures including the little wings, the ears that were cast onto the end of the beams that we heard evidence had failed during the collapse?

5 A. Sorry Sir I, I'm not quite sure what you're referring to with the ...

Q. Well the first, the first question I have is had that detail of sitting –

A. The seating.

Q. – those beams on round columns been used in other structures?

A. And that is yes.

10 Q. And the second question was to form the ends of those beams, those east-west beams to sit on the column they had to be cast with a, sort of a circular –

A. Yes.

Q. – end form –

15 A. Yes.

Q. – which left two wings on the beams unreinforced effectively.

A. I, yeah I, I don't know about unreinforced. I think the reinforcing that was to be in there needed to be sufficient that the horizontal bars and the beam would always be continuous such that the bottom bars in the
 20 beam would extend through into the core of the column and up the far face so they'd be anchored with a 90 degree bend on those bottom bars which would be anchored in the core of the column and they would overlap so that they met in opposite faces of the column and that the, the top reinforcing in the beam would be continuous across the, across
 25 the column and that would be poured within the floor. So that, that sort of mechanism whereby you –

COMMISSIONER FENWICK:

Q. Mr Harding the question was were the wings reinforced I think –

30 A. Well the wings were –

Q. Not how the beam was tied in.

A. The wings were reinforced by the horizontal bars in the beam.

MR MILLS:

Would you like me to bring up the drawing of this connection? It might help mightn't it.

5 **JUSTICE COOPER:**

Yes, perhaps if it was brought up for after the morning adjournment.

MR MILLS:

All right.

10

COURT ADJOURNS: 11.31 AM

HEARING RESUMES: 11.46 AM**CROSS-EXAMINATION CONTINUES: MR MILLS**

Q. Now I think we were going to pull up a drawing -

5 A. Yes.

Q. – that might help questions that Commissioner Carter had. It is WIT.FROST.0001.60. Now this of course is a drawing. It's been done by Mr Frost who gave evidence about the collapse issues and so there it is if that helps Commissioner Carter and the issues you were raising.

10

COMMISSIONER CARTER:

Q. Yes, my question really was is that the standard detail that you were provided with and you will notice the little wiggly line where the ends of those members dropped off, but we can deal with the reinforcing later.

15 Just is this a standard detail that you were given, thank you?

A. (no audible answer 11:48:12).

CROSS-EXAMINATION CONTINUES: MR MILLS

Q. All right, now just one other issue I want to just take you to, it's paragraph 12 of your evidence which is about the reliance on the Contours building. You've got that paragraph? You'll see that you begin by talking about the drawings that were presented to you and so on and I think we've been through most of those issues in a bit more detail now, but right at the end of that paragraph 12, where you're talking about the features of the Contours building that were to be replicated, you say the CTV building would be higher and of different overall size but this would just involve more repetition of the same details. You see that, now that included simply repetition of the details of the columns in the Contours building didn't it?

20

25

A. (no audible answer 11:49:50).

30 Q. I'm not sure your microphone, is it working.

JUSTICE COOPER:

5 Q. Will the answers up to this point have not been captured? No. Can we just go back to that drawing that was the first thing that you were shown and the question was whether that particular element of the building was the standard design that you used?

A. And the answer's yes Sir.

Q. And that was something that was given to you?

A. Yes.

10 Q. And not specifically designed for this building?

A. No, it was a standard detail which the draftsmen were familiar with. They'd used a lot of times. That would be automatically put on the carcass drawings before they were given to me.

CROSS-EXAMINATION CONTINUES: MR MILLS

15 Q. And then the next question I think was mine.

A. Yes.

20 Q. And so I'll pick it up there again, and it was in relation to paragraph 12 of your evidence. The issues around the replication of some of the details of the Contours building and I had taken you to the last sentence there in paragraph 12, which reads, "the CTV building would be higher and of different overall size, but this would just involve more repetition of the same details", you see that?

A. Yes.

25 Q. And that would include replication of the columns up through the greater height of the CTV building, correct?

A. Yes.

30 Q. Now did it occur to you or did you consider that when you used the same size and shape of columns in a six storey building as opposed to a four storey building that that would increase the axial loads on those columns?

A. Certainly.

Q. And what form did that consideration take?

- 5 A. Well when you're designing the columns you go through and add up the axial load on the column and if you are given the overall size then you can, in order to give the axial load capacity you're looking for, you increase the concrete strength or increase the vertical reinforcement in the column so that it matches the load that you've calculated.
- Q. And so do you say that when you took those column sizes which were given to you, from the Contours building, and they then had to be used in a higher building with greater axial loads, that you increased the concrete strength?
- 10 A. Yes.
- Q. And are you also saying that you increased the vertical reinforcing?
- A. Well I don't know what the vertical reinforcement in the Contours building was. I'm just saying that the concrete strength and the vertical reinforcement were designed to match the axial load for each level.
- 15 Q. I see. Thank you. So I finished taking you through the various design elements which in effect you were given by Dr Reay at least on your evidence. I want to ask you now about what your role was with what you had received, what did you do after that that was your work, and in part the question that Commissioner Carter asked you about the connections
- 20 into the column which you described as a standard detail, that was on my list but I take it you're saying that that wasn't something that you were responsible for, the way in which that beam column joint was detailed?
- A. I was responsible for the – for calculating the concrete strength and the reinforcement in the column and in the beams.
- 25 Q. All right, so those decisions were yours. Did you also make the decisions more generally on reinforcing in the internal pre-cast beams?
- A. I would have designed the reinforcing in the pre-cast beams to match the gravity load yes.
- 30 Q. And it would have been your decision on where the slab steel reinforcing would go?
- A. Yes.

Q. Would it also have been your decision on the amount of seating that the beams would have onto the columns or was that part of the standard detail that you were given?

A. That was part of the standard detail.

5 Q. Did you at any stage give any independent thought to whether that level of seating was adequate?

A. Yes.

Q. And what form did that thought take?

10 A. I took the view that once the core of the – once the concrete was finished in the floor, once the reinforcing – sorry once the concrete had been placed in order to complete the beam and the column with the slab reinforcement and the beam reinforcement in place, that the seating was no longer relevant. The seating was really only a concern as a temporary situation when you have props under the beam while you're building it anyway, you're obviously trying to have grout loss not being lost through the joint, but once the concrete is poured around those reinforcing bars, the horizontal bars in the beam, and they're adequately tied, they would be adequately tied into the column.

15 Q. And so that size of the seating then became essentially irrelevant?

20 A. Yes, well it comes to be a balance between the cover and I think the comment's been made by the Hyland report and by Nigel Priestley that he believed the cover was excessive so I mean the more cover you have to the column the more seating you have. The less cover you have to the column the less seating you have. So it's a balancing between the two.

25 Q. All right, and I take it that I think you've already confirmed that the way in which the north core or shear wall was connected to the floor diaphragms, that was your work, your decision?

A. Yes.

30 Q. Also the way in which the beams were connected into the western wall, that was your decision?

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A. Western wall?

Q. The western wall was the concrete block wall, remember the –

A. Yes the fact that it, in fact, that the beams weren't connected to it, yes, as I say I believe that that wall came late in the piece. I think when the, my recollection, and again I would normally be guided by looking at the drawings. There'd normally be a file with the preliminary architectural drawings and you would see how the design developed by looking at the file to see what the changes were but my recollection is that that wall originally wasn't there but because of the fact that an adjacent building was found to be there and that you perhaps couldn't build the wall the same way above that adjacent building as you did below it the block wall was a necessary element. So it was decided to isolate it from the building.

Q. So whenever it was that it came on stream I take it you're saying that the way that the beams were then connected to it or, as you put it, not connected to it, that was your decision?

A. Yes. I believe that there was a degree of standard details there. I think that had been done before as, again by my recollection the draughtsmen had basically prepared the carcass drawings with it in a certain method using vertical joints and what have you, that had been something that had been employed before, so I did put the reinforcing in it yes and made sure that I was happy it was separated. I expected that it was to be separated.

Q. But it isn't –

25 **COMMISSIONER FENWICK:**

Q. Can I just seek a bit of clarification there. You're saying you think the western wall, the block wall, was added after the design –

A. Oh it was part of the design but my recollection is that it wasn't there when the initial concept design started. I think it was something that needed to be added to the design during the course of doing the drawings.

Q. So you were not responsible for the detailing of tying the floor into the wall?

A. No I was.

Q. You were responsible for it.

A. Yes that was part of the design before it went to the Council but I'm just saying I don't recall it being on the design when it was first presented to me to start the job off.

CROSS-EXAMINATION CONTINUES: MR MILLS

Q. I take it that in relation to that wall, whenever it came on stream, and your requirement that it be seismically separated that you aren't disputing the fact that in some respects that seismic separation wasn't adequately shown on the drawings. I think you've said that in your evidence haven't you.

A. I agree.

Q. Now again, same question really that I asked you in relation to the things that had been given to you before you took over the design function. Is there anything else in the key design decisions that were decisions that you made?

A. After 26 years I'm sorry it's something I can't reply with any certainty. The whole design processes within the office with coming and going....

Q. You'd agree, I take it, that if, well because, as you say, that western wall wasn't there initially I take it you would accept that the design detail for the connection between the beams in that western wall wasn't something that was presented to you by Dr Reay when he handed it over to you.

A. No.

Q. Now you've said in your evidence that your principal concern in the design of the building related to ascertaining the inter-storey deflections.

A. Yes.

Q. I think it's clear isn't it that the reason for that is because the ability to utilise a gravity only building supported by shear walls was utterly dependent on the level of deflections?

A. No I, I can't say that I made that link.

Q. Is it not the case that in order to be entitled under the Code to design this building as a gravity only shear wall supported building that it had to be within certain deflections?

5 A. Well I think the inter-storey deflection criterion is set irrespective of whether you have secondary beams or gravity columns. I think if there was a secondary seismic frame I accept that you need to know the compatibility of the two and that that would be modelled in the ETABS analysis but to me the system of having a shear wall in a gravity protected, a gravity frame that's protected by the shear wall, where the
10 horizontal loads are taken by the shear wall, I believe the gravity frame would work just as well if the deflections had been at the Code limit as if they'd been below that Code limit. I don't know if I can explain that any more clearly.

15 Q. No I hear that and I think we, you may not have understood me but let me put it again. There was a Code limit for deflections that had to be met if you were going to utilise a gravity system for the columns and beams protected by the shear walls.

20 A. No I don't see that. I think that the Code limit is independent of that. I think the Code limit applies to protecting partitions and well I can't pre-judge as to why the Code limit is what it is, it's just what it is and that's what we design to.

25 Q. Let me try and come at it from the other end. Are you saying that you could utilise a gravity system of the kind you used in the CTV building irrespective of the amount of the deflection that that building might undergo in the lateral forces for which it was being designed?

30 A. Well I think I said earlier that there are p delta effects. If you get too much deflection then it would be a problem but I believe at the amount of deflection which the Code requires, nominates, as the maximum allowable inter-storey deflection. I believe within that deflection limit then the gravity frame will work perfectly okay.

Q. You are agreeing though that there was a deflection limit under the Code.

A. Of course.

Q. And that's what you were principally concerned with when you say that your principal concern was the inter-storey deflections?

A. Yes. That's the first, when you do the ETABS analysis that's the first result you're looking to see.

5 Q. Yes and that was really the principal issue wasn't it that you were looking for in that ETABS analysis?

A. It was a major one, yes it was perhaps the principal one. If you had, if you knew that the column and beam sizes were sufficient that you would satisfy the inter-storey deflection criterion then from then on the remaining design of designing the reinforcing and what have you was relatively routine.

10 Q. When you were considering the deflections and the design of the CTV building were you looking both at questions of capacity and demand?

A. In terms of the elements which support the building laterally, which is the shear walls, yes they were definitely designed to capacity design in that the, very similar to what was in that document prepared from the Park and Paulay seminar. The same criteria in there which are relating to shear walls, that's what was used.

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20 Q. Yes and was it your, were you conscious of the fact when you were doing this work that the Landsborough House shear core was inside the four corners of the frame as opposed to CTV where it was sitting outside it?

A. Yes.

25 Q. Did that cause you any particular concerns or raise any particular questions for you about the design that you were pursuing?

A. Yes I would definitely have preferred to have brought it in so that it was flush the same way as the Landsborough House. If I had that opportunity I would have done that for sure.

30 Q. Did you ever raise that issue with Dr Reay?

A. Yes it was discussed at the time when we were discussing the problem with the fact that it wouldn't work with the initial ETABS analysis and that additional walls were required. It was discussed what the options were

and obviously one of them would have been to do it the same way as Landsborough House and bring the core into the body of the floor and to try to turn that shear core into a torsionally resistant box as had been done for the Landsborough House but that wasn't an option because

5 that would have meant we had to redesign the building so it didn't look like Contours and it wouldn't have satisfied what the client was after.

Q. So you're saying are you that that issue was specifically raised by you and discussed with Dr Reay?

A. Yes that was part of the discussion which led to the inclusion of the southern shear wall.

10

Q. And are you also saying that Dr Reay quite specifically ruled out the idea of moving the shear core, the principal shear core within the frame of the building on the grounds that it was not acceptable to the client?

A. Yeah the, the basis of the brief from the client was that the building looked like the, the other building so we couldn't have shifted the shear core and still satisfied that brief. Therefore we, we excluded that as an alternative.

15

Q. There was a very little yes at the beginning of that before you moved on but I want to be sure that you did mean yes that Dr Reay had ruled it out on the grounds it would not be acceptable to the client.

20

A. That's correct.

Q. Now on this question of deflections was it your approach that even if the ETABS analysis showed that the deflections were right at the limits of the allowable deflections under the code that that wouldn't cause any concern, provided it was within those limits you could proceed with the intended gravity only plus supporting shear walls design?

25

A. That was my understanding.

Q. What would happen in those circumstances if the deflections did go into the inelastic range?

A. Well the limit which we are using includes for it to go into the inelastic range. The, the ETABS programme calculates the elastic deflection and you then multiply that by a factor which recognises the degree of plastic movement you expect and it's that magnified figure which has to comply

30

with the code. So it's accepted that there will be some inelastic deflection.

5 Q. And was the capacity of that building to cope with the inelastic range, was the fact that you say you had designed the columns as pin-ended columns, was that an important element in enabling the building to handle that inelastic range?

10 A. No it was, it was a means of justifying leaving the columns and beams out of the ETABS analysis. It's a case of when you're designing a building you either, well it's hard to describe really, you need to determine what the, where the loads are being resisted, rather than let the building decide you need to make the decision and put the strength where you believe it needs to be.

Q. And in your case you thought the strength needed to be in the two shear cores?

15 A. The lateral load resisting strength was to be in the shear walls.

Q. Anywhere else?

A. No.

Q. All right. Now are you aware of the fact that Professor Priestley has said in evidence that your columns were not pin-ended columns?

20 A. No I hadn't seen that evidence but (inaudible 12:12:40).

Q. All right well I want you to it so you can –

A. I accept that there will be a degree of continuity which is possible, yes.

25 Q. I'm just going to take you to that so you can see what he says and then you can comment on it. It's the, in the transcript. It's TRANS.20120711 and it's at pages 65 and 66. Now you see right at the bottom there it's, it's the line that's actually right at the bottom, just to the transcript, it's line, it begins at line 33. He says, this is a reference to you, no, let me go back up and start at line 25. "In reading Mr Harding's evidence it's clear that he states that the columns were designed as pin-ended
30 columns. So a pin-ended column when it's displaced laterally would not develop any forces and therefore would not be required to be detailed as a ductile or limited ductile column. The requirements I understand in the code were that if the, were the columns had to remain elastic at the

predicted response displacements to the building if they didn't do that then they would have to have ductile detailing although he," and that's a reference to you of course, "may have conceptually considered that they were pin-ended they weren't detailed as such."

