COMMISSION RESUMES ON MONDAY 9 JULY 2012 AT 10.05 AM

MR ALLEN:

I think Dr Hyland's counsel may wish to enter an appearance before we commence this morning.

JUSTICE COOPER:

Yes.

MR NAIDU:

Yes, I'm Vincent Naidu, personal representative to Dr Hyland, personal advisor. I have advised him in a corporate advisory capacity in the past and leading up to this hearing. I will continue to talk to my client privately and advise him during the course of the day. I do not anticipate any questions, however, if there are any questions then I will seek the permission of the Commissioners to ask these.

JUSTICE COOPER:

Thank you.

MR NAIDU:

Thank you.

MR ALLEN:

Where we left off on Thursday Your Honour may recall Dr Hyland had spoken to three slides comprising his summary of findings.

JUSTICE COOPER:

Yes.

MR ALLEN:

And the Commission was of the view that it would be appropriate to elucidate the issues by having Mr Smith comment upon those.

JUSTICE COOPER:

Yes.

MR ALLEN:

Which he's done and he's got three slides of his own which, basically, track changes and if we could have those.

JUSTICE COOPER:

All right.

MR ALLEN:

Then I'll commence with that.

JUSTICE COOPER:

We'll just get the witnesses re-sworn.

MR ALLEN:

Yes indeed.

CLARK HYLAND (RE-SWORN)
ASHLEY SMITH (RE-SWORN)

MR ALLEN:

Good morning Dr Hyland, Mr Smith. Mr Smith you have prepared your own summary of findings which now find their way into a three slide presentation. Is that correct?

MR SMITH:

That's correct.

MR ALLEN:

If we could have that please. Right now before I ask you to speak to these Mr Smith, Dr Hyland have you had an opportunity to review the, effectively what amount to tracked changes, to your own summary?

DR HYLAND:

And what comment do you have in general terms about the, the changes or refinements as Mr Smith described them last Thursday?

DR HYLAND:

I don't really have any problems with Ashley's view on, on these as reflected in here. I think the conclusions remain basically the same. Ashley takes, you know he's taken more care with some of the wording perhaps. I used more of a bullet point format for the presentation. I, in terms of the inter-storey drifts compared to those in the standards I, I still stand by that. There, there's some nuances in definition I believe in terms of how we interpret some of the standard requirements but, ultimately, we've come to the same conclusion. The, the drifts at, or the drift capacities that Mr Smith's come up with are quite similar to the ones I've come up with. He's used different software. In my view that's actually quite a, quite a good thing that we're getting similar sort of answers using different, different approaches. So I'm just, you know I'm quite comfortable that he expresses his views this way.

MR ALLEN:

Thank you doctor. If I could now turn to you Mr Smith and if you could just take us through those changes that you've made.

MR SMITH:

I would, I would just like to clarify that I see the summary of findings as supplementary to the report conclusions and not replacing them. So it's additional points that we want to clarify. So if I just talk through these bullet points. Obviously the first one just clarifying that we are talking about the 22nd of February aftershock in that first point. My point was that the building appears to have collapsed, inter-storey drifts much less than, than the

potential drift demands calculated rather than referring back to standards. So we did the non-linear analysis and we calculated the potential drift demand but we found that capacities of elements were exceeded by quite a large margin. The second bullet point, a number of collapse scenarios were evaluated. We, we kept an open mind about considering any scenario. The second sentence is basically just a qualification on that point and it's, it is the wording that's used in the report. So we're saying that there was variability and uncertainty and we weren't able to say definitely exactly what happened with the failure but we had some likely scenarios.

MR ALLEN:

So you're really emphasising the point made by Dr Hyland that one cannot be certain about any particular scenario although some might champion one scenario over others.

MR SMITH:

That's correct, yes. So my point, let's get to the second sentence in the second bullet point. Hang on, I've lost it. Can we go back to the previous slide please. Basically I confirmed on Thursday we were talking about a likely scenario. I've just got the pointer here. So we've been talking about this sentence here. "A likely scenario, and the scenario that appears most consistent with the collapse evidence and the eye witness reports, was initiated by the column on the east face at mid to upper level". So it's just really clarifying the wording there. "This column failure would have been caused predominantly by north-south direction drift". As I explained in my presentation that was the direction that the stiff beams connected into those columns "…but it could also have been influenced by east-west drift". In fact the beam connecting in the east-west direction was considerably shallower connecting to those east columns. So it had less rigidity to restrain the column. "It could have been influenced by east-west drift or vertical seismic load, spandrel panels or low concrete strength". So I guess slight change of emphasis on the spandrel panels, but I'm saying they certainly could have had an effect but are not a necessary factor to cause that mode of collapse. This

bullet point here I've, I've deleted. I'm not saying it's incorrect but I am not able to confirm that myself because I didn't, didn't work through that.

MR ALLEN:

I see.

JUSTICE COOPER:

Thank you.

MR SMITH:

The second to last bullet point. "The column, the columns along the east face", now Dr Hyland had north and east face. I believe he meant south face.

DR HYLAND:

South, yeah that's a typo.

MR SMITH:

So it was intended to be south face rather than north but I, I have said, we have discussed previously that we felt the south face was much more robust because it had the south wall there supporting that side. So we explained that on Thursday. So I've, I've reduced it just to say "the columns along the east face of the building were estimated from the pushover analysis to have drift capacities between 1 and 1.3%". So that's the type of analysis that I used to form my view on the drift capacities. Dr Hyland had, had a different method to come up with those other values but they are similar.

MR ALLEN:

Was that the Cumbria process Dr Hyland?

DR HYLAND:

Yes. I used the Cumbria software.

MR ALLEN:

Thank you.

MR SMITH:

Okay. "It appears that these east faced columns may have failed prior to diaphragm slab or drag bar disconnection at the north core". So I'm, I'm including the diaphragm slab in there, not only the drag bars. I'm calling it a disconnection rather than a failure just to clarify we are talking about the connection to the core and I, I've taken out the reference to the drifts because I, I felt that the diaphragm connection forces were very much influenced by higher mode effects which are not necessarily related to drift. So slight change in emphasis there. If we go to the next slide. I've kept these in the same format as Dr Hyland's slide on, on Thursday. Just clarifying here. "Specific factors that contributed (or may have contributed) to the columns failures include:

1015

Columns did not have the minimum amount of spiral confining and shear reinforcement required by the standard".

The next one: "There was no minimum seismic gap specified between the spandrel panels and the columns". Again just clarifying the wording there.

This point here: "The south wall may have begun to yield and lose stiffness at drifts as low as 0.4%". I'm happy with that, but rather than saying that was due to the asymmetry I have said that contributed to the asymmetry of the seismic resisting system thereby increasing column drifts.

The only other alteration just to clarify that we are talking about "the masonry may have changed the response of the structure". Started talking about the gaps at that point. Next slide please.

Yes, this is it. Okay, we're talking about the connections to the north core. "The Council did not have any record". I'm happy with that.

"The drag bars that were installed at levels 4 to 6 only lacked toughness and ductility and (in my opinion) could not be relied on to sustain the ultimate response of the structure". So it's making the point that they were only installed at levels 4 to 6. Whilst they, the original design loads appeared to

have, let's put it this way, if they had installed them at all levels the design loads that we understood they designed them for did seem to conform to the standard of the time but it, the connection in my opinion lacked toughness and ductility appropriate for that type of connection.

The next one here, the structure, which I talked to on Thursday: "The structural damage reported following the 4th September earthquake appeared to be relatively minor and was not indicative of a building under immediate distress or having significantly impaired resistance to earthquake shaking". This is the wording out of the report. I'm adding here: "Some key areas including diaphragm connections to the north core and column bases were not inspected and the photograph recently provided by Peter Higgins is a reference was an indication of damage to the connection between the columns C18 and the north core". So that was new information subsequent to our report. That completes my comments there.

MR ALLEN:

You mentioned that these are supposed to be sort of supplementary to the conclusions reached in the report. Do you have any comments in relation to the conclusions in the report?

MR SMITH:

Yes I do.

MR ALLEN:

Now we had a slide on Thursday, slide 75 of the presentation that set out the bullet point conclusions of the report. I wonder if we might have that please?

MR SMITH:

Now this is, no, right. Unfortunately it doesn't have the, some of the clauses that I'm referring to. Okay.

MR ALLEN:

You had an observation to make when you were, in relation to beam column joints?

MR SMITH:

Yep, yep. Following release of the report I was telephoned by several colleagues who had read it and this also came up in the evidence of William Holmes that we had done some work to assess beam column joint capacities. We had reported that in an appendix in the report and in the Compusoft Engineering report but we had not brought that through to the conclusions and I accept that beam column joint failure was a possible mode of failure. I consider the beam column joints to be an integral part of the columns and so yeah we didn't specifically mention beam column joints in the conclusions but in my opinion we should have.

Again, just clarifying the point I made on the slide previous about the some areas of the building were not inspected after September and the photograph of Peter Higgins, just reinforcing that point, would come through again in the conclusions. I did a clarify in the conclusions that analysis using the full February aftershock, sorry it doesn't come up on the slide we're looking at, I'm just reading from the conclusions, analysis using the full February aftershock ground motion records and assuming an undamaged state at the commencement of that analysis, so I've just clarified that our analysis did assume an undamaged state at the beginning of the February record and we are going to discuss that in more detail in the non-linear analysis subgroup or significantly, now one bullet point here on the screen, this one here, "significantly lower than expected concrete strength". I've just, I've said in some of the columns I don't think we can be certain that low concrete strength was in critical columns because we did have some uncertainty about the location of where the test samples came from.

This one here: "The plan irregularity of the earthquake-resisting elements which further increased the inter-storey drifts on columns", I don't think it's more widespread than just saying east and south face because we also had

increased drift on internal columns. This bullet point I'm pointing to at this location here. So instead of east and south faces I would just say “on columns”.

“Increased displacement demands due to diaphragm slab separation”, we’re talking about the low, oh hang on, okay, this was, I'm sorry, a likely or possible contributor. I would also say that some damage to those connections could have led to increased drift, not necessarily total separation.

And there was a slight, a subtle change here with this second to last bullet point: “The plan and vertical irregularity produced by the influence of the masonry walls on the west face up to level 4 which affected the torsional response rather than amplified…” because some of our analyses actually showed that a reduction in the drift occurred with the influence of the masonry but there was an effect. So that completes my comments on the conclusions.

MR ALLEN:

Just in relation to the beam column joints, Mr Smith, the conclusions presently commence with the investigation has shown that the CTV building collapsed because earthquake shaking generated forces and displacements in a critical column or columns sufficient to cause failure. You might add, I assume from what you've just said, or beam column joints sufficient to cause failure?

MR SMITH:

That's correct.

MR ALLEN:

Those are my only questions for the moment Sir.

MR REID:

Dr Hyland and Mr Smith, I'm counsel for the Christchurch City Council and so the interest amongst other things that the Council has in your evidence and in the proceedings generally is to do with compliance and whether the building

complied at the time that it was designed and reviewed by Council engineers. So those are the focus of the questions that I have for you and I know Mr Smith has filed a statement of evidence, his third statement of evidence, and that deals specifically with interpretation and compliance matters and you're coming back Mr Smith in due course to address those issues in the context of the compliance part of the proceedings but from Mr Hyland, as I understand it, you won't be doing that so my questions about compliance and interpretation are really directed towards you.

1025

DR HYLAND:

That's fine.

MR REID:

So do I have it correct from Mr Smith's brief, Dr Hyland, that there were some differences in approach in terms of interpretation between you and him in terms of the standards?

DR HYLAND:

Ah, I haven't read his brief through at this point, so I'm not exactly sure what he's saying so –

MR REID:

Well –

DR HYLAND:

– are there any specific issues that you (inaudible 10:25:36)

MR REID:

I think, well the issue that I'd just like to focus on for the moment is the drift capacity of the columns?

DR HYLAND:

Yes.

MR REID:

And the issues around the interpretation of the concrete standard, in particular clause 3.5.14?

DR HYLAND:

Right.

MR REID:

So do you know what I'm talking about?

DR HYLAND:

Yes, yes.

MR REID:

Yes, and do you understand there to be a difference between you and Mr Smith on that issue?

DR HYLAND:

Ah, yeah I think that, perhaps if we look at the, um, portion I've written in paragraph 4?

MR REID:

Yes, yes take us to that?

DR HYLAND:

That might help, if we go to page 256 and 257?

MR REID:

Yes.

DR HYLAND:

Now the –

JUSTICE COOPER:

Well is this going to be convenient to display those? You are referring to page 256 is it of your report?

DR HYLAND:

The building collapse report.

JUSTICE COOPER:

So we need to find that and have it displayed so that everybody can see it.

MR REID:

So I think that the page that's being displayed is 256, 0.256 in the numbering but is that the page that you're referring to?

DR HYLAND:

No sorry, it's, um, the bottom page number is 256.

MR REID:

That's the one isn't it?

DR HYLAND:

That's correct that's the one.

JUSTICE COOPER:

Yes. It's correct now, so it's the, our reference 189.2 8 by the look of it. Anyway it's page 256 of the original January report.

DR HYLAND:

So there were two checks that were required to be done by the designer to show compliance with the concrete standard. The first one was a overall drift check of the frames as a whole. So the, and the methodology was that the designer could assume in his analysis or her analysis that it was just the shear

walls, the south wall and the north core were, were participating and resisting the design loads. They could ignore the other beams and columns as long as they then followed up with a compatibility analysis, a drift compatibility analysis. They did some checks and those, those other elements, the beams and columns were designated as group 2, group 2 elements in section 3 of NZS 3101:1982 so the first check that needed to be done was they needed to do this, the drift check. Using, it was recommended, elastic response spectrum analysis. Okay, and we, we know from looking at the calculations that they did attempt to do a response spectrum analysis. So the first check, they go through, they check the drifts under the designated loadings that the standard required and the critical point is actually at the tip of the, the sort of the south eastern walls. South eastern or south western corner of the building. Okay, so we went through, we used the same analysis, ERSA analysis and found that that, that check complied so they've satisfied that check. Now that, that check was at 55% of the ultimate limit state loadings, which we use the ultimate state loadings now but they, and their code was 55%, um, no matter what ductility demand you had designed the structure for, basically there was an equation there K upon SM that you would use to then normalise your drifts or the loadings that you would put onto the structure at 55% of the ultimate. So they satisfied that one. The second check was then to apply those same drifts that had been derived from the analysis to the group 2 frames and to see if they satisfied a number of criteria which would determine whether they needed to be designed for additional seismic design demands, or seismic, seismic design requirements. The way the standard was set up in NZS 3101 is that you could, if your building was designed for an S = 5 which is elastic response in terms of strength design criteria, then you did not need to apply additional seismic requirements to the structure. You could assume it was like, there was adequate ductility inherent in it, just using the basic provisions of the standard. Just like if you had a wind storm or, or a dead load or live load, so it just said just use the basic because you've already designed for what we believe is the, you know, the ultimate design level action.

MR REID:

Dr Hyland can I just, I don't mean to interrupt you but can I just stop you there. Just because what you're doing is explaining your interpretation of the standards. Can I just take you to the standards and we'll just come back to your narrative but if you can just have a look please at the, at NZS 3101:1984 which is at ENG.STA0016? And the page in that document is NGA is 0.28, 0.28? I'll just wait for that to come up?

DR HYLAND:

Yes.

MR REID:

So that, that, the document that's on screen now is a piece of the concrete standard correct?

DR HYLAND:

Yes, yes sir.

MR REID:

And 3.5.14 3

DR HYLAND:

Yep.

MR REID:

That's the piece dealing with group 2 elements, is that correct?

DR HYLAND:

Yes it is, yeah.

MR REID:

And this distinction you're drawing between elements that needed to be designed using the additional seismic requirements of the code, and those that don't, is that, is that the distinction in 3.5 14 3A and B?

DR HYLAND:

Yes, so, so part A is additional seismic requirements for this code, so there was a series of clauses that that refers to, "Then not be satisfied when the design loadings are derived from the composed deformations new delta, specified in NZS 4203, and the assumptions of elastic behaviour". So that's, that's the new delta deflections or deformations are those displacement compatibility deformations that came out of the, out of the analysis of the frames for the 55% ultimate loadings and if you can show that the columns and the beams remained subject to the assumptions of elastic behaviour then you did not need to provide any further seismic design requirements such as limited ductile or ductile design requirement.

1035

MR REID:

Yes and is that, on your understanding is that how these, the columns being column joints and so on, is that how they were in fact designed, as though they were intended to be categorised under A?

DR HYLAND:

Yeah well that's, I have looked at through the calculations and there didn't appear to be any check done for this particular requirement.

MR REID:

But just looking at how they were actually detailed, that appears to be the case, doesn't it?

DR HYLAND:

It appears that they have, well (inaudible 10:35:35) I think I read David Harding say that they assumed these were pin ended columns and that the beams therefore were just continuous beams over (inaudible 10:35:50)

pinned column but there wasn't any justification for why you could assume a pin ended behaviour in those columns.

MR REID:

No but that approach might have been permitted I am not saying that – I know your analysis said something different ultimately but if these columns and beams and so on could be dealt with under A that would have been an acceptable approach?

DR HYLAND:

Yeah if they could have satisfied the drift requirements, the drift capability requirements they could go for A, yes.

MR REID:

Now that was a diversion. You were talking to us about your analysis I think in appendix F, is that correct?

DR HYLAND:

Appendix F, yep.

MR REID:

Do you recall where you got up to with that?

DR HYLAND:

Yeah we are just about that spot I think so basically we had done the analysis of the seismic resisting elements the have been assumed by the designer. The designer then was required to look at the capability of the group 2 frames. They are then required to, using those clauses to apply the drifts or deformations to those frames and that can be done using a 2D fame analysis so you could just do a separate frame analysis so it is sort of simplified analysis, you can then apply those deformations to it with using prescribed displacement approach and then you would check through that section 3 clause that we just looked at and said, well if it satisfied elastic behaviour at

those drifts, so those columns or the beams they still remained elastic then there was no requirement to provide additional, but the additional seismic design requirements, the limited ductile or ductile.

MR REID:

So that analysis of whether the additional seismic requirements of the code were required to be provided for these columns, is that the analysis you have got in appendix F?

DR HYLAND:

Yeah I have taken it a little bit further than that because what I have done there is actually, if you look at tables 13 and 14, what I have done there is actually, first of all used an elastic deformation limit that is based on use of the Cumbia software which is sort of a more modern tool and which is probably a much more generous approach than what would have been used back in those days. It appears that what the code was indicating the elastic theory would have been use of the appendix B type approach which was consistent with ACI 318 1971 where you would say, you could check it as, there was an alternative design method at the time, you could use an alternative method which was a working stress base, you could say, check it for that, if it does that then it will be equivalent to giving you a strength design limit. So using that method would be far more, how can I say, there would be a lot more of the columns that wouldn't have complied. What we have tried to do is take a most generous approach possible and say, well what would have been the best someone could have come up with in terms of determining elastic deformation limit. Then compared that to the K upon SM drifts which is, the notation may be a little bit confusing there but that is the same as the new delta drift that we were talking about.

MR REID:

Sorry which notation are you talking about, this is?

DR HYLAND:

In table, table 13 and 14 I have got under there NZS 4203:1984 K upon S equals 2.75.

JUSTICE COOPER:

So this is a reference to 189.288?

MR REID:

So just looking at those tables that you have referred to then are they just in layman's terms, are they tables that compare the deformation limits for the indicator columns that you are considering as against the model deformations?

DR HYLAND:

Yeah that is right, that is right. So we have got here column, let's see table 13 there is C1 which is actually column C2, C-1 is the grid reference.

JUSTICE COOPER:

Look stay with the grid reference that (inaudible 10:40:58) if that is what you are happy with, it's – I understand that my suggestion of giving each column a number is likely to be something that engineers aren't terribly comfortable with so stay with your grid references.

DR HYLAND:

Okay, that is all right, yep so what we have got here is, we have got the elastic deformation limit. There is also a failure limit at a concrete strain of .004 which is, the failure limit is the point of which we consider the column has lost capacity, it has lost its ability to carry load. A safe limit is probably more likely at a concrete strain of .003 but, so what we have done here is said, okay at that point where the column has got to a point where it is considered unable to carry load, what is the drift that would be applied to it. Under the NZS 4203: 1984 loadings, so if you go to the east-west earthquake loading, just down there you can see the elastic deformation limit perhaps say for a level 4, L4, was .73%, just point this to you. So .73%. The deformation, sorry the NZS

4203: K upon SM, 2.75 or the at 55% of ultimate was .79% so you see the, I have marked that red because that shows that the drift was greater than the elastic deformation limit, so therefore it would have been required to have been designed using the additional seismic design requirements, the NZS 3101.

MR REID:

So just to summarise that then is, you're comparing the deformation limits under the heading, "Elastic deformation limit," with the modelled deformations and that's the first of the two columns that are coloured, is that correct?

DR HYLAND:

Yes, yeah the red one, yep that is right, correct.

MR REID:

And where you have got red, they are the non-complying columns, so to speak, is that correct?

DR HYLAND:

Yeah so they are non-compliant yeah.

MR REID:

And what you mean by non-complying in this context is would have needed to have been designed to meet your additional seismic requirements of the code, is that correct?

DR HYLAND:

Correct, correct, yes.

MR REID:

So just looking down the numbers for column C1, would you agree with me that except for L5, L6, the other non-compliances are fairly close?

DR HYLAND:

In the context in the way this has been done, that may be the case but when you look at the sort of normal practice at the time, that wouldn't be the case.

JUSTICE COOPER ADDRESSES COUNSEL – RE RECORDING

1045

DR HYLAND:

So what we've done here, what I've done here is used a fairly generous approach. So I've used cracked section properties in the columns.

MR REID:

Yes.

DR HYLAND:

Whereas, as Commissioner Fenwick pointed out last week the recommendation from the standard was that you use no cracked section properties in the column and that means that you would stiffen up that frame quite considerably and it would reach its elastic deformation limit a lot earlier. So this is a, this is sort of an extreme end of performance and yet we find that it still would not comply in the requirements for using the additional seismic design requirements (inaudible 10:47:03).

MR REID:

Well just on the way that you've done the analysis, just leaving aside that it might have been done different for the moment, do you agree that the, the margin by which the columns don't comply is fairly small?

DR HYLAND:

No not really. As I said, I mean this is, this is right at the edge of the, you know, what you could possibly do. So you've taken, you've stripped, I've stripped out here the sort of, the potential safety margins in it.

MR REID:

Well I'm just, just asking you at the moment to focus on what you have done. I appreciate that you're saying it could have been done differently.

DR HYLAND:

Yep.

MR REID:

But just in terms of what you have done, would you agree with that proposition that at least for column C1, for L4, L3 and L2 at least that those margins are fairly fine?

DR HYLAND:

Well no, I think you've got to read them in context you know, in, in the way it's done I think. If you've, if you've done something with, where you stripped out the margins then, like anything over is over the limit.

MR REID:

And you'd have the same answer I take it if I asked you about the next column which is F2 where there just, on the way that it's set out at the moment there's a, what appears to be a fairly fine non-compliance at level S, sorry, level L5, L6 for the north-south earthquake only?

DR HYLAND:

Yeah, yeah. Yes the same, it's the same comment. Same response basically.

MR REID:

All right. So just going, just talking for a moment about how you've done the analysis. Do you agree that you have done it, you have completed the analysis in appendix F on the basis of assuming a flexible foundation?

DR HYLAND:

The way the, so the ERSA, the ERSA analysis was done was using the recommendations that we got from a geotechnical engineer.

MR REID:

Yes

DR HYLAND:

Yeah.

MR REID:

Who was that?

DR HYLAND:

Tonkin & Taylor.

MR REID:

But that was the case wasn't it that the, the analysis is done on the assumption of a flexible foundation?

DR HYLAND:

Yeah well it's using, it's using the, using the assumptions that the, yeah, Tonkin & Taylor would have used, yeah.

MR REID:

I can take you to the point but do you accept that that's the case, that it was done on that basis?

DR HYLAND:

Yes.

MR REID:

Yes. But my understanding of the standards is that they were required, the analysis was required by the standards to have been completed on the assumption of a rigid foundation. Is that your understanding?

DR HYLAND:

The designer was allowed to use a rigid foundation. It was a simplification, yeah, they're allowed to use that.

MR REID:

Allowed or required?

DR HYLAND:

Allowed to. They could use, there's always provision there for them to use the recommendations of, of a geotechnical engineer if they wish to.

MR REID:

Well can I just take you then to NZS 4203:3812, at clause 3812 and I'll just, I can give you the reference to that, hang on.

DR HYLAND:

Yep.

MR REID:

That's at ENG.STA.001863. So it's come up on the screen now. That's the section of NZS 4203 as it was at the time, talking about deformations due to earthquake loads and clause 3.8.1.2 says, "Computer deformations shall be calculated neglecting foundation rotations." Do you see that?

DR HYLAND:

Yes I do, yeah.

