HEARING RESUMES ON THURSDAY 2 AUGUST 2012 AT 9.32 AM

JOHN HENRY (RE-SWORN)

EXAMINATION CONTINUES: MR MILLS

WITNESS CONTINUES READING BRIEF OF EVIDENCE FROM PARAGRAPH 65

A. The formal calculations for the primary structure are usually bound in an indexed A4 set. However, other calculations are sometimes carried out on preliminary drawings or on the computer output and may not be bound together or filed with the indexed set. It was and still is normal to use judgement or experience or traditional details for some parts of the design. This was usually for less complex aspects or areas where the answer was known from another job.

In the course of preparing my evidence I have reviewed the calculations I did for Landsborough House, which I left with ARCL when I resigned. I have been advised by counsel assisting that the calculations I reviewed were obtained from ARCL. Most of my important hand calculations have been included. This includes the preliminary checking of the corner deflections that I did for the design configuration I had been given by Alan Reay that showed me it did not work and needed me to reconfigure the shear walls with a closed core. The calculations I reviewed also include the further set of preliminary hand calculations I did that satisfied me that the corner deflections for my reconfigured walls were less than code maxima and that this was enough to proceed with the ETABS analysis.

Q. Now would you like to be taken to those two sets of calculations you've referred to then?

A. Well I'm happy to go through them and show you the steps if you (inaudible 09.34.50 – overtalking)

Q. Well I think it might be useful. The Commissioners may need to understand this.

WITNESS REFERRED TO BUI.DUR287.0003C85

Q. And they run through ultimately to page 91 but there's the first of the pages you've referred to. Now do you just want to explain what it is that you're showing there and what you've done?. If you need to use the mouse to point to things please do so. The only reason you need to release it is to bring up the next power point but use it to point to things as we go along please. And if also, for the record, you can just identify sufficiently what it is that you're pointing to so that the record will accurately record that that would be appreciated.

A. Okay well I won't try and explain all the numbers I'll just say what's going on on the page if that's enough. This shows the start configuration that is essentially what was on the preliminary drawings that I was presented with, although it's slightly rationalised, these walls in the middle are longer to create more shear wall length and the rest of those calculations are calculating the mass, or the centre of gravity of each item.

Q. All right anything else you want to say about that particular PowerPoint.

A. Only other thing is that that's the north, the north wall that has the long shear wall and it's got four wing walls off it. The short one on each end that was shortened to try and increase the window space I think and the longer two in the middle trying to get more shear length strength.

Q. And the beams I take it are running north-south?

A. Yes the beams are running up and down the page. At that stage the beams haven't been shown but that's the intention.

Q. All right go to the next page, 86. Give us an overview of what you're doing there.

A. Yes. This is calculating the centre of rigidity, well actually, hang on, this is where I've assumed the centre of rigidity just on the basis of experience and work out what the design eccentricities to be applied to that configuration are and I suppose the key thing there, it says here "assume shear centre is at the north boundary wall". So it's right on the extreme side of the building and then from there on proceeded down the page to calculate the –

JUSTICE COOPER:

Q. Is that a conservative assumption Mr Henry?

A. Yes, yes.

EXAMINATION CONTINUES: MR MILLS

A. And then pressing on down the page there's two eccentricities for plus or minus 0.1v of displacement of the centre of mass and the torsional moments to calculate at the bottom on the building are 37,800 kiloNewtonmetres and 23,670 kiloNewtonmetres.

Q. Right do you want to go to the next page, 87?

A. Yes. So the next step was to calculate the relative stiffness of those walls in the Y direction which was the direction of the short walls. Obviously there's four walls, two at three metres and two at 7.2 metres and then there's a standard formula there: K for working out the stiffness of the walls as a function of their bending and shear properties and that's what the rest of those numbers are doing down there.

Q. You just let me know when you want to go to the next –

A. Yeah I'm uncertain how much detail we go to. It's probably better just to press on, unless there's a question, but what that's saying on the right-hand side there is 0.902. It's about 10 percent is taken on wall AD and 90 percent on wall BC, walls B and C, and that's just a comparison so obviously the two big walls are taking most of the load. They've got the greatest stiffness, 90 percent of the stiffness yep.

Q. All right page 88.

A. So this page is distributing the, calculating the shears on each of these four walls from the torsion on the building. This is the normal formula used here and down the bottom is giving the resulting shears on the walls.

Q. Yes all right, shall we move on?

A. Yes.

Q. Page 89.

A. This page combines what's called the direct shear as if there was no twisting on the building. It combines that with the torsional shear and

adds them together to get the net result of the shears on the walls. Those diagrams down the side there really show that there's a direct shear there, torsional shear and the sum of them at the bottom. The torsional shear is shown as coming from the side but that's just representing a moment a couple anyway. And then there I've gone on to, I've gone on there to quickly jump to the end of the shear strength of the walls and have a stab at, based on experience, what the over-strength shears would be on the wall, taking into account overstrength and also Omega for high mode effects. So that's 2.25 times those basic

0942

shears and worked out shear stress in the wall at the bottom and got about 3.6 megapascals in, okay, and carried on at that stage.

Q. All right. Have you got the next page?

A. Yes.

Q. 90. Page 90.

A. At that stage the walls have got enough shear area –

Q. Just wait a moment. We're just going to bring it up.

A. Yep and I've decided to check the period of the building and that's a formula, an approximate formula for preliminary calculations which at the bottom comes out at .65 seconds, and then onto the next page. I've now gone to look at the rotation of the building and to calculate (inaudible 9:43:17) delta from the maximum torsional shear on the walls. So I've noticed the predominant flexural deflection on the side and the total torsional deflection due to torsion there of .127 metres and over eight floors it's turning out to be 16 millimetres. That's .016 metres, that should be 15 millimetres per floor and then a check on the allowable five-sixth of .1 on the storey height.

JUSTICE COOPER:

Q. Just, what did you say about that figure of .016?

A. That's .016. It's, it's too small to see but it's meant to be metres.

Q. I see. So to the extent that it looks like there's two m's there. That's simply a mistake is it?

A. It looks like a what sorry?

Q. A mistake.

A. What does it look like to you a?

Q. Well I was wondering whether it was two m's but –

A. Yeah, yeah –

Q. In which case –

A. It looks like millimetres. Yeah. It's hard to say but it's metres, .016 metres.

Q. Is that the ms?

A. No, no it's millimetres. I'm sorry it's metres.

Q. Yes but ever the second, if, if it is, if you have written two m's there that's just an error is it?

A. It would be if it was, yep. Always working in millimetres and metres and sometimes you can accidentally write one down but it's metres all the rest of the way of the page.

Q. But it must be millimetres in context.

A. Well it's 16 millimetres.

Q. Yes.

A. Or .016 metres.

Q. Right.

A. Yep. So that's quite, there's a bit of shorthand going on here. What I've done is I've calculated the total and it is .127 metres and split it over eight floors. So .127 divided by eight and that gives you .016 metres per floor.

Q. Yes.

A. And so from then on I've pressed on to work out the rotation at the corner which is .016 metres over 21.6 metres to the corner.

Q. Yes.

A. That gives me a rotation and then lower down I've worked out the allowable deflection at the corner of 27 millimetres.

Q. Just go back to the main screen.

A. Before factoring by –

Q. Yes the rotation equation which, which immediately follows shows a fraction which is plainly expressed as being metres. So –

A. Yep.

Q. – that removes any doubt about the previous line doesn't it?

A. Yep. So you get the rotation and then I've looked at, at what the co-limiters which has been much discussed and it was 27 millimetres.

Q. Thank you.

A. And then I have worked out the scaling factor to 2.5 which is, this is K/SM which in this case K is 2 in the code divided by SM 1 times .8 and I've multiplied the 16 millimetres by 2.5 and got 40 millimetres and that says, "Due to torsion only." So what that tells me there is that from these preliminary calculations, and that configuration at the corner would have moved 40 millimetres only due to the twist without the direct load and that's greater than the 27 and that's probably the end of the story for that, yep. If we go to the next page –

EXAMINATION CONTINUES: MR MILLS

Q. So when you say it's the end of the story you're saying that that particular design wouldn't work?

A. Yeah I, that means there, I haven't written it down but that means it's too much.

Q. All right.

A. And on the next slide it goes straight to alternative core layout with perforated shear wall at rear of lifts and, and then the same procedure starts again. In the next slide we start to go through, consider the effect of the core tube and at that size, 5.6, .7.6 metres and then what is going on next is working out the torsional properties of the tube so that I can use the classic normal twisting formula for a tube and that's just like assuming the whole shear core is a tube just like any piece of tube, like a piece of downpipe and at the bottom of the page I've worked out the angle of twist in radians, 3.59 times 10 to the minus five radians per metre and on the next –

Q. Right you want 94?

A. Yes, yep. Now because the centre of rotation, actually it's the centre of rigidity is the same thing as the centre of rotation and for all intents and purposes it's now moved into the building from, away from the back, side wall, it's moved into the tube and then I've got it in the centre which is probably, considering there's holes in the wall, not conservative. It probably should have been a little closer to the back, to the side wall but at this case, at this stage it wouldn't matter because it's preliminary and – so I've gone to check the twist and I've got the maximum rate of twist highlighted there and I've worked it out at 2.65 millimetres. Now that's per storey, because I've multiplied it by eight and got 21 millimetres. Yes you can see there up under the box, over a 3.2 metre storey that twist, 3.59 times down to the minus five radians per metre. The storey height's 3.2 metres. That gives you the, 1.15 times 10 to the minus four radians, multiply that by 23 metres to the corner and that will give you the deflection from the centre of rotation to the corner and then multiply it by eight storeys and got 21 millimetres. So that looks okay. The twist is much improved. I will be able to, I've got some very simple models here to show you why the twist, why the stiffness of this shear core is so much better than an open one which I can show you.

Q. Do you want to finish going through these calculations first perhaps?

A. Yeah. Yeah. So pressing onto the next page.

Q. 95.

A. I'm checking on the torsional shear. So that's taking the total twist, twisting moment on the building and resisting that with the four walls is two couples and then checking equilibrium and then checking the shear stress and I've got "ok" there.

Q. All right. We move to the next page?

0952

A. Yep. As with the previous preliminary one, check the direct shears and the torsional shears added together and what's important to note here is that the wall closest to the middle of the building for loads in the critical direction across the building, picked up the maximum load which here is 4654 and by contrast the wall on the opposite side of the tube has a

cancelling effect, the torsion has a cancelling effect so it increases this wall and decreases that wall at the same time as these other side walls are resisting torsion and that is important to note because what it means is that virtually the full demand of the earthquake load comes on that wall, where the coupling, coupled shear – coupling bends are and that's the wall that dissipates the energy, there's virtually no energy dissipation going on the back wall, it becomes almost neutralised in the design and because of the eccentricity, so what comes to pass later in the design is that this wall is essentially designed for 100 percent of the load on the building and hence the coupling beams are apportioned for that reason, to take the full load. And then pushing onto the next slide.

Q. 97.

A. The – checking the wall thicknesses, adding the shears together this is just a basic check to make sure that the shear stresses are going to be okay on those walls.

Q. Go to the next page, 98.

A. Yes, and then – now I've gone into more calculations to check the deflection of the core on a direct load and there's – numbers for that are for bending are at the bottom and this is bending as opposed to shear deflection. I've added the two components together and on the next page –

Q. Ninety-nine.

A. The calculation continues for the shear deflection and then they are summed together for the total deflection at the bottom and so down here the total deflections are .024 metres and .028 metres, which is three to 3.5 millimetres per floor.

Q. The next page, page 100.

A. That is the direct shear with no twisting and from there, this is the last page, it goes on to combine the direct intorsional deflections at the extreme corner, approximately 23 metres from the centre rotation and using the all previously calculated rotation and then I've applied that side figure there, K/SM, and I've increased it to three there because the ductile coupled shear wall has a S of .8 and the initial assumption was

M of 1 and S of .8 minutes, sorry M of .8 and S of 1, now they're both .8. M of .8 and S of .8 so that's 2 over .64 and it near enough comes out to three. I haven't written that there but I just know that and so I've combined the direct and torsional deflections to get 12 millimetres at the corner.

Q. Do I take it that all the time what you're most interested in is deflections at the corners?

A. Yeah this is all going – only of checking the walls are thick enough for shear stress but it's all aiming for the corner deflections and then down the bottom I've calculated 68 millimetres total. So that is basically a preliminary design process to size the core elements and to get a firm idea that the thing is stiff enough to proceed on with the ETABS design.

JUSTICE COOPER:

Q. Can I just – and my colleagues will have to be patient with me at this stage, but as a non-engineer I just want to make sure I understand the context really of – or the process of these calculations because I've seen in similar documents calculations and I've noticed that they all seem to proceed in a sequence which is logical but they're not like calculations that some others might do because there are no crossings out or lines put through things. It's almost like there's some other exercise going on at the same time which is then transferred across to the finished article. Is that the way it happens?

A. No, well – no this is straight off – I've –

Q. I see, just flows on.

A. – been doing these for years and you just have a method, style and you have a rubber, eraser, you know –

Q. So these are pencil calculations?

A. Yeah, they're pencil, you don't, well some people use ink.

Q. That explains.

A. They're not perfect in that sense.

Q. Well my colleague Commissioner Fenwick is famous for his pencils and rubbers. So that explains that but now the other question that occurs to

me to ask is this. You have taken us through preliminary calculations for a design that was effectively abandoned but you have kept a record of that together with these other calculations of a design that actually formed the basis of what was built. Now why have you kept calculations for an abandoned part of the design process. Why do you do that?

A. Oh look, I didn't keep them, I had no idea the calculations were even there until Alan Reay's office handed them over to counsel assisting.

Q. Well you did keep them because you didn't throw them out when you said, "Oh well I'm not going to do that anymore." Why didn't they go in the rubbish bin?

A. No, well, just normally you start at page 1 and away you go, just keep turning the pages and then when it – I ...

Q. Well is the purpose so that there is a record kept of your thought processes, is that the purpose?

A. Well it wouldn't have been deliberate, it just would have been the way I did it and just put them in a heap and finished and ...

COMMISSIONER FENWICK:

Q. If I could just comment. I've mean I've done what, exactly what you've done many times.

A. Yeah.

Q. And usually if I abandon calculations I draw a double line down the side so I knew what had happened, but I would keep them because sometimes they tell you something you want to know later on as a guide so I mean that was my process. Would that what you would have done perhaps, I mean that was, certainly that's the approach I would take?

A. Quite possibly, look, I couldn't say why they're – I just did it.

JUSTICE COOPER:

Q. Well it's obviously whether you're having trouble articulating it though, it's something that you did and even if it was subconsciously for a reason obviously.

A. Well I – normally I'm thinking nowadays, yeah, I usually don't throw out anything that shows the development of the design, I'm probably not giving a good answer, but anything that shows how you got to the design is included in the calculations as a sort of a track record of how it came about and –

Q. Well what are the advantages of doing that?

A. Of doing that?

Q. Mmm.

A. Well it – yeah, I'm thinking of the job I'm working on at the moment where I'm not so sure about it because it's quite unusual and yes, I've gone back over those calculations and looked at what I did and then gone back, and okay, no we'll change that and I've done it again. This is basically a concrete dam for – on the West Coast, it's not what I normally design so I'm getting extra help on that. I'm sending those

1002

calculations to other consultants for comment and then getting them back again putting that in the file and carrying on and reworking it so that's probably more what you mean.

Q. So, in a way, that is the purpose that Commissioner Fenwick spoke of, your going back to an earlier stage to mine it for relevant information as the design proceeds, right?

A. Well, yeah, I mean the fact the these were kept I would say was just normal. The fact that I didn't cross it out and write superseded is just pressure of the day or whatever. I might have, I might not have. But, I mean, at the time I think, I'm sure, there's an onus on me to show that this thing didn't work, the configuration that was initially proposed because, as I said yesterday, that was what the commitment was to that arrangement so it was, it needed like substantiating. I said it wouldn't work but I'd have to substantiate it so that was the purpose of all that really saying right there there it works now, now it works I believe, and then went on with the ETABS from that.

Q. So it was an important part of the justification of the design given the context in which you were where you were heading to put forward a change in the concept.

A. Definitely yes.

COMMISSIONER CARTER:

Q. I think there is considerable benefit I think in the procedures you've followed in that you're, in effect, going through a trial and error process of deciding what will work so it's very useful from a checking point of view, a subject which has come up earlier in these hearings, the need to actually verify the decisions that have been made. If you've got, sometimes it's important to note the reason why something was rejected as it is to note why something is accepted. So I think it is of value to have kept the record of what you rejected. It includes certain assumptions which might be challenged again in the future that you did not need to have made that particular deduction and if you'd made a different one then that calculation can be reviewed again to come to a different conclusion so I think it's a reflection of the thoroughness of a process to keep the record of what steps you'd taken and the decisions that you'd reached, even if they were to cause a change in direction of your thinking. So I'm perhaps putting words into your mouth in saying that but I'm just endorsing, I think, what the chairman has been questioning that there is sound logic in retaining calculations that later on were improved or advanced into another state.

A. Mmm. Well I was just going to say I certainly wouldn't throw them out but what I do know is, what I very much appreciate is when these calculations were handed back to me I didn't know what I'd really done. I thought I knew what I'd done when I was writing my evidence and I was trying to say I'm sure I would have calculated the deflections before pressing on and when I received the calculations I was heartily relieved that I had done it and it was clear so, from my point of view, it certainly was a great thing to have them in this situation.

COMMISSIONER FENWICK:

Q. Could I just have it on the record. Looking through your calculations there which I can follow quite well I can also see you've made quite a few approximations. They are preliminary calculations –

A. Yes.

Q. – giving you the correct order of displacement, is that correct?

A. Correct yes.

Q. And they're not values you are going to rely on finally because they're going to be checked out more accurately with the analysis.

A. Definitely not, yep.

Q. So the fact you've assumed uniform torsion and uniform shear and so on, which you don't quite have, but it's, as far as you're concerned, it's a valid approximation to see whether the deflections are moving into the right order so you can proceed, is that correct?

A. Yes, yes, the decimal places and everything sort of gives the impression of great accuracy –

Q. Plus/minus 30 percent.

A. It's just for keeping track of the numbers. It's the big picture this thing and it serves the purpose of deciding do we proceed with this model or not. Once you use the model that's all superseded.

Q. Yes I just wanted that on the record and confirmed so that people don't come back and challenge you on a plus/minus 20 percent (inaudible 10.06.55)

A. Oh absolutely, yes, yeah.

JUSTICE COOPER:

Q. So putting that in my terms these calculations are such as to give you a degree of comfort that you're on the right track and you now have a design concept which is worth proceeding to the point of detail.

A. Yes.

Q. And I suppose another point that's probably an amalgam of everything that's been put to you is that it creates, it gives you the certainty in your own mind that you have been through a logical process in which the

forces that the building is going to have to sustain have been appropriately taken into account.

A. Yes and it gives you a fundamental feel for the thing as you go along. If you've reference point in your mind when you get the output from the computer you're looking for certain numbers that you've identified here and you're looking to compare them.

Q. Yes.

A. Like the base shear and the total torsional twist and so on.

Q. Yes. And I'll stop asking questions in a minute. I suppose another purpose would be that if somebody wanted to review your preliminary conclusions or your choice of the design at this preliminary stage they'd be able to pick this up and follow your reasoning and themselves form a view as to whether this was likely to be a robust design.

A. Yes.

Q. So that if you were going to be subjected to review at this stage you'd be able to say well there it is, here's my thinking.

A. Yes.

Q. Well that's been very helpful thank you.

EXAMINATION CONTINUES: MR MILLS

Q. Right just two other points on that paragraph before we leave it if you don't mind. The first is you said these preliminary calculations you had done when you got the results of the ETABS analysis, I think this is what you were saying, that having those preliminary calculations would also enable you to check those against what the computer analysis was producing –

A. Yes.

Q. – and is that partly also a cross-check against whether something's gone haywire in the computer analysis?

A. Definitely yes.

Q. And then, secondly, just to confirm this, that first set of the calculations that you did which led you to conclude that that design wouldn't work and then you moved on to the one that you thought would work, that first

design that you concluded wouldn't work was the one you'd been given by Dr Reay.

A. Yes.

Q. Thank you. You're at paragraph 67.

WITNESS CONTINUES READING BRIEF OF EVIDENCE FROM PARAGRAPH 67

A. All of this work is included in the calculations I have reviewed for the purpose of preparing my evidence. However the data I obtained from the ETABS analysis that I did for Landsborough House was not included in the information obtained from ARCL.

If David Harding had been following the calculations I left with ARCL the process he needed to go through to check the corner rotations resulting from the eccentricity of the CTV building should have been clear. However, there is nothing in the CTV calculations that I've examined that indicates he did do this.

Q. You're at paragraph 69.

A. I've been asked by counsel assisting to describe Alan Reay's involvement in the design of Landsborough House.

I was very much in the driving seat in doing the structural design for Landsborough House. I had the sole responsibility for the ETABS work, including the analysis of the output. To assist me with producing the structural drawings, Terry Horn, a draughtsman from Holmes Wood who was experienced in detailing this type of building, was engaged by ARCL. I had no dealings with the client at all and few dealings with the architect in relation to project management over the Landsborough House job but carried out my role behind the scenes as the technical designer, specification writer

1012

and structural detailer.

I expect I would have shown Alan Reay the results of the analysis. He did make some comments on the design and gave some instructions to improve the method of construction by using some pre-cast elements. The main instructions I recall related to the use of pre-casting for the

coupling beams to expedite the shear wall construction which I agreed was a good idea and the use of pre-cast concrete fire separation walls between the egress stairs and the service core which were then able to be lifted in for each floor. However, he was not closely involved in the work I was doing and had no involvement in the ETABS analysis.

I have been advised that the building permit application for the building was dated 6th of June 1985 and the permit is dated 9th of August 1985. I do not recall having any involvement with the building permit application process. My recollection is that this would have been about the time that I resigned from ARCL.

Q. And I think you now have agreed that your resignation was a little later than that wasn't it?

A. Yes well I didn't have any record. I rang Dick Cusiel to see if he had a record for when I started with him and he thought it was the end of September or the start of October that I started there so -

Q. Yes.

A. – that was the best –

Q. Which I think is broadly consistent with what Dr Reay had said –

A. I think so.

Q. – about the time he thought you departed.

A. Yep.

Q. Yes and you're at 73.

A. I cannot recall if construction of Landsborough House was underway at the time I resigned from the ARCL. I had no involvement with the construction of the building.

Q. All right. You're now going to talk about Bradley Nuttall House.

A. Right. Alan Reay subsequently used the design of the Landsborough House building again for the Mair Astley building now known as Bradley Nuttall House situated in Cambridge Terrace. I will refer to this building as the Bradley Nuttall building. This was identical in plan to Landsborough House but one storey lower. There was little needed in the way of structural design for this building because the structural design already existed in the Landsborough House. My

involvement with the structural design was limited mainly to the design of the architectural pre-cast spandrel panels that form the exterior façade of the building. These were bolted onto the main structure as non-structural elements, that is, they are separated from the structure so as not to interfere with the main structure during earthquake deflections and they carry only their own weight.

I had no involvement with the client on the Bradley Nuttall job and little to do with recycling the Landsborough House structural design within the office. Alan Reay handled this with the draftsmen. I cannot recall whether or not I left ARCL before the documentation for this job was completed. I have been advised that the building permit application date shown on the drawings as 18th of July 1985 and the permit is dated 23rd of October 1985.

Q. Now the Age Concern building?

A. The other eccentric shear core building I was involved with at ARCL is now known as the Age Concern building on the corner of Cashel Street and Cambridge Terrace. As I've already mentioned both this and Landsborough House were mentioned to me by Alan Reay as jobs that were in the pipeline when I was considering joining ARCL. I recall that this design was carried out concurrently with the Landsborough House design and utilised a similar configuration of walls for the shear core. I am advised that the building permit application is dated 2nd of April 1985.

I had no involvement in setting up the Aged Concern job. I did do the detailed design. This design is a four-storey reinforced concrete building –

Q. Now I think you want to make some slight changes to this next sentence don't you?

A. I do, yes.

Q. So I you could just read it the way you'd now like it to be and then we'll just make sure the Commissioners have got the changes.

A. Alan Reay used his tilt slab expertise to change their normal cast in situ walls to full height tilt slab walls forming the shear core.

MR MILLS ADDRESSES COMMISSIONERS:

So Commissioners if you could delete “design it with” and insert “change the normal cast in situ walls to.”

EXAMINATION CONTINUES: MR MILLS

Q. You're at, “At the time.”

A. At the time this was unusual and extended the limits of this type of construction in Christchurch. Again, I believe the typical eccentric shear core was chosen for the purpose of optimising open lettable space. There was no code requirement to use ETABS to analyse this building because this is only required under the code for buildings more than four storeys high.

Q. Just pause. The “used’ in that first line should be “use,” “no requirement to use” ETABS. All right. You're at, “I was able to carry.”

A. I was able to carry out the calculations by manual methods. I do not recall ETABS being used for this job and I do not think it was. I'll just repeat, “I carried out the calculations by manual methods,” yep.

Q. All right you're at paragraph 79 which deals with the development of ARCL’s expertise with multi-level shear core buildings.

A. I have been asked by counsel assisting whether the design work on the Aged Concern building would have provided ARCL and Alan Reay personally with the experience and expertise to the design of a multi-level shear core building.