5 And then he goes on, on the next page, and says, "The column reinforcement was continuous through the joint and properly lapped so that there would not be any possibility of a pin connection with no moment capacity forming and also the beams were continuous through the joint so they were detailed as moment resisting. The connections
10 between the columns and the beams and the columns and the column above were detailed as moment resisting with the result that if the columns were displaced laterally they would develop forces and if those forces were sufficient to exceed the calculated strength then they would need to be designed and detailed with ductile detailing which would
15 mean a great increase in the amount of reinforcement. So I suspect that those calculations weren't done." Now I'm inviting your comment on that.

A. It says they were detailed as moment resisting. The beams were continuous through the joint so they were detailed as moment resisting
20 and I'd agree that the beams were continuous and that it was moment resisting between one beam and the other but because there was no joint reinforcement where the column joined the beam and that there was a, a construction joint there, I do not agree that the beam column joint was designed as moment resisting. Now in terms of the, the fact
25 that there's never a perfect pin, whenever you design a pin joint there's always a potential for some bending moment to be induced into the column. Provided the column is suitable to resist that minimum eccentricity and the small bending moment which results then, which is a contingent thing in, in any column design, I don't see a problem and
30 when, when you talk about, I mean there's an article, there's a, I think a commentary in the loadings code 4203 which wasn't felt to be at the time of the design a requirement and therefore it wasn't considered

further. Because this isn't, wasn't considered to be a moment resisting frame.

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5 **COMMISSIONER FENWICK:**

Q. Mr Harding, do you know what I mean by a secondary element?

A. You'd have to explain what you believe a secondary element to be sir.

Q. Right, we need the concrete standards, that'll be ENG.STA0016.28 I hope. That's it, so if you can highlight section 3.5.14.2, it's on the right-hand side about a third of the way down. So secondary elements, there are two types. There's a type of secondary element which is not connected to the main structure and there's a type of secondary element which is your columns come into that case which when the structure drifts to one side, the columns drift with it so they are tied into the same deflection as the floor above the columns because they're tied into the structural walls.

10

15

A. Yes.

Q. So that's the type of secondary element. Then we have the floors below that, that's 3.5.14.3 please. Now I want to know whether you considered this clause when you were designing your columns and your beams. Did you consider them as a secondary element and did you attempt to comply with this clause or you just ignore it.

20

A. I didn't consider that that clause was relevant because I didn't consider that it was a seismic resisting frame.

Q. So you felt it was quite satisfactory just to ignore the concrete standard in this part of the design?

25

A. No sir I don't believe we're ignoring it.

Q. If the clause says in effect you have to check out the deflection whether your columns can take the deflection, which is what it's saying, you feel it's satisfactory to ignore it?

30

A. Yeah.

Q. Or did you just neglect it because you didn't realise it was there?

- A. I think the answer is that I was following the calculations previously given and if that wasn't there I probably didn't know it was there.
- Q. So you were not familiar with the concrete standard when you designed this building?
- 5 A. Obviously not to the extent of looking at that, I think the, perhaps it was something which would have been discussed and I think given that that was the system which had been used in the past, I accepted that that was something we would continue to do.
- Q. Who would you have discussed this with?
- 10 A. With Alan.
- Q. So Alan would have said, just ignore it?
- A. No, I'm not saying that. I think the answer was that it doesn't apply because it's not a seismic resisting frame.
- Q. I beg your – it doesn't apply because—
- 15 A. Because we weren't designing it as a frame.
- Q. But it's a secondary element which is displacing with your primary lateral force resisting elements –
- A. I understand.
- Q. – the floor slabs are rigid, the walls deflect, now does that frame deflect or not?
- 20 A. Yes it does.
- Q. If it deflects it is a secondary element in terms of that code clause so what you're saying is you designed you believed to the standard but you didn't – were not aware of the – of this part of the standard. Is that what you're saying?
- 25 A. I think that's probably true sir.
- Q. Yes, do you feel that is a satisfactory answer to be able to be not be aware of the standards to which you're designing?
- A. Well as I've said that was one of the first ones I had done, and that perhaps would have been one of the things that would have been good to know about. I think certainly if, there's, yeah, I don't believe it is
- 30 satisfactory, no.

Q. Have you not read the reports from the Department of Building and Housing, reports written by Mr Smith and Dr Hyland?

A. They talk at how much lateral deflection is going to be causing yielding in the joint and the fact that they believe that – yes I have read it, as I said, I believe that –

5

Q. And you still believe that what you did was correct?

A. I don't believe that that particular detail was material in the failure of the building. I accept that it would have been better to have ductile detailed columns and I – given my own choice would have had ductile detailing in columns throughout the whole building, but ...

10

Q. Now did Dr Reay say you could not have ductile detailed columns throughout the building?

A. No, I'm saying that if it wasn't required you wouldn't do it and I don't – I cannot say whether we were specifically discussing that detail because it's too long ago to remember but I do recall the discussion being that they were not to be designed as frames and they were to be designed for gravity loads only.

15

Q. So if you designed them as pin ended columns then clearly they would be able to take any drift that was applied to them, couldn't they?

20

A. Yes.

Q. That correct.

A. But the –

Q. You accept they weren't designed as pin ended columns because they – you would have had to have crossed the reinforcement to form a pin.

25

A. Well as I say there's never a perfect pin joint. It was considered preferable to continue the main reinforcing through than stop it and put something simpler in the middle of the joint. As I've said, it was a relatively standard detail.

Q. So can I summarise this, the inter-storey deflection you designed to be limited to five-sixth of a percent?

30

A. Yes.

Q. And you accept, you believe that when you'd done that that was all you needed to do?

A. Yes.

JUSTICE COOPER:

5 Q. Just arising out of that, a related question, I understand that Dr Reay intends to give evidence in which he will say that at the time the CTV building was designed you were more familiar with the concrete code than he was. Do you agree with that?

A. Well as I say Sir I can't comment on what Dr Reay's knowledge of buildings is. I would have thought –

10 Q. No, not knowledge of buildings, knowledge of the code.

A. Again I can't see how his experience and understanding of the concrete code could be less than mine when I'd really only come back into structural design very, very recently and he had been designing three storey buildings with the same configuration and the same type of construction apparently over the past few years. I was expecting that his experience and knowledge of the codes required was somewhat greater than mine.

15 Q. You can't remember on the basis of any discussions that you had with him whether he appeared to be more familiar with the concrete code than you were?

20 A. He was very familiar with the concrete code, that was – concrete is his forté.

CROSS-EXAMINATION CONTINUES: MR MILLS

25 Q. Back to this question of ETABS and the way you did that. You're aware aren't you that the evidence that Mr Henry's going to give will say that at the – in the ETABS model that you were using at the time, that it calculated deflections at the centre of mass only?

A. Yes.

30 Q. And he also says that in order to determine the deflections you were really working with, there then needed to be a separate hand calculation done to determine deflections at the corners?

A. Yes.

Q. And you have said I think at paragraph 17 of your evidence that you were not aware of that, is that correct?

A. Yes.

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5 Q. And because that, no I won't no okay so I'll just leave that there. Were you aware though at the time that you were working on this building that deflections were typically going to be greater at the corners of buildings than they were at the centre of mass?

A. When you think about it, yes.

10 Q. What about at the time, were you aware of it?

A. No I think I was basically too busy trying to get the computer program to work and to give any kind of result. When it gave one that was below the code I was grateful.

15 Q. So you accept then that on this issue which you've described as your principal concern in designing the building, which was determining the level of inter-storey deflections, that you did not accurately calculate them because you were not aware that you needed to calculate to the corners?

20 A. I accept that if you do the calculation, an additional calculation above what the computer analysis will give you, you may end up with a bigger number. Yes I, I think that's one of the, when I talked about having a more experienced engineer review your work that's the kind of thing which you perhaps are looking for.

25 Q. Yes, and just to be sure, I close this off, Mr Henry will say that he's unable to see any evidence in your calculations that you checked corner deflections and I take it you accept that's because you didn't?

A. Yes.

Q. Now you say in paragraph 18 of your evidence that, might be your supplementary brief, yes it is your supplementary brief at paragraph 18?

30 **WITNESS REFERRED TO PARAGRAPH 18 OF SUPPLEMENTARY BRIEF OF EVIDENCE**

Q. This is where you're commenting on various paragraphs of Mr Henry's intended evidence and you say, "I'm not an expert in the dynamic

analysis of buildings,” and then you go on to say that your contention is that the calculations of building deflections is still subject to considerable uncertainty. Now the question I want you to answer is whether at the time that you were designing the CTV building were you aware that the calculation of deflections was subject to considerable uncertainty?

5

A. No. I guess I was awed by the fact that this computer program was able to calculate deflections at all, certainly that it was, what it was able to do compared to in the past when if you were designing something by the static hand method you really didn't know what the deflection was likely to be and I guess that's one of the reasons why even if a building was less than four storeys high I would've thought that it was pretty important to get it through the analysis. But in terms of the limitations of the program and the effect of various variables that go into it, certainly following the earthquake I'm much more aware of the effect of cracking in reinforcement of foundation rotation and many other things which affect the actual deflection.

10

15

Q. Do you accept that as a result of the answers you've just given me and the answers you gave to Commissioner Fenwick, that you were working well outside your level of competence in what you were doing here?

20

A. That's the reason why I expected review. As I've said to you before I would not have taken this job on if I was acting on my own behalf. I've said that at the beginning.

JUSTICE COOPER:

25

Q. So Mr Harding, is the answer to Mr Mills' question yes?

A. Yes.

CROSS-EXAMINATION CONTINUES: MR MILLS

Q. Just one other thing I want to take up with you on the ETABS issue. It's an issue that came up in the course of my friend Mr Rennie's questioning of you about the Westpark building, and you recall that you were pressed with the proposition that you had done ETABS work

30

before you did the CTV building and you were equally adamant you had not?

5 A. Yes I, I now know that I was relying upon my, my memory without the benefit of any documentation and timesheet and now I've seen the calculations for the Westpark Tower I accept that they were done, it appears from the dates prior to the CTV building.

Q. Now I think that much is correct. I just want though to clarify this a little further, and I want initially to bring up document BUI.CAS056.0003.1?

WITNESS REFERRED TO SLIDE

10 Q. Now you'll see that these are calculations that have been done for Westpark. If you want to confirm that I can take you then to page 46 before I come back to this.

A. No, that's the Westpark.

Q. You accept that, that it's Westpark?

15 A. Yes.

Q. Now the writing on the first page and all the way through to page and including page 45, have you actually got a copy of it there do you?

A. I do.

20 Q. All right then I'll just let you flick through those first 45 pages and ask you whether that is your handwriting?

A. No, I believe certainly that is the first page of John Henry's and there are perhaps 45 pages I, I –

25 Q. Yes, well that's what Mr Henry will say, that the first 45 pages are his and that he was working on this when he was working for Alan Reay and left it and effectively left it to you as it turned out when he departed. So if you go to page 46, we'll just bring that up on the screen.

WITNESS REFERRED TO DOCUMENT

Q. Is that your writing?

A. That's my writing.

30 Q. Yes. So on that basis it looks as though from page 1 that the first entry which is done by Mr Henry is the 21st of August 1985 and then if we turn to page 47 you'll see that's dated and it's dated the 20th of February 1986 and that's your handwriting?

A. Yes.

Q. Now Mr Henry will say, and it hasn't been had to be raised with him before but it has been now because it came up in the course of questioning yesterday that he had commenced the ETABS analysis for Westpark, he'll have to clarify how far he had gone, and it appears that you then picked it up and took it from there. Is that your memory of it now?

A. Oh, look, I'm just going by what's ahead of me. I actually have no, this is new evidence I've just seen, but it appear that way yes.

Q. Do you think it's possible that the reason for your being so adamant in response to the questions from my friend Mr Rennie that CTV was the first ETABS you had done despite the dates apparent and that were shown to you with Westpark is because you weren't the person who initiated the ETABS work on Westpark, that was Mr Henry?

A. Yes he had done the preliminary design, it appears the concept design, the preliminary calculations which is what those are, and as part of those preliminary calculations created an ETABS model of the building which he had run through to confirm that the inter-storey deflections were okay so that he knew that the weights, the column sizes, the beam sizes and everything would work. So I basically ran with those same, same elements.

Q. So in terms of answering the question as to whether CTV was the first building in respect of which you had been fully responsible for doing the ETABS analysis that would be correct that it was would it?

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A. That's correct yes.

Q. Now I'm going to put to you at this point some of the evidence that's been given so far to this hearing about this building and about the adequacy of the design detailing, including some issues around Code compliance. I'm doing this because of your firmly stated view that the building is one that is well designed and, as far as you're concerned, fully Code compliant. Now does that remain your position in light of the questions you've had in the last hour?

- A. I think there's always going to be, the more you look at any design the more issues there will become in terms of whether it complies. It's like I've said earlier. If you send the same house, using a house 'cos you're not going to get a repetition of a multi-storey building, to three different Council's you'll get three different lists of queries. If you –
- 5 Q. So it does remain your position?
- A. If you satisfy the criteria that you believe that are in dispute with three lots of people, a fourth one comes along and finds something which he believes isn't compliant. That's always going to happen.
- 10 Q. So it remains your position, I take it, as stated earlier this morning, that the building is fully Code compliant.
- A. I think the wording that's on the producer statement is normally, I believe, on reasonable grounds.
- Q. And you still believe it.
- 15 A. Yes.
- Q. And you believe that the building is a well designed one.
- A. Yes.
- Q. And you believe it met the best practice standards of the day.
- A. Yes.
- 20 Q. All right well then I do need to put to you some evidence that's been given which is to the contrary. You can comment on it if you wish to but I need to put it to you. Now first of all we've heard evidence from both Mr Frost and Dr Heywood who did the nearest thing we have to a post-collapse forensic analysis of the CTV site and one of the, two things that
- 25 they noted. First of all they found no intact beam column joints. Were you aware of that?
- A. No.
- Q. They also found no evidence that the confinement of the columns was carried up into the joint zone. Were you aware of that?
- 30 A. I'm not surprised by that. I understand that's how it was built.
- Q. All right. they identified problems in the connection of the in situ concrete with the precast bonding because of smooth ends to the joints which had, as a result, failed to bond. Were you aware of that?

A. No.

Q. Professor Priestley, and these issues relate to the north core, north shear wall, and this is from the transcript, just for the record at day 57 page 54, he described the connections to the north core as “very remarkable” and that was not put in a positive way I can assure you.
5 Were you aware that he’d said that?

A. No.

Q. Professor Mander, who was called as a witness, an expert witness for Alan Reay, Dr Reay and his firm, and this is day 62 at page 37,
10 described those same connections as “remarkable”. He pulled back from ‘very’, the amplifier, but he too described the connections or the absence of them as remarkable. Were you aware of that?

A. No.

Q. Mr Geoff Banks, who was at the time employed by Alan Reay Consultants Limited, at the time that the Holmes Consulting Group problem was identified that my friend Mr Rennie took you to, he stated
15 in a formal response to counsel assisting the Royal Commission, a response required under the exercise of statutory powers, that in 1991 the connections of the diaphragm to the north core were non-Code compliant. Were you aware of that?
20

A. No.

Q. He also stated that there had been no relevant changes in the applicable Code provisions between 1986 and 1991. Were you aware of that?

25 A. No.

Q. You, of course, have just been reminded this morning about what Holmes Consulting Group identified with that connection and the fact that they thought it had the potential to have the building collapse in a moderate earthquake so I don't need to repeat that. Were you aware of
30 the fact that Opus looked at this building at one point in about 1997 or thereabouts as I recall it with a view to taking up a tenancy in it. Were you aware of that?

A. No.

5 Q. Were you aware of the fact that Mr Murray Mitchell, who will be giving evidence, did a desktop survey check of the building and identified in very short order the same serious problem that Holmes Consulting Group had identified with the north core floor diaphragm connection, aware of that?