MR REID:

And that indicates doesn't it that that was a mandatory requirement of the code at the time?

DR HYLAND:

Yeah I mean the codes, the way the codes are set up is that there has always been the, the, you know, the ability for a designer to use additional rational analysis, beyond the code, and so it's, it's quite often the case that people will say, well we'll take the recommendations of our geotechnical engineer because we've done some specific study and apply those and that is generally accepted as a reasonable way to do it.

MR REID:

And is that generally the way that you've done it, the analysis in appendix F. you've, if there was a better way to do it on the basis of scientific and technical developments since 1984 you've taken that approach?

DR HYLAND:

Yeah that's generally it. I mean we, we, our focus was primarily to look at the behaviour of the building during the, between the collapse or just, you know, during that earthquake.

MR REID:

Yes.

DR HYLAND:

So we, we wanted to get a best handle on what perhaps the foundation conditions were and how that would affect the response of the building.

MR REID:

Yes.

DR HYLAND:

So we've applied it to that. So you do need to interpret what we've done in accordance with that.

MR REID:

Yes.

DR HYLAND:

I think Ashley you could talk about, we did some sensitivity analysis on, on that didn't we?

MR SMITH:

Can I just clarify –

MR REID:

Yes, yes of course, by all means.

MR SMITH:

- that the analysis that was used to calculate the deformations was the same analysis. So we're on the same page with that.

MR REID:

Yes.

MR SMITH:

It was the assumptions that we used in the displacement compatibility that were a point of difference. So I can speak to the analysis that calculated the deformations because they are the same deformations that Clark used in his appendix, that was used, we did assume, we did make reference to a paper produced in 1986 by the Earthquake Society which had guidance on analysis for seismic loads and that had a recommendation for including soil flexibility that I would consider more recent than a code even though there was a statement in the code that said we could assume or you should assume rigid

foundations I would have placed a lot of weight on that Earthquake Society publication in '86 which was available at the time of design.

MR REID:

Yes.

MR SMITH:

So –

MR REID:

Because that was a better approach?

MR SMITH:

Yes.

MR REID:

Yes.

MR SMITH:

And there was a range of soil stiffnesses estimated by Tonkin & Taylor. We used an upper bound. They had a lower bound and an upper bound and the analysis that we carried out was with the upper bound as well as thickness which I, again I would consider a prudent thing to do if you were designing a building.

MR REID:

Yes, just leaving the foundations aside and perhaps I can go back to Dr, Dr Clark.

MR SMITH:

Sure, sure.

JUSTICE COOPER:

Dr Hyland.

1055

MR SMITH:

Yes, sure, sure.

JUSTICE COOPER:

Dr Hyland.

MR REID:

Dr Hyland, apologies. Dr Hyland. I think you said that in response to my earlier question that where there was a better way to do it effectively, a more recent but better way to do it that was the approach that was adopted as opposed to the strict approach that might have been adopted at the time, is that correct?

DR HYLAND:

Yeah, I mean, you got I think what we saw was, you got general practice, that is used is by you know 90, 95% of the practising engineers at the time which would be just to apply the standard using you know the general approaches. I mean this case we weren't you know and we could quite easily show that there was non-compliance with these requirements using those approaches but we were asked to, was there any way you could perhaps sharpen a pencil type of thing and still not get there sort of thing and so we've sort of done this sort of approach to do that.

MR REID:

Yes, but just so that we're clear, you're saying that the analysis that you've done in here is not an analysis in accordance with the strict requirements of the standard of the time?

DR HYLAND:

Yeah, okay. We've taken it, we've tried to be as generous as possible.

JUSTICE COOPER:

Just explain the implications of that final answer to me. If you hadn't taken the approach that you had taken what would the implications of that been for on this issue for whether or not the building complied with the standard or standards?

DR HYLAND:

Well it would have been much more obvious that at the time.

COMMISSIONER FENWICK:

Can I just interrupt quickly to check one point? When there's overriding requirements in the concrete standard which you make consistent assumptions so when you're making a generous assumption for the flexibility of the column did you also make a generous assumption to the flexibility of the structural walls which would have increased the overall displacements?

DR HYLAND:

No we didn't.

COMMISSIONER FENWICK:

Or did you choose selectively, we now would currently, assign different stiffnesses to those walls, if we assigned a lower stiffness than they did in those days but I have a problem when the assumptions aren't consistent when you're comparing it with the standard so I really wanted assurance that you did make consistent assumptions throughout? You didn't selectively say, "Oh well, we'll be generous and allow the column flexibility to or beam flexibility to increase here but not the walls"?

DR HYLAND:

No, no, we just kept the walls just as where they were. It was just the question was well how far could these columns really go before they collapsed and –

COMMISSIONER FENWICK:

Yes, but were the walls, when you're comparing code compliance were the walls assessed as required at the time by into this 3101:1982 or were they assessed in some other way?

DR HYLAND:

No, we just applied the stiffnesses, cracked section properties as recommended by 3102:1982 and then just looked at what were the limitations on how far you could perhaps push the columns if you really wanted to.

COMMISSIONER FENWICK:

So you've followed the recommendations for the code –

DR HYLAND:

Yep.

COMMISSIONER FENWICK:

For the walls but when it came to the columns you didn't because you assumed they weren't –

DR HYLAND:

No we (inaudible 10:58:55) –

COMMISSIONER FENWICK:

If you followed the recommendations for columns they would have been based on gross section.

DR HYLAND:

That's right. That's right.

COMMISSIONER FENWICK:

But you haven't? You've used half gross section or something like this which would allow you twice the inter-storey deflection.

DR HYLAND:

Yeah as I said we wanted to see what the bounds were so we checked initially with I-gross, found it didn't work and then this was sort of an extreme sensitivity check to see what would happen so it needs to be read in that context because there wasn't anything in the standard which said you must be consistent, it just says here are the recommendations –

COMMISSIONER FENWICK:

Oh, there's something that said you had to be consistent, but it didn't tell you perhaps what the consistent was –

DR HYLAND:

Didn't tell you what –

COMMISSIONER FENWICK:

But I would have thought if you're using you know a lower stiffness for your column then you should have also used a lower, a comparable stiffness for the wall. Now that's the point I'm trying to get at.

DR HYLAND:

Yeah, yeah.

COMMISSIONER FENWICK:

Did you choose appropriate stiffness values for both components?

DR HYLAND:

Yeah, as I said we did and what we were just trying to see what is the difference, what could potentially could someone have done by saying well the code wasn't clear, I've done it a certain other way, I'm not saying that's how what we're recommending but...

COMMISSIONER FENWICK:

Thank you.

MR REID:

Just going back to the issue about the foundation rotations for the moment, do you agree that your analysis had been done on the basis of an assumption of a rigid foundation that that would have been a more favourable interpretation for the designer?

DR HYLAND:

Not necessarily because the, if you use a rigid foundation your structural response changes so there tends to be, the building responds more at a lower, at a lower period. If you make the foundation flexible you get perhaps a lower response but you get a bigger, you can get bigger displacement so I don't think there's really much in it.

MR REID:

But have you done the analysis to know?

MR SMITH:

Yes, we have, we did, in my second statement of evidence I believe I summarised that we did response spectra analyses with rigid foundations and with flexible but we didn't, I'm not certain of the effect on column drifts but there is a considerably higher what we call base shear response if you assume rigid foundations which basically means higher loads need to be applied so.

MR REID:

All right, so back to Dr Hyland, so it seems, doesn't it, that you have an interpretation of the standards that differs albeit slightly from Mr Smith's, is that correct?

DR HYLAND:

No, I don't think we've come to that. What we've been explaining is the way this analysis was done, was done –

MR REID:

Yes, yes.

DR HYLAND:

Was done for a specific purpose.

MR REID:

Sorry, I, yes, I understand that, I'm moving on to slightly different point, just generally about the standards that have you read, you said you hadn't read Mr Smith's third statement of evidence?

DR HYLAND:

No, I haven't sorry.

Mr Reid:

Have you read Dr O'Leary's statement of evidence?

DR HYLAND:

No, I haven't sorry, no.

MR REID:

Or Mr Priestley's?

DR HYLAND:

Yes, I've read Mr Priestley's. Yep.

JUSTICE COOPER:

I think we should call him Dr Priestley.

DR HYLAND:

Dr Priestley.

MR REID:

Dr Priestley's. What I'm, Dr Jacobs, Professor Jacobs I think it is.

DR HYLAND:

Dr Jacobs.

MR REID:

Dr Jacobs, have you read his?

DR HYLAND:

No, look I haven't, I've read a lot of evidence but I wasn't called for the compliance section so I haven't read those ones in particular.

MR REID:

Right, but do you accept though that there are a variety of interpretations of the standards?

DR HYLAND:

Yeah, look I think it's one of the issues with these particular standards that the 82 and the 84 is that they were difficult to interpret and not easy documents. I mean, they're generally look in a design practice you'd expect someone starting out to perhaps take six to nine months to get reasonably comfortable using perhaps the concrete standard at the time. I mean they're complex documents. IPENZ you know requires generally sees it that you need sort of three to five years design experience, practitioner experience with mentoring and supervision to interpret and use these codes in a reliable way so it's not, they're not straightforward documents. So it's not surprising people have slightly different interpretations.

MR REID:

No, well would you agree, I accept your point but that it requires experience and training to be able to interpret these things correctly, but I think Mr Smith also says that the fact that there are a number of different interpretations is an

indication that the design codes of the day were not entirely clear. Would you agree with that?

DR HYLAND:

Yes, I would, yeah. Yes.

MR REID:

All right, well, can I just move on to the spandrel panels?

DR HYLAND:

Okay, yep.

MR REID:

Now I think your report on the spandrel panels is to the effect that there was no gap specified either side of the columns between the columns and the spandrels, is that correct?

1105

DR HYLAND:

Yeah there was a gap between the ends of the spandrel panels of 420 millimetres shown on the architects' drawings but there was nothing specific that said you must maintain a minimum gap between the end of a panel and a column.

MR REID:

But isn't it correct that interpolating from the gaps between the columns, or the space between the columns, the diameter of the columns and the diameter of the spandrel you get a 10mm gap either side?

DR HYLAND:

Yeah well that's just a nominal gap that isn't taking account of construction tolerances. I mean the construction industry recognises and the standards recognise that there is not even if you specify a column it's 400 diameter, it's not necessarily going to be perfectly 400, it could be 405 millimetres diameter.

You specified a panel that was six metres long. It might not be exactly six metres it could be six metres and five millimetres long, so you could eat up these gaps quite, quite easily. And unless the builder, it is communicating clearly to the builder that there must be a minimum gap specified, you know, left there, then it's, it's unreasonable to expect the builder to read the mind of the designer.

MR REID:

Is this an issue that focuses around a problem with the spandrels turning up on site having been precast and not being, not being custom made for the gaps in question?

DR HYLAND:

No not necessarily, I mean they would, they, oh, I understand they probably would've tried to do their best but there's no guarantee that the column at each level is going to be exactly placed above, you know, there's all these issues, I mean construction is not a exact science. There is a recognition that, you know, things, things move and do that so you have to make allowance for that and there didn't appear to be any allowance made for that, with that on the specification.

MR REID:

If the columns had been custom made on site would that have made a difference as to the need for a construction tolerance to be specified?

DR HYLAND:

No, no, it's still the same thing. I mean you've still got to be able to recognise people are placing things with cranes and using heavy equipment. It's not, you know, watch making, it's, it's heavy sort of labouring type stuff.

MR REID:

So the, turning now to the wall on line A?

DR HYLAND:

Yes.

MR REID:

I'd just like to go to the plans for a moment. I think it's S17 on the plan.

JUSTICE COOPER:

Are we going to come back to the standards or have we left them?

MR REID:

I'd left them. So this, on the plans this is BUI.MAD249.0284 18?

DR HYLAND:

Okay.

MR REID:

So the issue here's about the structural separation of this wall on line A from the rest of the building, is that correct?

DR HYLAND:

Yes.

MR REID:

And do you agree with me that in terms of the vertical plane, or the vertical, or the plan shows vertical gaps which would be sufficient to constitute a structural separation in that direction?

DR HYLAND:

Um, I think you need to also refer to section 6 on S9.

MR REID:

Yes?

DR HYLAND:

I don't think they're bringing it up as well, but the, the issue is there that the drawings – can you bring that up please?

MR REID:

Six 6 on S9 is MAD249.0284.10.

DR HYLAND:

Okay, so if we look at the right-hand side of that drawing, now the, the detail where the, where the, um, the top course is connected into the underside of those precast beams at level 2 and level 3, you'll notice that there is a horizontal reinforcing bar specified there, D12, and there is a grease bar that is fixed to the underside of that. At D12 this drawing shows that that was fully grouted for that wall and this drawing was fully grouted so that would've made it, if it had been built like that, that would've made it quite difficult to justify that it was fully separated even with those gaps in the other drawing. So I think there was some, some problem here with the drawing.

MR REID:

So is your issue then is about the gaps under the beams at the top of each wall rather than the vertical gap specified on S17, is that correct?

DR HYLAND:

Um, yeah, the, the problem we've got with this is that there doesn't appear to be an ability for the top of the wall to rotate without, um, engaging with the beam above. So, um, and the bar as it's detailed here would have been rigidly connected into the top. So it would've taken shear, direct shear loading direct into the beam. Often what you do here is you actually would leave that top course ungrouted, and you might separate the top of the block by a certain amount, so there's a gap, perhaps a 10 millimetre gap consistent along there so there's a bit more clear freedom. So I think the intention was, may have been, ah, you know, that they were trying to head in that direction but

somehow it didn't get documented that way. So I don't, I don't think this, this detail as it's drawn would've achieved that separation that we want.

MR REID:

So the detailing of a grease bar, correct me if I'm wrong but isn't that, isn't it greased so that it can move, isn't that the point of it?

DR HYLAND:

Yeah the idea would be that it would move vertically but it could perhaps slip, slip if there was some vertical movement, but there's no, um, another thing you could've done here perhaps was you could've wrapped, wrapped that bar with Denso tape or something so there was actually a gap there when you did grout it, but there's nothing, nothing here which does that. So that bar is rigidly, well as it's shown here it's rigidly connected in terms of shear. It could move vertically but then you've got to ask yourself how is it going to do that given the beam that's on top of it.

MR REID:

Are you familiar with the use of a grease bar? I don't know whether it's a common thing now, but are you familiar with that, that method of construction?

DR HYLAND:

Yeah, yeah they can be done on them, you can put sleeves on them, ah, I've certainly used sleeves on reinforcing bars, um, you know, polyethylene sleeves and things, so that's, people do that, but It's just in purely one direction, so if you're trying to get a horizontal movement you would put actually something that's a bit thicker that can crush or move, you know, like a Denso tape's like a thick tape so you don't need a lot of movement but there 's enough there to let it go. So there seems to be some problems with the way this was documented here.

MR REID:

Do you agree with Dr O'Leary when he says that, that you wouldn't use, a greased bar in this context would only be used in conjunction with a gap?

1115

DR HYLAND:

Yeah it is like a gap, yeah, so there has got to be some movement, yeah, no I'd agree with that.

MR REID:

So it is clear isn't it or do you agree that it is clear that the plans, by specifying a greased bar the plans contemplated a gap even if it wasn't expressly provided for?

DR HYLAND:

No I mean, I mean if I was a builder looking at that I would just assume that the engineer wanted that done exactly as he'd done there, put a greased bar in there and grouted up and you would just do what you are told.

MR REID:

But isn't here an inconsistency in the plan, the use of the greased bar and not specifying a gap, aren't they, wouldn't a builder look at that and wonder what was going on?

DR HYLAND:

Not necessarily, I mean a builder isn't trained to interpret the engineering aspects of drawings. They, their expertise is in executing the design. It is up to the, you know, this is where the engineer observing would perhaps look at the, what they are doing and perhaps interpret it if they saw there was a mistake they would perhaps change it on site or something.

MR REID:

But an experienced builder, don't you think I would have raised a concern at about the specification of a greased bar without a gap. Wouldn't they have wondered what was going on?

DR HYLAND:

I don't think so, I mean my experience with builders and trades people is that they are expert at what they do but they are not engineers and these sort of things they will just look at how he can do it, what is the best way to do it and assume the engineer knows what they are talking about.

MR MILLS:

It certainly had not been anticipated that we were at this stage going to get into issues of code compliance and I didn't want to interrupt my friend's questioning on this and a decision was made and perhaps in retrospect wrongly that because Dr Hyland's views were so clearly set out in the reports and we learn subsequently that they were his views rather than Mr Smith's that we wouldn't include him in the section that we have got coming up specifically on code compliance but I am not sure what my friend Mr Rennie now plans but I think it would be unfortunate if we now embarked upon a further round of questioning and examining on the code compliance issue and so what I am going to suggest is that depending upon what my friend Mr Rennie plans to do we will ask Dr Hyland to come back for that session on code compliance. His views are well known, he won't need to present any particular further evidence at that point but you would be available so that if there is questioning of him then he can do it then because I think it would be unfortunate if we embarked on that exercise now.

JUSTICE COOPER:

Mr Rennie?

MR RENNIE:

Sir I was going to seek before asked questions a slightly more general clarification because these witnesses were both put in the witness box and introduced on the basis that they were going to present the building collapse report. Now as Your Honour and the Commissioners are aware there are in fact three reports with Mr Hyland's report investigation materials and so forth,

there is the building collapse report and there is the panel report. Now then in support of –

JUSTICE COOPER:

They are not presenting the panel report.

MR RENNIE:

No, indeed Sir, but then in support of the table evidence presented by these two witnesses there are two final briefs of evidence from Dr Hyland, both of those in fact are spreadsheet responses to the evidence of other witnesses and there are six briefs of evidence filed by Mr Smith, one of which relates to the code compliance issue and there are differences in position between the two witnesses in respect of the material in those briefs of evidence and I assure you –

JUSTICE COOPER:

I am not sure whether we need to spend a lot of time on this Mr Rennie. I would have thought that you would be about to cross-examine them on the evidence they have given, except insofar as Mr Reid has strayed into areas of the codes, the standards which I think is for another day.

MR RENNIE:

I was certainly not expecting to proceed on code compliance today Sir. I saw that as a discreet issue.

JUSTICE COOPER:

Yes, now the other evidence you are referring to has not been given.

MR RENNIE:

Well no...

JUSTICE COOPER:

So I don't want to be listening to questions about it.

MR RENNIE:

That's to say the briefs of evidence that I have referred to has not at this stage been given.

JUSTICE COOPER:

That's right.

MR RENNIE:

And it did seem to me to be peculiarly unproductive to attempt to reconcile the differences between those two briefs of evidence with the same witness in the witness box so my intended line of questioning Your Honour is directed to what these witnesses have jointly presented which is the building collapse report simpliciter.

JUSTICE COOPER:

Yes, well I will just to check to see whether anybody has any disagreement to that proposal, Mr Mills?

MR MILLS:

Well that is clearly what I had (inaudible 11:20:59) to occur.

JUSTICE COOPER:

Mr Allen?

MR ALLEN:

It's what I had apprehended too Sir following discussions with Mr Mills.

JUSTICE COOPER:

Mr Reid?

MR REID:

Well I am sorry if I have done the wrong thing –

JUSTICE COOPER:

No it is all right but from this point do you have any difficulty with the course of action Mr Rennie proposes?

MR REID:

No, I mean just to clarify I have understood that this was the only time we'd seen Dr Hyland and his brief, I mean it is clear from various material that Dr Hyland, that the interpretations material in the report are his and he canvasses extensively interpretation issues in his response to others. That was the reason for questioning –

JUSTICE COOPER:

Yes, well an inquiry like this, one simply has to make pragmatic decisions about the limits of particular sections of the evidence so Dr Hyland I take it is prepared to return.

DR HYLAND:

Yeah no problem.

JUSTICE COOPER:

So we will, you won't have to repeat what you have done today. You will be spared that.

DR HYLAND:

Thank you Sir.

JUSTICE COOPER:

As indeed will we. So that others who wish to deal with that issue will do so at the appropriate time.

DR HYLAND:

Yes thank you.

JUSTICE COOPER:

Mr Rennie?

MR RENNIE:

Now Dr Hyland, Mr Smith, the way that I propose to ask you questions is that where I have a question which is specifically for one or other of you I am going to mention your name first and then ask the question. If it is matter on which I am going to seek the view of each of you I will ask the question and then I will invite one or other of you to respond followed by the other. If you have difficulty in following my process at any point please let me know.

DR HYLAND:

Sounds good.

MR RENNIE:

Now, the building collapse report which is commonly referred to as BCR throughout the material, is essentially the joint work of the two of you as I understand it.

DR HYLAND:

That's correct.

MR RENNIE:

And Dr Hyland you recently observed in an email to the Commission that the further NTHA work now going on is important. Your words were, "Because it is addressing the fundamental issues of the calibration of the NTHA to the observed physical damage," do you recall that?

DR HYLAND:

Yeah I remember making some sort of email, I can't recall it exactly.

MR RENNIE:

Well beyond recalling the email do you agree that the importance of the current NTHA work is that it addresses the fundamental issues of calibration of the NTHA to the observed physical damage?

DR HYLAND:

Um, yeah calibration to the physical damage as mentioned by Mr Smith yesterday, ah, sorry on Thursday has been difficult, been difficult.

MR RENNIE:

Yes, Mr Smith, your view on that?

MR SMITH:

On the further analysis that's been done?

MR RENNIE:

Yes?

MR SMITH:

Yeah I think we, I believe we've already made some changes that do better calibrate it through the observed evidence so.

MR RENNIE:

Now a further recent development with the NTHA, and I'm looking for an answer from each of you, is to consider the period from 4 September through to 22 February is it not?

MR SMITH:

Yes, that, that, we've agreed with Professor Carr and Mander that that will be studied in sequence with this further analysis, if that's what you're referring to.

1125

MR RENNIE:

Dr Hyland do you agree?

DR HYLAND:

Look I wasn't involved with the NTHA trade panel directly but if that's what they're doing, that's what they're doing.

MR RENNIE:

Well Dr Hyland the material that you've presented in relation to your investigations includes witness statements, doesn't it?

DR HYLAND:

Sorry?

MR RENNIE:

The material you've presented in relation to your investigations includes witness statements.

DR HYLAND:

Yes, yes that's right, yes.

MR RENNIE:

They're summarised and they are anonymised.

DR HYLAND:

Yes, that's correct.

MR RENNIE:

And they all relate only to the period of 22 February don't they?

DR HYLAND:

Yeah, I think the eyewitness statements do.

MR RENNIE:

Yes.

DR HYLAND:

I mean we did have statements, I took statements from people who were in the building after September and after December as well. So we had witness statements from them but the eye witness statements are what were recorded there to get their perspective on how the building collapsed on the day.

MR RENNIE:

When you say, we do have statements from people in the building, what are described in your report, that's to say the Hyland report as eyewitness statements are in fact confined to the 22nd of February aren't they?

DR HYLAND:

We've, we've got in here the, in the eyewitness section we've got eyewitness reports. So people who were around the building and who were in the building. That's what we defined as eyewitness, yeah.

MR RENNIE:

Yes. Where do you say the reports contain the material from the people who were in the building in periods earlier than 22 February?

DR HYLAND:

They're, they're on the, they're the interviews that are on the Royal Commission.

MR RENNIE:

Yes the data's been, some of the data's been handed to the Royal Commission hasn't it?

DR HYLAND:

I believe all of them have been.

MR RENNIE:

So when the Royal Commission heard evidence from people as to observed fractures, breaks, cracks, liveliness, moving elements in the building before 22 February they don't form part of your report do they?

DR HYLAND:

Yes they do actually.

MR RENNIE:

How?

DR HYLAND:

We've used those in assessing what the condition of the building was after September and after December. So they're background, background material that we've used.

MR RENNIE:

But they're not presented in the report are they?

DR HYLAND:

No well I mean the report's fairly thick as it is and we, we just left those out.

MR RENNIE:

It wouldn't matter how thick it was provided it was accurate would it?

DR HYLAND:

No, as long as it's accurate, that's right.

MR RENNIE:

So what has now happened at this stage is that for the first time in the building collapse investigation by the two of you the NTHA is going to look at the period 4 September to 22 February. That's correct isn't it?

DR HYLAND:

No, that's not correct. I mean the building was analysed using a September record as well.

MR RENNIE:

Using ERSA.

DR HYLAND:

No, no an NTHA.

MR RENNIE:

Mr Smith your view?

MR SMITH:

Yes, yes, let me just find the right page. There was an analysis done for September. It's page 206 of the report that describes, it was a separate analysis. So we carried out an analysis for the September earthquake for one of the records, CBGS, then we separately, the rationale behind that at the time was that we felt the response we got from that analysis did not, we didn't have evidence of a significant failure, in the assumptions that we were making, the analysis of the time, we did not see significant structural failures that would continue across into February. So we carried them out as separate analyses on the basis that the results were got from the separate analysis for February, assuming an undamaged state at the start of that analysis, indicated failure. So that regardless of whether we had some damage prior to that or not we felt we would still indicate failure so.

