Q. No, but it would indicate, wouldn't it, that after you'd finalised the plan there had been some attention to this and that drag bars were a necessary addition. Would you agree with that?

A. Well they probably, they weren't put in on the original draughtsman's drawing if that's what you mean, but they have been put in before the building was built, and I would say before a consent was issued for it.

Q. And presumably they will have formed part of the final as built structure?

A. I would hope so, yes.

MR PALMER:

I don't know what the procedure is for introducing this into the system but if the Commission wants it in it should be given a number?

JUSTICE COOPER:

Yes, well we'll receive it and it should be given an appropriate electronic life after that, including a number. Mr Reid?

MR REID:

I have no questions but I wonder whether we might see the plan before this witness departs Sir?

JUSTICE COOPER:

Q. Yes. Mr Jacobs.

A. I think it's a very different sort of thing to what's happened on the CTV and I mean these are just, that quite often happens where somebody, when they're checking through their drawings does put some extra bars in them. I mean I don't think it's, if they had been bolted on after the building was finished then I would agree with you more but I think what you've got there is just a something that probably with a recheck it may have happened within our own firm, with a known firm because I notice the person is a very senior engineer that had signed those drawings. Maybe I had checked them, maybe somebody else had checked them.

Q. Can you tell from the dates whether it would've been before a building permit was issued?
A. I can't tell that. I haven't looked specifically for that issue, but I would doubt it because they look like – no I don't, I can't tell you that.
Q. Would you like to have another look at it?
A. Yes I would, would have a look.
Q. So that building was erected, what, in the mid 1990s?
A. Yes it would've been erected about then yes.
1525
Q. Just have a careful look at the dates and so on I know it's difficult when these thing's sprung on you but…?
A. Well it seemed to be drawn, I mean it's very hard for this to be exactly right, it's got a drawn date there of the 11th of the 16th of '98.
Q. Ninety-eight did you say?
A. Yeah, yes '98 so 11th of the 2nd of '98 it was when it was actually drawn by the draughtsman but then these, it was signed which probably means is when it was signed for permit at the 7th of the 5th of '98 by a senior engineer.
Q. In your firm?
A. In my firm yes, but it doesn't have, it doesn't say when that was, when those bars, I don't think we can tell from that when those were put in there. It hasn't got anything here in the, there's a revisions list down the side. Normally when you put something on to a drawing post the building consent date it's listed as an amendment and it usually has a little cloud round it.
Q. Yes I've seen them.
A. The idea is that so the quantity surveyor can say well the building cost more than it did the day I tendered it you know so they can get some reward for what they're doing is extra but this, this drawing has got no revisions apart from revision (a) building consent tower so it hasn't got a revision post the building consent date.
Q. So what's that tell you?

A. That tells me that these drag bars were put in there before the building consent was done. Was given.

Q. And consequently they would have been part of the original construction?

A. Oh yes definitely yes you couldn't, you can't fit them in there, they're in the topping slab. There's no way you could fit them in afterwards. They are just extra steel that has been put in there to connect the returns in the shear wall to the floor slab.

Q. Right oh.

A. This building incidentally is, has got a moment frame round the outside of it, it was very heavily reinforced with seismic detailing and it has been recently checked and found to comply with the modern code so it has had design check on it very recently, independent.

CROSS-EXAMINATION: MR ELLIOTT AND MR REID – NIL

RE-EXAMINATION: MR MILLS – NIL

QUESTIONS FROM THE COMMISSIONERS – NIL

WITNESS EXCUSED

HEARING ADJOURNS: 3.28 PM

HEARING RESUMES: 3.51 PM

JUSTICE COOPER:
Now, Mr Palmer.

MR PALMER:
Yes Sir I'm going to ask Mr Latham to read his evidence which is contained within two, two evidence statements dated the 25th of July and the 1st of August and he's also prepared a PowerPoint presentation to assist in an

understanding of the evidence that he's about to present because of its technical nature, but just before I do that I would like to make some introductory comments which are important because it's equally important that Mr Latham's evidence must be understood in context. I just want to make the following observations about Mr Latham's evidence.

First, he's done an exercise as part of his role on the ERSA panel.

Secondly, in doing this exercise he explores the available interpretations under the code as it was in 1986. Nobody else on the panel has undertaken the same exercise using the information that Mr Latham has used, that is to say the information that would have been available at the time of design in 1986. That's an important contextual issue. The work Mr Latham has done, however, has stimulated considerable further work by other experts many of whom have filed briefs now in relation to it and those experts are not all in agreement over the issues. Mr Latham does not necessarily disagree with the other experts but his work does show that there are other ways of interpreting the code. Mr Latham has asked me to say that it's unlikely that he would undertake the exercise that he's undertaken in a practical situation and with those introductory comments I now would like to introduce Mr Latham.

MR PALMER CALLS

DOUGLAS ALEXANDER LATHAM

Q. Is your full name Douglas Alexander Latham?
A. Yes.
Q. Sorry.

DOUGLAS ALEXANDER LATHAM (SWORN)

JUSTICE COOPER TO MR PALMER:

Q. Mr Palmer just to make sure I'm understanding what you're saying Dr Latham is going to present an approach which it will be argued could have been taken to comply with the relevant codes but not one which he would advocate.
A. Correct.

Q. Nor one which was in fact taken.
A. That would appear to be the case Sir, but it is relevant to the issue of compliance with the code.
Q. Yes but it's not an approach in which Dr Latham himself has any confidence. Nor is it one that Mr Harding took. How does it, what's the point of it?
A. Well Sir Mr Latham I would argue is competent to undertake such an analysis because –
Q. Well I have no doubt he it but my question is not as to whether he's competent to carry it out but as to what its point is.
A. The point Sir is to understand how the code could have been complied with at the time. It is certainly an issue before the Commission as to whether or not there was compliance with the code and I think to put that all in context it's helpful to the Commission to understand how compliance could have been achieved in the circumstances which Mr Latham has identified. It's certainly been the subject of considerable further consideration by other experts, many of whom have different views and I think that fact in itself is rather interesting and perhaps if I could jump forward to where I want to be at the end and that is that arising out of Mr Latham's work he has prepared a list of issues which, in respect of which I don't think there is unanimous agreement amongst any of the experts that are before you in the panel and it's in, his work is valuable in understanding how each of those issues is considered relevant to the code as it was at the time.

