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Friday, 3 January 2020
(10.12 am)
MR NICHOLAS JOHAN SOUTHWARD (on former oath)
Cross-examination by MR KHAW (continued)
MR KHAW: Good morning, Mr Southward.
A. Good morning.
Q. On the last topic we discussed yesterday, I believe your answer was that insofar as factors of safety in different countries are concerned, using your own words, they are by and large similar, even though different countries may have different ways of approaching or using such factors. You remember that?
A. Yes.
Q. Yesterday also, during your exchange with Mr Chairman and also Prof Hansford, you told us that the code obviously covers matters more than safety-related matters. You remember that?
A. Yes.
Q. Would you agree that in that case, obviously the provisions in the codes in different countries, insofar as they concern the issue of safety, should reflect their differences in approaching and also in using the safety factor; would you agree?
A. Sorry, you will have to repeat that. The language got a bit flowery.

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Q. Yes. We have talked about the fact that the code obviously covers matters more than just matters of safety, and I believe we discussed that yesterday. Would you agree that if you look at the provisions of the codes in different countries, they should reflect different countries' differences in approaching and also using the safety factor; would you agree?
A. Sorry, what do you mean, the safety factor?
Q. The relevant factors of safety.
A. The different countries will use different design approaches and different codes and -- different safety factors, different methods, but all still resulting in roughly the same safety -- the same concept of safety.
Q. Yes. Obviously, for example, you talked about different levels of loading in different countries.
A. Yes.
Q. And different levels of loading will be applied in different countries, given their differences in terms of their geographical locations, history, social backgrounds, et cetera; that must be right, right?
A. Sorry, what was the question? I didn't ...
Q. Yesterday, when we talked about factor of safety and then you said in different countries factor of safety should remain the same within a minimum tolerance, according to your own words, and then you cited the

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example that, for example, the level of loading would be different because different countries will apply different loadings in view of their, for example, geographical locations, social backgrounds, et cetera.
My question to you was simply that the different loadings applied in different countries reflect their differences in terms of their geographical locations, social backgrounds, et cetera; would you agree?
A. It reflects the fact that in one country there are earthquakes, in another country there aren't. In one country there are three articulated truck trailers, where in another country there are only blue vans. I mean, it reflects that.
Q. Right. If I can now move on to section 5 of your report.
CHAIRMAN: Sorry, could I just put it this way: would you agree that whether a particular structure is safe or not is an objective fact determined by scientific methodology?
A. Yes.
CHAIRMAN: Whether a building code in any different country or, as against that, building codes in different countries set out requirements that those countries, for whatever reason, determine must be met?
A. Yes.

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CHAIRMAN: And the two aren't necessarily synonymous on all occasions?
A. Correct, yes.
CHAIRMAN: Even though, obviously, by way of a general rule, they are both aiming -- or the two should meet, should but not necessarily?
A. Yes.
CHAIRMAN: All right.
MR KHAW: If I can ask you to take a look at section 5 of your report, in particular 5.3 of your COI 1 report. You say:
"Five separate and independent companies have carried out structural analysis and checking of the station structures, and all typically reach the same conclusions, that the design is safe and is over-provided by a considerable margin. That is, they conclude that there is a substantial amount of spare structural capacity in the works."
Do you see that?
A. Yes.
Q. You probably should have been aware of this: that is, according to the stage 3 assessment, the utilisation ratios of some EWL slab connections to the diaphragm wall at area A, for example, have exceeded 100 per cent; you are aware of that?

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A. No. I'm -- no, sorry -- no, they don't exceed 100 per cent, because they only exceed 100 per cent when a 68 per cent reduction factor is applied. And, as I've explained, the 68 or the 35 per cent reduction factor is not realistic because the couplers are strong enough to withstand the loads. So -- yes.
Q. Let's look at the reports first and then we can discuss further. If I can take you to OU6, page 9308. This is the report prepared by Arup. If I can take you to --
A. Sorry, just before you continue, can you tell me which -- this is a page in the volume -- which actual volume is this? What's the title of -- can I just see the front page?
Q. Yes, of course.
A. "Volume 5 -- assessment report -- area A", yes.
Q. Yes. You want to see the front page of this particular page; correct?
A. I've seen it. It says "area A". This calculation is referring to what -- this table is referring to "EWL ... to diaphragm wall connections strength utilisations", yes.
Q. Yes. I would like to refer you to the second table on this page.
COMMISSIONER HANSFORD: Is that table 7.3, Mr Khaw?
MR KHAW: 7.3, yes.

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It's table 7.2. The second table under table 7.2, I'm sorry. It should be "EWL slab -- area A (permanent loadcase checking)".
Mr Southward, if I can take you to the last column, which shows "Utilisation percentage after considering defective couplers", and then you will see there is one sub-column, namely "Compliance criteria", and you will see that there are a number of figures which exceed 100 per cent, meaning that those areas were overstressed; do you see that?
A. I see that, yes. But can you see the top of the table where it says, "Utilisation percentage after considering defective couplers"?
Q. Yes, I see that. Then you are telling us that because you disagree with the defective rate, so if we apply your analysis in respect of the defective rate, then the utilisation ratio should not --
A. Not particularly my analysis. If you apply fact to it, then those defective rates would not be there.
Q. Yes. I am actually talking about the findings of the consultants as quoted in your report, 5.3, because at 5.3 you are referring to the findings of the consultants, the five companies which have undergone the assessment of safety, and what I was referring to you was the findings made by Arup in respect of the

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utilisation ratios.
So is it the case that merely from looking at the reports done by the consultant, it is quite clear that at least we have the findings that the utilisation ratios in respect of some areas have exceeded 100 per cent?
A. No, because this particular report is a finding that was prepared, as I understand it, on instruction of MTR, telling the consultant to ignore the defective couplers; okay? It doesn't change the consultant's original finding that the as-constructed -- sorry, that the structure as designed is adequate.
So the consultant has found that the structure, as designed, is adequate. The MTR has said, "I don't agree with that because I think there are 68 per cent defective couplers in area A, so please revise your findings", and that revision of the findings was in stage 3, the stage 3 assessment. But that doesn't change the fact that the design of the structure is adequate and typically has that 50 per cent utilisation.
Q. Right. So you mean, when you are referring to the findings of the consultants, when you talk about the fact that the design is safe and over-provided by a considerable margin, you don't need to qualify your statement by referring to --

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A. Shall we go back to my words?
Q. Yes, of course.
A. Okay. Thank you.
So the words say:
"Five separate [consultants] ... all typically reach the same conclusions, that the design is safe and is over-provided by a considerable margin."
Q. Yes.
A. So that is the design. That is not the as-constructed design that might or might not have defective couplers in it.
Q. Yes. But obviously, in this statement, you first refer to the analysis and checking carried out by the five separate and independent companies, checking of the station structures?
A. That the design is safe.
CHAIRMAN: So, in other words, five separate, independent companies have looked at the design, the drawings, how it's been drawn up, before anybody's actually put any concrete anywhere and said, "Those designs, when studied and analysed and checked, the design is safe and it is over-provided for by a considerable margin", so it's a very conservative design?
A. Yes.
CHAIRMAN: All right. How the design was put into effect in

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terms of bricks and mortar and concrete and steel bars is another matter.
A. Yes, and how the construction of that design is then subsequently interpreted is a different matter.
CHAIRMAN: Okay.
MR KHAW: Yes. But you then went on to say, as pointed out by Mr Chairman:
"That is, they conclude that there is a substantial amount of spare structural capacity in the works."
Now, if we know that there are areas where utilisation ratios have exceeded 100 per cent, obviously that would affect your view as to whether there is a substantial amount of spare structural capacity in the works?
A. But there are no areas where there is an over-utilisation, so that doesn't affect my view because there is no overstress.
Q. I'm sorry, I don't quite follow, because in your last sentence --
A. I don't quite follow either.
Q. -- you said, in particular, "that there is a substantial amount of spare structural capacity in the works". So here you are referring to "the works", obviously, by comparing the design and the final products.
A. I didn't say "in particular". What I said:

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"That is, they conclude that there is a substantial amount of spare structural capacity in the works."
So "the design", "the works" -- I mean, it's the same thing. It's the same thing.
Q. I've heard what you said.
A. I have not said "spare structural capacity in the as-constructed works". I have not said that. "The works" is a term that one uses to describe the project. I used it in my presentation yesterday many times.
Q. Right. Perhaps just a last question on this topic. When you are referring us to the findings of the consultants, and when you are trying to tell us that there is a substantial amount of spare structural capacity in the works, even if we have seen the results showing that the utilisation ratios have exceeded 100 per cent in certain areas, such findings can be ignored?
A. I think we are just repeating the same question.
The stage 3 assessment is not what I'm referring to here. The stage 3 assessment was done by the consultants at the instruction of MTR, where MTR unilaterally said, "Please discount all these couplers." That is not the same as what's written here.
Q. All right.
If I can then take you to another section of your

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report, 5.4 and also 5.6.2, where you talked about concrete strength of slabs. I understand from your report that you have decided not to take into account the concrete strength of the as-constructed structure. So, in essence, you have taken into account what you call the characteristic strength of the concrete cubes delivered to the site; is that correct?
A. Sorry, your question -- you said to me I have decided not to take into account the as --
Q. The actual concrete strength of the as-constructed structure.
A. No. What we've decided -- what we have done is taken into account the strength of the constructed structure.
Q. But no actual measurement or testing has been carried out for the purpose of ascertaining the actual as-constructed concrete strength; is that correct?
A. No. At least -- as I said yesterday, at least 6,000 tests have been carried out on the as-constructed strength of the structure.
Q. No. The 6,000 tests have been conducted in relation to the concrete cubes; is that correct?
A. Correct.
Q. And then you told us --
A. And that is how -- the concrete cubes is how we, in the civil engineering industry, assess the strength of the

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concrete structures that we are building during construction. That is the way we use it. That's the method.
Q. I'm coming to that, Mr Southward. Just be patient.
A. Sorry.
Q. In your presentation yesterday, you told us that "In design calculations the 28-day cube strength is factored by 0.67 to reflect the difference in the cube strength to the strength of the in-situ concrete"; do you remember that?
A. Yes, except I think you are quoting me wrong. It's a relationship, it's -- I said yesterday that the same concrete will have a different strength in a cube and in a cylinder, and it's the same -- and that is simply a relationship factor. So the 0.67 is also a relationship factor.
Q. I just want to make sure I have not misquoted you. If I can just take you to your own presentation slide. It's under the heading of "Concrete strength in structure". There's a diagram on this page. In fact, I just simply read from what you said in your presentation slide just now in my question. I said:
"In design calculations the 28-day cube strength is factored by 0.67 to reflect the difference in cube strength to strength of in-situ concrete."

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Do you see that?
A. Yes.
Q. And that is what you told us yesterday?
A. Yes. I mean, that is an explanation of note 1 on the diagram, which is extracted from the code.
Q. Yes. In other words, if we take into account, for example, figure A, as 28-day cube strength, if we take figure A and times figure A by 0.67, that may give you an approximate value of the concrete strength of the concrete as constructed?
A. That is the concrete strength that we use in design.
Q. Yes.
A. It does not necessarily mean that that is the strength of the concrete in the structure.
Q. Right.
A. It's the one that we use in design.
Q. In design.
Then in your PowerPoint, your second point says: "The concrete strength is further reduced by a material safety factor of 1.5."
Now, the concrete strength here, I suppose, refers to the actual concrete strength of the as-constructed structure; is that correct?
A. No. It reflects the concrete strength that we use in design, which is the 28-day cube test result, modified

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by 0.67, and then that is further reduced by 1.5.
Q. Right.
A. That's the number we use in design.
Q. Now, am I correct in saying that if you wish to gather data for the strength of the as-constructed concrete, not just the concrete cube, then one can do coring of the in-situ concrete in order to provide you with data on the actual concrete strength? Would you agree?
A. Coring of structures is done. I mean, typically, when you are assessing an old concrete structure that was built 40 years ago and you want to assess it for -- you know, in the case of an old highway bridge, you want to assess it for increased traffic loading, you would then go to that structure and find out what the concrete cores are, because you do not have the concrete cube tests because the structure is 40 years old and the records have been demolished.
Q. Back to my question, my question is simply this. In principle, if you wish to gather data in respect of the actual strength of the as-constructed concrete, you can do coring in order to gather such data; is that correct?
A. You could do coring, yes.
Q. Without such data from coring, you would not be able to verify the difference between the strength of the concrete cube and the actual strength of the

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as-constructed concrete; would you agree?
A. No, because I have 6,000 cube tests which reliably tell us the strength that we can use in the design and assess the concrete structure.
Q. Also, in the present case, you agree that the defective quality of the concreting works in various areas was quite alarming. We have seen the pictures of the honeycombing, et cetera. Would you agree?
A. There were workmanship defects in the concreting. I believe all of those defects have been rectified, in which case the structure is returned back to its original state.
Q. Yes. I'm not talking about the as-constructed condition of the concrete after rectification. I'm talking about the workmanship issues, as you have just raised. Given the workmanship issues that we have identified in the present case, would you agree that the actual strength of the as-constructed concrete may be further reduced as compared to the assumed actual strength of concrete as you have analysed?
A. Two points here. One, not if it's been remediated, which I understand it has. The second point is the purpose of the material safety factor of 1.5, that is a safety factor on the concrete strength to allow for the potential for concrete not to be what the designer

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assumes. And a 1.5 factor is a fairly significant reduction in strength.
So, in answer to your question, if the concrete slabs have been remediated, then the concrete strength will be as the test results show.
Q. So are you now telling us that this material safety factor of 1.5 ought to have already taken into account workmanship issues?
A. It's what's used in design to allow for unforeseen conditions in construction of structures. So, when you are designing, you are designing a long time before construction.
Q. So your short answer to my question, "Does the 1.5 factor already take into account workmanship issues?" -- your answer is "yes" or "no"?
A. It's a difficult one to be drawn into, because the 1.5 is a factor that you're using to design. In construction, if workmanship issues are identified, those workmanship issues will be repaired, so then the 1.5 factor is not relevant.
Q. So should I take it that your answer to my question is, "No, it does not take into account workmanship issues", in short?
A. The 1.5 factor takes into account that the concrete may not be -- you know, concrete has material -- concrete

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has different properties; right? It behaves -- no one can be absolutely certain what the strength of the concrete will be, because it is a variable property, and we can see that by the fact that when you test two cubes of the same strength, you get different test results. So the 1.5 factor is there to allow for the variability in strength. It shouldn't really take account of workmanship issues, because it's there to account for the variability in the concrete material.

Q. Thank you. Let's move on.

If we can then go to 6.2 of your report. Here, under the heading of "At the time of construction, what did the construction team understand was the requirement of embedment length from BOSA", then you said:

"Much has been heard during the COI of BOSA's requirements for coupler installation. It was suggested that a 'butt-to-butt' ...

However, there is no evidence that Leighton was aware or should have been aware of a 'butt-to-butt' requirement during the actual construction period."

Now, obviously you have read the QSP which refers to BOSA specifications. If we can just very briefly take a look. H9, first of all 4279, and also 4280, in relation to type A dimensions.

If you look at the box at the end of each page, it

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says the same thing:

"The tolerance established in the table above provides a lower limit on the permissible variation of the length of the threaded bar. The larger the nominal size of the rebar, the greater the tolerance allowed.

Note: BOSA CNC threading machines are always programmed by default to allow a positive tolerance on the thread length. This is to ensure butt-to-butt connections can always be achieved when the rebar are spliced inside the coupler."

And the same is repeated at the next page, 4280.

Then, in relation to type -- another page, the same bundle, H9/4089. 4089, in relation to type B, and then you will see the box at the bottom -- it says:

"Butt the ends of the two bars and then rotate the coupler using hand until the coupler is onto the continuation bar."

The specification also sets out the procedures required for the purpose of the coupler installation method.

I take it that you have read those requirements?

A. Yes, I have read the method statements that were submitted by BOSA.

So the pages you show -- I was confused, because the pages you show me refer to Servisplice. But both of

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these ones you showed me, this refers to Servisplice, which is not the coupler that was used on site. The coupler was the Seisplice. So 4089 refers to Servisplice, standard normal coupler, and that's different to the one that was used. So we need to go to --

MR SHIEH: Perhaps there's one point here, because if the point that is sought to be made is whether, as a matter of primary fact, the instructions or values or whatever as seen by Leighton contain certain instructions, then that factual foundation ought to be laid first. I note that this comes from the H bundle which is the government's bundle. If it is intended to be suggested that factually speaking the materials as seen by Leighton, let alone what was in the government's bundles -- if it is being suggested that it ought to have been seen by Leighton or Leighton's workers that there are certain instructions, then I would suggest that that factual foundation be laid.

CHAIRMAN: I confess to being in need of assistance here, because when I first heard the evidence from BOSA, "butt-to-butt" didn't appear to have any connection to anything, and I assumed, when butt-to-butt suddenly, like Excalibur coming out of the lake, appeared as being the future of everything, I went back to look at all the

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evidence to see what I had missed.

So butt-to-butt seems to have come in somewhat later. Forgive me, with a military background, having served through no desire on my own part, but there we are, in days of National Service -- things like this, to an ordinary trooper, are explained in simple language: screw it in, use a torque, clunk, you will get butt-to-butt, but there doesn't seem to be that, and it seems to me that if you are aiming stuff at good, solid workmen, with plenty of muscle but no degrees in engineering themselves, you want very clear, straight directions.

Now, on that basis, my misunderstanding clearly was based on this factor. If I am screwing this in as one of the workmen, I can't be certain that the parent that I'm screwing into is necessarily set absolutely at right angle, and therefore, when I'm screwing in, I might well be pushing it in at a slight mis-angle and then I will get to a certain stage which I can't see myself, because it's all covered, where it suddenly stops and I can't go any further. So I need something external as an indicator; okay? And external as an indicator is two threads.

Now, that was what I understood that to be, so that your ordinary guy down there has a foreman saying to

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him, "You put it in. Obviously if it's at completely wrong angles you are going to have to get some assistance, but otherwise look for two threads. If it's two threads and no more than two threads, you are going to be okay", and there is nothing in the documentation that came before me at the earlier stage to suggest anything contrary to that understanding on my part.