JUSTICE COOPER:

Relevant.

EXAMINATION CONTINUES: MR MILLS

Q. Relevant. Yes. You just didn't read what was there quite.

A. Sorry, expertise relevant to the design of a multi-level shear core building on the scale of the CTV building. In relation to the seismic analysis and shear core design it did not for two reasons. First, I do not

believe ETABS was used. Secondly, I did the detailed hand calculations for the shear core design and Alan Reay was not involved.

The Landsborough House, Bradley Nuttall and Aged Concern buildings were all designed by ARCL on the basis of the knowledge about shear core buildings that I learnt at Holmes Wood and brought to ARCL during my time there. Although I believed the design of these buildings met the code at the time they were all at the limit of what could be achieved with eccentric shear cores and there was no margin for error. My personal view was that these were not desirable structures to be designing. However, I endeavoured to make the best of them given the constraints presented to me and to ensure that they complied with the code requirements.

I resigned after about one year of working at ARCL. During my time with Alan Reay I found that he preferred to work as the principal consultant with other design disciplines such as architects being engaged by him. He exercised tight control of the office and was very much in charge of the projects. I found that I was essentially relegated to the role of backroom structural designer with my role limited to technical design and production of documents. This mode of operation did not suit me and I thought it was unlikely to change. I went to work with Lovell-Smith Cusiel on the design of what is now called the Holiday Inn building in High Street.

When I left ARCL there was no designer there who had experience of using either the ETABS system or multi-storey shear core design.

Q. All right. You now come to the CTV building design.

A. I had no involvement with the design of the CTV building. When I left ARCL in, that should be late 1985, I had no knowledge of the building. As far as I knew it was not even a possible job on the horizon.

In late 2011 I briefly discussed the CTV building with David Harding while chatting prior to a professional engineering meeting at the University of Canterbury. I know David Harding reasonably well from professional contact and I knew that he had worked for ARCL for a number of years before I went to ARCL. He then left and went to the

Waimairi District Council. I also knew he had gone back to ARCL after I'd left. He told me that he'd done the calculations for the CTV building using the Landsborough House calculations as an example.

I knew about David Harding's structural engineering background and I was surprised to learn that he'd been in the position of taking on the structural calculations for the CTV building. To the best of my knowledge David had no experience with the design of multi-level buildings prior to rejoining ARCL and I have been advised that David has confirmed this in correspondence with counsel assisting.

I was concerned with David Harding told me he had followed my calculations for Landsborough House for two reasons. Firstly, because it was unlikely that the calculations were sufficiently detailed for a first-time designer to be able to adequately understand the design processes. The calculations did not recall all my thinking processes or the decisions I had made on the basis of my judgment and experience. Secondly,

1022

although both the Landsborough House and CTV building designs were shear wall buildings, they were eccentric for earthquake loading in the east-west direction, their shear wall designs were significantly different.

Q. Just pause there for a moment. Dr Reay in his third brief of evidence I think it is where he's commented specifically on various paragraphs in your evidence. I asked him about this when I was questioning him, was critical of the fact that your calculations did not record all your thinking processes and that that should've been there and should've been in the Landsborough House file. Do you have any reaction or comment on that?

A. I do. Well when, I think my calculations were clear to an experienced designer and perhaps I haven't made that distinction there. But I think anyone who was used to designing such would pick them up and quickly follow them but I mean what's missing – I'm really saying there's no mentoring explanation or help there that if I had known someone wanted to follow those and they were, needed to be set up for that

purpose, I would've written little stories in the explanation paragraph saying, “We’re doing this because we need to check this or that,” and I don’t think it’s fair to say that that should be included in the calculations that an experienced engineer would normally do. So I don’t, I don’t think that’s a fair thing to say.

Q. Paragraph 87?

A. Oh, sorry, the only other thing I would add, I would never expect to do that to write a set of calculations that a first time as I would pick up and expect to use to design a building without any help, because that would be only just to tell him what I did. What was missing is the explanation of someone to guide him through it and help him, he’d still need that along with everything that was written.

Q. Yes?

A. Yeah, you couldn’t do it on its own.

Q. Now you’re at the section of your evidence dealing with differences between the CTV building and Landsborough House and you’re at paragraph 87?

WITNESS CONTINUES READING BRIEF OF EVIDENCE FROM PARAGRAPH 87

A. I will now deal with these differences and the significance of them. Some of these were readily apparent to me from looking at the CTV building and the remnants of the structure after it collapsed. Others only became clear to me after a closer examination of the drawings and calculations.

(a) Differences between Landsborough House and the CTV building that are readily apparent.

Wall configuration. The Landsborough House structure was designed to perform as a closed shear core or tubular structure.

Q. Now you let me know when you want to use these little models that I know you’ve brought along. I’ll just put that in your hands. You put your hand up when you want to use them.

A. Okay, yep, that's soon. It was offset to one side of the building and therefore torsionally eccentric for loads in the east-west direction, but central and symmetrical for loads in the north-south direction. The shear core provided the total shear and torsional earthquake resistance for the building. This was important for two reasons. First, a tube is more efficient at resisting torsion than an open walled configuration and a prime reason for using a closed shear core is to resist torsional forces arising from eccentricity. This is the point I would like to show you these rudimentary models that I've made, because I think it's important to physically grasp it. So I made these from medium density foam rubber because you can twist them and see what I'm talking about. That's just a rough proportion, rough shape of the Landsborough shear core up to the top suspended level. There's an extra piece of lift machinery I left off but this is four walls comprising a shear core that are not joined at the corners, and if you twist it you can see quite easily how it twists and you can see the bending of the wall predominant, making the twisting deformations. If you glue the corners together and try and twist it again you can hardly budge it. You can try it yourself, it really,

1027

it's like extraordinary, extraordinary increase in the stiffness and the reason is that by joining the corners it cancels out all of the vertical forces as you go around the tube from the vertical bending actions of these walls and all you're left with if you apply torsion at the top and resistance at the bottom, all you're left with is a shear in the walls and no vertical forces, and that's why it stiffens. So if you take the same thing and take one wall out of it, it just goes all soft and that's, foam it's exaggerating I know but, that's the significance of those core. Now I don't mean to exaggerate because this building, the Landsborough House has got the coupled shear walls and the doorways through into the lifts and that does soften that wall relative to this one. So if you have another model of this with holes in here and I did that it would, it would twist more. Not an extraordinary large amount more.

Now I do actually have a model of that if you want to see it later, but for the meantime that, that I hope demonstrates the principle.

COMMISSIONER FENWICK:

Q. Can you just, sorry just to illustrate to my colleagues here, can you do the same for flexure please, just take the wall where it's unglued and just show the factual deformation and then show the two again, because it's quite an important point?

A. This one?

Q. In flexure, not in torsion, just straight push.

A. In bending? Right, oh, yes, yes, yes good point. Yes well, yes, so for loads in that direction say the elements that resist the flexure are the two sidewalls and so if you push on it, it bends like that. These don't do anything. So if this was a bigger building these walls were moved further apart, for flexure those two would be doing the bending. In that way it's the same but the walls are deeper so they're stiffer and there's not so much bending. With the shear core joined at the corners, the properties are transformed not into walls that long but into walls that take up the flange as well and they are in the same way much stronger at bending. So you get a double, sort of a double banger effect. You get the torsional stiffness plus you get the stiffness of the tube versus the stiffness of individual walls. That really came through in those calculations I showed you where the, in the preliminary ones earlier on where we saw it and added to, the two things added together.

Q. And the final model where it's open, you're between the two but a bit closer to the first, that's right. The open, open sided one?

A. Well this one, for loads in this direction there's two walls to carry the bending, plus, plus the flange around the corner, so it's a channel shape and it lacks that wall, so it's softer on one side. In this direction you also have a channel shape and its, the stiffness isn't on the back. Actually you can see if you apply loads here it twists. So bend it so it doesn't twist you've actually got to apply a load about here actually. Even

pushing there it's twisting out the shear centre for that channel without, and fresh air behind it.

Q. Can I just make the comment there because it relates back to things we were looking at before? When you pushed it there the section was warping and we talked about warping in the wall before having a significant effect so thank you for illustrating that, it was a beautiful illustration to people who aren't full-time practising structural engineers, though they're getting that way.

A. Sorry I missed that last bit?

Q. I said it's a beautiful illustration for people who aren't full-time practising structural engineers –

A. Oh, right.

Q. – but they're getting that way.

A. I know there's going to be some honorary degrees I think at the end of this.

EXAMINATION CONTINUES: MR MILLS

Q. Now can I just ask you before we leave those? I take on board your point that the closed tube that you had there isn't precisely identical to what was done in Landsborough House and but the one, the open one there, and again with the same caveat that it won't be identical, is that more similar to the north shear core in the CTV building?

A. Yes this is, the CTV is this made wider with two more walls.

Q. Yes?

1032

A. And, but it's also not as deep and I think a significant thing that also affected it was that two of the walls are notched out at the bottom so they, they're 4.8 metre long up top but down the bottom they're 3.4, I think there's three of them at 3.4 and one at 2.6. So it effectively right at the hinging area the maximum, the point of maximum load you've cut down.

Q. All right Mr Henry if I've kept my finger in the right place you were on "secondly".

A. Secondly there were no other structural shear walls in Landsborough House that would influence the behaviour of the shear core under seismic loading. As a result its behaviour was reasonably predictable. This is a key aspect to appreciate when considering the wall system of the CTV building which had an inherent mismatch between the large stiff core located on the north side of the building and the smaller, more flexible coupled shear wall on the south side. The significance of this is discussed in more detail later in my evidence.

Core location.

The Landsborough House shear core was eccentric but it was still within the main body of the building, whereas the CTV North core was on the outside of the building, which contributed to increased torsional effects. It also reduced the possible contact area for connection of shear walls with the main floor diaphragms.

b) Differences that are apparent from a closer examination of the drawings and calculations.

Q. Just to be clear on this, the ones that you've dealt with are the ones that are immediately apparent to you.

A. Yep.

North Core interaction with the south shear wall.

My review of the calculations for the CTV building shows me that they generally follow the path and the design process that I used in the calculations that I left behind from the Landsborough House work. However, the calculations I did for that building were specific to that type of shear core structure. They would not be fully applicable for anyone designing a different structure and, as I have already said, one of the most significant differences between the two structures related to the location of the north shear core and its interaction with the south shear wall.

To reiterate, the structure of the CTV building included a major arrangement of shear walls grouped to form an open sided core located at the north end, and a considerably less substantial coupled shear wall

on the south end. For ease of description, I will refer to these as the north core and the south coupled shear wall. These were the two principal seismic elements in the east-west direction. However they were substantially mismatched in strength and stiffness. This is significant because even with this mismatch, they each needed to carry about the same level of earthquake loading under the east-west earthquake. This is shown in the diagrams showing the distribution of ground floor shears on page S12 of the CTV calculations.

Q. Alright we'll just bring that up. Just explain that to us.

A. Yes, this was a sketch plan that David Harding's done showing what I've just described at the north core and the south coupled shear wall. The top diagram relates to the static load case results, and the bottom one relates to, one of the dynamic, we call it dynamic, it's one of the ERSA results.

Q. Or ETABS.

A. ETABS. ETABS. ERSA results, yes. Now the top diagram has got two lots of results superimposed on it which makes it hard to read, and they're for the two eccentricities of plus or minus point one B. But the way to click into this is that total load in that direction, this direction up and down the page…

Q. That's east-west isn't it?

A. Yes. East-west. That's the critical direction. The total load is 3300 kiloNewtons. And you see that's been checked here, and when you look at these diagrams, these 2 loads here of 1000 kiloNewtons – that's on each side, each panel of the coupled shear wall – adds to 2000, and at the other end you see 1300. Adds to 3300. So those are the 2 matching ones and if you reverse that is 1925 and two lots of 688. They add to 3300 as well. They're not 50:50 there because the… for the design you're required to displace the centre of mass by .1B and that makes it 60:40. So the centre of mass is in the middle. One way you displace it that way, the other way you displace it to the other end and you get, you choose the worst effects. If you work out the 60:40 ratios of 3300 you'll get those numbers that are there which I have done to check it and then

down the bottom we've got the ERSA results from ETABS. The first thing to note is that the sum of the shears there is 2784 not 3300. I'll make a note of this now because it's important and that is because these results are for two different building periods. The top ones 3300 were for David Harding's first estimate of a building period of 0.7 seconds and those are manually input, those loads are manually input for the static load case into ETABS whereas the lower ones, the ERSA ones, ETABS calculates the period itself and so you've got to compare apples and apples when you look at these and at this stage it's comparing an apple and an orange. So it does get sorted out later on to a fair degree but the factor, the difference between the static and the ERSA is 0.71 at this point and if you multiply 3300 by 0.7 you get 2350 and the reason why I say that is because you can see that the ERSA load of 2784 is actually higher than the static when you compare apples with apples. And then, having said all that and looking at the distribution now on the ERSA results you've got 662 doubled, which comes to about 1324, and at the other end you've got 1460, so it's slightly higher but it's still roughly 50/50. So quite a long way of telling you that that page tells you, when you break the numbers down, that even though you've got a big north core and a little south wall in different stiffnesses and flexibilities they each are required to carry essentially half of the earthquake load in the east/west direction. Whereas you might think otherwise looking at the size of the north core. The reason that its, I come to explain the reason for that.

Q. Yes you do explain it in your next paragraph I think don't you.

A. Yep, yeah.

Q. Paragraph 92.

A. The reason for this is that they were the only two shear wall elements acting in the east/west direction and they were approximately equally spaced about the centre of mass of the building. The effect is that half the load went to each end. However, due to the difference in the stiffnesses or stiffness the south coupled shear wall was going to deflect much more than the north core and this would cause the building to

twist about a vertical axis near the stiffer north end of the building. This is shown on a separate diagram that I've prepared.

WITNESS REFERRED TO BUI.MAD.249.0405.1

A. This diagram shows, it's an exaggerated diagram, it's not drawn to scale for deflections in proportion to the plan area but the blue line shows the displaced shape once the building was deflected and its rotating about a point which was shown approximately with that dotted circle in the, basically in what would have been the stairwell. There's a lot of discussion on exactly where that point is but that's approximately it so it rotates about that point and on the south side of the building at the southeast corner and up at the southwest corner the deflections are greatest and on the diagram there, 89mm for an earthquake going in the east-west direction. These are factored for K/SM equals 2.5 with the eccentricity to the south, in other words the worst design situation that the Code asks you to look at.

Q. All right, nothing more you need to say about that? I'm not suggesting there is I just want to be sure –

A. No there's one more thing, the deflection in the middle of the building is 58mm, and by the way these all sound very precise these measures, but it's just for the purpose of being consistent. You would never expect

1042

that sort of degree of accuracy in real life, or what would really happen of course, so the middle of the building at the assumed centre of mass, it's not the dead centre, it's the assumed centre of mass which was displaced by .1B, the deflection there is 58, versus the corner being 89 so it's slightly more than half because it's displaced to 60 percent of the weight.

Q. And this I take it illustrates the significance of the points you made earlier that I think Mr Harding's acknowledged that he didn't do calculations of deflections at the corners?

A. Yes he has.

Q. And this is illustrating the significance of that?

A. Yes.

Q. A failure.

A. Yes, the ETABS output in those days, not the modern versions of these days but it gave you the deflections at this middle point so if you picked up the – all of the data and started reading it you say, it would read deflections and give you a list of them and that would be where they are given for, whereas what you need to do is interpolate them or extrapolate them by further calculations to find this corner deflection, so if you didn't know that when you picked up the output you would be on the wrong path and not realise it.

Q. Paragraph 93 please Mr Henry?

A. This approximately 50:50 share in the earthquake load between the two walls might appear to conflict with the expectation that a stiffer wall would attract a greater share of the earthquake load. However for it to do this the building had to be constrained against twisting. To achieve this there needed to be opposing walls in the orthogonal direction, ie. the north-south direction. In the case of the CTV building there were four walls in the north core which acted in the north-south direction but these were not sufficient to achieve significant torsional restraint.

The ground floor shears shown on page S12 of the CTV calculations demonstrate that for the north-south walls –

Q. The four north-south walls.

A. Sorry for the four north-south walls of the north core have relatively small shear forces in them under the east-west earthquake loading.

Q. Now we've looked at that S12 calculation before. Do you need to look at it again?

A. I don't need to.

Q. All right.

A. The shears when you look at them you can see that they're not – the walls are not attracting any significant load because of their flexibility, that's what it means.

Q. Yes. You're at, “This is because ...”

A. This is because they were relatively slender and open on one side, that's the core was open on one side. They were also close together

compared with the size of the floor plan. The small forces shown in the calculations on page S12 showed that these walls would not provide a substantial resistance to the torsional or twisting forces. The practical aspect of this was that the structural system being relied upon for the east-west direction of the CTV building was primarily a system of two elements with unequal stiffness, the north core and the south coupled shear wall.

Without the south coupled shear wall the CTV building would have had an eccentricity in excess of half the building. This would not have been workable. It appears that the south coupled shear wall at the south end of the building was intended to counter-balance the eccentric effect of the north core and this was the obvious place to locate such a wall. However in my view that solution was still not enough because it would place the bulk of the ductility demand on the lesser of the two walls and the first wall to yield would continue to yield with increasing deflection and rotation of the building.

Q. If Mr Harding had shown you that proposal with the south coupled shear wall in there, and the north core where we know it is, would you have just by looking at it had concerns about its adequacy?

A. Yes I would have, definitely.

Q. Paragraph 96.

A. The imbalance between the north shear core and the south coupled shear wall appears to have been increased during the design process by scaling factors applied to the earthquake loading. The scaling has resulted in a significant reduction in the earthquake loading used by ARCL for the design of the south coupled shear wall and this has significantly lowered the yield strength of that wall from the initial level using the static assessment. While the south wall was reasonably well detailed for ductility and would have been able to sustain the earthquake loading by ductile yielding and plastic deformation, the onset of early yielding would have increased the plastic deformation in the wall and increased lateral deflections of the south end of the building. The reasons for this are described in more detail later in my evidence.

A. The critical question for this design is whether or not the underlying design premise that the south coupled shear wall –

Q. And I think you wanted to leave the word shear there the second time don't you?

A. Well it reads best I think, the south coupled shear wall was stiff enough to provide the necessary protection to the gravity load system remained valid for the chosen level of design load. Actually that's got broken, that's (inaudible 10:48:21) but I'm saying the critical question for this design is whether or not the underlying design premise that the south coupled shear wall was stiff enough to provide the necessary protection, the gravity load system remained valid for the chosen level of design load.

Connection of shear core to floor diaphragms.

Because the CTV north core was on the outside of the building the possible contact length with the main floor diaphragms was reduced to approximately four metres.

Q. So just delete the word ‘the’ please Commissioners.

A. … where one area of floor slab extended into the core between the two western most walls.

Q. Western most wing walls.

A. Sorry western most wing walls. The two eastern most wing walls of the core had minimal connection where they contacted the floor diaphragms at their southern ends. Some of these connections were later upgraded in the upper levels as a result of review by Holmes Consulting Group.

By contrast the Landsborough House shear core was within the body of the floor diaphragms. This had what I would call a “spanner” effect that enabled the floor diaphragms to transfer torsional loads to the core in addition to the connections provided by reinforcing from the walls into the floors along the east and west sides of the core and the connection where the two main north-south floor beams attached at the corners of the core.

Location of gravity beams.

Landsborough House did not have gravity beams running in their critical east-west direction that would be vulnerable to deformations from inter-storey drifts during seismic loading and could introduce significant unintended bending and shear forces.

Q. Now you've read that as introduce – do you prefer that to induce?

A. Oh, induce, yeah sorry.

Q. And could induce.

A. Yeah, and could induce significant unintended bending and shear forces. The absence of the east-west gravity beams meant that the columns were relatively free to rotate as intended as pin ended struts in the east-west direction. This was consistent with the design premise of a shear wall protected gravity load system. I would like to just clarify a point there.

Q. Yes by all means.

A. It was raised somewhere at one stage that how could these be pin ended struts if the reinforcing is continuous through the joints and so forth at the joints for the beams. In this case I would like to say that that is a terminology which means not designed as part of the frame and in other words there were no actions or forces being taken into account in the design of those columns from beams. In this case the columns were in effect one length from top to bottom. If that was the height of the building the columns were like that, even though there are – were beams framing into them, going the other way, they in effect were doing that as opposed to having restraint from beams which, if this was a storey height column, would have done that. Am I too long – I need a long piece and a short piece to show everybody what I'm talking about but is that understandable?

Q. Yes.

1052

WITNESS CONTINUES READING BRIEF OF EVIDENCE FROM PARAGRAPH 101

A. By contrast the CTV building had relatively stiff floor beams running in the east-west direction that were capable of providing unintended

rotational restraint to the top and bottom of the columns and hence could induce unwanted seismic forces into the gravity load system if inter-storey deflections were greater than expected.

Block boundary walls.

In Landsborough House there was a full height concrete block boundary wall abutting the core on the north boundary. This was specially detailed with a number of vertical joints to create slender wall elements to prevent them attracting seismic load that would significantly influence the shear core. These slender block walls were on the outside of the structure, not between columns and beams. In this location they could not become engaged with the gravity beams and columns. By contrast the CTV building had a block wall between floors on the west side extending up three storeys and located between the columns and beams with a separation gap that may not have been sufficient to prevent the structure from engaging with the walls during earthquake loading. This may have affected the lateral response of the CTV structure causing it to respond in an unintended way.

Spandrel panels.

The Landsborough House spandrel panels were located well away from the gravity columns and separated so they could not come into contact with the columns during earthquake deflections. Some of the CTV building spandrels were located close to columns and could have come into contact with the columns during the earthquake.

Column reinforcing.

The Landsborough House column ties were 10 millimetre diameter square hoops and they were more closely spaced in the column end regions to provide for some ductility under extreme earthquake loading. In my review of the Landsborough House drawings I've been able to confirm that typically the column ties shown there are 10 millimetre diameter square hoops at 150 millimetre centres in the end regions adjacent to floor and ceiling. These are the critical areas. In the less critical middle region the ties are 10 millimetre diameter at

250 millimetre centres. In the ground floor the columns have 10 millimetre ties at 150 millimetres centres over their full height.

This amount of column tie reinforcing did not make full provision for plastic hinging, but I considered it was reasonable at the time given that there were no floor beams to restrain the columns and induce bending moments into the columns in the critical directions.

By contrast the CTV building had R6 spiral ties at 250 millimetre pitch which is about 20% of the typical ties used in the Landsborough House.

CTV calculations.

In the course of reviewing the calculations for the CTV building I've identified parts where ARCL has not followed the process that I used for Landsborough House. This is principally the calculations of the corner deflections. There are also some significant differences to the way I would have interpreted the code for determining the design earthquake loading and the application of the structural type factors, including the building period and the scaling factors used.

Corner deflections.

I've referred earlier in my evidence to the fact that at the time the CTV building design was done the ETABS analysis did not provide output results that could be used directly to interpret the deflections of the building. It was essential to calculate the inter-storey drifts and be satisfied with the proposed structure configuration before proceeding with detailed design. I had followed this procedure for Landsborough House.

The calculated east-west deflections in the ARCL calculations are smaller than I would've expected them to be. I saw nothing in the ARCL calculations that showed the rotation of the building had been taken into account to determine the maximum deflections at the south corners. There is no working of this in the calculations. Pages S15 and S16 of the calculations is where I would've expected to find this.

Q. Now that point I think has been acknowledged by Mr Harding, so unless the Commissioners want us to go to those two pages, I think it's now an acknowledged point. All right, so you're at, "It appears likely…"

WITNESS CONTINUES READING BRIEF OF EVIDENCE

A. It appears likely that the ARCL deflections are for the centre of mass and not for the maximum deflections at the south-east and south-west corners of the building.

I did a preliminary check on corner deflections on the computer at work, which is Eliot Sinclair work, using – that should read "a Microstran computer model"

Q. So we're going to delete the "ARCL"?

A. Yes, it should be "a Microstran computer model" of this south coupled shear wall. This indicated significantly larger deflection at the south wall than the deflections given on page 16 of the ARCL calculations. As a

1057

result of that I sought more detailed information from Clark Hyland.

I contacted Clark Hyland and asked him if he could provide me the ETABS model corner deflections of the CTV building that he had calculated as part of the consultant's report to the DBH so that I could compare these with the deflections calculated by ARCL.

Q. Do you want to go to that reference there or are you content to read through.

A. I'm, I'm happy to read on.

Q. All right.

A. After receiving this information I checked the corner and centre of mass deflections of the building. I have plotted the east-west deflections in graphic form for easier interpretation. That would be worth showing.

Q. Well I will take you to that. Perhaps you just read to the end of the paragraph and then we'll go back and pick that up and the next one.

A. The graph shows that the south wall corner deflections calculated by Clark Hyland are substantially greater than those given in the ARCL calculations for the east-west direction. Significantly, however, when the calculations done by Hyland and ARCL are compared on the basis of the centre of mass deflection they are much closer, although the east-west deflections are not as close as they are for the north-south.

Q. All right. Well let's go first to BUI.MAD249.0409 which is your, as I understand it is your plotting of the east-west deflections.