COMMISSIONER CARTER TO MR PALMER:

Q. Just by way of starters I think it might be helpful for those that are about to give evidence to us to see the way that the Commission is looking at dividing up the issues that are before it. So if those that talked to us subsequently would be able to sort of have in their mind the thoughts that we are trying to exercise in considering the matter which I'm sure everybody can see is a number of opinions and complex in itself.

First of all we do want to know about what would comply with the code in 1986.

Second, we want to know what would be best practice in regard to the codes, acceptable practice.

Errors that are present, were present in the code or difficulties in regarding to interpreting the code as it was in 1986 and

If any of those matters still continue into the present code.

So first of all the code as it was in 1986 and what would comply, the best practice that would have applied at that time, what would have been considered acceptable even if it fell short of best practice, what are considered to be errors within the code of difficulties in interpretation and, finally, do we still have any of those matters resident in our current codes.

A. Well thank you for that indication and I think that you'll find the evidence that Mr Latham is about to give does identify the key issues and examines each of them in turn to determine what are the bounds of each element in the code and what those elements were using the known information at the time. I suggest it will be of assistance to you, the discussion that ensues.

Q. Thank you.

A. With that I'll continue.

EXAMINATION: MR PALMER

Q. Is your full name Douglas Alexander Latham?

A. Yes.

Q. Do you reside in Christchurch?

A. Yes.

Q. Are you a structural engineer?

A. Yes I am.

Q. Could you please read your second statement of evidence commencing at paragraph 2.

A. In accordance with the requirements of rule 9.4.3 of the High Court Rules I confirm that I have read the code of conduct for expert witnesses and that my evidence complies with the code's requirements. Matters on which I express an opinion are within my field of expertise.
I am employed by Alan Reay Consultants Limited (ARCL) an affected party in this Royal Commission hearing.
I hold a Bachelor of Engineering with Honours. I am a graduate member of the Institution of Professional Engineers New Zealand.
I have been employed by ARCL since January 2010 after completing my studies over which time I have worked on a number of analysis and design projects. My full resumé is annexed to this statement.
Q. So do you need me to take you to that?
A. No.
Q. Carry on please with paragraph 8.
1600
A. Involvement in CTV Building Analysis.
Together with Chris Urmson, another structural engineer employed by ARCL, I have been working with Dr Alan Reay on an investigation into the collapse of the CTV building. This work has included:
(a) Reviewing the draft reports by the Department of Building and Housing (DBH) in December 2011, and preparing comments on the draft report, a number of which were picked up and reflected in the final report.
(b) Carrying out a retrospective analysis of the building's compliance with the building code at the time of the design, and when the drag bars were fitted in 1991 as well as reviewing the DBH collapse scenario of the building using analytical tools designed for these purposes.
I have already filed three statements of evidence before the Commission, being a statement of evidence dated 31 May 2012, and two affidavits dated 5 and 6 June 2012.
In preparing this evidence I have referred to and relied upon the following principle sources of information:

(a) CTV building structural drawings,
(b) CTV building structural specification,
(c) the calculations,
(d) the reports prepared for the DBH comprising:
    (i) the CTV building collapse investigation for the DBH prepared by Dr Clark Hyland and Mr Ashley Smith, and
    (ii) chapter 5, CTV building of the expert panel report on the structural performance of Christchurch CBD buildings in the 22 February 2011 aftershock.
(e) NZS3101:1983 "Code of Practice for the Design of Concrete Structures,"
(f) NZS4203:1984, "Code of Practice for General Structural Design and Design Loadings for Buildings,"
(g) other information referred to in my evidence including the seismic analysis report I referred to below.

Following an interlocutory hearing in which such information was sought by ARCL and Dr Reay from the DBH and Compusoft Engineering Limited in early June 2012 ARCL received copies of the full input files used by the authors of the DBH report for the ERSA analyses. I've used these files to assess the inputs for the DBH ERSA analysis and to carry out further analysis.

Royal Commission ERSA panel.

I have been a member of the ERSA panel constituted as part of the Royal Commission into the collapse of the CTV building pursuant to the order as to directions in relation to the elastic response spectra analysis evidence dated 18 June 2012.

The outcome of that panel was reported in a joint report prepared by Professor Carr. Areas of agreement and disagreement are noted in that joint report.

I am in a disagreement with a number of issues relating to the ERSA. Most of those issues have been noted in the joint report to the Commission.

Due to my disagreement over some of the ERSA panel issues, I have carried out a further ERSA analysis. I have prepared a seismic analysis report, a copy is attached to this brief, which sets out the analysis I have taken and the result of the analysis.

I wish to explain how this report came about and its context in relation to other work that I've done. In particular I have undertaken three tasks arising out of the ERSA panel work. They are:

(a) First, I've run a static analysis of the CTV building to determine the forces and displacements that could be used in the design of the structure in 1986. In running a static analysis I did so with the assumptions that I consider are justified on a straightforward interpretation of the relevant information available in 1986.

(b) Second, I performed an ERSA using the static analysis to carry out the scaling required by the code. Of course in doing so I adopted the same assumptions used in the static analysis.

(c) Third, utilising the subsequent results of my analysis I am in the process of completing a design review of the columns with a view to ascertaining whether there was compliance with the code as it was in 1986.

Q. And is that work now complete and the subject of your third statement of evidence?

A. Yes.

Q. Carry on.

A. For the reasons explained below the report accompanying this part of my evidence only includes the first and second task noted above.

Q. I don't think you need to read the last paragraph of that sentence. Finish at, continue with 17?

WITNESS CONTINUES READING BRIEF OF EVIDENCE FROM PARAGRAPH 17

A. It is important for me to record that as a member of the ERSA panel I have always promoted the dual viewpoints that:

(a) first an ERSA was not required in the circumstances of the CTV building design, and

(b) second, if the ERSA was going to be run it should be re-run using inputs derived from 1986. I note here that any such analysis, including static analysis, should also be run using inputs derived from 1986 circumstances.