MR RENNIE:

So to summarise you, you took the view that if it was damaged before 22 February that wasn't relevant because it would not have survived on 22 February anyway?

MR SMITH:

I wouldn't say it's not relevant but it would not alter the position that we had predicted a failure to occur in February which, if we'd have had some damage prior to that.

MR RENNIE:

Did you regard that approach as consistent to your terms of reference?

DR HYLAND:

Who are you addressing to?

MR SMITH:

I think it was agreed at an expert panel meeting that that was how we would proceed subsequent to the terms of reference. I can't recall the exact wording of the terms of reference but that was agreed at an expert panel meeting in Wellington as to how we would proceed.

MR RENNIE:

I'll take you to that a little later. Is it correct that when you say that the 4 September NTHA analysis was done with reference to one record you're talking about one seismic record from one location nearby.

MR SMITH:

That's correct.

MR RENNIE:

Ultimately you used three seismic locations.

MR SMITH:

Yes.

MR RENNIE:

One of the contentions put in issue in the evidence filed by the parties that I represent is that there should have been post 22 February seismic testing on the actual building site. Do you recall that?

MR SMITH:

Yes.

MR RENNIE:

Do you agree with that?

MR SMITH:

It would be of limited benefit to give some indication under certain conditions of the variation of response but it would not, obviously not be able to give us a record of what happened there on 22nd of February.

MR RENNIE:

Well plainly it couldn't, absent a time machine, but it would give you a calibration to enable you to compare the experienced seismic effects on that site post-earthquake with the experienced seismic effects on the other three sites of measurement wouldn't it?

MR SMITH:

It, it gives you a basis for comparison for a, a certain magnitude of aftershock that was experienced, obviously, when you had that information there.

MR RENNIE:

And are you aware that that seismic testing has in fact been done?

MR SMITH:

Yes I am.

MR RENNIE:

And you've seen that?

MR SMITH:

I have, I have seen that in Brendon Bradley's evidence I believe.

MR RENNIE:

Yes.

MR SMITH:

Yes.

MR RENNIE:

And the calibrated comparison which is now available from that, will that be part of the further NTHA testing now being done?

MR SMITH:

No I believe not anticipated at this stage.

MR RENNIE:

Dr Hyland is it a fact that the NTHA testing was suspended because of budget constraints?

DR HYLAND:

We started doing the NTHA quite early on along with the ERSA and we needed to be efficient with what we were doing in our resources. We, there were concerns that maybe it was going to become expensive. We needed to focus on getting the initial findings out of the ERSA, get that right, get the model right and then move into the NTHA. We didn't have at that point the concrete test results and a number of issues, you know like reinforcing steel. So it was better to put that on hold for a number of reasons.

MR RENNIE:

In fact I don't think we need to go to the page but in your reply, the reference is WIT.HYLAND.0001.9 at C19 you actually say that it was suspended due to the budget considerations don't you?

DR HYLAND:

Yeah, yeah I've said that just then.

MR RENNIE:

Your budget?

DR HYLAND:

No, we had a budget. We wanted to keep the Department informed of where we were going.

MR RENNIE:

Well it's a bit more than that isn't it? You had a contract capped at a fixed amount.

DR HYLAND:

No we've had, I mean the contracts have moved as we've gone along and the Department has just been open to what, what we've been doing as long as we've discussed it with them.

MR RENNIE:

Are you saying that the current operative contract does not have a capped amount in it?

DR HYLAND:

It's got a, it's got a capped amount there.

MR RENNIE:

Yes.

DR HYLAND:

But it's, it's just dependent on what happens.

MR RENNIE:

So the decision to suspend the NTHA costs was a decision of you and Mr Smith not a decision of the Department?

DR HYLAND:

No we, I mean we've talked with, with the project manager about it. It was agreed let's, let's get the ERSA sorted out, do what we can and then we'll –

MR RENNIE:

Do you have a view on that Mr Smith?

MR SMITH:

I think there were, were reasons other than budget but at the time we did not have the input data sufficiently well defined to proceed with that analysis. It is quite a lot more involved clarifying, as we've seen in the evidence, clarifying the input data from the, for the non-linear time history analysis and, you know,

1135

and it is a very time consuming process so for example those analysis we've talked about for September earthquake ran for approximately two weeks for each record to run one analysis, so.

MR RENNIE:

The terms of reference required you to consider the period from the earthquake on 4 September through to the earthquake on 22 February didn't they Mr Smith?

MR SMITH:

Yes.

MR RENNIE:

Can you say then why you didn't do an end on end analysis of those two earthquakes?

MR SMITH:

Well as I explained before we, we, obviously if we'd done an analysis for February and it found that it did not indicate collapse then the collapse may have been more due to that sequence effect, whereas we felt that our separate analyses had shown shall we say marginal, not marginal, I'm just trying to think of the right words, a response in September that was not, not indicative of building failure but a response or a separate analysis in February that was, and therefore the sequence effect was not critical we felt to that finding.

MR RENNIE:

Dr Hyland?

DR HYLAND:

Yeah look, um, I think it's, it's, um, fairly clear from the people who inspected the building after the September earthquake and the December one that there was very little damage. There was one column that had a crack in it between level 1 and level 6. It was deemed to be insignificant, not necessary for even repair. There wasn't any observed damage to the masonry infill wall on the west side by those who were working on it, right up against it. There was apparently one fine crack, diagonal crack at the base of the south wall. So in normal engineering terms you would say this building was largely undamaged. There was if anything, unremarkable damage I think someone said. From an analysis point of view that is not enough damage to even consider that you would bother about considering sequence effects from my, my opinion.

COMMISSION ADJOURNS: 11.37 AM

COMMISSION RESUMES: 11.55 AM

MR RENNIE:

When we broke we were reviewing the pending report from the further NTHA analysis as you'll recall and Mr Smith, I don't think we need to go to the reference but in your sixth brief you expressly reserved the right to change or modify the views you've expressed in the light of the outcome of that analysis, don't you?

MR SMITH:

Yes, I do.

MR RENNIE:

Dr Hyland, would you hold the same view?

DR HYLAND:

Look, I'd look at it, definitely.

MR RENNIE:

You would look at it?

DR HYLAND:

Yeah, sure and evaluate it.

MR RENNIE:

Do you mean by looking at it you would look at it, review it and you might change your view?

DR HYLAND:

If necessary, if it conforms with the evidence we've got.

MR RENNIE:

Now Dr Hyland, you were putting to me the proposition that the observed damage prior to 22 February was such that you were entitled to assume that the building could reasonably be assessed in February as not having

sustained any significant amount of damage? That was your proposition wasn't it?

DR HYLAND:

Yeah, when you analyse buildings you assume that some sort of cracking can occur. A building can crack and that does not, that is assumed in your analysis so your analysis, analyse a building assuming cracking so even if you saw some cracking in the building that doesn't necessarily mean that the building has been damaged from a structural point of view. So you could be quite reasonable to analyse that building as though it was undamaged on the structural analysis point of view.

MR RENNIE:

There were successive aftershocks between September and February, weren't there?

DR HYLAND:

Yes, there were. Yes.

MR RENNIE:

One of the more significant is what is often called the Boxing Day aftershock, isn't it?

DR HYLAND:

Yes, there was an aftershock on 26th of December roughly about a half the response we believe, yeah.

MR RENNIE:

Well, we'll come to the question of the level of that quake but do you recall amongst the eyewitnesses you interviewed, Mrs Jackson telling you that after that shake the stairwell next to her jumped around?

DR HYLAND:

During the shake?

MR RENNIE:

After the shake.

DR HYLAND:

After the shake, I'd have to look back –

MR RENNIE:

In the intervening period between –

DR HYLAND:

I've read her evidence, I didn't recall that, after the shake.

MR RENNIE:

Do you recall the eyewitnesses as you put it from level 6 Relationship Services talking about an increased liveliness in the building after the Boxing Day shake?

DR HYLAND:

Yes I interviewed Jo Vivian I think her name was.

MR RENNIE:

Yes.

DR HYLAND:

Yes, and we had a detailed discussion. We looked at the, what damage had occurred in her tenancy. I made some drawings, she made some sketches which and we've got photos there that she gave me that have been referred in the report. Liveliness is an interesting topic in that analysis showed that the building had floors which were quite long-spanned using that hibond floor, 200 hibond. At those spans in open plan areas it is, would be quite expected that you could get some level of discomfort to people in those rooms. In areas

where there are partitions across those areas then it is less likely because you have more damping available but in open plan office areas and in meeting rooms I think David Miller brought that up as well that there was a sense of the building you know this floor vibration. Now I remember –

MR RENNIE:

Right, well now we've established that there is the floor vibration but my question was whether persons from those levels reported an increase in floor vibration after the Boxing Day earthquake?

DR HYLAND:

People, people were more sensitive I think. I mean it's, it's well recognised when you in design guidelines for floor vibration design of buildings that people who are more tense are more perceptive to floor vibration.

MR RENNIE:

What would you regard as the indicator you would have wished to see before you would have investigated the extent of damage between September and February?

DR HYLAND:

What do you mean by that, sorry?

MR RENNIE:

Well you're telling me, as I understand it, and I am confining the question for the moment to you Dr Hyland, that on what you knew about that period you did not consider it necessary to carry out any structural investigation or assessment of the damage which might have occurred during that period? Is that right?

DR HYLAND:

We did the, we, undertook interviews with people who had been in the, you know, had been, who had been in the building after September, after

December, and their recollections of what damage they saw. They said they, there was damage to partitioning. I think there was one window was broken according to Mr Ayers. The comparative ERSA that I did of the three records showed that the, the expected response of the building in December would be about half of what would have been in September and from the damage reports from September it was clear that very little damage had occurred at a structural point of view so there didn't seem to be any reason for us to investigate the December, the December event in terms of structural analysis if you're talking about computer analysis –

MR RENNIE:

If you –

DR HYLAND:

We've investigated the September one.

MR RENNIE:

I'm going to ask that you're shown an email dated 14 October 2011. The reference is BUI.MAD249.0494B.31? Can you have a look at this email please?

WITNESS REFERRED TO DOCUMENT BUI.MAD249.0494B.31

Mr RENNIE:

Do you recognise that comprise an email from Mr Jury to Dr Priestley and yourself which incorporates an email which you sent in relation to the situation from the September earthquake? Do you see that?

DR HYLAND:

Yeah, I, just give me a chance to read it please? Oh, yeah, yep. (inaudible 12:03:28)

MR RENNIE:

Now let's start by establishing Mr Jury who sent that email was with Beca, or is with Beca and is a member of the panel, that's correct?

DR HYLAND:

Yes.

MR RENNIE:

And Dr Priestley, similarly a member of the panel?

Dr HYLAND:

Yes, I think he was the vice-chairman.

MR RENNIE:

And this is an email sent by Mr Jury to yourself and Dr Priestley on the subject of 'CTV analyses and collapse scenarios', that's it's title isn't it?

DR HYLAND:

Yes, that's its title.

MR RENNIE:

And Mr Jury addresses Dr Priestley but obviously with the intention that you read it saying that, "He is leaning," he says, "towards the scenario you have outlined below. I also believe it is likely as you have suggested that the slab could have been cracked in the Darfield event," that's the September earthquake isn't it? "And possible that it had cracks adjacent to the wall prior to September," you see that?

DR HYLAND:

Yes.

MR RENNIE:

So that at the 14th of October you personally knew that both Mr Jury and Dr Priestley considered that to be a live possibility, didn't you?

DR HYLAND:

Yes, and I incorporated that into scenario 4 that you'll see in the report so we analysed this scenario quite vigorously.

1205

MR RENNIE:

So now you're telling me that independently of what the witnesses said and what the damage looked like and what you thought you did actually carry out an investigation of the possibility of building damage arising in the period September to December, that's correct?

DR HYLAND:

What we did is we –

MR RENNIE:

Can we, can I just pause you there. Is the "we," I'm not quite sure what the "we" is, is that you and Mr Smith, is it you, is it, what is it?

DR HYLAND:

No with the analysis we, we undertook this analysis so -

MR RENNIE:

Well can you tell me who the "we" is please. Who's encompassed in the "we?"

DR HYLAND:

Mr Smith and myself.

MR RENNIE:

Right, thank you now.

DR HYLAND:

So scenario 4 which was put forward by Professor Priestley which is his theory that there was this, perhaps this damage and rocking of the north core and breakaway of the slab adjacent to the north core prior to collapse elsewhere we, we treated that with respect and we applied the analysis to it. The evidence was that there wasn't any cracking in the slab adjacent to the north core. If you look at the, for example the evidence of the people who were on level 4 none of them mentioned cracking in the vinyl in the lift lobby area where you would expect this cracking to have occurred. If it had occurred you would expect it to be reflected in this, in the, in the vinyl but it wasn't there. However, this was a valid scenario that we needed to investigate and it has been fully investigated. However, the evidence that, the convergence of the evidence is that it was not the scenario that initiated the collapse so.

MR RENNIE:

Mr Smith I'm going to ask you in a moment but just before I do Dr Hyland and Mr Jury then went on to give you a specific task which was to consider, "Shrinkage stresses generated in the slab adjacent to the wall." Do you see that?

DR HYLAND:

Yes, yes.

MR RENNIE:

And his proposition was that those shrinkage stresses might arise due to restraint between the north wall and the rest of the structure particularly the stiff infill wall. That's the question he put to you?

DR HYLAND:

Yes I remember him, yeah, I remember this, yes.

MR RENNIE:

What did you do to investigate that?

DR HYLAND:

Yeah I remember, I mean I could go back and perhaps dig it out but the question was would the, was the, was the mesh critical to the failure and was it non-ductile. Tests I'd done showed that the mesh that was used in this particular building, or the tests I'd done on it, that were done by SAI Global in Christchurch were that this, this particular mesh had good elongation for its type. The, you do get shrinkage stresses in reinforcing mesh in buildings always but these aren't considered to be causes of structural failure because the, the mesh is able to cope with, cope with the deformation, cope with that cracking and still maintain sufficient ductility to, to still perform as a, as a slab. Now the other thing I think is important to remember is that these slabs are, are very ductile elements. These, particularly high bond, high bond and these composite slabs are in accordance to BS5950 part 4 which is what they are required to be designed to and tested to in New Zealand up until the Eurocodes were brought in but these slabs must be able to cope with a displacement of span upon 50. So they must be able to cope with a displacement in this particular building of 140 millimetres before they fail. So there's a significant amount of deformation capability in these slabs that can be coped with before they're going to be, they're going to fail. So, so a few cracks is, is not enough to cause you failure.

MR RENNIE:

Mr Smith I'm still going to come to you shortly. First can be go back please one page, the previous page, page 30. Now this is your reply to Mr Jury. Do you see that?

DR HYLAND:

Are you talking to me or Mr Smith?

MR RENNIE:

I'm talking to you.

DR HYLAND:

Yep, yep.

MR RENNIE:

And I'm talking to you because it's headed up "From Clark Hyland."

DR HYLAND:

Good. No, I thought you addressed Mr Smith to start with.

MR RENNIE:

No I said I was, I just want him to know that I haven't forgotten to give him his chance to speak.

DR HYLAND:

Good, good, good. Yes, so what, what's your question?

MR RENNIE:

It would seem, it would seem that the duration of the time required to investigate this proposition was about one hour and 22 minutes judging on the timing of the email. Mmm?

DR HYLAND:

So –

MR RENNIE:

Well one hour 22 minutes later you replied rejecting Mr Jury's proposition and saying you were stunned that he should rely on his instincts regardless of what the evidence showed.

DR HYLAND:

No I think what I've done there is set out a reasonable line of argument.

MR RENNIE:

Including what you were telling me before about the mesh?

DR HYLAND:

That, that, that is dealing with the mesh.

MR RENNIE:

Yes.

DR HYLAND:

So that, that is putting forward the issue of shrinkage in the mesh and how it behaves.

MR RENNIE:

So do you say that you in the one hour and 22 minutes had ascertained Mr Smith's view on the issue?

DR HYLAND:

I'm not sure whether I've done that or not. I may have done some calculations before this time.

MR RENNIE:

Can we go back one page please to 29. The lower of the two emails on that page is Mr Jury replying to you saying that you shouldn't be stunned by his comments because you seem to have misinterpreted them. What he has been saying is that there needs to be strong evidence available before obvious intuitive failure mechanisms are discounted.

DR HYLAND:

Yes.

MR RENNIE:

And he goes on, "This must include careful evaluation of the ITHA results and the forces that are predicted in the slab to wall connections by those analyses." Do you see that?

DR HYLAND:

Yes, yes, yep.

MR RENNIE:

So Mr Jury's coming back to you in October drawing attention to the importance of not discounting possible failure mechanisms until the ITHA results are available isn't he?

DR HYLAND:

Yeah we, we, you know we were doing, you know, as I said scenario 4 took into account the scenario that was proposed by Professor Priestley and, and investigated that fully. We, we didn't find it to be the critical one but it was investigated fully.

MR RENNIE:

So which, which time history analysis process do you say investigated this?

DR HYLAND:

This is scenario 4.

MR RENNIE:

Yes.

DR HYLAND:

So, yeah, that's, that's what we, we investigated.

MR RENNIE:

And when do you say you ascertained that you had the evidence to explain to Mr Jury that his propositions were contradicted by the evidence?

DR HYLAND:

Well that came out in the report. Mr Jury was on the, the panel, the expert panel and he was kept up to date with the development of all these scenarios and was part of the, the committee that eventually approved the document. So we're talking about an issue in progress here and a lively exchange -

MR RENNIE:

Well we can see that.

DR HYLAND:

A lively exchange at the time.

MR RENNIE:

We can see that because if we look at the top email on page 29 you basically say, "Don't be offended but I'll leave you to your instincts for the present. Will catch up next week. I need to progress the report." That was how you dealt with Mr Jury's response wasn't it?

DR HYLAND:

Yes I did, yes I did.

MR RENNIE:

Yes.

DR HYLAND:

Yes.

MR RENNIE:

So in fact you had a settled view by October that this was a column failure and you weren't interested in any alternative proposition were you?

DR HYLAND:

I don't believe that's what's been shown sir.

MR RENNIE:

Now Mr Smith do you have any recollection of being asked by Dr Hyland to evaluate Mr Jury's questions of the 14th of October?

MR SMITH:

Can I just make a brief statement before I answer that?

MR RENNIE:

Yep.

MR SMITH:

Just to put the questioning on the emails into context, and I was copied that email. I submitted all of the emails that I either received or sent on the project being approximately 2800 in number and we received a list of some of those

1215

that you would like to ask questions on which is fine but we haven't had a chance to know what those questions are to review the emails or to check if there are other emails that may be relevant to the ones we're talking about but given that context I'm happy to answer the questions that the, yeah.

MR RENNIE:

Sure. My question was put solely on the basis of recollection. Do you have a recollection of Mr Jury's questions being raised with you by Dr Hyland?

MR SMITH:

I don't have a specific recollection of that query. I would, I could explain how we approach that with the analysis if you would like.

MR RENNIE:

Well I'll put it to you this way. Are you satisfied that the time history analysis which was underway in September/October evaluated the possibility that the slab was broken?

MR SMITH:

It did not evaluate the scenario that they were broken prior to February, if that's what you're referring to?

MR RENNIE:

Correct. That's what I'm asking.

MR SMITH:

It did not, I've already –

MR RENNIE:

It's not evaluation?

MR SMITH:

I've already explained that we assumed an undamaged state at the start of the February earthquake.

MR RENNIE:

Yes, the difficulty I put it to you with that is that if the building was significantly damaged prior to the 22nd of February, its occupancy might well have ceased?

MR SMITH:

Maybe.

MR RENNIE:

Well that would have made a huge difference, wouldn't it?

MR SMITH:

You mean, I didn't quite understand so you're saying if there was evidence of significant damage the building may have been vacated?

MR RENNIE:

Yes.

MR SMITH:

Okay, so.

MR RENNIE:

You see, we know that Mr Coatsworth examined the building between September and December, don't we?

MR SMITH:

Yes.

MR RENNIE:

And we know what his findings were?

MR SMITH:

Yes.

MR RENNIE:

But we are not aware of any examination of the building between Boxing Day and February are we?

MR SMITH:

No we're not. We relied on interviewing tenants and others but not an engineering assessment.

MR RENNIE:

There was no, but no.

DR HYLAND:

But there was, sir, the, we've had people go through that building who were looking at damage from a repair point of view and I think we had a very systematic approach from Mr Pagan who went through. He was a quantity surveyor and he was looking at coming up with costs to repair, now do you

think he would have seen items that would have needed repair such as cracks in slabs?

MR RENNIE:

And when did he go through?

DR HYLAND:

He went in after September sir.

MR RENNIE:

Yes, but not after Boxing Day did he?

DR HYLAND:

But we know the Boxing Day event was less or about half the demand on the structure than the September so –

MR RENNIE:

So are you saying that's what your assessment established?

DR HYLAND:

Yes, that's what the comparative assessment that I did showed.

MR RENNIE:

And what's the measure you're using to make the one-half evaluation?

DR HYLAND:

There was a comparative assessment done in the report using the ERSA, using the comparisons of the spectra so –

MR RENNIE:

The ERSA is a design tool, isn't it?

DR HYLAND:

Yes sir.

MR RENNIE:

It's not a forensic tool?

DR HYLAND:

It's a design tool like any tool sir. How do you define a forensic tool?

MR RENNIE:

Well, the difficulty unfortunately Dr Hyland is that I ask the questions and you do or don't give the answers. The forensic investigation is something I'm coming to.

DR HYLAND:

Okay.

MR RENNIE:

But the ERSA which you referred to involved taking a design tool which in its earlier form when Mr Harding used it in 1986 was known as Etabs.

DR HYLAND:

Yes.

MR RENNIE:

And putting into it various assumptions, in his case with a view to identifying whether the building that he was designing would be compliant or not. That's what it's supposed to be used for isn't it?

DR HYLAND:

Oh, you can use a tool for anything if you know how to use it.

MR RENNIE:

Yes, you can butter bread –

DR HYLAND:

We –

MR RENNIE:

- with a spade if you want to but let's –

DR HYLAND:

No but you can, but there is a tool kit available to engineers from hand calculations through to linear elastic 2-D analysis, 3-D static analysis, ERSA time history analysis, all of these tools are actually being used in this building so I do not understand why you would try to say that we're not allowed to use the ERSA. Do you have that expertise sir?

MR RENNIE:

The proposition that I put to you was that your discarding of these damage scenarios was based on using ERSA. That's what you told me?

DR HYLAND:

No, what I said, a comparison between the response of the building between two spectra from the September earthquake and December and the February indicated that response of the building using that methodology you would say that the response of the building to the September earthquake was twice what it would have been to the December one. Therefore if there was no damage apparent after the September earthquake which was twice as big in terms of building response from the December one, then you would not expect there to be damage, you know, in the December one, so why would you, why would you expect there to be more intensity to be put into analysis on December when September already showed there wasn't any problem.

MR RENNIE:

The input data that you were using you were saying earlier to my friend involved foundation and soil information from Tonkin & Taylor?

DR HYLAND:

Yes, that's correct.

MR RENNIE:

That information didn't exist when Mr Harding designed the building did it?

DR HYLAND:

He had a, he had a geotech report.

MR RENNIE:

Yes, he had a geotech report from Mr McCahon didn't he?

DR HYLAND:

I'm not sure the name of the person who provided it, but that could be the case.

MR RENNIE:

Did you run the ERSA putting Mr McCahon's information in?

DR HYLAND:

The model I used, which was just for comparison purposes, so using the same baseline for September, December and February, so the effect of the foundations was taken out in terms of comparative response, just showed that the September earthquake was two times, the response of the building would have been two times that of what it was in December and the February response would have been approximately 2.2 times what it was in September so for the purposes of comparison that was whether you use flexible foundations or not. That was you know using McCahon's or using Tonkin & Taylor wasn't an issue, it's a constant –

MR RENNIE:

You're now talking about using snapshot events on particular occasions instead of the end on end analysis that I was putting to you before, aren't you?

DR HYLAND:

Yeah, I, and I think I've given the reason for that.

MR RENNIE:

Mr Smith, were you involved in the processes just described by Dr Hyland? The ERSA evaluations?

MR SMITH:

I was involved in the code, are you, referring to that for code interpretations only.

MR RENNIE:

So you were not part of the testing process using ERSA with Dr Hyland has described?

MR SMITH:

Having said that we did refer in the panel report and elsewhere we did compare the response spectra from various recording stations for September, December and February to get some overall appreciation of relative intensity, shall we say.

MR RENNIE:

Because that's the key input data isn't it? You have to assume the intensity of the near field event so that you can know what values to put in so that you can test for the likely outcomes.

MR SMITH:

Sorry, I, I don't understand the question.

MR RENNIE:

Okay, well it may have been unfair to ask you but while I'm still asking you questions, do you defend the use of ERSA instead of NTHA for the evaluation through this period?