A. Yes.

Q. I'd like you to explain that.

A. Yes. The blue lines are the calculations taken straight out of the ARCL, or the deflections plotted, taken straight out of the ARCL calculations for the east-west direction and this is with the K/SM equal to 2.5 which is what David Harding used and the yellow line is what I got from Clark Hyland for the south-east corner. So they were actually, the ones that David Harding were using, the deflections were quite low. You can't quite see the bottom but about 25 to 30 millimetres, 25 millimetres I think whereas the, the Clark Hyland ones were about 90 millimetres. That's the difference between the centre of mass and the corner.

COMMISSIONER FENWICK:

Q. Can I just seek some clarification there. Did the Clark Hyland ones assume soil springs under the walls which would have made them more flexible do you think?

A. I think they did. I, I asked him that and I said what, what's the difference, did you check the difference? And I can't recall a categorical answer but Clark Hyland said he didn't think there was much difference.

Q. Yes certainly the, the calculations by Harding would have been a fixed, would have been –

A. Definitely –

Q. – rigid soils which was standard at the time.

A. Yes everything went in as fixed base.

Q. Yes.

A. Solid, yep.

EXAMINATION CONTINUES: MR MILLS

Q. All right now are you done with that PowerPoint?

A. Yes.

Q. Well let's go to the next one which is 0412. All right again I invite you to explain that.

A. Okay this is comparing the, the same, the blue is ARCL, the yellow is Clark Hyland's and this is east-west direction at the building centre of mass and they are different. So Clark Hyland, and significantly different, there's a factor of about two there. Clark Hyland has got higher deflections at the centre of mass than, than David Harding did.

COMMISSIONER FENWICK:

Q. If you take out the apparent rotation at the base I would say they're almost identical.

A. At that stage, yes, I was simply plotting numbers to see what David Harding used compared with what was being reported and I think to be fair to, in comparison you'd need to make sure you had the base, the correct base conditions so they were matching. I mean it's, the next slide perhaps, I suppose it raises more questions in that sense because they're nearly the same. If we were to put the next slide up –

EXAMINATION CONTINUES: MR MILLS

Q. What's the next one that you want?

A. This is the north-south direction.

Q. No this is east-west according to you, your evidence -

A. But I've plotted, we've had the east-west, now this is the north-south. So in my evidence I'm saying, where was I up to –

JUSTICE COOPER TO MR MILLS:

Q. This is the last document referred to I think Mr Mills at the end of paragraph 111.

A. Yes.

Q. Although that document reference should be 0412.2 I think.

A. It should, yes.

EXAMINATION CONTINUES: MR MILLS

Q. Is that, is that correct or are there two documents here you wanted to look at?

A. Well this, that helps to compare –

Q. Yes that's, there really are two you should, that we should be referencing here around there. There's 0412.1 and 0412.2.

JUSTICE COOPER:

Yes.

EXAMINATION CONTINUES: MR MILLS

A. In the simple sense what this is doing is comparing the centre of mass deflections that Clark Hyland gave – the yellow line – with deflections that David Harding used – the blue line – and I'm not saying the centre of mass deflections that David Harding used and I'm not saying corner because you don't really know what he used but to bring together by looking at those two graphs the right-hand one is for the north-south direction, there's very close correlation, whereas in the east-west direction there's not and I can't say much more about it than that. That's just puzzling and one's wondering what's going on.

Q. All right. You're at paragraph 112.

A. If this is correct the ARCL calculations would have under-estimated the deflections. This may have misled ARCL in relation to the potential performance of the building for the chosen configuration of the shear walls with the design being completed in the belief that the underlying design premise had been met, namely that the gravity load carrying system was protected against earthquake forces by the stiffness of the shear walls.

This would also explain why the gravity load beam column frames did not have any special detailing for members subject to seismic loading, including the absence of column reinforcement for possible plastic hinging action.

Design Earthquake Loading.

My concern about the design of earthquake loading relates to the period of vibration of the CTV building and the scaling factors that were used. To explain this I need to comment briefly on how the loads are derived.

The design earthquake loading is derived from the NZS4203:1984 loading standard. Under these provisions the simple method for determining the earthquake load for a regular building under four storeys high is called the static load method. The static load is a horizontal load applied over the height of the building with a bias towards the top of the building. It is calculated using a simple formula where the total earthquake load on the building is determined by a base shear co-efficient Cd=CRSM. In this formula C is the basic earthquake load determined as a function of the first period of vibration of the building. This is shown in the code as a graph and is called the response spectrum. The value of C is a proportion of gravity, or the weight of the building. For example, the value of 0.1 means 0.1g or 10% of gravity.

The second factor, R, is the risk factor which is 1.0 for most buildings of normal use.

The third factor, S, is the structural type factor. This determines the level of ductility that the building's to be designed for. Usually the S factor is set as 1.0 for the analysis and adjusted for each wall depending on its height to length ratio but within limits as indicated in the commentary to the code. Ideally the S factor would be kept the same throughout the structure, at least in each orthogonal direction.

For ductile or slender cantilever shear walls the S factor would be 1.0. For coupled shear walls which are more ductile the S factor could be reduced to 0.8 depending on the proportion of shear forces carried by the coupling beams in the wall. The south coupled shear wall of the CTV building was such a wall which was

1107

ductile enough for S=0.8. For large stiff walls the S factor would be increased to a maximum of 4 which reflected that it would behave in an

elastic manner without significant ductile yielding. The north core of the CTV building was such a wall.

M is the material factor which is 0.8 for reinforced concrete and constant for the whole building.

The period of vibration for the building is very important in establishing the basic earthquake load value of C. in the 1980s the rule of thumb method for quickly estimating the period of vibration for Christchurch earthquake loading was 0.1 seconds times the number of storeys. For example a six storey building such as the CTV building had a first period of vibration of 0.6 seconds.

The shape of the response spectrum graph in the 1984 Code that applied to Christchurch was such that for any period of less than 0.7 seconds the earthquake load is constant on a plateau at a maximum level. Beyond 0.7 seconds the earthquake loading reduces linearly with period until the value of 1.2 seconds where the graph flattens off.

For the CTV building the initial period assumed in the ARCL calculations was less than 0.7 seconds and the structural type factor was assumed as 1. With the importance factor as 1.0 and the material factor as 0.8 this resulted in a base shear coefficient of Cd = CRSN = 0.125 x 1.0 x 1.0 x 0.8 = 0.10. This resulted in a total base shear of 3300 kilonewtons.

The ARCL calculations I have reviewed show that the period of vibration found by the ARCL ETABS analysis had increased the first period of vibration to 1.06 seconds and the earthquake loading was reduced accordingly by approximately 30 percent. This resulted in a base shear coefficient of 0.071 and a base shear of 2350 kilonewtons.

This period of 1.06 seconds was consistent with the DBH report findings which found the building period to be 1.03 seconds in the east-west direction and 1.2 seconds in the north-south direction. However it differs significantly from what I would have expected based on experience with other shear wall designs. These tended to have a period of vibration consistent with the rule of thumb of 0.1 seconds times the number of storeys.

When I did my Landsborough House design I did an initial manual calculation using this rule of thumb approach which gave a period of 0.7 seconds. I then did a further calculation based on NZS4203:1984 C3.4.4.1. My experience with Landsborough House and other stiff shear wall buildings I've worked on has confirmed for me that these buildings generally do perform in a manner consistent with the rule of thumb assessment. Applying that to the CTV building this would have led me to stick with the initial assessment of 0.7 seconds.

Q. Just before you leave that we've already looked at the second of those two references I think in your paragraph 125. Is there any need to look at the first of those?

A. I'm okay, I don't need to.

Q. All right thank you.

A. I'm also surprised that the longer period of 1.06 seconds was used for the CTV building because it is not consistent with the stiffness of the north shear core. The information supplied to me by Clark Hyland, to which I've previously referred, shows that the first mode of vibration for the east-west direction was dominated by the response of the south coupled shear wall, not the north core which had a considerably shorter period of vibration of 0.32 seconds.

My concern is that the design was, the design load was reduced on the basis of a period of vibration appropriate to the response of the south coupled shear wall and that the lower loading derived from this longer period would reduce its design strength relative to the north core, which was inherently over-strength due to its large size.

Scaling factors.

The code provides for a scaling factor to be applied to the ETABS results so that they remain within limits controlled by the simple static load case. This is because for the ETABS analysis the earthquake loading is determined in a different more complex way using a greater number of higher modes of vibration for the building.

This method of analysis is called and elastic response spectrum analysis, or ERSA for short. The normal approach is to use the first

three modes in each of the principle directions, these being x, y and z. These are the axes corresponding to both the horizontal orthogonal directions and the vertical axis of the building. The complication with using a number of modes is how to combine the modes in such a way that the behaviour of the building is represented reasonably realistically. The differing modes may be acting in different directions at any given point in time so they may cancel or they may add together depending on the nature of the earthquake.

The Code specifies the methods for combining the forces from the selected higher modes. In 1984 the Code method used to determine the forces resulting from the higher modes was called the square root of the sum of the squares.

Q. I'll ask you to pause. You read I think 'used to determine' you've actually written 'to combine' –

A. Oh sorry. The method, yeah, okay, the Code specifies the method. It's important actually for combining the forces from the selected higher modes.

Q. Sorry, it's your second sentence which you read.

A. Okay, okay.

Q. Do you intend it to read as it is currently stated there, that second sentence?

A. In 1984 the Code method used to combine the forces resulting from the higher modes was called the square root of the sum of the squares and it is called SQRSS for short by engineers. This eliminated any negative values from the equation and allowed them to be combined as a positive sum and then to take the square root for the final answer.

It was often found using ETABS that this SQRSS method of combining the forces resulted in a lower level of overall load on the building model than would be determined using a simple static loading method. The Code allowed the ERSA results to be lower than the static results but limited to 90 percent of static load for the whole building and 80 percent of static load for any one storey. The reason for allowing this was given in the commentary to NZS 4203:1984 Clause C 3.5.2.4 – "When a

building is designed to resist the more accurate distribution of loads given by the spectral modal analysis then an improved performance will result. Base shear values are, therefore reduced to 90 percent of the values given in the section 3.4". Section 3.4 is for derivation of the static load case.

My practice in using this scaling factor was use it to set a lower bound in order to ensure that the forces determined from the ERSA method were not too low relative to the static method. In effect the static load case was used as a baseline or control value against which the ERSA results could be calibrated.

Scaling adjustment to the ERSA results.

The scaling factor K was determined by comparing the static base shear or total static earthquake load with the ERSA base shear. If the ERSA base shear was less than 90 percent of the static base shear it was scaled up. Similarly if at any particular storey level the ERSA shear was less than 80 percent static it was scaled up. If the ERSA base shear was greater than 90 percent static then the results could be scaled down but with caution. In my experience there is a closer correlation between the static and ERSA results with a symmetrical building than there is with an eccentric building where there can be quite significant differences.

On my review of the Landsborough House calculations I can see that I could have scaled the ERSA results down on the basis of base shears but I chose not to do this and I used the higher level of forces for the static base shear. This produced design forces for the critical walls that were higher than any of those given by the ERSA analysis. By contrast the ARCL calculations showed that for the CTV building the ERSA results were scaled down.

Q. Now do you want to go to that calculation?

A. Yes I think we've got to go to that one because from here on it's quite a lot of, it's quite difficult to follow without that slide.

Q. It's on your screen now.

A. I've put some highlighter on my version so I can… So this is the page David Harding has done, the scaling factor, so he calls it dynamic but, as I said, that's what we called it then, it's the ERSA results, so he's, in the overall sense, he has got a scaling X earthquake scaling factor and a Y earthquake scaling factor and down the bottom a

1117

multiplier for static is what he calls it. So looking at each of those in turn at the top he first calculates your scaling factor. It's called K which is a little confusing because it's a different K to what is used for the deflections, the K /SM. So here he's calculated K for the X direction which is north-south as 1.33. Now this is as I was trying to indicate earlier the apples and oranges thing. The calculation there is for 3300 kilonewtons for the static, using the period of .7 seconds whereas the dynamic one underneath, 2233 is the ERSA result which would have used 1.03 seconds I think it is so he has recognised that in the next line down and then scaled that by the factor of .712 and noted to allow for building period larger than assumed. So this reduces the K factor down for that direction to .95 and then at this stage there's – he's included another change by – it says further change to dynamic times SM, and multiplied it by 1 times .8 to get, which is .8 and reduced the .95 by .8 to .76 and the basis for that is what he's – what I think David Harding is saying there is that the ERSA evaluation analysis didn't have an SM factor in it whereas when he did the static loads which he input into the computer as fixed loads he had applied an SM factor to that so he's saying again it's an apple and orange thing, I had SM equals .8 there, I didn't have it here, I need to put it in there, but I think that it has already been included in the scaling above in the 3300.

Q. So do you say he's effectively double counting in some ways?

A. I think it's been double counted and I do say in my written evidence that to check that properly you need to see the output which is not available so it remains a question but in fact it becomes superseded later in the evidence or later in the calculations and it's not the actual final design case anyway so we can sort of carry on without getting hung up on it.

So pressing onto the Y earthquake which is the critical east-west direction, for torsional eccentricities, the same process is gone through and produces 1.07 on the face of it, which is then scaled down by .712 for the period shift and by the .8 again for SM and that produces .61. So at that point it would appear that the ERSA results if they were to be used would be scaled down for the north-south direction by .76 and for the east direction by .61. Now I may as well explain this while I'm looking at it on page, what David Harding has then said, "Oh but there's another factor of .8 and I'll compare it with .8 static," and hence he comes up with the final number on the page of .57. So those three numbers are there to bear in mind during the rest of my reading of evidence.

Q. And you're at paragraph 135.

A. For the critical east-west direction, or the Y earthquake as it's called in the ARCL calculations, the scaling factor was determined as 0.76 based on the longer period of 1.06 seconds. If I can just stop there, I've got to clarify a point here because that .76. It looks like it's wrong, it looks like I've got it mixed up from the top because when I read this I got confused. The .76 there for the X earthquake is a different .76, the .76 I'm talking about there comes from 1.07 times .712 and it's just a coincidence that it's the same number but when I wrote the evidence I had worked that out on a separate piece of paper and that's why I wrote it down that way.

Q. And are you saying that the .76 that you've got in paragraph 135 is correct.

A. It is correct, yes and so for the period shift from .7 seconds to 1.06, the scaling factor dropped to .76 and I'm simply saying there at that stage I would not have done this because of the mismatch in stiffness between the north core and the south coupled shear wall. I'm at paragraph 136 – is a written explanation of what I went through on the slide and I'd just like to say it's –

JUSTICE COOPER:

Q. Well we can take it as read then I think can we?

A. Please, yeah.

EXAMINATION CONTINUES: MR MILLS

A. The effect of these interpretations for the scaling factor resulted in ERSA – scaled ERSA forces that were less than .8 static as shown in the summary table on page S18 of the calculations.

Q. Do you want to go to those?

A. We need to see that one, yes.

Q. Maybe you just read to the end of that paragraph and then you could explain the ...

A. From the summary it appears that the greater the design forces for .8 static were chosen for the design for the shear walls because they were greater than the scaled down ERSA values.

So looking at the slide if you look at the lower table, the Y earthquake which is the east-west, there's a column here, .61D. That means .61 dynamic which was .61 ERSA and then you look across, it looks like 1.05 but it's actually 1.0S which is standing for 1.0 static so David Harding has listed out the shears there for the maximum/minimum eccentricities and then he's multiplied them by .575 which was his scaling factor of – producing those to .8 static. It's actually comes from .71 times .8. So what he has looked at there and he's circled 570 and it compares with 404, that's the number to compare it with.

Q. It's the dynamic?

A. Yes, yes and down the bottom he's written, “ie reduced static loads governed for each case” so, then he says, “Total shear resisted equals .57 times 3300 kilonewtons,” and that's the original static load case base shear for a period of .7 seconds multiplied by .71 times .8 which is what the .57 factor is and that brings the base shear down from 3300 to 1881, so yeah.

Q. All right, are you now wanting to be on paragraph 138?

A. I think I've actually covered paragraphs 138 and, oh I should read 139 because it talks in terms of the south coupled shear wall.

Q. So 138 in effect you've explained by what you've just been doing?

A. Yes.

Q. All right, 139.

A. Structural type factor

For the final design of the south coupled shear wall a structural type factor equal to S was applied for the .8 static results, resulting in a level, a load level of .64 of the static. In summary and in numerical terms this reduced the original 2000 kilonewton static base shear on the south coupled shear wall derived from the original analysis using a period of .7 seconds by .712 on the basis of the longer period of

1127

1.03 seconds to 1424 kilonewtons. This was further reduced by SM equals 0.8 times 0.18 equals 0.64 to 912 kilonewtons and the factoring is shown on page S29 of the ARCL calculations as 0.57 static times 0.8 equals 0.456, ie. 46% of the original static load for the period of 0.7 seconds.

Q. Now Mr Henry, just before we go to the next page of your evidence I just want to ask you about paragraph 138. You say there that the scaling process that Mr Harding went through and the .8 static load case it resulted in, you say this is less than the minimum load level set by clause 3.5.2.4.1 of NZS4203:1984 et cetera. So is there a code compliance issue here that arises?

A. Right, actually yes I didn't cover that. I need to explain this perhaps a lot more globally. The, basically what the code was saying is that the ERSA results were more accurate, a more accurate realistic representation of the forces in the structure up to the point of yield than you could derive using the static method, because the static method only took into account the first period of vibration. So it was approximate, and because of that they said well since it's more accurate if you get lesser results you can use them but only so far. And the code allowed a 10% drop in the total load on the building to 90% of static. So static is like your calibration, your baseline model that you've got to use as a way of essentially making a calibration. But then the code also

recognised that these ERSA results could still be quite variable in any particular storey or element even, and they can even be less than .9, quite a lot less in some cases. Well, because it's an individual element all in one storey we can be a bit more lenient, it's not the whole building, so we'll let those drop to .8. And so you have these two demarcations of point. You can take a .9 drop for the whole building load or a .8, drop to .8 for a storey or an element as I interpret it. This is an important point because to drop a whole storey to .8 while the other storeys are .9 would be like a big no no to a designer. You'd essentially create potentially a soft storey so I was taught by Andy Buchanan only apply .8 static to a member. So it might be a coupling beam if you were trying to smooth out the forces in the coupling beam and you had a wide variety you could use it, or a beam, in other words use it, with yeah a fair amount of caution. But it's definitely, in my view, not intended to be, okay we went through .9 let's choose .8 for the whole base shear. Definitely not. That point there, this drop from a global .9 reduction which I think has been using the wrong scaling factors anyway, to dropping down to .8, I don't think it was correct and in fact it actually brought the loads a bit from what would've been used which was the .61 and the .76 so it was a little bit of an improvement really at that point.

Q. Is the answer to my question to you that what you've just described and what Mr Harding has done does not comply with the code in that area, in that specific respect?

A. Yeah in my view it doesn't comply.

HEARING ADJOURNS: 11.32 AM

HEARING RESUMES: 11.49 AM

EXAMINATION CONTINUES: MR MILLS

Q. Now Mr Henry just before the adjournment you had finished reading paragraph 139 but I think you'd like to go to that final document reference there so if we could bring that up, it's BUI.MAD249.0272.29.

Right, there's the document that you've referred to, perhaps you could just explain the relevance of that and why we wanted to bring that up?

A. This calculation page is showing the final design forces that were chosen for the south coupled shear wall, it's called walls 1 and 2. The top line is really what my evidence I was just reading before the break, it's the point it came to, it was the sort of conclusion that the load factoring is .57 times .8 equals .456 and that is of the static loads and in from there the design loads have been given for one wall element. On the right-hand side here you'll see 456, that's for one element and there's two of them, one on each side of the coupling beams, you double that and you get 912. It's the design shear for the south coupled shear wall.

Q. All right. Then turn to paragraph 140 please.

A. The practical significance of these rather detailed calculations I have referred to is that this reduction of load leads to a corresponding reduction in the reinforcing requirements for the south coupled shear wall. This in turn reduced the stiffness of the south coupled shear wall because the stiffness is a function of the amount of reinforcing. In other words the south coupled shear wall was softer than it would have been if the higher earthquake loading had been used. This increased the susceptibility of the south end of the building to increase lateral deflections under east-west earthquake loading.

This increased the imbalance in the building, because it –

Q. You wanted to make an amendment here I think didn't you?

A. Yes.

Q. So just read it the way you want to read it.

A. Okay. This increased the imbalance in the building because the reduction in loads effectively only applied to the south coupled shear wall and not the much stiffer and stronger north core.

Q. So delete the word 'it', insert 'the reduction in load'.

A. Given that the load demand on each of these elements was shown on the ARCL analysis to be similar under east-west loading, the earthquake load on the whole building would have been largely governed by the

yielding of the south coupled shear wall. Once it yielded the system would essentially be limited to that load level. Any higher level of load would cause the building to rotate about the north core.

Signals of irregularities in the output data.

There were some strong signals in the ETABS analysis output data indicating irregularities in the structural model that should have alerted an experienced designer and triggered questions and further investigation into the behaviour of the structural model.

These included the longer building period that I've referred to earlier in my evidence of 1.06 seconds produced by ETABS, the ERSA base shear being larger than the static base shear.

Q. And I think you wanted to add some words there didn't you?

A. In the east-west direction.

Q. Yes.

A. And the contrasting difference in the S factors between the north core and the south coupled shear wall given their approximately 50:50 load demand.

In addition there were some strong signals in the ETABS deflection data indicating that something was irregular with the model or the structural concept. These are first the deflections given in the ARCL calculations to show that the building would have deflected four to five times more in the north-south direction than the east-west direction under their respective earthquake loadings, and secondly, the ARCL deflections were at the code limit for the north-south direction but not the east-west direction and were relatively small for the east-west direction. For me this would have indicated a possible error or inaccuracy in modelling the walls in the ETABS model and the need for closer consideration to check out the disparity between the two directions. I would like to just add a point there.

Q. Yes by all means.

A. That the deflections that were shown on the earlier graph which were comparing Clark Hyland's deflections with David Harding's possible / probably centre of mass deflections, those initial deflections that David

Q. All right, then you're at paragraph 146.

A. So the conclusion.

I can see from the calculations that the CTV building was designed on the basis of the underlying premise that the gravity load elements of the building would be protected against excessive lateral deflections and earthquake forces by the stiffness of the primary seismic shear walls. If the intended deflection limits implied by this design premise were not met then the gravity load system of the building could be vulnerable to damage and instability in the event that the earthquake, sorry the earthquake deflections exceeded those anticipated.

In this respect I believe that the eccentric and unbalanced structural configuration of the CTV building and the characteristics that I've described in my evidence, made it susceptible to increased lateral deflections under severe earthquake loading in the east-west direction.

Q. All right, you now turn to your period at the Christchurch City Council.

A. In 1992 I decided to take a salaried position with the Christchurch City Council where I worked in the building control unit from 1992 to 1995. The Council was looking for a structural engineer to assist in a transition from local government by-laws to the Building Act 1991 which resulted in a major reorganisation of the Council Building Inspectors service centres and building consent processes. I worked alongside Bryan Bluck and Graeme Tapper during that process. Bryan Bluck was the

head of the building control unit at this time. Graeme Tapper was the senior building engineer and he reported to Bryan Bluck.

Counsel assisting has asked me to describe the building control processes used by Graeme Tapper and Bryan Bluck and their interaction with consulting engineers in the course of building consent applications, in particular interaction with Alan Reay and ARCL during my time at the Council.

The role of a reviewer in the Council building control unit required ongoing interaction and liaison with the structural engineering community in relation to the building consent processes. I worked

1159

closely with Graeme Tapper in reviewing the structural engineering aspect of building consent applications. He taught me the bureaucratic processes and I assisted him with detailed technical matters as I was more up-to-date with the engineering codes and design methods than he was.

I became aware after I'd joined the Council that Alan Reay and ARCL building consent applications were causing the building control staff a lot of concern because of particular structural details used in the designs. It was not uncommon for ARCL jobs to be closely queried by Graeme Tapper and held up because he was not satisfied with the responses that he got from ARCL about these details. I found that Alan Reay and ARCL did not like Graeme Tapper's close scrutiny of their work. It was not uncommon for Alan Reay to go directly to Bryan Bluck to obtain the release of a building consent when he could not get approval from Graeme Tapper.

Q. I'll just ask you to pause there because I need to just ask you a few questions about what you've said there. First of all your reference to, "Alan Reay and ARCL building consent applications causing the building control staff a lot of concern because of particular structural details used in the designs." Are you able to be more specific about what those details were that you're talking about?