I understood from the, "Order as to Directions," dated 18 June 2012 that

1605

if agreement could not be reached amongst the ERSA panel on the Compusoft's ERSA reliability that a further ERSA would be carried out. Reference clause 4.4 of that order.

From the outset on the ERSA panel I have challenged Compusoft's ERSA reliability and as noted above have promoted the need for a separate ERSA to be completed using 1986 derived inputs. Notwithstanding the possibility contemplated in clause 4.4 of the order as to directions no separate ERSA was run by the ERSA panel. Accordingly, I determined that I would do an appropriate analysis myself.

In considering running an ERSA with the 1986 derived inputs I came to the view that running an ERSA was not required under the code. It was only once I got to the point of assessing the CTV building for running an ERSA that I reached a definitive conclusion on this issue. I concluded that instead it was feasible and appropriate for a static analysis to be run for the CTV building and that analysis was all that was required.

In the process of running the analysis it occurred to me that I then had all the information I needed to undertake a design review of the columns, measured against the code as it was in 1986, so I was in the process of completing that review but at the point that this brief was prepared had not finished.

Q. Now you have given the fact that you have now achieved what you discussed in the rest of paragraph 21, could you just continue with paragraph 22 please?

WITNESS CONTINUES READING BRIEF OF EVIDENCE FROM PARAGRAPH 22

A. Summary of seismic analysis report.

In summary my seismic analysis report on my static analysis and ERSA concludes:

(a) The CTV building is only of moderate eccentricity using the McCahon soil stiffnesses and therefore a static analysis can be used exclusively to determine the design forces and displacements compliance with the 1986 code.

(b) Under both the static analysis and ERSA the CTV building complies with the drift limits in the code.

It can also be noted that the design drifts determined from both the static analysis and ERSA are such that the columns appear to comply based on the criteria used in the DBH CTV building collapse report by Dr Hyland and Mr Smith.

Q. Thank you Mr Latham, just a couple of housekeeping matters. The seismic analysis report that you refer to in your evidence which is document WIT.LATHAM.0002.11. Do you have a copy of that with you?

A. Yes I do.

Q. Could you please go to page – what is page 15 in the Commission's reference and it is page 3 of your report under the heading, "Modelling inputs."?

A. Yes.

Q. There is a table, table 2 at the bottom of the page. Do you wish to make some corrections to the first paragraph below that table?

A. Oh, right, yes the reference for the coordinates of the building used in this report are mirrored that, of the DBH report. The calculation of the building mass used a different set of coordinates in the appendix so where it says in table 2 X and Y measured from the intersection of grid A and grid 1, that refers to the coordinates used in the appendix not the report.

Q. So should that be, should those references be changed from A to F and from 1 to capital A?

A. Yes.

Q. And further – when it carries on with positive X in the east direction, should that really mean north direction?

A. Positive X is in the north, positive Y towards the west.

Q. In the west. And if you could just turn the page of your report to page, what is page 16 of the Commission's version page 4 of the report, underneath paragraph 3.3 is the – that report that is dated there that is dated the 5th of June 2012 from Mr McCahon?

A. Yes.

Q. The reference for that is BUI.MAD249.0460.1. Now with those housekeeping matters out of the way, could you please turn to your third statement of evidence which is dated the 1st of August?

A. Yes.

Q. Could you read that report, beginning at paragraph 2 please?

WITNESS CONTINUES READING THIRD STATEMENT OF EVIDENCE PARAGRAPH 2

A. I refer to my second statement of evidence dated 25 July 2012 for full details of my qualifications and experience. I again confirm that I have read the code of conduct for expert witnesses and that my evidence complies with the code's requirements.

As signalled in my second statement of evidence I have carried out a design review of the secondary frames in the CTV building relevant to code of compliance.

I attach my report on secondary frame design review report dated 31 July 2012.

Summary of secondary frame design review report.

In summary my secondary frame design review report concludes:

(a) Consideration of gravity frames as secondary frames. It is reasonable to expect the gravity elements of the CTV building such as the beams and columns to be considered as secondary elements and detailed accordingly to the requirements of NZS3101:1982 outlined in clause 3.5.14. This was the basis of the lateral analysis carried out in my seismic analysis report dated 25 July 2012.

(b) Requirement of ductile detailing. Based on the equivalent static drifts determined in my seismic analysis report, the additional seismic requirements of NZS3101:1982 were not required to be satisfied as the imposed deformations on the secondary frame elements did not result in plastic behaviour.

(c) Column design. The design of the columns appears to be consistent with the provisions of the required codes and standards for load combinations involving earthquake loadings.

(d) Beam design. The design of the beams appears to be consistent with the provisions of the required codes and standards for load combinations involving earthquake loadings.

(e) Beam column joint design. The design of the beam column joints does not appear to be consistent with the provisions of the required codes and standards for load combinations involving earthquake loadings.

I elaborate and explain each of these conclusions in my secondary frame design review report.

Q. Have you prepared a short Powerpoint presentation which is BUI.MAD.249.0583.1?

A. Yes.

Q. If that could be brought up please. Now if you can take control of the mouse and, or what is the easiest way to do it. It is easier if you do it if you click your way through it and if you just explain each of the slides in the way that you wish to?

A. Right.

WITNESS REFERRED TO POWERPOINT PRESENTATION

A. Right so I will just start by explaining the context of the review. So obviously the context has been taken with a 1986 context, obviously when the building was designed. That involved the application of the standards NZS4203:1984 and NZS3101:1982. Those were the relevant standards in the Christchurch bylaw. The review does not intend to replicate what was done in the original design. It looks at what could have been done in 1886 so that is an important point.

The assessment has basically been undertaken in two phases: the first phase involves a lateral analysis of the building as a whole using ETABS to determine the drifts and displacements of the building under the code loads. From that then we can then look at the assessment of the columns under those drifts determined above and the assumptions must be consistent between the two phases. The two phases there, one and two are the two separate reports that I've prepared.