Now, I'm not suggesting BOSA has slipped into some other set of suggestions late in the day. Far from it. I'm just saying I've obviously missed something.

MR KHAW: Yes. If I may just refer to one more document, as Mr Southward was referring to the Seisplice type A dimensions. That can be found at page H9/4280.

CHAIRMAN: I'm sorry, could I just complete this sudden diatribe on my part. The other thing that strikes me is that, as an ordinary workman there on the ground or as a foreman, without a degree in engineering, I would then say, "That's what you have to do. Make sure that there's no more than two threads showing." And if you do that, that's okay, because that effectively are the instructions given by the manufacturers.

Now, if they are the instructions given by the manufacturers, they must be, in the view of the manufacturer, safe. In other words, if you do that, that's got to be sufficient. The ideal may be

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butt-to-butt, if it's possible -- I don't know, we will come on to that -- but that is going to ensure safety, so that if you showed two threads along 100 metres and every single one showed two threads, that would be perfectly safe and ideal installation.

Now, I give you that, because I need to be dispossessed of any error I'm making here, in order to better understand the matter.

MR KHAW: If I may just clarify this knowledge point on the part of Leighton.

CHAIRMAN: Sure.

MR KHAW: First, H9/4280. It's about the dimensions of Seisplice type A, and then again at the bottom there's a box containing the same remark that we have seen:

"The tolerance established in the table above provides a lower limit ...

...

This is to ensure butt-to-butt connections can always be achieved when the rebar are spliced inside the coupler."

Do you see that?

A. I do see that text there, yes. I mean, you could also look at 4160, which is exactly the same picture but doesn't have that text on it. Then you should also look at 4173, which is the installation method for the

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Seisplice, which is what was repeated in my report. That's different from what you showed us originally.

Q. Then if I can take you to Mr Karl Speed's first witness statement. That's C7604, paragraph 43. He said:

"The following documents set out the standards and requirements for the installation of the reinforcement bars in the diaphragm walls and platform slabs".

And one of the documents that he refers to is (h):

"BOSA (coupler manufacturer/supplier) technical and quality assurance manual".

Do you see that?

A. Yes.

Q. So, with such evidence and also the BOSA specifications that we have seen, would you qualify your statement regarding Leighton's knowledge in relation to the butt-to-butt connection?

A. I don't think so, no, because that instruction thing does not say, "Engage it until it's butt-to-butt." So no.

Q. And obviously, the BOSA manual that we have just seen in fact was attached to the quality supervision plan as submitted by Leighton; you know that?

A. Yes.

Q. 6.2.2 of your report.

CHAIRMAN: Sorry, Mr Khaw, could you help me. Forgive me.

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So that I understand the background, what is suggested by the government in this regard? Is it suggested that there were instructions that it should be butt-to-butt, but if you couldn't get butt-to-butt, two threads showing would be sufficient, or was it something different from that?

MR KHAW: We say that the butt-to-butt connection was actually specified in the BOSA manual, and then the BOSA manual in fact was incorporated by Leighton when Leighton submitted the QSP.

CHAIRMAN: Fine. So however it's formulated and whatever the basis by which it came to the notice of Leighton or should have come to the notice of Leighton, you are saying that BOSA's instruction and its lectures to the workmen were clearly, unequivocally, "butt-to-butt", and where this "two threads showing" thing has come from is devilish mischief and it's simply not there? Because if it has to be butt-to-butt, you don't need to talk about two threads. What you should say is, "It's got to be butt-to-butt and if you've got two threads showing, it's not in properly", unless you are talking about different-level -- different-size rebars.

MR KHAW: It really depends on the length of the threaded rebar, because we have evidence that the threaded rebars actually used on site were of the length of 44 to 48.

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CHAIRMAN: Right. Okay. So what you are saying then, effectively, is mention of two threads showing was not devilish mischief which has somehow ghosted itself into these proceedings; it relates to the longer rebar?
MR KHAW: Yes. The thread length -- it refers to the thread length. If I can just take you to one page, also in relation to BOSA's specification.
CHAIRMAN: Sorry, and the 44 to 48, obviously this was not random. The 44 was needed for some specific form of installation, the 48 for another specific form of installation. Then the workmen would have been told, "If you are doing", I don't know, "a vertical installation, then you can show two threads, but otherwise you can't", because that's how you make it clear to the workmen. If it's going up, no threads, or you can show threads, but if you are doing it horizontally, no threads.
(Tribunal conferring)
MR KHAW: If I can just --
CHAIRMAN: Sorry, I'm sharing things here with Prof Hansford whose knowledge of these things is entirely full in all respects, and I give it great respect, not that he's giving evidence for himself, not at all, but he also seems to have some concern. His concern is more refined, his concern is more sophisticated, but

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nevertheless there is some concern.
For myself, I would like it in plain language, because these workmen were actually lectured by BOSA. They receive lessons from BOSA. And they are not all, with the greatest of respect to all of them, hard-working, decent men, they are not all Albert Einsteins, and they would have required plain language as to what was necessary and what constituted a successful installation, on each occasion. At this stage, I don't really have that myself.
And I thought the opening-up exercise also had some reference to two threads showing.
MR KHAW: Yes. Just for the purpose of illustration, if I can take the Commission to one page in relation to BOSA specifications, just to demonstrate our point, at C7016.
CHAIRMAN: There we are. So you are talking about acceptable thread tolerance. Okay. Now, I read that as meaning there is room for tolerance and there's an acceptable level of tolerance and that's how you measure it. And you measure it -- and this is, it seems to me, done for the good, honest workman by showing him, especially if there's language problems, with the many languages spoken here -- by showing him in clear, strong, visual language, with things such as big red

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tick marks. Ideal; that's the way universally it should be done.
MR KHAW: Yes. If we take a look at the first point of the summary on this page, it says:
"After connection has been fully tightened, one should see a maximum of two full threads to ensure a proper installation."
We say that if we take the thread length of 48mm, then that would be the case.
CHAIRMAN: Okay. All right.
MR KHAW: But of course, in relation to Mr Chairman's earlier query regarding whether clear language was given to the workers as to what "butt-to-butt" actually meant at the material time, then I think we are bound by all the evidence that we have heard.
CHAIRMAN: Sorry, just go up slightly on that picture. Is there any measurements there, millimetres, 44, 48, anything like that, on that picture? There doesn't seem to be.
You see, it's quite important, as I see it -- and I'm quite happy to put forward my own ignorance, and the purpose of doing that, and in my view it's a legitimate judicial tool -- a judge is entitled to say to counsel, "I don't know what you're talking about. Please come back and give it to me in plain language so that I can

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understand it", because that is the judicial function; it's to understand and then to come to a decision.
Now, I've got a situation where I've got evidence of tolerance, allowances. I've got evidence of two threads. I've got evidence that BOSA was instructing the workmen, "If there's two threads showing, it's okay." Then I've got matters by way of statistics which say, "If it's not butt-to-butt or if it's not within a certain level, you don't take it into account at all as being any form of structure within the concrete", and in order to resolve that issue, which is clearly a fundamental issue, as to the issue of safety and fit for purpose, that needs to be clarified, I think, certainly for myself.
MR PENNICOTT: Sir, I'm extremely reluctant to intervene because I very much appreciate that Mr Khaw is in the middle of cross-examining an expert on a very important point.
CHAIRMAN: Yes.
MR PENNICOTT: There's plenty one could say at this stage, but I'm bound to say I think at the moment I should refrain from saying anything. The government really ought to be putting its case clearly, unequivocally, to Mr Southward, Prof McQuillan and Dr Glover in due course, what their case is, because at the moment

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I struggle to understand it, other than to say it seems to be an exercise in absolute perfection, because you don't get butt-to-butt and two threads showing unless you get 48 millimetres in every single piece of rebar.

MR SHIEH: Because for as long as it is accepted that there must be a variance between 44 and 48, which Mr Khaw just uttered about five to ten minutes ago, two threads exposed must be inconsistent with always butt-to-butt.

MR PENNICOTT: That's the incompatibility that three of the experts have agreed in the joint statement.

CHAIRMAN: Look, what I'm going to do is, because I think I've already made my own purely personal concerns known and, let me stress again, I put them forward so that -- they have some asserted point of view, so that counsel can consider them and say, "This is how we can disabuse him of his ignorance or how we can make clear the basis upon which we put our case."

Now, it seems to me that perhaps we can have the morning adjournment now -- it's 11.15 -- say 15 minutes this morning, and then we'll just see where we are.

Mr Khaw, my apologies.

MR KHAW: Not at all.

CHAIRMAN: I really don't want to cut across you. I'm well aware of your high professionalism in all matters that have been before this Commission, for which many thanks,

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and the problem lies with me, it doesn't lie with you. All right?

MR KHAW: Not at all.

CHAIRMAN: Thank you very much.

(11.13 am)

(A short adjournment)

(11.35 am)

MR KHAW: Mr Chairman, if I can just very briefly address the issues that we discussed before the morning break and then I will move on to continue with my cross-examination of Mr Southward.

CHAIRMAN: Yes, certainly.

MR KHAW: If I may first start by referring the Commission to the oral evidence of Mr Paulino Lim of BOSA. It's Day 36 of the transcript.

CHAIRMAN: Yes.

MR KHAW: Starting from page 98, the last few lines showing Prof Hansford's question to Mr Lim. It says:

"I understand now. My final question -- probably my final question -- I'm still a bit confused by your answer to a previous question where you referred to butt-to-butt. Now, I know [what] butt-to-butt means, but I thought you were allowed to have one or two threads exposed after the coupler is connected.

If the threads are exposed, how can it be

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butt-to-butt?"

Then Mr Lim said:

"That's a very good question. If you refer back to page 44854 -- in our design, when we are manufacturing threads, we always programme our machine to produce an extra 1 to 2mm on the actual length of our thread. We just wanted to make sure that when the two ends abut inside, connected inside of a coupler and tighten, that they are actually butt-to-butt.

So if in a worst case scenario we were to have both ends with a maximum tolerance -- for example the diameter 40 rebar which says tolerance of 4mm, the 4mm basically is one thread, equal to one thread, so if both ends has a maximum tolerance of one thread, after you have connected the two ends together, you will have a chance of seeing two threads exposed."

So the butt-to-butt connection and the two threads exposed are not mutually exclusive, according to Mr Lim's oral evidence, because what he says is that the thread length normally will be 44mm minimum, with one thread tolerance, which can extend to 48mm, and that's why we say, if we use a thread of the length of 44 to 48mm, and if we apply the mechanism as shown at page C7016 that we have just seen, one point is important. That is if we look at the bottom part of the

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coupler, that part should always be fully engaged because no threads will be shown. Now, say for instance, if we use a thread of the length of 48mm, then once you fully screw in that thread at the bottom part of the coupler, then no thread will be shown. And then, when you screw in the other part, which is 48mm, of the same length, maximum there will be two threads shown at the top of the figure.

So that's why, at point 4 of the summary on this page, it says:

"As illustrated in the above scenario, the exposed thread, if any, always occurs at the top of the continuation bar."

So it won't be a case that there will be two threads at each end of the coupler. The two threads will only be shown, applying the 44 to 48mm threaded bar, the two threads will only be shown at the top continuation bar.

So that hopefully will explain the question regarding whether butt-to-butt connection and two bars exposed are mutually exclusive. They are not.

CHAIRMAN: I appreciate that, but could I ask just one question, because I don't want to linger too long on this, but how does the workman -- and I associate myself democratically with the workman in this matter -- how does the workman know that he's got rifling, if I might

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call it that, that's 48 or 44? Does each rebar come out with a little sign on it saying, "This is 48"? Because if he doesn't, he's just got another rebar and he screws it in and he sees two threads and he says, "Well, that's fine."

MR KHAW: Yes.

CHAIRMAN: Now, depending on the length of that thread, the length of the rifling, and he doesn't know what that length is, it may be butt-to-butt or it may not be butt-to-butt, and on that basis, it would seem that BOSA is saying, "That's fine", because there's no other system that is apparent there to ensure butt-to-butt.

MR KHAW: The case that we advance is that the workers, obviously they were not given the opportunity to do any measurement in respect of the thread length on the site, but they were trained to fully engage the threaded rebars into the couplers.But obviously they were trained to do the work by way of full engagement. So we say, if they fully engaged the two threaded rebars into the coupler, that should give the result that we wanted to achieve.

CHAIRMAN: I'm not going to argue with you here. But one thing that a judge has to do, one thing that a Commission has to do, is to have some empathy. Empathy is not sympathy. Empathy is an understanding of

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how the real world works.

Now, you are down there in the bottom of this tunnel. You've got these long, 3 metre rebars.

COMMISSIONER HANSFORD: It could be 6 metres.

CHAIRMAN: It could be 6 metres. You are working all day, you are sweating, you want to get the job done, and you know that if two bars are showing or if two threads are showing, you are okay.

Now, have you got some magical means of knowing that it's butt-to-butt? No. Do threads sometimes become soiled? Are there perhaps small nicks in the threads, or is it not at the exact right, 90-degree angle, full angle? Yes, all of these things arise. You are working away, you're doing the best job you can, and clunk, it's not going any further, you look, you've got two threads showing, and you say "Thank you very much", and you move on to the next job.

That's empathy, that's understanding how workmen do it, and I would hate to have a situation where this Commission, through its own ignorance, puts out documents which effectively act as condemnation of the quality of workmen in Hong Kong when they don't deserve it.

Now, forgive me if I sound a little bit over the top on it, but that's why these kinds of issues to me are

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very important. Is it perhaps just that the system needs to be improved in the future? That is equally important as making sure that blame isn't placed on a group of workmen who don't deserve it.

So that's why, for me, this matter is quite important. Do you see? I'm sorry if I've taken you all down a long pathway.

MR KHAW: Not at all, but perhaps -- that is all I could address the Commission's earlier question regarding the potential inconsistency between butt-to-butt connection and the two threads exposed. That's a point that I would like to address.

CHAIRMAN: Of course.

MR KHAW: As to the workman's knowledge and also the contractor's knowledge regarding the requirement, as I have said, I have to be bound by the evidence that we have heard and I cannot go further than that.

CHAIRMAN: No, certainly, I appreciate that. Thank you, Mr Khaw.

MR KHAW: Thank you. If I can move on to another topic. If we can take a look at your paragraph 6.6.1, Mr Southward, where you refer to the static tension tests for all coupler assemblies, and then you say:

"The static tension tests for all coupler assemblies passed the acceptance criteria."

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If I can just take you to have a look at the acceptance criteria in relation to the static tension tests. This is in fact contained in one of the acceptance letters: H9/4042, paragraph 5(b) which refers to static tension test. It says:

"The splicing assemblies must develop in tension the greater of 100 per cent of the tensile strength of the bar (ie ... 529 Newton/square millimetre for grade 460), and 125 per cent of the specified characteristic strength of the bar."

So there are two elements here. One is the greater of 100 per cent of the tensile strength of the bar, and we know it's 529 and, secondly, 125 per cent of the specified characteristic strength of the bar, and here we know it's grade 460, so presumably it should be 1.25 times 460 and that would give us the figure for the second element of this item; would you agree?

A. Yes.

Q. And 1.25 times 460, that will give us the figure of 575 Newton/square millimetre. You can take it from me.

A. Yes.

Q. I've done the calculation. It's 575 Newton/square millimetre.

Then if we look at the results, OW1, page 93 first.

If you take the figure for "Tensile strength at

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failure", we will see that they all passed element 1, ie the 529 Newton/square millimetre, which is the same as the megapascal that we see here.

If you look at G, 571, it fails the second criteria, that is the 1.25 times 460.

Do you see that?

A. Yes, I do. Yes.

Q. If we take a look at another result, at page 97, against the first column which shows "1112-Lab-U", that particular item, "00009G-A", and we can also see that the tensile strength, it's below 575; do you see that?

A. I do.

Q. And the same applies to page 99, tensile strength in relation to the first and the last columns -- sorry, it should be just the last column, 554, which falls short of 575; do you see that?

A. I do, yes.

Q. So in view of such results, do you think you would need to qualify your statement that the static tension test for all coupler assemblies passed the acceptance criteria?

A. My understanding of the acceptance criteria was highlighted in my report at chapter 6.5.2, which repeats what BD had specified as the acceptance criteria. So that was my understanding of what the acceptance

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criteria was, where the figure of 529 was specified. So that is what I compared it against.

Of the test results that I've seen, the lowest figure that I had was 565, so I have to confess that I have not seen the figure in the last report that you mentioned of 551. I have not seen that one. None of which would change my view that the couplers are strong enough and adequate for their use in the works.

Q. Right.

Then if we talk about cyclic tension compression test, which you also mentioned in your presentation yesterday -- do you remember that? -- and you told us that the cyclic tension compression test is irrelevant; do you remember that?

A. Correct.

Q. Perhaps we can just take a look at your bullet points in this regard. Under this heading of "Irrelevance of cyclic tension compression tests", the second bullet point, you say:

"Cyclic testing of partially engaged couplers is not relevant for this project."

Then you go on to explain why, and you say:

"This is because at the location the couplers are used there is no stress reversal. All couplers are either permanently in tension, or permanently in

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compression."

Do you see that?

A. Yes. I mean, the principal reason is the first bullet point:

"Cyclic testing is not required for the non-ductility couplers ..."

That's why it's therefore irrelevant.

Q. Right. And obviously point 3 is also the explanation for your conclusion that cyclic testing of partially engaged couplers is not relevant; is that correct?

A. That is one of the points, yes, but primarily it's because of the non-ductility.

Q. Yes. If we can take a look at the stage 3 assessment, at OU6/4489. That's part of the Atkins assessment report.

Here we have this chart showing us "East diaphragm wall -- area A -- NSL slab bending moments at face of support design moment", et cetera.

Then we will see that the line in yellow represents "Panel sagging moment", and that should be, if my knowledge is correct, that should be a bending moment which produces --

A. Sorry, I can't see what you are seeing.

CHAIRMAN: Which is the yellow line? I don't have yellow.