A. Yes.

Q. All right. Well could we have some further detail then?

A. Well the, the primary cause of concern related to connection of pre-cast floor systems to concrete wall panels and I think when I was there they were really the root cause of all the problems with, that, that happened to do with hold-ups and Graeme Tapper not being satisfied and so forth and there were two parts to this that were worrying Graeme Tapper. When I turned up he sought my opinion quite readily on this which I agreed with him and then basically backed him up. Those two parts were later checked or reviewed and it turned out that Graeme Tapper was well justified with what he was holding up and they were that, (1), the pre-cast concrete floor units which might be a uni-span or Dycore unit were being seated on precast walls by, into a rebate which was 30 millimetres deep and the nominal setting was 20 millimetres for those units which was minimal compared to what one would have expected at the time and the building inspectors were reporting back from jobs that had been given a building permit that they weren't getting the 20 millimetre seating, sometimes it was 5 millimetres, and this was just not durable. So that was one part which was in dispute. The other part was that it had concrete toppings poured on top of these, the proprietary floor systems I should call them, with pre-cast element, a pre-stressed, pre-cast element supporting them but the topping were abutt of the wall at, at these rebates was anchored to the wall with 12 millimetre bars which didn't really get any effective anchorage length because typically it was a 120 millimetre panel with 30 millimetre rebate and by the time you took off the cover concrete there wasn't much left. You might have had 60 millimetres or something to anchor the bar and that was bent down the wall. So there was a bend radius. So that really wasn't a detail which Council was happy would meet the code and so these two, these two aspects were essential to all this. They were eventually cleared up. The, the reinforcing anchorage was tested at the University of Canterbury when Professor Park asked me. This was much later on, but asked me if there was anything he could help with and he did assist with that and they tested it and showed that it needed to be longer and

the, the seating was altered in the 1995 amendment to the Concrete Code and increased to 50 millimetres. So it wasn't until then that there was resolution on those details. In the meantime they, they were given building permits and consents in a sort of a, what would you say –

Q. Reluctant?

A. Yeah, well nobody would be able to satisfactorily prove the point on either side.

Q. So how –

A. Yep.

Q. Now so is that all you wanted to say about that?

A. Well at the moment I haven't got the presence of mind to think of anything else to say about it but if it comes up I will say so.

Q. All right. I know this is all quite stressful for you in that you've been required to give evidence which you may not have wanted to give but that is the position and –

A. There is –

Q. Yes?

A. There is one thing. I think what's important because that, as I say it's hard to have the presence of mind to think of everything at once but the situation became, when I arrived at the Council was that Graeme Tapper was unsure the, the mode of operation that Bryan Bluck had in place was such that, you know, you only ask so many questions and then it's up to the consultant and so these things had been consented but they were a concern and with more technical input from me it increased the pressure on all this so that eventually the impasse in consents was somehow resolved. It's not totally clear to me how it came about but steel angles were introduced under these floors to provide the backup support and I think that is how there was an interim period before this other resolution took place that the building permits carried on but Graeme Tapper was never, was never happy with that.

Q. I see. All right and the second thing I wanted to ask you about that paragraph 100, 151, is you say, "I found that Alan Reay and ARCL did

not like Graeme Tapper's close scrutiny of their work." And I suppose putting it rather crudely, how did you find that?

A. Well the, the main thing was that Graeme Tapper couldn't really get an acknowledgement of the things he was raising. He couldn't get Alan Reay and ARCL to take on board the real things he was worried about like you could get, you'd put a query and you'd get back some, he used to call it arithmetic, you know, "We're worried about the 20 millimetre setting." "Well there's a calculation to show the bearing stress is okay." "We're not worried about the bearing stress we're worried about it pulling off. It's not being built right." "Well," and so it would go on. So that's, that's what I found and that's, I mean when I say didn't like I mean if you liked it you'd say, oh, okay, let's fix it.

Q. Yes all right, and then finally you say it was not uncommon for Alan Reay to go directly to Bryan Bluck to obtain a release for building consent when he could not get approval from Graeme Tapper. How do you know that that was happening?

A. Well Bryan Bluck would just come straight out and tell us. It wasn't, it wasn't just a casual thing. It was, I mean this, this is why it's so memorable. I can remember this, on several occasions, that, this, this is quite difficult evidence really because it gets to a personal level but Bryan Bluck would come to us in an agitated state from communications with Alan, Alan Reay and not so much demand but he was exasperated about, why can't we get these building consents out and they would result in, you know, very heated arguments, such that you would never imagine in a, in a workplace and, I mean although I was involved in the whole process I was more of a, a bystander. There was nothing targeted at me and it wasn't as if they weren't good mates, they were, but over, over these technical, these operational differences I suppose you could call them a very heated argument would start up to the point where –

Q. Just to be clear, you're talking about arguments between whom?

A. This is between Bryan, Bryan Bluck and Graeme Tapper.

Q. Right.

1209

A. Extreme arguments with Graeme Tapper. He wasn't that well. He had a heart operation and he would literally have to go to the sick bay after these arguments to recover and so no these were really stand out points, particularly as I was new to it. In the end the other senior staff had to take over and put control on it and that is as a result Graeme Tapper. He just couldn't cope because things had to go through and so they would go through on a basis that Bryan like felt he could live with and that's why I say what I say.

Q. And these huge arguments that you're describing between Bryan Bluck and Graeme Tapper, did they generally reflect different views about the proper role of the Council building staff?

A. Do you mean between Bryan and Graeme?

Q. Yes?

A. Well Bryan Bluck, I mean let me first premise this by saying that nothing I'm saying about either of these two gentlemen is in any way intended to besmirch or anything, cast any doubt about the integrity of what they were doing, because they each had a role they had to fulfil and it was a matter of trying to get a balance. So Bryan, his general way that he operated, and he always had operated was our job is to review. If you see something you're not happy with you're to query it. You get the answer back and you essentially if it's reasonable leave it at that. But the consultants are the experts. And he was happy for the Council to sit in that position and not dig for detail and start fights over stuff he didn't know anything about, or didn't know enough about. And I think that Graeme Tapper actually worked fairly consistently with that principle except when he knew darn right he had a situation that he could live with basically. And when he was, they were both very, very conscious of public health and safety, that's what it was all about, and Graeme Tapper when he got me onboard and I said, "Well I don't agree with that detail either," and we had a number of things, reasons quite clearly set out, he wouldn't let go. And so you had Graeme Tapper who you might say was, not stubborn but wanting to stick to his guns, and Bryan saying, "You've got to live and let live to keep things moving

through and get things issued, get these building consents out," 'cos holding them up was big pressure. And so that's the sort of difference in the way that they saw their roles. And as I say, both trying to do their best under the circumstances.

JUSTICE COOPER:

Q. Can I just ask Mr Henry, when you commenced working for the Council was the situation of ongoing argument between Mr Bluck and Mr Tapper something that was apparent from day one or is this something that developed as your period of employment with the Council continued?

A. When I when there and first arrived you mean?

Q. Yes?

A. Oh, no the situation was existing when I got there. But it became elevated with me there because my technical input created the basis for Graeme Tapper to stick to his guns much more so.

Q. And was it the situation where sometimes you would be, because of your, generally you had a greater technical understanding than Mr Tapper, was that your view?

A. Yes.

Q. Is a consequence of that was it the case that you sometimes ended up being the Council officer who ended up taking these issues to the consultants? Were you having to front these issues?

1214

A. Definitely. In fact, well the background is that I was training, I was in training so and the way that they operated in the Council bureaucratically was the first thing I started to do, because I got my hand smacked to use a term that's been used before here, but you don't do it like that, this is how you do it. You don't tell the consultants what you don't like about the detail when it's wrong. You write to them and you say can you please explain how that detail complies with such and such clause of the Code which is, when you get those, what does that mean. So that was something I had to adjust my thinking to. So I was being trained the whole time and at the same time Graeme Tapper said

to me look (inaudible 12.14.43) I'm fed up with this can you take it over and try and do better and he instructed me in the process. So I was sort of essentially what I'd call in an intermediary position with no baggage. I just walked into this and thought oh okay and before I knew it, I thought okay I can fix it I understand it, I was tangled up and embroiled in these things.

Q. Well would, it might have been possible for consultants with whom you were dealing to think that you were problem rather than Mr Tapper?

A. Well with, yeah quite possibly with Alan Reay's situation definitely could have done because there was a lot, he had so much work going through compared to the others, it was, you know, a very dominant workload from Alan Reay's office so there was a lot of contact but, I mean, it didn't really happen with other consultants. If they, if you raised the problem and often they didn't like it but you know, you got it fixed, you just worked it through.

EXAMINATION CONTINUES: MR MILLS

Q. Just one final question about that paragraph. You say that at the end of the paragraph "it was not uncommon for Alan Reay to go directly to Bryan Bluck to obtain the release of a building consent when he could not get approval from Graeme Tapper". I just need to know whether was it your experience that when these issues arose, which I suppose technically were issues with the company, with Alan Reay Consultants Limited, was it invariably Dr Reay who would take up these issues with Bryan Bluck, not another member of the company?

A. Oh yeah, well the way, as I said before the way I knew was that Bryan Bluck would come to me and say Alan Reay had been on the phone and that's the only terms of reference I've got on that one. I mean we didn't have, say, Geoff Banks on the phone, he would never do that.

WITNESS CONTINUES READING BRIEF OF EVIDENCE FROM PARAGRAPH 152

A. A number of technical disputes arose in relation to ARCL building consent applications during my time at the Council and I observed first

hand the manner in which these disputes were handled within the Building Control Unit. On a number of occasions they led to disagreements between Graeme Tapper and Bryan Bluck with Graeme Tapper ultimately being overruled by Bryan Bluck on ARCL permits.

Bryan had a wider more diplomatic role including reporting to the Council and a long history of reasonably good public relations with the consulting engineering community and because of that role he always made himself available to consultants.

In my experience working with Graeme Tapper I thought he usually had the correct technical grounds for raising his concerns. He was a competent senior engineer. He had developed a good sense of the potential weak points in the structure. He'd done civil engineering quality assurance work on Benmore dam and he had worked as a structural engineer for Royds Garden, a well respected Southland firm. I believe he had good experience and training. This was evident in the way he carried out his work.

However, he could be confrontational when dealing with the consultants. He maintained high professional and ethical standards and had little tolerance for consulting engineers who submitted poor details or incomplete work. This would often result in difficult situations which Bryan Bluck then had to deal with.

My observation was that part of the reason for Bryan Bluck overruling Graeme Tapper at times was that Bryan did not have a sufficient understanding of the technical matters involved to be able to confidently support Graeme Tapper. Based on my review of the 27th of August 1986 letter that Graeme Tapper wrote to Alan Reay Consulting Engineer expressing concern about aspects of the structural design I can see that there were particularly detailed technical matters involved and I do not think Bryan Bluck would have had enough of the technical –

Q. Would have known enough I think –

A. Sorry would have known enough of the technical details of the Code to determine whether the aspects queried by Graeme Tapper met the Code or not.

Bryan Bluck's attitude was that the consulting structural engineers were the experts and, therefore, the responsibility for Code compliance lay with them not the Council. On occasions and under pressure I observed that he tended to let the consulting engineers have the last say.

In the course of preparing my evidence I have been shown a handwritten letter from Graeme Tapper to Alan M Reay, Consulting Engineer, which is a Council request for further information in relation to the building permit application for the CTV building. It is dated 27th of August 1986.

Q. I'll bring it up a little later on. I think it's more relevant as you go along.

A. In my experience it was not unusual for Graeme Tapper to communicate in writing when he was concerned that he would be overruled. He would often say that he wanted to leave a paper trail.

Graeme Tapper's letter identifies a number of concerns with the documentation provided to the Council and also with some of the structural detailing. This includes a reference to drawings S15 and S16 which show the floor connections to the shear wall system. Graeme Tapper has identified a concern about the mesh not providing adequate restraint to the steel tray deck Hi-Bond flooring system for fire rating purposes. He also refers to "general connections between the floor slab and walls … and the stirrups for the columns".

WITNESS REFERRED TO LETTER – PAGE 14 AND 15

Q. Now first of all could we just enlarge a little bit that reference to SH15 at the top of the right-hand page that we've got there, which is the reference you were just making. Now I take it from the way you've given your evidence here that you're reading two issues that have been raised there are you? One about the fire rating and the other a more general question about floor connections. Is that the way you're interpreting it?

A. There's two points in there yes.

Q. And what do you, based on your understanding of working with Graeme and knowing something about his way of communicating are you able to give an informed view on what you think the issue is he's raising there?

A. Well the first one about the Hi-Bond. That wasn't very common back then. I think it wasn't really a normal proprietary floor system. It was coming onto the market and the first thing everybody thought was oh it's got no fire rating because the steel tray deck is exposed to any potential fire on the underside and there was literature put forward by the suppliers that the system would work without fire rating under certain conditions which involved the amount of restraint that there was to the floor. It gets quite technical but basically I didn't have a deep understanding of it but they were trying to say it won't collapse because it expands and it jams itself against the other structural elements. That was one thing. People didn't really buy into it so in the end the people using it put reinforcing in the bottom of the trays as well so if there was a fire and the tray got destroyed the reinforcing that was left behind would, in theory, still carry the load. I think what he's talking about there is that.

Q. All right and what about the second point that you've identified there? Do you have a view on what that's saying?

A. Well he's basically talking about transfer of floor diaphragm loads into the shear walls.

Q. Now I think you're at your final paragraph. We'll just leave that up for the moment.

A. I have examined the structural drawings for the CTV building. A number of the issues raised by Graeme Tapper would have caused me concern as well, this includes the shear wall connections.

Q. Now just to be clear, because you have said a number of the issues raised by him would cause you concern. What did you have in mind when you used those words?

A. Well there's some matters there that are not so structural, like I'm not worried about the fire flex and PEF backing strips so much. Anything like shear core floor slab and stair landing details are missing, well that would definitely concern me. Reinforcing of spandrel fixings that would concern me because they're above the street.

1224

Anything, if there's welding not shown, yes that would concern me. There's reference, I think you've mentioned the stirrups?

Q. Yes I think I was going to ask you about that. That's the sheet 14 reference isn't it at the bottom of the first page?

A. Yeah, well I mean and R6 spiral would definitely attract your attention, no question about that. And I see he's got it pretty high up the list.

Q. Well before I sit down I just have one or two other things that have come up I have to ask you about. The first one is the issue that came up I think yesterday about this Westpark building in which you were involved before it was taken over by Mr Harding. Now if you don't mind I think what I'll do is give the witness the hard copy and it will come up on the screen as well, but I just want him to look at something which I think you'll find easier with this. Now I think you all know what this is don't you, this is the Westpark calculations. Now before I give it up and don't have the number anymore it's BUI.CAS056.0003.1 is the first page of it.

WITNESS REFERRED TO DOCUMENT

Q. Now the general issue I want to raise with you is this question about the ETABS work that was done on this and the extent to which, when Mr Harding came in on this job, ETABS work had already been done by you or conversely had not been done by you, and to what extent, whatever you had or had not done on ETABS was a leg up for Mr Harding, understand the general question I'm interested in?

A. Yep.

Q. Now if you need to look at that to refresh your memory I'll give you a moment to do that, but I'd like to know after you've done whatever memory refreshing you need, the answer to that question?

A. So the question is, do you think how much I helped –

Q. Let me put it in simpler bites. How far had you gone, if at all, with doing the ETABS analysis for Westpark before you left the firm?

A. Right, well I do, I certainly remember having worked on this when I left because it was the last thing I did.

JUSTICE COOPER:

Q. What do you mean having worked on it "when I left"?

A. Sorry. Having had worked on it.

Q. Yes?

A. I do remember having worked on it, that's the first thing.

Q. Yes?

A. And yes these are my calculations. These are what I think are the preliminary calculations I did. I think it was getting the job off the ground so to speak. Someone was developing this site and wanted a building and I did enough work on it to be able to I think cost it probably, and so I took it that far, and I can see here I've got a heading, "Input data for ETABS," so yes I've done an ETABS.

Q. Does that document have page numbers on it?

A. Page 6.

Q. Yes?

A. So I can see I've worked out all the normal input data that would be needed.

Q. So can you tell us, is it possible for the record for you to tell us in that document what page numbers are your calculations?

A. Yes I can do that easily. Page 1 through to, well I've got to –

MR MILLS

I think actually this may help you. One of those pink tabs which I would've put in was agreed by Mr Harding to be the point at which it's his handwriting not yours, so if that helps you at all, one of those pink tabs will mark that dividing line.

JUSTICE COOPER:

Q. So what's the page that that question refers to?

A. Well my page numbers are not consecutive.

1229

EXAMINATION CONTINUES: MR MILLS

Q. Use the numbering the Commission staff have put on it in that top right-hand corner, see it's been stamped on there, if you will from that number.

JUSTICE COOPER:

Q. That will be BUI.CAS056.0003. something.

A. Yeah, it looks like 43, and possibly 44, this has got nothing on it, 45 is not mine and then 46 changes to David Harding's writing. Just looking through it looks like all the rest of it is David Harding's.

Q. Well Mr Mills asked you to familiarise yourself with the document so that you can have confidence in the answers. Just take a few minutes, don't – this is quite important to get it right Mr Henry so just have a look at that rather thick document.

A. Well I can see straightaway that this is all quite detailed calculations that I'm – and it's not my handwriting, I didn't do it for sure and –

Q. Well what I want by reference to a page number that Commission's series of numbers which will be on the top right.

A. Yeah.

Q. Is a definite answer as to the page at which your inputs stop.

A. I would say 43. Hold on, I do say 43.

EXAMINATION CONTINUES: MR MILLS

Q. All right, well having ascertained that and again take your time if you need to, I want you to look at pages 1 to 43 and then tell me how far you had advanced with the ETABS work on the Westpark building before you stopped working on it, at least as recorded in that document.

A. All right, okay. Well I –

Q. I don't want you to feel rushed in any way.

A. No, no, I can see it straightaway, well actually the building, I'll just say a very simple ETABS model this one. It doesn't take a lot to get it going because ETABS was set up for, it was designed for uniform buildings from top to bottom and if you had the same properties on the top floor

as the bottom floor, it was just about a one liner, you know, to make it, the computer go, one line of properties, one control card, one line of properties and that would generate the building from top to bottom.

Q. And are you saying that's what we're dealing with with Westpark?

A. That's what Westpark is, and it's got, it's an octagonal building with four what they call ladder frames and one on each of the flats and so that was a very easy one to generate and I've done it, I say I've done one run by the look of it to get the basic forces out and for the preliminary design and I've gone from there. So that is – there's no doubt about that, and once I've got those forces I've sized the beams and things, yeah.

Q. All right, so on the basis of the work that you had done Mr Harding coming in and picking up that work.

A. Yes.

Q. How much assistance would he derive from what you had already done on ETABS?

A. Well the model would be there sitting ready to go. If he'd wanted to change anything it would be straightforward enough to change the data that's already there so the – it would have been very helpful to him to have that model sitting there. You could have amended it, edited it and run it again without having to set it up so to speak.

Q. So in your view not the equivalent to doing ETABS on the CTV building?

A. No, no definitely not.

Q. All right. Now I have a question I've been asked to ask by Mr Harding's counsel, Mr Kirkland, who isn't here today and so pretend I'm Mr Kirkland, and here's the question. Somebody who has not done ETABS work before, what steps would be required in your view to train them in the use of ETABS to a level of competence sufficient to do the ETABS analysis on the CTV building?

A. Back in those days you mean?

Q. Back in those days, '86.

A. Well I'd start with a simpler more symmetrical building. This would be a good example, this Westpark one because it's – eliminates a lot of the complications and that would get them introduced to the system and

understanding to what the inputs were, that would be the first step. Could potentially be quite a long answer to this question, depends how the person took to it as well but I mean, I can, perhaps the question you asked me before as well is interrelated. For a shear wall building I mean, ETABS wasn't specifically set up for shear wall buildings to make them, that wasn't its first prime use. Frame buildings were very simple but once you got a shear wall building you had to introduce these panel elements to model the walls and basically stack them all up, like – and join them together with something that can – mathematically would create all the forces, so you had to make a virtual frame to put the panels in and as I indicated before you know the things had to be joined together at the corners to get the right effect and how ETABS joined things at the corners was always I think a bit of a mystery so you needed to be able to interpret what came out of it to ensure that, say if you were designing the tube, and this is the complex part of what was coming out of the results of the tube was what you expected and that's where, if you hadn't even had the mentor or someone like Andy Buchanan who could see it and explain it to you, because for the next step from there was to take those forces from the elements and design the tube when you've got elements – forces from various panels at the bottom of the wall and then you want to apportion reinforcement of those. There was no programme you could just feed it into and push a button and the answer would come out. There was quite a lot of trial and error with that, particularly because in one direction you've got a certain lot of reinforcing and the other direction you've got a different lot and at the corners they overlapped and so you had to balance the reinforcing around the corners so that it didn't overdo one direction and not the other.

Q. Now I might just try and help Mr Kirkland here by putting his question a little differently.

A. I'm trying to help myself actually to get an answer.

Q. Let me just ask you, this probably is what he's really asking. Imagine you are training up Mr Harding to a level where you feel that he's

competent to do the ETABS analysis on the CTV building. What steps would you think you needed to take him through before he could do that. I think that's what he's wanting to know effectively?

A. Well okay, I don't mean to complicate the answer but if it was just doing the analysis, like as an analysist versus the design of the building, there's two different answers there and I assume mean enough to be able to understand the output, what's coming out and adjust it and re-run it until you're satisfied with what you've got.

Q. I assume that's what he's wanting to know.

A. Yeah, well I would expect to do a straightforward building and a more involved building with shear walls in it and definitely one with a shear core in it so maybe three buildings.

Q. You mean working with him, is that what you're saying?

A. Yeah, you'd definitely would work with him and as he went along the various parts would become obvious and you wouldn't have to – certain inputs you work out as David Harding has done in here, he can work out those straightforward but it's what comes back out and what you do with it, that is the thing that takes the experience to I think if you like expertise and judgements.

Q. Yes.

1239

A. And deciding whether you're going to run it again and to determine what's got a sensitivity and what hasn't, in terms of that changing its properties.

Q. Well he's not here to say whether that's a sufficient answer or not.

A. No.

Q. It's good enough for me. Just one final question about your time at Alan Reay, Alan Reay's firm. During your time there did you have any understanding of how the mail system worked? In other words mail coming into the office. Did you have any knowledge about how that was received and distributed?

A. Oh…

Q. And if you don't, you don't, it's a question?

A. I mean in terms of who brought it in the door or whatever, and who opened the envelopes I couldn't give you any sort of clear answer on that, but in terms of who controlled it, it was definitely Alan Reay controlled the correspondence flow in the office. I mean there really was only him at that sort of level before I got there, who would do that sort of thing anyway. There was draughtsmen, tracers and sort of receptionist, but I mean I didn't do it, put it that way.

Q. Right, and are you talking just about output correspondence or input as well? I mean incoming as opposed to outgoing?

A. Well, mmm –

Q. Again if you don't, if you're not in a position (inaudible 12:40:46)

A. You'd have like written correspondence, letters, all sorts of stuff from suppliers and whatnot normally comes into a firm, and then there's drawings and they can sometimes be brought in the front door by someone from an office who will hand them to a draughtsman or even to the engineer so I could've easily been involved in that sort of correspondence but letters and things, I think that was Alan Reay's domain.

CROSS-EXAMINATION: MR RENNIE

Q. Mr Henry at paragraph 80 of your brief of evidence you referred to three projects in sequence, Landsborough, Bradley Nuttall, and then Aged Concern, do you recall that?

A. Yep.

Q. I mean and they are all buildings constructed generally on the basis of what you describe in your paragraph 28 as the shear wall protected gravity load system, is that right?

A. Yes.

Q. And you note in your evidence that you regarded at least one or two of those buildings as being about as far as one could take the application of that design system in designing multi-storey buildings, is that right?

A. Yes, yes.

Q. What did –

A. Sorry, sorry, that's a torsional, the eccentricities, not the shear wall gravity load system.

Q. Right, so thinking then in concept of the CTV building, that's to say six storeys with a south shear wall and a north shear wall, would you regard that as a building which could in principle be designed as a shear wall protected gravity load system?

A. A six storey building of reinforced concrete, yes.

Q. Yes. And so is the issue that you've really been addressing in your evidence, or one of the issues the question as to whether that design was adequately or correctly done for that particular building?

A. The overall fundamental issue which I'm driving at is torsional restraint. Once the yielding commences in the building and the imbalance.

Q. What I'm seeking to clarify Mr Henry is do you consider that in principle a building approximately the same as the CTV building could have been designed using a shear wall protected gravity load system, but with different shear wall elements and connections and so forth?

A. Yes.

Q. Yes. And so I put it to you that the criticisms that you've been making of the design relate to the way that that concept was implemented, not to the fact that it was attempted at all?

1244

A. There's a series of things that took place in the design which amplified the, what I'd call the start position, and the start position to me was not a starter because of the imbalance and also the poor torsional restraint from the shear core which, which would be called upon in, in the event of yielding.

Q. So if you'd still been at Alan Reay Consultants when this job came in would you have taken a different approach to the design and location of each of the shear walls?

A. Definitely, yes.

Q. Yes.

A. Yes.

Q. Isn't what you're really saying a bit like the Irish expression, “If I was going there I wouldn't start from here?”

A. Well if you're asking me as an experienced designer would I start with that configuration the answer is, no, I wouldn't.

Q. Now one of the tensions in the design world is between the architect and what they want it to look like and the engineer and what they know to be necessary, isn't it?

A. Yes, definitely.

Q. You would have encountered that repeatedly through your career as an engineer?

A. Yes.

Q. We'll come back to that. Now just moving on, you were with Holmes Wood between 1986 and 1991. That's correct?

A. Yes.

Q. And I think as I understand your evidence you were the engineering manager there until a reconstruction of the firm in 1990?

A. Yes. Well that's broadly speaking, yes.

Q. Yes. Mr Henry at any time if you want to add a detail or have a moment to reflect or to refer to a document please let me know.