A. No.

10 Q. Professor Priestley described the building, picking up on a term that had been used by Dr Reay and others, that the building was innovative as being innovative only in a very undesirable manner. Were you aware of that?

A. No.

Q. Professor Mander, at page 33 of his evidence in the transcript, described the diaphragm as being “very troubling”. Aware of that?

A. No.

15 Q. At page 34 he described it as being “not sufficient”. I take it you weren't aware of that either.

A. Is he referring to the connection that had been made post 1990 or –

Q. No he's describing it in the form in which you designed it.

A. No.

20 Q. He described the design methodology that had been relied on as involving a very liberal interpretation of the Code but he said “I don't agree with it”. Are you aware of that?

A. No.

25 Q. At page 36 of the transcript he says the design in relation to the diaphragm connection does not represent best practice. I take it you weren't aware of that evidence either.

A. (No audible answer 12.45.06)

30 Q. Now are you aware that the latest non-linear time history analysis that has been run at the direction of the Royal Commission has identified diaphragm disconnection as a likely initiator of the collapse?

A. No I wasn't aware of that.

Q. Now on the issue of the absence of ductile detailing at page 38 of his evidence in the transcript Professor Mander said that it was not best

practice the way it had been detailed. You wouldn't have been aware of that?

A. No.

5 Q. He said that if the interior columns had been made bigger, somewhere between 500 and 600 millimetres it wouldn't have involved an architectural issue because it was interior and "you get marvellously better performance". You wouldn't have been aware of that.

A. No.

Q. Do you agree with it?

10 A. Yes and I, that really comes back to my issue regarding the vertical acceleration. If you had a column which was designed to take a bigger axial load you would need to make it bigger and you would get better performance.

15 Q. On the issue of the beam column joint Professor Mander said, and this is pages 40 and 41 of the transcript, "even under gravity load there should be some reinforcing bars in the joints". Your view on that.

A. My view is that that's not how it had been done in the office with that standard detail so it wasn't included because it would have made the detail difficult to construct.

20 Q. He then went on to say at the same page at lines 18 and 19 "it's definitely not best practice". Do you agree with that?

A. Well I think it comes back to your definition of best practice. It comes back to –

25 Q. Well let's apply your view of what best practice is. You regard it as best practice?

1247

Q. Well let's apply your view of what best practice is. You regard it as best practice?

A. No.

30 Q. He then went on to say at page 42 of the transcript that the beam column joint in his view did not have the code prescribed amount of transverse reinforcing in the columns. I take it you disagree with that? Because that's a code compliance comment.

A. No I think that the point being that the beam column joint, it depends whether you call it part of the column or not.

Q. Yes.

A. Or part of a beam.

5 Q. Yes, all right.

A. And I think that, my contention is it's part of the beam not part of the column but I accept that it's got axial load through the middle of it but whether it needs lateral reinforcing, given that there's reinforcing in the slab and in the beam, I, I wouldn't have thought the fact that it didn't have joint reinforcement was relevant.

10

Q. At page 43 of the transcript he said that the seating sill on the western wall which you said previously was your design detail was, "Not well anchored, it was quite poor." On reflection do you have a view on that?

A. Sorry that, you'd have to show me the detail I'm sorry.

15 Q. All right I'll come back to that after lunch because I'll have to dig that up for you unless somebody immediately produces it but I'll need to find it in the drawings.

COMMISSIONER FENWICK:

20 It's in the drawings. I can give you the drawing number.

MR MILLS:

That would be very helpful.

25 **COMMISSIONER FENWICK:**

I'll just skip through and find it. Yes it's drawing number S19.

MR MILLS:

All right. Now we should have a number –

30

COMMISSIONER FENWICK:

That'll be BUI.MAD249.0191.2. There's another series of drawings so it's on that one.

JUSTICE COOPER:

We'll go for the ones with the, with Mr Harding's signature on it which is 0284.20.

5

MR MILLS ADDRESSES JUSTICE COOPER**JUSTICE COOPER:**

BUI.MAD249.0284.20. These are the ones with the Council stamp on them.

10

COMMISSIONER FENWICK:

That's it.

CROSS-EXAMINATION CONTINUES: MR MILLS

Q. All right. So that's the drawing that you wanted to see I take it.

15 A. So which detail are we referring to?

Q. Yes and this is Professor Mander describing the seating sill on the western wall as being, "Not well anchored. It was quite poor." Is there any one of those that you need blown-up to look at it more carefully?

A. So he's talking about the beam above the block wall.

20 Q. He is (inaudible 12:50:42).

A. Yes I, I, I agree that's not well anchored.

Q. At page 45 of his, of the transcript, at line 30 he described the building as, "A building with a significant number of problems." I take it you still don't accept that?

25 A. No I, in retrospect having had those things pointed out to me I, I can't deny that.

Q. That it has a significant number of problems?

A. Yes.

30 Q. And finally at page 47 of the transcript he said, "Ultimately the responsibility for compliance lies with the designer not the Council." You agree with that?

A. Yes.

Q. And do you regard yourself as the designer?

A. In part, yes.

Q. And who else do you regard as the designer?

A. Dr Reay.

5 Q. On the question of vertical accelerations to which you have attached a great deal of significance, again referring to Professor Mander, and I'll just get this brought up. This is the transcript, it's TRANS.20120724.49 and its lines 7 to 14. You'll see that first of all he was asked whether he
10 terms of their effect on the CTV building in either September or February. Do you see that at the top of the page? If you just read those first few lines.

A. Yes.

15 Q. He said that he agreed with that and then he was asked, "Would you agree with me also that whatever those vertical acceleration forces were on the building that they're likely to have exacerbated any existing structural weaknesses in that building?" Answer, "Absolutely." Question, "And I think we're also agreed that there were a significant number of structural weaknesses in that building." Answer, "Yes."

20 Now do you accept that that's a correct series of answers to the effect that any vertical accelerations may have had on this building, that whatever they were they would have exacerbated weaknesses in the building and there were a significant number of structural weaknesses in the building?

25 A. I guess that's true, yes I can't argue with that.

30 Q. So given those various points that you're now accepting is the only significant remaining issue in determining the issues around this building the extent to which it didn't comply with code? We've identified a number of weaknesses. You're now agreeing I think that those were weaknesses in the building. You're agreeing that in some respects it doesn't comply with best practice. In that context I ask you, in your view, is really the principal issue that remains to be determined the extent to

which that led to a building that didn't comply with code and in what respects it didn't comply with code.

5 A. I don't know what you mean by issues. I still am of the view that if the building, with the defects that you are alluding to and referring to, if that building had been designed for the degree of vertical acceleration to which it had been subjected then those defects wouldn't have been material, that it would not have caused failure.

10 Q. Do I take it that you're saying that if we'd all known the level of vertical accelerations that were coming and designed to meet them then it would have met them?

A. Yes.

Q. Well that's a –

15 A. No, no, no sorry. I'm not saying it would have met them. I'm saying it would not have met the degree of vertical acceleration that was coming. If we had known that we were going to have that degree of vertical acceleration –

Q. Yes.

A. – then the columns would have been bigger and various other details would have also been different.

20 Q. So if we'd known what was coming and had designed to meet it, it would have met the vertical accelerations without collapse. Is that what you're telling us?

A. I'm not saying that this building was designed to take those vertical accelerations. I'm saying it was not designed to take them.

25 Q. Yes but as I put to you before no other building collapsed in the way this did and you agree with that.

A. And I started to try to explain to you why I thought that was the case and you interrupted me.

30 Q. Well that's because as is not infrequently the case I'm afraid that before you explained I wanted to know your answer and if you want to give me a yes/no to that and then add an explanation I won't stop you.

A. Well I can't give you a yes/no because we can't say, for example, that the PGG building may have been affected by vertical accelerations. I don't think that's been looked at either.

1257

5 Q. But the question I was putting to you which I would have thought was pretty simple is that there's no other building in Christchurch which collapsed in February in the way in which the CTV building did?

A. Well that's without dispute but the cause of that is what I'm discussing.

10 Q. Well I agree. There may be other issues about cause and if you want to have a further say on that, I certainly won't stop you but the answer I think to the obvious point was you agree. All right, now if you, and I take it that's right, you agree, no other building in Christchurch collapsed in this way.

A. Yes.

15 Q. Now if you want to say anything further, then subject to a contrary view from the Commissioners I'm not going to stop you from saying that.

A. Well I'm saying that the degree of vertical acceleration was greater at this side of town, that this particular building, the design of it as a gravity – that stabilised shear wall building was more susceptible because the
20 columns were designed solely for axial load with no – if they had been designed as a ductile frame as – and the lateral force resisting system of that building was in fact a ductile frame, then the columns would obviously have been bigger and the effect of vertical acceleration wouldn't have been the same. If the building had been designed for that
25 degree of vertical acceleration the columns would have been bigger. That building is more susceptible to that problem because there is a very high dead load component in the design. The dead load of the floors relative to the live load is very high. That makes that type of building more susceptible to failure under vertical acceleration, and my
30 contention is that if the building had been designed for the degree of vertical acceleration that it went to, it, for the particular kind of design this building had, it would have made a big difference to the size of the columns. It wouldn't have made such a difference to a building which

had lighter floors, which had timber floors, which had been designed as a ductile frame building. You are pointing at deficiencies and non-compliances with the code as if that is the only cause or the major cause of the failure and I'm suggesting that is not the major cause of the failure.

5

Q. Anything else you want to add at this stage?

A. No thank you.

HEARING ADJOURNS: 1.00 PM

10

HEARING RESUMES: 2.15 PM**MR MILLS:**

I've given more thought to this over the adjournment, Sir, and it's not
5 necessary for me to take it any further.

CROSS-EXAMINATION: MR ELLIOTT - NIL

Your Honour I will have some questions for Mr Harding during the Code
Compliance session but, given the evidence so far today I've no questions.

RE-EXAMINATION: MR KIRKLAND

10 Q. Mr Harding, it's, this is in response to a question from Mr Mills. I think
he took the answer part of the way and it's also, it followed on from a
question from His Honour. Before I get to that is the foundation stone or
one of the foundation stones in your evidence is clearly when you came
to Dr Reay's office for the second time you were inexperienced with,
15 one, the ETABS system, is that correct?

A. Yes.

Q. And, two, multi-storey buildings, the design of multi-storey buildings.

A. Yes.

Q. And you were relying on Dr Reay. I think Mr Mills referred to
20 'supervision' and you preferred to categorise it as 'review'. Is that
correct?

A. That's true.

Q. And that led to His Honour question and the point that Mr Mills took up
in respect to, effectively, as I understood His Honour, the thrust of the
25 question was if you were requiring supervision/review did you call out for
it? Is that correct?

A. I wasn't calling out for it no.

Q. And in answer to His Honour's question I think there was only the one
example that you gave and that was a discussion or help from Dr Reay

in respect to designing a shear wall on the south part of this building, is that correct?

A. Well just to agreement that that was an appropriate way of resolving my concerns regarding the torsional eccentricity of the building.

5 Q. And I think that from your evidence yesterday flowed from, I think you said you had six ETABS results, and I think "two were duds" and, therefore, you sought the assistance of Dr Reay.

10 A. Yes well I can't guarantee six but I do recall there being a very high wad of paper and of trial runs on the shelf for some time. I would say six is a reasonable estimate.

Q. So you sought, if I can call this part one, assistance from Dr Reay in respect to discussion regarding the insertion of a wall on the south part of the building, a shear wall, and its design, is that correct?

15 A. Yeah I was looking for his agreement that it was going to be satisfactory to include another wall on the building in that location without compromising his brief to the client.

Q. So you were seeking review on the part of Dr Reay, is that correct?

A. I guess, yes, that is correct.

20 Q. I come to the second part of the review that I don't think Mr Mills carried through from your evidence the other day. My understanding from your evidence under the head 'Review' there were two further chains. The first one was Dr Reay discussing matters with the draughtsmen and then coming to discuss matters with you. Is that correct?.

A. Yes.

25 Q. And would you put that under the head of review?

A. Yes I understood that to be confirmation that he was monitoring the progress of the design.

30 Q. And the second chain was Dr Reay going directly to draughtsmen but not coming to you. Would that be fairly cast under the head 'Implied Review' in your mind?

A. Yeah that's how I would anticipate that the thrust of the review would take place in terms of the design of the building and if he had any queries he would have checked the calculations but, yeah.

COMMISSIONER FENWICK:

- 5 Q. Mr Harding, can you just briefly outline to me the sort of steps you would have taken in this design. So I assume, perhaps, you might have started with the modal analysis, so you might have done the (inaudible 14.20.46) before that but you'd start the modal analysis, would that be correct?
- 10 A. Yes to model the building as it was given to me on the drawings without the south wall, model that in ETABS and measure the inter-storey deflection to see what came out of the program once it had –
- Q. If we can come back to that detail later on. Having run your ETABS analysis what was the next step you went through?
- A. In terms of the first time I ran through with the walls –
- 15 Q. No we'll just assume you've done the last ETABS now so you've got your deflection down to your limiting 0.83 percent drift. What was the step you went to after that?
- A. That would be to work my way through the design of the gravity elements then of the shear walls, then of the foundations.
- 20 Q. You didn't do a capacity design?
- A. The capacity design was part of the design of the shear walls. They were the lateral load resisting element so that it was essentially making sure that the shear capacity of the walls was greater than that implied by the over-strength bending moment of the wall. So you calculate the
- 25 over-strength moment of the wall and...
- Q. Thank you we'll come back to that in more detail later on. I just wanted to get the overall steps but you did do a capacity design.
- A. Yes.
- 30 Q. When you did your ETABS analysis I think you've already said that you did assume that the floors, the walls were rigidly attached to the ground. There was no flexibility in the soil. You didn't allow for any flexibility in the soil in your analysis, is that correct?

A. Well I understand that the ETABS program at that time didn't have provision for that.

5 Q. Yes, I mean I think that was probably, perhaps you can even confirm, this was the common assumption at that stage that that's what you did, you just ignored deformation in the soil.

A. No I didn't ignore it. The Code at that time does say that the design shall be made assuming that it's a rigid fixing. I think that's mentioned in 420, ah, excuse me –

10 Q. Yes it's not, I know the reference there. It doesn't quite say that but it does say in deformations you don't include it.

A. That's correct, so that was the, why we didn't do it.

Q. Now when you went into your ETABS analysis did you do an equivalent static analysis before you looked at the ETABS?

A. Yes.

15 Q. You did?

A. Yes.

20 Q. And from that you deduced that it was a highly eccentric building. You didn't comply with the requirement in 3.4., well do I need to put it up? You checked the rotation was too high to assume it was just moderately eccentric. It was highly eccentric. You checked that criteria?

A. Well I think the criterion I used was that if the shear induced in any wall due to torsional effects was more than the shear induced by translational effects then it was, it was a torsionally eccentric building for the purposes of that clause.

25 Q. So you checked that criteria?

A. Yes.

30 Q. That was 0.75 of the thing but that's fine, you've got the, got that off so that's good. Now how did you determine the inter-storey drifts from your modal analysis. First of all did you follow the process set out in the loading standard, NZS4203:1984?

A. I believe so. It was a case of working out the elastic deflections and not applying them by the K over SM factor.

Q. Yes it's more a question of how did you find the elastic deflections.

A. Well from my recollection it was just a case of following the dots with the ETABS programme, putting... Are you asking about the properties of the stiffness of the walls or -

1425

5 Q. No, no I'm assuming you've got properties of the stiffness of the walls correct. You say you took them from a paper published by Paulay and, sorry I've forgotten the other name, but there was a paper which identified the stiffness and I believed you used those properties, so I'm
10 I'm just wondering how you actually worked out the, did you follow the process in the code for calculating the inter-storey deflections? And perhaps we should have ENG.STA.0018.60 please?