MR KHAW: Sorry. I'll see whether I have given you the

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wrong page. It's 4498, sorry. If we can take a look at the heading of this diagram again. It's "Hung Hom Station -- East diaphragm wall -- area A -- NSL slab bending moments", et cetera.

Then you can see the yellow line represents "Panel sagging moment"; do you see that?

A. Yes.

Q. Then, either orange or red, the orange line should show "Panel hogging moment"; do you see that?

A. Yes.

Q. Presumably, the panel sagging moment is a bending moment which produces concave bending, and panel hogging moment is just the opposite, it's a bending moment which produces a convex bending; is that correct?

A. Correct, yes.

Q. So with such results, contrary to what you said, would you agree that such results show that at the location where the couplers were used, there's actually stress reversal?

A. No, because this is an envelope of all the bending moments in the structure during the lifetime. So what I would have to do is to go in and find the loadcase that represents the yellow and the loadcase that represents the orange. I suspect that one is due to construction, during the construction loadcases. When

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you excavate down and you construct the slabs, that's when you will have bending moment on one side. Then, when you've completed construction and you've turned off the dewatering system, the structure will then end in -- it will then be in a constant state in one particular -- whether it's hogging or sagging, I don't know which. So I would really have to go into the numbers, but I don't believe there is stress reversal during -- from now on, at the end of construction, once it's all built, I don't believe there's stress reversal.

Q. I see. But am I correct in saying that at least this chart tells us that the couplers can be subject to both tension and compression?

A. During construction, the couplers -- I mean, hypothetically speaking, in terms of -- without looking at this I can't say but I surmise that during construction there is a constant load on the slab in one direction, and then, when the dewatering system is turned off, there is therefore a constant direction in another -- in another direction.

COMMISSIONER HANSFORD: Constant load.

A. Yes.

So in terms of stress reversal, there is one stress reversal at the end of construction, when the dewatering system is turned off, but thereafter there is none.

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So the point of cyclic testing is to test something backwards and forwards, many, many times, until you get failure. That is not relevant to a slab that is constantly under -- to a coupler that is constantly under tension.

MR KHAW: Further, you have referred us to the effect of the permanent elongation test, and I believe the difference between your opinion and Dr Lau's opinion is that partially engaged couplers, according to Dr Lau, manifest initial slip when it is stressed, and his opinion is that with such slip, when the structure is loaded, there's a likelihood that there will be an impact on the crack width, and with excessive crack width there's greater likelihood that this may give rise to corrosion of reinforcement, spalling of concrete over time, which would affect durability. That is his view.

And according to your presentation yesterday, you told us that it should not have an effect on durability because you classified the station structure as condition 1 exposure condition; do you remember that?

A. Yes.

Q. I can actually take you again to your PowerPoint presentation, under "Long-term durability". I think you are trying to address Dr Lau's point by telling us that the Hung Hom Station is a mild and dry environment, and

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that is why the exposure condition can be classified as exposure condition 1. Then you have given us the classification on this slide, which is the classification set out in the Concrete Code, Hong Kong Concrete Code, and it says, "Mild":

"Internal concrete surfaces.

External concrete surfaces protected from the effects of severe rain or cyclic wetting and drying ...

Concrete surfaces continuously under water, or rarely dry -- not seawater.

Concrete in contact with non-aggressive soil."

If we can then take a look at the relevant classification contained in the Concrete Code. It's at H8/2856.

If we can go to the bottom, under "Classification of exposure conditions", and up a little bit further. Let's look at the table.

Now, you have given us the explanation of exposure condition 1, and then if we continue to look at exposure condition 2, classified as "Moderate", it says:

"Internal concrete surfaces exposed to high humidity eg bathrooms and kitchens.

External concrete surfaces exposed to the effects of severe rain or cyclic wetting and drying eg fair faced concrete, concrete with cladding secured by dry or

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mechanical fixing ..."

Then 3 is "Severe":

"Concrete surfaces exposed to seawater spray through airborne contact but not direct exposure, ie structures on or near the coast.

Concrete surfaces exposed to corrosive fumes."

Now, would you agree that in our case, at least part of the station is under seawater level; would you agree?

A. This station is under seawater level, correct, yes.

Q. It's also close to seashore?

A. Yes.

Q. So it will be subject to, potentially, high humidity?

A. No, I mean, it's not -- it's a dry -- the inside of the station is a dry internal environment. It's not wet. When we went to inspect it, it was completely dry. The outside, there may be seawater outside, but inside it's dry.

Q. But when you are trying to classify this exposure condition of the station, would you agree that you would need to at least take into account the fact that the station is near the sea?

A. Not the internal environment. The internal environment is not affected by whether or not the station is close to the sea.

Q. Let us take a look at --

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CHAIRMAN: Let me just ask this. What is between the sea and the box-like structure that makes up the station?
A. The diaphragm walls.
CHAIRMAN: The diaphragm walls?
A. Yes.
CHAIRMAN: Right.
MR KHAW: And obviously the diaphragm wall is part of the station structure?
A. Yes.
Q. In that case, would you not agree that it is subject to high humidity, if it is under sea level and also close to seashore?
A. No.
Q. You say no?
A. No. It's an internal environment. It's ventilated. There are trains going through, ventilating -- moving the air. It's dry.
Q. Now, let's take a look at another part of the Concrete Code: H8/2858. At paragraph 4.2.4.4, that shows us limiting values for nominal concrete cover; do you see that?
A. Correct, yes.
Q. It also refers to the exposure condition, "Condition 1", "Condition 2", "Condition 3", "Condition 4"; do you see that?

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A. Yes.
Q. Then if you go to the part regarding nominal cover -- well, we are talking about C40 concrete, so for condition 1, the nominal cover required is 30, and for condition 2 the nominal concrete cover required is 35.
CHAIRMAN: Sorry, can you help me again, what's "nominal cover"?
MR KHAW: I will just show you. It's the figure calculated for -- required for the reinforcement for durability of the concrete.
COMMISSIONER HANSFORD: Mr Khaw, I just explained to the chairman that it's the amount of -- it's the thickness of the concrete from the reinforcement to the edge of the concrete. Is that an acceptable definition for you?
MR KHAW: Yes. It's nominal thickness, yes.
CHAIRMAN: Thank you.
MR KHAW: If we then take a look at another document, H14/19168. It's part of the Atkins assessment report.
If we can take a look at 5.2.3, in relation to "Reinforced concrete cover and crack control". If we look at the minimum concrete cover for, for example, "Structural wall -- non-soil surface": 40mm. Then "NSL base slab -- internal face": 40mm. And also "EWL top slab -- exposed and not protected face": 40mm, et cetera.

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So the minimum concrete cover required, as shown, actually, at those areas, at the minimum of 40mm, shows that those areas could not be classified as exposure condition 1 because if you look at exposure condition 1 earlier, according to the Concrete Code, the nominal concrete cover is 30 for condition 1, 35 for condition 2, but here the figure that we have seen is at least 40mm.
A. So your point is?
Q. It's that if we look at the structure here, ie the structural wall, EWL top slab, et cetera, the 40mm minimum concrete cover shows that they could not be classified as condition 1, because the figure is apparently larger than the nominal concrete required for condition 1 under the Concrete Code.
A. So your question or the supposition in your question is not correct. The Hong Kong Code of Practice specifies the minimum concrete cover. The client who's building the structure will specify a greater cover. It's quite common to use larger covers than what the code uses.
So here the client has said, "All right, I want to have a minimum cover of 40mm", that gives him an extra 10mm, and I understand the cover is greater anyway because of the fire durability requirement and there's even mesh reinforcement in the cover between the

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concrete and the reinforcement.
So what you're saying to me is because it says "40" here, then the code -- then it can't possibly be condition 1 because condition 1 says 30. I say to you that it says "30" in the code and the client is just taking it bigger than that.
COMMISSIONER HANSFORD: Sorry, Mr Southward. You are saying the client is making it bigger than that for reasons such as fire resistance?
A. Well, okay. Here he writes:
"The concrete cover listed is the minimum durability requirement. The actual cover can be thicker ... to meet [fire] ..."
I think from recollection the actual cover is 45 or something. We might be able to check from the drawings. But it is very common to use a larger cover than the minimum cover specified in the codes. And nominal cover -- so this talks about concrete cover, whereas the Hong Kong Code of Practice refers to nominal cover. Now, nominal cover is an engineering term that is used -- for example, when you calculate crack widths, you calculate the width of the crack at the nominal cover, not the actual cover away from the reinforcement.
So -- how do I -- have I answered your question?
MR KHAW: But here we are talking about Atkins' assessment

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in relation to concrete cover and crack width. What I want to know from you is that the minimum concrete cover of 40mm as shown in those areas that I have just highlighted, at least it shows that the structure is not taken by the designer, Atkins, as a structure under exposure condition 1; would you agree?

A. No, I would totally disagree with that. This just says that they want 40mm cover.

Q. If we can just go down a little bit on this page -- no, up -- now, here it says, "Reinforced concrete cover and crack control":

"All structural concrete elements shall be designed to prevent excessive cracking due to temperature, early thermal shrinkage and flexural cracks in service limit states.

In order to provide adequate durability, the proposed minimum cover and design crack width in the design waiver should be as below."

So Atkins here was talking about the proposed minimum cover and also the design crack width, not anything else.

A. That's exactly what I've said. It's not -- this doesn't talk about the classification of the exposure condition at all, and you are trying to relate it to that and I'm saying they are not related.

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Q. But earlier on you told us that one of the possible reasons why Atkins would have wanted to have the minimum concrete cover of 40mm instead of 35 or 30mm, it's due to consideration regarding fire resistance.

A. Sorry, it says there that this cover is in -- fire resistance cover is extra to the cover in this table. Sorry if I misquoted then. But it says clearly in the table the fire resistance is extra to this.

Q. At the end of -- well, in the explanation notes under the table, you can see:

"The concrete cover listed is the minimum durability requirement."

So it is on this basis that Atkins conducted this assessment.

"The actual cover can be thicker than the specified here to meet the fire resistant requirement."

So obviously the 40mm is to cater for the minimum durability requirement; is that correct?

A. That's what it says, yes, but that's got nothing to do with the exposure classification of the station.

Q. What I'm trying to discuss with you is simply that if Atkins considered that the structure is within what you told us, ie condition 1, they don't need to have 40mm as the minimum durability requirement.

A. Can we go back to the Hong Kong Code of Practice and

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that table?

Q. Yes.

A. There it says "Nominal cover".

Q. Yes.

A. Nominal cover is not minimum cover. Nominal cover is an engineering term that's used to calculate crack widths, and it's different to the minimum cover that the designer wants to put in his structure.

Q. So are you saying that nominal cover usually is greater than or less than the minimum cover?

A. Nominal cover is less than the minimum cover, typically. I can show you an example, in the Hong Kong Structures Design Manual, which is the other code, which says, "The nominal cover shall be X. The minimum cover shall be Y."

Q. But obviously nominal cover is there to also ensure the minimum durability requirement; is that correct?

A. The minimum durability requirement is specified in the Hong Kong Code of Practice as 30mm cover for grade 40 concrete.

Q. Exactly. So if this is also to ensure the minimum durability requirement, there's no reason why Atkins would use 40 as the minimum concrete cover if they consider the structure as condition 1 structure.

A. Well, let's go back to the workers building the

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reinforcement, placing those heavy steel bars and trying to get those heavy steel bars into the correct position. They may not necessarily achieve that, so there has to be some -- a good designer will allow for some tolerance because 30 is the absolute minimum, so you want to make sure that whatever happens you've got more than 30.

So Atkins or the client here has specified 40.

Q. No, no, no.

A. I don't know the reasons why they specified 40. All I'm telling you is 40 actual cover, minimum cover, is different to the nominal cover in the Code of Practice.

Q. Right. But you just told us that the Atkins minimum cover is the absolute minimum; right?

A. No. The nominal cover, the nominal 30 millimetres nominal cover, that is the absolute minimum that must be used in order to ensure durability, because that's what's specified in the Code of Practice.

Q. Thank you. Let's move on.

There is one part in your report which talks about engineering judgment, section 6.9.3. Then you have given us an example at the last two paragraphs under this section. Perhaps we can first look at the second paragraph on this page, starting from, "In the particular field of construction, an engineer uses his engineering judgment to assess if defects have occurred

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in the construction work and how such defects could be treated. Often, this treatment means doing nothing -- the engineer uses his engineering judgment to demonstrate that the defect has no demonstrable effect and does not need any remedial works.

An unrelated example of the exercise of engineering judgment is when it is discovered that a contractor has constructed a building with the dimensions of a supporting column incorrectly. Say, for example, this column was designed to have a length and a width of 1 metre each. But, in error, the contractor constructed this column with dimensions of 0.8 metres and 0.9 metres respectively.

The engineer will exercise engineering judgment in assessing the strength of the reduced size of column and if it can be proved by calculation that the reduced size can take the design loading, then the result of such engineering judgment will be to keep the column and not require the contractor to knock down the column and rebuild to the originally intended size."

That is the example that you have given us; do you see that?

A. Yes.

Q. But in assessing the strength, according to your example, of the reduced size column, the column of the

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reduced size, in order to ascertain if it can take the design loading, for the purpose of checking the reserve strength, obviously you have to refer to the standards set out in the code; is that correct?

A. Correct.

Q. I mean, you can't use engineering judgment to, so to speak, move the goalposts or to change the parameters set out in the codes for the purpose of taking the loading; is that correct?

A. Yes. I mean, in the case -- the example is meant to demonstrate that -- or was meant to explain that when the column is built wrongly, it is not -- you are not using your engineering judgment if you simply say, "It's not right, therefore knock it down." You use your engineering judgment to decide whether what has been built can be incorporated. You would make a calculation using the design codes with the revised dimensions, to check that it was okay. If it wasn't okay, then you would consider the actual strength of the concrete in that column, based on the cube test results, and see if that's okay.

Q. Yes.

A. And if it was, it's fine and you've done your job as an engineer.

Q. Yes. Now, going back to your last paragraph under this

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section, where you said:

"The engineer will exercise engineering judgment in assessing the strength ..."

And then to determine whether the structure or the column should be kept or should be knocked down.

Would you agree that a similar approach in fact has been taken by MTR in conducting the stage 3 assessment?

A. Yes, they have done a recalculation of the structure, and it's evident that the recalculation has been an awfully lot more well defined and perhaps better carried out than the original calculations, because all the new calculations show a lot less reinforcement than that that was originally specified.

Q. Thank you. I will then move on to the shear link reinforcement. In your paragraph 7.1 of your COI 1 report, the last paragraph under 7.1, you say:

"The findings of MTRCL for HZ01 ..."

We will go to -- in fact, it has been shown here, but there are further photographs showing the opening up for the investigation of the presence of shear links. Now, here you said:

"The findings of MTR for HZ01 are that, as no shear links are visible, then no shear links are present at this location. I disagree with this finding and suggest that the reason no shear links are visible is because

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the location of the right angle slots are not positioned correctly in order to pick up the shear links."

That is your view as to why no shear links were picked up for that particular photograph.

A. That's my suggestion.

Q. Yes. Did you have a chance to look at the method statement for the opening-up exercise for the purpose of investigation of shear links?

A. I've seen all the results. I've seen a file entitled "Report 01" which has all the photographs of that. I'm not sure I've actually seen the method statement.

Q. I see. If I can take you to the method statement now: OU9/11386. That's the method statement for shear link investigation at EWL slab soffit.

If I can take you to 11388, regarding the work procedures. I take it that you have not had a chance to look at this method statement before?

A. No, I have not seen this method statement.

Q. If we look at the work procedures, it says:

"Conduct setting out for the 1,000mm by 1,000mm open-up area on site.

2. Conduct cover meter scanning ..."

Then I think, first of all, you need to:

"Identify a 300mm by 300mm open-up area."

And that would be opened up to expose two main

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rebars. Point 3 continues to say:
"Break the concrete and expose up to the 1st layer of main reinforcement ... with hand breakers. Further breaking to 2nd layer of main reinforcement ... to locate the shear link if necessary."
Do you know that the reinforcement bars are at about 150mm spacing?
A. Give or take construction tolerance --
Q. Yes.
A. -- which can be considerable.
Q. Yes. Are you aware that according to the design drawings, the spacing of the shear links in both longitudinal and transverse directions could either be 75mm, 150mm or 300mm? You are aware of that?
A. I am, yes.
Q. So would you agree that with this 300mm times 300mm opening-up area, at least one shear link ought to have been exposed in this 300 times 300mm area, if shear links were constructed according to the design; do you agree?
A. If the shear link had extended right to the very bottom and wrapped around that bottom reinforcement, then in a 300 square, give or take -- I mean, if I was doing it, I would have made it a bit bigger, to be sure, to allow for construction tolerance. So if you made a big enough

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square, you ought to see a shear link, you ought to see at least one, if it had been extended all the way to the bottom.
Q. Right.
Then the second step, according to the work procedures, is that: "Based on the location of the exposed shear link ... conduct two pilot strip 200mm wide" and around 200mm long should be further opened up to investigate the arrangement and condition of the shear links installed.
Do you see that? 600mm long and 200mm wide.
A. Yes.
Q. In view of such work procedure, given the areas opened up, would you agree with me that it is unlikely to miss the presence of shear links in the opened-up areas if shear links had been installed according to the original design?
A. Yes. I mean, if those shear links were there and they did extend all the way to the bottom, you probably would see those shear links. The point that I was trying to make it that that photograph doesn't bear much resemblance to what's drawn here, and I don't think the slots are wide enough to fully expose the rebar.
Q. Right.
A. So I don't believe that is any proof that the

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reinforcement is not there.
COMMISSIONER HANSFORD: When you say "that", you are talking about the photo on 7.1?
A. Figure 5, yes.
COMMISSIONER HANSFORD: Thank you.
A. I wasn't allowed -- I wasn't given the opportunity to go and physically inspect the opening-up. Dr Lau, in his report, had the same photographs with dimensions drawn on them. Again, I don't know where those dimensions came from. I've not seen this. So the first time I knew about these 200 slots was when I saw Dr Lau's report.
COMMISSIONER HANSFORD: Thank you.
MR KHAW: If I can take you to one of the appendices of Dr Lau's report, his appendix regarding the result for EWL shear link investigation. That should be a picture regarding HZ1. It should be appendix 5.
If we can just scroll down.
MR PENNICOTT: Sorry, where are we looking?
MR KHAW: Further down. The next page. Yes.
That in fact is a picture showing the same location, HZ01, as discussed in your report; do you see that?
A. I don't know because I've not seen this -- I mean, I've seen the photograph in James' report but I haven't seen it before. I don't know whose photograph it is, so

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I don't know whether it's HZ01.
Q. I can tell you that in fact it's a photograph showing from a different direction regarding the same area.
COMMISSIONER HANSFORD: It appears to be the same photograph.
MR KHAW: Yes.
COMMISSIONER HANSFORD: It appears to be the same photograph as in figure 5 of Mr Southward's report, just orientated, judging by the markings. Would that be the case?
A. A different photograph of the same area.
COMMISSIONER HANSFORD: I see.
MR KHAW: It's probably the direction --
COMMISSIONER HANSFORD: A different photograph of the same area. I understand.
A. It's not the same photo.
COMMISSIONER HANSFORD: I understand.
MR KHAW: It's probably from a different angle.
COMMISSIONER HANSFORD: Yes. A different photograph of the same area. Thank you.
MR KHAW: So if we continue to look at the photograph contained in Dr Lau's report, would you agree that with this opened-up area (indicating), it is unlikely that the presence of shear links would be missed if they had been installed according to the design; would you agree?