A. Okay.

Q. I'm, I'm endeavouring to go at your speed not mine.

A. That's fine. Thank you.

Q. And, and I do urge you to let me know if you have any concern in that respect.

A. Thank you.

Q. Now am I right that the documents and information that you've been able to consider for your evidence have all been provided to you by or through counsel assisting?

A. What are you thinking of, calculations and drawings?

Q. Yes the documents that you've referred to.

A. I think so. I can't think of any at the moment.

Q. Were you provided with a copy of the Holmes Wood 1990 review of this building?

A. No.

Q. No. You've not seen that document.

A. No.

Q. Thinking back to your time at Holmes Wood in 1990 were you aware that Mr Hare and Mr Wilkinson were involved in a review of this building?

A. I wonder what time 1990 it was because –

Q. It was at the very beginning of 1990.

A. Yeah. No I wasn't.

Q. Could we have please BUI.MAD249.005.7. Now what I'm, of course subject to the direction of the Commission Mr Henry, well what I'm going to do is briefly take you through this document now. We're quite close to the break and I'm going to offer you a hard copy of it you can have a look at in the break so that if there's anything additional that comes to mind you have an opportunity to raise it. I believe that may not be quite at 2.15 but whenever it is that we return to your evidence. Now you'll see that this is a structural report dated January 1990, you'll see bottom right, and would you agree that this appears to be a report issued by the firm that you were working for at the time?

A. It, it does, yes.

Q. Now if you turn over the page at point 8 is simply the contents. Point 9 is an introduction. Point 10 is a list of people involved with construction and we come to point 11 which is a section headed "Conclusion." Do you see that?

A. I do.

Q. Now I'm just going to go through those with you one by one. It starts out with the qualification that due to the limited time available for the report the review has been limited to a brief inspection of the building and documents and approximate calculations. I'll come back to show you in a moment just what was inspected. "No materials testing has been undertaken and inspection has been limited to such areas as were readily accessible." And I'll bring you back to that information in a moment. "Given these qualifications our conclusions are as follows,"

the report states. “The first is that the building is in a condition appropriate to its age and the contractor has developed a form of construction.” Do you see that?

A. Yes.

Q. Now the second conclusion, “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. I see that.

Q. Yes. Now that would be in contrast to the assessment that you have made of this building wouldn't it?

A. Well I don’t know how they worked that out.

Q. No. Then the third matter is a vital area of non-compliance with current design codes seen in the document is in the tying of the floors to some of the shear walls and I take it you would agree with that?

A. Yes.

Q. This item, they say, “Is under review with the original consultants but if confirmed will require potentially expensive remedial work. However this cost is a matter for discussion between the current owner and their consultants”. And then, finally, item 4, “Apart from ongoing maintenance costs which should be minor no major costs are anticipated in association with the structure subject to (3) above.” Do you see that?

A. Yes I see it.

Q. Now if you turn over to point 12, this is the point I said I’d next take you to, and you will see that firstly they have reviewed a full set of architectural drawings and some structural drawings made available from Alun Wilkie Architects. Do you see that?

A. I do.

Q. Now Mr Wilkie’s evidence is that his records were lost in the 2011 earthquake and have not been available to the Commission. Next they say, “In addition we were able to view the full design, documentation, soils investigation and complete set of drawings at the office of Alan M Reay Consulting Engineer on 26 January 1990.” Now

just looking at that description of what Holmes reviewed does that match what you have reviewed for the purpose of your evidence?

A. I haven't seen the soils investigation.

Q. Otherwise, and I appreciate that there may be matters of detail in the other ones but generally does that appear otherwise to be the documents that were referred to you for your evidence?

A. Design and drawings I've seen, yep.

Q. Yes. The next says, "The original design engineer was unavailable for comment having since left the company but Mr Geoff Banks was available for comment on aspects of the design." See that?

A. I do.

Q. In relation to your own assessment of this matter other than the meeting at the engineering function you've referred to did you have an opportunity to discuss these matters with Mr Harding in a formal sense?

A. Sorry as?

Q. Well you've mentioned that you met him at an engineering function –

A. Yep.

Q. – and briefly discussed it. Other than that did you have an opportunity to discuss these matters with Mr Harding in a formal sense?

A. You mean this report or?

Q. No. The whole matter that you've done. All your work.

A. No.

Q. No and I take it by definition you will not have spoken to Mr Geoff Banks about the matter either?

A. No.

Q. No. In fact in carrying out your assessment have you spoken to any of the engineers, drafts people or other persons involved in this matter?

A. The only time I've spoken with David Harding is when he contacted me to jog his memory about buildings that were designed with Alan Reay is after being questioned by counsel assisting at which point I told him that I was also being interviewed by counsel assisting and let him know that I was looking at his work and that sort of brought the conversation to an end because he was respectful of that. That's the only time I've spoken

to David Harding about the building. Well I actually didn't speak about the building really but is that what you mean?

1254

Q. Yes I'm asking you whether he or any other engineer or draughtsperson gave you any information or have you worked off solely the material counsel assisting gave you?

A. That's correct yes.

Q. Now the next paragraph an inspection was made on the 30th of January 1990. Levels 1 and 4 were unavailable for inspection but the remaining floors were taken as representative. Access was gained to the lift machine room, cooling tower and onto the roof. Would you accept that that was a sufficient physical examination for the purpose of a report of this type?

A. Actually I don't know what the report is. If I've seen it I could probably end up more confident about giving an answer to your question there.

Q. I'm sorry I'd overlooked that you not having seen it you wouldn't be aware of that. If you turn back to the front cover, page, point 7. You'll see it says it was prepared for the Canterbury Regional Council by Holmes in association with Buddle Findlay and Schultz Knight Consultants, do you say that.

JUSTICE COOPER ADDRESSES MR RENNIE

CROSS-EXAMINATION CONTINUES: MR RENNIE

Q. Mr Henry the evidence, and I don't understand there to be any contest about this, is that the Canterbury Regional Council were considering occupying and/or acquiring this building and the report was obtained for that purpose.

A. Right.

JUSTICE COOPER TO MR RENNIE:

Q. Mr Rennie I can't remember the detail of this report but is there an introductory page in which there's reference to any limitations or anything like that?

A. Not to my knowledge, sir, I believe it had associated with it other material, as one would expect, in relation to land titles and lease terms and things.

Q. Well what's on the next page?

A. Sorry sir, what's on the next page meaning.

Q. Point 8.

A. Point 8 is a contents document, Sir, and contents you'll find Sir the numbers there relate exactly to the pages we have.

Q. Right and then introduction – have we discussed everything?

A. Introduction is point 9, Sir, we looked at that and then people involved with the construction of the building is point 10 and so on through, Sir. And I think the position I'd reached, I was just putting it to the witness that the investigation which took place, sorry the inspection which took place on 30 January 1990 was sufficient for a report of this type and the witness very fairly said well what was the purpose of the report.

Q. Yes, thank you.

CROSS-EXAMINATION CONTINUES: MR RENNIE

Q. Mr Henry do you now accept that an inspection of the type described would be sufficient for a report of this type?

A. Looks reasonable to me.

Q. If we go to point 1-3, we have here a summary description of the building and this is a matter I'm just going to leave you to look through over the break on the basis that if you have any particular comment on that then I'll ask you about that when we resume. If you go to point 1-4 this is the structural design aspects. There is a more detailed discussion as you will see of foundations, gravity structure, lateral load resistance and then, on the next page, point 1-5, roof and fire escape. Again I'll give you the opportunity to look through that in your own time. And at point 1-6 a condition report and you will see that there is a discussion in that of state of the building, standards of workmanship, current damage, as at January 1990. So Mr Henry if that's a convenient

time, Your Honour, I will hand you a hard copy of it and come back after you've had a fair opportunity to examine it.

A. Yeah, that's fine yep.

HEARING ADJOURNS: 12.59 PM

HEARING RESUMES: 2.15 PM

WITNESS INTERPOSED

AN ORDER IS MADE THAT THIS WITNESS IS NOT TO BE FILMED OR PHOTOGRAPHED DURING THE PRESENTATION OF HER EVIDENCE AND NO IMAGE OF HER MAY BE PUBLISHED

MR ZARIFEH CALLS

PATRICIA CONSTANCE TAPPER (SWORN)

Q. Mrs Tapper is your full name Pat Tapper?

A. Ah no, it's Patricia.

Q. Patricia sorry.

A. Patricia Constance.

Q. Patricia Constance Tapper?

A. Mhm.

Q. And are you the widow of Graeme Tapper?

A. Mhm, I am.

Q. Your husband Graeme died in 2004?

A. That's right.

Q. And was he previously working at the Christchurch City Council, particularly in 1986 in relation to the building we're concerned with as an engineer?

A. Yes he was.

Q. Now I think you've got in front of you a copy of your signed statement?

A. Yes.

Q. Just have a look and confirm that?

A. Yes.

Q. Can I ask you please to read that out to the Commissioners and start at paragraph 2 because I've covered paragraph 1.

A. I was married to Graeme for 49 years. Graeme was a qualified civil engineer and during the period of our marriage he worked in a number of different civil engineering positions, including work on the Benmore Dam, the wharf for the Manapouri Power Station at West Arm and the foundations for the aluminium smelter at Tiwai Point. He also worked at Southland County Council for approximately five years before we moved back to Christchurch. He then worked the Ellesmere and Paparoa County Councils before taking up a position at the Christchurch City Council.

I always thought of him as an old school engineer. While I was not really in a position to know how good he was as an engineer, I felt it likely he was. I heard stories that he could be difficult and sometimes irascible, but I thought he was very rigorous and very honest.

Graeme was a person who never talked about his work at home. He had a father who had done this all the time and I think Graeme just made a decision he was not going to do this. The one exception was the CTV building.

Graeme went on and on about the CTV building. At first I thought this was related to Alan Reay where there was a personality clash. However I soon realised that what Graeme was unhappy about was the building itself.

Graeme was never happy with the building, his view was there were earthquake risks. It was not a question of if, but when, and when it happened he was concerned the CTV building would not prove to be strong enough.

He told me he had not wanted to sign the building off at the Council but he was under huge pressure to sign it off from Bryan Bluck who was above him in the Council hierarchy. Graeme said he was concerned about his job.

Q. Thank you, I just want to ask you a couple of questions to clarify some of the things you've said.

A. Mhm.

Q. Firstly in paragraph 4, 3 sorry you talked about Graeme Tapper's character. Was he someone who would stand up for what he believed was right?

A. Oh yes, yes he would.

Q. You said in paragraph 4 and the following paragraphs that the one exception of him talking about his work was the CTV building.

A. Mhm, excuse me I didn't know it was that. I thought it was just a building in Madras Street.

Q. All right, well I was going to ask you that because we're referring to a building called – is the CTV building, when going back to this time that you're talking about when your husband was talking about it, how did he refer to it?

A. Well it was just a building that he was concerned about and it happened to be in Madras Street, and, mmm.

Q. Did you know about, anything of the location of it?

A. Well I sort of thought it was somewhere – we were married in St John's, you know.

Q. Where's St John's?

A. Which is no longer there and I thought it was somewhere near there.

Q. Where was St John's Church?

A. Well it was sort of Latimer Square way, yeah, it was – I don't know.

Q. Is that the corner of I think it's Hereford and Madras Street on Latimer Square?

A. Yes, it would be.

Q. And did you know who had built this building or who had designed the building rather that he talked about?

A. Well, he did say it was Dr Alan Reay and that's when I thought perhaps it was a personality, you know, just they didn't get on together or something.

Q. What makes you say that?

A. Well it just seemed to be there was going to be this meeting, this one particular day and –

Q. No I meant what makes you say that you thought it might be a personality clash?

A. I don't know, I – just something, you know just a feeling I had I think.

Q. Had you heard your husband talk about Alan Reay at all other than in the context of this building?

A. Not a lot no.

Q. But from what you said, did you form an impression of their relationship?

A. Well I just thought perhaps they'd got off on the wrong foot together or something, you know.

Q. That's how it appeared to you?

A. That's how it appeared to me.

Q. The – this evidence you've given about Graeme being unhappy and going on and on about the building. Can you tell us over what time period that happened that he was going on and on about it?

A. It was only – it wasn't a long time and I had the impression there was going to be a meeting.

Q. Right.

A. And he didn't really mention it after that particular meeting, you know.

Q. You said in the end of your evidence that Graeme said he was concerned about his job?

A. Mmm.

Q. Is that something he told you?

A. Well as he was going out the door on the day that I sort of thought this meeting was going to be, I might be wrong, he said, “Oh well, mightn’t have a job when I come home tonight,” and I just said, “Oh well, we’ll cross that bridge when we come to it.”

Q. Did you know who the meeting was going to be with or not?

A. Well I knew it’d be Bryan Bluck and I just surmised it was going to be Alan Reay, but it could have been someone else, I don't know.

Q. And we know that the CTV building was designed in 1986 and built 1986, 1987, so just in terms of those years, ‘86 and ‘86, and your husband, your late husband going on about it, was that around that time then?

A. Well it's a long time ago, I just thought it was 1986.

Q. So after the day he went off and you said that you thought he was going to a meeting, did he not go on and on about it after that?

A. No, it sort of, just sort of gave up, he didn't sort of say anything then, mmm.

CROSS-EXAMINATION: MR LAING

Q. Good afternoon Mrs Tapper, I represent the Christchurch City Council and I’d just like to ask you one or two further questions. Did your husband ever talk about his relationship with Bryan Bluck at all?

A. Well as far as I knew they got on pretty well. You know, we visited each other and things like that, but, mmm.

Q. Did he ever refer to any other clashes or disputes with Bryan Bluck?

A. Not really, no, that's what makes it stand out in my memory that he didn't ever speak of work at all. He might say someone was coming round and he was going to fix their car or fix, perhaps there’s some welding or …

1425

Q. So quite good personal friends?

A. Yes as far as I know.

Q. But when your husband indicated that he might not have a job would that seem out of character for Mr Bluck to say something like that?

A. As far as I remember Bryan yes very much. Whether Graeme was just sort of you know preparing me in case he lost his job.

Q. So it just might have been a throw away comment?

A. A throw away comment I would say yes.

Q. Yes. Thank you very much.

CROSS-EXAMINATION: MR RENNIE

Q. Mrs Tapper, good afternoon my name's Hugh Rennie and you might have been told I'm here to represent Dr Reay and Alan Reay Consultants. First thank you for coming. I appreciate it won't have been easy.

A. No.

Q. And I know it's a long time ago.

A. It is a long time ago.

Q. The discussion that you mentioned leading to your husband going off to work and saying I mightn't have a job when I get home. You remember that as being a particular day really, is that right?

A. That's right.

Q. Was there a lead up to that? Was he going on in the previous –

A. Yes prior to that he was.

Q. Yes. What some weeks? Some months? What do you think?

A. It would be only be a week or so. It wasn't that long.

Q. And when he got home that night did you say have you still got a job or anything like that?

A. I think I might have probably said that but he and he sort of nodded and said yes he did but he didn't really mention it after that so whether he was brassed off or not.

Q. Went back to his pattern of not bringing the work home with him.

A. He didn't bring his work home I must admit.

Q. I suppose the years after that before he passed away you may have gone up Madras Street sometimes and did he ever say that's the building that worried me or anything like that?

A. No but he appeared often on TV and I just said to my daughter this morning he must have gone into that CTV building because that was where he would be filmed.

Q. Yes. And that's in relation to local news and discussions and things like that?

A. Well it was, he was President of Grey Power and stuff like that.

Q. Yes he was really quite known in his time wasn't he?

A. Yes I think a lot of people knew my Graeme.

Q. Yes. Now my friend Mr Laing who is representing the council was asking a question or two about getting on, your husband getting on with Mr Bluck do you recall that?

A. Mhm.

Q. Some evidence that we're yet to hear from Mr Nichols who worked at the council. Do you know a Mr Nichols at all? He was an engineer working with your husband for a while?

A. I don't know he often I can remember a couple of the people that used to work with him but I can't remember him.

Q. Don't particular remember him?

A. Was he a young man at the time?

Q. Look truthfully I don't know because he hasn't come yet so I can't really help you on that but Sir the reference is WIT.NICHOLS.001.10. I don't think we need to put it up but Mr Nichols refers to your husband and Mr Bluck and these are his words, "Another of their fairly regular fracas".

A. I think that's could have been about engineering I think though.

Q. Well I'm assuming that's exactly what it was about. Would you regard your husband as being a vigorous debater in terms of engineering issues?

A. I'm wondering he used to get young men to read the book called 'The Prince' by Machiavelli so I'm wondering if that's – I used to say you can't do that Graeme and he says why not.

Q. I think you might be surprised Mrs Tapper how many of us were given that advice in earlier years, but for you an expression like a fairly regular fracas would be a lively or vigorous debate. Is that –

A. It wouldn't go deeply no.

Q. And beyond connecting Dr Reay to the building do you remember him saying anything else in particular about it?

A. No.

Q. I mean size or style or anything like that at all.

A. No.

Q. Didn't go on to explain what the concern was that he had?

A. Just thought he might have – look I really couldn't say. I'm not an engineer. Things must have worried him I think about it.

Q. Yes. And that's why it particularly stands out in your mind?

A. Mmm.

RE-EXAMINATION: MR ZARIFEH – NIL

QUESTIONS FROM COMMISSIONER FENWICK:

Q. Mrs Tapper, I appreciate the trial it must have been for you to come here. I'd just like to tell you I actually worked for the city council for a short period of time between when I graduated, when I finished my final exam till I started university and I worked in the structural checking department and that would have been in 1962 just for a short period so that was a long time back but and I checked quite a few structures through and found quite a few errors and a few blunders and I can well appreciate the stress you get under with that and so I think we actually owe a lot to people like your husband and other people who take on that job which can be one which they don't get much credit for when they're checking someone else's work but I think they've done a very good job for Christchurch so I just wanted you to know that.

QUESTIONS FROM JUSTICE COOPER:

Q. Mrs Tapper, you've given evidence that your late husband spoke about the CTV building and he was never happy with it and he was concerned that it wouldn't prove strong enough and that he had come under great pressure to sign it off from his colleague Mr Bluck. Now are you sure

that all that evidence relates to the building that we know as the CTV building which collapsed in the February earthquake?

A. I'm pretty sure it was.

Q. Now why are you sure?

A. Well because of where it was built in Madras Street.

Q. And that's –

A. It wasn't called the CTV building.

Q. No.

A. I can't remember what it was called actually.

Q. So that's the extent of your memory?

A. Yes it's not much is it really but that's yeah.

WITNESS EXCUSED

JOHN HENRY (ON FORMER OATH)

CROSS-EXAMINATION CONTINUES: MR RENNIE

Q. Mr Henry, when we broke I had given you a copy of the Holmes document I was asking you about before have you had an opportunity to look through it now?

A. I have.

Q. Yes. I'll first give you an opportunity to say anything that you wish to say from having now been able to look through it.

A. Okay. Well just to reiterate you did ask me have I seen it. No I haven't. You asked me was I the building manager, sorry engineering manager there at the time and I said well yes in a broad sense. What I think I should say first is that while I was engineering manager was a role of organising and looking after resources and technical matters on several big jobs including Parliament buildings and Price Waterhouse Centre and Antarctic Centre and I had a certain area of work and I was not a director. I want to get that straight.

Q. Sure.

1435

A. So I didn't, I can't sort of link myself to this report in that sense. In other words this job could have come in the door and been done by somebody else quite quickly. I would never have seen it. So I can't comment from that point of view. I've read the report. I think it's fairly, the wording I think could have been, had better limitations put around it to make it commensurate with what the report's actually saying. I think in fact in some ways, you know, it's possibly said too much for the work that's been done and it has used words like "it appears" and so forth as consultants do when they don't actually, categorically can state something and to me this, this carries with it a sense of, well, we've had a look, a general look over it. We did some check calcs of our own and in that sense and then they've latched on, whoa, there's something wrong with the connections to the shear walls and identified that and maybe that's where they've left the case and I don't take it from this

report that, we've been through the structural design and checked the design loads and with the capacity design and the balance of the building and so forth even though they haven't picked up what I'm picking up that there is an obvious imbalance in it.

Q. Thank you. The background on justification for the report of course will be a matter for Mr Hare –

A. Yes, yes.

Q. – when he comes to give evidence and I'm not trying to turn you into him, it was simply the fact that you had the firm connection there.

A. Yep.

Q. And I can indicate to you that something over 20 pages of engineering calculations but as you haven't seen those there's no point in asking you about that. The –

A. I agree that they should be able to explain that to you. I can't attempt to do that.

Q. Yes, yep. Now the point that particularly you gave attention to when we were talking about this before was in the conclusions. So 0.11 is the page reference at the top and it was the second one which said, "The layout and design of the building is quite simple and straightforward and generally complies with current design loading and materials, codes," and you questioned how they could have arrived at that.

A. I agree. I cannot see from this report how they would have arrived at that.

Q. Yes. In essence then evaluating the design plans and the calculations which they looked at would that lead you to accept that different engineers would take different views as to whether there were issues to enquire or whether it was apparently compliant?

A. I, I think that yes the different engineers with different, differing levels of experience would not see it as I did. I mean I, and I don't mean to say this in any sort of know-it-all type way –

Q. No, no.

A. – but I had a really, relatively speaking compared to other engineers of the era, a very intense period of structural design of these buildings and

I was the person in the Holmes' office in 1984 that these buildings were brought to.

Q. Yes.

A. And from that point of view I've sort of got the advantage of, of that knowledge and what I also say, and this may be a particular thing to me, but I absolutely, totally remember Professor Paulay saying on at least two occasions, he put it on the board, I wrote it down, I checked it, I got my notes out, he pointed out torsional instability and he said, "A building with two walls or even three is torsionally unstable. You must add the fourth wall," and I have the note in my notes and I'm not just making it up in retrospect. So from that point of view I'm adamant that if someone put that building in front of me I would have said, whoa, hang on, it's unstable and that's probably all I can say.

Q. Did you know that after the report that we're looking at there work was done the following year on the CTV building to install drag bars?

A. No I didn't know anything about that –

Q. No, no.

A. – until it happened, until the building collapsed.

Q. I am talking about the more recent period. Did you know when you were doing the work on the design and calculations that you'd been discussing that in 1991 drag bars were installed on three levels between the slabs and the north shear walls?

A. Yes I did make a note in evidence that that had been done, yep.

Q. Yes but have you looked at that issue as to the adequacy of effectiveness of that work?

A. I, I have looked at it and I didn't have any technical information on that but I'd looked at it and I didn't, I chose not to comment further than I did in the report because I didn't have the information but I certainly have my own views about it.

Q. Yes but before reaching a firm or final view on it you would have wished to have information as to exactly what was constructed and how?

A. Final view on?

Q. On the adequacy of the drag bar installation.

A. I definitely would if I was asked to comment on that –

Q. Yes.

A. The drag bars, definitely would need to see the information, yes.

Q. Now I take it that was not information that you were supplied with for the purpose of your evidence?

A. It wasn't supplied and I didn't comment on it.

Q. And, equally, not information that you requested from anybody?

A. I didn't request it. I discussed it at one stage and said I'm not copying, sorry, I'm not commenting on that.

Q. Right so that the evidence that you've given is directly focussed on the adequacy of the design work done in 1986 and not any later modification of it?

A. Yes I, I was asked to comment on Dave Harding's, ARCL, calculations and that's what I did.

Q. Yes. Now Mr Henry in your brief of evidence you indicate that you are giving evidence in respect of four areas, the first of which was your time at Alan Reay Consulting Engineer, the second was to review the calculations and I think in reality it was to review the drawings and calculations –

A. Yes, yes.

Q. – which Mr Harding did for the building, the third was to discuss design principles in the 1980s and the fourth was to provide some evidence in relation to the City Council consent process in the time that you were there.

A. Yes.

Q. And you indicated in your brief of evidence that part of your evidence consisted of expressions of opinion and in respect of those you addressed it from an expert evidence point of view. Do you recall that?

A. Yes.

Q. Did you regard your expert opinions as relating solely to the calculations and drawings or did you think any of your evidence under the other three headings was in the nature of expert evidence? I can run back over them if you'd like. Your time at Alan Reay Consulting Engineer,

that wouldn't be a matter of expert evidence, it'd be a matter of personal experience wouldn't it?

A. Yeah I think, matters of fact I think is, was the term used, yeah, I think.

Q. Yes. Design principles in the 1980s. Are you expressing an expert view on that or a practical experience from the time?

A. Probably both I think.

JUSTICE COOPER:

Well practical experience can still be an expert one.

MR RENNIE:

Absolutely Sir and the witness has just said "both". I'm just seeking to understand the status that he claims for the evidence that he's given Sir.

JUSTICE COOPER:

All right well I'm sure you'll be careful but, you know, we can get into trouble if we put well-known legal classifications to people who aren't lawyers. The answers cannot be, can require interpretation.

MR RENNIE:

I totally agree Sir and I use the opportunity to again say to the witness that if he needs time or wants clarification he should ask me for it.

CROSS-EXAMINATION CONTINUES: MR RENNIE

Q. And lastly the City Council consent process. Do you see yourself expressing an expert opinion in relation to any part of that?

A. Well I didn't when I wrote the evidence but as a result of the discussions that developed I think it has got into the area of expert evidence.

Q. Yes.

A. With regard to the technical matters raised.

Q. Yes. Now are you aware that part of the Commission's process has involved the carrying out of a non-linear time history analysis for which a panel was constituted and also a panel constituted of experts in relation to ERSA?