MR SMITH:

I think it's a qualitative tool only, other than for code interpretations.

MR RENNIE:

Yes, now the issue of ERSA is, and this is a question firstly for you Dr Hyland, is I think one could fairly say roundly condemned by Dr Priestley in his evidence, isn't it?

DR HYLAND:

I don't know. I mean the issue where you have to realise is ERSA is required for the design of the building. It is used, it is still used in the analysis of buildings by practitioners. From an academic level maybe it's not the most perfect tool but at a practitioner base that is widely used and respected.

MR RENNIE:

I'll try the question again. The use of ERSA in this way is roundly condemned by Dr Priestley, isn't it?

DR HYLAND:

I'm not sure what he says exactly about that.

MR RENNIE:

Have you, well you've replied to his evidence.

DR HYLAND:

Yes, I have, yeah.

MR RENNIE:

You've done a written reply.

1225

DR HYLAND:

Yes I have, yeah, yeah.

MR RENNIE:

Do you not recall what Dr Priestly says?

DR HYLAND:

I tried to address the issue sir that, that he may have an opinion about ERSA. I, my view is that it is an appropriate tool. It is one that is still being researched. I think if you look in my reply I mention some work that's been done by (inaudible 12:25:28) and he, at a recent paper presented at a conference I was at where he was looking at practitioner based use of ERSA, some improvements of it for use with the Eurocodes. So this is a, this is a tool that is, that is widely used and widely respected by practitioners and is useful when used within the limitations of its, of what it can do.

MR RENNIE:

I'll try the question once more, the use of it is roundly condemned by Dr Priestley, yes or no?

DR HYLAND:

What, what do you think sir?

MR RENNIE:

Dr Hyland it's possible that I could come over and give evidence and you could come and ask the questions. Whether it would be shorter I'm not sure. Could you now just answer the question. Do you agree, yes or no, that Dr Priestley roundly condemns the use of ERSA for this type of evaluation?

DR HYLAND:

We, Professor Priestley seems to have an issue about use of ERSA. I do not hold that view.

MR RENNIE:

Thank you. Now Mr Smith the current, not yet complete NTHA. This is currently being done on terms which involve a level of confidentiality I think.

MR SMITH:

Is that the, okay, you're referring to the input data or?

MR RENNIE:

Well particularly referring to the input data but more generally the position is that no-one yet knows the outcome of that work, do we?

MR SMITH:

We don't have an outcome at this stage.

MR RENNIE:

Correct. So in a sense your presentation with the reservation that you may yet change your view could be described as premature. Do you agree?

MR SMITH:

Well I, I'm keeping an open mind shall we say.

MR RENNIE:

Yes, thank you and can you confirm that the outcome of the work now being done will, in fact, be an end-to-end analysis of the nature that I was previously asking about?

MR SMITH:

I am aware when I left Auckland the work in progress was an end-to-end analysis for September and February. I am not sure about other aftershocks.

MR RENNIE:

Are you not aware of the request from the Commission that other aftershocks above a particular level be considered?

MR SMITH:

I'm, I'm aware but there are limitations on the time available and the, you know, so there were limitations on the computing capacity and time available.

MR RENNIE:

So to make sure that I've followed you, the Commission's request that other quakes above a particular value be included in the analysis may only be able to be accommodated to the extent that the computing capacity available makes that possible.

MR SMITH:

That's correct.

MR RENNIE:

Is that really what you're saying?

MR SMITH:

And, and the time available.

MR RENNIE:

Yes, yes, well computing capacity translates into the time of processing really doesn't it?

MR SMITH:

Okay, I accept that.

MR RENNIE:

Now it therefore follows does it not that there are a range of possibilities which could yet come out of that which may yet require revision of either the building

collapse report or its replacement by some updated report. Would you accept that?

MR SMITH:

I think it's premature to say that.

MR RENNIE:

I was only putting it as a possibility.

MR SMITH:

A possibility.

MR RENNIE:

Now one of the witnesses to be called by the parties I represent is Professor Mander. Do you know Professor Mander?

MR SMITH:

Yes I do.

MR RENNIE:

Professor Mander attaches significance to both the cumulative effect of successive aftershakes and the reduction in capacity of the building as a result of those cycles. You're aware of that?

MR SMITH:

Yes I am.

MR RENNIE:

Is that an analysis that you agree with?

MR SMITH:

We, we are aiming to, aiming to investigate that as part of this further analysis.

MR RENNIE:

Dr Hyland your view on that?

DR HYLAND:

Well I've, I've read Professor Mander's statement of evidence and I think he's, I guess he's raising a, you know another idea. My understanding he is, he believes that perhaps there was collapse initiated by failure of the slabs by perhaps some sort of fatigue or something or.

MR RENNIE:

Multiple cycles causing slab disintegration.

DR HYLAND:

Yes, yes, I mean I have some experience with fatigue. One of the things I guess that we have to think about with that scenario is what would have happened to the slab response if it had deflected a certain amount, yep, and was that enough for it to fail the slab or to cause, cause any damage and one of the things I notice is that that slab was designed as a continuous slab and it appears that the ends were tied into the slab to give it reasonable serviceability. What I mean by that is that it was, was a long span slab and if it wasn't tied into the ends with the reinforcing to provide some negative bending moment then the slab, there would have been significant deformation, you know, under its normal, normal conditions. It wouldn't have been serviceable as an office. It appears that the designer must have sort of assumed that he was going to get a reasonable performance out of the slab by, by putting that reinforcing in. Now after the, as I said before, those slabs are designed to be able to cope with deformations of span upon 50 as a minimum, 140 millimetres of displacement they can cope with before there's any damage to them, and for a slab to go to that level of displacement perhaps even from a, from a high acceleration, maybe .65 g or something, the response of the slab would have to change from say 4 hertz which is it's natural frequency, I've calculated and I think he's agreed, you would, you would have to go to something like 1½ hertz so that the response of that slab

would actually have to change significantly. The calculations I've done on that indicate that, and I've just done some rough calculations using hand calculation methods, and using just a simple beam method, indicate that at that sort of response the, the floor could be seen to move quite significantly, maybe 50mms or something but the stresses wouldn't be sufficient to yield the reinforcement. So, so when you're talking about fatigue you're talking about, if he's talking about high-cycle fatigue you're talking about millions of cycles. We tend to work on a base of two million cycles, that sort of serviceability type stress range is to start to initiate fatigue cracking. If you're talking about, which I think is where he's going, is low cycle fatigue which you're talking about fracture which is initiated, not so much from a fatigue mechanism but from, the initiation from a ductile notch, so where you've got perhaps a notch in your, in your reinforcing or something that may occur you need that, you need that reinforcing to go plastic and to be going cyclic plastic backwards and forwards and I've seen that occur when, when I was in Chile following the earthquake over there and there were some cyclic fractures of reinforcing that I did a presentation on to a conference in Auckland, at the Auckland University before the September earthquake and that requires significant deformation, particularly the bar has to, has to bend and buckle and come backwards and forwards and you will get low cycle fracture of, of bars like that but if you're going to get that sort of effect, cause of fatigue type behaviour you would have seen major spalling of the concrete after September earthquake and there really wasn't any of that. No-one saw that. There was no evidence of

1235

that cracking, the quantity survey didn't pick it up and the quantity survey will pick up anything that is going to cost the client money so that is his job, so he didn't see anything. The inspecting engineer didn't see anything. There was a crack, along I think near the south wall that Mr Coatsworth picked up, he picked up a crack. That crack could have been a shrinkage crack. If it did occur in September, well then it closed up it wasn't one that would have affected the response of the floor and certainly not one that would have been linked to you know, plastic cyclic fracture of the reinforcing. So I find it hard to see how you could expect there to be fatigue, you know fatigue of the

reinforcing steel in that slab because of the September earthquake and the following aftershocks up to February I just, from a fatigue engineer –

MR RENNIE:

Do you know how many aftershocks above a value of five there were between September and February?

DR HYLAND:

No I am not sure.

MR RENNIE:

You referred to the low cycle fatigue leading to the fracture of bars. Do you recall referring to that?

DR HYLAND:

Actually yes.

MR RENNIE:

In this building there will be such bars between the foundations and the shear walls, won't there?

DR HYLAND:

Sorry, you mean?

MR RENNIE:

In this building there will be such bars between the foundations and the shear walls?

DR HYLAND:

That have been subject to cycle fracture?

MR RENNIE:

I am just starting with the bars, we will worry about whether they are fractured afterwards.

DR HYLAND:

Okay so you are saying that there were in the columns or in the –

MR RENNIE:

No, no I am talking about the shear walls being connected to the foundations by metal bar?

DR HYLAND:

Yes reinforcing steel, yep, yep.

MR RENNIE:

There will be such steel.

DR HYLAND:

Yes.

MR RENNIE:

And in the low cycle fractures, the fatigue fractures that Professor Mander is talking about, those are bars that may break in low cycle fatigue?

DR HYLAND:

Well low cycle fractures as I said, you have got to get cyclic you know, for earthquake type fracture you have got to get those bars really deformed in elongated and so you are getting spalling of concrete when you get into that type of...

MR RENNIE:

But let's forget about what you have to get. We are just concentrating on the fact that the bars and there and conceptually general proposition, they are capable of fracturing under low cycle fatigue?

DR HYLAND:

Well if you can get the loadings into them yeah, you can –

MR RENNIE:

They are capable of fracture. It is actually that failure which is going to lead to the demolition of the IRD building just across the road from this site, isn't it?

DR HYLAND:

I don't know I haven't investigated that one sorry.

MR RENNIE:

The CTV building, the north tower, the lift tower was standing at the time that you and Mr Smith commenced the inspection, wasn't it?

DR HYLAND:

Yes it was, yep.

MR RENNIE:

And at the south shear wall level the lowest level of the south shear walls was actually the first exhibit marked E1 by Mr Frost wasn't it?

DR HYLAND:

Yes, E1, yep.

MR RENNIE:

You remember seeing that there?

DR HYLAND:

Yes I inspected each of those on site, yep.

MR RENNIE:

Did you inspect the bars between that part of the shear wall and the foundations below it?

DR HYLAND:

No it appeared someone had jack hammered the concrete out for some reason, so I concluded they had been affected by the demolition work.

MR RENNIE:

Now the north tower, they were unaffected until the tower was demolished, weren't they?

DR HYLAND:

Unaffected by?

MR RENNIE:

Demolition.

DR HYLAND:

Yes that is right, yep.

MR RENNIE:

And in fact you requested that the tower not be demolished until 20th of May 2011?

DR HYLAND:

Yeah I didn't request it to be demolished at all but we were asked by CERA if we had finished with it and we got a memo through the Department of Building asking whether we had finished with it or not and at that time I had seen it twice and been up it twice and photographed it, measured drag bars, measured where reinforcing was or wasn't coming out of the wall at the ends and so yeah we didn't have anything more to do with it.

MR RENNIE:

Were you taken up in an inspection platform by a crane were you?

DR HYLAND:

Yes once I was taken up in a man cage and the second time I was in a fire service snorkel with Mr Smith.

MR RENNIE:

Did you consider that you had authority to retain the north tower for such time as was needed for forensic investigation?

DR HYLAND:

Yeah we had what we needed from it and we knew that when it was demolished –

MR RENNIE:

No, no, no, the question was about authority. Please listen to the question. Do you consider you had authority to retain the north tower –

DR HYLAND:

I didn't have authority to do -

MR RENNIE:

No, okay, who had the authority?

DR HYLAND:

CERA I understand.

MR RENNIE:

One of the key elements in a forensic investigation is in fact the collection and retaining of the key exhibits, isn't it?

DR HYLAND:

Yes, yes.

MR RENNIE:

You mentioned talking at a seminar in Auckland about the Chilean earthquake you recall mentioning that?

DR HYLAND:

Yeah I just –

MR RENNIE:

Were you in Christchurch on the day of the earthquake, the 22nd of February?

DR HYLAND:

The 22nd, no I was actually in Wellington.

MR RENNIE:

Did you know that there was a conference, a seminar being held that morning on forensic engineering in Christchurch?

DR HYLAND:

Yes I understand there was. Interesting timing wasn't it?

MR RENNIE:

Are you aware whether that seminar was held in any centre other than Christchurch?

DR HYLAND:

I think it might have been, yeah.

MR RENNIE:

Did you attend it?

DR HYLAND:

No I didn't sorry.

MR RENNIE:

One of the purposes of that seminar was to equip members of the New Zealand engineering profession with the knowledge and systems required for forensic engineering, do you agree?

DR HYLAND:

Yeah, it would be great.

MR RENNIE:

Mr Smith, did you go that seminar?

MR SMITH:

No I didn't.

MR RENNIE:

Mr Smith, you state in your evidence that forensic engineering is an interest of yours?

MR SMITH:

It has become an interest with the two projects that we've studied. The collapse of Stadium Southland and the CTV collapse but also other projects that have not been collapses but have had problems that we have investigated, yeah.

MR RENNIE:

Yes the two of you at the time of the 22 February earthquake had a contract with the Department to investigate the Stadium Southland collapse, didn't you?

DR HYLAND:

That is correct.

MR SMITH:

Correct, yeah.

MR RENNIE:

And that stadium collapsed in approximately the middle of October in the previous year?

DR HYLAND:

That's right.

MR RENNIE:

That was a structural steel building not a concrete reinforce building, wasn't it?

DR HYLAND:

Oh, it had mixtures. I mean there was concrete columns supporting the steel roof. We had to investigate that, look at buckling of the columns, they were quite slender, you know, and more slender than the ones on the CTV building by quite a bit.

MR RENNIE:

The findings and that related to workmanship in respect of structural steel didn't it?

DR HYLAND:

Oh, there was a range of findings. I mean the report is on the website.

MR RENNIE:

And the reporter states that its issue in May of this year was delayed because one of you was caught up in the Christchurch earthquake in the early stages. Which of you was that?

DR HYLAND:

That was me Sir.

MR RENNIE:

And what was the first date that you were in Christchurch?

DR HYLAND:

Oh, I can't remember, I had been assisting the Christchurch City Council after the September earthquake setting up the data management system for the building safety evaluation systems and when the February earthquake occurred I was asked to go back and just see how they, how the systems had moved on and you know just see how things were going and I recall it was reasonably early on, maybe a day or two afterwards.

MR RENNIE:

So is it the position from what you were saying that at least in respect of the north tower you couldn't preserve that for forensic purposes because it wasn't held by you but by CERA?

DR HYLAND:

Yeah I believe the authority over the, that CBD area was held by CERA and they were in charge of that.

MR RENNIE:

The Christchurch *The Press* of 12 May and we can put this in if needed shows the tower being demolished on that day?

DR HYLAND:

Okay.

MR RENNIE:

That is earlier than the 20th you had requested. Did you know that?

DR HYLAND:

I don't know Sir.

MR RENNIE:

Did you go down and look at the demolition of the north tower?

DR HYLAND:

No what we did was we had, when they said they wanted to demolish the north tower one of the things we made sure is that we got a CERA engineer to act on our behalf to look at the condition of the

1245

foundations before it was demolished. It was John Snook and we asked him to get the contractors to lift the slabs, big bits along the sides of the foundations and so that's reported in the site examination, the materials testing report.

MR RENNIE:

Did he investigate whether the bars between the north tower and the foundations showed signs of low cycle damage or fracturing?

DR HYLAND:

He found there weren't any cracks so that would indicated there wasn't any low cycle fracturing.

MR RENNIE:

You're saying he found there was no cracks in the concrete? Did not retain the bars?

DR HYLAND:

No, sorry he, he didn't see any cracks so there was no evidence of distress there, and certainly no evidence of low cycle fracture like I've been describing to you sir.

MR RENNIE:

Neither were the drag bars retained from the demolition of the north tower were they?

DR HYLAND:

No they weren't but we knew that all that material was going to a secure area at the, um, Burwood Landfill. It was, it is still there so all that material is there if it is considered that, um, someone really needs to look at, ah, you know do a test on a piece of steel from a drag bar they could dig it out I'm sure if that's needed. I didn't believe we needed to. I think we'd got enough information.

MR RENNIE:

Do you say that the north tower is all at Burwood?

DR HYLAND:

I understand that's the case.

MR RENNIE:

There was a considerable body of material retained on site that Mr Frost had both put aside and marked with coding letters wasn't there?

DR HYLAND:

Yes, yeah that was excellent that he did that.

MR RENNIE:

And he had notes which he had prepared identifying what they were?

DR HYLAND:

Yeah I didn't see those notes until I saw his statement of evidence but, um, I talked to him after I heard that he'd been involved and I interviewed him and he gave me some valuable information.

MR RENNIE:

Did you take a brief of evidence from Mr Frost?

DR HYLAND:

No I didn't take a brief of evidence. I interviewed him though.

MR RENNIE:

Did you record the interview?

DR HYLAND:

Ah, yeah I think there were notes that are, that are on the, were placed on the DBH website that I think have been passed through to the Royal Commission.

MR RENNIE:

Are you familiar with the practice of the investigation of accidents in the transport field?

DR HYLAND:

No I'm not involved in transport. I'm a structural engineer sir.

MR RENNIE:

I wasn't suggesting you were, but there's a parallel is there not between the Transport Accident Investigation, Commission Investigation and the Building Accident Investigation?

DR HYLAND:

I'm not aware that in New Zealand we have any specific guidelines for investigation or collapse after an earthquake.

MR RENNIE:

Would one then look at the North American guidelines as made available by the organisation which Dr Shepherd has headed?

DR HYLAND:

Um, yeah look I've looked at some of those things but they're not, um, you know they're not a requirement to follow those, they're not a recommen – you know they're not a practice that is legislated in New Zealand.

MR RENNIE:

Mr Smith are you familiar with what I'm talking about?

MR SMITH:

Yes I have seen that in Mr Shepherd's evidence. Professor Shepherd's evidence.

MR RENNIE:

And are you aware of the standard processes for forensic investigation in transportation accidents?

MR SMITH:

I, that is one of the things that I personally initiated the investigation for Stadium Southland based on knowledge that I had of what was done for air accidents, but to my knowledge that's the first time it's been put in practice so.

MR RENNIE:

Some of the key elements include securing and retaining all the exhibits?

MR SMITH:

Yes.

MR RENNIE:

They include recording all interviews on a sound and transcription basis? These are standard processes in aviation aren't they?

MR SMITH:

Now I would just point out that, shall we say I wouldn't mind starting with Stadium Southland just to say that my knowledge of what's done in the air industry is limited but I thought it had a parallel so we should do a similar thing. With Stadium Southland we found we did not have powers to do that. We did not have a power to cordon off the site and retain everything and so

there's limitations on what we could do. If we move onto the CTV building collapse much of the material, or most of the material had been moved or taken away from the site before we even got engaged to carry out that job or visited the site, so there certainly were compromises as far as what is the ideal practice.

MR RENNIE:

Yes I appreciate that the saving of human life and the investigating the loss of human life runs ahead of the forensic work?

MR SMITH:

Yes.

MR RENNIE:

And this is an acute example of that isn't it?

MR SMITH:

Yes it is.

MR RENNIE:

But the fact remains that a forensic process by its very definition is intended to assemble all the evidence so that it can be examined, not only by the investigators but in turn by such bodies as a Royal Commission, you'd agree with that?

MR SMITH:

Yes, ideally.

MR RENNIE:

Do you agree with that Dr Hyland?

DR HYLAND:

Yeah, as best we can. I mean we have to take a pragmatic approach, um, you know, once we'd photographed and measured things and you know taken the cause and things and we had no reason for those pieces to be left at the site. Um, there was quite a bit of pressure to have the site cleared in the interests of the public, so you know, and these things were huge pieces of material, you're not talking about you know, instruments out of an aircraft, you're talking about big concrete beams and you know, moving them and shifting them was quite a logistical problem, so you know they would've been damaged on the way out there and it was just the way it was. So in terms of the, what we needed for engineering investigation to determine the collapse of a building, we had what we needed and we knew that the evidence was there if people needed to, to follow it up further in a more detailed level.

MR RENNIE:

So what you're saying is that if anybody other than you wants to look at the evidence, go to Burwood and go look?

DR HYLAND:

Sure, well yeah.

MR RENNIE:

But in fact a number of the key samples retained by Mr Frost went to Opus for testing didn't they?

DR HYLAND:

No, no which ones do you mean?

MR RENNIE:

Do you accept that Opus tested a number of elements from the building site?

DR HYLAND:

Yeah I directed testing of a number of elements.

MR RENNIE:

Yes, that included columns?

DR HYLAND:

Yes, yes, yeah. That's outlined in the site examination and materials report.

MR RENNIE:

And none of that then went to Burwood did it, it was thrown out?

DR HYLAND:

No it was taken to the, to Burwood. The only, only bit that was, that was not taken to Burwood was a portion of column C18 which we had cut off at the, it was still standing, so, ah, we extracted that and they took it back to their test laboratory, cored some holes, did the tests, photographed it, um, and then once they'd finished with it, it was disposed of.

MR RENNIE:

Column C18 just happens to have been the column reported as having the weakest concrete strength doesn't it?

DR HYLAND:

Yes, yes, yeah.

MR RENNIE:

So the opportunity now to find a) whether that is correct, and b) if so why? Is now gone isn't it?

DR HYLAND:

Well I don't think there's any argument about whether their testing was correct. Are you, are you saying that?

MR RENNIE:

Dr Hyland I think you're missing the point with respect. The point is you considered, and I think it seems to be you rather than you and Mr Smith, that you didn't need this material any longer. But it wasn't retained in the way that a forensic investigation would retain material was it?

DR HYLAND:

Ah, well I've just been through it. The, all the material was taken to the Burwood Landfill.

MR RENNIE:

That's an area of the order of about two to three football fields isn't it?

DR HYLAND:

Yes but it's secure and, ah, the CTV material is on a secure spot, separated out.

MR RENNIE:

In the sense that it's all physically in the same space?

DR HYLAND:

It's all physically there.

MR RENNIE:

Apart from column 18. Do you say it's labelled?

DR HYLAND:

Sorry?

MR RENNIE:

Do you say it is labelled?

DR HYLAND:

What is labelled?

MR RENNIE:

The material at Burwood?

DR HYLAND:

Ah, it's in a designated area. It was what I understood, that, um, CERA had put it in a designated area.

MR RENNIE:

And have you been out to have a look?

DR HYLAND:

Yes I went right through the field at the time and, ah, I talk about that in the examination. That's how I found the column.

MR RENNIE:

The time being when?

DR HYLAND:

Sorry?

MR RENNIE:

The time being when?

DR HYLAND:

Ah, when I was doing the extraction of the columns for testing.

MR RENNIE:

Yes, since then?

1255

DR HYLAND:

No, no I haven't been out there since then.

MR RENNIE:

You made a throwaway remark about aviation investigations just keeping a few instruments. Are you not aware that whole aircraft are kept in hangars securely sometimes for years under the aviation process?

DR HYLAND:

Yeah, but we don't have that sort of regulation in the, in this building situation. I don't think there's anything in the Building Act around how we, how we're to do that, so there's no regulations that I'm aware of.

MR RENNIE:

Why would it need a regulation?

DR HYLAND:

Well I think that's maybe something that the Commission will be looking at.

MR RENNIE:

It would simply need a decision by the relevant government department to make the facility available wouldn't it?

DR HYLAND:

To, sorry, to?

MR RENNIE:

To make the facility available, the storage or the warehouse or whatever is required?

DR HYLAND:

Yeah there wasn't any, any Act that I'm aware of that governs the investigation of building collapses in New Zealand that mandates that certain things must be done.

MR RENNIE:

I, I, look, we're not talking about Acts. We're talking about best practice forensic investigation. I understand that both you gentlemen considered you were conducting a forensic investigation?

DR HYLAND:

We were conducting an investigation into the collapse of the CTV building.

MR RENNIE:

Well let me put it to you this way. Do you consider yourself, Dr Hyland, to be a specialist forensic engineer?

DR HYLAND:

Um, all I can say is that I've undertaken investigations on behalf of the Department of Building into the collapse of Stadium Southland, and I was appointed to take, undertake the investigation into the collapse of the CTV building, I was also engaged to do a examination, site examination of the collapse of the Forsythe Barr stair. I was engaged to undertake site examination of PGC building. I have undertaken evaluations of buildings that have been collapsed or damaged in Indonesia as part of the Earthquake Engineering Society an NZA team that went up there. Ah, I have been on reconnaissance trips with New Zealand Society of Earthquake Engineering looking at the damage of buildings following severe earthquakes, so I have experience with evaluation of buildings that have been damaged in earthquakes. I have experience with testing of materials and setting up testing programmes of materials, and I have experience in analysing structures. So that's, that's my credentials sir.

MR RENNIE:

Now the simple question. Do you consider yourself yes or no a specialist forensic engineer?

DR HYLAND:

Ah, well I'm getting more experience in that area sir.

MR RENNIE:

Mr Smith?

MR SMITH:

Ah, I would not consider it my primary expertise, but it is a considerable expertise.