So it was part of the DBH report a 3D ETABS model was developed by Compusoft and one of the features of this model is that it used flexible foundations using the upper bound soil stiffness recommended by Tonkin and Taylor.

As part of the Royal Commission work a panel was set up to look at the ERSA and the areas of agreement and disagreement and to essentially determine whether that model made for the DBH report was the most reliable and I was a member of that panel and we requested that the foundation stiffnesses used in the model should reflect the recommendations by the original geotechnical engineer Mr Ian McCahon. Another area that came up was that the masses of the building should also reflect the 1986 information and assumptions in full. As part of that work there was no further ERSA analysis undertaken by Compusoft so I took that upon

1615

myself to carry out that extra work so I, we, we received the ETABS models and I adjusted the soil stiffnesses to reflect the recommendations from Ian McCahon. There was some other minor changes made to the model but the soil stiffness was the major change and then subsequently that work was presented in the reports attached to my briefs. In response to this analysis Compusoft have now presented further analysis and they've covered three cases: one, the first one a fully rigid base, the second using the most probable soil stiffness values recommended by Tonkin and Taylor, and the third the lower bound soil stiffnesses recommended by Tonkin and Taylor.

One of the effects of these varying foundation stiffnesses is a change to the natural period of the building so as the soil becomes more flexible the natural period lengthens. If we look at the fixed base model the period was about .8 seconds and if, for the Tonkin and Taylor stiffness ranges the period was in the order of one to 1.4 seconds and with Ian McCahon values the period lengthened to 1.2 seconds in one direction and two seconds in the north south direction. One of the other key changes was that it affected the relative stiffness of the north core wall to the south coupled wall and I've borrowed this figure that Mr Smith has prepared and we can see the centre of mass in the middle of the building there and the various positions of the centre of rigidity, so for the fixed base case the centre of rigidity is to the north of the building near line 5 as the, some soil flexibility is introduced that centre of rigidity moves towards the south and there's a range there indicated by Mr Smith and then using the softer soil stiffness recommended by Mr McCahon the centre of rigidity moves further south where it's shown in red there. This is an example at level 4 only and the implications of that are that it can be, the building can be considered using the definition in the loading standard to be of moderate eccentricity with the McCahon stiffness as opposed to a high degree of eccentricity with a rigid base or the Tonkin and Taylor stiffness and again the implications of whether it's of moderate or high degree of eccentricity relate to the type of analysis that can be used on the building. If it has a high degree of eccentricity then a ERSA or a 3D ERSA was recommended, not required but recommended, and that was in fact done in the original design as well.

Now one of the issues with using a flexible foundation model is how you treat it with, in relation to this clause 3.8.1.2 of the loading standard which stated: *"computer deformations shall be calculated neglecting foundation rotations"* and so a flexible foundation model is in conflict with this clause. If we used a fixed base model then there is no such problem. Now one interpretation of, if a flexible foundation model is used is that the columns still undergo the drifts and therefore they should be included. If you interpret this clause literally you are required to neglect the foundation rotations and so that is the basis of the analysis report that I have done which neglects the foundation rotations. I've just got a quick summary of the different models. I'm not going to go into the numbers but I'll just highlight a couple of trends. The Compusof model with the Tonkin and Taylor upper bound stiffness which was that presented in the DBH report generally has the highest drifts. If we then look at the Compusoft model with the fixed base the drifts are reduced and then finally the ARCL model which uses the McCahon soil stiffnesses and neglects the foundation rotations the drifts are lower.

And again on, this is that previous one was line F, if we go to grid 1 we see the same trends the Compusoft Tonkin and Taylor upper bound stiffness has the highest drifts, the fixed based model reduced and the ARCL model with the foundation rotation components neglected has the lowest drifts.

And this is line 2, the internal columns, same trends again.

So then we can then go on to move to the second phase of assessment which is looking at the detailing requirements of the columns. And so clause 3.5.14.3 of NZS3101:1982 outlined the requirements for group 2 secondary elements such as the beams and columns and we've heard this a number of times before but essentially if the columns remained elastic then the additional seismic requirements of the code were not required to be met and if the columns did not remain elastic then the additional seismic requirements were required. They are fully ductile or limited ductile. So we can then ask ourselves well how do we determine if the columns remain elastic?

And there have been a number of approaches put forward so the first method there is to carry out moment curvature analysis, this was carried out by Dr Hyland and was presented in the DBH collapse report. A second method has been proposed by Dr Hyland which is the working stress method in Appendix B of the concrete standard and one thing to note with this method is it required different loading factors to be applied in the, the loading standard 4203 provided different factors and if, to use the working stress method only required 80% of the earthquake specified in 4203 so that just needs to be consistent if you're comparing. The third method there is an elastic frame analysis using uncracked properties and then assessing the demands on the column against the dependable strength and that's the method that Mr Smith appears to have used, and finally using an elastic frame analysis but using cracked properties and then assessing it against the dependable strength and that's the method that I have presented.

So talking about the degree of cracking one option to a designer is to use a simplistic assumption of uncracked properties for all columns. Another option available was to carry out a more detailed assessment equation 4.4 in the concrete standard provided a method for getting a more accurate picture of the cracking, now that if, essentially what that equation does for members that had a high degree of axial load on them such as the lower floor columns you'd expect less cracking because of the high axial loads and so you end up using the gross stiffness. For members, columns towards the higher end of the building with lower axial loads then you can expect more cracking and the stiffness is reduced to reflect that.

So if we just make a comparison of some of the methods and models that have been used to date, we have on, we're looking at grid F in the north south direction, the demands that have come out from the ETABS model and then scaled accordingly are presented on the left. There we show the Compusoft fixed based model and ARCL model with the McCahon soil stiffnesses with the foundation rotation component removed. And then on the right there we have the elastic capacity as determined by these, those different methods for assessing the columns which I outlined above. Essentially if the elastic capacity is greater than the demand then the columns are remaining elastic. If the elastic capacity is less than the demand then the columns are not remaining

1625

remaining elastic. So if we assess the different criteria that have been put forward to date with the different models we can see that using the

Hyland criteria then the columns are remaining elastic for both the Compusoft model and the ARCL model. If we use Mr Smith's criteria they are not remaining elastic under either models apart from the ground floor and using the criteria I put forward they are remaining elastic at all floors under the ARCL model and not at one floor under the Compusoft fixed base model.