WITNESS REFERRED TO SLIDE

15 Q. So we want clause 3.5.2.6.1. So that clause says, "The horizontal forces and overturning moment shall be derived from the shears given by clauses," and there are two options there, 3.5.2.1 which is the equivalent static method and 3.5.2.5 which is the modal method?

A. Yes.

Q. Did you use those values?

20 A. Yes both.

Q. So if we now go to .63 please?

WITNESS REFERRED TO SLIDE

25 Q. So this says then, oh, 3.8.1.1. I must just say the way this is handled in this code is very different from the way it's handled in later codes. This is a slightly roundabout way which tends to be a little bit on the conservative side. So that one says then, "Computed deformation shall be those resulting from the application of the horizontal action specified in section," in our case, "3.5 that's the modal, multiplied by that factor."?

A. Yes.

30 Q. You agree?

A. Yes that was used.

Q. Now how do you find those forces which were specified in the previous section identified?

A. Oh, I'm sorry Sir.

Q. You found the modal shears and now you're going to use those modal shears to find your deflections, that's what the clauses, two clauses relate isn't it?

5 A. Yeah, look, I haven't been through this calculation for 26 years. In that I can only refer you to my calculations I did at that time and I would...

Q. Do you think you might've taken the inter-storey deflection straight from your modal analysis?

A. I can't answer that Sir.

10 Q. That's a fairly crucial question. If you took them straight from your modal analysis and then multiplied them then you've not done this according to the standard?

A. Well I don't have the calculations with me and I, I haven't studied that so I can't answer that question directly I'm sorry.

15

JUSTICE COOPER:

Mr Mills, those calculations are on the system aren't they?

MR MILLS:

20 Yes we've got them (inaudible 14:28:51)

JUSTICE COOPER:

Q. But probably, do I take it that you haven't been through your calculations again in preparation for giving this evidence?

25 A. Not all of them Sir, no.

MR MILLS:

Would you like me to give the witness a hard copy and we can also bring it up on the screen?

30

JUSTICE COOPER:

Q. Well I'm not sure whether it would be fair if he hasn't looked at this point. What do you think Mr Harding?

A. No, I wouldn't, I'd be reluctant to answer.

Q. Are you prepared, you're coming back next week I think?

A. Yes.

5 Q. So could we ask that question next week on the basis that you will look at your calculations in the meantime?

A. Yes.

QUESTIONS FROM COMMISSIONER FENWICK CONTINUES:

10 Q. We talked before about having calculated a drift, inter-storey drift and the need to check whether the columns can resist that drift, and as I understand it you said you didn't think it was necessary to check that and you didn't check it and am I correct you now accept that was an error to not check it as a secondary element. Am I correct?

A. Yes Sir I think –

Q. That was a mistake?

15 A. I accept that it should've been done.

Q. Now you also said that if the columns were larger in diameter the building would've been fine. Do you still hold to that concept?

A. Yes.

20 Q. Can I point out to you that if you'd made the column larger it would've been stiffer, it would've attracted more moment. If you think of the limiting strain you can stand in the concrete, the larger that beam the earlier you'll get that, the larger that column the earlier you'll get to that strain and the earlier it will start to crush the concrete. Now do you accept that is correct?

25 A. I do but I, I think we're all assuming that it was the horizontal loads and their resultant strains in the column that caused the failure and my contention is that the original earthquake in September didn't cause that failure, that it was the axial load, the vertical load which caused the failure and that the horizontal loads weren't the cause and that having
30 bigger columns would've meant that it was more able to take the vertical loads.

Q. So your position is then that the bigger columns would work because the horizontal displacement was not an issue?

A. Yes Sir.

5 Q. When you did your capacity design, what was your critical ductile mechanism that you had assumed?

A. A plastic bending at the base of the vertical shear walls and in the coupling beams and at the base of the coupled shear wall.

Q. So in the north-south direction you get the forces from the floor slabs going into that north core, pulling it over?

10 A. Yes.

Q. So the fundamental requirement of capacity design is what? What do you have to do to design, you're wanting a plastic hinge to form at the base of that –

A. I accept what you're saying Sir –

15 Q. – floor?

A. – that the diaphragm force in the floor should've been greater than that required to cause the plastic bending at the bottom and I accept that it wasn't that high.

Q. Yes, you didn't check that out?

20 A. No I didn't think far enough to include that as part of the capacity design.

Q. Now did you follow the steps in NZS4203:1984 to calculate the diaphragm forces?

A. I can't answer that at this time.

Q. Would it help if I put up the appropriate section?

25 A. I would probably have to have another look at the calculations as well for that and talk about that next time as well perhaps.

JUSTICE COOPER:

30 Q. Can you just explain why you didn't look at your calculations again before giving evidence today?

A. Yes Sir, there's so much correspondence and so many, so many, so many reports I'm at the limit of my capacity to cope with it all and I'm just limiting. If I start looking at every report and every, every opinion that's

been given my – I'd find it difficult to answer any question sensibly. So I've answered the questions as I've been given them in the various correspondence during the various letters. If I had been aware that you were going to ask me questions on the calculations I would have looked at them. If there was other evidence you wanted me to review I would've done that, but I'm sorry I haven't able to look at everything.

5

Q. So the beam column joints, you gave no attention to those other than to anchor a couple of beam bars in the joint. You didn't consider whether they were adequately anchored or what influence those bars might have on the behaviour of the joint, am I correct?

10

1435

A. I took the view Sir that if there was any kind of plastic damage to the column that it wouldn't affect its axial load capacity or the, or the lateral load capacity of the building.

15

Q. Can we have BUI.MAD249.0493.3 please. That's the internal beam column joint drawn out pretty well to scale and you'll notice there if you have bending in the column, the moment in the bottom column going in an anti-clockwise direction, so you get tension on the left and compression on the bottom, and the opposite in the top column. You'll notice I've drawn in a flexural crack there which goes in the corner. That you'll agree would be a reasonable place for a flexural crack to form, from the bottom of the beam going through up round the reinforcement, that zone's in tension?

20

A. Yes.

25

Q. So that crack's not going to do much for the development of that hooked bar is it which is hooked into the middle of the column? It's going to rather destroy the bond on that bar isn't it, greatly reduce it.

A. Are we talking about the bottom bars?

30

Q. Yes, the bottom bars, bottom bar, the beam on the left-hand side, the bottom bar's shown in tension, you've got compression on the top, you've got that tension force somehow has got to be resisted by that hooked bar, it's located directly above a column which is in tension. Do

you agree you're going to get a concrete, a crack in the concrete at that point?

A. If the horizontal bar's not adequate to take the bending moment.

5 Q. But to take the bending moment wouldn't you agree that there has to be a tension force in that bar?

A. Yes.

Q. If you've got a tension force in the bar somehow you have to anchor that tension force into the concrete don't you?

A. Are you suggesting that bar's not adequately anchored?

10 Q. Would, would you say that bar is adequately anchored?

A. Yes.

Q. You'd say it is adequately anchored?

A. Yes.

15 Q. What is the development length. Would you be able to assess a development length for that sort of bar, in a crack zone, which has got a flexural crack around it?

A. Well I would normally take it as the 14 bar diameters or whatever it is past the start of that 90 degree bend.

Q. The 14 bar diameters times 28 millimetres.

20 A. Yeah maybe it's not 14. I haven't got that code ahead of me.

Q. You've actually provided about two-thirds of the development length, if it's a good zone for anchoring it in, I'd say it's not because it's got a crack. Now if you've got that bar anchored there's got to be some compression force in the concrete to resist it hasn't there? Did you think about this when you anchored that bar, how, what force was going to anchor it in place?

25 A. Well as I've said to you Sir it wasn't designed to take a bending moment from the column.

30 Q. How did, how were you going to stop the column taking a bending moment? As you were applying a drift of .083%, which is 27 millimetres, how were you going to stop it not taking, how were you going to avoid it taking a moment from the details?

A. Well as I've said to you and as you've asked me before I didn't do that calculation for the structural, for the secondary frame to take it anyway.

Q. Right so can I, can I assume it's something you just completely ignored?

5 A. Sir if I'd known it was there, but I, I didn't know that clause was there. I think that not having used it before I, I obviously failed to see the significance of it.

10 Q. Mr Harding whether the clause was there or not's irrelevant. Surely your structural ability should tell you there was a bending moment there regardless of what's in the code. You've got to have some, surely you need to be able to apply some knowledge of what you're doing to your design? Would you not have to think, you have to think out what the forces are and see what they are then perhaps go back? Would you not do that and then go back perhaps to the code?

A. In hindsight, yes.

15 Q. Can we have BUI.MAD249.0565.2 please. Now this is showing a construction joint, a joint in the, between the pre-cast beams. That's the beam you see there with the steel coming out that's bent and this was just photographed recently on the site at Burwood. You can see the form where the beam has been rounded? Mr Mills described to you before the wings on the bottom of the beam. That's the beam there. You can see where the beam was cast to the clean round surface against the beam. Can you see that?

A. Yes.

25 Q. Now the specification says all surfaces cast against concrete shall be roughened. Now there was no indication on the drawing that that surface should be roughened. If you look at the specification and it said you roughen it by brushing it while the concrete's still plastic. So would you accept that those beam ends were not roughened?

A. They do not look roughened, you're right.

30 Q. And would you agree that that's as it's shown in the drawings?

A. Sorry, repeat that.

Q. Would you agree that that's how it's shown in the drawings, that there's no indication on the drawings to show those surfaces should be

roughened? It's covered in the specification but I mean the method given in the specification clearly could not be applied here could it?

A. Well I, I haven't got the specification but it, it isn't, it isn't roughened. I agree with that.

5 Q. Yes. Can we go to WIT.FROST.0001.60 please. Now Mr Mills showed you a picture before which showed the corners being broken off when that, when you put a negative moment on that beam across the column you're going to have compression at the bottom of that beam and you've got that hard, smooth surface where there's absolutely no bond between
10 the new concrete and the old and that's going to push outwards and you agree it will tend to push off those, what we call the wings, off that member.

A. Yeah.

15 Q. If you look at that drawing that's roughly what they saw on the drawing. Those cracks are roughly put into position where they observe they formed. You've got roundabout 150/200 millimetres between the cracks, the wings having fallen off. So what you've got is you've got the dead load of that beam being resisted by bearing on the portion between the cracks, would you agree with that?

20 A. The dead load. Are you, are you referring to –

Q. The beam has a dead load in it doesn't it?

A. Before, before the concrete in the core is poured, before the concrete inside the column is poured?

25 Q. Before or after because there's no shear transfer across that smooth interface.

A. Fair comment.

Q. If you rub a pocket knife or something over it, slightly powdery surface, there was no contact between the two.

A. Yeah.

30 Q. So the load in those beams, they span about 7.5 metres. They're supporting a width of about 7.2 metres, the dead load plus live load is approximately, well I've assumed six kilonewtons per square metre. The floor was four, you've got the weight of the beam, you've got some

added dead load, you've got some live load, you'd think that would be a reasonable figure?

A. Yeah.

5 Q. So we multiply six by the area, we come to an axial load of 162 kilonewtons. Now those beams as drawn were supported on 25 millimetres of cover concrete. Would you like to guess at the compression stress at that support?

1445

A. I'm sure you've worked it out sir, no I don't want to guess.

10 Q. You wouldn't like to have an order –

A. No.

Q. – magnitude. Thirty-two megapascals. What do you feel about that stress level if all that load's carried by compression on that interface. Would you be happy with that?

15 A. No.

Q. Of course if those columns are going to spall they're actually going to spall right at the joint zone aren't they in the maximum stress. So once that goes the only load supporting that column will be tension through the topping, through the slab, the class in situ slab?

20 A. Yes, I mean I think the fact that those bottom bars haven't got full anchorage, they still would have some anchorage and I think even with shear friction across that joint there would still be quite a lot of shear transfer available.

25 Q. I doubt it because there would have been a crack there wouldn't there, a flexural crack. Could have been a flexural crack and I can tell you that that surface was dead smooth, slightly powdery, no concrete stuck to it at all.

A. Yeah, it should have been roughened.

30 Q. Do you think that might have been a cause for problems in the structure, magnitude megapascals with no vertical acceleration?

A. No, I believe that the anchorage of that bar, I mean that same detail that you're referring to has applied to other buildings which haven't failed. It's not an uncommon detail and it hasn't been the case in other

buildings with exactly that same detail. The only difference between the other buildings and this one I believe is that vertical acceleration. It's an additional load over and above the one you've described.

Q. Where were those other buildings?

5 A. Well a lot of the other buildings which have now been demolished probably, but there's a lot of buildings that Alan Reay has done, the office has done which has exactly that same beam column joint detail in it. I can't itemise them all for you but certainly many of them that we've already talked about, Landsborough House for example.

10 Q. Can we have BUI.MAD249.0123.17 please. On the left-hand side diagram the higher one's the one first we want to look at if you could please. Thank you. That shows the north wall and the slab coming into the north wall doesn't it?

A. Yeah.

15 Q. And if you're imagining the earthquake acting, push the slab towards the west, so pushing up, that force has to be resisted by the wall doesn't it, the wall on line 5?

A. Yes.

20 Q. It has to be resisted by that bay at the top because that's the one with the toilet's in it, because the next one is the stairs which is a – got a gap and then you've got the lift core which has got a gap so all the shear has to be resisted in that one bay.

A. Yeah.

Q. Correct?

25 A. Yes.

Q. So if the slab is pushing up, the wall on line 5 must be pushing down mustn't it?

A. Yeah.

30 Q. Pulling down. So if I look at that section between line C and the next slab down, the other side of the toilet, that's got to resist all the shear?

A. Yes.

Q. And where there's shear there's bending moment?

A. Yes.

Q. So the bending moment at line 4 is going to be equal to, possibly slightly greater, but equal to the force in line, the wall in line 5 times the distance to the beam on line 4 isn't it?

A. Yes.

5 Q. Would the reinforcement you put in the wall, in the slab, have been sufficient to resist that shear and that bending moment?

A. Well certainly not if it was a diaphragm force designed for plastic capacity design of the wall, no.

Q. Did you design it for that shear and that moment?

10 A. I believe so.

Q. You did, good, well it'd be nice to know what page number your calculation's on, perhaps next time. Thank you.

QUESTIONS FROM COMMISSIONER CARTER:

15 Q. Just one question Mr Harding, we've heard quite a lot about the expectations of you in your employment and what your expectations were. When you were offered this position by Mr Reay, did he offer that to you in some written form describing what he expected or was it the conversation all oral, was your duty to – as a designer spelled out in any way by either oral or written communication?

20 A. I don't believe so no.

QUESTIONS FROM JUSTICE COOPER:

25 Q. Mr Harding, when Dr Reay gives evidence one of the things that he proposes to say is that he believes that you would have been involved in setting the fee which was probably set as a percentage of the total build cost, probably a percentage of the structural value. Now first of all were you involved in setting the fee for this building?

A. Absolutely not.

Q. Do you know how the job was charged for?

30 A. I have no idea, I wasn't involved in the funding or the financing or the fee proposals or the – any discussions with the owner or the client

whoever – I don't even know whether the owner – the client was Williams or Prime West, I've no idea.

Q. Now I think you told us that since leaving the employ of Dr Reay's firm you have as a structural engineer designed two buildings which might be described as multi-storey, one of four levels and one of five levels. Is that right?

5

A. Yes.

Q. The four level building, do you remember the address of that?

A. Not off the top of my head, it's in Moorhouse Avenue.

10 Q. It's in Moorhouse Avenue, and when do you think you designed that building?

A. About - oh sorry the one, there's one of those two is built, the other one isn't built, it's designed about two years ago.

Q. This is the one that was built?

15 A. Yes.

Q. And that's somewhere in Moorhouse Avenue?

A. Yes.

Q. Now the other one, is it just a proposed building?

A. It has a building consent but it hasn't been started yet.

20 Q. Right, and do you remember the address of that?

A. It's alongside, that's 20, yeah, I –

Q. It's alongside the other one is it?

A. Yes, they're two different, two adjacent sites.

25 Q. I wonder if by next week you could let us – just look up and let us know what the addresses are. Would that be possible?