MR RENNIE:

The magnitude of this engineering failure in terms of the consequences, human life particularly, but not just human life, means that this will stand out as the engineering issue in New Zealand for a number of years to come, won't it?

DR HYLAND:

I think there's a huge number of lessons that we're going to learn from this.

MR RENNIE:

So the investigation of it I put it to you had to reach the level of skill that the importance of the matter justified?

MR SMITH:

Yep.

MR RENNIE:

You agree with that?

MR SMITH:

Yes I agree, yeah.

DR HYLAND:

I agree with that.

MR RENNIE:

And I take it that both you gentlemen presented yourselves to the Department of Building and Housing as having the knowledge and skills required to conduct this investigation? Do you agree with that?

DR HYLAND:

Yeah we laid out our credentials before the Department and they, um, believed we were capable for the job.

MR RENNIE:

Did it occur to you to involve an expert forensic engineer from for example California as part of the team?

DR HYLAND:

No it didn't, no.

MR RENNIE:

And did that represent a confidence that between you, you had the sufficient skills to actually carry out this exercise?

DR HYLAND:

Yes.

MR RENNIE:

Do you still believe that to be the case today –

MR SMITH:

Yes.

MR RENNIE:

– each of you, one by one?

MR SMITH:

Definitely.

DR HYLAND:

Yes I do with the knowledge that we had the expert panel to review things as well so.

MR RENNIE:

Now on the 6th of April 2011 the Minister of Housing announced that several firms including your two firms had been retained to carry out investigations into four named buildings and possibly further buildings in Christchurch. You recall that?

MR SMITH:

Yes, I remember there was an announcement.

MR RENNIE:

And associated with that was a set of terms of reference?

MR SMITH:

Yes.

DR HYLAND:

Yes.

MR RENNIE:

Mr Smith in your brief of evidence you say, and I can give you the reference if you need it, that on the 14th of April the two of you presented a proposal to the Department to carry out the work. Do you recall that?

MR SMITH:

Yes I do.

MR RENNIE:

So is it that you were engaged and announced first and then detailed what you were going to do second, Mr Smith?

1301

MR SMITH:

That is correct.

MR RENNIE:

So in terms of presenting your credentials was there some earlier event than the 6 April announcement at which you stated your case for this work Mr Smith?

MR SMITH:

Ah, we – I guess we were, had the previous experience on the Stadium Southland so the Department was aware of our credentials prior to that.

MR RENNIE:

Yes you were currently working for the Department at that time, weren't you?

MR SMITH:

That is correct.

MR RENNIE:

So to what extent was there any detailed examination as to whether you had the skills and resources for this investigation before the Minister announced it on the 6th of April?

MR SMITH:

Maybe a question for the Department.

MR RENNIE:

Now the person dealing with the matter in the Department seems to be a Dr Hopkins, is that correct?

MR SMITH:

He's the project manager, yes.

MR RENNIE:

And Dr Hopkins has the title Senior Advisor Building Standards in the Department, is that correct?

MR SMITH:

I am not sure what his title is.

MR RENNIE:

Do you know Dr Hyland?

DR HYLAND:

I think that is correct.

MR RENNIE:

And is that a fulltime engagement as part of the Department?

DR HYLAND:

I think you need to direct that to the Department, I am not sure of the –

MR RENNIE:

Well put it this way, it doesn't appear that Dr Hopkins is going to give evidence so who do you suggest I should ask?

DR HYLAND:

I would just ask the Department.

MR RENNIE:

Shall I drop them a note or send them an email or something like that?

DR HYLAND:

Yes, you could.

MR RENNIE:

Okay, we'll see. Now, on the 11th of April the Government announced the establishment of this Royal Commission. Did you know on the 6th that that was going to happen?

DR HYLAND:

Oh, you are sort of putting dates there. I can't tell you the exact dates of these things but...

MR RENNIE:

I am not asking you to confirm the date. I will take responsibility for that. I am just telling you as a fact that on the 11th, that is the date of the Royal warrant of this Commission, the first warrant?

DR HYLAND:

Yes.

MR RENNIE:

Five days previously on the 6th the two of you had been appointed to carry out the terms of reference which I am going to come to after the break. Did you know on the 6th that there would be a Royal Commission announced on the 11th?

DR HYLAND:

I can't recall.

MR SMITH:

No I can't either.

MR RENNIE:

When you were asked to be involved was it explained to you how the work that you would be doing would fit in with the work of the Royal Commission?

MR SMITH:

Ah, I mean from my point of view I would like to know the date of the first panel meeting because I think that is when we had the first briefing for the project shall we say.

MR RENNIE:

Yep.

MR SMITH:

I can't recall that date sorry.

MR RENNIE:

I can't give it to you immediately but I will after lunch. So that would be when you were first aware of the scope and (inaudible 13:04:04) to the project?

MR SMITH:

That is correct.

MR RENNIE:

And did the briefing at that meeting include a briefing on the relationship of the Royal Commission?

MR SMITH:

I can't recall.

MR RENNIE:

At all times up to the time when you completed your building collapse report, did you consider that you were doing that report solely for the Department or also for the Royal Commission?

DR HYLAND:

Oh, we knew that the Royal Commission would be – it would be referred to the Royal Commission and that there would be some exchange.

MR RENNIE:

Were you expecting that the report would go to the Department and the Department would transmit it to the Commission in such way as it saw fit?

DR HYLAND:

Yes.

MR RENNIE:

Although in fact Dr Hopkins hasn't come to present to the Commission, you have. That is the case isn't it?

DR HYLAND:

Yeah I mean we were contracted to the Department to do the report. I had to do the site examination, the materials report and we did the collapse report jointly so those were our two deliverables to the Department.

MR RENNIE:

And one of the curiosities is that at the foot of each page of the building collapse report you two gentlemen claim copyright in it, don't you?

DR HYLAND:

Ah, yep, yep that is normal, you know subject to the client's, I have got provisos from them.

MR RENNIE:

So it is your report or the Department's report?

DR HYLAND:

It is ours, it says on the cover for the Department of Building and Housing so we've undertaken the report for the Department of Building and Housing.

MR RENNIE:

But as copyright holders I am going to quote from it after lunch do I have your permission to do so?

DR HYLAND:

Definitely.

COMMISSION ADJOURNS: 1.06 PM

COMMISSION RESUMES: 2.18 PM

MR RENNIE:

Mr Smith, before the break you told me that your recollection was that you first learnt about the terms of reference of the Royal Commission and the enquiry investigation at or about the time of the first panel meeting. Do you remember telling me that?

MR SMITH:

Yes, yes.

MR RENNIE:

We've now located the date. The first panel meeting was on the 30th of March 2011 and the minutes show you as attending. So that would –

MR SMITH:

Okay.

MR RENNIE:

- give you a date in that respect.

MR SMITH:

Sorry, what was the date again?

MR RENNIE:

30 March.

MR SMITH:

3-0, yeah.

MR RENNIE:

3-0 March 2-0-1-1.

MR SMITH:

Okay thank you.

MR RENNIE:

Just while we're on the matter of the expert panel, the expert panel met on a number of occasions in person in 2011 and the dates that have been provided by the department show meetings in March, April, May, June, July, August, a meeting on 20 October 2-0-1-1 and I'm just going to ask now, and I apologise if you won't have this number but it's 249.049, sorry, I'll try again, 0459A.8, 0459A.8. If we could just that brought up. If you look at the lower part of this Mr Smith you will see E2 at paragraph 8 of your letter. Do you see that?

MR SMITH:

I see, yes.

MR RENNIE:

Now this is a DBH reply to a number of questions put by the solicitors instructing me and the question which was put as you will see was a request to confirm that there were no further documents in relation to the expert panel

meeting after 21 October 2011. Do you see that? And the Department's answer was, "I can confirm that the last expert panel meeting was held on 20 October 2011. The expert panel's subsequent work was done via an exchange of emails and discussions of drafts of the reports." Do you see that?

MR SMITH:

Okay, so just to clarify, is this correspondence from the Department?

MR RENNIE:

This is from the Department to the solicitors instructing me.

MR SMITH:

Okay.

MR RENNIE:

My question is, is that consistent with your recollection that the expert panel did not meet again after 20 October?

MR SMITH:

I, I'm not certain of that but that could be right.

MR RENNIE:

Now the draft report, the next draft report because there were several, was not issued until the first week in December was it?

MR SMITH:

Look again I'm, I had several, certainly –

MR RENNIE:

Yes.

MR SMITH:

- many copies of the draft report.

MR RENNIE:

Do you recall that there was a copy of the draft report which Alan Reay Consultants Limited replied to in some detail?

MR SMITH:

Yes I do, yes.

MR RENNIE:

And that reply came in on about the 22nd of December 2011.

MR SMITH:

Yes, okay.

MR RENNIE:

I can show you the reference if necessary.

MR SMITH:

Yes, no I recall that.

MR RENNIE:

And the, the draft report, that's your draft report, the building collapse report that I'm talking about then had some alterations and revisions made to it before being issued in its final form dated the 25th of January, actually released I think around about the 8th of February. Do you recall that?

MR SMITH:

Correct, yes.

MR RENNIE:

So does it then follow that the expert panel did not meet after 20 October and in that sense did not meet as a panel in relation to those last two stages of the report process?

MR SMITH:

Yes I believe that's, not after the 3rd of December?

MR RENNIE:

Yes.

MR SMITH:

I'm quite confident of that, yeah.

MR RENNIE:

Yes. So when the expert panel issued its report on your report that must have been created off the top of your report I take it.

MR SMITH:

There was interaction between the panel report and, and our report. We, there was cross-communication sometimes so, yeah.

MR RENNIE:

Now you were not involved in that process or were you?

MR SMITH:

I was certainly involved in the email correspondence and, and teleconferences.

MR RENNIE:

So as you understood it was that simply an exercise of trying to write a panel report from the conclusions of the building collapse report?

MR SMITH:

No I think, as I say I think there was communication both ways. That there was some elements included in the panel report which we felt would benefit being, also being included in our report. So it worked both ways.

MR RENNIE:

Does it follow that the two reports could therefore be said to be aligned by the time they were both issued?

MR SMITH:

As best we could align them given the I suppose variances of opinion on some issues. We, we did intend that they be aligned as closely as possible, yes.

MR RENNIE:

Aligned, to be clear in my mind, means consistent between the two so you got the same answer whichever you read. Is that how you took it?

MR SMITH:

The same conclusion, yes.

MR RENNIE:

Yeah. Now Dr Hyland I'm going to ask that you be shown a document which I think you do have the reference for, 249.0125.230. I'm sorry, 249.0125.230.

DR HYLAND:

Yes, I've got it, yeah.

MR RENNIE:

25238 and I'm looking for 230.

DR HYLAND:

Right, yeah.

MR RENNIE:

I could possibly think of a question about that page but I think I'll just wait for 230. Now this is the draft report at an earlier stage, and I'm going to ask you Dr Hyland to look at point 4 of the conclusions and point 4 states, "It has been difficult to reconcile the damage predicted by the analysis with reports of damage by others after the Darfield earthquake. The analysis generally indicated a higher level of damage than was reported." Do you see that?

DR HYLAND:

Yes, I do.

MR RENNIE:

So at that stage in the draft report you were actually reporting damage after Darfield and prior to Boxing Day or February as not only existing, being higher than what was reported. Do you see that?

DR HYLAND:

What I said there was that it was difficult to reconcile the damage that was predicted by the analysis with the reports of the damage. The analysis seemed to be predicting higher demands than was commensurate with the damage that had been observed.

MR RENNIE:

Yes. In fact in one of the first runs of the analysis it actually showed the building failing on the 4th of September didn't it?

DR HYLAND:

There was, there was, yeah that indication with the NTHA that it, it seemed to be indicating, you could interpret it that way and so, yeah, that's right.

MR RENNIE:

That's right. Now by the final report, and the reference for this is 0189.259, paragraph 4 has become somewhat different hasn't it? Sorry, it's now

paragraph 6. Now it says that overall the output of the NTHA analysis was not inconsistent with the reported condition of the building after 4 September 2010. Do you see that?

DR HYLAND:

Yes I do, yeah.

MR RENNIE:

So are you saying there were more NTHA analyses which were run between those two draft reports?

DR HYLAND:

What we'd done is look at the, look at this issue of calibration and there was quite a bit of discussion with the team which included the expert panel and we, it was, and it's still a difficult area to reconcile.

MR RENNIE:

This is part of the, the calibration's part of what's being worked on now isn't it?

DR HYLAND:

Look I think they were still trying to do it. I think it's, it's, it's, the issue is how do you reconcile the, the behaviour we're getting predicted by a computer model to what we see in reality and, you know, with the best modelling that we could do it was still difficult to fully convince everyone on the panel that the model was predicting the damage that we saw. Some, some took the view it was not inconsistent. Some said it was. So this statement is a, is the attempt at a consensus view from the team to say it's not inconsistent for some, it is consistent for others, it's, it's sort of a half way house (inaudible 14:29:52).

MR RENNIE:

So is this one of these places that Mr Smith was telling me about where the final report by the two of you was brought into alignment with the panel view?

1430

DR HYLAND:

Yeah, we worked in this, I think you can see by the number of meetings that we had with the expert panel right through the process there was a consistent attempt to report our findings progressively as we developed findings and to take on board the views of the panel as best we could. There was a team effect and we just as you know there's a lot of effort went in to try and accommodate the different views from leading experts that we had on that panel.

MR RENNIE:

So the panel was forming views of your own draft materials investigation report and of your joint BCR report reaching a view and then feeding it back into your report? Is that what was happening?

DR HYLAND:

Yes, we were getting, there was a feedback, feedback loop. We appreciated that.

Mr RENNIE:

Now we come back to the question I asked you which was, had you done further NTHA analysis between the draft and the final report?

MR SMITH:

From the 7th of December one?

MR RENNIE:

Yes.

MR SMITH:

I don't think we had –

MR RENNIE:

So in fact what we have here is a reinterpretation of the existing data to align with your view of what you thought happened?

MR SMITH:

Can I just make a comment?

MR RENNIE:

Certainly.

MR SMITH:

I personally have the view that the results were not inconsistent so not only was it between us and the panel group but between us and that was on the basis that I was aware of the limitations of the analysis that we had to accurately predict those failure points so, I'm comfortable with the wording 'not inconsistent', I think it's possibly Clark that's not –

MR RENNIE:

But the pressure, Mr Smith, at this time from the department was to come out with a single conclusion and finding, wasn't it?

MR SMITH:

Yes, I think there are various levels, there was the whole report, there's the exec summary, the panel report and then what we went to the media was a condensation process to get a one-liner, you know, what happened. We do lose some of the context in doing that so, yeah.

MR RENNIE:

So just, because this is important, at this point in time the alignment process we're talking about meant moving from several possible scenarios, each of them ranging from possible to probable, to a requirement from the department that there be one outcome, one conclusion, as you put it one sort of short line for the media? That's what you were being asked to deliver wasn't it?

MR SMITH:

Well, that was beyond, I did the report, the department was involved in the media thing so but yeah, what you're describing is correct but they needed a concise statement.

MR RENNIE:

Dr Hyland?

DR HYLAND:

Well, I mean I didn't feel that they were trying to push it one way or the other at that point, I think it was, you know we had these four scenarios. We had analysed them using the various methods. We'd, we had the collapse evidence, we had the testing, we had the witness statements and we put all those together with them and I, you know, like we, I think we did in the presentation there was sort of like a funnel effect so you say well we've got all this evidence, got these four scenarios, which one tends to fit best with the evidence of all of these things that, all those things and the conclusion we came to and it was the majority view of the panel was that scenario 1 appeared to be the most consistent, scenario 2 was probably next in line, there was the potential there for vertical acceleration effects on an internal column with perhaps weak concrete strength to maybe have initiated a collapse in that zone, scenario 3 the detachment of the level 2 and level 3 diaphragms from the north core was quite realistic as well but didn't seem to quite match up with the collapse evidence as well and then scenario 4 detachment from the north core again quite a reasonable scenario but again didn't seem to match up with what we saw in terms of the actual, the way the debris had fallen so, that was just a view that we came to.

MR RENNIE:

Beam joint failure?

DR HYLAND:

Beam joint failure was considered in there but I think the thing to remember with being column joint failure is that we saw column hinging behaviour so we did actually see column hinging in the collapse evidence I put up yesterday to give the spandrel one so if you can accept that you had column hinging occurring then that to me probably precludes beam column joint failure occurring prior to that but the, as we said again, the vulnerabilities in the structure were such that there was only, if one thing didn't go there, there was something which could have gone so we just sort of talking about a pack of cards and just kicking one out and the whole thing gone.

MR RENNIE:

One of the elements in your preferred scenario involved the concept that the concrete was weak, that's correct?

DR HYLAND:

The –

MR RENNIE:

In the columns?

DR HYLAND:

Oh in the columns, yeah, well we looked at the effect of weak concrete and the effect of that would be if it occurred in a particular column then that could have been initiated, could have contributed initiation but the problem we have is that we don't know where that particular weak concrete may have been so it's, what we decided to say is that the primary considerations were the lack of confinement, reinforcing, the hoops, the spirals, there was effects, other contributing effects such as spandrel panel interaction, weak concrete, vertical accelerations, beam column joints, drag bars, things like that and so we said well these are all things which can and could have contributed to the collapse, very difficult to quantify which and how much at a particular point.

MR RENNIE:

But the final report, nonetheless, placed some reliance on the concept that elements of the concrete in the columns was weak, that's correct?

DR HYLAND:

Yeah, I think we said the wording was, was does it say there? Just try and find it. Yeah, page 31, the BCR, says, “The following factors were identified as likely or possible contributors to the collapse.” So we said these are candidates, these are vulnerabilities, how you rank them difficult to -

MR RENNIE:

Now I know we get to the concrete another day, but this is a question for both of you. How do you explain doing the assessment of the 4 September position on the basis that the columns and beams meet the specification yet you identify weak concrete as part of the explanation on 22 February?

DR HYLAND:

Not sure what you –

MR SMITH:

I don't think we used the same assumptions for concrete strength in both analyses, September and February.

MR RENNIE:

So you're saying you did or you didn't?

MR SMITH:

We did.

MR RENNIE:

But at the time that you first analysed the 4 September you had no information about the concrete did you?

MR SMITH:

No, what we said, when we, we didn't say that, I think you're referring to the point where the time history was put on hold for a time before we had the input data established that was quite some time before and no analyses had been completed at that stage.

MR RENNIE:

And that's the point I'm making, that at that point you were making assumptions about whether the building had been damaged in the 4 September earthquake under ERSA for example by assuming that the building had been built to the specifications?

MR SMITH:

Oh, I see what you mean. Well we were carrying out those concrete tests in parallel so I guess we may have had some information but not all.

MR RENNIE:

In reality it doesn't make sense to test it on a meet specification basis for September and then to say in February that it didn't meet the specification does it?

MR SMITH:

I think the analyses, even the final analyses were done on the basis that it did meet specification so it was specification plus two and a half MPA was the concrete strength used in all the time history analyses apart from the one that's being conducted at the moment which has a variation which we'll also see if that makes an effect but all of ours were based on the same concrete strength.

MR RENNIE:

Now part of the construction method used for this building was that the columns were poured insitu, the beams were installed, the metal decking was installed and then the slab was poured on top of the metal decking, that's correct?

DR HYLAND:

Yes.

MR SMITH:

I believe so, yes.

1440

MR RENNIE:

So is there any ways in that you can identify why the column concrete would differ from the joint concrete and the slab concrete.

DR HYLAND:

Oh, okay, would you like me to?

MR RENNIE:

I am just giving you open choice.

DR HYLAND:

Yeah okay. It was interesting I wondered that myself given that they had specified 25 MPa, 30 and 35 MPa concrete for the columns that also specified 25 MPa for the walls. One thing I noted when I talked with Bill Jones was that he said that at times they might order concrete from say, Isaac's and a Ready Mix truck might turn up and the dock would be from Isaac's so there seem to be, there seemed to be some issues where one company would perhaps sub-contract out another company to deliver concrete. Now each ready mix plant would have its own mix designs and I wonder whether maybe some confusion could have arisen.

MR RENNIE:

Even assuming that there was some variation in the sourcing of the concrete, that would not explain difference in performance between columns, joints and slabs would it?

DR HYLAND:

Joints and slabs, well the slabs are poured separately.

MR RENNIE:

Yes.

DR HYLAND:

And the beams were pre-cast so they would have been constructed by another offsite –

MR RENNIE:

Yeah I am not talking about the beams, I am talking about the in situ concrete.

DR HYLAND:

The in situ concrete, yeah so the concrete in the beam column joints is probably more likely to have been slab concrete I suspect.

MR RENNIE:

Well it would depend because this building was erected floor by floor wouldn't it. So we have a multiple sourcing, multiple time sequence for the concrete floor by floor for each of the three elements that I am talking about?

DR HYLAND:

Yes.

MR RENNIE:

Recognising that you have to build the columns first?

DR HYLAND:

Yes, yeah you built the columns –

MR SMITH:

Built the columns up to the soffit of the concrete beams and then above there is, we understand was poured together with the floor.

MR RENNIE:

Now, I have indicated that I was going to take you to the terms of reference and if we could now have BUI.BAR.0056.10 and these will come up for you. if you are turning to the terms of reference in your panel report, I will just caution you that the wording of that is not the same as the wording I am taking you to, sorry in the BCR report the wording in that is not the same as the wording I am taking you to in the panel report.

DR HYLAND:

Okay.

MR RENNIE:

Did you realise that?

DR HYLAND:

No, I don't.

JUSTICE COOPER:

Why are you questioning these witnesses about the wording in the panel report?

MR RENNIE:

I was only going there as a convenient place for the four wording Sir because the wording in their report omits part of the terms of reference.

JUSTICE COOPER:

I see.

MR RENNIE:

You have to go to the next page I am sorry 11. I will tell you what the differences are.

DR HYLAND:

Okay, thank you.

MR RENNIE:

If you come down you will see that it gives terms of reference, matters for investigation and the fourth bullet point is matters for investigation is re-phrased in your report. You may just like to compare the two if you have your report in front of you. The terms of reference in your report I have only got the document reference which is 249.0189.69. You may or may not have had a reason for re-phrasing it I don't know but –

DR HYLAND:

No I –

MR RENNIE:

Well it is not a major point but I didn't want a misunderstanding. If you come down to the bottom you will see the words in the document I have referenced you to a heading, “Report required,” and some words that follow, they don't form part of the quotation in your report, do they?

DR HYLAND:

Is that the, is this the terms of reference for the –

MR RENNIE:

You look at the terms of reference on the screen, there we are we now have both of them although we will need to go over to 189.70 to see the point I am mentioning?

DR HYLAND:

But the bottom report is a report by the Department.

MR RENNIE:

That is what I am about to ask you about, that says the Department will prepare a detailed written report setting out the conditions, I am sorry the conclusions drawn from the investigation about the matters referred to in the above section by 31 July 2011, see that?

DR HYLAND:

Yes.

MR RENNIE:

So in fact the conclusions drawn, seems to be a matter that the Department has reserved to itself to state in a separate report, doesn't it?

MR SMITH:

Well they did prepare a separate report.

MR RENNIE:

And which report do you categorise that as?

MR SMITH:

There was our report then there was the panel report and there was also a Department report.

MR RENNIE:

If you go above what I have just read to you it says, "Matters outside the scope of the investigation". We don't need to consider that because that is not in contest and then we then come up to the matters for investigation, you see that?

MR SMITH:

Mhm.

MR RENNIE:

Now the matters for investigation are specified. The first of those was the original design and construction of the building. The second was the impact of any alterations to the building. The third was how the buildings performed in the 4 September 2010 earthquake and the Boxing Day aftershock, in particular the impact on the buildings. The next was, what assessments including the issuing of green stickers and any further structural assessments were made about the buildings stability and safety following the 4 September 2010 earthquake and the Boxing Day aftershock and then why these buildings collapsed or suffered damage, you see that?

DR HYLAND:

Yes.

MR SMITH:

Yes.

MR RENNIE:

So those were all matters that you were specifically tasked to investigate.

DR HYLAND:

Right.

MR RENNIE:

In reporting on that there was no requirement that you come out to a single finding or conclusion is there?

MR SMITH:

No there is not.

MR RENNIE:

And then it says the investigation will take into consideration the design codes, construction methods and building controls in force at the time the

buildings were designed and constructed and changes over time as they applied to these buildings, do you see that?

MR SMITH:

Yes.

MR RENNIE:

The next, "Knowledge that a competent structural geotechnical engineer could reasonably be expected to have of the seismic hazard and ground conditions when these buildings were designed."?

MR SMITH:

Yep.

MR RENNIE:

Next, "Changes over time to knowledge in these areas." And next, "Any policies or requirements of any agency to upgrade the structural performance of the buildings," you see that?

MR SMITH:

Yes.

MR RENNIE:

So those were the matters you were mandated to consider and the topics you were mandated to investigate, that is correct?