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A. Can we blow this -- can we zoom in on the photograph in this area here?
Q. Yes, of course.
A. Just a bit further. So the shear links will be going around -- how do I move the hand here? So the shear links will be going around that bar there (indicating) or that bar there (indicating) or this bar here (indicating). The shear links can only go around the second layer of bars in, not the first layer. So when I look at this photograph, I don't see any visible bar on that side (indicating) of the bar that goes up and down -- sorry, on the right side of the bar that goes up and down, and then also on the left side of the bar that goes up and down. So in this slot I've only got one gap that's probably 100 millimetres wide where potentially there could be shear links. So that is why I was saying these slots need to be much wider to expose both sides of the transverse bars, the horizontal bars in the picture, so that you have the opportunity to see shear links, because for all I know, where my hand is, the hand on the screen, there could be a shear link there (indicating), or the shear link could be here (indicating). But this slot was made without -- it's just one slot showing 100 millimetres wide of bars and, okay, there's no shear links there, and I say so what,

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because the shear link could well be here (indicating) or it could well be here (indicating).
That's why I said it really should have been a 1 metre square so there could be no argument about whether or not shear links were there.
COMMISSIONER HANSFORD: So you are saying that's inconclusive?
A. Yes, absolutely.
MR KHAW: If I can take you to the overall findings of the shear link investigation, at OU5/3332, regarding EWL slab.
Here, we can see the results in relation to 40, a total of 40 locations, and we could see that a total of 16 locations, including locations in honeycombing inspected areas and also the additional opening-up areas, they show 16 locations where no shear links were found.
A. Sorry, are you waiting for --
Q. Yes.
A. I've seen in detail the submission on the opening-up investigation. I have not looked at the honeycombing areas. It strikes me that the opening-up -- we should be looking at the opening-up areas because those are the ones that were chosen statistically for this purpose, in the same way that in the statistical exercise, the

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opening-up for verifications was not included in the statistic thing, we should only be looking here at the 18 locations. So that's what I've focused on.
Q. But at least you would not be saying that shear links were not picked up in all those 16 locations simply because the locations of what you call the right-angled slots, for example, were not positioned correctly?
A. Sorry, I would not be ...?
Q. Because the locations of the right-angled slots as mentioned in your reports, you won't be saying that in relation to all those 16 locations, shear links were not picked up because of the angle in respect of the opened-up area?
A. Sorry, there are so many double negatives there. I won't be saying ...?
Q. We have seen 16 locations out of 40 locations where no shear links were found. Now, you have pointed out that in one location, ie HZ01, and you said, well, there could be shear links there, but because of the angle in respect of the opened-up area, it's possible that there were shear links but they were not picked up. But you won't say that in respect of all 16 locations where shear links were not picked up, it was because of the same reason?
A. Well, I think that's what I have said. Isn't it?

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Q. And bearing in mind that out of the 16 locations, in fact 10 locations were at the honeycombing inspected areas, where your point regarding the right position slot, angle slot, would not automatically apply?
A. As I say, I've not seen the honeycombing areas. I've concentrated on the 18 opening-up areas, and all I'm saying is that that opening-up investigation does not prove that the shear links are missing, because of the limitations in that opening-up.
Q. But at least with 16 locations out of 40 locations where shear links were not picked up at all, would you agree that at least as a matter of prudence one simply cannot assume that shear links actually existed in those locations?
A. No, I don't think I would, because I think you've got to look at what the evidence is. First of all, the investigation of those 18 locations is not very thorough. Secondly, there are hundreds of photographs, site photographs, showing the shear links in position, some of which I showed you yesterday and, you know, it beggars belief that someone can see, "There are no shear links there", when we can plainly see they are there. That strikes me as being conservatism beyond the pale.
So I think the evidence shows me that there are shear links there, and the evidence that there is to

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disprove that shear links are not there is not sufficient to demonstrate that they are not there.

COMMISSIONER HANSFORD: So are you saying that your view is the shear links are there but the opening-up just hasn't exposed them?

A. Yes. And that example at HZ01 was one example I've just shown you here as to why the shear links -- why the opening-up has not shown shear links to be there.

CHAIRMAN: The photographs upon which you rely, are they linked in terms of area to the opening-up?

A. I asked for the site photographs and I said, "Please send me the photographs which show" -- so I sent to Leighton the plan that is the page above, on the other thing -- on my slide, there was a long plan which showed all the green dots, so I sent that to Leighton and said, "Please send me record photographs of the rebar placement in those particular areas, so I then got sent lots of photographs back a day or two later, and my first comment was: okay, how do I know that these photographs are in the right place? To which the response was: they can be -- the locations can be identified by the features that are there.

So on one of the first photographs that I showed yesterday, it might have been HZ01 actually --

COMMISSIONER HANSFORD: Yes, it was HZ01.

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A. Or at HZ05, there's a big pipe that sticks up here.

CHAIRMAN: All right.

A. So the guy said that pipe is on the drawings in the same location.

There's another one that has -- at HZ09, there's six pipes in a row there, and those pipes are in the HZ09 location.

CHAIRMAN: All right. So you got photographs, you did your best to try and ensure that the photographs -- took photographs of what was happening in the locations?

A. Correct.

CHAIRMAN: The concrete hadn't been poured and there's physical evidence of the links, the stirrups as the Americans call them, and if they are there already, there's absolutely no reason to untie them thereafter?

A. Yes.

CHAIRMAN: You will now move on to pouring concrete?

A. Yes. You can see the stirrups lying on top of the mat, ready to -- in fact, this guy at HZ18, he's probably in the process of installing those shear links on the slide now.

MR KHAW: Mr Chairman, I'm moving to another topic and I will be another 20 to 25 minutes. I wonder whether that's a convenient moment.

CHAIRMAN: All right. But just before we adjourn -- thank

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you -- perhaps this is an opportune moment.

In October, counsel will probably realise that leading counsel for Leighton, Mr Paul Shieh, said that they would like to address the Commission regarding the concept of full-time and continuous supervision. The Commission had of course already made interim findings on this topic, but the Commission was sympathetic to the application, essentially on two bases, as I recall. First, that the findings in the interim report were provisional, and that the question of supervision, of course, and the nature of the supervision required, was at the very core of the important matters that had to be considered.

The Commission was of the view that if an involved party is allowed to reopen a matter, then they should be allowed to see all the relevant sections of the interim report in full, because obviously if you want to reopen the matter, you need to see what has been said in the interim report so that you know what you can argue in respect of.

In result, the chairman, namely myself, but through those who assist me, sent a formal letter to the government in late October to seek approval to disclose relevant redacted parts of the interim report to all involved parties in the Inquiry. The government

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replied, stating that the redactions had been made based on legal considerations to avoid any prejudice in ongoing proceedings. It was the government's position that disclosure of the redacted parts may hamper any such proceedings, and therefore a risk of prejudice could not be precluded. The government considered that any such disclosure should be subject to proper safeguards by this Commission to prevent further disclosure of any part thereof by the involved parties to other parties or the public.

The Commission was of the view that that was simply not tenable, and clearly all the parties who wish to put forward submissions or answer submissions should be entitled to have access to this material, and that in light of, unfortunately, some of the unfortunate history, we couldn't guarantee that matters wouldn't stray. So the Commission informed the government that it would not proceed to seek further disclosure of the redacted parts of the interim report.

That doesn't help us, but it's a question of weighing up the judicial responsibility of ensuring that if an issue is to be aired, then parties should be entitled, and that is all the parties that are involved should be entitled, to have full access to it and to argue it, and that was just simply not going to be

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feasible in the circumstances.
So, for those representing Leighton today, if you wish to reopen this issue, which obviously the Commission has already indicated it's happy to allow to happen, you will be doing so with the handicap that you will not be quite sure what our provisional findings are.
That said, our provisional findings are exactly that, they are provisional, and they can be set to one side, so that you may say: Whatever your findings are, we feel we need to try and emphasise that you should come in the final analysis to a particular viewpoint, so we don't see that it actually handicaps you to the extent that it prevents you from putting forward any further argument.
Good. The other thing is, before we rise, as Prof Hansford has put forward, it is quite important, we think: arrangements for tomorrow for the experts.
MR PENNICOTT: Yes, sir. I think, but I'll be corrected if I'm wrong, that the experts have -- at least some of the experts have discussed my idea of a potential site visit, but the idea appears to have fallen on stony ground and is unlikely to take place.
CHAIRMAN: Okay.
MR PENNICOTT: I think it's thought that there is little, if

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anything, to be gained or benefited from a site visit.
Sir, the only outstanding point in terms of the evidence at the moment is, as you will recall, I mentioned yesterday, at some point yesterday afternoon, that the method statement upon which I had invited some answers from Mr Chow turned out perhaps to be not the latest, current version of the method statement. We now have got, and I've provisionally considered, the up-to-date method statement overnight. What I'm afraid I haven't yet concluded is whether we need to trouble Mr Chow further, to bring him back, to ask him some more questions about the new, current method statement, and indeed perhaps more importantly why the method statement has changed from the November version to the December version, because there do seem to be some rather important alterations to the method statements, and I know Prof Hansford has had an opportunity of looking at those alterations himself, and as I say I'm still actively considering whether Mr Chow needs to come back. I'm not sure I'm going to be able to give you an answer this afternoon, but I certainly hope to be able to do that before Monday morning.
CHAIRMAN: All right. And tomorrow, Saturday?
MR PENNICOTT: Sir, the way we are proceeding at the moment,

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I don't think there's any necessity for us to sit tomorrow. It sounds, from what Mr Khaw says, that he's going to be another -- did he say half an hour or so? -- with Mr Southward. Subject to how long Mr Boulding is going to be with Mr Southward, it sounds to me as though we are going to reach Dr Lau this afternoon.
We have had circulated this morning, although I imagine you probably haven't seen it, or at least had an opportunity to consider it, Dr Lau's slides that he proposes to go through, I imagine, in his presentation. I've had a brief look at those but not studied them in any great detail yet.
So I think we are progressing quite well. It sounds to me, unless something goes wrong, we are going to reach Dr Lau this afternoon, we are going to have Dr Lau's presentation this afternoon, how far we will get in cross-examination I'm not entirely sure yet, but we seem to be doing quite well.
COMMISSIONER HANSFORD: And the estimated length of Dr Lau's presentation?
MR PENNICOTT: Sir, orally I don't know. I can tell you it consists of some 86 pages, but how quick he will be going through it I have no idea.
MR KHAW: It will be within one hour.
MR PENNICOTT: About an hour.

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CHAIRMAN: Good. Thank you very much indeed. It's just gone 1.00.
MR PENNICOTT: 2.30.
CHAIRMAN: 2.30. Thank you.
(1.04 pm)
(The luncheon adjournment)
(2.34 pm)
MR KHAW: Mr Southward, in relation to construction joint, which is perhaps the last issue in your COI 1 report -- now, we know that under the revised design assumptions of the updated designs, the construction joint was no longer shown to be overstressed; you are aware of that?
A. (Nodded head).
Q. Yes. But for the purpose of investigating the condition of the horizontal construction joints, you recall that four holes were cored and samples were taken for examination; you remember that?
A. (Nodded head).
Q. And I think the result is that defects were found in two out of the four cores, and the defects obviously showed poor workmanship; you agree with that?
A. (Nodded head).
Q. Yes. Gaps were apparently found in the horizontal construction joint, and that is the defects that you refer to?

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A. In one of the samples, I think a small gap was -- not really a gap, two bits of concrete were touching each other but not homogeneous.
Q. Right. Would you agree that such small gaps might create paths for water to go into the reinforcement zone?
A. Not in this instance, as I explained in my presentation yesterday. So I can't agree to that, no.
Q. And for the reason that you have given us, that is the CJ is capped and hence no water can get in; that is your reason?
A. It's encapsulated, not just capped; it's encapsulated.
Q. Encapsulated. However, according to the joint memorandum, it should be the first joint memorandum, regarding the meeting held on 20 December 2019, you have agreed that from a public perspective, it would be prudent to remediate the two locations where poor workmanship had been identified; do you remember that?
A. Yes.
Q. What do you mean by this public perspective as stated in the joint memorandum?
A. Well, if a defect has been found, from an engineering perspective, we all know that that defect has no implication or concern on the performance of the structure. We know that and all the -- but the public

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don't have the benefit of our engineering background and aren't aware of the engineering thoughts and the processes that go into the decision that we came to. So there is a visible defect, so it would make sense from a public perspective to reassure everyone that it's okay, by repairing that defect.
Q. So the decision -- correct me if I am wrong, so the decision to have the defects repaired was made from an engineering point of view, but you obviously wanted to --
A. No, no, I didn't say that. I said it wasn't made from an engineering -- it was not made from an engineering perspective.
Q. I see.
A. Because we have the engineering skill to know that it doesn't matter.
Q. Right. So it's only to satisfy the public that some repair work would need to be done that you make a decision to remediate the two locations?
A. I don't know what the public are asking for, so I don't know whether it would satisfy them or not.
Q. Yes, but presumably -- you use the word "public perspective", so I just wanted to ascertain from you what you mean by that perspective.
A. Well, as I've just said, from the public perspective.

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How else could I explain?
CHAIRMAN: I suppose -- would it be fair to say that if the public are walking in and out of this building and they see jagged edges and bits of broken concrete, it doesn't build a lot of confidence in the building itself; it may suggest that there's something more wrong? You know there isn't, but by plastering it over and making it look nice, you assuage any public concern?
A. True, yes. Yes. But of course in this particular instance everything is hidden below the trackwork concrete so no one would see it anyway, so it's just the talk about the joint the public will have heard of, so perhaps it's best to remediate it.
CHAIRMAN: Oh, I see.
A. No one is going to see it.
COMMISSIONER HANSFORD: Because you've told us it's totally encapsulated.
A. Yes, absolutely.
MR KHAW: The last point on construction joint, and that is your view on the suitable measures. You have told us that your view is that there is a risk that the dowel bar installation is likely to cause damage to the shear link bars. That's what you have stated in your COI 1 report. Do you remember that?
A. Something along those lines, yes.

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Q. We can take a look at the exact wording that you have used.
A. I can't find it.
COMMISSIONER HANSFORD: Is this 8.7?
MR KHAW: 8.7.
A. Yes.
Q. The third bullet point, where you say:
"If vertical bars are to be drilled into the top surface of the EWL slab and then downwards into the D-wall, there is a significant danger that the horizontal shear link bars might be cut by the action of the drilling."
That's what you said.
A. (Nodded head).
Q. I believe you were asked about the method statement yesterday and you told us that you had not seen the method statement before.
If I can now take you to the latest method statement, at OU11402. Perhaps you can take a look at the work sequence from points 1 to 9 -- the procedures, actually. And 10 onwards in relation to what needs to be done after the drilling process.
If we take a look at the first page, 11402, point 9 says:
"Concrete coring will be carried out at the same

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location of step 8. In case the drilling/coring crashed with the existing rebar, it will be stopped immediately, and we will agree another drill hole location with MTRC."

This is the method statement from Leighton.

Would you agree that with this procedure, ie in the event that the drilling actually encounters the existing rebar, then it will be stopped immediately and then the parties would need to agree on another location -- would you agree that this method would help eliminate the risk that you have outlined in your COI 1 report?

A. Partially yes, but partially no, and there is one -- well, there are two -- I have not seen this document before so I've not had time to reflect on it but there are two things that jump out at me. The first, most obvious, case is when you drill down, you hit a bar with the drill, so what is the skill level of the operative, how much of the bar will he hit before he realises it's been hit and how much of it will be cut away? So where else -- they've hit a bar, then where else do they go? It doesn't say where else they go. So that's one issue.

The other issue is -- okay, so they drill down, they've drilled this 16 -- 12 millimetre drill down, and they drill down all the way down to the bottom of the

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red -- if you go up on the screen to the 6.2 figure, as I understand this, point 8, they will drill down to the bottom of the red hole, with a 12mm drill bit, and then they will drill down with an M16 drill bit. So fine. But they have not drilled down to the bottom of that hole with a 36mm -- I understand the actual core hole that the bar goes down, it was mentioned yesterday, was 36 millimetres -- 32. Maybe -- can I draw and explain what my concern would be?

Q. Yes, please.

A. Is there a pen?

COMMISSIONER HANSFORD: Yes. (Handed).

A. So imagine here are our T40 bars in the EWL slab.

CHAIRMAN: Thank you.

COMMISSIONER HANSFORD: We are looking in section, are we?

A. We are looking -- this is the top of the slab that's been exposed like that (drawing on the whiteboard).

COMMISSIONER HANSFORD: Okay.