A. Certainly.

QUESTIONS ARISING – MR KIRKLAND, MR RENNIE, MR REID, MR MILLS – NIL

WITNESS EXCUSED

30 1455

MR RENNIE:

Sir, I call Dr Reay and, as on the previous occasion, there is a compiled version of his briefs, which is the material relevant to design which he is to do today – WIT.REAY.0005.

5 MR RENNIE CALLS**ALAN MICHAEL REAY (SWORN)**

Q. Dr Reay you have a copy of your composite statement of evidence available to you?

A. Yes.

10 Q. And you are Alan Michael Reay. You reside in Christchurch and you are a Chartered Professional Engineer and a company director.

A. Yes.

Q. Would you read from paragraph 9, which is the next paragraph in the sequence please.

15 WITNESS READS BRIEF OF EVIDENCE FROM PARAGRAPH 9

A. Most of the events that are relevant to my evidence occurred around 26 years ago. I set out below the events as I remember them to the best of my recollection. The passage of time means that it is not possible to be precise about many of the events. While, for some reasons some details stand out, others do not.

20

ARCL does not have full files relating to the CTV building. ARCL's record keeping and record destruction protocols related solely to statutory requirements under income tax legislation. The records that ARCL does still hold for the CTV building have, over the years since the building was constructed, been subject to decisions on retention or destruction made at the discretion of individual managers when files ceased to have currency or thereafter. ARCL shifted premises in 2000 and a major cull of historical records was carried out at that time. The actual practice followed by individual principals and staff shows an emphasis on retaining drawings, calculations and geotechnical reports

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30

for significant projects. This is consistent with the records held by ARCL in respect of the CTV building.

EXAMINATION CONTINUES: MR RENNIE

Q. Now Dr Reay, if you just pause there for a moment, you'll recall when you previously gave evidence you were asked questions about records, computer discs and so forth.

5 A. Yes.

Q. And did you subsequent to that assist in the preparation of a memorandum for the Commission.

A. Yes.

Q. In respect to the records.

10 A. Yes.

Q. And are you able to state whether the computer disk which you were asked about was identified or found?

A. No it's not found.

Q. In terms of the data which was on that disk are you able to say whether
15 it was all transferred before that disk was disposed of?

A. It was all transferred yes.

Q. And in relation to the contents transferred are you able to say whether that material has been made available to the Commission?

A. Yes it has.

20 Q. And did you assist in the preparation of a schedule attached to the memorandum setting out the plans, calculations and related documents relevant to the CTV building?

A. Yes.

Q. To your knowledge is that a correct statement?

25 A. It is.

Q. Would you keep reading at paragraph 11 please.

**WITNESS CONTINUES READING BRIEF OF EVIDENCE FROM
PARAGRAPH 11**

30 A. As noted above I established ARCE in 1971 and began practice on my own account. Initially it was just myself and a couple of draughters and tracers. Generally in these early days ARCE had no other registered

engineer. The business grew steadily and by 1986 employed around 13 professional and support staff.

5 During the early 1970s structural engineering practice was generally stable with no price competition. Fees were set based on a recommended scale and generally each significant architectural practice utilised the services of its preferred engineer and rarely used others unless clients insisted.

10 The work available was from young architects setting up, architectural designers and contractors. This was the market I pursued in establishing a consulting engineering practice.

15 During the late 1970s and early 1980s the design/build market became more prevalent where the contractor employed the architects and engineers and I undertook work for various contractors.

20 During that time I developed construction systems for the design of precast concrete, on site cast structures and also for the use of cold form steel in the light industrial and farming sector of the building industry throughout New Zealand and parts of the South Pacific.

25 Prior to the early 1980s I'd been responsible for the design of an eight storey office building in Hereford Street, a seven storey apartment block in Carlton Mill Road and a six storey concrete frame building in Liverpool Street, that was with Hardy and Anderson.

30 In the late 1984 I employed John Henry to undertake primarily medium height multi-storey buildings, a number of which I had started to take on at this time. Amongst other works he designed the Landsborough House building.

Following John Henry's departure to set up his own consulting practice around the end of 1985 I'd been advised by a common acquaintance that David Harding, who had worked with me previously, was considering changing jobs. Mr Harding had worked with ARCE for a period around the late 1970s before leaving to pursue other interests. In late 1985 Mr Harding accepted a job with ARCE which was to include the design of medium height multi-storey buildings. I considered that he had the experience, was a registered engineer and was competent to undertake the work.

5

10

ARCL was incorporated on the 18th of August 1988 and took over the assets of ARCE.

15

David Harding left the practice around October 1988 and set up his own consulting practice which I understand still operates today. Geoff Banks joined the practice at that time. Mr Banks had previously worked for Holmes and he had left to set up his own firm called Cambridge Consulting Engineers Limited. He shut down his business after he came to work for ARCL. Mr Banks later became a shareholder and director of ARCL.

20

Geoff Banks' role initially, as had been Mr Henry's and Mr Harding's, was to be responsible for the design and construction observation of the multi-storey structures that were being designed at that time.

25

For many of the projects that were undertaken by ARCE I had the role of principal consultant. Under this role ARCL employed the architect services, together with the required electrical and mechanical engineering consultancy and the quantity surveying services for the projects. I note that Landsborough House was undertaken and delivered by this methodology. This contrasted to the CTV building which was designed after the Landsborough House building and was a

30

project in which ARCE was involved solely with the structural design and not as principal consultant.

1505

Responsibility for design of the CTV building.

5 I am unable to recall how the CTV building came to ARCE. It was a design build project by Williams Construction Canterbury Limited, Williams, for Prime West Corporation Limited, Prime West. At the time I was fully engaged on other projects and would not have had the time to take on this job. Mr Harding took responsibility for it.

10

I have read Mr Harding's letters to the Royal Commission. I disagree with many of Mr Harding's statements as to my involvement in the project. I set out below the extent of my involvement in the project.

15

Despite what Mr Harding says, I was not involved in the design of the project. As with all significant projects my role was to check the quality of the client, in this case Williams, and given that it was a design build contract, ensure that the contractor had the knowledge and experience to undertake the work proposed. At the time Williams had a strong reputation for building quality buildings. I also verified that the engineer, in this case David Harding, considered himself capable and prepared to commit to undertake the work. I would have also ensured that an appropriate draftsman was allocated together with any other staff required to assist in the work the engineer was undertaking.

25

On the basis of my enquiries I would not have foreseen any significant issues relating to undertaking the job and would have been happy for Mr Harding to undertake the work. Therefore with my approval as manager and following an agreement being reached with Williams in terms of professional services contract, Mr Harding took on the responsibility for this project for ARCE.

30

It is standard practice to look at drawings, calculations and other records of other buildings for background information when starting a new job and I expect Mr Harding would have done this.

5 The drawings would have been prepared by draftspersons and tracers at the direction of Mr Harding.

Mr Harding would have carried the project through including dealing with Council, any site visits and other necessary attendances. I would not
10 have been involved in any of these stages in more than a minor way.

Mr Harding prepared structural drawings calculations and a structural specification. I cannot be certain that these calculations or drawings represent the full set of calculations for the CTV building. It is possible
15 that Mr Harding did other calculations or drawings which are no longer on ARCE's or the Council's files.

There was no review procedure in place at that time. Mr Harding was a qualified, experienced and capable engineer and would have taken
20 responsibility for the project. He was employed in a role where he wanted to, and was expected to, take on projects such as the CTV building without supervision. He was also expected to be building up his own client base. Mr Harding and any other qualified engineer employed by me was expected to seek advice if he needed it. I do not recall
25 reviewing the drawings, calculations or specification and I would not have expected to have done so. At the time Mr Harding was more familiar with the concrete code NZS3101:1982 than I was.

Q. Just pausing on that Dr Reay, what's the basis upon which you make that statement?

30 A. Mr Harding when he was previously with me undertook the design of concrete structures and when he returned he designed a four level – a four level apartment building and he – in addition to that he had when he was with me in '79 had been to a course at the university on ductile

frame design and additionally in the July of '86 he went to a three day course on the concrete code.

Q. Did you go to either of those courses?

A. No.

5 Q. Was there a reason why the firm sent Mr Harding on those courses?

A. Yes, because he was focusing on the design of the significant concrete structures.

Q. And if you can just pause Dr Reay, can we have BUI.MAD249.0555.3. Dr Reay did you assist in the preparation of this list?

10 A. Yes I did.

Q. And did you review the criteria for which buildings were listed on it in relation to Mr Harding's work?

A. Yes.

15 Q. In referring to the buildings listed on that list, what was your level of involvement with Broadway?

A. I was the principal consultant for that project so I had the overview of the project in total. I didn't undertake the structural design.

Q. Drainage Board?

20 A. That one I was the principal consultant for and responsible for, Mr Harding for that particular one's work was mainly related to doing testing of the final design.

Q. And that was in the nature of filter covers, not in actual building as such?

A. Yes.

25 Q. Were there structural elements in relation to that project?

A. I beg your pardon.

Q. Were there structural elements in relation to that project?

A. Well the fibreglass segments were all structural elements.

Q. The next one, medical accommodation, your role?

30 A. That was a project where it was a structure only job and Mr Harding handled the whole job.

Q. Westpark Tower?

A. That was where I was the principal consultant and would have been involved in the overall design of the building and I did not undertake the structural design on that building.

Q. Who did the structural design?

5 A. The initial work was done by John Henry and then the final work was undertaken by David Harding.

Q. And the CTV building you've dealt with, the Letz building being the next one?

10 A. That was another project where I was the principal consultant and David Harding undertook all the structural design.

Q. Shangri-la extension concept?

A. That was a project that I had no involvement in. David Harding dealt direct with the contractor.

Q. And finally the residential development concept?

15 A. I had no involvement in that one.

Q. And going back to your brief, would you continue reading.

JUSTICE COOPER:

20 Q. Could I just ask the question, you mentioned that Mr Harding had been responsible for the design of a four level apartment building when he was previously in your firm's employ. Can you remember where that building was, the address?

A. No. I'm sorry Sir it was when he was working part time before he joined me, when he designed the four storey apartment building.

25 Q. Oh I see. So that was when he was still at Waimairi and was working out his notice?

A. Yes.

Q. I think that building's been discussed. Just remind me where it was?

A. 32 Cashel Street.

30 Q. Oh that's on this list as medical accommodation.

A. Yes, it's an apartment building owned by, or was owned by the Hospital Board.

Q. I see, so it's accommodation for people working at the hospital?

A. Mmm.

EXAMINATION CONTINUES: MR RENNIE

Q. Now from paragraph 33 please Dr Reay.

5 A. A geotechnical report was obtained from a specialist soils engineer, Soils and Foundations 1973 Limited. This report would have been used to design the foundations of the building. I cannot say specifically how the report might have influenced Mr Harding's design.

10 In the mid 1980s the economy was strong and the construction industry was performing well and experiencing good growth. It was not a particularly competitive environment for engineers and there was not a lot of pressure on fees. I believe that Mr Harding would have been involved in setting the fee which was probably set as a percentage of
15 the total build cost, probably a percentage of the structural value. I do not believe there would have been any great pressure on Mr Harding to meet any financial constraint.

1515

Q. Dr Reay you're aware that Mr Harding denies an involvement in those
20 financial matters?

A. Yes I am.

Q. And your response to that?

A. Well I have said what I believe was my process at that time but if he's adamant that he wasn't involved I accept he wasn't involved.

25 Q. 35 please.

A. The environment can be contrasted with that of the late 1980s / early 1990s when the economy took a significant dive and the construction industry suffered as a consequence. The cost environment was considerably more competitive during that time.

30

Computer Modelling.

I am unable to recall whether any computer modelling was carried out during the design process. I was not involved in any modelling for this building.

5 I found on ARCL's historic files an invoice from the University of
Canterbury for computer charges that may have related to the
CTV building. It refers to the ARCE job number for the
CTV building, 2503. The invoice also refers to another job number,
2548, so I cannot be certain that the invoice relates to the CTV building
10 job. Based on the quantum of the account it appears to be for computer
time only which if it does relate to the CTV building would suggest that
the inputs were prepared by Mr Harding and run through the computer.
If a university staff member worked on the analysis I would expect this
to be noted on the account and the account to be higher. The computer
15 analysis was probably an earlier version of the ETABS program.

Construction.

I do not recall being involved in construction of the building or have any direct dealings with Williams.

20 As a design-build contract the engineer's role was potentially
diminished. Any site visits would have been carried out by Mr Harding
or under his direction. I do not know to what extent he would have
visited the site. At most, Mr Harding's role would have been one of
25 observation, not supervision. He may have visited the site before major
concrete pours.

I note that a Council engineer visited the site from time to time as I would have expected.

30 As noted above Williams had a strong history and a reputation as a high
quality contractor specialising in concrete construction. It's pre-cast
concrete work in particular was of a high standard.

I do not recall becoming aware about the ownership issues of Williams on the site at the time of the construction of the CTV building which resulted in the building being finished by Union Construction Limited.

5

As Built Drawings.

ARCL has no record of any as built drawings for the CTV building and it is unlikely that there would have been any. They were not normally prepared at that time and the Council would not normally have required them.

10

However, I note there are differences between the set that ARCL has in its records compared to the Council's records. The set of drawings annexed to the DBH report appears to be the set that I provided to Dr Hyland and which is held on ARCL's file. However, some of these drawings appear to differ from the Council's set. A slightly different set of drawings appears on the Council files.

15

Q. And Dr Reay are those differences now identified in the schedule which you've prepared and which has been filed with the Commission by memorandum?

20

A. Yes.

Q. Keep reading at 57 please.

A. For example on the ARCL sheet 25 there are at least three additional details and in the bottom right corner it is noted that S25 was amended on the 29th of April 1987. This compares to the Council's signed plans dated 30th of September 1986. There are also differences on sheet 26. There is no notation as to date of amendment on the ARCL S26. Neither set are as-built drawings.

25

30

Compliance.

As the design engineer Mr Harding was responsible for ensuring that the design complied with the relevant codes. I expect that Mr Harding would have taken all reasonable care to ensure that this occurred.

Traditionally ARCE did not include a design review and as a small firm relied on the Council review process. ARCE was different in this respect from other larger firms where there was a core group of engineers who review each other's work.

5

Reading from the second statement of evidence on Landsborough House.

Landsborough House.

10

This building is on the corner of Gloucester and Durham Street and was designed in 1985 by John Henry when he was with ARCE. Mr Henry discusses his design work on Landsborough House in his evidence. He makes observations about the design of Landsborough House and states that parts of its design were utilised in the work Mr Harding did in designing the CTV building including that Mr Harding adopt many of Mr Henry's calculations for Landsborough House when designing the CTV building.

15

20

I've reviewed the structural drawings and calculations for the Landsborough House building. The design was generally similar to the CTV building. I comment on some particular features and how they compare to the CTV building.

The height:

Landsborough House was eight storeys and the CTV building six storeys. The CTV building had 40% larger floor plates.

25

Asymmetry:

The design asymmetry of the buildings is similar with the Landsborough House building being slightly more asymmetric.

The beam column structures of both buildings are designed as secondary structural systems in terms of NZS 3101:1982.

30

The Construction:

Both buildings used pre-cast concrete beams, in situ concrete columns and shear walls for lateral loads including coupled shear walls with diagonal reinforcing.

5 The buildings differed in the location of the coupled shear walls, or wall in the case of the Landsborough House building. The coupled shear wall was an integral part of the core shear wall system to Landsborough House, but the coupled wall was a separate wall on the south side opposite the side of the northern shear wall system for the CTV building.