Looking at that same scenario but on gridline 1 in the east-west direction the Hyland criteria remains elastic at all levels under the ARCL model drifts and it does not at one floor under the Compusoft fixed base model. Again, Mr Smith's criteria, they do not remain elastic for either model apart from the ground floor and then using the criteria I have put forward they remain elastic at all floors for the ARCL drifts. They do not for the Compusoft fixed base model drifts.

And, finally, on grid 2 which represents an internal column the Hyland criteria remains elastic for either model at all floors as does the criteria that I have put forward. Mr Smith's criteria does not at the upper floors.

So in summary the columns remain elastic using the ARCL drifts in either the Latham or the Hyland column criteria. Similarly for the Compusoft fixed base model drifts they remain elastic for most floors but not all. One of the key points to note is that there are different methods of analysis available to the designer. There are different assumptions that can be made and there are different interpretations of the code clauses. And the conclusions on compliance are dependent on the above methods and assumptions and as the slides before showed we can get some different results.

Q. Thank you Mr Latham and finally have you prepared a one-page sheet with a list of issues that you consider arise out of your evidence?

A. Yes, yes I have.

MR PALMER:

I think has been provided to the Commission Sir. I'm not sure if everyone else here has a copy but I've got additional copies here for those that don't. I provided it to counsel assisting. I thought it was to be provided to you.

JUSTICE COOPER TO MR PALMER:

Q. Yes we've seen it. I'm not quite sure what it's, this is just a sort of aide memoire is it?

A. Yes. Mr Latham thought that analysing all of the other evidence that has come in on this issue he's summarised in this one page the topics that, where there seems to be divergence of opinion and so it's a useful reference point to consider the issues that arise from the evidence that he and others have presented on these issues. That's all Sir.

JUSTICE COOPER:

Thank you. Now can I just ask have members of the expert panel seen the summary that we've just been through, that Mr Latham has just taken us through, the various slides?

MR BRADLEY:

We've seen his briefs of evidence but we haven't seen the summary just discussed.

JUSTICE COOPER:

The summary.

MR BRADLEY:

No.

JUSTICE COOPER TO MR PALMER:

Q. So it would be better if that was made available too wouldn't it?

A. Yes Sir I'll make sure that is. Sir it does have a number. It's in the system as BUI.MAD249.0583 at 1.

Q. Yes but in order for people to know what they're wanting to call up they'd have to be reasonably familiar with this wouldn't they?

A. I've got some extra copies here Sir.

Q. Yes well I think they should be made generally available because we're obviously not going to finish this discussion tonight are we.
A. No. If that could be circulated to the other members of the panel.
Q. It needs, are they colour photocopies? Have a look at the last –
A. Two colour photocopies Sir. It probably needs to be in colour.
Q. It does doesn't it. So in due course if you could make coloured copies available to all the members of the panel.

JUSTICE COOPER:

Now Mr Henry's just joined us. What's happened is that Mr Latham has read two statements of evidence, successively called his second and third briefs, to which was attached reports setting out his conclusions following the exercises that he's done. He's then gone through a series of slides which purport to summarise the contents of the two reports that he's given in evidence and that's brought us to this point.

MR MILLS:

Sir I've just realised that Dr O'Leary is supposed to take this aspect as well. It seems to be that now that Mr Latham's done his presentation as we've done in previous panels he could create another seat up there and we could –

JUSTICE COOPER TO MR MILLS:

Q. Well it depends upon the answer to my next question.
A. All right.
Q. Is it not intended that Mr Latham be cross-examined on what he's presented?
A. My understanding was that the –
Q. You'll need to be speaking into a microphone obviously.
A. My understanding was that the intention was that there would be the normal sort of panel discussion and then at an appropriate time, and I hadn't thought it would be initially, that the opportunity would be given to any lawyers who are here who wish to question on this but at least initially what I think counsel assisting had contemplated was that it

would simply go into the opportunity for these other panel members who are lined up here, all of whom have provided briefs responding to Mr Latham, which are being taken as read, that there would be an engagement in the normal way on the issues that Mr Latham has raised. Whether the lawyers present do want to ask questions, that's a matter for them.

JUSTICE COOPER ADDRESSES COMMISSION:

Well is everybody content to proceed in that way?

UNKNOWN SPEAKER:

Yes Sir.

JUSTICE COOPER:

Yes, right, Commissioner Fenwick.

COMMISSIONER FENWICK:

Q. Just to start things off. You have done a degree course?
A. Yes.
Q. You've spent three years or thereabouts specialising on civil engineering and design.
A. Yes.
Q. And the same was true in 1960s. So Mr Harding would have gone through the courses as well. Mr Harding would have gone through the courses in 1970 I think, but about that time, but over that time there has been a three-year course and it's necessary would you agree for engineers to go through that training and to have some experience before they're capable of design. Would you agree with that?
A. Yes, yeah.
Q. It's essential isn't it do you feel, it's essential they have that training so they understand the code and how structures work so they can work out how to apply that standard?
A. Yeah, it's important working with someone experienced, yes.