A. And the diaphragm wall is down here (indicating). Have I drawn that right? No. The diaphragm wall is this way (indicating).

So we drill down, so there is a shear link down here, say (drawing on the whiteboard), and here and here. So if you drill down with your M16 drill hole, you are going to drill down to the end of the hole, and

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it's clear (drawing on the whiteboard). So that's great.

But then when you come down with your core hole -- sorry, that's badly drawn, but you can see what I mean -- you can hit the shear link. So that step probably needs to be added in, that maybe you need to drill down all the way around the perimeter of the core hole to check there's no bar first, before you do the main core hole.

COMMISSIONER HANSFORD: So are you saying that using the M12 as a pilot hole is no guarantee that you won't hit steel with the M32 core?

A. Yes, logically that would be the thing, because, you know (demonstrating), that's the difference.

COMMISSIONER HANSFORD: Yes. So the risk is reduced a little?

A. The risk is certainly reduced, yes.

COMMISSIONER HANSFORD: But still exists. Thank you. Is that right?

A. Yes. I mean, unless -- you know, that's just --

COMMISSIONER HANSFORD: Sorry, I don't want to put any words in your mouth, Mr Southward.

A. That's just with the words in this method statement that I was asked to comment on. There may well be a way around it.

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COMMISSIONER HANSFORD: Okay. Thank you.

MR KHAW: So, in that case, would you have any further suggestion to further reduce the risk, from your point of view?

A. I would really need to think about that. Off the top of my head at the moment, it wouldn't be right for me to say, at this unconsidered point.

COMMISSIONER HANSFORD: But presumably, if the view of the expert is the work isn't required at all, the risk is reduced by not doing it?

MR KHAW: It goes back to the question as to whether the works would be required in the first place.

COMMISSIONER HANSFORD: It does of course, yes.

MR KHAW: Finally, Mr Southward, regarding your COI 2 report, there's just one point that I wish to discuss with you, and that relates to the trough wall. I would like to know whether, in your yield line analysis, have you checked the deflection at the tip of the trough wall?

CHAIRMAN: Sorry, can I have that again?

MR KHAW: Have you checked the deflection at the tip of the trough wall?

CHAIRMAN: At the tip of the trough wall?

MR KHAW: Yes.

A. Deflection checking, to the best of my knowledge,

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doesn't come into yield line analysis.
Q. No. If I can just show you a drawing at DD -- it's a COI 2 bundle -- DD19/19058. If we look at the right-bottom part of this drawing, you will see a shaded circle just below the figure 900; do you see that?
A. Yes.
Q. There are two horizontal lines on top of -- well, one actually straddling across the circle and one above, two parallel lines above the figure 900; do you see that?
A. All I can see is a lot of blurred lines. Where -- maybe can you show where?
Q. Yes.
A. I can see a recess in the trough wall to allow for the presence of the column.
Q. I'm talking about this (indicating) first line above "900", and then the parallel line below -- my hand is shaking -- that line. Do you see that? So that actually makes a rectangular shape just above the shaded circle; do you see that?
A. That looks to me, from this drawing, as if it's a recess in the wall to accommodate the column.
Q. But that rectangular shape, that represents the trough wall; is that correct?
A. Well, I would guess so, yes, the sort of diagonal lines that are this (indicating) far apart, those must be the

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trough walls beside the columns, yes.
COMMISSIONER HANSFORD: So does that appear to be showing that the trough wall is narrower in the vicinity of the column?
A. Yes, that is. Yes.
MR KHAW: So it shows that there are locations where the trough wall is very close to an existing column which supports a podium above; is that correct?
A. That's correct, yes.
Q. If you have not checked the deformation of the trough wall, is there any way for you to ensure that it will not hit or damage the column when the trough wall is hit by a derailed train?
A. Well, to the very best of my recollection, that area there is an area that AECOM checked and passed and said was acceptable in their calculations. I can recall seeing this recessed bit in their calculations.
The concern about the trough walls is solely limited to the places where there is a construction joint in the wall. Now, on this sketch here, in the area that you've highlighted, there are no construction joints. That is a vertical construction joint in the wall. I can't see anything that indicates a construction joint.
Q. If we can blow up this, maybe we can see a bigger part of this drawing. If we go to the top-right corner, we

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can see the words "MJ"; do you see that?
A. Yes, I can see that.
Q. So that line actually represents a movement joint; right?
A. Yes. Sorry, can you zoom in on that corner?
Q. Yes.
A. So there's a dimension there of 5 metres. I don't know where that dimension is from, but looking at it, the joint appears to be a considerable distance away from that column, which I guess is the rectangular column with the I section contained within it. So that looks to me as if the column is a fair distance away from the joint.
Q. Yes, this movement joint actually extends all the way to -- if we can scroll down a little bit, all the way -- further down -- yes, all the way to the column that we have seen; right?
A. Well, if that is a movement joint, then it does, yes, it does extend, although I'm a bit sort of -- I don't think the drawing is terribly clear, because -- if you just go back up -- I can't see on here, it's too -- just go back up to the top.
Q. Yes.
A. It's difficult to see what that really is, I have to say. It says "MJ" there, but does that really mean it's

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the MJ all the way down the page? I don't know. I'm not familiar enough with the drawing.
Q. Right. But assuming that MJ extends all the way to near the column that we have seen, near the figure 900 that we have seen, would you agree that if the movement joint does not pass the requirement, does not meet the requirement, then it has a risk that it will hit and damage the column, at least?
A. No, I don't think so, because this joint -- obviously, this joint is not -- hold on, let's just see; what's that? I don't know. I don't know what the -- it's impossible to tell what the clearances are. The thing about the yield line analysis is that it's an energy absorption calculation method, so in order for the wall to fail, it absorbs the energy of the impact. So any resulting movement will not have the energy of the train when it hits the wall, because that energy is absorbed and is required in order to break all the reinforcement inside that wall.
So I understand your concern. I really don't think it's relevant, because of the energy that the wall has absorbed. Then also the wall itself behind, there's backfill everywhere, so in order for the wall to move, it will push against the soil and the backfill that is behind the wall.

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So any residual load/force that might or might not hit that column would be extremely small.
COMMISSIONER HANSFORD: And the reason it would be small is that energy has been -- part of the force has been absorbed by both the wall and the soil?
A. Well, you know, all of the energy will have been absorbed by the wall in order for it to break.
COMMISSIONER HANSFORD: Yes.
A. Then behind that is all the soil, so that will take up any residual impact of that bit of the wall moving.
COMMISSIONER HANSFORD: I see. Yes.
MR KHAW: Thank you. I have no further questions.
Cross-examination by MR BOULDING
MR BOULDING: Good afternoon, Mr Southward. As I think you know --
A. Good afternoon.
Q. -- from past experience, I'm Philip Boulding and I act on behalf of MTR. In the light of the experts' joint statements and the evidence you have given to my learned friends already, I really don't have very much to ask you. It's one matter, really, an issue concerning shear links. Perhaps you would be kind enough to turn to your original hearing report, and that's ER2/14.1 at page 38. I'd like to look at paragraph 7.9, please, so scroll down.

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There you deal, do you not, with shear calculations? You tell us:
"The shear calculations of all of the consultants involved demonstrate that the shear demand is considerably less than the shear capacity of the concrete and only the nominal minimum shear links are required in limited areas of the slabs."
Do you see that?
A. Yes.
Q. It's correct, is not, that you go on to give various reasons for your opinion that there is no justification for completely disregarding the shear links in the design calculations? That's right, is it not?
A. Yes.
Q. Then if we go down to various bullet points, you set out, do you not, various bullet points for that particular opinion? The one I had in mind and want to go to is the one on the next page.
There you say:
"The evidence of the as-constructed shear links show that links were used that, although do not comply with the detailing rules of the HKCoP, can carry the design loads due to their over-provision and are therefore compliant with the HKCoP."
So we see there, do we not, that you accept that the

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as-constructed shear links do not comply with the detailing rules of the HKCoP?
A. I do accept that, but if I may add a "but", my report went to considerable lengths to explain why those detailing rules can be modified, because those detailing rules are only applicable for fully loaded shear link bars at full design loading.
Q. And, as I understand it, you attempted to do that by using a series of calculations to justify the non-compliance with the detailing rules of the HKCoP; that's what you did, did you not?
A. Yes. Yes.
Q. Okay. Just for the record, we would find those calculations, would we not, in slightly earlier paragraphs, paragraphs 7.5 to 7.8 of this particular report; correct?
A. Yes.
Q. Now, presumably you would accept, would you not, that whether or not the shear links comply with the detailing rules of the HKCoP is a compliance issue? That's a compliance issue, is it not?
A. Yes. Whether or not something conforms to a code is a compliance issue. What my calculations were showing was that those calculations -- that detailing rule is only applicable, as I said before, to a bar that's fully

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loaded. Our bars are not fully loaded because of the over-provision, and because of that we can take account of the reduced force in the bar so that the anchorage doesn't need to be as long.
Q. I hear what you say, but the transcript will record that you agreed initially with my proposition that whether or not the shear links comply with the detailing rules of the HKCoP is a compliance issue. Now, proceeding on that basis, presumably you'd accept that the Commission is not concerned with that particular matter because it is a compliance issue. That's something you'd accept, would you not?
A. Yes, I know the Commission is not concerned with compliance, absolutely. My calculations were done on the basis of safety: can the shear links withstand the load?
MR BOULDING: Yes. I understand that and that will suffice for my purposes. Thank you very much indeed.
COMMISSIONER HANSFORD: I have one question for Mr Southward.
Part of the brief, part of the terms of reference of the Commission is to make recommendations for the future, so we are looking at suitable measures -- and I use the word "suitable measures" in a different context to the suitable measures that have been included

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for remedial works here -- suitable measures to promote public safety in the future.

The bit that I'm interested in in particular is the correct use -- the correct installation of couplers. What we've seen here, with these BOSA couplers, is that the manuals indicate that the decision on whether or not they have been correctly installed is based on a visual inspection of how many threads are exposed. Do you think there's a better way? Do you think there's a way of more positively indicating that the couplers -- that couplers, and I'm talking about future works here, not for this particular project -- have been properly assembled, in your expert opinion?

A. That's a difficult one. Putting me on the spot.

Obviously, there are other types of couplers.

COMMISSIONER HANSFORD: Indeed.

A. Other types of couplers have different installation methods. I believe there's a coupler that has a triangular end that has to be torqued in. That will only stay in -- because of the triangular end, that will only stay in if it's torqued in. That's not to say that the BOSA coupler is not sufficient because it can carry the load. It's a difficult --

COMMISSIONER HANSFORD: The reason for my question is: it seemed to be slightly hazardous that the decision on

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whether the coupler is correctly install is based on being able to see exposed threads and recognise that in many cases there will be limited visibility, limited access, congestion of steelwork, and I'm just wondering if there's a more positive, more deliberate way of identifying that a coupler has been correctly installed, rather than a reliance on counting threads.

A. I'm not sure. I hesitate to say, other than using a different type of coupler.

COMMISSIONER HANSFORD: Okay.

A. I don't know. I really don't know.

COMMISSIONER HANSFORD: Thank you. I may well explore this with other experts.

A. Okay. Thank you.

Re-examination by MR CHANG

MR CHANG: Chairman and Professor, just two minor re-examination issues.

Mr Southward, can we bring up bundle C13, page 8389. That's the HKCoP. That's the version I use, C13, I believe, 8389. Thank you.

This morning, you were asked questions on your categorisation of the station box structure as falling within exposure condition 1, being "Mild", and you were being asked questions about whether your view would be changed if it -- it was put to you that the box

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structure was close to the sea and therefore would you not consider there to be high humidity.

Then followed a question from the chairman who asked you this, and again I'm reading from the transcript. The chairman asked you this:

"What is between the sea and the box-like structure that makes up the station?"

And your answer was, "The diaphragm walls."

Just to clarify, between the diaphragm walls and the sea, is there anything else?

A. There's quite a lot of soil, rock, however many, I don't know, half a kilometre between the station and the sea, or 200 metres, I don't know how far.

Q. Thank you.

A. There's a fair distance of soil.

Q. So the box structure is not in immediate contact with the sea; right?

A. No.

Q. The second question is this. In answer to Mr Khaw's question -- again, I'm reading from the transcript -- Mr Khaw asked you this, on engineering judgment, and he asked you whether the MTR, when doing the stage 3 assessment, was exercising engineering judgment in assessing the strength to determine whether the structure should be kept or should be knocked down. You

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recall being asked this?

Your answer is this, and that's where I need some help -- you said this:

"Yes, they have done a recalculation of the structure, and it's evident that the recalculation has been an awfully lot more well defined and perhaps better carried out than the original calculations, because all the new calculations show a lot less reinforcement than that that was originally specified."

I'm reading from the transcript. So help us on this. What do you mean by "original calculations" and what do you mean by "new calculations"?

A. Originally, Atkins did the design in 2012/11, that kind of time. Originally, they had -- their design drawings showed four layers of T50s -- four layers of T40 bars in areas in the EWL slabs. The stage 3 calculation's pre-application of any strength reduction factors showed that actually you only need two layers of reinforcement. So that's what I mean about -- that's the difference.

Does that answer your question or --

Q. So the new calculations, you are not taking into account the strength reduction factor? In other words, are you endorsing the holistic report when you say the new calculations are well defined?

A. I'm endorsing the calculations that were done up to but

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not including the application of the strength reduction factors.
MR CHANG: Thank you. These are our questions. Thank you very much.
CHAIRMAN: Thank you.
Questioning by THE COMMISSIONERS
COMMISSIONER HANSFORD: There's one matter that's been puzzling me a little. Can we return to your slides, please, and to the exploration for shear links. So it's the photograph you show on the -- not that one but the one that shows the opening-up. Somebody help me.
A. Is it titled "Width of investigation slots"?
COMMISSIONER HANSFORD: It could be. The trouble is, these slides are not numbered.
A. Yes. Apologies.
MR PENNICOTT: 11.
MR CHEUK: 19.
MR PENNICOTT: Sorry, 18 and 19.
COMMISSIONER HANSFORD: That's the one. Well, actually, no, the one before that, I think.
MR PENNICOTT: The one after.
COMMISSIONER HANSFORD: The one after that. What's puzzling me is when this investigation was done, no shear links were visible from this investigation. Would it not, in your view, have

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therefore been sensible to break out slightly wider to look for those shear links? Because I think your evidence is, in your view, they are there, it's just they haven't yet been exposed, so as an experienced engineer faced with this examination and the examination does not identify the shear links, would it not then be prudent to expand the investigation to look for those shear links?
A. Yes. I think if you were to condemn -- or if you were to make a statement that there are no shear links in the structure, I personally think you would need to do more investigation to prove that, and my point was simply that not enough has been done to show no shear links, and yes -- I mean, when I was questioned by Mr Khaw, I showed that -- we zoomed in on that one particular slide --
COMMISSIONER HANSFORD: Yes, that's what I was actually looking for.
A. That's in -- that's somewhere --
COMMISSIONER HANSFORD: That's elsewhere, but nevertheless it's the same point.?
A. That only -- that showed two bars, just at the edge of the concrete, but there was only one possible gap where the shear links would have been. So, yes, if I was doing it, I would have said, "Can you please break out

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those two strips", just to make sure -- just to see whether there's shear links on that side or that side.
COMMISSIONER HANSFORD: Right, and that wasn't done?
A. That wasn't done, no.
COMMISSIONER HANSFORD: Thank you.
CHAIRMAN: Good. I think that concludes your evidence. Thank you very much indeed, Mr Southward. You may be recalled, as you know. There's always that possibility. But otherwise, thank you very much indeed and you are now excused. Thank you.
WITNESS: Thank you.
(The witness was released)
MR SHIEH: That's all for Leighton's expert evidence.
CHAIRMAN: Thank you.
MR KHAW: I am going to call Dr Lau. Given the time, shall we have an early afternoon break --
CHAIRMAN: Yes, that sounds sensible.
MR KHAW: -- and then Dr Lau will be ready.
CHAIRMAN: Thank you very much.
(3.25 pm)
(A short adjournment)
(3.48 pm)
MR PENNICOTT: Sir, before Mr Khaw calls Dr Lau, can I just mention that I've had a brief word with Mr Khaw and, subject to your consent, what we propose to do is to

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call Dr Lau now, for him to give his presentation, but on the basis that I would prefer to start cross-examination on Monday morning.
CHAIRMAN: Yes.
MR PENNICOTT: And also to allow Mr Khaw to have access to Dr Lau over the weekend, we won't start the cross-examination this afternoon.
CHAIRMAN: All right. That's fine.
MR PENNICOTT: That's on the basis it's going to be about an hour anyway, so I would have thought we are not going to lose much time anyway.
CHAIRMAN: Yes, that's right, and we're now at 3.50.
MR KHAW: I'm grateful to Mr Pennicott for this proposed arrangement.
DR LAU CHI WANG, JAMES (sworn)
MR KHAW: Thank you. In view of the arrangement that has just been referred to by Mr Pennicott, perhaps, Dr Lau, you could make your presentation first, by referring us to the slides that you prepared.
Presentation by DR LAU
A. Okay. Actually, sir, I am James Lau. Next, please. My professional experience: I have over 50 years of experience in the fields of civil, geotechnical, structural engineering, in construction, design and research. In Hong Kong, I have been an AP

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since 1983, an RSE since 1981, and an RGE since 2004.
CHAIRMAN: You will have to help me.
A. "AP" means authorised person.
CHAIRMAN: Yes.
A. And "RSE" means registered structural engineering and "RGE" means registered geotechnical engineer.
CHAIRMAN: Thank you very much.
A. At the moment, I'm the chairman of the Hong Kong regional group of the IStructE, I was the chairman of the Engineers Registration Board of Hong Kong from 2004 to 2007, and I was a VP, vice-president, of the IStructE in 2002. I am a member of the Academy of Experts in the UK.

Next, please. I have experience of sitting on the steering committees as a representative of the HKIE, Hong Kong Institute of Engineers, of the following Codes of Practice in Hong Kong. The first one is the Foundation Code 2004. The second one is the Code of Practice for Structural Use of Concrete 2004, which here we call the Concrete Code. Third is the Code of Practice for Structural Use of Steel 2005. Fourth is the Code of Practice for Precast Concrete Construction 2003. And Highway Slope Manual. And the last one is the Code of Practice for Fire Safety in Buildings 2011.