MR SMITH:

Yes.

MR RENNIE:

And it is explicit on the face of those that you were considering the building across a time period from 4 September to 22 February with specific reference to earthquakes on 4 September, Boxing Day and 22 February, isn't it?

MR SMITH:

Correct, yes.

MR RENNIE:

It is also specific that you were to take into consideration, second bullet point below that heading, "Knowledge that a competent structural geotechnical engineer could reasonably be expected to have of the seismic hazard and ground conditions when these buildings were designed." Do you see that?

MR SMITH:

Yes.

DR HYLAND:

Yes.

MR RENNIE:

So that actually obligated you to base your ERSA test on Mr McCahon's information from 1986, didn't it?

MR SMITH:

Well we engaged Tonkin and Taylor to advise us on, specifically on that aspect and we did have a report from them so they had taken into account the original investigation.

MR RENNIE:

Yes but Tonkin and Taylor in 2011 were telling you what was known in 2011–

MR SMITH:

No I don't –

MR RENNIE:

Not what Mr Harding knew in 1986?

MR SMITH:

I mean they commented, one of their comments I believe in their advice was that they felt the investigation was, I can't remember the words they used, something like common of its era or something to that effect so...

MR RENNIE:

In other words they validated Mr McCahon's work and in turn Mr Harding's use of it, didn't they?

1450

MR SMITH:

Yes, yes.

MR RENNIE:

Yes, and that was the basis of which, against which you were directed to report, not Tonkin and Taylor's 2011 investigation of what could now be known about?

MR SMITH:

I think whilst they didn't find any fault in what was reported, there was thought in about the soil stiffness to be used for assessing gravity load effects is somewhat different to what you would use for normally affect – assess seismic effects, and the seismic effects are much shorter duration which you have essentially stiffer soil properties. So I don't think, I'm not clear on whether Tonkin and Taylor advised that that was not common knowledge at that time. I would, I would defer to them on that, but my understanding was those effects would've been, the geotech – the engineers would've been aware of that difference.

MR RENNIE:

Well we can ask them about that when we get to them, but the point I'm referencing you to is your actual mandate to carry out the investigations. This

was a basis specified to you against which you were to make your assessment wasn't it?

MR SMITH:

I mean I – you might be reading that literally, I read that and to me it means I need geotechnical advice to advise me what to do about that, so I don't want to make an interpretation myself on whether that original investigation was what we needed to use.

MR RENNIE:

Well I'll come back to some other elements of those terms of reference in a moment but, on the, that was on the 6th and on the 11th of April the Royal Commission terms of reference came out.

MR SMITH:

Okay.

MR RENNIE:

And we have those at GEN.CERC.001.1. You don't have that by you? I'm sorry. I'll leave you take your time on that and I'll simply ask you, each of you one by one, when did you first read the Royal Commission terms of reference?

MR SMITH:

I can't recall.

MR RENNIE:

Did you ever?

MR SMITH:

Yes, yes, definitely.

DR HYLAND:

Yeah I can't recall reading it actually sorry.

MR RENNIE:

At all? I suppose there's a special irony that we can't bring up the Royal Commission's terms of reference on the screen but –

JUSTICE COOPER:

What is the irony Mr Rennie? What is the irony?

MR RENNIE:

Simply the position it puts me in Sir, that I'm in front of the Royal Commission talking about the terms of reference and I can't get them brought up on the screen but –

JUSTICE COOPER:

Well I am rather surprised if they were proper subject of cross-examination?

MR RENNIE:

My line of cross-examination as I'm quite happy to proceed on Sir without there, I was just simply seeking to assist the witnesses. It appears that the task that they had been set by the Department largely coincided with the terms of reference to the Royal Commission and I am wanting to ask them whether the Department advised them as to whether their terms of reference had been modified by this later event and how their role sat alongside the Commission's role, because it is my client's contention with respect Sir that what has happened here, and I'll just put it in a sentence is that this report has in effect made statements about the issues which it is for the Commission to determine and we have ended up arguing about this report instead of arguing about the issues. Because every time one addresses an issue, one is then met with the answer of, "Oh, but we rejected that in the report," as if that is somehow helpful, when with respect those are the evaluative matters for the Commission and not for these witnesses.

JUSTICE COOPER:

Well I am not sure really that much of this matters to us. The departmental inquiry resulted in reports and the process is actually referred to in our terms of reference in a kind of aside. We are told that it can influence the timing of the way in which we schedule our work. But the attitude that we have taken all along is that the departmental inquiry is one thing and our inquiry is another.

MR RENNIE:

With which –

JUSTICE COOPER:

And the outcome of that inquiry will no doubt be interesting and something that we should consider, but that whether or not it is correct or not we've seen all along is a matter that would be fully able to be canvassed in our own hearings.

MR RENNIE:

Indeed Sir, and I know the Commission has stated from the outset, including on its website that that is exactly the position.

JUSTICE COOPER:

Yes.

MR RENNIE:

What I am pursuing is whether the Department was engaged in advocating a single outcome which would then be pressed upon the Commission, or merely identifying a range of possible explanations which would remain open and not simply a settled point which the Department has of course already publicly said is what happened, and which it is of course the purpose of my cross-examination to contest. Now cross-examination is only helpful, Sir, to the extent it helps the Commission, and having explained what I'm doing if it's not helpful I'll simply move on.

JUSTICE COOPER:

Well one hesitates to say in the middle of something that it is not going to be helpful but I am not seeing clearly how it is going to help us. If that is of any?

MR RENNIE:

Oh, well it is, well it is indeed Sir because I mean I've been able to indicate my point which I was going to put to these witnesses.

JUSTICE COOPER:

Yes.

MR RENNIE:

But by putting it to you Sir it achieves the same purpose that what we have is an open book of evidence for which the answer is yet to be given and with respect will be given by the Commission.

JUSTICE COOPER:

Yes.

MR RENNIE:

Now, you'll recall this morning I was asking you about the role of Mr Hopkins in the formulation of the final form of the panel report and in turn by alignment your own report, do you recall that?

MR SMITH:

Yes.

MR RENNIE:

Can you please be shown MAD, no I'm sorry I don't have the right reference. BUI.MAD249.494.D.58? Mr Smith this is an email from Mr Hopkins addressed to you?

MR SMITH:

Mhm.

MR RENNIE:

You'll see it's dated 25 January 2012. Do you recall this email?

MR SMITH:

I, look I can't recall it specifically but I'm, I'm happy to comment on what I see now so.

MR RENNIE:

Yeah well I'm just going to ask you to accept that this is Mr Hopkins giving you detailed directions as to what is to be done with your draft report?

DR HYLAND:

Okay, yeah, no I recall this.

MR RENNIE:

And the opening words are, "The way in which these issues have been worded is not acceptable to DBH for reasons discussed," do you see that?

MR SMITH:

Yes.

MR RENNIE:

Now I'm going to ask that be shown BUI.MAD249.0494.M.35? You'll see this is another email from Mr Hopkins, 10 October 2011. This is the panel members rather than to yourselves. It represents an evaluation of Dr Hyland's new report, Mr Smith's report, it says, "They represent a significant improvement but there are still quite a few issues." Do you see that?

1500

DR HYLAND:

Yeah but this is not one we were copied into with respect.

MR RENNIE:

No I'm just asking you though whether you recall being asked to establish an improvement in a report that you had prepared at about that time by Dr Hopkins.

DR HYLAND:

What date's this? Is it 10th of October?

MR RENNIE:

10th of October.

DR HYLAND:

What was the previous one sir?

MR RENNIE:

That was in January of the following year.

DR HYLAND:

This one's prior to –

MR RENNIE:

Earlier.

DR HYLAND:

This is earlier. I guess as I said before we were working jointly and with the oversight of the expert panel, the Department and the, David Hopkins and the expert panel were active in giving us feedback and we took on board as much as possible any criticisms and viewpoints. You know it was a very robust process in my view and we didn't agree with everything David put forward, or every member of the panel, and we were given the freedom to, to put our views in the best way, you know, with, with consideration of what the overall

team was telling us. You know it was a joint linked-in process. You know we made special efforts to, to work through the processes with the expert panel through disagreements and agreements. I think that's a reflection of that perhaps.

MR RENNIE:

249.094F49. This is another panel level email from Mr Hopkins. In the second line he says, 11 October 2011, "You may recall the story line that I drafted after our Auckland meeting." Do you see that?

DR HYLAND:

No.

MR RENNIE:

Were either of you ever given a story line by Mr Hopkins?

DR HYLAND:

This is Richard Sharpe, was it? Richard Sharpe was asked to give me some assistance with drafting the executive summary at one point and, because he'd been involved I think with PGC and so he sort of gave me that to have a look at. I looked at it and I tried to use the format and approach that he'd taken but I didn't use the story line that was put there. I don't know if I was intended to use that but I, it, it didn't agree with what I, I had so that was that.

MR RENNIE:

When did you first become aware, either of you, that the Department had an expectation as to how your report was going to turn out?

DR HYLAND:

I don't know. You'd have to ask the Department if they did have an expectation. I don't, I'm not aware that there was a direct expectation.

MR RENNIE:

What would you say Mr Smith?

MR SMITH:

I agree.

MR RENNIE:

Now if we can go back to your terms of reference, BUI.VAR0056.10. Next page I'm sorry, decimal 11. The matters for investigation, the second bullet point, "The impact of any alterations to the building." Do you see that?

MR SMITH:

Yes, yep.

MR RENNIE:

Now at some point the, after the commencement of the television tenancy a hole was cut in the floor slab on the 2nd floor of the building. That's correct?

MR SMITH:

I, I thought it was part of the tenancy fit-out for that television tenancy.

MR RENNIE:

There's a little confusion because there seems to have been more than one television company but in all events at the commencement –

MR SMITH:

Okay.

MR RENNIE:

– of the television period and prior to that we've been told by Mr Morris that he delivered workmen to the building in his business of cutting holes in buildings in concrete. Do you recall that?

MR SMITH:

I, I saw his testimony, yep.

MR RENNIE:

Yes. Now I accept there's an issue about how many holes and where. "Holes cut in the slab had to penetrate both concrete and metal." That's correct?

MR SMITH:

They would have, yes.

DR HYLAND:

The decking, you mean the decking?

MR RENNIE:

If by decking you mean the –

DR HYLAND:

High bond.

MR RENNIE:

The high bond, yes, yes.

DR HYLAND:

Yes.

MR RENNIE:

It would have to penetrate that to go from floor to floor.

DR HYLAND:

Yes.

MR RENNIE:

And one of the features of the design of this building as we know was that the stairwell and lift and related areas were actually external to the north and not part of the core of the building as normal. That would be correct?

DR HYLAND:

Yes.

MR RENNIE:

So that if for example one was cabling between two floors of the television building some other means of putting the cables through would have to be found. Do you agree?

DR HYLAND:

I'm not sure. We don't know the circumstances of what they were trying to do so can't really comment.

MR RENNIE:

It's been said that an inspection at Burwood has not identified beams with holes drilled in them.

MR SMITH:

Okay.

MR RENNIE:

That would leave holes drilled in the slab to be considered wouldn't it?

DR HYLAND:

Yeah there were holes found in the slab at the north core.

MR RENNIE:

Yes.

DR HYLAND:

If you look at, yeah, in the SEMT report.

MR RENNIE:

Down in the south east corner we do know that the floor slab was cut don't we?

DR HYLAND:

Yep, for the stair?

MR RENNIE:

Yes.

DR HYLAND:

Yep, yep.

MR RENNIE:

We don't know whether holes were cut in that area for cabling or not do we?

DR HYLAND:

No.

MR SMITH:

No.

MR RENNIE:

We do know from the internal layout plans of CTV that their main control room, servers and related technical equipment was in the proximity to the stairwell. Do you recall that?

MR SMITH:

I wasn't personally, I wasn't personally aware of that.

MR SMITH:

No.

DR HYLAND:

But that could be right.

MR RENNIE:

Do you also, there's also an uncertainty as to whether in that section of the slab the specified reinforcing was in fact present at the point it joined up with the south shear wall. Do you recall Mr Frost identifying that?

DR HYLAND:

I don't.

MR SMITH:

No I don't.

MR RENNIE:

I'll give you the reference in a moment. The document is WIT.FROST.0001.14 and this is at paragraph 59. I'll just give you a chance to read through 59 to yourselves. It's probably a pleasant change to having me read it out to you.

DR HYLAND:

Thank you.

(witness reads paragraph)

1510

MR RENNIE:

Now you'll see that paragraph 59 is in turn reference to the two of Mr Frost's photos. Do you see them reference there in the paragraph? Would you like to see those before I ask the next question?

DR HYLAND:

Can I just read the – I'm still reading the paragraph.

MR RENNIE:

I'm sorry, I misunderstood you.

(Dr Hyland continues reading)

MR SMITH:

I mean, I would like to see photograph 66 if that's feasible?

MR RENNIE:

WIT.FROST.001.66. That seems to be the design, the photo is actually 64 and 65.

JUSTICE COOPER:

Mr Rennie, Commissioner Fenwick's raised the point with me that suggests that Mr Frost's evidence about what he saw, of course, must be accepted but what he saw is in conforming with the drawings because the drawings did not provide for reinforcing at that point. Now –

MR RENNIE:

The point I'm after Sir is slightly different which relates to the extent to which they investigated the building alteration as a whole.

JUSTICE COOPER:

Right, well that is a different point but –

MR RENNIE:

I'm not asking, going to ask them about, I'm really setting the environment within which the whole has to be evaluated if I can put it that way?

JUSTICE COOPER:

Yes, yes, well you went into the question by talking about Mr Frost's evidence of the lack of reinforcing in the slab. I suppose that cuts both ways, doesn't it?

MR RENNIE:

Oh in terms of outcome, I'm sorry.

JUSTICE COOPER:

Yes.

MR RENNIE:

In terms of outcome so it has all sorts of issues but I'm focusing on the discharge of the issues under the terms of reference.

DR HYLAND:

So 64, looking at 64?

MR SMITH:

That's it here.

DR HYLAND:

Yeah, so in this photo you've got so the bars were at 600 centres specified, the Hibond decking is, what's the spacing of that? 300?

MR SMITH:

300 there.

DR HYLAND:

So you haven't got a full 600 in that view, possible that the H12's are not in that picture.

COMMISSIONER FENWICK:

Can I just interrupt you there? That picture was taken through the gap between the two walls, the 12 mm bars go into the walls not into the coupling beam so when the thing dropped you wouldn't see the reinforcement there, that was the point we were making.

DR HYLAND:

That's a good point, oh, okay, right, right.

MR RENNIE:

I'm sorry Sir if I've pursued an unhelpful topic because I was not actually here when Mr Frost gave the evidence so I'd missed that point.

COMMISSIONER FENWICK

Let's put it this way. We believe Mr Frost misinterpreted his own picture.

MR RENNIE:

Thank you Sir, and I'm certainly not in a position to draw attention to competing material, but my main purpose was to ask you when you first became aware that the slab had been cut in this area?

MR SMITH:

When I saw the, I went through the building consent file and saw the drawings for that area.

MR RENNIE:

And the assumption made, the engineering assumption made in those drawings is that the beams on each side are sufficient to provide, to retain the diaphragm structure of the slab in that area? That's correct?

MR SMITH:

Yes, that's correct.

MR RENNIE:

That's the assumption but would you agree with that?

MR SMITH:

I think I didn't make any specific assessment but I think that's a reasonable assumption. If you look at the difference between that end of the building and the north core obviously the north core is much more critical.

MR RENNIE:

This is at the point where the slab on level 2 interacts with the south shear wall isn't it?

MR SMITH:

Yes. It is not directly in front of the wall, it's to one side of the wall.

MR RENNIE:

That's correct, the western-most point of the cut in the slab is slightly to the east of the eastern end of the shear wall.

MR SMITH:

Right, okay.

MR RENNIE:

So that the integrity of the slab at level 2 in that area is reduced to some extent you'd agree?

MR SMITH:

Yes, agree.

MR RENNIE:

And the question I'm pursuing is what evaluation of this building alteration you then undertook?

MR SMITH:

I think I didn't do a – I'm aware of the distribution of seismic loads is normally predominantly higher loads at the top of the building, lesser loads towards the bottom. This was the first suspended floor so you'd normally expect somewhat

lesser loads in the slab at that point. As a proportion of the total slab on that side we looked at that and you would have to say that that when I say small proportion, a significant proportion but a proportion was removed at level 1 when you compare that to the loads at level 1 versus level 6 I would on that basis determine that it wouldn't be necessarily critical.

MR RENNIE:

Are you saying that's an assessment you made at some point during the preparation of your report?

MR SMITH:

Yes.

MR RENNIE:

At what stage in your –

MR SMITH:

Well when I first saw that alteration, yes.

MR RENNIE:

If we can have the terms of reference back? And while we're doing that, some of the eyewitness accounts, or the participant accounts speak of the building falling towards the south-east on the 22nd of February. Would you regard the cut in the slab as potentially relevant to that?

MR SMITH:

I think it was to the east and not the south-east. I don't believe that was relevant for that.

MR RENNIE:

No, I'm sorry, their terms of reference, not the Royal Commission. Just give me one moment. VAR0056.10. Now another matter which relates to the history of this building is the various occupancies of the building which took

place over the period between construction and 22 February and where it states that the investigation will take matters into consideration there's reference to a couple of elements affecting change of use. The most relevant probably being the last bullet point: "any policies or requirements of any agency to upgrade the structural performance of the building". That's a matter which would arise from a change of use of a building after the coming into effect of the Building Act, do you agree?

MR SMITH:

Yes.

MR RENNIE:

And we know that at various times there were changes of use involved in level 3 which for a period had a tenancy in respect of a training entity of some kind called Going Places; level 4 which as we know had the Kings College occupants on 22 February; and level 5 where a health facility or medical clinic was installed in January of 2011. Going Places had left by the time of the earthquakes and level 3 was vacant. You understand that?

1520

MR SMITH:

Yes.

MR RENNIE:

But Going Places had obtained a consent to change of use for its use of level 3, did you consider that?

MR SMITH:

Yes I did. I think the point about the change of use is, we certainly identified in going through the building records that that had occurred. I looked carefully at the code provisions for the medical clinic, or certainly for the education facility there were changes to the design loadings required. For the clinic it seemed to me that there were requirements for public hospitals but not necessarily for a clinic, so I didn't classify that in structural terms as being a

change of use. And the same, same for the television studio. That it was talked about public television studios. It's, given that it was on the ground floor and given that it was, I understand, a private facility I again didn't see that immediately as being a structural change of use.

MR RENNIE:

Well just dealing with the medical clinic first. The Christchurch district plan deals with major health facilities which are hospitals, and then with health facilities which are lesser medical facilities, did you examine both of those?

MR SMITH:

I didn't examine the Christchurch plan in detail.

MR RENNIE:

Right, because it seems to be clear that if a consent from the Council was required for the medical clinic, none was obtained. You didn't see any did you?

MR SMITH:

I can't recall. No I can't recall about that sorry.

MR RENNIE:

What in principle are the change of use issues arising from placing a clinic like that on the fifth floor of a building, essentially an office building like CTV?

MR SMITH:

What are the structural implications? Well, I mean I'm not sure what perspective I should be looking at. If I've done work for medical facilities. They sometimes have equipment, we need to check whether the floor is suitable for it. There's various things, but they're not necessarily covered in the standard so, for this, the purposes of this one I was purely looking at did the standard require a different design loading either for gravity or for seismic for a medical facility and I didn't see it that way.

MR RENNIE:

Next the Kings, did you reach a different view for Kings?

MR SMITH:

For Kings I could not find records in the plans that I went through from the Council about that change of occupancy.

MR RENNIE:

Do you consider, on your assessment that the occupancy by Kings affected the loading requirements for that floor?

MR SMITH:

According to the standard it would be slightly higher design loading, yes.

MR RENNIE:

And if that occupancy had occurred after the coming into force of the Building Act would you have expected there to be a consent required?

MR SMITH:

Yes I would.

MR RENNIE:

And if a consent were required what briefly are the impacts of that in terms of the assessment of the state of the building and its ability to take a load at that time?

MR SMITH:

Oh, look, I, as I say there was a change in the design standard for the floor loading so I guess some assessment should have been made of that.

MR RENNIE:

And was that a view that you put in relation to the building collapse report?

MR SMITH:

We identified the fact that there had been a change of occupancy which didn't appear to be recorded on the Council records. I didn't go on further from that to explain what possible implications that would be, but we had, we thought we'd fulfilled our brief just by pointing that out.

MR RENNIE:

Do you recall at one point taking your own legal advice on this issue?

MR SMITH:

Yes I do.

MR RENNIE:

And you put that advice forward in relation to the preparation of this report?

MR SMITH:

It determined some of the wording, definitely.

MR RENNIE:

What was the outcome that you were looking for in terms of the reference to this matter?

MR SMITH:

Look I think the point I realised was it was potentially an issue that we were obligated to highlight in the report, but the consequences we did not investigate, so we didn't, the fact that there were a change of use at, in a limited portion of the building, I think the wording of the Act has something like, "As near as practicable," or something to that effect which implies there's some judgement either on the Council, from the Council policy or from some other reason as to what needed to be done at that point, so we didn't go into that.

MR RENNIE:

Dr Hyland did you take part in that issue?

DR HYLAND:

Yes, I mean I, I didn't have the same level of experience in dealing with these change of use issues, but Ashley brought it up and it was an issue that he was concerned about. We raised it with the chairman of the panel, about how we would address that. He, he said, "In my view," well I can't remember exactly what he said, but Ashley felt strongly about it and got the opinion so I supported him in that and he put that to the panel, chairman or project manager, and we had that put into the report, yeah.

MR RENNIE:

Did you feel that you needed the permission of either of those people before you could put it into the report?

DR HYLAND:

Well the thing is I think we respected them as, I mean the chairman was a lawyer and, and we didn't necessarily understand all the implications around us. I mean we're structural engineers rather than interpreters of these things so we put it to them, say this is our concern, how do we report that? You know we, there was a contrary view, we chased that up and we put that forward and it was accepted so it was, it was a robust discussion then but ultimately we had that put into the report.

MR RENNIE:

Now speaking of engineers, in relation to the lessons to be learned from this building, changes of use in buildings of this type may affect their performance and their safety?

DR HYLAND:

Yes, it can do, yeah.

MR SMITH:

Well, well sometimes, if I can clarify, a change of use may require a design to a higher standard, so it might not affect the performance in a certain earthquake but it's expected to perform, perform to a better level.

MR RENNIE:

In terms of the work which you did, did you, either of you form the view that the present procedures and provisions are adequate or inadequate?

MR SMITH:

Well I was concerned that there was no consent for the level 4 change of use.

MR RENNIE:

Clearly when the tenant on the third floor was there, they had perceived a need for a consent and obtained a consent?

MR SMITH:

Correct.

MR RENNIE:

Were there any particular conditions that you identified from that consent which were relevant to the occupancy on the fourth floor?

MR SMITH:

I didn't see for the level 3 consent they had identified it as a change of use but they had not, it seemed to me, carried out a structural assessment or made any recommendations about what needed – whether there was any change needed to the structure. So I couldn't see any information on that.

MR RENNIE:

In terms of the evaluation of the causes for the failure of the building, do you consider this to be a relevant matter or simply an ancillary matter which has come up as part of your investigation?

MR SMITH:

I think it's, I think it goes back to the point that it was a partial occu – it's difficult for me to make a call, it was a partial occupancy. There was some judgement in there because of that "nearest practicable" wording. I think, you know, obviously if the whole building was an educational facility you would have increased the performance level required for that building under earthquake as well, so it's not immediately clear what the consequences are – were for this building.

MR RENNIE:

One of the effects of requiring a change of use consent is to trigger an assessment of those effects isn't it?

MR SMITH:

Yes it is.

DR HYLAND:

Correct.

MR RENNIE:

And in that sense the triggering of that assessment could be said to be a missed opportunity in the history of this unfortunate building?

MR SMITH:

Yes.

MR RENNIE:

Would you agree with that?

DR HYLAND:

Indeed, yes.

MR RENNIE:

And moving aside from this particular building, just to put my question generally once more, did either of you form the view that this is an area where there should be an enhancement or improvement in procedures for the future?

1530

MR SMITH:

As I say I don't know whether there was some procedure followed that decided that there wasn't something necessary as the result of the change of use or whether there was, whether that was not triggered, I don't know the circumstances in this case, so...

DR HYLAND:

Yeah I think it was a missed opportunity, yeah that is the way I see it.

MR RENNIE:

Now we've had reference a short time back to Mr Frost and my understanding of it is that neither of you were aware of Mr Heywood's interest or involvement in qualifications until this hearing got underway, is that correct?

DR HYLAND:

Yes, we had an interview with the USAR, some of the USAR engineers. They mentioned there was some Australian guy but that was it, we didn't really get anything further than that.