Q. You don’t think the initial training is, the initial under-graduate degrees, courses in geomechanics and so on are important?
A. The, the under-graduate degree is important? Is that what you're asking?
Q. Yes.
A. It’s very important, yes.
Q. So it’s important they know some geomechanics, they know structures –
A. Yes, absolutely.
Q. – they know how they’re designed, okay, right, and so when we’re looking at what you're proposing –
A. Mmm.
Q. – I can't myself see it. I just wonder how you’ve, I can't see it in terms of just a code because someone’s got to have background experience to be able to apply that code.
A. Yes.
Q. And therefore isn't a mixture of two items we’re looking at? What would an acceptably competent engineer do in this case?
A. Mmm.
Q. If you agree it’s more than just what the code says and the way you interpret it 30 years later.
A. Yes well I mean the approach, the approach that we’ve undertaken in this exercise is to then look at what the code says and what the code requires.
Q. Right. Well just to illustrate the point.
1635
Q. Well just to illustrate the point –
A. Mmm.
Q. – you have used the recommended soil stiffnesses from McCahon and Co in 1986 and those were derived for structures for long-term gravity loading, is that correct?
A. Apparently yes.
Q. Yes, and we know that what happens, because you’ve done geomechanics, two or three courses of it, we know that occurs because

the water drains out and settlement occurs gradually. On the sand it's relatively fast, on silts it's slower, it takes a few days and so on. So they are slow period times, aren't they? Now we know if we look at the record of the letter you got from, I've forgotten the name, but the letter you got recently asking about the properties, he says in that letter does he not, that okay it may be that liquefaction occurs or partial liquefaction occurs and the stiffnesses values determined for the long-term loading might possibly have been appropriate for earthquake loading?

A. Yep.

Q. Now what I'm saying, as an acceptably competent engineer, could you possibly design or analyse a building only on those soil stiffnesses? Is it possible and conceivable that anyone who had had two years' experience had known that normally the dynamic stiffness is very much higher than the other stiffness, would use that on the basis that it may have been possible that the soil was more flexible in liquefaction, in fact they didn't know much about liquefaction until the 1990s but would that have been a possibility, you could have possibly designed it only on that case or that being an extreme case that you would've looked at, now what's the answer?

A. Yeah I mean it's important to understand the range, and I mean I think initially if we look at this, we had one model with one value presented and one of our requests was to look at the effects of what would happen if other values were inputted, including those that were put forward by Mr McCahon as recommended in 1986.

Q. For long-term loading?

A. Yeah, well so now we, now we've looked at that and we've also got these additional models now, so I mean we're in a much better position to actually assess what the structure should be designed for or assessed against. I think it's important to look at the range though and not just have this one model that we had to start with which, which I mean –

Q. So your judgement then on whether this building, the columns and members – and we'll talk more about that later, go inelastic is going to based then not on just your minimum soil stiffness. It's going to be on the likely higher stiffnesses as well, is that correct?

A. Yep, well that's correct yeah I mean and in say my presentation that's why I've presented both you know the rigid case and also the most flexible case. So I mean we in effect have that range there.

Q. So wherever the rigid case controls and says this is critical, that's the value we use?

A. Yeah.

Q. And that's what is acceptably right? Now I've got a second question too. You've taken the drifts that you're checking for off your ERSA analysis?

A. Correct.

Q. Now would a rationally competent engineer do that? Now, the reason I'm saying this is you have done an elastic model and you've predicted the deflection on that. But we know that plastic hinges form don't they?

A. Yes.

Q. All right, so your elastic model at the base would have very little of that deflection because of the stiffness of the ground, but we know in fact, do we not, when it forms a plastic hinge it's going to rotate?

A. Correct.

Q. Correct, right, thank you. So the inter-storey drift you get off your ERSA analysis, how are you going to adjust for that? I mean I'm saying would not an acceptably competent engineer recognise that you can't just take and ERSA value and use it?

A. Well I mean the numbers that come out of the ETABS analysis are scaled.

Q. What way are they scaled?

A. Well they're, there's, in the 1986 or the 1984 loading standard they were scaled by factor K over SM which in effect allowed for the ductility.

Q. Well I'm going to say to you I don't think a reasonably competent – I agree that's what it says there –

A. Mmm.

Q. – but I think a reasonably competent engineer would recognise that when you form a plastic hinge at the base of a structure that's not going to give you the correct scaling because we know that when you form a plastic hinge it's going to rock over. So you've got your elastic

1640

Q. deflections plus your plastic deflections. So I've a question, any engineer who took that value as that, can I judge that as a reasonably competent assumption? A reasonably acceptable assumption? Now would you agree or not?
A. I would agree in today's terms. In 1986 I couldn't tell you what the standard procedures were.
Q. You don't think in 1986 they knew about plastic hinges?
A. Oh, I'm sure they did, yes.
Q. And you don't think they knew about the way deformations occurred?
A. Yes I'm sure they did.
Q. So if they knew that a plastic hinge was going to form, or your coupled wall was going to lean over like that, wouldn't it have been grossly incompetent to ignore that when you're assessing the deformations on your columns?
A. Well they're not, they're not really ignored because they're taken into account by this increased, increased factor that's dependent on the ductility.
Q. So for simplicity –
A. Mmm.
Q. – when you've got zero rotation of your column at the base –'
A. Yep.
Q. – when you multiply K over SM does it increase from zero?
A. No.
Q. So it's not correct is it?
A. No.

WITNESS EXCUSED

DEREK BRADLEY (AFFIRMED)
BARRY DAVIDSON (AFFIRMED)
CLARK HYLAND (AFFIRMED)
ASHLEY SMITH (AFFIRMED)
JOHN HENRY (AFFIRMED)
ARTHUR O'LEARY (AFFIRMED)
DOUGLAS LATHAM (AFFIRMED)

JUSTICE COOPER:
The first point that has arisen I think is as to well in two ways I think. What Commissioner Fenwick's "reasonably competent engineer" might have done to apply this code in 1986, and I wonder if Commissioner Fenwick could just in a brief way put those two propositions that he's discussed with Mr Latham to the general panel for response?
1645

COMMISSIONER FENWICK:
The propositions I put were how do you treat the soil information from 1986 where you are given a soft soil parameter, a comment that this may possibly apply for dynamic analysis, the person that wrote that said they are not an expert in this area. That was the first proposition. Whether that is sufficient to do an analysis just on and draw conclusions on that.
And the second one was the inter-storey drifts. Is it rational to scale ERSA ones or should one be making what are acceptably competent engineer actually have made some allowances for the inelastic deformation knowing that scaling ERSA values does not give you the correct reflected shape particularly in the lower regions of the building where the axial loads are higher? So those were the two points I was really discussing with Mr Latham.

JUSTICE COOPER:
Can we start with you Dr O'Leary, somebody who was probably designing buildings at the time.