A. I am, yes.

Q. Have you seen the reports of either of those matters as reported to the Commission?

A. I've, I've seen the DBH report, the big thick one I've got in my bag.

Q. That's Dr Hyland's report –

A. Yeah and –

Q. The Hyland Smith report.

A. The Hyland Smith report. I've seen that one and –

Q. The work I'm referring to is much more recent (inaudible 14:44:58)

A. Yes I've seen the, Alan Reay's worker is it, Latham –

1445

Q. Right, you've seen Mr Latham's –

A. Latham yeah, I've read his report.

Q. Yes and I'll come to that. Last week we had expert panel presentations in relation to an NTHA analysis which was headed by Professor Carr. Have you seen that work?

A. I watched most of it as much as I could.

Q. Yes.

A. Yes.

Q. And we similarly had a presentation in relation to ERSA. Did you also have a look at that?

A. I watched some of it, Clark Hyland and co. I'm a little bit mixed up but I have tried to keep track of it yes.

Q. And you understand that the ERSA panel decided not to carry out a further ERSA and following that one of the panel members, Mr Latham, employed by Alan Reay consultants, has done an ERSA?

A. I didn't know that's why he'd done it but I know he's done it, yeah.

Q. Now dealing firstly with your time at Alan Reay Consulting Engineering, that's before the company was formed, the work which you expected to undertake when you went there from Holmes Wood was of what nature?

A. Sorry, it was –

Q. The work that you expected to undertake when you went there from Holmes Wood was of what nature?

A. Structural, it could have been anything, but I knew there was multi-storey work needed.

Q. Yes. Was it explained to you that the firm was experiencing requests from its clients for multi-storey design for which they needed someone to undertake it?

A. No it was just that Alan said he had a couple of jobs in the pipeline and you know, that's in a way it's an attraction for someone's who needing a role where you've had that.

Q. Yes.

A. This continuity of work so that was the way I saw it.

Q. And on the basis that you would be the person in the firm doing that multi-storey work?

A. Not entirely. Well I mean I would be doing it but I didn't expect to be doing it on my own, put it that way.

Q. No. Who did you expect to be working with you?

A. I expected to work with Alan Reay.

Q. And was that on the basis that you perceived him to have competence in multi-storey design?

A. I perceived him to have competence in structural design, to say in multi-storey design explicitly, that would be wrong because I had a fair idea that he hadn't done a lot, but I still expected that he would be an assistance in the sense that he had a doctorate and a lot more years experience and so forth and so therefore I did expect he would assist in some form.

Q. And what was your actual experience when you got there as compared to that expectation?

A. Well I think I probably did tell you in my evidence earlier today but I can summarise it, that my experience with the big buildings, well my experience first, and generally Alan was very competent, proficient and clearly had a good grip and understanding on the work that he typically did and when it came to multi-storey buildings I was, I don't suppose there's a better way of putting it, I – that first initial Landsborough House meeting with that configuration that was presented was disappointing

and – but I – you've got to remember I was still a quite a young bloke and it was just like a new job and so forth, put it out of your head and keep going and there's a chance to prove you know what you can do I suppose so I just carried on, but the – as I reluctantly had to give evidence on yesterday afternoon, I was disappointed again when I realised that Alan wasn't really of the same mind as I was with regard to Professor Paulay's status I guess, or not so much status I shouldn't say that, I would say viewpoint, viewpoint, so I at that stage I think I realised I was basically on my own with that type of design and it was a bit lonely to be honest.

Q. Now did you know that Dr Reay had himself on at least one previous occasion if not more, himself gone to Professor Paulay for assistance in such matters?

A. No.

Q. Well Dr Reay will say when he next gives evidence that that was indeed the case and that far from being dismissive he considers he had a high respect for Professor Paulay. That conflicts with your understanding?

A. Well I didn't say that I thought Alan Reay had – didn't have a high respect. What I said was my distinct memory of what happened and then my interpretation of what you think he meant and I tried to balance my evidence with both of those statements and I don't for a moment think that Alan didn't respect Professor Paulay, everybody did. He was very, very highly qualified and held in I think I heard the word revered, sort of state.

Q. Yes, true.

A. But what I think is that I do genuinely think that Alan thought that's academic idealism, this was the real world we're dealing with here but nevertheless the result was as I tried to put it, dismissive of that aspect and we carried on. In other words I went for review, I got the answer, I told him and we carried on after that discussion.

Q. Yes. But you felt that on that particular issue on that particular day Dr Reay didn't give sufficient weight or attention to what you had brought to him from Professor Paulay?

A. I would say that at the time I was left – I don't want to use terminology which gets in the Press again.

Q. We're all stuck with that problem.

JUSTICE COOPER:

Q. Well Mr Henry, you need to forget about the Press and simply concentrate on your oath.

A. Yes, well like disappointing is an understatement to be in that position and I had what you'd call a double bind. I had Professor Paulay telling me something which you know somehow needed to be acknowledged and on the other hand to have my relatively new employer saying, just carry on, and so at the time, if this is what you're asking me, I – left me feeling that I wasn't getting a lot of support.

CROSS-EXAMINATION CONTINUES: MR RENNIE

Q. Yes.

A. And so I made – I resolved that by saying, okay what's going to happen, more deflection, watch the columns, put some more steel in, none of that was designed at that moment and later on I did something about it. It wasn't the only thing I did about it. I haven't gone into those details but I kept up the column design. I used twice the load on them virtually as the interior ones, sorry the exterior columns were twice as heavily loaded roughly speaking as the interior, used the same column design throughout. When it came to the ETABS ERSA design as I've already said I kept the load up, I didn't scale it down. I could have scaled it down to .9 static, and all of those things in my mind were buffering the structure against something unexpected.

Q. Now the firm at that time comprised two engineers, Dr Reay and yourself. Is that correct?

A. Yes.

Q. And at paragraph 81 of your brief of evidence you don't need to turn to it, you said that ultimately you felt you had been essentially relegated to the role of a back room designer, do you recall that?

A. I said that, yes.

Q. And in what way did that differ from what you aspired to do yourself in the firm?

A. Aspire to –

Q. In what way did that differ from what you yourself aspired to do in the firm?

A. Well, what I had been doing is what I naively assumed I would keep doing because I didn't realise with the change in organisation to a much smaller firm that that really wasn't going to happen because of the nature of the client base and the way the firm was run, but what I had had, and would have liked to have kept up was involvement, developing involvement with the project control groups, and I mean for example the building that I was working on beforehand, the AA Centre, that involved me going to Wellington and joining in the project control meetings, it

1455

involved me going to Warren and Mahoney and having meetings with Miles and other people to discuss how the building was going to be designed conceptually and that happened on other jobs like from the Academy Savings Bank Westpac building same thing. I went to meeting with Mr Lundy and Mr Dickson who was the director of the Westpac building and so I was involved at those levels and that's what I was used to so when I went to some of those offices I didn't sort of think that would just drop out of the equation.

Q. Essentially you were left to progress projects like Landsborough House independently of Dr Reay's involvement, is that right?

A. Not totally. I basically as I've said was in the driving seat. I knew what to do. I did it. He liaised on a reasonably regular basis because the whole office could have fitted in this space here so you couldn't miss what was going on and he knew what was going on. I told him the key parts when it came to being drawn. It was on the drawing board. Everyone could see it and you would have to walk past me to see what was being designed so from that point of view I didn't see it as being,

being in a situation where he couldn't have or wouldn't have had a view on the work.

Q. This was a small busy office quite different to Holmes Wood, wasn't it?

A. Holmes Wood was a busy office. This office was, it was steady and very quiet. When I say quiet in the sense you could hear a pin drop.

Q. In the sense of the working environment?

A. I would say it was just a reasonably normal workload environment at the time I was there.

Q. We've been told that when you left you gave a month's notice, do you recall that?

A. That's correct.

Q. And at that point in time Landsborough was underway as a construction project and you were working on Westpark, is that correct?

A. I didn't know, I couldn't remember if it was underway or not. They might have put a site checks out or something like that and Westpark I think was probably the last thing I did when I was there so that would make sense.

Q. Did you have anybody to hand your work over to when you left the office?

A. Only Alan.

Q. And in relation to Westpark did you have any formal handover process or briefing in relation to that or was it just simply left in the office?

A. I don't think it was going anywhere. I definitely didn't hand over any jobs to anyone other than Alan Reay.

Q. And in the sense of –

A. There might be one exception to that. There might be one exception. The trickling filter covers which were under construction. I worked on that. I did the design and analysis for that thing and it was – because we were sort of a new area of work I remember at the time insisting that it be tested in some form and we did erect a number of the panels of a spider shape form to do a real test load on it and I'm unsure, I have a recollection that Dave Harding may have come along or been at that

test or he may have asked me to do it or I may have been asked if I was interested I'm not sure.

Q. Would that reflect a knowledge on your part that Mr Harding was coming in to replace you?

A. I knew he was because he told me.

Q. And did you have any view at the time as to whether Mr Harding would be able to pick up a job like Landsborough or Westpark from where you'd left off?

A. I don't know that there was any need to pick up. Landsborough would have been site work. I don't know they'd even considered Westpark. I wouldn't have thought of it in that sense.

Q. Well put it this way did you regard Mr Harding as a suitable and competent replacement for the position you had?

A. I didn't think that – well if I'd thought about in that sense if someone, if he had said to me I'm going to do multi-storey buildings I would have said why. How can you do that?

Q. And that was based on your knowledge of Mr Harding at that time?

A. Absolutely. I'd knew what he'd done, yes.

Q. Did you express any reservations to Dr Reay as to whether Mr Harding was suitably qualified for the work that you'd be leaving behind?

A. No it wasn't known at that time that David Harding was going to be replacing me. I only knew later because he told me at a meeting or something like that.

Q. Was this a matter of your coming back after you'd left in relation to the filter covers?

A. No it didn't come up at that time. I didn't know that there was any multi-storey buildings around when I left.

Q. Other than Westpark?

A. Other than Westpark.

JUSTICE COOPER:

I thought – I had the impression from something Dr Reay said that that job was taken to a certain point by Mr Henry and then it went into abeyance.

MR RENNIE:

It certainly went into abeyance for a term Sir yes, that not's an issue but that didn't mean that it wasn't going to revive at a point and require someone to do it.

JUSTICE COOPER:

I accept that but I don't have the impression from the evidence that it is something that Mr Henry would be have been thinking about when he left because well perhaps you should be asking him to confirm.

MR HENRY:

I'm happy if you ask me that's fine.

CROSS-EXAMINATION CONTINUES: MR RENNIE

Q. Well you understand the point His Honour's making. Do you want to respond to that or shall I put you a question?

A. If I'm reading it right you're asking me if I, if it was appropriate or I needed to pass on a job and brief someone so they could carry it on.

Q. Yes.

A. No, well that wasn't the case. In fact I think I was sort of relieved because I didn't have to walk out in the middle of anything and it was, from my point of view it was convenient for everybody. The only thing I think I, if I felt a sort of pang of I might be letting Alan down would have been the construction where it was ongoing and he would have had to do it himself. I think he actually got Terry Horn to do that.

Q. I'm now going to go onto some aspects of your review of the calculations of the CTV building.

A. Yes.

Q. Now firstly you have mentioned that you have seen the ERSA which Mr Latham prepared and which he is to present next week.

A. Yes.

Q. You understand the basis upon which he prepared it is to start from a zero base and work out whether it was feasible to design a building essentially the CTV building in compliance with the code. In other words he hasn't simply redone Mr Harding's work, he started from a zero base.

A. Yes I do appreciate that yes.

Q. And the outcome of that is that to a large extent, perhaps the full extent – that's a matter for next week's evidence – he has completed that exercise and contends that it can be done in compliance with the code. Do you, have you looked at his work in that respect?

A. I have looked at it and I do, I have looked at it quite closely and I have a view on it yes.

Q. Well I'm asking you the obvious reason to give you an opportunity to express that view.

A. Well –

Q. By the way you're not compelled to do that. This is an opportunity not a compulsion.

A. What I say is first I've read it twice as carefully as I can and I have condensed down from that several points which I have in my bag. I can open up and read them.

Q. If you find that convenient and subject to His Honour's direction you may do so. Is that acceptable to you Sir?

JUSTICE COOPER:

Yes.

CROSS-EXAMINATION CONTINUES: MR RENNIE

A. And I did note that before I went too far with my comments I would appreciate a review by somebody else because I think that there's – I don't want to get on a one on one basis situation because I think it all needs to be considered and in fact I did say in my notes here that I think these aspects should be considered but I can read it if you'd like me to read what I've written or I can summarise it but –

MR RENNIE:

Well given that you have taken care in writing it out and subject again to His Honour's direction it might be preferable if it's read Sir.

1505

JUSTICE COOPER:

Well I'm in your hands really because you're cross-examining Mr Rennie.

CROSS-EXAMINATION CONTINUES: MR RENNIE

Q. Yes Sir well I'm endeavouring to ensure that the witness is able to express his answer in the way that he prefers Sir.

A. I don't mind. As long as you appreciate that these are my preliminary comments.

Q. Yes.

A. And I'm quite happy for someone else to have a look and review them as well.

Q. And I anticipate that that will develop when Mr Latham presents his evidence Mr Henry.

A. Okay well I said the purpose of the report is stated as being for considering whether or not the design was consistent with the design standards and codes applicable at the time of design of the CTV building in 1986. The conclusions drawn from analysis are summarised as follows.

(1) The degree of eccentricity was moderate and therefore the static mode method or the ERSA method could have been used to analyse the building.

(2) The inter-storey drifts were compliant being 0.47% for static and 0.53% for ERSA versus the code limit of 0.83%.

(3) The design forces and deflections used in the report can be used as the basis for assessing whether the CTV was designed in accordance with the code and

(4) the drift levels do not exceed the limits given on the DBH report.

With respect to the conclusion points above I comment.

(1) Eccentricity. The calculations for the degree of eccentricity appear to rely upon a centre of rotation located closer to the centre of the building than that given in the DBH report. I'm calling it the DL report. I'm sorry, is it Douglas Latham?

Q. It is Douglas.

A. It is, call it DL for short. He locates the centre of location in the middle bay, three/four, by reference to co-ordinates which when plotted is not on the stairwell of the north core as in the DBH report. I've worked this out from co-ordinates provided assuming the origin of co-ordinates is the same as that used in the ARCL calcs, ie at the south-east corner of grid location F1. There was no plan diagram given by DL to show this which would have been a good cross-check. I suggest it needs to be questioned and confirmed with ARCL. On the basis that my interpretation of the co-ordinates is correct this appears to make a reduction of about five metres in the eccentricity and would explain why DL has been able to calculate the building as moderate eccentricity which, even so, is marginal being within 5% of the limit given in the commentary to the code, not the code itself. I cannot see why the centre of rotation would have changed by this amount if I'm interpreting that correctly. It may be caused by the flexible foundation conditions that have been assumed using information that was provided by Ian McCahon for the original design. Clark Hyland would be best to comment on this and to review my findings.

(2) Inter-storey drifts. The DL reported drifts are about 60% of the code limit of 0.83% including the K over SM factor. These drifts are of similar order to those discussed. This is actually written to counsel assisting at our last meeting when I showed you the graph with the code drift limits on it compared with the ARCL centre of mass drifts and the DBH corner drifts. Those drifts included the code factor of K over SM where SM equals 0.8 and K equals 2 for static load drifts and 2.2 for ERSA load drifts. The DL report appears to use the same K over SM factors, ie S=1, M=0.8. However, as I pointed out in my email following the last meeting the actual S value used by David Harding for the design of the

south coupled shear wall was 0.8. In addition he scaled the loads down by a further 0.8 which I believe was a misinterpretation of the code scaling factor when using ERSA values. To expand on that the code would allow the overall ERSA load or base shear on the building to be factored to 0.9 static but with an additional provision that at any level the shear drive was not to be taken less than 0.8 static. I've said this earlier today. My training and experience with that provision at Holmes Wood was to use it as a back check when designing for particular members using the ERSA output. It was not a factor to apply to the overall building loads. For the final design of the south coupled shear wall David Harding applied S=0.8, M=0.8, plus a further 0.8 scaling factor which is 0.8 times 0.8 times 0.8 equals 0.51 to reduce the design loading for the south coupled shear wall. This effectively changed the value of SM when compared with the original calculations where SM equals 0.8. Douglas Latham appears to have used the same SM equals 0.8 value in his report. Hence the calculated drifts appear to be correspondingly unreported. Since deflections in the east-west direction are critical on the south wall the final deflections for that location should have been recalculated using K over SM increased by the ratio of 0.8 over 0.51 equals 1.57 which results in deflections much nearer the code limit depending on whether or not static or ERSA values are used. My reading of the DL report is that the overall base shears have been reduced from David Harding's design at least for the static load case from 2350 kilonewtons to 1920 kilonewtons but somehow the design force for the critical south coupled shear wall has not changed significantly from David Harding's design before he applied S=0.8 factor and the additional scaling 0.8 factor. This needs further detailed checking or questioning of ARCL. Application of the S=0.8 factor is a code provision for a coupled shear wall however my evidence is that it further increases the imbalance caused by the north core versus south coupled shear wall configuration and hence increases susceptibility to increased deflections. This is because the reinforcing is correspondingly reduced and hence the wall stiffness is also reduced.

We at Eliot Sinclair have carried out approximately calculations of the south coupled shear wall stiffness with differing reinforcing contents to show that this is the case and is significant. That's what I wrote.

Q. Leading on from that you've referred in particular to Mr Latham's calculation of base shear. You said the figure he arrived at was about 1920 kilonewtons.

A. Yep.

Q. In contrast to the approximately 2300 kilonewtons which Mr Harding arrived at as his reduced figure after doing his ETABS and Mr Latham in fact has two values for the base shear on a north-south and east-west basis doesn't he, one slightly different to the other?

A. Actually yes, I, I haven't written it here. I have noted it separately that the basis for that reduction in load appears to be that the building period has been recalculated and I've probably got that noted here somewhere too but Mr Latham has now calculated a period for the critical east-west direction as 1.2 seconds which is up from 1.06 and for the north-south direction a period of 2 seconds, up from 1.2 which I find extraordinary. That's more as you would expect from a building like 20 storeys high.

Q. The alterations in the building period and in the base shear calculation have a material impact on whether the structure does or does not comply with the code don't they?

A. The actual base shear that the building's designed for, it can vary quite a lot.

Q. Yes.

A. It's the, it's when you get uneven yielding of the building that the problems set in. So I think in a general engineering sense engineers wouldn't argue too much over the level of load that's chosen provided that everything else follows through, and what you find, for example, is in Auckland where the earthquake loads are lower they have less structural, less walls, less columns, so their buildings are more flexible –

Q. Yes.

A. – then say Wellington where it's much higher loads and they don't have as much deflection and, similarly, Christchurch. So when you use a

shear wall building, as I said before, there's a (inaudible 15:13:58) of 0.1 seconds per storey is what normally would have worked at the time. So you're talking 0.6 seconds is what you'd expect. To come up with two seconds is like, as I say, it's extraordinary. It couldn't proceed with that period in my view.

Q. And is this where your point is that you make about expertise coming in as a result of experience on a succession of buildings?

A. Absolutely, yes.

Q. Mr Harding was asked about that and his proposition in evidence was that after the CTV building he considered that he was able to use ETABS effectively and design buildings. I understood him to being saying that in contrast to his use of ETABS on the CTV.

JUSTICE COOPER:

After the use of ETABS on the CTV building or Westpark?

MR RENNIE:

No he said after CTV Sir. I can find the reference.

JUSTICE COOPER:

That's all right. That's all right. So after, what was the proposition? After the use of ETABS on CTV -

1515

MR RENNIE:

He was putting the proposition Sir and I can spend a moment and find the reference if needed that he was not – thank you, the reference is the transcript from 30 July. It's TRANS.20120730.85 and from line 9 and this is Mr Harding's answer, "Certainly I did that job," that was a reference to Westpac, Park Tower, "And it was definitely after CTV that I did it and at the time I did the Westpark Tower I was obviously familiar with ETABS having done the CTV and following on John's example of the other job, I was then in a position to do that building." I understood there to be an assertion by him, I

know it says Westpac in the transcript, a little confusing because there is a Westpark Tower and Westpac Tower but you can see from the nine storeys that it's Westpark we're talking about and I understood the witness Mr Harding to be saying that after he had done the CTV building and following on Mr Henry's example from the Westpark job he considered he was in the position to do the next building. That was a sufficient experience with ETABS.

CROSS-EXAMINATION CONTINUES: MR RENNIE

Q. Now Mr Henry's indicated that perhaps three buildings were needed before you could feel that you were sufficiently familiar with ETABS to use it on a standalone basis. Is that right?

A. Well when you say, I did qualify that by saying not just putting the data in and getting it out, but understanding what it means enough to proceed and be confident that you're on the right track, and I said even then it needs to be done with review and assistance.

Q. The calculations that Mr Harding did which you reviewed for the purpose of your evidence, do you accept that on their face they appear to show confidence that the designer is actually able to do that work and knows what they're doing?

A. I did see it following the format of my calculations, in my own calculations and from that point of view they do have an appearance of an experienced designer but it didn't take long, actually reading them, get to page 15 and see that the deflections didn't tally, weren't right and that was my first impression when I opened it, it was very obvious to me that something was wrong there at that point but if you didn't know and you could go, look at the whole set and think it was okay.

Q. Yes and that was really my question to you, that Mr Harding got through to the end and believed that he had done it all correctly, whereas you have identified points where he went astray?

A. Yeah, I think that's fair to say.

Q. Now if we could have please and I tripped on this one last time Sir, I'll try and get it right this time. BUI.MAD249.0284.15 which is sheet S14

from the Council's approved designs. You will have seen this plan before Mr Henry?

A. Yes.

Q. If we could stay right away from where I got into trouble last time and instead go to the left-hand side of the plan and perhaps it could be turned sideways so that it's clear and if we could just enlarge the first segment, oh the first two segments of the drawing please. Now Mr Henry just taking a moment to get on top of this, the extreme left of what we're now looking at you can see that the second set of design elements is column C1, C2, C3, C5, C6 et cetera, you see that?

A. Yes.

Q. And if you look above that you will see a diagram which shows the placement of reinforcing through those vertical columns doesn't it?

A. You're talking about the column laid on its side now, that one is that you mean?

Q. I'm saying that the very top of that diagram shows the reinforcing content which goes into the column below?

A. Oh the inscription of it, yeah.

Q. Yes,

A. It's showing the spirals.

Q. Correct and it's the spirals I'm particularly paying attention to and the spiral is for example the first one on the left which will be the first level is shown as I think it's 3.1 metres of R6 spiral at 250 pitch, you see that?

A. Yes, I see.

Q. And that spiral stops short of the first beam column joint doesn't it?

A. It does.

Q. And then the next segment is 3.2 metres of R6 spiral at 250 pitch, you have that?

A. Yes.

Q. And on the face of that, that starts below the first beam column joint or possibly just in it, and carries through to immediately below the next beam column joint doesn't it?

A. It does.

Q. And that pattern is repeated through the following upper levels of the building isn't it?

A. Yes.

Q. Now when I asked questions of Mr Harding, and this is at page 5 of the transcript at 9.40 on the 31st, I asked him the following, "You've indicated that on a number of occasions you went to the construction site while the building was being constructed?" Answer, "Yes." "Was a part of that visit the inspection of the beam column joints at each level?" Answer, "Yes." "Were you checking for the presence of spiral reinforcing in the beam column joints at that time?" Answer, "No, because there's none shown on the drawing and none was intended to be put in." Question, "And so the absence of spiral reinforcing from the joint would not have concerned you?" Answer, "No." Would you agree that that answer is in conflict with what is drawn on the plan?

A. It is in conflict yes.

Q. What level of importance would you attach to the presence of the R6 spiral reinforcing in the beam column joints as shown on that plan?

A. Well it's not a lot of reinforcing that would do very much to be honest, so if it was in there, it would only make, well I can't, I don't want to guess but minor difference to the joint strength I would say. It's very difficult to say because the joint was compromised for other reasons but I mean it's definitely an improvement to have it in the joint. If you can get it in without, yeah, because it was tight to get it in as well.

Q. Do the answers that I've just read to you suggest that there was a disconnection between what Mr Harding thought he was doing and what he had designed in the plans?

A. Well it does sound as if he's either confused or forgotten.

Q. Would you agree that in terms of the review of the drawings and calculations to go to the Council that the person carrying out that review will be relying on what is drawn and not on what is in fact going to happen in the engineer's mind?

A. Well in the Council you'd certainly take it as what's on the drawing is what's going to be built.

Q. Yes. Now we are having some separate – a separate session on permitting but I – so I'm only going to ask you a couple of questions about this point now just to complete this issue and come back to that, but the calculations which you've reviewed and which went to the Council would be examined by the Council from your Council process knowledge, would be examined by the Council as to whether they validated the design?

1525

A. Well there's a question of timing because things changed over the years.

Q. Yes and I appreciate that might be difficult because you weren't with the Council in 1986 so please feel free to categorise your answer by time or however you wish.

A. I, I think that in the '80s typically the Council would look at the calculations and they would say, they might be impressed by them and say, "Well they've done their job." They might read the first few pages and look at how the loads were derived, more than a cursory look if the calculations were there but by no means a detailed review say like I did of David Harding's calculations.