Suspended Floors:

10 The suspended floors differ in that the CTV building has a metal – and that should read Hibond – floor with 664 mesh and the Landsborough House building had a concrete rib and infill floor with topping slab reinforced with 665 mesh. The CTV building has 28% more mesh per square metres within the mesh reinforced floor than the Landsborough House building.

15 Q. Now Dr Reay the Hibond referred to there was the subject of evidence by Mr Harding. Did you hear that evidence?

A. Yes.

Q. His assertion was that Hibond was selected by you for the CTV building. What do you say to that?

20 A. I do not believe it was selected by me. I believe it was selected from options by the builder.

Q. And his contention was that you promoted Hibond at that time because of an association you had with the Fletcher organisation. Did you hear that?

A. Yes I did and that's certainly not true.

25 Q. In terms of the selection of Hibond for this building do you recall playing any part in that specification?

A. I have no recollection at all of doing so.

Q. If you had been consulted would you have had a view on the use of Hibond in this building?

30 A. In 1986 I would have considered it an acceptable flooring material. The company had specified its use on one or two occasions albeit it with steel framing rather than concrete, a concrete beam system.

Q. Can you account for the fact that Landsborough was done with concrete rib and infill and that the CTV building was done with Hibond?

A. No I can't.

Q. Would you read at paragraph 13 please.

5 A. The reinforcement of the columns varied. Neither was designed for additional requirements of ductile seismic detailing under NZS 3101:1982. The columns in the Landsborough House building were generally 400 millimetres square with ties of 10 millimetre at 150 or 250 millimetre centres generally.

10 1525

The CTV columns were 400 millimetres circular columns with six millimetre ties at 250 millimetre centres. The vertical reinforcing laps were 900 millimetre for the Landsborough House building and 1200 millimetres for the CTV building.

15

Foundation:

The foundations differed in that the Landsborough House building were supported on piles and the CTV building was based on shallow footing foundations.

20

The Landsborough House earthquake damage.

I inspected Landsborough House on the 16th of May 2012. Damage to the structure that was evident on this date was as follows:

Shear walls: there was minor cracking to the shear walls surrounding the shear core.

25

The coupling beams: the coupling beams particularly at the lower levels had substantial damage and would've introduced a significant degree of flexibility on the coupling beam shear wall line of the building.

The stairs: there was no significant damage to the stairs or supporting system.

30

The columns: there was some limited movement between the column and beam soffit interface at the top of the column with some limited initiation of column cover concrete spalling.

I should add that subsequent to that inspection that spalling may have in fact been caused when the beams were being installed on the columns, during the erection process. It may not have been due to earthquake response.

5

JUSTICE COOPER:

Q. That's a view you formed since your inspection, is that right?

A. Yes.

EXAMINATION CONTINUES: MR RENNIE:

10 Q. From further work or further inspection or merely further thought?

A. Further thought essentially.

Q. Carry on at E please?

WITNESS CONTINUES READING STATEMENT FROM E

A. Beam column joint: there was no evidence of cracking or joint failure.

15 Floor diaphragm: there was no cracking to the floor diaphragm in the immediate area where the floor was adjacent to the shear wall system.
Foundation levels: I understand that the differential settlement of the foundations is approximately 100 millimetres.

20 Based on my inspection the Landsborough House building has performed satisfactorily with no significant damage to the columns, beam column joints or stairs.

Additional evidence.

25 As a result of locating additional records and historic files held by ARCL I wish to give some supplementary factual evidence.

I have located the ARCE time records for the time of the CTV building project. I produce these records. The CTV building was job number 2503. Other job numbers, names of staff that are not involved in this hearing and totals have been redacted. The schedule summarises the time spent by various staff members on the project.

30

Q. Now Dr Reay those time records were found in what location?

A. In one of the storage areas at the company's offices.

Q. Were they associated in any way with the job file for this building?

A. No.

5 Q. Or for any of the other buildings on the list of Mr Harding's buildings which we've just looked at?

A. No.

Q. What were the records contained in?

A. They were contained in a box marked "miscellaneous".

Q. And is that a filing box? A large box?

10 A. It was a foolscap sized filing box.

Q. And other than the time records were there any other documents in that box of relevance to the matters before the Commission?

A. No.

15 **JUSTICE COOPER:**

Q. Have you ever found any invoices relating to the CTV work?

A. No the invoices for that period and indeed later have been destroyed long ago.

20 Q. I know you've, there's a dispute between you and Mr Harding as to how the, or who was involved in working out the fee that would be charged but do you have a view as to how the fee would have been calculated? I think you've said it was probably on a percentage of the value, is that right?

25 A. Around that time fees were, had been calculated as a percentage of the value of the work and so if you were undertaking the total job as principal consultant it might've been six or seven percent of the value of the total construction. If you were undertaking the structural work only it would be related to the value of the structural work.

Q. And would that have been the case in the CTV building?

30 A. Well I can only guess but I think that would've been the most likely basis it would've been worked out on.

Q. I must say I'm finding it hard to follow why setting the fee would've been left to an employee when you're the principal of the firm. Can you help me with that?

5 A. It wouldn't have been left to Mr Harding. What I suggested was that I thought I would've had him have some involvement in it.

Q. But –

A. The final decision would have been mine I'm sure.

10 Q. And it wouldn't involve, it wouldn't have involved, are you clear that it wouldn't have involved charging for structural engineering work on an hourly rate?

A. I don't believe so because with design-build contracts the contractors always want a fixed fee and so I can't, I can't, I don't believe they would've accepted an hourly basis.

15 Q. So we don't know what the fee was but it would've been fixed on some basis, probably in relation to the percentage of the cost of the project?

A. That's what I think, yes.

HEARING ADJOURNS: 3.32 PM

HEARING RESUMES: 3.47 PM**EXAMINATION CONTINUES: MR RENNIE**

5 Q. Dr Reay, we're now at your third statement of evidence and would you read from the paragraph numbered 3 please.

A. The purpose of this third statement of evidence is to respond to matters raised in the evidence of a number of other witnesses that have provided statements of evidence to the Royal Commission.

10 John Henry

There are aspects of Mr Henry's evidence that I do not agree with or wish to comment on. I respond with reference to paragraph numbers. At paragraph 24 Mr Henry refers to buildings at 58, 64 and 329 Durham Street. At least two of these buildings are significantly different to the CTV building. The building at 329 Durham Street contains a long shear wall on the opposite side to the core which while it has some coupling beams the stiffness of the wall is such that these would not contribute significantly to the seismic response of the structure. The building at 64 Kilmore Street has what are described as shear columns on the wall opposite the shear core and as such would expect to have energy absorption at the base of those columns only. This is in contrast to the CTV building which has a coupled shear wall structure opposite the shear core which is able to absorb energy through the yielding of the coupling beams over five levels.

25

At paragraph 31 Mr Henry refers to his work on the Westpac Centre. Mr Henry states that this building was a shear core building and it was symmetric. It was therefore significantly different to the CTV building. The symmetry of this building would have normally indicated that it would have performed well. I note that the shear core has not protected the columns. I have observed that the columns in the building suffered significant damage and that the building is currently being demolished. I

30

also understand that the building suffered damage in the 4th of September earthquake.

5 At paragraph 41 Mr Henry refers to his work on an eccentric 14 storey building called the AA Centre. I note that this building is an eccentric shear core but it also has a perimeter frame that provided torsional resistance and is therefore significantly different to the CTV building.

10 Relevant to paragraph 42 based on Mr Henry's experience as he has noted, he had not designed buildings similar to Landsborough House prior to joining ARCE.

15 At paragraph 43 of his evidence Mr Henry suggests that I had only designed tilt slab buildings at the time he joined ARCE. However I was also at that time the leading engineer in the field of cold form steel and its use in buildings plus many other structures. By way of example I designed the then world's largest span fibreglass trickling filter cover at the Christchurch City Council's Bromley sewage plant. The span was 54 metres. Mr Henry worked on the initial stages of that project with me and is therefore well aware of my experience in this respect. Neither Mr Henry nor I had at that time experience of fibreglass structures of that scale but this project illustrates that competent, registered and experienced engineers do and are expected to work on structures that extend their basic knowledge.

25 In relation to paragraph 44 of Mr Henry's statement I do not agree that experience and a high level of expertise was required for the design of reinforced concrete shear wall structures. A level of expertise and experience could be said to be required for all multi-level building structures and such experience is the basis of engineering registration. 30 The critical knowledge was at that the engineer knew he or she was beyond his or her capability and at that stage the engineer should seek

assistance from appropriate senior engineers just as John Henry did in consulting with Professor Paulay.

5 At paragraph 45 of his evidence Mr Henry refers to the Ibis House building which I had designed prior to his arrival at ARCE, incidentally not ARCL as he has incorrectly referred to in this and other paragraphs. Ibis House, an eight storey building designed in 1974 was partly block work as were the three 1970s Holmes building referred to by Mr Henry, but the primary load resisting elements in the east-west direction were
10 reinforced concrete moment beams connecting into walls and columns. The beams were designed for ductile action in an earthquake. The building was asymmetric and account was taken for this in the design. A computer analysis was not used in the design of Ibis House.

15 The Ibis House building survived the earthquakes but has subsequently been demolished. There was no evidence of cover spalling, of cover concrete spalling at the underside of the first floor level as there was at the five storey Spicer House building referred to by Henry.

20 Beginning at paragraph 46 Mr Henry discusses the Landsborough House building. I also discuss this building in my second statement. There are further comments on this building which I wish to make in response to Mr Henry's evidence. The initial plan for Landsborough House was prepared by the architect without structural design input.

25 It is not correct to state as Mr Henry does in paragraph 48 that I was committed to an offset configuration for Landsborough House. As principal consultant it was my role to ensure all options were considered.

30 I do not agree with Mr Henry's statement in paragraph 49 that an ETABS analysis was mandatory. A requirement of the code was that for

particular structures, a spectral modal analysis could be used as an alternative to the equivalent static force method.

Q. You've read would be used or do you mean could be used?

5 A. Could be used. Either of these methods could utilise the ETABS software.

10 At paragraph 50 Mr Henry suggests that an ETABS analysis was the only method of accurately determining likely response to earthquake loading. This is not correct. I refer to my comments in paragraph 15 above. The method is only reliable while the structure is elastic. The seismic coupling beams are designed to be subject to inelastic behaviour and in this mode an ETABS analysis could be unreliable. Best practice at that time, if there was such, could have been to have utilised an analysis based on research such as Dr Sharpe's PhD research on inelastic structural response analysis.

15 At paragraph 52 Mr Henry states that the ETABS analysis for the Landsborough House building showed that the structural model worked. I emphasise his follow-on statement that the corner deflections were at or near the maximum code drift limits.

20 I note that Mr Henry discussed the Landsborough House building with Professor Paulay. It appears Professor Paulay agreed with my opinion that the eccentricity was not a major issue.

25 At paragraph 63 of his evidence Mr Henry states, I was dismissive of his concerns about the Landsborough House building. I was not dismissive of Mr Henry's concerns. I was aware he had appropriately discussed his concerns with Professor Paulay and I advised him that I was satisfied with the solutions agreed.

30 At paragraph 64 Mr Henry states that he was concerned about whether the gravity load system for Landsborough House would be adequately

protected by the shear walls. In response he detailed the column tie reinforcing, the a reasonable provision for some ductility demand in the end regions. I questioned why if Mr Henry was concerned about the gravity load system he did not detail for full ductility or modify the column design accordingly. I suggest that what Mr Henry did was in accordance with the standards in Christchurch at that time.

At paragraph 68 Mr Henry refers to David Harding's calculations for the CTV building. He also refers to a requirement that the Landsborough House and CTV buildings be analysed using ETABS. If Mr Henry is referring to a spectral modal analysis then I disagree with the statement and consider both buildings could have been analysed by the equivalent static force method. I also note that Dr Arthur O'Leary has stated that static analysis would have been a compliant code analysis for the CTV building.

In paragraph 55 of Mr Henry's statement he is saying that it was essential to complete the concept design of which inter-storey drifts were part before proceeding to the detailed design.

20 1557
This is standard engineering practice.

In paragraphs 53 and 54 Mr Henry has gone to some lengths to explain how difficult it was to use the version of ETABS that he had utilised. It is not clear whether the version used by Mr Harding was the same as that used by Mr Henry. However, in any event the use of ETABS and the perceived difficulties that Mr Henry had in calculating deflections is not, in my opinion, a complex issue at all. I also note that the full extent of Mr Harding's calculations is not known. There may well be significant further calculations which have not been retained.

At paragraph 61 Mr Henry refers to a building with a wall on each end and otherwise little torsion resistance which, he says, could lead to the

majority of the yielding occurring on one of the walls. This example also applies to the two east-west shear walls in the Landsborough House. The north wall is designed to remain effectively elastic and the south wall ductile by the use of coupling beams.

5

At paragraph 70 Mr Henry states that he was very much in the driving seat in doing the structural design for Landsborough House. It was Mr Henry's role to undertake the responsibility for the structural design and documentation of Landsborough House. He was not employed to project manage the job or to take the lead consultant role as I understood he had no experience in this role.

10

At paragraph 71 Mr Henry states that I was not closely involved in the work he was doing on Landsborough House. As lead consultant review of the construction methodology was my responsibility.

15

In relation to paragraph 72 of Mr Henry's statement as lead consultant I would have been responsible for the provision of the permit documentation.

20

At paragraph 75 in relation to Bradley Nuttall House Mr Henry says he had no involvement with the client and little to do with recycling the Landsborough House structural design within the office. Again, I was lead consultant on this project. The architectural façade elements were separated from the structure by the architect to provide a deeply modelled façade. This was also the case with the Landsborough House building. My recollection is that Mr Henry did undertake significant structural design work on this project in addition to the façade. For example, the foundations were based on shallow foundations and Mr Henry would have designed these as they were different to the fully piled foundations of Landsborough House.

25

30

At paragraph 82 of his statement Mr Henry states that when he left ARCL, (again actually ARCE), there was no designer there who had experience using either the ETABS system or multi-storey shear core design. I agree that I had not used the ETABS software to design a multi-storey building at the time of Mr Henry's departure from ARCE however he is incorrect to say there was no-one with experience in designing multi-storey shear core buildings using computer analysis. Dr Robert Donald had written software for modal analysis of building structures which I used in the latter half of the 1960s.

10

JUSTICE COOPER:

Q. Is that the Dr Donald who used to practice in Wellington?

A. Most of his time has been spent as a property developer rather than as an engineer.

15 Q. That's the one I'm thinking of. I think, he may have worked in both Wellington and Auckland.

MR RENNIE:

Yes I think so. He did indeed. He undertook a number of Wellington projects.

20

JUSTICE COOPER:

He did, didn't he, yes.

MR RENNIE:

25 Yes including Oriental Bay and up Molesworth Street were two Sir.

JUSTICE COOPER:

Paragraph – you're at paragraph 30.

EXAMINATION CONTINUES: MR RENNIE

30 A. At paragraph 83 Mr Henry states that he left ARCL in early 1985. I believe he left ARCE in late 1985 not early '85.

At paragraph 84 of his statement Mr Henry states that Mr Harding had worked for ARCL for a number of years before Mr Henry went to ARCL. In fact Mr Harding only worked for ARCE for about one year before Mr Henry joined.

5

At paragraph 86 Mr Henry states that he was concerned to hear that Mr Harding had followed his Landsborough House calculations for the CTV building design for two reasons. Firstly he states it was unlikely his calculations were sufficiently detailed for a first-time designer to be able to adequately understand the design process. Secondly, Mr Henry notes that the shear wall design for the two buildings were significantly different. In respect of Mr Henry's first point the design engineer's calculations should include reference to decisions made based on experience. The concept of the design should have been summarised in the calculations. Further I do not know if the Landsborough House calculations were all that were available to Mr Harding at the relevant time. I also note that the construction drawings for Landsborough House and other projects were available to Mr Harding.