DR O'LEARY:

The first question related to the treatment of the soft soil stiffness, is no, it is not a legitimate stiffness to use. I might point of course that it does lengthen the inter-storey drift because it lengthens the period but neglecting that which isn't an insignificant point, no the soft soil stiffness is not legitimate. We all know that stiffnesses under a dynamic situation tend to get pretty high. It is the first question.

JUSTICE COOPER:
Well we will deal with them one by one shall we.

DR O'LEARY:
Yeah.

JUSTICE COOPER:
Is there anything else you want to say on that one?

DR O'LEARY:
Not on that one, no.

JUSTICE COOPER:
Mr Henry?

MR HENRY:
So you want just the first question about the soil that we are talking about?

COMMISSIONER FENWICK:
Yes the use of the soft soil and the analyses Latham carried out, Mr Latham has carried out and then he has used those to analyse the structure and then remove the soft soil deformations out of the structure. So the question I had was it legitimate to use the soft soil only knowing that this was an absolute – well from what I interpret as being a likely lower, a possible lower limit of stiffness.

MR HENRY:

Okay, well in the 1980s it would essentially be unheard of to even consider modelling the soil underneath the building. The standard procedure was a fixed base model which tended to keep the periods short and the load at the highest level and therefore produce a stiffer structure but I don't, I mean the programme ETABS it couldn’t really deal with an equivalent stiffness for the soil properties, I mean it could be done by the dummy storey as it was called but really it would just be an approximation would probably be a reasonable word for it, you’d have to try all sorts of different values and then try and correlate them with what is on the site to even consider that you had something realistic so that’s, I mean really it was just not done. If you were, if you did have soft ground and you really thought it through, in terms of using the, I mean I should just take one step back. We did do a job once with soil properties which was the Union House base isolated building, that was 1982 where we had the piles, essentially a building on stilts in tubes and restrained it ground level by the dissipaters, energy dissipaters and we had to model the ground to make sure they didn't come into contact which was done with the two dimensional programme ReMoKo at University of Canterbury. It was a very expensive, drawn out sophisticated analysis. Professor Carr helped us through that, so it was really quite an extreme thing to even consider it. Anyway, taking a step back from that, in terms of what it actually means though if you are using the soil rotations if you were to. What the code was really saying you don't need to take into account these flexible or the soil flexibility for building deformations because it is really, considering that the whole building is going as a whole and all the relative inter-storey deformations are the same providing the whole building moves as one unit but, then that would be fine if you had a one big foundation and everything sits on one pad but when you have stiff foundations on the ends and isolated pads in the middle with flexible columns on them then you are going to get a difference where the flexible columns want to stay behind in the ground storey at least and, but the upper storeys they’d be constrained the diaphragms holding everything together. So the ground storey, the rotations of the end walls in the case of the CTV would drag the ground storey columns with them and enforce them to take, undergo the rotations. So if you have calculated I think as in the case of Mr Latham has, rotations that were three times the fixed base deflections, there is four times the deflections would be imposed on the ground storey columns.

COMMISSIONER FENWICK:
Can I summarise that -

DR O'LEARY:
Yes.

COMMISSIONER FENWICK:
- by saying that except the competent engineer would recognise that you could not remove the soil deformations where the structure was separated on, supported on individual pads?

DR O'LEARY:
Yes, yes.

JUSTICE COOPER:
Dr Davidson, do you have a view on this issue?

DR DAVIDSON:
No my view is more or less in line with, I guess Commissioner Fenwick's, it is very difficult –

COMMISSIONER FENWICK:
I have no view I am just asking questions.

DR DAVIDSON:
Oh, okay. Okay, your summary then shall I say. No, no I was involved with many analyses though I am not a structural designer so to some extent I was guided by the designers that I work with and –

JUSTICE COOPER:
What was the practice in the 1980s?

DR DAVIDSON:
The practice was as Mr Henry said, it was a fixed base. Typically the analysis was done with a fixed base.

JUSTICE COOPER:
Dr Hyland.

DR HYLAND:
Yes, there is a number of points. I think the first thing is when we are looking at code of compliances to consider how these codes are developed and the process of development and that there's the code committee takes a body of knowledge that has been derived through research and through academic processes and then that is transformed into a set of principles that are then agreed and then prescribed qualitative, prescribed quantitative measures are then developed by a code committee that it is assumed an experienced engineer will then apply and so when one approaches interpretation of these things should used a fixed base shouldn't you – the requirement is that you interpret the full body of the standard, the qualitative and the quantitative proportions of the clauses. I think we have quite an interesting contrast between the last two witnesses in that you have Dr Jacobs and you have Mr Latham taking probably quite different approaches, one perhaps looking at the qualitative and the one looking at the quantitative only and you know, it is not the intention of a standards committee to just restrict interpretation just to quantitative clauses. I know through my involvement with steel structure standard that we were asked, could you make everything very quantitative when we develop the revision to the standard and we had to say, no you can't do that, because every design is different, every situation is different, you are expecting an experienced engineer to use the principles which have been set down in a way that another experience engineer could look at it and say, yes,

you have applied this code in an appropriate manner to a situation, a specific situation which couldn't be totally quantified by the quantifiable requirements. So in answering the question of, should you allow for soil deformations, the experienced engineer would say yes you must because that is a principle of design. So I don't think it is appropriate to just take a clause and say, that is all you have to do because that is a convenient quantitative measure.

COMMISSIONER FENWICK:

The question Mr Hyland really was, could you base, rationally base a design on the low soil stiffness derived from a settlement foundations, with the

1655

qualification from the person that knows they're not an expert in this field but may be if there was liquefaction or partial liquefaction that might be appropriate. My question is would it be appropriate to base an analysis on that soft soiled or would you need to do one at the other extreme where you took a more realistic stiffness?