Q. Yes.

A. But by the same token they may not be given, they may have to be asked for.

Q. Well I think without going to Mr Tapper's letter we can see that the calculations were requested by Mr Tapper.

A. Yeah.

Q. Although he may have had a particular reason for that because it looks as if the plans that were sent to him were incomplete in a number of respects doesn't it?

A. Yes that was often the case in the '80s.

Q. And was that really on the basis that people would try and get their plans in to get up the consent queue and get approval for their buildings and get them underway?

A. Yes in the '80s with the building, the rounding up of work for the, the building boom that happened –

Q. Yes.

A. – people were doing everything. There was staged consent for foundations only where they might be reasonably detailed and the rest of the drawing would be not much more than carcase and that's about the time I think that Graeme Tapper was engaged or employed by the Council because there was just too much incoming and I think Bryan Bluck and co. were not coping with it and the, the standard of stuff coming into the Council then was varied. I remember because even at Holmes we've tried to do staged consents and getting agreements with Bryan Bluck for that and he would make an agreement if it was quite clearly defined and separate designs given for those stages but even so there was a lot of stuff going in there which I think was incomplete because Graeme Tapper knocked it on the head. He came to some structural group meetings and complained to the whole group along with poor documentation, incomplete documentation and sort of a rash of very poor weld plate details with poor welds and he straightened the whole thing up quite, in a general sense quite well and then he started on particular jobs that he felt needed to be dealt to.

Q. Just to clarify, when you say he came to a structural meeting you mean a meeting of structural engineers in the Christchurch area, is that?

A. Yes the, the Christchurch engineers, well it used to be called the Canterbury Structural Group. I was chairman of it for three years and we'd organise about a monthly meeting, have a few beers and pizzas and then give a talk, someone would talk about something relevant and so if there were other general issues it could be raised and at least one of those meetings Graeme Tapper came along with Bryan Bluck. Bryan Bluck usually came and he would be very forthright with what he said. He would make it absolutely clear that what, if he thought he had something to say. So that was quite a good way to communicate. It sort of died out to a large extent because of the earthquakes. It's been taken over by other meetings but, hopefully, it will start up again.

Q. And, so when Mr Tapper called for the calculations in this case or when the Council more generally called for calculations and was sent they would be examined and either would or would not provide sufficient comfort to the consenting engineer to grant approval. Is that right?

A. If, if they were asked for there was definitely something the reviewer wants to look at.

Q. Yes.

A. And they would go for that point and see if the calculations made sense.

Q. And in the event that there was a concern after sighting the calculations would the Council require either revised plans, further calculations or peer review?

A. In my experience there if it wasn't satisfactory we would say so and indicate why and ask for something further and try and grant ground and solve it and as I've already indicated that could be compromised depending on the level of degree and the type of answers that came back. If you got a stalemate situation, in other words there was disagreement, in terms of peer review I would say that it was essentially unheard of for the Council to go external for a review before the Building Act and where that process was brought in, when I was the building control engineer with Albert Luman as the public health and safety manager he brought down a sort of expert local government consultant who had put in place a peer reviewing system for Auckland and brought it down to Christchurch and we implemented it here where we registered a number of external reviewing consultants and we then formally put it in place and if we had too much work to do or difficult jobs or difficult customers you could refer it to those reviewers and that was –

Q. That do you think was a post Building Act development?

A. Post Building Act and it was used quite, quite widely at first but it turned out to be that the reviewers were much harder on the applicants than we were. They found all sorts of things that we would have let go, in a broad sense, that we, well, had allowed ourselves to be satisfied with. It did create more arguments with the Alan Reay job as well and some pretty tense situations and it got to be very expensive because the

consultants were charging out at twice the rate of the Council officers and that really didn't go down well with the building owners, especially when there was a protracted argument. When I left the Council in '95 it was in place, it was workable but I think it was having difficulty for those reasons.

HEARING ADJOURNS: 3.32 PM

HEARING RESUMES: 3.47 PM

CROSS-EXAMINATION CONTINUES: MR RENNIE

Q. Mr Henry, when we broke we had been talking about some aspects of the way in which the city council process worked in the 1980s and 1990s and we'd noted that in the case of the CTV building Mr Tapper had written requesting the provision of calculations. You're aware I think that the council's records are incomplete on their own account of the matter and in that sense it's not known what responses may have gone back from the council. Equally there is nothing to suggest that the council requested more calculations or other evidence. From your knowledge of the practice at the time if the council had not been satisfied by the calculations would you expect to see that reflected by amended plans at the permitting stage?

A. Normally. Normally a query raised would be resolved. Yes probably with an amended detail. Either that or an explanation that's satisfactory.

Q. Could you anticipate the council in terms of the practice you are familiar with giving building consent without being satisfied by the calculations which are provided?

A. On the basis that I talked about earlier in the day I could see the council would give a building consent if they were satisfied they had reasonable grounds for it and that wouldn't necessarily mean then exhausting technical compliance. It could mean that okay we've asked for this, we've been told that, we haven't got the capacity to fully understand that or be sure so this person is the expert. That is reasonable grounds

having raised it and brought to their attention, we've got a reply. That will do and that's how it could come about.

Q. Now there's been reference to a document that Mr Bluck issued at some point in time as to the limits in the approval of plans and an indication that council staff should not themselves alter plans. Are you familiar with the document I mean?

A. I've seen it but I'd have to refresh myself.

Q. If you'd not seen it I wasn't going to get it brought up but if we could bring it up it's WIT.NICHOLS.0001.10. That's the document you were thinking of?

WITNESS REFERRED TO DOCUMENT

A. Hang on let me read it.

Q. Take as long as you like.

A. I've seen that as part of the documentation becoming available with the Inquiry. I don't know where I saw it but I have seen it but when I was at the Council I was not, I didn't see that. I wasn't given in that paper form but certainly the item number three was well understood and we certainly also did not amend drawings, always asked for the documentation to be provided from the consultant or applicant.

JUSTICE COOPER:

I'm taking it that this document or slide was current probably prior to 1991 –

MR RENNIE:

Certainly.

JUSTICE COOPER:

Because of its reference to NZS1900.

MR RENNIE:

Indeed Sir and Mr Nichols indicates that it goes back to his time which was in the eighties and of course there is two different ways I suggest of looking at this document and one is it's somewhat of a document in itself and the other is

simply being reflective of the way in which the Council operated at that time and it's the second leg of that that I'm going to go to because the witness hasn't the document at the relevant years.

CROSS-EXAMINATION CONTINUES: MR RENNIE

Q. And Mr Henry the question I have for you going back to the time when you were with Holmes Wood and then with Alan Reay Consulting Engineers you haven't seen that document but would your experience with dealing with the council in those years consistent with the terms of that document?

A. Yes it was yes.

Q. Now you may know that there have been several references. You may have even heard me quote one of them to the interaction between Mr Bluck and Mr Tapper.

A. Yes.

Q. In relation to decision making. Mr Nichols in paragraph 19 of his first brief you may have heard me quote that, talks of the particular CTV matter being perhaps, "Another of their fairly regular fracas". Do you recall them as regularly interacting in a way which could be called a fracas?

A. Well on those occasions that I mentioned earlier where Bryan Bluck would come to us as a result of complaint and that was in relation to the ARCL jobs that I referred to earlier. Those were the fracas I think, they were more than that, but they were very heated and I think they got worse. They escalated to the point where they had to be taken in hand by other senior staff.

Q. And in that sense are you pointing to something that went beyond strong debate to something which was less rational?

A. It was certainly beyond strong debate yes.

Q. And senior counsel assisting Mr Mills back in his opening in this enquiry spoke in relation to the CTV matter of a volcanic standoff between Mr

Bluck and Mr Tapper. Did you ever see any event which could be called a volcanic standoff?

A. I did.

Q. In relation to a particular consent matter or more generally?

A. Not, it wasn't general but the ones I witnessed were in relation to what I'd call impasse situations relating to the floor detail and connection detail primarily with those applications from ARCL and I think the degree of tension increased with the more of the delay and the greater the impasse.

Q. And did that relate to a difference of view between Mr Bluck and Mr Tapper as to the way in which slabs should be tied into columns and shear walls?

A. It related to the connection detail of floor to wall not columns. What did you say columns to shear walls?

Q. Slab –

A. Slab to wall.

Q. Slab to wall?

A. Yes essentially.

1557

Q. And was that resolved by the introduction of an additional angle bracket fixing of that connection?

A. It was resolved with an angle bracket. It went through a stage of what I think negotiation might be the term to use because I can't remember who introduced it and it wouldn't have been Graeme Tapper because he very much went to stand his ground and wait for the other person to –

Q. To adjust?

A. Yeah. I won't say, I'm not saying he wouldn't cooperate, but he didn't see it as his role to step forward and offer solutions but what happened was somebody, I don't think it was me either and not for the same reason but probably one of the other parties suggested the steel angle for this particular detail and it was a case of okay, we'll go with that so along came the detail from ARCL with the additional steel angle and attached to it was a condition that this was a requirement of the

Christchurch City Council and not the responsibility of ARCL which was like, as far as Graeme Tapper was concerned, we'll say highly unacceptable, whereas this was, the detail was like, just on the cusp of taking all the pressure off at that point and so I can categorically tell you but I think that triggered this, the maximum tension and argument between Bryan Bluck and Graeme Tapper. How it transpired exactly from there I'm not sure other than to say the permits or consents did get issued, the buildings got built, the, you know the (inaudible 15:59:17) went and everything flowed.

Q. Well it's probably not important to this enquiry because you're talking about a matter in the 1990s aren't you?

A. Correct.

Q. But I could show you documentation where from that point the angle brackets were included.

A. Yes, there was I think. It's all to do with the time which is vague, but what basically happened is I took over from both Graeme Tapper and Bryan Bluck in that building control engineer role with the Building Act and I think I was prepared to run with the angle because, you know, the thing couldn't fall off but there was still a remnant problem in the sense of the reinforcing connection and that is where in 1993 when we got the opportunity when Professor Park basically said, "Anything we can do to help with what you guys are doing," we said, "Yes, we've got this sort of disagreement or questionable anchorage detail," and he volunteered to have it tested which was good, by a PhD student and he did a number of different types of anchorages which were being used by ARCL and I think other consultants were – had similar details.

Q. I was going to say to you it was a wider debate between the structural engineers in practice and the Council as to what was the correct way to go.

A. It was, I mean the real issue is how hard one pushed it. I mean as I was saying earlier when it had a 120 thick panel there and took 30 mm out, and tried to anchor the bar on what was left, others were using 150 millimetre thick and not using a rebate and so that would be more

acceptable and so it was pushed to the limit and hence that was – what was driving the sort of unhappiness, uncertainty with its safety so we got that done and surprisingly whereas if would have used the code you would have got an anchorage length (inaudible 16:01:24) down of maybe up to 200 millimetres for those reinforcing rods. They actually fully anchored off and for a 12 millimetre bar 115 millimetres and so it was possible to use the detail with a 10 millimetre bar and more of them so –

Q. That was the outcome of the testing you were referring to?

A. The outcome of the testing so that started to happen but shortly afterwards I think ARCL, once that was done that was the total end of it, it was solved and there was no disagreement at that point.

Q. Yeah.

A. And as a result ARCL redesigned that fixing. I think they got Opus to help and they designed a sort of quite an ingenious sort of a double U shaped hook thing and brackets that went into the (inaudible 16:02:15) and hooked over and it became almost like another one of ARCL's sort of patented systems and that enabled the walls to go up, the floors to butt up and have their sort of hook arrangement.

Q. And to meet the code requirements?

A. And I left at that time and I think it was Murray Mitchell at Opus who was assisting them.

Q. Thank you. Now you may have heard Mrs Tapper when she gave her evidence speaking of Mr Tapper's concern and I'm not going to go to the main content of that but she made a reference that she initially thought it might have been due to a personality clash between Dr Reay and Mr Tapper. Was that your perception of the relationship in the time that you were at the Council?

A. It was, yes.

Q. And as a consequence of that did ARCL frequently deal with the Council through other members of the firm than Dr Reay such as Mr Banks for example?

A. When I was there it was Geoff Banks and Grant (inaudible 16:03:25).

Q. Yes and they had the primary role working around the personality issue that Mrs Tapper referred to?

A. When I came along there was definitely a conscious effort to shift the onus off Graeme Tapper dealing directly with Alan Reay Consultants and which is where I say he'd brought me in as a sort of intermediary position so I was effectively carrying out the same work under instruction with other people on the receiving end who I think were effectively receiving the same instructions in a similar sense from Alan Reay and I say that because their responses were of the same ilk and in my view they were – I worked with Geoff Banks for several years and I was at university with him and that was not his nature to respond in that manner from my understanding of him.

Q. Now just going to move from the Council matters to a small number of questions about Landsborough House which you discussed in your evidence. Am I right that that was the first four storey plus gravity frame building that you designed?

A. Landsborough House?

Q. Mmm.

A. No that was, no that was – I'd done a number before that.

Q. A number that had actually gone to construction or just design?

A. The ones that had gone to construction were – when I say design this as part of a group?

Q. Yes.

A. Canterbury Savings Bank which is Westpac. That was a 13 storey building.

Q. That's at the time you were at Holmes Wood?

A. Holmes, yeah. The AA Centre in Wellington which is 14 storeys, the Union House building in Auckland was 12 storeys base isolated, Fletcher Challenge House in Lambton Quay which was 21 storeys which Andy Buchanan and Russell Poole had done and I helped to finish that one off. Waring Taylor, Featherston Street in Wellington five storeys. There's probably some others.

Q. But those are the ones that come to mind and they were Holmes Wood stage?

A. They were Holmes Wood, yeah.

Q. So the difference then was simply that when you came to Alan Reay Consulting Engineer and did Landsborough House instead of the team, you were doing it by yourself?

A. Essentially yes, oh yes.

Q. And did you find that a difficult transition?

A. Well as I said before it was lonely really, I, yeah, it wasn't, certainly wasn't that happy about it. I mean I coped with it, you know you aren't unenthusiastic I suppose but –

Q. It wasn't what you expected?

A. It wasn't what I expected no.

Q. Could we have WIT.JACOBS.1001.4 please. I'm not sure whether you've had an opportunity to consider Mr Jacobs' evidence?

A. I haven't seen anything no.

Q. I'm just going to ask you one question when we have it up on the screen. If you have a look at paragraph 12 please and you'll need to read paragraph 11 and then go to paragraph 12.

1607

A. Yes okay I've read it.

Q. My question about Landsborough is that if Dr Jacobs is correct in that proposition do you agree the same criticism would apply to Landsborough?

A. The operative word there is "practicable", and that was, that had a huge amount of flexibility on it. Practicable doesn't mean to say, it means possible, practicable is interpreted as how it can be fitted to the situation and still work essentially because there's so much different requirement for what people wanted but I mean obviously what it's indicating is not, try and get it symmetrical if you can.

Q. So from your view Landsborough would meet 3.1 on symmetry?

A. Yes.

Q. Does it then follow that CTV building would similarly meet 3.1, sorry 3.11 on symmetry.

A. Look put it this way I wouldn't challenge the design of the building on that clause myself. Even though its intent is clear, as I say, there's a fair amount of leeway was given in those days to the word "practicable."

Q. And if we could just go over two pages please to 1.6. This is in relation to columns and you will see that, again this is Dr Jacobs commenting on the columns in the CTV building. You'll see that he first states the code provision and then goes to paragraph 16 and I'm just going to ask you to read that to yourself and then ask whether you consider the same criticism would apply to Landsborough.

A. Paragraph 16?

Q. Yes.

A. Okay you want my comment on that?

Q. Yes. Well the question was, does the same criticism or proposition apply to Landsborough?

A. I have to give you a more detailed answer than a yes/or there.

Q. I'm not asking you for a yes/no, I'm asking you to put it the way you'd wish to put it.

A. I mean the first thing here is that, I mean these paragraphs can all look very well if they're taking out of the context but the context is that the buildings, these buildings, the fundamental premise is that their gravity load structure is protected by stiff shear walls and whilst that holds there's not a problem. If your walls aren't stiff or the building's flexible for other reasons, say because it twists a lot, then suddenly, yes, the beams and the columns are vulnerable and if there's excess load on them over and above what they were originally intended for which was very little then they're brittle and the structure's in trouble. So the key thing is the walls must be of a requisite stiffness and that's what the designer needs to satisfy himself with, with this type of design.

Q. Now lastly Mr Henry but lastly I'm afraid involves several questions. You may know that in response to your brief of evidence Mr Harding

replied to a number of the points in your brief. Have you had the opportunity to consider those?

A. I have, yes.

Q. Yes. Well Mr Harding's counsel, Mr Kirkland, is, as I think you've already been told is not here today, and I want you to understand that in putting Mr Harding's responses to your brief I am doing that so you may deal with the issues. I'm not necessarily indicating that the party that I represent agrees with the statement, if you follow the difference.

A. Okay, yep.

Q. Now the first reference is in reply to your paragraph 97 of your brief, and you may want to turn to paragraph 97 –

A. Okay.

Q. And in his reply [the reference Sir is WIT.HARDING.0001A.4 but I'm not suggesting it needs to be put up] Mr Harding says, "I agree that the performance of the south coupled shear wall was critical in protecting the gravity system against horizontal loading. As stated in my main evidence I believe that the substantially undamaged condition of the coupling beams in the south shear wall is evidence that this wall performed its function satisfactorily". Would you agree with that?

A. Well I, I don't, I don't agree on the basis that, from what I've seen I can't believe or convince myself that the south coupled shear wall wasn't damaged. I think it was damaged but I, in saying that, there is, it's questionable how much damage because of the way that the remnants were moved around.

Q. Yes. The difficulty is if we don't have the forensic opportunity to examine the ruins. That's really the problem isn't it?

A. But I make my comments on the basis that I have had the opportunity to inspect other buildings with coupled shear walls in them.

Q. Yes.

A. Three or four and I've seen the type damage they have after, also June the 13th of top of February 22 and December the 23rd and how it changes and some of Canterbury, Westpac has got very little damage in the coupling beams, only at level 2, 3 I think where the structure

became somewhat, had an extra opening and disturbed the pattern. Other buildings I've seen a range of damage and what I saw in the CTV building was not the pictures that have been shown by Frost and, I'm sorry, the Australian –

Q. Dr Heywood.

A. Yeah they indicated that there wasn't any damage from, when the wall was laying down and I think, well, okay, were they looking in the right places, was the wall actually bent like that and squashed all the cracks shut, was it hairline cracking which later after moving the pieces around became weak and opened up, because the photographs that really, strangely, coincidentally I just took on my home one day when I'd been in the red zone show classic cracking of the coupling beams at level 2 and some of the shear cracking in the side panels, also classic cracking near the base. I got out Professor Paulay's scale model test he did and you can hold the two together and look at them and you can see the same crack patterns. Now someone suggested well maybe that was from a contractor moving it around but, but you know to crack one of those panels either side of the door you need like a 1000 kilonewtons to crack them and to get that sort of load into them you've got, you'd have to drop it from a massive height onto solid concrete and on a particular angle so that you can lift the thing up and move it around and you won't crack those sides. You might twist the coupling beam and you might wreak damage that was there in a final sense to open it up, make it look worse but my judgment, strong sense from what I've seen and also particularly that the damage is limited to the lower two storeys because this has also been a very strong feature that that's where all the damage happens and I know from designing them that there is like a bulge in the shear diagram. The top drops off very quickly and so you get this big bulge and stresses around level 2 and 3 and the top storeys which are usually sort of put in for a practical nature, all the same, they become over-strength and so they don't get subjected to the bigger forces. So there's a concentration around levels 2 and 3. That's where the cracking's happened. That's where it was on what I saw in the

remnants. So my own view subject to, you'll never know how much they got moved around, is that I think it did suffer yielding damage in that area.

Q. Just some small points arising out of your answer. Firstly you said the December 23 earthquake. Did you mean the December 26 earthquake? The Boxing Day earthquake?

JUSTICE COOPER:

Or were you referring to the earthquake at the end of last year?

MR HENRY:

Yes, end of last year.

MR RENNIE:

I'm sorry. Thank you Sir.

CROSS-EXAMINATION CONTINUES: MR RENNIE

A. The building standard had been through the whole lot of the earthquakes, yeah.

Q. Yes. The second thing is you made a demonstration with your hands which of course won't make it into the transcript. When you put your hands together and pressed down were you indicating the wall being under compression at that time and closing up the cracks?

A. Yes I have looked back at the photographs to see -

1617

Q. I'm just trying to make sure that what you were describing –

A. Yes.

Q. – is fairly recorded?

A. Yes the wall folded, the south wall folded over a collapsed floor of that level one and then laid sort of flat and I questioned whether the wall was flat or sagging in which case it would close all cracks, or whether it was hogging and bending the other way or both and in which areas and so what I'm really saying it's possible that the people inspecting when it

was first fallen may not have been aware of cracks because of the way the wall had sagged and therefore didn't see them.

Q. The third point is you referred to some photographs that you yourself took.

A. Yes.

Q. Am I right that they were photographs of the CTV building?

A. Yes they were remnants which were laying on the site. I was in there a lot in the red zone and I used to drive past and I saw the remnants there as I did on other occasions, went and had a look and the shear wall, I think there was three segments were laying there, and marked up with spray paint and I photographed them in thinking, okay the forensic boys have been here and they recorded all this but I'm going to have a photo anyway because it's interesting and I was quite surprised that no other photographs like that turned up in any evidence that I've seen and why was I the only one that had photographs of it.

Q. And are those photographs that you've relied on in your evidence?

A. In the sense I've just described.

Q. But they're not as I understand it presented by you as part of that evidence is that correct?

A. You mean in my written evidence. No the evidence is talking about it from the design point of view. In other words whether the building collapsed or not this was the situation I see or saw.

Q. Do you feel your photographs have captured relevant matters? Do you think the Commission would be assisted by them being available?

A. They are available. They've got numbers on them and all. I think they have been shown by, it might have been one of your colleagues actually. He said he challenged Mr Frost's evidence with it.

Q. Now going on with Mr Harding's response to your paragraph 99 I'm at now and his response was to your paragraph 99 that it's noted that the shear core is connected to the floor diaphragm by reinforcing from the walls and by the connection of the floor beam. The concrete slabs surround more of the core but the type of reinforcement connection is

the same as the CTV building and it does not include drag bars. Do you agree with that?

A. Yes I think what he's trying to say there is that there wasn't drag bars in Landsborough House therefore it was okay that I didn't have them. The Landsborough House connection was by a different, well it is a different system. It had a spanner effect is the best way for the layperson's point of view to describe it and it didn't have drag bar reinforcing coming out of the main wall under the slab and at that time that era that was how the floor diaphragms were viewed essentially that they, we have a lot of reinforcing crossing between the walls and the slab which clamped on with shear friction and there was a bearing factor of the floor topping bearing against the walls so that if you imagine you're trying to undo the wheel nut on your car and you put a spanner on it, an open spanner it wants to slip off and round the corners. If you welded that spanner on it won't come off. That is like the same effect as having the reinforcing crossing from the slab through the walls into the slab on the other side. Landsborough House had that gripping effect like that and there was a bearing effect on the ends of the main wall which if you do the numbers which I have done to back check it because when I saw it I thought anyway it works.

Q. You just described what I was about to ask you which is that your spanner is an open spanner and not a ring spanner and the effect is achieved by it encircling the shear wall rather than being fixed directly to it?

A. A ring spanner is much, much better which was what you have when you move it into the diaphragm. To have the open spanner as I say you get the slipping off the nut effect.

Q. Yes.

A. But it's like as I say weld the spanner onto the nut with the bars crossing and that stops it happening. For the north-south direction on Landsborough there's heaps of reinforcing for that. On the east-west according to my calculations that the equivalent of that welding is also plenty for the torsion. The direct force is taken by the bearing on the

end of the wall. No today you wouldn't do that and I know that was the message we used at Holmes in several jobs but definitely today you would put a collective beam in there to poke right into that wall and make sure it went in.

Q. And are you saying in essence to Mr Harding's response though that he failed to understand that that was how the Landsborough system worked?

A. I maybe didn't realise the tongue of slab poking into the toilet area is what he's meaning with the similar connection. He means I believe that he's got reinforcing starters out of the walls and the slab and that's like the welding a nut on. This tongue sticking out I think it was a reasonable for the east-west load it had a reasonable chance for a load that moved uniformly, concentrically as if there's no twisting but as soon as the twisting effect came on then there is a, well put it in another layman's terms like a claw hammer effect where the drag ties are being ripped out, like a claw hammer pulling out a nail and that's where the things start to depart wildly from what Landsborough House is. There's more to it than that but in a general sense I think it gets the picture across.

Q. Now you know that Dr Reay also replied to sections of your brief in his brief of evidence and you considered those I take it.

A. I didn't quite catch that sorry.

Q. Do you know that Dr Reay also replied to your brief?

A. Yes I've seen that.

Q. You've seen that. I think we've covered maybe two exceptions everything that he raised and I just ask you to turn to paragraph 100 of your brief.

A. Yes.

Q. Probably if you just look at 100 and 101 you refer to the location of the gravity beams in Landsborough House and the CTV building?