10

15

20

I also refer to the 1990 Holmes report. The report describes the layout and design of the building as quite simple and straightforward. There is no reference in the Holmes report to the design difficulties as claimed by Mr Henry. Indeed the Holmes report suggests the opposite.

25

Beginning at paragraph 87 Mr Henry discusses differences between the CTV building and Landsborough House. I have also covered this issue in my second statement.

30

In paragraph 88 Mr Henry comments on the wall configuration. While there are elastic response benefits from a tubular structure this benefit reduced followed the inelastic behaviour of the coupled shear wall. It is this response which Professor Paulay would have been concerned with due to the increased rotation of the structure. The location of the

coupled shear wall in the CTV building being on the south side with the main shear core on the north side would have provided more control over the torsional response of the structure in the event of post-elastic behaviour.

5

At paragraph 91 to 93 Mr Henry refers to the shear wall arrangements for the CTV building. These issues are simply part of the design process just as was the case for Landsborough House and other eccentric shear core buildings.

10

At paragraph 95 Mr Henry states what might have happened if there were no south coupled shear wall. Of course there clearly was so, so this discussion seems irrelevant.

15

In paragraph 97 to 99 Mr Henry refers to issues for the design associated with south coupled shear wall and connection of the shear core to the floor diaphragms. The analysis of the building by the equivalent static force method will provide the resolution of the issues Mr Henry discusses.

20

In paragraphs 100 and 101 Mr Henry refers to the location of gravity beams in Landsborough House and the CTV building. The code has no requirement regarding gravity beam alignment. Because the buildings are approximately square this potential benefit is not significant. One benefit of the floor beams located as they were in the line of the north-south shear walls is that they could also act as drag bars in the north-south direction.

25

At paragraph 105 Mr Henry states that there were no floor beams to restrain the columns in Landsborough House. This is not correct. There were beams and they restrained the columns in the north-south direction. Also the beam floor system had torsional strength which could induce actions in the columns in the east-west direction.

30

In paragraphs 107 to 147 Mr Henry refers to the CTV building calculations. I do not propose to comment specifically on these matters. I refer instead to my comments in paragraph 42 below.

5

I note that Mr Henry's comments are predicated on the use of spectral modal analysis using ETABS software. The use of ETABS was not a mandatory requirement for this building under the code therefore I do not comment on this aspect of Mr Henry's evidence as it is based on an analysis which is not a requirement in terms of the building code. I also note that Mr Henry's comments are based on the calculations available. I consider it more appropriate to consider the as designed building and review that in relation to the code and standards of the day in Christchurch.

10

15

At paragraph 151 of his statement Mr Henry makes comments on the Council's view of myself and ARCL. I do not agree with Mr Henry's comments. In particular I do not agree with the comments regarding Mr Tapper or his statement that ARCL did not like the scrutiny of Mr Tapper. I do not agree that I went to Bryan Bluck to override Mr Tapper.

20

I also note that Mr Henry was involved in reviewing much of the ARCL work at the time he was at the Council and appeared to take a lead role in this compared to Mr Tapper or Mr Bluck. ARCL did not ask Mr Bluck to overrule Mr Henry. We always responded in writing to Mr Henry's queries on behalf of the Council as we did with queries from any other Council engineer.

25

1607

30

At the time Mr Henry was at the Council, many of the Council queries were dealt with by other people at ARCL.

I do not agree that Mr Bluck was a lesser engineer than Mr Tapper, or that Mr Tapper was confrontational.

5 I also do not agree with paragraph 157 in Mr Henry's evidence where he states that Mr Bluck tended to let consulting engineers have the last say. That was not my experience with Mr Bluck. I recall that at times a peer review would be an option to resolve any issues.

10 I note that Mr Henry's experience at the Council was some six years after the CTV building was submitted for a building permit.

15 I recall there were reviews of the ARCL work by Mr Henry or his assistant Mr Enright who was also an engineer. These reviews appeared to suggest that while the ARCL details complied with the code, they were not of a type favoured by Mr Henry. This became, I recall, a significant issue in relation to a building consent approval for the three storey apartment buildings at 75 and 77 Gloucester Street where the building consent approval was delayed for some months as a result of issues raised by Mr Henry.

20 Q. Dr Reay, just pausing on that. In relation to issues were they code compliance issues or were they design issues as to which way to design the building?

A. They weren't code compliant issues, they were the latter.

25 Q. Can you account for Mr Henry departing from Mr Bluck's instruction that Council staff were not in fact to do that?

A. I'm not aware of Mr Bluck's instruction to Council staff.

Q. It's a document exhibited at the back of Mr Nichol's evidence. You've not seen that?

A. I haven't seen the actual instructions no.

30 Q. I put the question another way, can you account for Mr Henry intervening in the design concepts of an ARCL project while he was at the Council?

A. Not directly, no.

Q. Do you recall how the matter was finally resolved?

A. It was resolved by adding some steel angles to the walls to, in the event that the floor connection failed from the wall that the floor wouldn't fall down.

5 Q. And after that did Mr Henry have a building consent role with later projects for your firm?

A. No, his role seemed to fade out over time.

Q. Was that a Council initiative as you understood?

A. I, it was only, I only heard it third hand, I couldn't be sure.

10 Q. Read from paragraph 49?

**WITNESS CONTINUES READING BRIEF OF EVIDENCE FROM
PARAGRAPH 49**

15 A. Finally I note that Mr Henry has not notified ARCL that he was reviewing ARCE's work as he was required to do under rule 53 of the Chartered Professional Engineers of New Zealand Rules.

20 Q. Dr Reay, just pausing there before we go to your review of Mr Harding's evidence. You've heard Mr Harding say that, and he put it in various ways through his evidence, let's put it this way, that there was discussion between you and him as to his not referring to Mr Henry in relation to design aspects of the CTV building. Do you recall those various interchanges?

A. I recall him saying that yes.

Q. And your position on that is what?

25 A. I would not have stopped him referring to Mr Henry if that's what he thought was important to do. I would've, probably though suggested that he referred if it was a structural design matter to Professor Paulay, or an analysis matter to at the time Dr Carr, rather than go to Henry, but if he, if there was no other alternative he could've gone and talked to Henry.

30 Q. Mr Henry gave you a month's notice in 1985?

A. Yes.

Q. Was that something which was anticipated or was that something that arose quite suddenly?

A. It appeared to occur suddenly.

Q. Mr Harding has speculated that there was, there were differences between you and Mr Henry before Mr Harding arrived. Your position on that?

5 A. No, I had no difference with Mr Henry. I regarded him as an excellent engineer and was disappointed that he left.

Q. He left before Mr Harding arrived?

A. Yes he did.

Q. Was that the handover that you had anticipated?

10 A. It isn't the handover that I would've preferred.

Q. To your recollection did Mr Henry carry out a formal handover of his work when departing?

A. I have a recollection of him handing over a job but I, I can't, I couldn't be certain which job it was.

15 Q. In all events it was not a handover from Mr Henry to Mr Harding?

A. I'm sorry?

Q. At all events it was not a handover from Mr Henry to Mr Harding?

A. Not an overall handover no.

Q. In relation to the Westpark job Mr Henry had worked on that?

20 A. Yes.

Q. Do you know what transfer of knowledge took place between Mr Henry and Mr Harding in that respect?

A. No I don't recall.

Q. Can you now read from paragraph 50 please?

25 **WITNESS CONTINUES READING BRIEF OF EVIDENCE FROM PARAGRAPH 50**

A. I do not propose to respond in detail to Mr Harding's statement of evidence. As I noted in my first statement of evidence I do not agree with large parts of Mr Harding's evidence and my recollection of events is set out in my first statement. I comment only on a small number of specific issues.

30

Contrary to Mr Harding's evidence I did not design the CTV building. The timesheets annexed to my second statement evidence the amount of time I spent on the project as compared to Mr Harding. Mr Harding never said he had a problem.

5

I recall that at the stage that Mr Harding received the architects' drawings I asked him what the structural lateral load system was, he said it was a core structure on one side and shear wall system on the other. I would've asked to see the plan layout and recall noting that I considered the design a more stable layout than the Landsborough House design.

10

Mr Harding did not advise me of any concerns he had in relation to the project, as would've been expected of a registered and experienced structural engineer if he had such problems. I particularly note that no concerns were raised following his attendance at the July 1986 concrete seminar.

15

I ensured that Mr Harding was conversant with the current status of concrete design. He had attended a course on ductile frame design in 1979 and a course on concrete design by Professor Paulay and others in July 1986 which was during the period he designed the CTV building. I note that this course covered many of the design aspects relevant to the CTV building including the use of the 1984 version of ETABS.

20

It is relevant to record that Mr Harding held a Bachelor of Engineering Civil with Second Class Honours. He worked at Hardy and Anderson before gaining registration which is also where I did my initial training. Mr Hardie and Mr Anderson, and also Peter Douglas who was there at the same time as Mr Harding were excellent engineers. Mr Harding had over 10 years post-registration experience when he designed the CTV building.

25

30

Wayne Strachan

Based on the time records annexed to my second statement Mr Strachan did not lead the preparation of the drawings for the CTV building project as claimed. In fact the records show that he did
5 little work on this job.

Contrary to paragraph 16 of Mr Strachan's evidence I did not prepare the initial drawings for the permit application.

10 Terry Horn

Based on the time records annexed to my second statement Terry Horn led the draughting team on this project. He did this under the direction of David Harding.

15 Q. Dr Reay attached to your brief as the next page is a schedule of the time spent by differing persons in your firm on the CTV project for the period between February 1986 and December 1986. Do you have that?

A. Yes.

Q. And this has been prepared from the time records which you produced?

A. Yes.

20 Q. And looking at the first column, that is to say the column attributable to yourself, your position in relation to the hours recorded in that column as compared to the hours that you may have spent on this project?

A. Those will be the hours that I recorded undertaking specific tasks. There will have been administrative hours which will have been not –
25 which wouldn't have been recorded under the job number but more under the administration number that the company used.

1617

Q. So did you have a separate time code for administration work in your time system?

30 A. Yes.

Q. And did that administration work – have a single category or was it also job specific?

A. I think it was a 9000 number and there were various categories. The general administration one I think was 9003.

Q. But was that as to the type of work or as to the particular project or job involved?

5 A. No it was nothing to do with the project or job.

Q. Now secondly looking at the column for Mr Harding. In relation to the total time that you would expect him to have recorded through the year, what sort of proportion of his working time is shown there?

10 A. He would have worked I would imagine around a 45 hour week, so it's whatever that means.

Q. So the calculations can be done from there. Coming onto Mr Strachan, there appear to be only two short periods of time that the time records show him working on this job. Can you account for that?

15 A. Well I imagine he just helped out very briefly with some minor work in those two months that there's some time recorded.

Q. Could there be a possibility that Mr Horn's time and Mr Strachan's time is being confused in the coding of the time records?

A. It's very unlikely.

20 Q. And indeed in monthly terms it would appear that Mr Horn recorded time in each of three months in relation to this project?

A. I'm sorry, he what?

Q. In relation to Mr Horn, it would appear that he recorded time in relation to three months in respect of this job?

A. Yes, yes.

25 Q. So before there could have been a transfer of time, there would have to be errors in each of those months I take it?

A. Yes.

30 Q. And in relation to the known progress of the job with the, Mr Harding's approved plans being sent at the end of August and consented by the Council in September, does the time recorded by Mr Horn fit in with that work programme?

A. Yes it does.

Q. And would the same be generally true of the entries in respect of draughtspeople and tracers?

A. Yes.

5 Q. Now Mr Harding has made some statements in his oral evidence about looking to the draughtspeople to originate design on a standard detailed basis. You've heard that?

A. Yes.

Q. Were there standard details which draughtspeople could have applied to this design in that way?

10 A. I don't recall that there were. The in situ shear walls were not standard details, the foundations wouldn't have been standard details, the block wall wouldn't have been, the circular columns were not specifically standard because they had to be designed job by job. The use of pre-cast beams, that was a feature of several of the projects, both low rise
15 and high rise but my recollection is that they, the beams and the other ones I can remember had square ends. They didn't have the whatever it was described as, the U shaped ends on them, and the jointing system was more of a rectangular block of concrete that matched the beams. The floor system wouldn't have been described as a standard design.
20 What I would expect is that if Terry Horn was the draughtsman he was the one most familiar with drawing these types of buildings and he would be familiar with going ahead and producing carcass drawings based on the architect's drawings for the structure.

25 Q. And his familiarity arose from having been previously with the Holmes Wood firm?

A. Yes.

Q. When Mr Horn joined you, did you give him any instructions as to the design expectations or design policies of your firm?

30 A. He came with a considerable degree of experience from Holmes and I – for undertaking these sort of buildings I wouldn't have anticipated in having to give him a lot of instruction, no.

- Q. Do you recall having available standard details, standard drawings, standard designs for buildings of this type for the draughtspeople to follow?
- A. No.
- 5 Q. And in relation to the column design in this building, which was a 400 round column in respect of the central columns was there a precedent building of that type which comes to mind in your practice?
- A. Not a building of this scale that I can recall.
- Q. Now you may have heard my friend Mr Mills asking Mr Harding some
- 10 questions about what he called the culture of your firm.
- A. Yes.
- Q. You heard that?
- A. Yes.
- Q. Were you aware in 1986 of your firm having a culture?
- 15 A. Not that sort of culture.
- Q. How did you see it from your perspective?
- A. I considered that we had a culture of quality, that to deliver that quality there were several factors that were important. One of them was code compliance, another was buildability. I always had the view that if the
- 20 building was difficult to build, it would probably not be built well, errors would occur, and there was a culture of delivering quality drawings that could easily be read and were complete in terms of the necessary detail.
- Q. Mr Scott of Williams Construction in his brief speaks of his company bringing the job to your firm. Is that how you recall it?
- 25 A. I would agree that he would have initiated the offer of the job to the firm, yes.
- Q. He speaks of being attracted to the way in which your firm approached such jobs. Is that consistent with the way you hoped your firm would be seen?
- 30 A. Yes it is and he would have gained that experience from, or his company would have from building the four level Aged People's Welfare building near the Bridge of Remembrance because they were

responsible for the construction of that building, it was designed by my company.

5 Q. Mr Harding appears to have felt that he ended up, I'm not quite sure whether he said a number muncher or a number cruncher, but I suspect it means the same thing, in a back corner without external contact and profile. Is that how you recall it?

10 A. No I don't recall it being like that. His job was to produce the structural designs, but he wasn't restricted from dealing with contractors or people and if architects came into the office there was no reason why he wouldn't deal with them.

1627

Q. Do you recall any complaint from him at the time that he was being denied client contact and/or architect contact and/or construction company contact?

15 A. No, no there were no, I don't recall any complaints and I would have acted on it if there were.

Q. And had there been such complaints what action would you have taken?

20 A. I would have established what contact he wanted to develop with the people that he wanted to work with and would have made sure that that happened.

Q. A regular part of your firm's work involved dealings with the Council.

A. Yes in terms of building consent processing.

25 Q. To your recollection had you imposed any limitation or restriction on Mr Harding's ability to deal directly with the Council?

A. No.

Q. Do you recall the Council referring matters to you on projects which were Mr Harding's projects?

A. No.

30 Q. Were you at any time aware of any dissatisfaction by the Council with its dealings with Mr Harding?

A. No.

CROSS-EXAMINATION: MR REID

Q. Yes just one matter, Dr Reay, you say in your brief of evidence that it's apparent from some documents that a Council engineer attended the site, is that correct?

5 A. I'm sorry I couldn't follow that.

Q. Sorry, I'll refer you to paragraph 52 of your brief of evidence.

A. Yes.

Q. So you say there, don't you, that a Council engineer visited the site from time to time as you would have expected?

10 A. Yes.

Q. And you refer there to a document.

A. Yep.

WITNESS REFERRED TO BUI.MAD.249.0117B1

15 **JUSTICE COOPER:**

This is paragraph 52 on page 6 is it Mr Reid.