MR RENNIE:

There are minutes and I will come to those after the break but there are minutes of a meeting I think of 26 of April 2011 which took place in Auckland and was attended I think by both of you, the Departmental representative and some four or five USAR engineers?

DR HYLAND:

Down in Christchurch.

MR RENNIE:

Down in Christchurch was it, I have misunderstood the minute. That minute is held by the parties I represent under Official Information Act disclosure where the names of everybody other than the two of you have been redacted from the document. Can either of you recall whether Mr Frost attended that meeting?

DR HYLAND:

No he didn't.

MR RENNIE:

Now Dr Heywood you've indicated, sorry Dr Hyland, you have indicated that you did know Mr Frost?

DR HYLAND:

Yes I know Graham Frost for many years.

MR RENNIE:

And you indicated that you interviewed him but as I gather it, apart from some handwritten notes there is no formal record of his input from that point of view?

DR HYLAND:

Yeah I am not sure what is up on the website but yeah I interviewed him, didn't record an interview with him. He was actually leaving to go overseas at the time so I got him at the airport. Made some notes.

MR RENNIE:

Did you know that on the 3rd of March 2011, that is before you gentlemen were appointed, Mr Frost prepared three pages of notes as to his experiences on the site?

DR HYLAND:

Yes I think he sent those to me.

MR RENNIE:

BUA.MAD249.0246A.1. Have you seen these before?

DR HYLAND:

Yeah they look familiar to me.

MR RENNIE:

(inaudible 15:34:00) you have seen them and if you look right down the bottom in the right-hand corner you will see the coding of the date of them?

DR HYLAND:

Right, yes.

MR RENNIE:

So Mr Frost had prepared a careful note as to his observations and issues at about the time, presumably about the time that he left the CTV building site, that is correct?

DR HYLAND:

Look yeah I'd have to look at his – he gives a date, and dates and things in his evidence I haven't correlated that but they look pretty close to when he would have.

MR RENNIE:

Do you know when they came to you?

DR HYLAND:

Sorry?

MR RENNIE:

Do you know when they came to you?

DR HYLAND:

I could look it up I haven't got it right on me at the moment.

MR RENNIE:

Well put it this way, when you met with the USAR engineers in April would you have had them by then?

DR HYLAND:

I think I mentioned to them that – 'cos they asked me I think in that minute whether I had contact with Graham and I said I did, yeah I did have, yeah, so that would be right.

MR RENNIE:

And Mr Frost maintained an on again off again involvement in terms of contact with you Dr Hyland, through to the completion of the report, didn't he?

DR HYLAND:

Yes.

COMMISSION ADJOURNS: 3.36 PM

COMMISSION RESUMES: 3.54 PM

JUSTICE COOPER ADDRESSES MR RENNIE

MR RENNIE:

Now before the break I was asking you about Mr Frost and Mr Heywood and I also mentioned the minute of the meeting with USAR engineers. Do you recall all of that?

DR HYLAND:

Yes, 28th of April.

MR RENNIE:

I can put the minute up if you need it but –

DR HYLAND:

That would be helpful sir.

MR RENNIE:

Right. It's MAD249.0516.RED. Now you'll see that this is, you're quite right in Christchurch on the 28th of April 2011 and as I mentioned to you it has been redacted so that the only people we can be certain were at the meeting were the two of you.

DR HYLAND:

Okay.

MR RENNIE:

Along with six anonymous people. Now the purpose of this meeting I take it was to achieve some drawdown by the two of you of the information that USAR held in respect of their time and their involvement in the CTV building.

DR HYLAND:

That's correct.

MR RENNIE:

There seems to have been one or two suggestions in the minutes, for example on the second page you'll find that you noted that you've been provided with some photographs by I think Mr Frost and the, you'll find this at 5.1 and 5.2, and the immediately observation of somebody was that you may have got those photos when they were the property of the Fire Service and you didn't have proper authority for them. Do you see that?

DR HYLAND:

Yes.

MR RENNIE:

Was that reflective of a reluctance by these people to provide you with information?

DR HYLAND:

I think they were just being very careful.

MR RENNIE:

You, when you set out on your investigation you were looking for information, records and photographs from other sources including the, the police?

DR HYLAND:

Yes.

MR RENNIE:

Did you have any difficulty in accessing that material?

DR HYLAND:

No.

MR RENNIE:

In the uploaded documents there's a bundle of photographs which is labelled as "police photographs." Were they the only photographs you got from the police?

DR HYLAND:

I believe so, those were the ones.

MR RENNIE:

Are you aware that a considerable number of police photographs have since been published? There's a book and a DVD in support of a charity arising from this matter.

DR HYLAND:

Yes I have (inaudible 15:57:50).

MR RENNIE:

Have you looked through those?

DR HYLAND:

No I haven't had a chance.

MR RENNIE:

On the basis that the photographs that you got from the police are the only ones that are uploaded it would appear that the police had substantially more photographs than they handed over. Can you account for that?

DR HYLAND:

No I can't.

MR RENNIE:

Did you ever ask the police for the full extent of the photographs that they held?

DR HYLAND:

I think it was just a request that was made through the Department for, for photos and things.

MR RENNIE:

So it's not a matter you handled personally?

DR HYLAND:

No, no.

MR RENNIE:

Would you accept that in terms of photographs taken over the first couple to three days of this matter that every photograph has the potential to be helpful?

DR HYLAND:

Definitely the earlier the better.

MR RENNIE:

Yes the Department issued a public appeal for the provision of photographs didn't it?

DR HYLAND:

Yes it did, yep.

MR RENNIE:

And beyond issuing that public appeal are you able to point to any other measures that were taken to obtain that information?

DR HYLAND:

From the public or?

MR RENNIE:

From any source.

DR HYLAND:

Well when we, when I interviewed people I'd often ask them if they had any photos and some, some of them came forward with photos.

MR RENNIE:

Was it ever your experience that people would not provide you with photos?

DR HYLAND:

No, no some people would give them but didn't want to be identified, who they were from.

MR RENNIE:

Yes, well that's understandable isn't it.

DR HYLAND:

Mmm.

MR RENNIE:

Now in relation to Mr Heywood, Mr Heywood actually wrote to the Royal Commission offering to come and provide evidence. Did you know that?

DR HYLAND:

I, I understand that's the case.

MR RENNIE:

Did you ever have a similar communication from Mr Heywood?

DR HYLAND:

No.

MR RENNIE:

Did Mr Frost suggest you contact Mr Heywood?

DR HYLAND:

No.

MR RENNIE:

Did, at what point in time did you first see Mr Heywood's photographs?

DR HYLAND:

I think it was just a few weeks ago when I saw his evidence.

MR RENNIE:

Was the matter of getting photographs out of USAR left to the Department to achieve or was that a matter you yourselves dealt with?

DR HYLAND:

No we just asked them if they had any photos. One of the people at the meeting was actually John Trowsdale and he, he tabled some photos which, some of those were in the evidence that he put forward. So that was helpful and we discussed those at the time.

MR RENNIE:

Now for the purposes of this investigation did you have administrative resources?

DR HYLAND:

Sorry?

MR RENNIE:

Did you have administrative resources for this investigation? Well did you have staff, did you have gofers, did you have secretaries, did you have –

DR HYLAND:

Okay, well we, we had the assistance of the Department. So there was project co-ordinators there and people who would chase down a lot of things. If we asked they would, they would do it, very helpful.

MR RENNIE:

But beyond the two of you were you reliant on your own efforts without having your own dedicated or assigned staff for this project?

DR HYLAND:

I contracted various people to assist me as required and Ashley I think may have done the same. Is that right?

MR SMITH:

Yeah. I, I had several engineers from Compusoft and also Tonkin & Taylor, Tim Sinclair assisting.

MR RENNIE:

I'm actually talking about those people who actually keep the files and find the photos and keep the records and that sort of thing. How was that achieved? The administrators?

MR SMITH:

We, we kept our own records.

DR HYLAND:

Yeah, I kept my own, (inaudible 16:01:37).

MR RENNIE:

And did you keep them as distinct, separate collections or did you have a merged filing system or how did you work?

MR SMITH:

I kept them separate, individual files on the computer, individual folders sorry.

DR HYLAND:

Yeah.

MR RENNIE:

For an investigation of this scale do you consider that you were adequately administratively resourced for this work?

DR HYLAND:

Yes.

MR SMITH:

Yes I do.

MR RENNIE:

Now Mr Frost told us that in his evidence that he had read parts of the final report before it was issued. Do you recall that?

DR HYLAND:

Yes I'd asked him to comment on the debris removal sequence I think, yeah.

MR RENNIE:

And subsequent to the issue of the report Mr Frost sent you a document identifying some matters which he considered should receive further attention. Do you recall that?

DR HYLAND:

It was after the issue of the report?

MR RENNIE:

Yes.

DR HYLAND:

Yes I got a, I got something from Graham.

MR RENNIE:

It's BUI.MAD249.494.BB. Do you recognise this?

DR HYLAND:

Yes I think so, yep.

MR RENNIE:

And this is Mr Frost on the 20th of February of this year identifying three issues in relation to collapse scenarios which he considered could have received, as he puts it in the second line, "A little more attention in the report." Do you see that?

DR HYLAND:

Sure, yeah.

MR RENNIE:

Now his first point is, "Weak beam column joints." Do you see that?

DR HYLAND:

Yes, yes.

MR RENNIE:

His second is, "Strain hardening in the south wall shear wall," and his third was, "Lack of confinement at beam ends and in beam column joints." Do you see that?

DR HYLAND:

Yep.

MR RENNIE:

So his focus as to possible collapse scenarios was in areas quite different to those which were your four scenarios in your first preferred explanation in the report wasn't it?

DR HYLAND:

Yeah I, I, I went back to Graham on this and sort of talked through it so I can discuss it if you like.

MR RENNIE:

Well we haven't probably got a benefit from doing it in detail but the point for today is that even after reading your report he came back to weak beam column joints, strain hardening and lack of confinement at beam ends, in beam column joints.

DR HYLAND:

Yep.

MR RENNIE:

As key points for him. Did he?

DR HYLAND:

Yeah, no I accept that's his, that's his view, I respect him for it.

MR RENNIE:

And those, each of those may be valid issues.

DR HYLAND:

Yes, I've considered those.

MR RENNIE:

Now they are also issues which are raised in the evidence which is to be presented by persons retained by Alan Reay Consultants Limited aren't they? 1605

DR HYLAND:

Okay, good.

MR RENNIE:

Well I mean I think you know that because you've seen the evidence?

DR HYLAND:

Oh this is Professor Mander?

MR RENNIE:

Particularly Professor Mander, Dr Shepherd, Mr Bradley.

DR HYLAND:

Yes.

MR RENNIE:

Dr Latham to the extent that he obtained particular samples and had them tested and so on. You've seen all that evidence?

DR HYLAND:

Yes, I've been through most of that.

Mr RENNIE:

Mr Smith I think has filed a reply brief in relation to three of those?

DR HYLAND:

That's right.

MR RENNIE:

All I have to ask you today because that material's not directly before the Commission yet, is that you accept that the persons who have given those briefs have expertise in the fields that they have given evidence about?

DR HYLAND:

Oh definitely, yeah, I have respect for these people.

MR RENNIE:

And in relation to response to the points that they raise you've each had the opportunity to respond to those points?

DR HYLAND:

Yes, I mean I haven't given a statement of evidence in response to Professor Mander's. I've run out of time, I have got some comments though.

MR RENNIE:

Yes. Well that would seem it's a matter for the Commission of course but it would seem there might be a later opportunity when you're back and I can certainly indicate to you that from the parties that I represent there would be no issue about your making a response to those points.

DR HYLAND:

That would be great, thank you.

MR RENNIE:

And Mr Smith, you've actually filed an explicit reply brief haven't you?

MR SMITH:

Yes, I have. Again I felt I had limited time so tried to pick out the main points rather than –

MR RENNIE:

Yes, and you have an equal acceptance of the expertise of those evidence briefs the persons given?

MR SMITH:

Yes. Yes.

MR RENNIE:

So on the basis we discussed I don't need to take that further and those are my questions, thank you very much.

MR MILLS:

I'm just reflecting on this question that's just come up about Dr Mander and when's the appropriate time for Mr Smith and Dr Hyland to respond to this and

perhaps I should just ask you about that initially, as to whether you are in a position now to make those comments or whether you prefer to deal with it at a later stage?

DR HYLAND:

Well I've been through part of the evidence. I haven't finished it so I'd like to do them the honour of being through it thoroughly if that's possible?

MR MILLS:

And again just to help me to schedule this into our programme, are you able to give, both of you, some guidance right now on what issues with Dr Mander's evidence you particularly want to focus on in terms of topics?

DR HYLAND:

I guess first things would be the response of the floor, buckling columns.

MR MILLS:

So they're structural issues?

DR HYLAND:

Structural issues, yeah.

MR MILLS:

Mr Smith?

MR SMITH:

I think some of it relates to non-linear time history of which further work is being done at present so I think –

MR MILLS:

Yes.

MR SMITH:

We've both said that we would, if, we can't really discuss that in detail at the moment because we'd like to see the results of further analysis.

MR MILLS:

Yes, well I mean that's understandable and that will obviously fit quite comfortably within the session that we've got yet to be scheduled on the time history analysis. Well we need to reflect on this because one fits comfortably, the other really brings us back to some of the issues that we've been dealing with, with you today but I'll just park that for the moment and give some further thought to that perhaps overnight, discuss it with the Commissioners.

I want to just go through some issues with you that you've been dealing with in your evidence and which have been the subject in some cases of questions from my friend, Mr Rennie, just to be sure that to the extent that we can that we've narrowed down the areas of difference here and the, and really identify the basis on which some of your conclusions have turned. So I wanted to ask you first about this collapse theory that you've both put forward with some slight differences between you but some, a lot of common ground, but I wanted to ask you particularly about the issues of column drift and how that works in the analysis that you've done. Now correct me at any point if you think that I've got some of the core facts wrong here because I'd be the first to say that this is a complex area for non-structural engineers.

My understanding is that at least initially the starting point of this analysis of the column drift and where you positioned that in terms of initiating events for the collapse was the conclusion that under that code standard the columns should have able to accommodate an inter-storey drift of 1.51%, have I got that right?

DR HYLAND:

Yeah, that's my contention.

MR SMITH:

Yeah, I think that is a limit set in the standard but not necessarily a requirement for each building. It's an upper limit.

MR MILLS:

Yes.

MR SMITH:

Not necessarily a requirement for each building to achieve that limit.

MR MILLS:

Yes, but am I right that in the analysis that you've done and reported on, that that was the starting point at least in the report, this proposition that –

DR HYLAND:

No.

MR MILLS:

I'm not right?

DR HYLAND:

No.

MR MILLS:

All right, please correct me.

DR HYLAND:

So the analysis we checked the drift and found that using the 55% ULS or 55% ULS loading (inaudible 16:11:26) factored loading that the frame got very close to the .83% drift limit which is equivalent to the 1.5.1% drift limit for the structure at ultimate so the building came close, very close to that drift limited based on the design analysis.

MR MILLS:

All right, and am I right that you then moved from that to an actual estimated drift of between 1.15 and 1.45%.

MR SMITH:

I just –

MR MILLS:

I know you've got a different view on this.

MR SMITH:

Just a small alteration to those figures.

MR MILLS:

Yes.

DR HYLAND:

Yeah, yeah.

MR MILLS:

Now just while we're on that I saw that in your, one of I think in Dr Hyland's supplementary brief or one of them, there's a reference to Compusoft having come back and said they needed to correct some of the original figures that they used for drift limits.

MR SMITH:

Yeah, that it was in my brief.

MR MILLS:

In your brief?

MR SMITH:

Yes.

MR MILLS:

Now it wasn't clear to me as I read it through whether in the end that made any difference. Can you –

MR SMITH:

No it didn't. It didn't make any difference to the conclusions or in the, the alteration was to the figures in tables 11 and 12 of the report.

MR MILLS:

Yes.

MR SMITH:

It didn't make any alteration to the figures in tables 1 and 2 of the report.

MR MILLS:

These were all ones that we looked at earlier when you were being questioned by my friend?

MR SMITH:

Yes, yes.

MR MILLS:

Yes, so for present purposes any rate I can set that to one side although as a matter of history it's a relevant piece of the narrative, and am I right that you then estimated for the purposes of the analysis you were doing that at a 1% drift along line F that there would be drag bar failure?

DR HYLAND:

Yeah, that was an observation I made that from the results we had from the NTHA that it seemed that in both the analysis that was done using the September record and the February record that we were getting drifts about 1% at level 4 when we were getting drag bar failure initially, you know, indicated in that analysis.

MR MILLS:

So am I right that first of all that that had to be based on an estimate that you'd done by drag bar strength?

MR SMITH:

Yes, that's correct. Yes.

MR MILLS:

So if that was too high that would obviously have an effect on the conclusion that at 1% drift you'd get some detachment, wouldn't it?

MR SMITH:

Yes, that's right so if it was too high you would, it could have happened earlier.

MR MILLS:

Yes.

MR SMITH:

That's right. I think, can I just clarify that one of the alterations I made to that summary of findings was to take out the reference to the 1% drift.

MR MILLS:

Yes, no I'm aware of that.

1615

MR SMITH:

So you're aware of that? The other point is I know there has been discussion about the calculation of drag bar capacity or the diaphragm connection capacity. I considered that our estimate of the capacity that was used in the analysis to be an upper bound and yet it was still indicating potential failures so it seemed to me regardless of the actual strength whether it was somewhat lower you would still have got disconnections in the analysis so for using an

upper bound strength we were still indicating some disconnection which seemed to bound the problem as far as I was concerned, yeah.

MR MILLS:

Isn't it relevant though in terms of trying to get the best possible insight into the initiating event to reach the best possible view on drag bar strength than when it, than what it is?

MR SMITH:

I think the limitation, the other thing I am bearing in mind is the limitations of our analysis with regard to predicting the actual forces in those drag bars for the various earthquakes they varied and given that we don't have a record for CTV, given the very high sensitivity to floor stiffness that is assumed in the analysis, the various approximations which I believe make it impractical to definitively say what forces were in drag bars for those earthquakes.

MR MILLS:

But of course that applies to everything, doesn't it? Not just the drag bars?

MR SMITH:

But more so to the drag bars than I believe column drift and...

MR MILLS:

And why is that?

MR SMITH:

Why is it? Because I believe the overall sway of the building, the performance of that building as far as lateral drift is concerned governed say 90% by the shear walls you know, we certainly have got some difference in drifts from the three earthquake records but they are much more well defined in my mind given my knowledge of the assumptions in the analysis and so I just have an awareness of the assumptions made in floor stiffness interaction with that shear wall that it is very sensitive so I do believe there is more variation likely.

MR MILLS:

Have you – have both of you seen the brief of evidence that has been given by Mr Dixon on the drag bar strength analysis, have you seen that?

DR HYLAND:

I had a brief look at it.

MR MILLS:

You have only had a brief look at it?

DR HYLAND:

Sorry.

MR SMITH:

I have seen it.

MR MILLS:

I might ask you if you could just take a look at that a little bit more carefully because he estimates lower strengths than the ones that you have come to so at some point it would be useful I think to have your responses to that, whether we can do that while you are giving evidence or whether we can just get some comment from you at some other point?

MR SMITH:

We have, I have provided some comment to Athol Carr in relation to the further analyses were are doing on that issue, so yeah.

MR MILLS:

Yes, well that may take care of it because the - Mr Dixon's brief of evidence I think was provided to Athol Carr as part of that time history analysis that you are reworking so it may get taken care of in that context.

DR HYLAND:

Yeah I think and just my initial overview was he'd used characteristic strengths rather than what I used was the, sort of our test strength and so we'd get a you know, more an upper bound perhaps whereas he perhaps, I understand may have been using a sort of designer's approach so you will get a lower value perhaps what you more use for design purpose rather than...

MR MILLS:

Well given that it has gone and is being considered in the time history analysis I suppose we could wait and see what comes out of that. Just coming back to this question of the process of working back on what I'm going to characterise as sort of drift reduction factors which move you back from your starting point on drift reduction to where you – on drift, to where you end up. Am I right that because of this conclusion which appears not to be totally shared that a drag bar failure was estimated to occur at 1% drift along line F, that in order to get the column collapse precede the diaphragm disconnection at least on the face of the figures you are working with you need to get that column collapse at a lower drift than your diaphragm disconnection, is that correct?

DR HYLAND:

Yeah.

MR MILLS:

And am I right that the factors that you then took into account in going through that drift discount were first of all the potential for spandrel interaction, is that the first of them?

DR HYLAND:

No the first thing is just the actual capacity of that column so that the drift capacity sheets are the columns and we found some of them were quite close to that 1%.

MR MILLS:

How close?

DR HYLAND:

Very close because some was I think, reported 1.15 to 1.45.

MR MILLS:

Yes this is your 1.15 to 1.45 –

DR HYLAND:

As I said Mr Smith has –

MR MILLS:

I took as your starting point.

DR HYLAND:

Yeah.

MR MILLS:

So in terms of reducing that further, the first thing and I don't have these in any order of priority but number one is the spandrel interaction?

DR HYLAND:

Yes that is in my view, yep.

MR MILLS:

The second one is the under strength concrete?

DR HYLAND:

Yep that is potentially.

MR MILLS:

The third one is the vertical accelerations?

DR HYLAND:

Yes.

MR MILLS:

Does the western wall interaction have any role in this at all?

DR HYLAND:

The western wall, yeah potentially does. The problem we have with the western wall is how well was it connected in or how much wasn't it connected up so –

MR MILLS:

Yes I understand that –

DR HYLAND:

There is a sort of issue there about dealing with that so it does have an effect on changing the location of the centre of stiffness and –

MR MILLS:

Yes I understand that but in your own thinking about trying to look at these intersecting points in effect between the column collapse and the diaphragm disconnection, did that feature in your analysis by which you were reducing the point at which the columns would be likely to have collapsed on whatever line you are identifying?

DR HYLAND:

For me it just raised the question of maybe we are getting greater demand down perhaps the east wall and what otherwise may have been so...

MR MILLS:

Yes, all right I understand that. Am I right that in addition to those kind of physical property discounts, physical property of the various elements, that you also based it on the visual evidence of the collapse?

DR HYLAND:

Yes definitely.

MR MILLS:

And am I right that in terms of that visual evidence the – is the principle witness that influenced your thinking on that, Mr Godkin?

DR HYLAND:

No, no, we didn't know about Mr Godkin until after the report had been presented actually.

MR MILLS:

It is just that I noticed that you refer to him a couple of times when you were talking about this issue. I take it that at least at this point, am I right that you are regarding his evidence as being particularly confirmatory I suppose of that view that you have reached about the collapse sequence?

DR HYLAND:

What I have found from Ron Godkin's evidence was that it indicated to me that it discounted the possibility scenario 4 because of (inaudible 16:23:04) so up to that point there was still debate in my mind. I felt that the collapse of the – the debris had sort of indicated that collapse had started down the south end of the building and that is where we had both come to but the fact that he was standing at level 4 and was not you know hit by the level 5 slabs coming down on him –

MR MILLS:

Yes.

DR HYLAND:

And he saw collapse down the south, to me confirmed.

MR MILLS:

Yes I want to come back a little later on to where Mr Godkin might have been and not to challenge you in anyway but just to just test some of these conclusions that you are – or some of these issues that you have based your analysis on.

DR HYLAND:

Sure.

MR MILLS:

And I take it also that, in terms of that visual evidence from witnesses, both Mr Frost and Dr Heywood have also been relevant at least in the case of Mr Heywood to subsequent thinking but in terms of Mr Frost thinking at the time?

DR HYLAND:

Yes, yes.

MR MILLS:

Now you are not saying anything so if you disagree –

MR SMITH:

No I agree, yeah, yeah.

MR MILLS:

I take it that you also are, both of the view that in terms of the most highly loaded columns in the building they were the internal columns at line D, is that right?

DR HYLAND:

D and C I believe.

MR MILLS:

D and C?

DR HYLAND:

Yes.

MR MILLS:

And I take it even though I think in you report you emphasised D2 that it really is that whole line, 1, 2, 3, 4?

DR HYLAND:

There is four columns.

MR SMITH:

Right in the middle there.

MR MILLS:

And all of those you regard as the most highly loaded in the building?

DR HYLAND:

Yes, from a gravity point of view.

1625

MR MILLS:

Yes. Yes. And of course as the Commission knows there are several witnesses to come who for that reason regard that as being the more likely collapse initiator than the line F which you've both ended up favouring?

DR HYLAND:

Yes we're aware of that.

MR MILLS:

Yes.

MR SMITH:

It's a, that's what we've called scenario 2 (inaudible 16:25:27)

MR MILLS:

Yes. I'm curious to know, and I don't know whether it lends itself to this level of analysis, but I'm curious to know how many of these drift reduction factors that I've just run through with you need to hold up before at least in terms of the detachment point for the diaphragm and the column collapse initiator scenario, before the numbers shift so that the diaphragm connection – disconnection comes before the column collapse?