A. Yes.

Q. And Dr Reay says the code has no requirement regarding gravity beam alignment. Do you agree with that?

A. No there's no contesting that, nothing to contend there.

Q. He says because the buildings are approximately square this potential benefit is not significant. One benefit of the floor beams located as they were on the line of the north-south shear walls is that they could also act as drag bars in the north-south direction would you accept that?

A. Well I agree that the beams being located there does create that opportunity. In fact there was some reinforcing from those beams into the shear walls with a drag bar effect, but the sentence before that what was that about?

Q. The code has no require, sorry I've read that. Because the buildings are approximately square this potential benefit is not significant.

A. That doesn't really make sense to me because as I've said in evidence it's clear that if you have the beams running at right angles to the critical direction for torsion then you have eliminated the frame action in the critical direction so that there are no beams acting in the, in the primary sense of the frame action. There are no beams actually on those columns to put the forces into them that are actually are the problem.

Q. And at paragraph 105 you state there were no floor beams to restrain the columns in Landsborough House?

A. In the east-west direction which is what Dr Reay has left off.

Q. Right. He says that he disagrees with you and says there were beams and they restrained the columns in the north-south direction so in fact what you've just put maybe reconciled to what Dr Reay says.

A. Well what I'm saying they were to the east-west direction when you put that in there it makes sense. Yes there were beams in the north-south direction. I think I said the building was concentric. No torsional problems in the north-south direction and the walls are very stiff in the north-south direction such that, I mean it's hard to say without, to show you without the ETABS output. The deflections were not a problem in that direction so that we're only worried about the east-west where there are no beams.

Q. He proposes that the torsional, sorry try again he proposes that the beam floor system had torsional strength which would could induce actions in the columns in the east-west direction?

1627

A. Yes that is a secondary action. It's probably in the order of about 10 percent of the forces that you would get from a frame being in that direction. What he's trying to say is that here's your column, here's a frame, here's a beam coming in like that and this column being that way, that this action is going to twist that beam and that beam is going to resist. Well by inspection from my experience in working out torsions in beams, my view is that's not a problem. When I saw that I did a calculation to double check it and I got the cracking torque of the beam to be about 20 kilonewton metres versus the actual gravity bending load moments of more than like 300 so it's that sort of order, in other words once the beam cracks it loses any stiffness. The only way that torsion can really get in there, anything to resist that, is by the topping slab from the floor which is relatively thin and only the – you know, there's not the – I'm trying to say there's very little then to create that torque in my view. If someone was to do a rigorous analysis of that I'd be surprised if they could come up with a different answer.

Q. Through the matters that we've been discussing you've referred to the information sources that you used for presenting your evidence. We identified that you didn't have discussions of any significance with Mr Harding or with Alan Reay Consultants Limited. Did you have discussions with Dr Hyland or Mr Smith or any other persons from the DBH team?

A. I had discussions with Dr Hyland and I got the information from him that I mentioned.

Q. And were you satisfied that from the DBH team you were able to obtain the information that you needed for giving your evidence?

A. They supplied whatever I asked for, is that's what you mean?

Q. Yes.

A. Yeah.

Q. There's really two strings to that of course, one is did they give you what you asked for, and do you consider that everything you got was all you needed?

A. The point of asking for that information was, I was trying to put myself in the shoes of I'd just done the analysis and I wanted to check the certain things which are, you know, part of the – part of what you do. The first thing is the base shears and every design that I did, the first thing was to get the base shears, a plan of those where they all go in a building to make sure they add up in both directions and the second thing is what are the deflections and Clark Hyland gave me that information.

Q. And can you confirm that you did not at any time ask Dr Reay or Alan Reay Consultants Limited for any information?

A. That's correct.

Q. And therefore by extension that you were not refused any information?

A. Ah definitely, no correct, yes.

CROSS-EXAMINATION: MR LAING

Q. Good afternoon Mr Henry. Yesterday you talked about the advent of the Building Act 1991 and you made reference to producer statements and then I think you went on to talk about design certificates and I'd just like to ask you a few questions around the two regimes. I think you came to the Council round the time the Building Act 1991 came into force. Is that right?

A. Yes.

Q. And you were obviously heavily involved in setting up some new systems for the Council?

A. I was yes.

Q. Can you explain to me what the role of a producer statement was from there onwards. Was it always required by the Council for a structural design?

A. Basically yes. Would have to be a very small design not to get one.

Q. Yes, and so typically for a large commercial building there would be a producer statement that dealt with the structural design and the issue of compliance with the then building code. Would that be correct?

A. Yes.

Q. And when you got such a producer statement, what role did you then have in terms of checking the – any documents, the plans, the specifications, any calculations?

A. Well it'd depend on the building and who designed it. Every time you would have looked at the documents including the drawings. We may have asked for the calculations, they may have been supplied and depending on what we were looking at, that could vary.

Q. Yes, but for a, say a multi-storey commercial office building you would look at that producer statement to make sure that it covered the relevant design structural code requirements, but you'd also do some, obviously some additional checking as well. Is that right?

A. You'd make sure the producer statement said what it was supposed to say about the building.

Q. Yes.

A. And, yeah actually the – what was the question after that?

Q. I'll re-phrase the question for you. So you would have received a producer statement, you would look at it to make sure that it covered the various design structural documents, make sure it covered the right ambit of documents, but you'd also look at the plans, the specifications and calculations if you had them. Is that the process?

A. We'd definitely look at all those things. Whether the calculations were supplied or not was a different matter. I think there was a period there where the calculations were not compulsory with a building application, and although it didn't matter, we'd soon ask for them but some consultants put them in anyway.

Q. Right. And so can I just now contrast the situation before the Building Act came into force. I'd just like you to use your own knowledge and experience as a consultant from the mid-eighties to when the Building Act came into force. You – I think you said yesterday that when you

were at Holmes that design certificates were the norm to be provided to the Council?

A. Yes, actually look if you won't mind if I just go back a wee bit, because when you said just to contrast, that was before the Building Act.

Q. Yes.

A. What I was – I can see what you're trying to get at. The procedures with what we would ask for and what we would do with that information got more stringent as things went along under the Building Act and that – that was over the period of 92 to 95 when I was there, and this was part of the reviewing process that was going in place, so a big building that came in it ended up there would be quite definite requirements to supply information for an external reviewer. So that built up, is the best answer and so before that the process was there maybe calculations, there may not, may ask for them, may not but you would always expect a design certificate.

Q. Yes.

A. If not you'd ask for that definitely. The idea was to get the design certificate, that was the key piece of information that, or that was the statement that connected the responsibility to the consultant.

Q. Yes, so there was obviously importance in terms of the producer statement as being the consultant's sign off and certification that there was compliance with the building code?

A. Definitely, in fact asking for the calculations was – at times there was a feeling it was taking on board more liability than was necessary because if you asked for the calculations, it would be assumed that you would actually review them and the Council would pick up liability because of that. So to an extent, I can't remember the times exactly, it was more of a case of get the – if it looks all right, drawings okay, get the producer statement and away you go, 'cos don't look too deep, don't get into trouble basically.

Q. Yes, thank you for that. Now if we just go back to the situation prior to the Building Act under the Building Bylaws and if you could, if I could just ask you to recall your practice or Holmes' practice at the time that

roundabout the CTV building was built and did I understand your evidence, did I understand your evidence correctly to say that it would be the norm for Holmes to provide a, or any other consultant of the day to provide a design certificate to the Council?

A. Yes that was normal.

Q. Could I get you to look at a document please BUI.CAS.056.0001.15 please. Can you see that all right?

A. Yes.

1637

Q. And that's a document relating to the Westpac, Westpark Tower.

A. Yes.

Q. But is it Cashel Street?

A. Mmm.

Q. Is that the sort of document that you would have provided to the Council, in IPENZ form?

A. ACENZ form.

Q. ACENZ form. Sorry.

A. That's correct, yes.

Q. So that's a typical document that would be provided?

A. They came in a book, a standard book supplied I think by ACENZ with carbon copies and whatnot.

Q. Yes. So was it the situation that that form of design of certificate was volunteered by the firms that you worked for or was it only provided if it was requested?

A. No it was supplied as a matter of course. If it wasn't it would be an oversight or something like that or a job in a hurry whatever but I don't think that, even that would have been reality really.

Q. Yes and clearly the Council would place some importance on that document as being the design professionals' sign off on the questions of compliance with the relevant standards?

A. Definitely. Absolutely.

Q. Yes and I think that one is actually designed by Dr Reay.

A. Yes.

Q. Thank you. Now just coming to the vexed question of the relationship between Mr Bluck and Mr Tapper. Now –

JUSTICE COOPER TO MR LAING:

Q. Mr Laing just, I'm sorry if you're moving on, tell me because I don't know. Was the provision of a design certificate – I'm asking Mr Laing this question really – is the Council's case that provision of design certificates was mandatory?

A. No, the, the – when I open the Council's case I will take you through the building bylaw 105 from 1985.

Q. Yes.

A. And that clearly states that, well there are some circumstances where a design features report could be requested and otherwise you could provide calculations or provide a form of design certificate. So they were alternatives.

Q. All right.

A. So I'm not suggesting to this witness that they, that was mandatory.

Q. No, no I wasn't, I wasn't suggesting that you were. I was just curious as to what the position was.

A. No.

CROSS-EXAMINATION CONTINUES: MR LAING

Q. So if I can just turn to this relationship and obviously you saw these people in two different roles. Prior to you going to the Council you were a structural engineer working in Christchurch and you saw them, you saw them at that time obviously?

A. Saw them, saw who, the?

Q. Mr Bluck and Mr Tapper.

A. Yes.

Q. You saw them at meetings of engineers?

A. Yes, yes.

Q. What was your involvement with them on any buildings that you were designing? Did you have any direct involvement?

A. Jobs like the Parkroyal and Price Waterhouse Centre I had involvement, making arrangements for design-build staged consents and that meant agreeing that we would give documentation up to a certain level or point sufficient for them to see that, say, the foundations had been, the building had been thought through. In other words we'd give foundation details and details to level 1 and then we'd give carcase for the rest of it and they would trust us to finish the design off accordingly.

Q. And do I take it they dealt with you in a professional manner and you had no –

A. We, I think we did it in writing. I think we agreed the stages and it was quite formal, yep.

Q. Did you ever receive a letter of the kind that Mr Tapper wrote to Alan Reay requesting further information or –

A. Not of that, I just don't think I did. I don't recall. He may have sent a letter asking for something. It could vary widely what he'd ask for. He might ask for better drawings or more drawings. When I say better, if you gave him some, say for a staged consent he wanted to see more but even then I'm, I'm floundering a bit to really say that would even be definite. I can't remember receiving any letters like that.

Q. At that stage you, you were not aware of, you did not see any evidence of personality clashes between Mr Bluck and Mr Tapper at that stage of your career?

A. I didn't have any idea about that until I entered the building and shouldered it.

Q. Well maybe we could just come to that and I appreciate you've answered a lot of questions on this topic already but just looking at the respective roles of Mr Tapper and Mr Bluck clearly ultimately, I won't perhaps use the word buck but ultimately Mr Bluck was the chief building design engineer wasn't he and ultimately in terms of the, he had to, ultimately he was the one who had to take responsibility for any decision that was made. Would that be correct?

A. Well in the sense that he was the manager and had the title I think of building and (inaudible 16:42:58) engineer I think ultimately it was his responsibility, yes.

Q. Yes and so if there was deadlock whether it was with Alan Reay or some other consulting engineer that was his role wasn't it?

A. If there was what?

Q. If there was disagreement between Mr Tapper and a consulting engineering ultimately Mr Bluck as being the person in charge of the building control unit had to make that decision didn't he?

A. Yes I'd say so.

Q. Yes. Thank you. Could I just take you back to the Tapper letter of 27 August.

A. Yes.

Q. I just want to ask you a few questions about that. That's WIT.HENRY.0001.79. Now I think you've already said that the matters that Mr Tapper was raising in this letter were the things that you had some concerns about as well.

A. Well I, I agree that I would have concerns about other things in that letter. What I didn't say is I had a concern about other things as well.

Q. No and that letter was written clearly before the Council had received any calculations?

A. Yes.

Q. So it must have been a review based on the plans and specifications that had been received to date.

A. It must have been, yep.

Q. That seems to follow doesn't it?

A. Yep, must have been, yep.

Q. And would it be fair to say that Mr Tapper has done a thorough job in going through the plans?

A. I would say he had a really good look through and, yeah that, that, because he hasn't, the big structural issues there that he's picked up are the diaphragm connections in the columns. Whether or not he has

perceived anything beyond that is not clear from that letter but he's certainly had a darn good look at it.

Q. Yes at that stage he only had the benefit of the structural drawings but not the calculations in support of it.

A. Yes, yep.

Q. And at that stage at least what he's signalling on page 2 at the top there, that's in relation to S15 & 16 are the sort of concerns that, or matters that you obviously thought of as well.

A. Yes.

Q. Now I'd just like to go onto a different topic and my friend Mr Rennie has already referred to a Mr Nichols who's going to give evidence and could I have WIT.NICHOLS.0001.2 please and just for explanation Mr Henry Mr Nichols worked for the Christchurch City Council between 1978 and 1984 so obviously well before you were there.

A. Yeah.

Q. Could I ask you to look at, go to the next page and look at paragraph 11, it's 1.3, and could I ask that the last sentence in paragraph 11 be highlighted, expanded.

A. Yes that's about –

1647

Q. I'll read it to you, "During the period I worked with Bryan I was aware that his acknowledged expertise was being utilised by his periodic appointment as a committee representative, responsible for the preparation number of New Zealand standard bylaw documents." Were you aware that Mr Bluck had that involvement?

A. I was yes.

Q. Yes, and would you accept that statement there that he had a knowledge expertise?

A. What I think is that as happened with me there also people, on code writing committees, wanted input from local authority engineers so they were getting the full picture of what they were doing because the local authority engineers come into contact with so much of what's going on in the town, and all the different engineering methods and so there's

great value in having someone like Bryan Bluck on a committee like that but what I would – and whilst Bryan had, he had really good fundamental understanding of buildings and structures, like anybody who doesn't do the hands on day to day design the nuances and intricacies of the code are just not encountered and so I have indicated this earlier in my evidence, you can know the fundamentals, you can know what to look for but if it comes down to the nitty gritty of which code clauses will match up and what to use, if you're not doing that intensely on a regular basis then it's just another thing and you can't go there, and that's what I'm really saying that Bryan wasn't involved to that level of degree. We had expertise to adjudicate it in that detail but he could stand back, he could say that floor diaphragm doesn't look like it's connected properly to me but I wouldn't have expected him to say, for example on the CTV building that south coupled shear wall looks soft, I wouldn't expect that at all. He just wouldn't have had that sort of variance.

Q. But that's something you think that Mr Tapper would have been able to, or obviously did have?

A. I think he would have been suspicious about it but he wouldn't – I don't think he would have done enough of that sort of design to probably pick the significance of it, I would say.

Q. Would the problem really have been at the time that this form of design was fairly new?

A. No not at all. This type of shear wall protected gravity load system had been going on for, I mean the Holmes ones that I talked about earlier and I think 1977 was the earliest one and there's probably more before that, the idea of if you provide just the st…, earthquake resistance in the shear walls and you have the secondary column and beam system that's not new, no.

Q. Not new by itself but for a design that's applicable to the CTV building was clearly one that was perhaps if I could use the words not in the ordinary?

A. Absolutely not in the ordinary at all.

Q. And that for a Council engineer might be quite challenging to unravel?

A. I agree.

Q. And just coming back though to the time when you were there, clearly when there was some dispute and maybe with Alan Reay, it may have been with somebody else, but when it came to debating that dispute, that was something that you would have put your own expertise, undoubted expertise into wouldn't it?

A. I did contribute yes.

Q. And you would put your views obviously to Mr Bluck before any decision was going to be made?

A. Yeah, I would say my recollection is that he definitely knew what was going on, if not the detail.

Q. So somebody like Mr Bluck, he had a good working knowledge of design and obviously compliance, but ultimately one of the merits of that sort of debate would be that people like you could contribute to that debate and deal with some of the real fundamentals in the –

A. Yes.

RE-EXAMINATION: MR MILLS – NIL

QUESTIONS FROM COMMISSIONER FENWICK:

Q. There are two points. Just quickly the first one, in the 1980s what would you have assumed in terms of the stiffness of the ground, flexibility of the ground under a shear wall. What would have been the standard code?

A. The standard was in my experience was to assume that it was rigid. We didn't do any special analysis of the ground stiffness except for, I remember we did it for – we used ReMoKo, a university programme, I think it was the Union house building, remember doing the base isolation.

Q. Is that the building in Auckland on the waterfront? Is that the building in Auckland Mr Henry?

A. Yes, that's – it was a specialist thing to include the ground stiffness and not standard.

Q. The question relates to the south wall. We did actually send out a minute to different groups and asked the engineers to look at it and it won't have gone to you but I was interested to get the reactions of how that south wall would have performed as a coupled shear wall. We did get a response from Professor Mander and I don't know, you've probably did not see his response.

A. I saw some of it. I can't remember what he said about that.

Q. Yes.

A. Well, yes, yes he reckoned the base yielded didn't he, he reckoned the base yielded.

Q. Not quite but the point I'm putting is you've got a wall with five or six coupling beams in it and you've got axial load on that wall. Now the strength, if the strength of the coupling beams is high, if the shear you can transfer across those coupling beams is higher than the total axial load, acting on that part of the wall and the tension force and the reinforcement at the bottom of the wall, can that wall act as a coupling beam? Is that a point you've considered, well could those diagonal members actually yield, you with me? It's rather hard to visualise.

A. Yeah, I'm totally not with you actually but are you meaning, are you talking about or trying to take account of the contribution of axial load to the hold down?

Q. Split the beam down the middle so you go through the coupling beams and from the coupling beams you can calculate how much shear can be transferred. Now if the shear's got to be transferred, if you've got compression on one side of the coupling beam and you've got tension on the other, then the shear, if the force has got to be – if the shear strength is more than the axial load and the tension force at the bottom, then if the shear strength is greater than that then it's not going to act as a coupling beam. The shear reinforcement cannot – the diagonal reinforcement cannot yield can it?

A. So you mean that's effectively the coupling beams are over designed compared to tensile hold down?

Q. Yes.

A. Yes, they can't act as coupling beams, of not yielding coupling beams.

Q. Right, well that was my – that was – I'm trying to get people to look at it and comment on that. When I did it, it looked marginal but I mean I wanted someone to confirm that because you can make different approximations and so on.

A. Yes.

Q. Can we have BUI.MAD249.0493.2 please. So this is what I was trying to get at and this is probably a feature which doesn't appear in our standards but I was just curious as to whether it might have been a problem in the CTV. Now my calculations may be wrong, they are very crude but as far as I could see the coupling beams were marginal. But if you look at that when the compression member is always stronger than the tension because there is concrete confined and there's concrete rounded, while in tension you've only got the reinforcement so when you rock it to one side, you get what we call is elongation.

A. Right.

Q. Diagonal becomes longer and you'll be familiar with that and then you realise that those coupling beams are lined up with floor slabs so if you've got elongation in the coupling beams, something has to give in the floor slab.

A. Yeah.

1657

Q. So would you agree with me those floor slabs actually might strengthen those coupling beams?

A. Yes I would and we didn't use to account for that.

Q. Yes that's right. I mean that's something that's just come out in the last, it's taken a long time for the engineering profession to recognise it. It came out 30 years ago but they're recognising it now.

A. And it would have a disproportionally greater effect in the upper storeys where the forces were less which may be another reason why I haven't

seen cracking up there but at the bulge in the shear forces they're at level two.

Q. Yes of course the problem here is that you're restraining those elongations actually they're something to the bottom walls too. They start acting in a different manner actually. The whole wall becomes stronger but –

A. Frame action going.

Q. That's right. It's very different and the strains in the reinforcement are very different.

A. Clarke Hyland he did say that he thought that the wall had acted more as a cantilever shear wall and he was indicating that he thought the block wall had sort of in part caused that which I didn't see enough strength in that block wall to do that but what you're saying makes more sense.

Q. It's just a posture of the mind and I was hoping to get some feedback. I mean you might be interested to just look at it and I'd be interested in your comments to see. The fact that that wall was stronger than intended I don't think would have helped but I'd be interested in your reaction. I'm only putting it out as you might just like to consider that particular point.

A. I think what we found in our calculations at Eliot Sinclair was that by reducing the demand on the wall and therefore corresponding the, reducing tensile requirement at the base of the wall for reinforcing steel that the stiffness dropped almost linearly at the same rate and my own view is that it's the softness of that wall as opposed to its strength that's the issue and for example the capacity of the wall due to just the weight of the load, the gravity load is about six or 7000 kNm and the start position for the static load of .77 period I think was about 28,000 kNm for design and that was about a quarter but in the end I think the capacity was about 12,000 kNm of a design and Clarke Hyland calculated a capacity along those lines. Actually that is another piece of information I'm sorry I didn't remember before. I did ask him for that. He's had it in his report and I was comparing the stiffness of the north

end and the south end is like 168,000 kNm on the north core and 12 on the south which is an extraordinary difference but it wasn't as bad as that because I think the north core rocked about half that but it was still enough to make a disparate difference but what I'm really getting at is by reducing the demand on the wall and therefore reinforcing content of those values the crack value right at the base was something like about a third of what assumed when it was inputted into the ETABS program and my view is that the softness of the wall is what made the building susceptible to deflections –

Q. There's another point and I'm sorry to drag on just I see it's getting to 5 o'clock but there's one other you would be familiar with Professor Paulay's coupled walls and how they perform. I mean the thing that's remarkable about them when you displaced a coupling beam yield but when it stops yielding it retains a lot of its stiffness.

A. I mean, that's the thing about the land of the –

Q. I mean it's beautiful and that was the critical issue –

A. (overtalking 17:01:29).

Q. So that's important I mean if it degrades and stuff you're in trouble so it doesn't so it always (inaudible 17:01:33) and retains it. Now if of course the wall is yielding at the bottom it's not acting like a coupling wall. Do you agree it's actually going to degrade in stiffness?

A. Yes and get either classic flotations at the hinge at the base.

Q. There's another aspect which comes in there which would not be fair to people who have not studied Professor Pauley's coupling systems. Thank you.

QUESTIONS FROM COMMISSIONER CARTER:

Q. I'd like to ask you some questions about the forensic examination that Mr Frost and Dr Heywood carried out, and are you familiar with their observations?

A. I did watch as much as I could of that.

Q. The thing of interest to me and to us is the dynamic analysis is an analysis that looks at the progressive behaviour of the structure as it

goes through a sequence of earthquake oscillations and the behaviour of reinforced concrete as it gradually progressively deteriorates through cracking and yielding of steel and so forth. So these events all take some number of oscillations.

A. Yes.

Q. The two analyses that we've have done direct some thinking towards what the sequence of failure might have been but drawing attention to the fact that those analyses are very dependent on the assumptions that go into them.

A. Yes.

Q. And there can't be any certainty about whether the findings of one analysis are superior to another. So we come back to what the witnesses to the collapse observed and to what we saw in evidence from the materials after collapse. So Mr Frost predicted that he thought that the south wall had been pulled over the top of the collapsed structure which took place within the building itself possibly at a column joint or columns. Do you have any view on what sequence you would favour from those various observations?

A. I think the south wall fell last because it's on top of everything and yes it did fall over and get bent over at first floor level because the floor appeared to drop and created a sort of a prop and it bent over that and that caused damage about the first floor level which confused the damage but below that there was cracking in that wall which others have indicated was not cause to the falling of the wall but was caused due to the earthquake forces.

Q. You feel the degradation of the south wall could have occurred in much the way your analysis would suggest and which Commissioner Fenwick has just been questioning?

A. I think that from what I have seen in Professor Paulay's examples that he did of the testing that the degradation takes place over like 10 or 15 cycles. It does take a lot of cycles in the elastic range with no damage at all according to his testing. Only once they go past the yield point and go into the yield plateau and start coming back again does the

damage come in but even then they maintain their integrity for a lot of cycles but that testing is done gradually, slowly building up and all right we'll see how it goes. Let's start pushing it further and further and ultimately a big push whereas that February 22 earthquake it just started with a big push oomph, oomph and I was just down the road in United Building Society and I know what it was like. Apart from being horrifying and thinking the building was going to collapse that I was in, there was no gradual build up of like 10 or 15 cycles it was just this huge force suddenly inverted onto the base of the wall and the point I'm really getting at is you only need a couple of movements and those big movements you've lost your initial design premise. You don't need 15 cycles. You just need one and you've gone too far past that deflection limit and the wall might have yielded, well would have yielded on the way to get in that position and that's when, that would explain why there wasn't a lot of damage to the wall because it didn't get a chance to and having said that this is assuming that the diaphragm connection was at the other end maintaining some sort of integrity so we'll never know whether they gave way or the wall deflected too far first or both at the same time or some combination of that.

Q. Coming back to the deflections that would have induced in the columns and the joints and could have been a very sudden consequence of an excessive defamation of the shear walls themselves or the way the diaphragms did not connect adequately to the north shear wall.

A. Yes well I think it's possible that the sudden pulse in the instantaneous deflection of the south shear wall caused the northern to move out of the stiffness or the – it deflected beyond its initial design assumptions and that could have been instantaneously just for a fraction of a second.

QUESTIONS ARISING ALL COUNSEL – NIL

WITNESS EXCUSED

HEARING ADJOURNS: 5.09 PM

INDEX