MR REID:

It is, Sir, yes.

20

JUSTICE COOPER:

We've got several streams of numbers going through these composite briefs so we'll have to, just tell us what the page number is.

25

MR REID:

Yes, Sir, apologies.

CROSS-EXAMINATION CONTINUES: MR REID

30 Q. So now this document, Dr Reay, is the document that you're referring to at page 52, is that correct?

A. Yes I can't read that.

Q. Well that is the, it's the summary doc-, the summary I think of the relevant Council inspection records that have been put together and can you just, do you think you could get a bit closer to it and see if you can read that. You will have seen this document before I'm sure.

5

JUSTICE COOPER:

Can't it be expanded, or it has been?

CROSS-EXAMINATION CONTINUES: MR REID

Q. Perhaps the first card could be expanded for a start.

10 A. Yes I can read that.

Q. Yes. There's a reference to an engineer in the second line of that document on the date of what appears to be the 16th of the 10th '86. Do you see that?

A. Yes.

15 Q. And can we have the next card please. So that's the next one in the summary sequence and there's no reference to an engineer there is there?

A. In the next one?

Q. In the one that you're looking at now, that's the middle of the three.

20 A. No there isn't.

Q. And if we could have the last one please. That's the last of the three in the summary sequence and there doesn't appear to be a reference to an engineer there either, correct?

A. No there isn't.

25 Q. Now I'm happy to take you to all of the inspection records if you like or, alternatively, you can take it from me that those are the ones, the summary ones that have been put together by the Commission and they have all the relevant details on them. Are you happy to accept that from me?

30 A. Yes.

Q. So just to go back to the first of the inspection records. This is the one that does have a reference to an engineer. Is that the reference that

you're referring to for your evidence at paragraph 57 of your brief of evidence, page 6 of the consolidated brief?

A. Yes that plus I've read somewhere where I think one of the building engineers, it may have been Mr Bluck, was at the site at one stage. But
5 I can't recall where I've read it.

Q. Well just leaving that to one side.

A. Yes.

Q. Just read the reference under the date 16.10.86. The entry is 'Engineer
10 due'. That could equally be a reference to the design engineer attending couldn't it?

A. Yes it could be.

Q. And given that it's Mr Harding's evidence that he attended quite frequently that would seem to be likely wouldn't it?

A. Oh that is possible certainly.

15 Q. Yes well there's no indication on that record at all is there that it was the Council engineer that was being referred to?

A. No it doesn't define who the engineer is.

Q. All right now in relation to, you mentioned the evidence about Mr Bluck attending, is that the evidence of the meeting that occurred with Mr
20 Nichols, that occurred adjacent to the site one day when Mr Bluck was out for a walk. Is that the evidence you're referring to?

A. In my comment I think that is the evidence.

Q. And are you relying on that meeting for the purposes of s 52 of your consolidated brief, page 6?

25 A. The comment here on the screen and that yes.

Q. Well I can take you to the relevant portion of Mr Nichols' brief but what I'd like to suggest to you before I do that is that that was simply an informal coincidental meeting as it's reported by Mr Nichols and nothing to do with a formal inspection by a Council engineer, would you accept
30 that?

A. Yes I would have expected it to have been an informal inspection if the Council engineer did go to the site.

Q. Yes but in relation to that meeting that Mr Nichols is talking about he's saying it was just a coincidental meeting between him and Mr Bluck on the street outside the building. There was no inspection taking place. Is that your understanding of what Mr Nichols is talking about?

5 A. Well he, they were discussing the particular building so from that point of view I presumed that they were actually looking at it.

Q. All right well perhaps I can get that brought up. This is in Mr Nichols' brief of evidence. I think the relevant paragraph is paragraph 47 of WIT.NICHOLS.0001.6 and it's paragraph 24. So if I can just read that
10 out. This is Mr Nichols talking. He says "I had been standing there observing the construction of the building for about 10 minutes when Bryan Bluck came up to me. I assumed he was taking his usual midday constitutional walk as was his habit and I had worked for him, when I had worked for him. We greeted each other and exchanged usual
15 pleasantries" and then they go on to discuss the conversation that occurred but all I want to suggest to you that it's quite clear isn't it from that report of the meeting that occurred that there was no formal inspection taking place at that time?

A. No they were discussing the building yeah.

20 1637

CROSS-EXAMINATION: MR KIRKLAND

Q. Dr Reay I'll, just while it's fresh in my mind I'll just take you back to some
25 paragraphs in this composite statement and at paragraph 29 you say, "I agree I have not used ETABS software to design a multi-storey building at the time of Mr Henry's departure." I assume you could use the system. Is that a safe assumption? You say you had not used the system.

30 A. Yes.

Q. But I assume you could use it?

A. Well I never have used it so I, but I presume I could.

Q. Right. Thank you. And at paragraph 32, this is Mr Henry speaking again when he talks about the calculations, these were the Landsborough House calculations, were unlikely his calculations were sufficiently detailed for a first-time designer. That appears to me to be a signal that Mr Harding, and I'll come back to this in some detail, would have needed supervision or review within your office. What do you say to that?

A. I think that to suggest that only the calculations were available to Mr Harding is not correct. He had access to the drawings for the building, the specification and you would expect an engineer to read the calculations in conjunction with the finished drawings. The, there was also the work that was done on the other building that was undertaken before CTV building where there was also further work from Mr Henry and it certainly would have given Mr Harding a very good start to undertake ETABS. The aspects that he appeared to struggle with, as I've learnt today, were really related to torsion and the buildings were, when you're designing with ETABS all the buildings were subject to torsion, that's expected, so I don't think, I think that he had a good introduction to it. He had the time to go and work at it and he never said to me that he was struggling with ETABS.

Q. I'll come back to that. Why then just in your view would Mr Henry describe Mr Harding as a first-time designer? What do the words "first time" mean to you?

A. I can't answer how Henry has written that.

Q. If I was to put it to you Dr Reay that "first-time" means an inexperienced designer –

A. No he was an experienced designer. He was using ETABS for the first time.

Q. At paragraph 42 you talk about the ETABS system. You say the use of ETABS was not a mandatory requirement for this building under the code. Can I have please brought up ENG.STA.0018.53. That's on your screen Dr Reay?

A. Yes.

Q. Yes if I could take you down to paragraph 3.7, 3.4.7.1(c) which is at the bottom right-hand corner.

A. Yes.

Q. Have you found that?

5 A. Yes.

Q. Now it's my understanding when you say it's not mandatory, but the word "shall" is in that sub-paragraph. Is that not a mandatory word?

A. Yes but you need to refer to another clause which, the clause (b) says that, "For reasonably regular structures, more than four storeys, the static method can be used," and this was a reasonably regular structure.

10

Q. Mr Harding's evidence as I recall Dr Reay that this was an irregular structure. You don't agree with that?

A. No I don't.

Q. And as I recall he defined an irregular structure as one with torsional eccentricity. Is that a correct description?

15

A. Well the eccentricity or the torsional eccentricity is a different matter to regularity.

Q. So just one of the many points that you and Mr Harding do not agree on.

COMMISSIONER FENWICK

20 What about the commentary on that clause, the bottom two paragraphs which actually starts to describe what is a moderately irregular building there. I think though that's not perhaps compulsory it's certainly best practice to follow the commentary. Would you like to follow it up with Dr Reay?

25 **MR KIRKLAND:**

Yes, certainly.

CROSS-EXAMINATION CONTINUES: MR KIRKLAND

Q. On the same page Dr Reay is there anything in the commentary that you wish to comment on?

30

MR KIRKLAND:

That I assume Sir is starting at (c) 3.4.7.1?

COMMISSIONER FENWICK:

Just the last two paragraphs that deal with the moderately irregular structure.

5 CROSS-EXAMINATION CONTINUES: MR KIRKLAND

A. Yes the, the first of the last two refers to, "Reasonably regular buildings which have no major re-entrant angles and which are substantially uniform in plan."

COMMISSIONER FENWICK:

10 Q. Right, thank you, and the second paragraph?

A. That's for eccentric buildings. There is a formula there for determining the ratio of the unfavourably affected wall.

Q. And would the CTV building have fitted into that category? Would that have been decided as eccentric or not?

15 A. From the work that has been done by Mr Latham it, it meets that requirement and is not a, defined as an eccentric building.

Q. But the work done by Mr Harding did not meet that criteria if I understand his response to my questions.

A. Mr Harding's work didn't meet that, no.

20 CROSS-EXAMINATION CONTINUES: MR KIRKLAND

Q. And at paragraph 50 Dr Reay I don't think you answered Mr Rennie's question. Mr Rennie's question was that did you give an instruction to Mr Harding not to contact Mr Henry?

A. No I didn't.

25 Q. You didn't?

A. No.

1647

Q. And in paragraph 54 where you refer to the two conferences that Mr Harding attended, you're not seriously putting forward, Dr Reay, that
30 by attending two conferences that's going to bridge the gap in inexperience?

5 A. The, Mr Harding was experienced in concrete design. He was not an inexperienced designer. He had an engineering degree and he had 13 years' post-graduation experience. The, it was not a conference, as you say, it was in fact a seminar, three day seminar series and it covered many of the aspects, in fact the particular aspects it covered was the concrete code 1982 NZS3101 and the purpose of that seminar was to assist engineers with that code.

10 Q. In that composite statement, Dr Reay, you have addressed the majority of Mr Henry's views but you haven't addressed paragraph 81 of what Mr Henry says. He talks about, among other thing, that you and I quote, "He exercised tight control of the office and was very much in charge of the projects." Do you need that to be brought up to have a look at that? WIT.HENRY.0001.21?

WITNESS REFERRED TO SLIDE

15 Q. Mr Harding's evidence was that was a very accurate description. Your response to that Dr Reay?

A. I was certainly responsible for managing the office. The, I wouldn't describe it as tight control. In the case of Mr Henry I was the principal consultant for those projects so had the overall responsibility for them.
20 That was not the case for the CTV building though.

Q. So this was the one project that you're saying that you were not very much in charge of?

A. The CTV?

Q. Yes.

25 A. Not in the sense of being the principal consultant where you're more familiar with, where you are familiar with what the various people working on the job are doing as an overall role.

Q. Mr Rennie referred to the last document annexed to your composite brief, can I have brought up again please WIT.REAY.005.20?

30 **WITNESS REFERRED TO SLIDE**

Q. Mr Harding's evidence, as I recall Dr Reay, and I quote that, "Mr Strachan..." that's how it's pronounced, "...spent 95% of the draughting job on the CTV building." Your response to that?

- A. Well I'd make two comments. One is it is unlikely that the time records are wrong. Secondly I note that in an earlier letter to the Commission Mr Harding did refer to a draughtsman from Holmes undertaking the work and if that was the case it had to be Mr Horn.
- 5 Q. Mr Horn in paragraph 8 of his brief says that, "I have no memory of the CTV building project. I have looked at the drawings that were submitted to the Council but I do not recognise them." Surely Dr Reay, if someone had spent 141 hours on these drawings, even after the passage of time, a draughtsman would recognise them?
- 10 A. (no audible answer 16:52:50)
- Q. Your response to that?
- A. Well, if I, provided Mr Horn was available and not on another job, he is the person that I would've put on that job.
- Q. Because he was more experienced than Mr Strachan?
- 15 A. Mmm.
- Q. And in paragraph 12 of his evidence, I'm coming to Mr Strachan now, in part he says, "However, since I looked at the second full set of drawings for the CTV building there was no doubt that I had done the majority of the draughting for this building." How can the majority of the draughting of this building, Dr Reay, if Mr Strachan's got it right can equate to 2.75
- 20 hours?
- A. I think Mr Strachan has also said that the drawings are traced and that the tracing is similar to his handwriting and he has also said that he has a memory problem from a chemical poisoning, hasn't he?
- 25 Q. So we've got Mr Harding saying one thing, we've got Mr Horn saying one thing, we've got Mr Strachan saying one thing, but they all seem to be consistent with their theme. So on that basis can these time records be relied on Dr Reay?
- A. Well there were several buildings and if you, and people like Terry Horn
- 30 would've worked on several of them, some of them. Wayne Strachan would've worked on some of them, probably fewer than Terry Horn, and after 26 years I would suggest that the time records are probably the best indicator of who actually worked on the job.

Q. When you say Dr Reay, "several buildings" the top of this time sheet has got job 2503?

A. Mmm.

Q. That's a stand alone building, the CTV building?

5 A. Yes.

Q. So these records don't relate to several buildings do they?

A. No, but at that time Landsborough House was drawn, Mair Astley, Cashel Street.

10 Q. I'll come back to this later Dr Reay, but just while I've got this, this schedule on the screen, does it surprise you that you only spent 3.5 hours working on the CTV building?

A. Was that a question?

Q. Yes it was a question?

A. Sorry I missed it?

15 Q. The time records that are up on the screen record you as allocating, or having allocated only 3.5 hours working on the CTV project. Does that not surprise you as the principal of the firm?

20 A. No I would've written down the specific times when I was undertaking a task that I thought warranted recording, that it wasn't straight administration. I would've spent, as I've said, other time which I would describe as more administrative or management but rather, but not design.

25 Q. I think in a question from His Honour you said in all probability the fee for this job was fixed. Did I hear that correctly or understand that correctly?

A. I think that's the probability.

1657

Q. So then there would be no need to record hours if a fee was fixed, or a lot of hours?

30 A. Well one still needs to know how well, what the job costs at the end because when you're weighing up the fees for a following job you do need to know what the real costs are.

Q. So these hours of yours of 3.5 would be over and above the fixed fee?

A. The fees over and above 3.5 would be treated as management.

Q. The early 1980s Dr Reay was a very busy time in the building industry as I recall. Do you agree with that?

A. I think I've said so.

5 Q. You had a number of public companies that had surfaced, and a lot of them were involved in either (a) building buildings for themselves or themselves and spec buildings. Do you agree with that?

A. Not so much in Christchurch, more so in Auckland.

10 Q. And with Mr Henry giving notice you were really left on your own with a draughtsman for – is that correct, from a point of view of engineering personnel?

A. Oh yes. That's correct.

15 Q. So you were keen, maybe an obvious question to fill that role reasonably quickly because of the pressure of having a lot of work in the office?

A. Well there wasn't pressure in that sense, in that, at that time I hadn't committed to undertaking any more multi-storey buildings.

20 Q. So this was 1985 moving into 1986, it was a sort of a very busy time in the office. We hadn't arrived at the 87 share market crash if I could put it that way.

A. Well it was as busy as what one wanted to make it.

Q. But your office was particularly busy at this time.

A. Well the work was there. I wouldn't describe it as exceptionally busy.

25 Q. And you were in need of an engineer who (1) was able to design multi-storey buildings. Is that correct?

A. If we were going to carry on designing them, yes.

Q. And (2) an engineer capable of using the ETABS system?

A. He would need to be capable of doing that, yes.

30 Q. Mr Harding's evidence is that you were encouraging or the firm was encouraging business, or the business of designing high rise buildings, so you were trying to capture that part of the market?

A. No that's not correct.

Q. Is that not correct?

A. No. No we had existing clients who had decided to – that they wanted to develop some medium rise buildings and we were certainly not setting out to go beyond that.

5 Q. When you employed Mr Harding, Dr Reay, you knew in some detail of his experience dating back to the Hardie and Anderson days, his engineering experience?

A. I knew what his experience was because he'd worked for me previously.

Q. And the previous time he worked with you was between 1978 and 1980. Is that correct?

10 A. Yes, it was in that region.

Q. And as I recall I can go to his evidence if I need to, but I think he was mainly involved with low rise buildings, the static method of calculations involved?

A. That would be correct.

15

WITNESS STOOD DOWN

HEARING ADJOURNS: 5.02 PM

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