Next, please. As part of my experience, you can see

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from my CV that I have done 12 Cap 545 cases at the Lands Tribunal as structural expert. The reason why I want to point out this experience is I have been dealing with old buildings, over 50 years old, and my job as the expert was to show to the tribunal that what is the cost of rectification compared with the cost of redevelopment. So to do that, I had to do a large number of coring tests on the concrete of the existing buildings, and also had to open up the concrete, to look at the reinforcement inside, and then I prepared an assessment report, and also, after that, I prepared a cost estimate of how much it is to do the rectification and how much it is to do the redevelopment, to the tribunal.

So, in that particular capacity, I have a lot of data on the strength of cores of old building, concreted old buildings, and I can basically say that because of the age of the buildings which are all over 50 years old, the core strengths of this concrete are normally much lower than the design strengths.

Basically what it means is the strength after -- the concrete after it has been cast will continue to rise because of chemical reaction we call hydration, so the strength will be higher than the design strength, but after two to three years, the chemical reaction stops,

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and because of the creation of micro-cracks during the use of the building, there will be a lot of micro-cracks being accumulated in the concrete, the strength starts to fall. So with the age of the building the strength of the concrete can decrease. This is what I tried to tell the tribunal.

So the age of the building can have some effect on the strength of the concrete in the building.

Next one. I am also a contractor. At the moment, I have over 30 years as a contractor in Hong Kong. I do ground investigation, I do demolition and I do foundation as well as superstructure. Actually, in Hong Kong, I demolished over 30 old buildings in Hong Kong. The reason why I want to point this out is that in every one of these cases, I always found a gap between the base of the suspended slab and the soil, and quite often if there are pile caps, I always found a gap, quite often larger than 300 millimetre, between the base of the pile cap and the soil. The reason being during the life of the building there may be dewatering around the site. The dewatering causes increase in effective stresses in the soil and this causes the settlement of the ground, leaving a gap between the suspended slab and the soil.

On the other hand, if the base of the building is

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designed as on-grade slab and if the soil settles, the base slab also settles, then there will be no gap between the base of the slab and the soil. So it depends on the design of the particular slab. If it's suspended slab, there will be a gap after 50 years, definitely. If it is on-grade slab, there won't be any gap, but the slab will settle together with the soil.

I also do a lot of drilling work in Hong Kong, a lot of drilling work, as a GI contractor, and I know that we are talking about the possibility of, when we do the drilling, we will cut the rebar in the concrete, in the construction joint, and I can tell you that it wouldn't happen. I tell you why. If the drill bit hits the reinforcing bar, there will be a loud metallic noise coming out and the driller knows right away, and no driller will allow the drilling bit to cut through reinforcement because it causes damage to the drilling bit, which are very expensive. So I don't think any driller will allow the drilling bit to cut through the rebars.

It also takes a long time to cut through a rebar, so I don't think there will be damage to the rebar in the drilling process. I don't think so, as a drilling contractor.

Next one. This is also interesting because I want

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to tell the tribunal, the Commission, that my research at King's College involved research on strain softening materials, such as concrete and rock, and I used elasto-plastic non-linear finite element method. I write a lot of completed code for my research. I'm not writing finite element --

CHAIRMAN: Sorry, help me. King's College I should know and whoever from King's College can say whatever they like about me afterwards, I won't complain, but King's College where?

A. London. Sorry.

COMMISSIONER HANSFORD: Sorry, it's not a rival to UCL. I describe it as a sort of sister college.

A. Okay. All right. Anyway, what I did was I write software for the constituted matrix inside the elements, to allow me to analyse any structure using this so-called elasto-plastic non-linear finite element method. And for strain softening, I allowed stress-strain curve to drop, so it is different from linear elastic, it's also different from the perforated plastic material, also different from the strain hardening material. In fact, if we use strain softening, the crack application will go through much faster and further. That's what I want to explain.

It also takes a large number of iterations in each

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increment to converge.

Next slide, please. And it takes a lot of computing time to analyse a simple structure. This is the reason why commercial packages usually do not include strain-softening idealisation in the materials, because it takes too much time and effort. The exception is FLAC or UDEC. These are normally used to analyse tunnels, because in tunnels they want to use this sort of method to do it --

CHAIRMAN: I'm so sorry. What is FLAC and what is UDEC?

A. FLAC is a special training for a computer program, and also UDEC as well. They allow joint development in the concrete.

CHAIRMAN: Okay, thank you.

COMMISSIONER HANSFORD: And forgive me, Dr Lau, when was your research at King's College?

A. 1973 to 1977, four years at King's, and I worked under Prof Nash, Gibson and also Dougall, in a group called stability analysis group. We worked on strain-softening materials, the whole group.

Next one, please. I am asked to look at two questions by the COI. The first one is whether the as-constructed works are safe and fit for purpose from an SE perspective; and secondly whether the suitable measures, as agreed in the holistic report, are

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necessary if the works are considered not safe or fit for purpose.

Next one, please. For me, for the purpose of safe and fit for purpose, I need to look at certain relevant criteria during the intended design working life. I think this point is very important, because in the Concrete Code, the intended design working life was for 50 years, but in this particular MTRC structure, the designed working life is 120 years. This has a lot of meaning for me, as far as durability is concerned, so we have to bear this in mind, because of this particular client's requirement.

Next one. In safety, we have to consider four parameters. The first one is stability. We want to make sure there is no overturning. We want to make sure there is no buckling failure of a member under design ultimate loads.

The next one, we have to consider rupture of section. In this case, all sections in the structure should be checked against overstressing and rupture under design ultimate loads.

Next one. The third one is robustness. I think we talked about this quite often in this particular Commission. Basically it means that we do not allow any accidental damage of one part. We make sure it would

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not lead to collapse or progressive failure of the structure. This is what we call robustness.

Number 4 is ductility. I think this is very important in this particular study, because we do not allow brittle failures, because brittle failures are sudden and can take place without warning, so the structure should be checked against brittle failure. This is very important, in particular in this particular case, in the updated design, Atkins allowed a 30 per cent redistribution of moment from the fixed ends towards the centre. For this redistribution to take place, we need ductility in the structure.

Next one. Fit for purpose, in my opinion, it overlaps with safety to a substantial extent. A structural engineer must consider the intended usage or function of a structure. That is what we call serviceability under the serviceability limit state design approach. We also need to consider the client's requirements in the project. In this particular project, there are two special client's requirements. The first one is the seismic design. The second one is the 120 years intended working life of the structure.

Next one, please. Going back to serviceability, SLS design, we need to consider a number of items. The first one, I think the most important one, is

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durability. We want the structure to be durable. The second one is deformation. We don't want the structure to deform excessively. It may affect the partitions, any glass partitions, et cetera. The third one is fire resistance. We want to make sure that in case of fire, the building will not collapse, and it has enough resistance against fire spreading.

The fourth one is very important in my consideration. It's cracking. The cracking can cause the ingress of moisture or weak carbonic acid. We have weak carbonic acid in the atmosphere because of carbon dioxide. When you mix with moisture it may diffuse into the concrete structure, causing what we call carbonation of the concrete. When the concrete is carbonated, it is the ideal condition for corrosion of reinforcement, and that can cause eventually -- when the reinforcement corrodes, it expands and causes spalling of concrete. In Hong Kong in particular, we have a lot of old buildings which have this sort of spalling concrete problem. If the concrete spalls in a multi-storey building, the dropping of this piece of concrete can cause a lot of injury to people underneath. So cracking is a very important consideration for me.

Vibration. Fatigue --

COMMISSIONER HANSFORD: Sorry, Dr Lau. On cracking, you

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then have a piece in brackets which you might just like to expand on.

A. I added this in, mainly because I heard something during the evidence, I heard something about it being considered "mild", not exposure condition 1. I'm going to talk about this later on.

COMMISSIONER HANSFORD: Okay.

A. Because this is a very important point.

CHAIRMAN: This is the fact that the concrete is all underground, it's not open to the elements.

A. Yes. I have a different opinion on this point.

COMMISSIONER HANSFORD: It's fine. I'm happy for you to raise that later. It's just that it happened to be on this slide.

A. I want to raise this later because I think it's an important point for the Commission to consider.

COMMISSIONER HANSFORD: Thank you.

A. This is my opinion. I need you to consider this particular point later on.

CHAIRMAN: Of course.

A. And fatigue, I heard that it needs a stress reversal.

CHAIRMAN: Sorry, vibration first.

A. I think we need to consider vibration, because a train station, when the train comes in, we don't want the vibration to cause discomfort to the people, and also

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there may be very sensitive equipment housed in the station and this vibration can cause damage to the sensitive equipment, so we have to consider this.

Fatigue. I heard that you need stress reversal, but I have a different important because even if there is no stress reversal, but if the number of cycles is big enough, high enough, you can still have fatigue problem. It depends on the cycle, N. If you look at any literature about fatigue, if there is stress reversal, the number of N is very small. Maybe you try to bend a piece of steel, maybe ten times you break the steel, but if we are talking about very small variation in stresses, it may take a large number of N, but still we have to consider that, depending on the number of N. The number of N is the number of cycle.

Next one, please. The above identified, I call them parameters, the above parameters have to be considered, as far as I'm concerned, but basically, apart from one or two items, for example seismic design and 120 years intended design working life, otherwise they are all similar to the parameters specified in the Concrete Code under the headings of ULS checks, ultimate load state checks, and SLS checks. Basically, they are the same, but two additional items, that is the seismic design and the design working life, they are additional things into

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this particular safe and fitness for purpose.

The determination -- in the Code of Practice, actually, the so-called factor of safety is the minimum factor of safety. In fact, during the -- as I said, I was on the steering committee -- during the discussion about the Hong Kong Code, there are a lot of discussions about what sort of factor of safety should be used for Hong Kong. Obviously, at that time, we consulted documents from a lot of other countries. Obviously, different countries have different Codes of Practice -- parameters. For example, poor country, developing country, may have a smaller factor of safety because a high factor of safety can affect the economy of the particular country because if you have a high factor of safety, all the buildings have to be designed stronger and that may cause a lot of cost to the economy. In fact, in this particular case, we considered this in great detail at the time when we do the drafting of the Concrete Code in Hong Kong.

Actually, as I said, the determination of the applicable minimum factor of safety actually varies from one place to another.

CHAIRMAN: Sorry, but doesn't that -- I gave Mr Southward a difficult time yesterday because I was talking around in circles and that's my fault -- well, obviously it's

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my fault, it's nobody else's -- but it seems to me this may indicate my concern. You talk about the fact that in different countries, different parts of the world, you have a -- you may well have different codes, building codes --

A. That's right.

CHAIRMAN: -- dictated, for example, by the fact that if the country can't afford this type of -- but safety, I doubt you would find anybody, no matter how poor, no matter how wretched the country, saying, "Yes, our building code allows us to build buildings that are not safe, they are going to fall down in three years and kill a lot of people." They will never say that, and it's obviously not -- so it's safe --

A. It's still safe.

CHAIRMAN: -- but you have different levels of requirement --

A. Yes.

CHAIRMAN: -- depending on the code. So you can have different levels of code requirements without any of them undermining safety.

A. Let me put it this way. For example, if you go to China, the slopes are steeper than those in Hong Kong, because if they require the same factor of safety for all the slopes in China, it's going to cost them a lot

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of money. You can imagine, if all the slopes are all 45 degrees rather than -- so they do have influence on the economy of the country, definitely.

COMMISSIONER HANSFORD: But the issue there, Dr Lau, is are those steeper slopes safe?

A. They are still safe, but a different factor of safety. We are not talking about factor of safety of 1. We are talking about safety of 2 or 1.5. They are still safe. But actually, if you go to some places in China, if you look, the slope looks nice, but after rainfall there will be quite a number of minor slope failures. You can see them. But in Hong Kong, not many. We have put in so much money to repair our slopes, so in Hong Kong the slopes are very safe, compared with some other places in the world, because -- in fact we put in a lot of money to repair our slopes, to make sure they are safe, up to certain factors of safety.

CHAIRMAN: Yes. Thank you.

A. Okay. Next one, please. Let me go to COI 1. Actually, in COI 1, we are looking at defects/workmanship problem relating to, first of all, couplers; second, shear links; and the third is construction joints. Actually, there was an original design check by Atkins.

CHAIRMAN: Can I just ask one thing, and I don't think anybody has raised it and it's probably because it's

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self-evident, but the type of coupler construction that we are talking about in this tunnel, and there are a lot of tunnels in Hong Kong, mainly MTR tunnels, but this was not entirely novel, was it, what we are talking about now?

A. No.

CHAIRMAN: It's been done before?

A. Of course.

CHAIRMAN: On lots of occasions, presumably?

A. Sure. Not just on tunnel, we use it on building as well. I use this --

CHAIRMAN: But in a tunnel you want to have a very large amount of it over a very extended --

A. We use it very often on buildings in Hong Kong. This is not novel.

CHAIRMAN: No, I'm not saying -- and I'm being mischievous now, this is purely mischievous, I'm putting a question. I mean, if you went off and went through all the tunnels in Hong Kong and started drilling in and looking at the old couplers that are there, do you think 100 per cent would all be butt-to-butt?

A. I'm sure. I'm sure, I'm sure.

CHAIRMAN: You're sure they would be?

A. Because they will check.

CHAIRMAN: Okay. I'll take your -- that's very, very

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commendable indeed.

A. I think, as I said, supervision is very important.

COMMISSIONER HANSFORD: I think we can only take that as an opinion though, can't we?

A. Okay.

CHAIRMAN: That's fine, thank you.

A. Because I use couplers myself in my projects.

CHAIRMAN: As I say, it was a provocative question, just to see what the answer would be, but thank you. Yes.

A. Thanks. In the original -- after all these defects had been found, there was an original design check by Atkins, mainly because of rupture of section checks. I don't think there's any stability problem. It's only local overstress problem, what we call rupture check, and they found a number of overstressed -- a number of areas with overstressed sections.

Then there was an updated design check involving 30 per cent redistribution of internal bending moments. That means putting the excessive bending moment into the centre of the slab, of the beam or slab. And because of that, the number of overstressed areas was reduced. Now it's reduced. In that case, if we try to do the redistribution, we need the structure to be ductile, otherwise you cannot have that redistribution. So ductility becomes very important in this particular job,

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after the updated design check, in my opinion.
Actually, the redistribution is allowed in the Hong Kong Code. It's allowed. The reason why we need ductile -- because we have couplers, we are asking the joint at end to become a plastic hinge, basically, and in order to be a plastic hinge, it has to be ductile. Otherwise, how can you have a redistribution? So it all comes down to ductility. A very important point here.
Next one, please. The review is actually based on the results of investigations and assessment at the three stages of the holistic report. It's generally agreed there is no stability problem on this particular job, on this particular project because, as we all understand, the as-built structure has a high margin of reserve in the original design. A high margin of reserve. However, a number of overstressed areas were identified in the "rupture of section" checks, and they have to be dealt with, in my opinion, anyway.
Next one, please. The overstressed areas identified in the updated design in the holistic report, in my opinion, were unsafe and not fit for purpose.
CHAIRMAN: Sorry, just help me again so that I understand. A number of overstressed areas were identified --
A. Yes.
CHAIRMAN: -- in the rapture of section.

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A. Checks, yes.
CHAIRMAN: That means -- I know you have already defined "rupture", but meaning --
A. In this particular case, everybody agrees, all the consultants, all the experts agree, that it's defined by what we call the utilisation factor, in the element, in the structural element.
CHAIRMAN: Yes.
A. If it exceeds 1, then we call it overstressed.
CHAIRMAN: Yes. Fine. Thank you.
A. If it's less than 1, for example, maybe 0.5 --
CHAIRMAN: That I have. I'm just interested in the rupture of section check, so you were checking for ruptures of any particular section of the works?
A. Yes.
CHAIRMAN: Okay. Thank you.
A. Anyway, this point is the difference between me and the other experts. I think some suitable measures have to be carried out, according to my opinion.
CHAIRMAN: Yes.
A. And because of that, rectification works have to be carried out to make the as-built structure safe and fit for purpose. Now, "fit for purpose" is not just safe. It has to be fit for purpose. That means for the next 120 years. This is my main point. It is safe not just

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for at this moment in time. I want it to be safe for the next 120 years. That's the fit for purpose requirement by the employer and the client.
CHAIRMAN: Yes.
A. When you come to this point, I want it to be durable for the next 120 years, without --
CHAIRMAN: Sorry, have I misunderstood you? I know I'm slowing you down. You have to bear with my pedantic approach. But the overstressed areas you say are unsafe, but you are not saying they are unsafe at the moment. You are saying that they may be safe at the moment but when you look at the intended lifespan of the structure, they will become unsafe unless the remedial measures are taken?
A. Not necessarily like that. First of all, rupture of section check found they were overstressed in the sense that the utilisation factor is over 1, so we need to do something to reduce it back to 1 or below 1.
CHAIRMAN: Okay. Yes.
A. So this is what I call rupture of section check. But after that, I still want this section to be durable for the next 120 years.
So there are two -- section check, okay, I still want it to be durable, because later on, when I carry on -- you understand what I mean?