MR HYLAND:

Well the first answer to that is that well first of all you would get advice from an experienced geotechnical engineer and they would give you a report and they would give you limits and they'd give you say, "here's, here's a bound, here's a lower bound, here's an upper bound". And you would then use that as your, as your basis for a design. The – my understanding of the, the advice that Mr McCahon gave is that he said it was qualified just for settlement purposes and not for dynamic uses so he wouldn't be using that for a compliance check in my view. The other, the other issue related to this is the complication with the, the Harding model is that they've used a, they say they've used a fixed base structure yet the period of vibration was 1.05 seconds which doesn't seem to conform with what you would have for a fixed base. If you used the fixed base then the south wall would be much less compliant with the standard if you use the 1.05 seconds you're getting closer to compliance but there's a, there's a, there's an inconsistency in the approach that has been taken in the calculations that either they used a fixed base or they used some sort of intermediary approach it's not clear because we don't have the, the analysis results.

JUSTICE COOPER:
Yes Mr Smith anything you wish to add to that?

MR SMITH:
Yes I'd just like to, yeah my recollection being a practising engineer in Wellington at the time was that we modelled things with a fixed base, which was the accepted practice at that time. I would like to refer to a paper that was included in Dr, Professor Carr's report for the ERSA panel that if I can give a reference, WIT.CARR.0002B, page one initially. Can we put that on the screen?
WITNESS REFERS TO REPORT
So we did discuss this in the ERSA panel and I think we agreed at that time that the fixed based model was common practice. However this, there's this paper that I referred to dated 1980 in the Earthquake Society Bulletin that was directly relevant so, so we're looking at, if we can zoom up on the paragraph 2 on the right-hand column please.

JUSTICE COOPER:
Well what page is this.

MR SMITH:
This is page 46.

JUSTICE COOPER:
WIT.CARR.0002B.46.

MR SMITH:
Forty-six. Sorry about that, okay the, the title of the paper is The Analysis and Design of the Evaluation of Design Actions for Reinforced Concrete Ductile

Shear Wall Structures. So that is directly relevant for the CTV building and on that top right-hand paragraph, paragraph 2 I'll just read it out:

"Deformations of the foundation structure in the supporting ground such as tilting or sliding are not considered in this study as these produce only rigid body displacement for the shear wall superstructure. Such deformation should however be taken into account when the period of the structure is being evaluated or when the deformation of a shear wall is related to that of adjacent frames or walls which are supported on independent foundations."

So this is relevant to what we're talking about and I would consider this paper dated 1980 whilst it may have been common practice to model things with rigid foundations because that was the way the software worked in a, in most cases, this paper would have been common knowledge and I would consider that to be best practice shall we say so that we should be aware that when we're modelling it with a fixed base there are limitations to that and that would have been known at the time. Just going back to the, to the, our, the Smith, the Hyland Smith report modelling with the upper bound soil stiffness that we were given by Tonkin and Taylor the reason for that is that we knew it was critical that the column drifts we were assessing would determine whether the columns complied or not and the most, the least onerous drifts shall we say would come from the case with the upper bound soil stiffness so that's the reason we used the upper bound stiffness rather than the lower bound because the lower bound stiffness would give higher drifts. So that's probably the points I had.

JUSTICE COOPER:

Thanks you, now Dr Derek Bradley, have you anything to add?

DR BRADLEY:

I'd just on the first question I don't believe it would be appropriate to base a dynamic analysis on a long term settlement stiffness and I'd like to add that if there is uncertainty on a parameter something like a soil stiffness then and it, then an engineer would be expected to do a sensitivity analysis on that particularly if it did affect the results considerably. On the second question.

JUSTICE COOPER:

Well we haven't arrived at that yet.

DR BRADLEY:

Oh yeah, sorry.

JUSTICE COOPER:

Now Dr O'Leary at one stage you looked as if you wanted to say something more, this is your opportunity.

DR O'LEARY:

Thank you. From maybe '85, '84, '85 in our practice in Wellington we did actually use foundation flexibility but it was always used for pile supported buildings rather than pad supported buildings so that rotation at the head of the pile was insignificant apart from the ground first floor.

JUSTICE COOPER:

You'll have to, I'm sorry, you'll have to stay on contact with the microphone. Could you just repeat the last sentence please?

DR O'LEARY:

So we used foundation flexibility but the rotation that it imparted to the head of the pile was as relatively minor influence on, well it was a very minor influence on anything above that because we had to develop plastic hinges at ground level anyhow and the reason we used foundation flexibility was it lengthened the period of the building so something more appropriate to real life. It also increased the interstorey drift a little which for separation of window systems was again more appropriate to real life so yes we, I don't agree that it was a totally uncommon practice but by default we complied with 3.8.1.2 which says computer deformation shall be calculated neglecting foundation rotations. The way we used it it didn't actually make any difference.

COMMISSIONER FENWICK:

Right so did you remove the deformation due to the foundation deformations?

DR O'LEARY:

No this is only piled structures. What we used to do was pin the pile at an appropriate depth and use soil springs horizontally I think to try and have a realistic view of the flexibility of the soils above and we used for that particular exercise a ASCE paper from about 1956 which got so dog-eared and until Professor Pender's paper came along on horizontal reactions on piles then we could use that but in the mid '80s it was this ASCE paper.

170505

COMMISSIONER FENWICK CONTINUES TO DR O'LEARY:

Q. So your analysis was purely stiffness in the horizontal direction.
A. Yes.
Q. The vertical was very high because it was just the axial stiffness of the –
A. The axial stiffness of the pile was that –
Q. Down to four, four pile diameters?
A. Well usually it ended, sorry, usually it ended up about six pile diameters if you pinned them but the vertical flexibility of greywacke is pretty high, pretty low sorry.

JUSTICE COOPER TO MR LATHAM:

Q. Mr Latham is there any response you wish to give to the discussion on this point?
A. No, again, I mean some of the other issues about, you know, sensitivity being raised, I mean again we were presented with one model. We went to the original geotechnical engineer to see what his thoughts were and he gave us his thoughts and that's what I used to put in the model to see what effect it would have.

COMMISSIONER FENWICK TO MR LATHAM:

Q. He gave you, he said "might," "may," "possibly." He indicated, he didn't say this was a value you should use. If you look at his document he's saying, I'm not an expert in this field, it may be, it's possible, very

INDEX