MR SMITH:

Yeah, I think from my point of view we don't need any of those factors to indicate a column failure with the analysis we did.

MR MILLS:

All right, I'm inviting you to develop that?

MR SMITH:

The sequence between the diaphragm and the column, as I've explained, there is quite a high degree of uncertainty and through the further analysis work we're doing with modified properties for the four floors we are getting reduced loads in those connections to the diaphragm, so.

MR MILLS:

This is as part of the –

MR SMITH:

Yes.

MR MILLS:

– Athol Carr facilitated process that you're referring?

MR SMITH:

Yes it is yeah.

MR MILLS:

Well it will be interesting to see the results of that.

MR SMITH:

The short point is I don't think there's any factors that necessarily had to be at work to indicate a column failure, other than drift, yeah.

MR MILLS:

Yes, yes, and Dr Hyland do you have a view on that?

DR HYLAND:

I'm not a party to the results –

MR MILLS:

No.

DR HYLAND:

– but I mean if, if the results show that greater drifts could've occurred prior to drag bar disconnection then it just means that there was, as Ashley would say, less of these extra factors have to be there.

MR MILLS:

Well it may mean then that that will make far less relevant this kind of line of questioning that I was going to just try and get some clarity around, because I take it at least in terms of the report that you've done, Dr Hyland, that there, it would make a difference if we were in effect to set to one side one or other or perhaps more of the factors that you relied on to reduce the drift capacity of the columns. So for example if the spandrel interaction issue didn't stand up then that would have an impact, and so on down the line. That would be true in your analysis wouldn't it?

DR HYLAND:

So what you're saying, so you would need less, less of these sort of discounting factors –

MR MILLS:

Yes.

DR HYLAND:

– but at the same time you wouldn't, they still could've been there so I accept that you couldn't rule them out either. It just makes it more, it just, I think in my view it just points more to scenario 1 being much easier to justify.

MR MILLS:

If we didn't have that photograph of the diaphragms leaning up against the north core following collapse, would you be as confident as you seem to be that the diaphragm disconnection only came after the column collapse?

DR HYLAND:

Oh, there were a number of things, I mean the drag bar condition in the north core when I inspected them, as I said before, you know the drag bars hadn't been bent over where the bars were within the confined area, so it looked like the slab had tipped or pivoted around the outside edge and the slab had broken away around the 1200 millimetre mark and so for that to have happened the column C18 must still have been in place at that point, so there was a number of things which to me, not just the lean, sort of seemed to indicate that was where it was heading.

MR MILLS:

So the photograph's not a crucial issue for you, do I take it, in terms of your conclusions about collapse sequence?

DR HYLAND:

Well it's part of it, you know, and I think ultimately any analysis we do has to relate to the facts we've seen, so, you know, other tests.

MR MILLS:

I'll just ask you while we're on the question of the diaphragm, another issue that I think has just been raised in one of your supplementary briefs. Am I right that you now think that it's possible that in September that there was movement in the connections for the drag bars by slippage along the bolt connection point?

DR HYLAND:

Yes, I was, I was sort of reflecting on the comments that have come through from some of the witnesses where they've said they heard sort of groaning or creaking or noises in the building after September and I was trying to think what may have been a cause for that, and one thing I thought may be a possibility is just slippage of the steel drag bar against the galvanised decking.

MR MILLS:

Yes.

DR HYLAND:

And the fact it was in a sort of a lift well that perhaps there may have been a bit of a creaking noise that sort of reverberated through.

MR MILLS:

And am I right that, again it's just estimates that you've given, but I think you say in that supplementary brief that the room that there was for slippage, if it was slipping, was between two and three millimetres?

DR HYLAND:

It'd be about two millimetres. The bolts, the bolts were put in, or the anchors were put into the two millimetre oversized holes, which is just construction tolerance.

MR MILLS:

Yes, so that's the hole you're thinking it might slip in?

DR HYLAND:

Yeah I was thinking maybe there was a bit of, a bit of slip there.

MR MILLS:

Yes.

DR HYLAND:

It does happen in buildings.

MR MILLS:

Yes, do you want to comment on any of this?

MR SMITH:

I'm, I'm, like I'm hearing that as a possibility. I keep coming back to we didn't have a inspection of those drag bars after September so I still come back to the point it's not a proven statement of evidence. It could be, it could be a possibility.

MR MILLS:

Yes.

DR HYLAND:

Yeah put it as that, just put it as that.

MR MILLS:

And I'm not suggesting any higher than that, and of course the reason that, as you'll be aware I think, that this is of some interest to evidence that comes later from Professor Priestley is that he has, or will give evidence that a movement of two millimetres would be enough to fracture the mesh. Now I'll

just ask you on that, without needing to reach any view on whether that's what happened here. If there had been fracturing of the mesh as a result of that sort of movement, what would that do to the ability for the loads that occurred, the earthquake loads that were put on the building in February, to transfer through the floor diaphragm and into the north core? Would that have any effect on that?

DR HYLAND:

Whereabouts is the, I mean I haven't, whereabouts is he saying a fracture would've occurred?

MR MILLS:

I don't think he was specific from memory. I've got his passage from his evidence here somewhere. I'll just find it for you. Yes, no he isn't specific. The Commission has seen this before so I don't imagine you'll need me to bring it up again but I'll give you the reference, it's, well it's paragraphs 79 through 81 of his brief of evidence and particularly after talking about his view, which I think you're aware of, do you want me to have that brought up for you, I can?

JUSTICE COOPER:

Yes.

MR MILLS:

The reference is WIT.PRIESTLEY.0001.24.

DR HYLAND:

Where's his paragraph sorry?

MR MILLS:

Here it is, it's in front of you now, and you'll see this has been referred to before with other witnesses, but you'll see that in paragraph 80 after expressing his view which I think you are aware of, that it is entirely possible

there's a partial floor diaphragm north core connection in September, he says, "It might have been difficult to observe during the post-September 4 inspections. The investigators would probably not have known about the
1635
drag bar installation and hence would not have paid them attention. If fracture of the HRC mesh in the floor had occurred this might not have been visible because of floor coverings or may have been construed as shrinkage cracking as crack widths of only two millimetres are required to induce mesh fracture."

DR HYLAND:
Okay, yes.

MR MILLS:
Now as I say without wanting to decide whether that might be right or wrong I'd just be interested in your views, and I mean both of you, on whether that would have had any effect on the ability of the loads, the transfer into the north core in February if there had been that fracture?

DR HYLAND:
Yeah I, I made some comments in my reply to Professor Priestley on that issue. There's a few things. The first thing is what we found in the NTHA and the ERSA was that the highest diaphragm stressors and things that may occur would have been at level 4.

MR MILLS:
Yes.

DR HYLAND:
Where the first drag bar was installed and in that location there was apparently vinyl on the floor reported by Marie-Claire Brehaut and Ron Godkin and they, they went into quite detail about the, the vinyl and it humping and things and we tried to address that but they never mentioned any cracking.

MR MILLS:

Yes, now look I don't want to embark on whether there was or there wasn't. I'm just saying let's assume that that did happen. What I'm interested in your opinions on is whether that has any effect and if so what on the ability to transfer loads through the floor diaphragm into the north core in February, assuming there's been fracturing of the mesh.

DR HYLAND:

Yeah, okay, I just don't really, the thing is the drag bar on those external walls, DE and D were still competent so the slippage doesn't, didn't change the competency of those bars, those drag bars to transmit a load. If there'd been any fracture I guess it must have occurred near the area where the, the line full beam would have gone into the amenity block area.

MR MILLS:

That would be right I think.

DR HYLAND:

Yeah. We didn't see any, I mean the floor slab evidence is that it fractured outside the 1200 millimetre extensions of the saddle bars in February.

MR MILLS:

Well again I'm just asking you to address the hypothesis.

DR HYLAND:

I'm just trying to work it through.

MR MILLS:

Yes, all right.

MR SMITH:

Perhaps I'll give him a chance to work it through.

MR MILLS:

Yes I was going to say while he's working it through why don't you give me your answer.

MR SMITH:

I think, I think that you would have to say that it would have an effect if it had fractured.

MR MILLS:

Yes.

MR SMITH:

It's basically looking at the tensile capacity of that diaphragm slab as made up, we assume the concrete does not provide a tensile capacity and that therefore you've got the mesh. There was some debate about, and still some uncertainty shall we say, about a possible contribution of the metal decking as a tensile connection. So I would have to say it had some effect because it made up some of the tensile capacity of that slab.

MR MILLS:

Yes.

DR HYLAND:

I guess I'm coming to the point, I just, I find it difficult to reconcile that you would get fracture of that reinforcing mesh because you had slippage at the, at the eastern end.

MR MILLS:

Let's assume for the moment that, that we do. Is your answer any different to what Mr Smith has given me?

DR HYLAND:

I just find the premise difficult to cope with given that we didn't observe anything. So it's sort of very hypothetical.

JUSTICE COOPER:

Yes but it's put to you on that basis. So just answer that.

DR HYLAND:

So if the, if the reinforcing mesh had fractured somewhere along that line is –

MR MILLS:

Well I think what Professor Priestley is saying, that two millimetres is enough to fracture it and so let's assume that we've got two millimetres right along that point. So I'm, we'll ask him when he gives evidence but let's assume for the moment –

DR HYLAND:

I think that's important.

MR MILLS:

– that it's separated along that line.

DR HYLAND:

Yeah that's where because there wasn't any, there wasn't any mesh going into the ends of those wing walls.

MR MILLS:

That's correct.

DR HYLAND:

So it wouldn't have been there that he was talking about I suspect.

MR MILLS:

He's talking about the long, the line, along line 4 I think is what he's talking about.

DR HYLAND:

Along line 4 but there we have DH12 bars at 200 centres which we know didn't fracture.

JUSTICE COOPER:

So is it your position that it's an impossibility and it can't be discussed?

DR HYLAND:

Well the only place I can see where he could be talking about it would be at the tips of the H12 bars, at the tips of the H12 bars. So if it'd, if, if there'd been fracture of the, of the mesh along the tips of the H12 bars after September then that would have been a significant weakness, definitely, yep.

MR MILLS:

And would have affected load transfer into the north core?

DR HYLAND:

Yeah, yeah, guess so, yeah.

MR MILLS:

All right. Thank you.

DR HYLAND:

Yeah.

MR MILLS:

Now just while we're on the issue of the drag bars, just to clarify one other point and that's this issue of the drag bars not being installed on levels 2 and 3 and you're aware of that and you mention it in your report.

DR HYLAND:

Mmm, yes.

MR MILLS:

Can you just clarify for me, and again individually and I don't care what order, what your view is on the relevance, if any, of that decision to the way the building performed in February?

DR HYLAND:

Huge, I think if they hadn't had those drag bars in I think you would have seen the building collapse a lot earlier.

MR MILLS:

I may not have been clear enough. It's the lack of them on levels 2 and 3.

DR HYLAND:

Lack of 2 and 3. Well my, okay my, my opinion is, is that we considered that in scenario 3 which was proposed to me by Dr Charles Clifton originally and that's quite a valid scenario. The only, the only thing is that once you're getting down to collapse initiating at drifts of, in the order of 1% at line F the, the level of drift you'd be getting down at the connection to the, the north core at sort of line C and CD from that amenities area is, is relatively small. So it, it, so demand is sort of like, there's, there's a greater vulnerability out on the east face which to me would be, has the highest risk of going first.

MR MILLS:

So am I hearing from you that you don't think that the absence of the drag bars on level 2 and 3 plays any real role in the way the building performed in February?

DR HYLAND:

It would have had some effect on, on the way it responded but all I'm saying is it appears to me that while it was a significant vulnerability it wasn't necessarily the thing that, that actually initiated the collapse.

MR MILLS:

All right.

MR SMITH:

Wasn't necessarily but may possibly have had an influence is really, I would like to, I can't rule out that it didn't have an effect so.

MR MILLS:

Yes. Do I take it that if you had been called on to do this retrofit you would have had it, had drag bars on every floor? Is that what I'm hearing?

DR HYLAND:

Yeah I think, I guess it's great to be retrospective but yeah the approach is that, I think we would take would be, well I would take is that you would be looking to make sure you can develop the capacity of the, of the north core so that this wasn't the weak link so, that would be the approach but having looked at the, the loading standard in 1984 there does seem to be a pathway you could follow through in the design of the diaphragms that meant that they were, you know, they didn't have the capacity to cope with achieving the full capacity of the north core.

MR MILLS:

Your view Mr Smith?

MR SMITH:

I think, well I clarify that in my findings this morning that not only would I have put connections at levels 2 and 3 but I would have had a more robust connection at levels 4 to 6 if I was doing the design.

MR MILLS:

Now just to clarify, the Commission does have to look under its terms of reference not only at issues of code compliance but at best practice. Are you saying that as a matter of code compliance or best practice?

1645

MR SMITH:

No, I'm saying best practice or yeah, it's a judgement, the code is, there is judgement involved in use of these codes, yeah, engineering judgement.

MR MILLS:

Yes, right. I want to just turn now again to Mr Frost's evidence and if need be I can have these parts of the transcript pulled up but I'll just see where we get to on this. Do you agree with me that, I know you've both read it, both read his evidence I think haven't you?

MR SMITH:

Yes, I have. Do you agree with me that he identified the point of collapse as being interior columns?

DR HYLAND:

Yes. Yeah, it was interesting, I saw he also talking about floor slab failure or something as well.

MR MILLS:

Well maybe I'd better get these brought up because I think I've made arrangements for them to be available. I think the relevant parts in the transcript any rate at, begin at 46, page 46 of the transcript. Just go over to the, wait a minute, just give me one sec. Yes so you see there and as you just I think mentioned Dr Hyland, there's a reference there to slab failure and that for him was one of the explanations for why the southern half of the building came down so directly which was evidence from eyewitnesses of course about the cars parked in front and how they were virtually untouched?

MR SMITH:

Yes.

MR MILLS:

Could we then just go to that next page, 47? You'll see there at line 7 and following, he describes what he saw and then refers to the floor slabs leaning against the north core, and says, "This suggests that the collapse of the floor and beam elements started near interior columns before the north and south wall strong elements. This was also supported by the fact that most of the concrete floor slabs in the southern half of the building appeared to have dropped with very little horizontal displacements," and so on.

MR SMITH:

Oh sorry, this is his transcript from?

MR MILLS:

This is the transcript.

MR SMITH:

Okay, right.

MR MILLS:

This is the transcript. Some of this involved his response to the question so that's what I want you to look at. Now you were aware I think even before looking at the transcript that that was his view, were you, that the collapse sequence in the columns began with the internal columns?

DR HYLAND:

Yeah, I know he had a view on the beam column joint failure. I hadn't been aware of his vertical acceleration issue on the slabs until I read his statement but.

MR MILLS:

Now, at least in terms of the physical collapse evidence he probably had the best view of this of anyone didn't he? Perhaps along with Dr Heyward?

DR HYLAND:

Well I mean I understand he got there 30 hours after the collapse so it was you know some of the material had been removed. I think John Trowsdale was there earlier.

MR MILLS:

Yes.

DR HYLAND:

But Graeme's got quite a lot of experience from the construction engineering point of view so it's interesting to see what he thinks.

MR SMITH:

I think one, during the time before he got there all of the collapsed debris on the east side had been moved.

MR MILLS:

Yes, I think that's right.

MR SMITH:

So, which is quite a key thing.

MR MILLS:

You think that's a key thing? I suppose –

MR SMITH:

It's a key thing in our scenario.

MR MILLS:

Yes and is that the basis on which you've discounted what he says?

MR SMITH:

No, no, no, discounted, I wouldn't say we discounted but it is a missing link in his evidence.

MR MILLS:

Yes.

DR HYLAND:

Yeah.

MR MILLS:

Right.

DR HYLAND:

I mean, I don't think in respect I don't think Graeme's done any cal - you know, significant calculations –

MR MILLS:

No he hasn't.

DR HYLAND:

But he has put forward some, some useful thoughts.

MR MILLS:

Yes. All right. I want to now just ask you a little bit more about this western wall because I think there's just, while I don't think we'll probably ever totally resolve this, there's one issue with it which I do want to give a little more attention to. Do you agree with me that where we get to on this, at least in terms of the evidence that's been given, is that – this might be directed more to you Dr Hyland – that the principal witness you rely on for this is Mr Fortune, the man who was up on the wall, the exterior wall?

DR HYLAND:

There were two of them, there was Leonard Fortune and Bruce Campbell, I understand.

MR MILLS:

Yes.

DR HYLAND:

They'd both been working on the wall.

MR MILLS:

And you're aware, aren't you, although I think it may have changed slightly during the course of his evidence to the Commission that Mr Coatsworth who did the inspection in early October, that he at least thought there, well said he did find sealant inside against the columns?

DR HYLAND:

Yes, no I knew that.

MR MILLS:

Did you ever look at the photograph that he showed the Commission in the course of his evidence which showed what might appear, at least to an untrained eye, silicone down the connection with the column?

DR HYLAND:

I've certainly, we've got a photo in the report that was from Mr Coatsworth that did show –

MR MILLS:

I'll just get it brought up and let you have a look at it again?

DR HYLAND:

Yeah.

MR MILLS:

I don't think it will be new to you but I am –

DR HYLAND:

Oh, okay.

MR MILLS:

-interested in the views that both of you have with your trained eye as to what this might say. It's WIT.COATSWORTH.00018.2. No that's not it. 18. Should be a photograph showing the interior of that wall with the column wall line very clearly photographed. It's 0018.2 according to the note I've got.

JUSTICE COOPER:

00 or 000?

MR MILLS:

000. While they're looking for that, rather than hold it up, just let me let you know because you won't be aware of this at this point, that after Mr Frost and Dr Heyward had given evidence they took a second visit to the Burwood, I'll come back and I'll deal with it here, this is the photograph.

DR HYLAND:

Oh yes, yep. Now –

JUSTICE COOPER:

What is the number?

MR MILLS:

It is the one I gave, 00018.2.

JUSTICE COOPER:

It's 1B.

MR MILLS:

Oh, it's my eyes. That's the problem.

JUSTICE COOPER:

It may be your writing, rather than your eyes Mr Mills.

MR MILLS:

I think it was the eyes first and the writing second is the sad truth. Now there's the line that we're talking about, at least on one of the wall connections, isn't it?

DR HYLAND:

Yes, yes.

MR MILLS:

Now to an untrained eye it looks like mortar in the blocks and something different in that connection down there but I'd be interested in your view of it?

1655

DR HYLAND:

Yes it looks like a sealant to me.

MR MILLS:

Yes that is what I would have thought.

DR HYLAND:

That is what he stated in his –

MR MILLS:

That is what he says?

DR HYLAND:

Yep.

MR MILLS:

Although in fairness he became a little less certain in the course of questioning from Mr Zarifeh and we also heard evidence from a gentleman by the name of Mr Van Den Berg who was a contractor who also looked at doing that re-cladding and he looked at the wall too pretty carefully but he wasn't sure either but that photograph at least I think you are saying that does to you both look like sealant?

DR HYLAND:

Yes it is a different colour. It looks like it has sort of been sort of textured in there.

MR MILLS:

Now the other thing I was just going to let you know is that when Mr Frost and Dr Heywood made a second visit to Burwood after they had given their evidence, they were asked to look specifically to see whether they could see any signs of sealant on the columns and they did find sealant on the rectangular columns consistent with it being adjacent to the block work and we are getting further briefs of evidence from them which we will make available to you when they come.

DR HYLAND:

Just a comment, was that in two places or just on one place?

MR MILLS:

I will have to wait until we get the further brief.

DR HYLAND:

Okay will be interesting to see.

MR MILLS:

Obviously that at this stage they are just indicators?

DR HYLAND:

Yep.

MR MILLS:

Now the other thing I did want to ask you about and it came up in the course of my friend Mr Rennie's questioning of you, it relates to this greased bar detail.

DR HYLAND:

Right.

MR MILLS:

Now one of the things that came back from Burwood from the visit from Mr Frost and Dr Heywood was one of those greased bars.

DR HYLAND:

Right.

MR MILLS:

And so what I am interested in with that is in part what you were asked before, which is, as I understand and I think you have confirmed this, the reason for that detail is to allow some movement in that greased bar for the purposes of allowing, for accommodating seismic movements?

DR HYLAND:

Yep.

MR MILLS:

That's its purpose, isn't it?

DR HYLAND:

Yeah a bit of vertical movement.

MR MILLS:

Now I can see that you've got the structural drawings in front of you and just for the Commission the two relevant drawings are S17 and S39. The point I really want you to consider and then comment on is that it is at least, in the view of some people who have looked at this, a very difficult detail to achieve.

DR HYLAND:

Mhm.

MR MILLS:

And in the evidence that I think you gave in response to questions from my friend Mr Rennie, I think the comment was that the top row of the blocks was grouted but in fact we know I think from Mr Fortune that it wasn't, he commented on the hollow top row. So the question I have for you really is given that it is a difficult detail to put in place, I think you agree with that and indeed some people have looked at it and said they can't see how you would do it, but it appears it was done, doesn't that rather suggest that after going to the effort of doing something like that to achieve seismic effects or to give some seismic movement that it would be most unlikely that you would then not do the much easier connection of sealant between the block wall and the columns?

DR HYLAND:

Yeah there is a few things there with respect. When I was talking with Mr Reid earlier in the day the way it was documented showed that it was fully grouted and it was, actually I understand it was grade B masonry which meant it was required to be inspected by the engineer and signed off with a certificate but the fact that it was supposed to be grouted on the drawings but when Mr Fortune and his workmate found that it wasn't actually perhaps filled fully, the question was, was this a deliberate thing following an instruction from the engineer or was this just something that the builder just found too hard

and I don't know. So we, you know accepted there's, you know we have got hollow or partially hollow top course. I still have a problem with the way

1700

it's detailed though because why would you put a vertical slippage potential by putting a greased bar there and then fit the block hard up against the underside of the beam so you couldn't get any vertical movement? My practice in doing these sort of things is that you would leave a gap as well.

COMMISSIONER FENWICK:

If you go to the drawing S9 it shows a section through the wall?

DR HYLAND:

Yes.

COMMISSIONER FENWICK:

Now there are a number of what looked like absurdities to me in that particular diagram which you might like to comment on. If you go to the top level of the top of the masonry wall on the left-hand side of S9, do you see that the U shaped block there is, does not appear to be filled? If you come down to the next level and it's shaded as though the block is filled. You go down to the level below and it's shaded, it's sort of indicated it's not shaded, indicating it's not filled. Now I can't conceive of why one would put in a D12 bar in an empty cell, but –

DR HYLAND:

Certainly.

COMMISSIONER FENWICK:

– I just note there is that quite odd detailing on the blockwork which indicates to me that maybe they didn't intend to fill it, and then maybe they forgot about it and, when they drew it?

DR HYLAND:

Yeah, I remember when I talked to Bill Jones and I asked him how they constructed that wall, he said, well he couldn't remember directly but it's possible they could've built the wall and then placed the pre-cast beam on top of it, or they might've built it underneath, he couldn't remember, so.

MR SMITH:

I just find the detail is, it's a little bit confusing, I mean the way it's constructed doesn't match what I would've thought was intended.

MR MILLS:

Well really the principle reason I raise it with you both is as I said, that I think it's agreed it's a difficult detail. It's a detail that would be used to enable some flexibility in the wall isn't it? That's why you'd do that?

DR HYLAND:

The detail with the sealant?

MR MILLS:

No the detail with the greased bar?

DR HYLAND:

Oh, yeah, it's just, as I say it's sort of, it's missing a, there's a missing link there in that it doesn't have a vertical separation detail there.

MR MILLS:

I understand that but I think you've just agreed with me that the reason you have that detail is because of a concern about –

DR HYLAND:

Yeah.

MR MILLS:

– some kind of seismic movement in that wall and irrespective of the possible confusion in the drawings to which Commissioner Fenwick has just drawn attention, it does appear from the evidence of Mr Fortune that that top row was left unfilled and in light of that I just invite you to consider and with the photograph that we looked at, doesn't it seem more likely really that that wall was built as it was supposed to be?

DR HYLAND:

Well I just respect the witness that you have two men who worked on that wall, who have obviously been in the building trade and they were scraping that wall with spades and they both said there were no gaps at the columns, at those spaces, so I take them at their word.

MR MILLS:

I see, so in the end that's principally what you're relying on?

DR HYLAND:

Well I see no reason not to. I, the way I see it, if you combine their statements with what was seen to me, it appears that the outside of the wall there was no gap visible to them, it appeared to be masonry, they didn't notice anything odd about that. I didn't prompt them about it, and then on the inside there was a gap that was sealed.

MR MILLS:

Yes.

DR HYLAND:

So to me it just indicated that the gap between the columns and the panels had been compromised to some extent. That may have had some effect on response which is difficult to quantify.

MR MILLS:

Do you have any different reaction to that?

MR SMITH:

Yep, I'm happy with that. Yeah I agree with that.

COMMISSION ADJOURNS: 5.04 PM

5