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CHAIRMAN: I see. So you are saying that right at this moment, it's not a case that it's safe now but over the years to come it's going to degenerate. It's a case that there are overstressed areas now --
A. The overstressed areas now within -- I think we have, after a few measures, we reduce it back to --
CHAIRMAN: Your remedial measures will remedy that?
A. After remedial measures, yes.
CHAIRMAN: All right.
A. So, basically, let me clarify this again.
CHAIRMAN: Sorry, and "overstressed" now means -- because you have spoken about "brittle" before -- are you talking about brittle structures being overstressed and might snap, and that's it?
A. No. Let me clarify this. I'm not saying that. At the moment -- let me go back to the original. In the original design, based on the original design, quite a number of elements have the utilisation ratio over 1. So, in the updated design, there's a 30 per cent redistribution, and this sort of overstress area goes back to the centre of the slab, but still some sections are still overstressed. So that's why we need suitable measures to reduce the stress in the overstressed sections.
CHAIRMAN: And this is a result of -- I think I know the

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answer but I just need it spelt out -- in your view, this is not a design fault, this is a fault of failing to build properly?
A. It's not design fault. Nothing to do with design fault.
CHAIRMAN: So it's purely and simply a failure in this instance to build properly?
A. Because it depends on the defective rate we are arguing about now. Now, after the updated design, for me, it's still not satisfactory, because of the defective rate in the coupler, take for example, in the couplers. I'm talking about in the area A, 68 per cent defective rate, but the other expert believes that it's not 68 per cent, it's much less, because it goes back to the definition of what is a defective coupler.
COMMISSIONER HANSFORD: So what you are really saying, Dr Lau, is it's overstressed if you accept the defective rate, or if you accept the strength reduction applied because of the defective couplers?
A. That's right, otherwise there's no disagreement between us. Now, actually, all four experts basically agree that this is the utilisation factor, but if you apply the defective rate into this ...
CHAIRMAN: All right. Yes.
A. So we have different answer then.
COMMISSIONER HANSFORD: Yes.

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A. For me, if I accept those defective rate accepted by government, then we need suitable measures.
CHAIRMAN: I'm with you.
A. But the other people, the other experts, think that the defective rate does not need to be that high.
CHAIRMAN: Okay. And by "defective rate", just so that we understand each other, we are talking about the defective rate of rebars into couplers?
A. Yes.
CHAIRMAN: We are not talking about anything else?
A. We are not talking about measurement. Only couplers. First of all, there are only three items here: couplers --
CHAIRMAN: That's right.
A. -- shear link, CJ, in the COI 1.
CHAIRMAN: Yes.
A. That's the only item we are talking about.
CHAIRMAN: Sorry, what was the third item you mentioned?
A. CJ, the construction joint.
CHAIRMAN: The construction joint, sorry. Thank you very much. But essentially here, when we are talking about the defective figures, we are talking about couplers?
A. Couplers. First of all, couplers, and then we go to shear link. At the moment, let's talk about couplers, otherwise we will get very confused.

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CHAIRMAN: Yes.
A. So, because of defective couplers, we need suitable measures.
CHAIRMAN: Fine.
A. And that depends on the so-called defective rate we agreed on.
CHAIRMAN: Right.
A. Okay.
The next one, please. For me, I consider only fully engaged couplers, that means butt-to-butt connection and locked, should be used in the structural assessment. I'm talking about the assessment. This is my opinion.
CHAIRMAN: Yes.
A. And also this coupler should satisfy the permanent elongation test, and to some extent also the cyclic tension compression test. This is for me.
CHAIRMAN: Again, let me understand you.
A. Sure.
CHAIRMAN: I appreciate everybody else is sprinting ahead and I'm the last horse in the race, but okay --
A. I'm very happy to --
CHAIRMAN: -- but I'm the horse that has to write the actual judgment at the end of it. Only fully engaged couplers, butt-to-butt, should be used in the structural assessment. My reading of that, as a layperson, is that

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unless it's fully engaged, you don't use it in any form of the assessment of the strength of the structure --
A. Yes.
CHAIRMAN: -- or the integrity of the structure, so it's the equivalent of it not being there.
A. Not just strength but also fit for purpose. Two things: strength and deformation.
CHAIRMAN: Okay. So it's the equivalent that it's not here?
A. Sorry?
CHAIRMAN: It's the equivalent of it not being there?
A. The equivalent -- you mean partially engaged?
CHAIRMAN: If it's not fully engaged and it's not going to be used in the structural assessment, then it's the equivalent of the coupler and the rebars not being there?
A. I agree, yes, in the assessment.
CHAIRMAN: In the assessment.
A. And this is the approach adopted by Atkins.
CHAIRMAN: By Atkins?
A. By Atkins. This is the approach adopted by Atkins.
CHAIRMAN: Or is that the approach adopted by Atkins after they were told to adopt it?
A. That I cannot say. I don't know.
CHAIRMAN: Okay.
A. But anyway, I'm looking at the holistic report. In the

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holistic report, this is the approach adopted by Atkins.
COMMISSIONER HANSFORD: And you are saying because of this item, then there are overstressed areas?
A. Yes, because of this item. Because of this item. I think this is the only difference between me and the other experts.
COMMISSIONER HANSFORD: Yes, I understand.
CHAIRMAN: I'm struggling with this a bit. It's been a very interesting learning curve. The reason you have the rebars running through, and the reason why they go into couplers, I understand, but now you've got them all there, and my understanding -- please correct me now -- is that you don't have to have two pieces of iron actually going clunk into each other, using highly technical language. They can be just above or just below each other, overlapping slightly, and they will still transfer --
A. You mean coupler or just steel bar?
CHAIRMAN: Lapping like this.
A. Steel lapping? I don't think so.
CHAIRMAN: Okay. Let's just take the steel bars. So you've got steel bars running for metres that way, the same one running for metres that way, and they are now a couple of millimetres apart from actually touching each other, but they have a big encasement of iron or steel around

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them and there's concrete there, and you say that for an assessment of integrity, the structure might as well not be there.
A. This is the problem, because if they are not properly connected, there is elongation, and the elongation, when it's cast in concrete, when --
CHAIRMAN: No, no. We'll come to that later. I'm just interested in the really dull layman's approach of saying: you are saying that what I have just described, including the coupler, which is a pretty strong piece of iron, all next to each other, running 100 metres along, on top of each other as well, all of that you ignore as having any integrity or value whatsoever in the structural assessment?
A. In the structural assessment.
CHAIRMAN: Okay. All right. Now I understand your point and --
A. This is my point.
CHAIRMAN: Absolutely.
A. One of the main reasons being, apart from strength, we must consider deformation of the coupler connection, because there is a lot of permanent deformation, over the maximum anyway; it's 0.51. When you have a deformation like that in the concrete, it causes a lot of cracks inside the concrete, because concrete is very

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weak in tension. If you introduce any tensile strength in the concrete, you crack the concrete. And this is a durability problem. Cracking of concrete is a durability problem.
CHAIRMAN: Yes.
A. So, for me, if you -- the COI asked me to look at the safety and fit for purpose aspect. I have to include cracks in the concrete, deformation in the rebar. I have to include that.
But you only ask me to look at only safety.
CHAIRMAN: Yes.
A. It's a different matter.
CHAIRMAN: Thank you very much, Doctor.
A. Okay. Actually, at the moment, there are no tests at all to demonstrate that partially engaged couplers can meet the SLS checks, not at all, because BOSA doesn't bother to do any check like that because they don't want to sell partially engaged couplers, they want to sell fully engaged couplers, and they say they have no intention to do any tests based on partially engaged couplers.
CHAIRMAN: Again, you have lost me. I don't see how BOSA selling fully engaged couplers -- I think they are selling couplers and rebars which you then engage --
A. Okay, because there's a letter BD asked BOSA, "Can the

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partially engaged couplers meet the permanent elongation criteria?", and they said it would not and they have no intention of testing it.
COMMISSIONER HANSFORD: We've seen that letter, Dr Lau. That's a letter that came in, I think, from memory, about January of last year, but it was partway through this Inquiry.
MR BOULDING: January.
COMMISSIONER HANSFORD: Thank you. I thought it was January. Very good. We both have similar memories, Mr Boulding, or maybe you looked it up.
CHAIRMAN: That's related to the permanent elongation test.
A. Permanent elongation, yes. Because for me, as a contractor and designer in Hong Kong, I will not use this sort of coupler to be used on my side. If I don't know, of course, I wouldn't know; but if I know, I would not consider it to be used in my assessment at all. Of course, if I don't know, there's nothing I can do about that, but once I know I will not use it on my site, for structural assessment.
So actually --
CHAIRMAN: Sorry, again, are we saying that if they had done the proper checks, the BOSA coupler shouldn't have been allowed?
A. Can you repeat your question, sir?

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CHAIRMAN: Are you saying that BOSA couplers should not have been allowed?
A. No.
CHAIRMAN: I didn't think so.
A. Only fully engaged couplers should be allowed. That's what I mean.
CHAIRMAN: Okay. And you only fully engage couplers by doing physical activity on site. They don't come fully engaged.
A. Of course. I agree.
CHAIRMAN: So you may have the one already in and then you've got to fit the other one in?
A. Of course.
COMMISSIONER HANSFORD: You don't even have the one. It all comes in separate parts.
A. Yes.
CHAIRMAN: Yes, it all comes in separate parts. So what you are saying is there's nothing wrong with the BOSA couplers.
A. Nothing wrong, no.
CHAIRMAN: Fine, but you wouldn't accept --
A. The workmanship is only workmanship, nothing to do with the coupler.
CHAIRMAN: That's right. So you would require some clear work process in terms of which you could be 100 per cent

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sure that every insertion of a rebar is butt-to-butt?
A. Yes.
CHAIRMAN: Okay.
A. And that's --
CHAIRMAN: And you've done that yourself in the past?
A. I have to do it myself in the past. I have to instruct my foremen to do the same thing in the past. Because first of all you make sure that all the threaded bars are either -- 44 millimetres. The standard is 44 millimetres. But there may be tolerance of up to 48 millimetres. You need to check this. If it is 48 millimetres, then there will be two threads outside. This is the whole point of the checking by BOSA. In fact BOSA, I understand they always train the workers on site in the use of the coupler. They always train them.
CHAIRMAN: Okay. Again you are going to have to help me, and you were here this morning and listening to me. I've got a lot of workmen on site and I've got a lot of rebars coming in. Their threading is slightly different, 44 up to 48, that's the sort of tolerance level. I don't remember any evidence of, say, paint marks or something like that, you know, bright red paint mark means it's 48, bright green means it's 44. So you've got to work on the workmen understanding unmarked

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rebars are of a particular threading.
A. Actually, it's quite simple, because if you tighten -- because when the bars come to site, sometimes, you know, the BOSA people will thread -- will put the bar into one side of the coupler.
CHAIRMAN: Yes.
A. So that will be fully tightened. That part will be fully tightened.
CHAIRMAN: Yes.
A. Now, the next one is for somebody else to tighten the other side.
CHAIRMAN: Yes.
A. If there's two threads -- if you tighten it butt-to-butt, the maximum tolerance will only be two threads, maximum.
CHAIRMAN: Okay.
A. Now, if you tighten it up, there will be no problem, but if you don't tighten it up, there will be a problem.
CHAIRMAN: Okay. So again, as I understand it -- then I'll let you proceed, and please forgive me, and thank you for your assistance -- you are saying it's not merely a statistical matter, looking at butt-to-butt and whether you encounter it or not; it's an actual practical, matter-of-fact construction matter --
A. Yes.

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CHAIRMAN: -- that if it's not butt-to-butt, that thing is useless? It must be; it's the equivalent of not being there.
A. It should not be used. If you know about that, you should not use it in a structural assessment. You should not.
CHAIRMAN: But that's the point. Are we talking about a statistical matter here --
A. No.
CHAIRMAN: -- or are we saying, "That's not butt-to-butt, that is as good as worthless. It's no good, you might as well take the whole thing away because it is of no effect"?
A. For me, it's basically a substandard coupler. Not the material itself, I'm talking about the workmanship is substandard.
CHAIRMAN: I appreciate that but again we are avoiding each other.
A. Sure.
CHAIRMAN: I can say, "That's substandard", and somebody can say, "What do you mean, substandard?" And I can say, "It's only running at 80 per cent of what it should do", do you see what I mean, tuning an engine or something like that? But you're not saying that, you're saying that coupler is not butt-to-butt, it's not fully secure,

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it's therefore -- not just merely in statistical terms but in real, actual scientific, engineering terms -- worthless. It's doing nothing to ensure the integrity of the structure.
A. That's what I mean, yes.
CHAIRMAN: Okay.
A. Okay. Can I --
CHAIRMAN: Sorry. Thank you very much. Please proceed, yes. Thank you.
A. So that's why I said it is prudent to ignore the contribution of partially engaged couplers in the stage 3 structural assessment. This is what Atkins did.
COMMISSIONER HANSFORD: Sorry, I know we keep interrupting you and I do apologise. I don't think you are saying it's prudent to ignore. Aren't you saying it's essential to ignore?
A. Okay. You can say this.
COMMISSIONER HANSFORD: Well, are you?
A. Well, as a prudent engineer, I would ignore it. I'm a prudent engineer. When I have to assess the structure, any structural assessment, I will ignore it.
COMMISSIONER HANSFORD: Maybe I haven't quite got the definition of the word "prudent". I thought, from what you just told the chairman, where if it's partially engaged it cannot be considered at all, you are

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therefore telling us that it's essential to ignore it?
A. Essential to ignore it, yes.
COMMISSIONER HANSFORD: Is that what you are telling us?
A. Yes, I am telling the Commission that.
CHAIRMAN: Sorry, what then is the remedial work that will replace hundreds of metres of -- I'm laughing because it just seems so dramatic to me, and I'm not saying it's wrong, please don't -- I appreciate fully what you are saying and one has to be very careful here, but this is a little more confronting than perhaps what other people have said.
So what sort of remedial work would there be necessary to now ensure that -- what amounts to an entirely useless set of connections all the way along the slabs?
A. In this case, if there are -- what we did at this moment on the site is that we ignored the partially engaged couplers in the assessment; right? So if it is overstressed in terms of utility factor, we try to add something in, the suitable measures is to reduce the stress in the joint. You add something in to reduce the stress in the joint, to replace, you know, what we ignore.
CHAIRMAN: Okay. I see what you mean. Thank you very much.
A. This is what the suitable measures is being done on the

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site.
CHAIRMAN: Thank you.
A. Now, if we want to include the partially engaged couplers, in my view, we need robust research and development and quality assurance, quality control programme, to establish the structural performance of partially engaged couplers. If you want to use it in the future, we need to do a series of tests, not just the tests done by MTR or GCE at the moment. There should be an R&D programme for partially engaged couplers, in my view, so we are sure that we can use it in our structure. But there is no such thing at the moment. The only test we have done is done by MTRC and GCE, to tell me that they have certain strength. But this coupler does not meet my requirement for permanent elongation either. So they have failed to meet the so-called safety and fit for purpose requirements, for me.
Next one, please. In fact, this particular requirement for permanent elongation is not restricted to Hong Kong. In the UK we have the same thing, the CARES product assessment scheme, certificate of product assessment -- the next page, please -- they also have a similar requirement for permanent deformation less than 0.1 millimetres after loading to 0.65 fy. It's not

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just for Hong Kong, it's for other countries as well.
Next one, please.
CHAIRMAN: Sorry, again, just to try to remind myself -- Mr Khaw may be able to assist me otherwise -- these couplers, they were tested before they were delivered?
A. Of course they were tested. Yes, of course.
CHAIRMAN: That's right. And didn't they meet the standard testing requirements?
A. Yes, but we are not talking about the coupler itself. We are talking about workmanship.
CHAIRMAN: That's right. I appreciate that. I just wanted to make sure. But you are saying here:
"Where reinforcing bars are required to be coupled, the coupling system shall have a current ... certificate ..."
So I wanted to make sure --
A. Based on partially engaged arrangement. Now, if they want to -- at the moment, I think the other experts said we can use the partially engaged couplers, based on the number of tests done by MTRC and also by GCE. I said, "If you want to use partially engaged couplers this way, we need to have a full programme of testing on the partially engaged couplers, not just the 54 number of tests."
CHAIRMAN: All right. So, basically, what we are saying

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then is that the couplers that BOSA sold, they had passed all the necessary tests as couplers ready for sale?
A. Yes.
CHAIRMAN: Okay? And they came on. What you are saying is it's essentially a workmanship problem.
A. Yes.
CHAIRMAN: The workmanship problem, if there's not butt-to-butt connection, then brings into issue the elongation test?
A. Yes.
COMMISSIONER HANSFORD: They were tested as components.
CHAIRMAN: That's right.
COMMISSIONER HANSFORD: What we are now talking about is all the components being drawn together.
CHAIRMAN: Yes. That's it.
So, as the professor says, they were tested before sale --
A. Sure.
CHAIRMAN: -- as individual components?
A. Agree.
CHAIRMAN: And they would have attached the necessary elongation test as an individual component ready for sale?
A. And butt-to-butt in there.

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CHAIRMAN: Yes. But once you get it onto site, it then becomes a workmanship issue in joining everything together, and if it's not butt-to-butt then it won't pass the elongation test?
A. Yes. It's the workmanship problem.
CHAIRMAN: All right.
Then we've got other issues, of course, which go around: do we need to have an elongation test in these circumstances? But thank you. That helps me.
A. I agree.
So, in my view, the couplers must meet -- must satisfy with -- must comply with the technical recommendations of BOSA, and actually, in my view, there is no incompatibility between BOSA's inspection protocols and the requirement for butt-to-butt connection.
The next page. This is the BOSA thing. On the left, where there is no -- now, one end, for example the lower end, it's properly connected, the lower end. We are only talking about the upper end. If it is 44 millimetres, we should not see any threads on the top. Then you go up, 44 and maybe 45, 46 and then 48. At 48, there would be two threads coming out. All these are still fully tightened butt-to-butt.
So, in my view, there is no incompatibility

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between --
CHAIRMAN: Sorry, but what we are talking about now is -- this here -- that's produced by BOSA?
A. BOSA, yes.
CHAIRMAN: I don't see any measurements on it.
A. But the measurement can be seen from the exposed threads at the top. I don't understand what you mean.
CHAIRMAN: You know, with respect, Doctor, you are a very eminent engineer and you will understand that, but again I'm going back to some empathy here. I'm talking about a not highly indicated although decent man, working on site, and perhaps doesn't understand the language very well. What I'm trying to find, other than hidden in footnotes like a sniper, is something clean and obvious which says, "Getting this butt-to-butt, lads, is really important, and if you don't get it butt-to-butt, it's as good as not having done it in the first place", and I haven't found anything like that, certainly not in the original evidence from BOSA as to what their lectures were about. And I don't see anything here, with the greatest of respect.
I understand from yourself, Doctor, but that's your education, it's your sophistication and it's your eminence in this field, and we obviously all bow to that, but I don't see it for the average working guy.

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A. Actually, I'm not site; I don't know what happened on this --
CHAIRMAN: No, no, I'm just talking about this document in front of me.
A. But normally, for my other sites, we have training course by the coupler manufacturer on site, to teach my workers how to do it. I don't know what happened on this site so I'm not going to comment on this.
CHAIRMAN: That's fine. That's very understandable. Thank you. Yes.
A. I can only comment on my sites.
The next one. This is how I understand; you know I make a drawing. If it is 48 -- if it is 44 both sides, there would be no threads exposed, zero. But if it's 44 on one side and 48 on the other side, there will be one thread exposed, 4 millimetres. If there are 48 on both sides, there will be two threads exposed on the right-hand side.
So for me, this is the way to ensure that it is butt-to-butt, for me. As you said, I don't know what happened on this site. I don't know. But for me, this is how I look at it.
Next one, please. Anyway, because of the defective rate, Atkins -- and it is confirmed by Prof Yin's statistical analysis that the defective rate for EWL

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slab should be 36.6 per cent; for NSL, it should be 33.2; and the EWL slab in area A, should be 68 per cent. Now, because of this reduction factor, we put it onto the utilisation factor to identify what panel or what joint is overstressed. This is the way Atkins are doing; right?

And also, don't forget that apart from partially engaged couplers, there are also couplers there's no connection at all. We call it zero engagement, according to the inspection report, and Prof Yin actually worked it out to be 15.5 per cent. So forget about partial couplers; some couplers actually have no engagement. That goes up to 15.5.

So we cannot have any reduction factor lower than 15.5 per cent; right?

CHAIRMAN: Again -- sorry -- so what we are talking about, in the building industry in Hong Kong -- just so that I understand this from your evidence -- which in the past has stood shoulder to shoulder with building industries anywhere else in the world as far as tunnelling is concerned --

A. Sure.

CHAIRMAN: -- where installation of couplers is invariably butt-to-butt, in this particular instance we've got rates on one of 36.6 per cent failure.

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A. Yes.

CHAIRMAN: On another one, 33.2 per cent failure, and another one, a 68 per cent failure rate.

A. Yes. This is based on statistical analysis.

CHAIRMAN: On your evidence, and that's not merely less than proper. That's almost sabotage.

A. This is based on the number of defects found and then using statistical analysis. I'm not an expert in statistics.

CHAIRMAN: No, but what I'm saying is your evidence so far has been you should expect 100 per cent butt-to-butt; okay?

A. Yes.

CHAIRMAN: But in this instance, the studies have shown 36.6 per cent failure rate, 33.2 per cent failure rate, and with the EWL slab in area A, leaving aside other stresses and things which may mitigate the issue, a 68 per cent failure rate.

A. This is the data in the holistic report. I accept it because it's based on the number of defects found, and then the expert in statistics worked out this defective rate. But I'm not an expert in statistics, but anyway the number of defects found are validated. Everybody agreed that these are the number of defects found on site.

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Then based on those defects, they found it to be 36.6, and so on.

CHAIRMAN: Sorry, are these figures -- I don't wish it to be misunderstood -- like the EWL 36.6, these are an estimate of a failure to be butt-to-butt?

A. Yes.

CHAIRMAN: 36.6 per cent of the couplers were not butt-to-butt?

A. Yes.

CHAIRMAN: Thank you.

A. On this basis --

CHAIRMAN: And this is with inspection teams from Leighton and from MTR being present?

A. Yes. Well, evidence I'm not --

CHAIRMAN: I have to say it's a very shocking revelation.

COMMISSIONER HANSFORD: It's shocking, but I think we need to be cautious, because I'm not sure this is saying it's 36.6 per cent that were not butt-to-butt. It's saying it's 36.6 per cent that were defective --

A. Defective, yes.

COMMISSIONER HANSFORD: -- and may have not been butt-to-butt.

A. Okay. You can say that, yes.

COMMISSIONER HANSFORD: Well, I don't know. Is that what --

MR PENNICOTT: Or could not have been butt-to-butt.

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COMMISSIONER HANSFORD: Or could not have been butt-to-butt.

A. Actually, all these so-called defects were found by either zero engagement in the report or using the PAUT test to find the so-called defective coupler or when they look at the exposed threads, more than two, either one of these, and they come to this sort of number of defects, and based on the number of defects, the expert extrapolates to the statistical ratio, based on this.

CHAIRMAN: Okay.

A. I don't think anybody questions the number of defects in terms of zero engagement or the number of threads or PAUT test. I don't think we argue about that. What we argue about is that whether the six-thread coupler or seven-thread coupler can be used. I think that's the only difference.

CHAIRMAN: That's right, yes. But if on the basis that it has to be butt-to-butt, otherwise it's of no value, it has no structural integrity, and if on the basis that historically, in Hong Kong's building industry, invariably it always has been 100 per cent butt-to-butt, in this instance there's been a great fall from grace. There had been quite an alarming failure to ensure proper installation of the coupler with the rebar, and that must mean a failure to make it butt-to-butt because unless it's butt-to-butt, it's worthless.

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COMMISSIONER HANSFORD: With respect, there's a great assumption there that all the other projects have been butt-to-butt.
CHAIRMAN: No, but what I'm doing at the moment is I'm discussing matters with Dr Lau on the basis of his long experience, when he says that his background is 100 per cent butt-to-butt you should expect and you should work for and there's no reason to think that there wouldn't be, except for the occasional mishap, and that in integrity terms, if it isn't butt-to-butt, it's not worth being there.
COMMISSIONER HANSFORD: I think I would just make an observation that on this particular structure, we've had a lot of examination and have been able to identify what's actually been constructed. On most of the other structures in Hong Kong and probably elsewhere in the world, such examination has not taken place so we don't actually know.
CHAIRMAN: Absolutely. That's right.
COMMISSIONER HANSFORD: That's an observation that I'd like to record in the transcript.
CHAIRMAN: Exactly.
A. In fact, I agree with you, sir, because on my sites, if my foreman inspects the reinforcement properly, I assume it is butt-to-butt too.

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COMMISSIONER HANSFORD: You assume?
A. Yes, because they follow certain procedures, just like we have this picture, they follow -- they tighten it up until it locks and then they inspect the number of threads outside and they assume that it's okay.
CHAIRMAN: Doctor, forgive me if I'm being a bit combative. It's purely and simply this, that having no engineering background whatsoever, and in my ignorance I have an instinctive difficulty in thinking that a failure to make it butt-to-butt must reduce to nothing the value of that particular piece of construction. That's the first thing.
The second thing is against what we've heard already, my understanding is that it doesn't necessarily have to be butt-to-butt but it has to be within certain parameters; there are certain tolerances which can be allowed.
A. On this coupler, I think there's a big problem, I tell you. If you don't lock it properly, there's a lack of fit movement always, so it's very important for it to be locked, for this coupler in particular. In fact for most couplers it's like that. You have to lock it is to stop any movement, lack of fit movement. It can easily be demonstrated.
So this sort of movement will cause problems, will cause cracks in the concrete.

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CHAIRMAN: Yes, I can see that. Thank you very much.
A. The reason why we have the 68 per cent for the EWL slab in area A is that because there were only a few number of tests on these couplers. On one side, we have two failures of seven, on the other side we have two failures out of 11, and based on this probability, Prof Yin worked it out to be 68 per cent. And we don't combine it with the other coupler mainly because the method of construction is different, because if you are talking about difficulty of screwing of the coupler, because on the capping beam, it's very easy for you to screw it on, at least for one side. It may be more difficult to screw it on the next one. But even on that basis, there are two failures out of seven, even on that EIC working condition, there were two failures out of seven, and this is one of the reasons for the EWL slab in area A to be 68 per cent.
Next one, please. As I said before, most of the other couplers -- there's no problem with the couplers inside the diaphragm wall. The problem is only on the other side, when you try to screw the threaded bar into the coupler. But for the 68 per cent in the area A EWL slab for the capping beam, the working methods, the working conditions, as well as the levels of difficulty

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involved in respect of the installation were different from the rest of the coupler connections between the platform slabs and the diaphragm wall, and this is the reason why the defective rate at this area is 68 per cent.
Next one, please. Because of that, because of the high, 68 per cent defective rate, a number of locations at the EWL slab in area A near the capping beam were overstressed, meaning with strength utilisation ratio factor greater than utility. Therefore, suitable measures were required. Basically, the suitable measures involved the use of drilled-in dowel bars, local thickening of the slab. This is to reduce the stress to cater for the defective rate. This is the suitable measures. But only in area A. There were no such problems in other areas.
COMMISSIONER HANSFORD: Sorry, are you sure that's correct, Dr Lau, the use of the drilled-in dowel bars is related to the coupler problem in area A, not the construction joint issue?
A. The construction joints also have another issue, but this is only for the area A coupler issue. This is the suitable measures recommended by Atkins.
COMMISSIONER HANSFORD: Right.
A. I think it's still being carried out on site.

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COMMISSIONER HANSFORD: Thank you very much.
A. It's being carried out there.
Next one, please. The next one of course is the shear link. Defects were found in a number of areas, four special issues. The first one is complete absence of shear links. The second one was shear links of inadequate anchorage length. Number 3 is undersized link diameter. Number 4 is over-spacing of shear links.
So in Atkins' design or the updated design, they adopt the assumption of no shear links in the updated design, and in fact this is a disagreement between me and the other experts.
Next one, please.
CHAIRMAN: In other words, so we proceed on the basis that there were no shear links at all?
A. Yes, that's right. I show this particular plan mainly to show to the Commission that in fact there are a lot of openings in the slab. This is for areas B and C1.
Next one, please. On the section, you see all the openings in the slab.
Next one, please. These are again the openings in the slab, please.
Next one, please. This is some argument between Mr Southward and me. This is the method statement basically from MTR, to identify the missing shear links

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on the soffit, on the underside of the EWL slab. Initially, they have used a cover meter to identify the location of the main steel bar, and then from that particular -- from the result of the cover meter, they opened up an opening, 300 millimetres by 300 millimetres, to locate the two main bars which are 300 millimetres -- which are 150 millimetres apart. Then, after locating the two main bars, they opened up 600 millimetres on one side -- on both sides, about 200 millimetres wide, in order to locate the shear link. This is the method statement of MTRC.
Next one, please. Now, the red one, I tried to reproduce what Mr Southward did in his report. He said he could not identify any shear link, but I also superimposed the MTR investigation, you see the red lines. In my opinion, this particular investigation by MTRC I think is sufficient to identify any missing shear link, because if the shear link is only -- the spacing is about three types, 75 millimetres, 150 millimetres and 300 millimetres. If we adopt this sort of investigation by MTRC, in my opinion, it is sufficient to identify all the shear links.
The shear links are all identified by dotted green surrounding the shear links.
COMMISSIONER HANSFORD: Sorry, so this is identifying that

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shear links were actually present?
A. Yes. Actually, not all investigation showed no shear links. In this particular case, it shows shear links there, but it's only other defects, for example the anchorage is not long enough or the spacing not correct, that's all.
The next one, please. We try to -- in this case, we try to push the yellow line to another side. We can still identify the location of the shear links. So in order to demonstrate that the MTRC method is not -- even though it's L-shaped, you can still use it to identify all the -- if there are shear links, we can identify the shear links.
Next one, please. Another way to do the same thing. We can always identify the shear links inside the L-shaped opening.
Next one. Now, this is -- you can see the blue one, the DS26, it's an investigation opening in area A, and to the left is the position where suitable measures is required. Over there, we assume there is no shear link.
Let us go to the next page. This is the description of that opening. You can see that I put the dotted line there. In that particular opening, it says shear links were not found in the investigation.
Next one, please. Another indication of no shear

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link is because of the honeycombing investigation, of the EWL slab soffit. This is a plan showing all the honeycomb area on the underside of the soffit, on the soffit of the EWL slab, in different areas. In fact, there were very extensive honeycomb defects.
Next one, please. These are the close-up pictures, photos, of the honeycomb area. In fact, we should find shear links in this but there were no shear links.
Next one. Another picture. In fact, MTRC have a full report on this.
Next one.
Next one. In fact, MTRC have a full report, it's in my expert report, they identified about over 40, including the opening investigation and the honeycomb investigation, there were 40 of them, and 16 of the investigations showed no shear links at all.
We come to the third problem. It's the construction joint. Initially, we were concerned about the joint being overstressed.
Next one, please. Later on, now, at the moment, we come to the next issue, about the workmanship of the CJ. In my opinion, this particular joint, the CJ, is a very important joint, because it's a fixed moment joint. This fixed moment joint or fixed-end joint is important, because when they design the diaphragm wall as well as

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when they do the redistribution of the moment to the centre, there are a lot of fixed-end moment in the two joints, two ends, two joints.

We cannot allow the joint to be defective. We cannot allow the joint to be defective because it will affect the final fixed-end moment. If the final fixed-end moment is reduced because of failure reason, for example corrosion of reinforcement, et cetera, it will cause overstressing of the reinforcing bar, of the diaphragm wall itself.

Later on, I will show you some problems with the diaphragm wall later on, because the problem on this site is not the slab. The slab is very rigid. But the diaphragm wall, which is rather thin compared with the slab, it's 1.2 metres diaphragm wall connected to 3 metre thick slab. The problem is in the diaphragm wall, not on the slab itself. All the problem is in the diaphragm wall, because of the inherent weakness of this particular design. The thin diaphragm wall will be subject to a lot of stresses, not the fixed slab.

CHAIRMAN: Sorry, that problem lies in the original design?

A. Yes.

CHAIRMAN: Okay. Not in the building of the diaphragm wall?

A. No, no, no. The diaphragm wall is okay. No problem with the diaphragm wall. The design itself ensures that

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the weak point is in the diaphragm wall. We have a very rigid slab but a rather flexible diaphragm wall. I will show you later on, on one of the finite element analysis by Atkins and also OAP, in a minute.

Nowadays -- actually --

MR KHAW: Mr Chairman, I hate to interrupt Dr Lau, it's just that I note the time. I realise it's only the third day of the new year and everyone is still very energetic but I can see there are still about 40 slides so I'm not sure whether we should let Dr Lau continue with the remaining 40 slides or ask him to --

CHAIRMAN: I think maybe we might find an opportune stopping point. I notice that we move on shortly to Mr Southward's report and comments in that regard.

COMMISSIONER HANSFORD: I think that's right. I think probably the end of slide 47 might be a natural break point.

MR KHAW: Yes, before he comments on Mr Southward's report.

COMMISSIONER HANSFORD: Sorry, perhaps I should rephrase that. It's not a break point. A point for us to pause, if you know what I mean.

A. Okay. Now the construction joint becomes one of workmanship problem, because when they drill four holes into the joint, they discovered, of the two holes, they found two defects, so it's about 50 per cent defects in

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the investigation.

So my concern later on -- my concern actually is I'm worried about cracks and seepage at the joint, because if there's seepage into the joint, it will cause corrosion of the reinforcement. This is a durability problem again. And the suitable measures now is the dowel bar and the grouting. We talked about that on the first day of this Commission.

Next one. Now, on the left-hand side, it is a finite element analysis by Atkins. All these red lines are actually the cracks. You can easily imagine -- this is a joint like that, and there's a bending moment going this way and there's another bending moment going this way (demonstrating), so all the cracks will be on the outside, and the cracks in the diaphragm wall will be on the soil side, and the cracks on the top of the diaphragm wall will be underneath the track concrete.

The same appearance appeared in Mr Southward's analysis. I point it out in my report. The same problem appeared in OAP's analysis. As I said, the weak point is in the diaphragm wall. And don't forget that this particular joint is submerged in seawater. It is submerged in seawater. The level of the EWL slab is about plus 2. The water level outside is plus 1.

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COMMISSIONER HANSFORD: Sorry, did you just tell us it was immersed in seawater?

A. Because what happened was, this is tidal influence. I think this morning even Mr Southward agreed that it is -- seawater in the sense that the water has salt content.

COMMISSIONER HANSFORD: In the groundwater, you mean?

A. In the groundwater, because it's close to the sea. I'm not saying it's seawater but anyway.

CHAIRMAN: So its groundwater, proximity to ocean, will ingest a certain amount -- the ground will ingest a certain amount of extra salt and acids, and then that will go into the water?

A. Because I understand there is tidal influence. That means, when the tide goes up, the groundwater table rises up, and when the tide goes down, it also goes down. So, in that sense, I think the seawater has some influence on the groundwater table here, and this is the sort of durability problem I'm concerned about. This is not -- even though inside the building it is air-conditioned, but on the outer side, on the weak structure which is the diaphragm wall, it may have other problems.

COMMISSIONER HANSFORD: But nevertheless you are telling us, in your view, Dr Lau, that the application of the

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suitable measures removes this problem?
A. Important, to reduce the stress, because this is at the ultimate load. The crack appears. So very important to reduce the stress.
So, in my view, suitable measures is very important.
CHAIRMAN: And if that's done, that will make it fit for purpose over its intended lifespan?
A. Yes.
CHAIRMAN: Okay. Thank you.
A. Next one, please. As I said, the cracks at the top and also soil side of the D-wall, it is submerged in groundwater, the table is plus 1mPD, it is tidal, so I said "possibly seawater".
CHAIRMAN: Sorry, could you assist me again, 1mPD, what does that mean?
A. That means it's only 1 metre above the sea level.
CHAIRMAN: I've got it. Yes, thank you. We had that right at beginning. Yes, I remember that.
A. This picture, this drawing, is the plan of suitable measures of CJ in areas B and C. Actually, in the suitable measures required, it's about 60 metres near the joint, and Atkins selected the panels with the highest stress, with the high stress. So I think it's a good thing because we try to reduce the stress. We try to reduce the stress to make the joint intact.

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I think this is very important. We want to make sure the joint is intact.
COMMISSIONER HANSFORD: This is the plan we saw with Mr Chow yesterday. Thank you.
A. Next one. This is the method statement. I tell you, I don't think the drilling of the hole, you damage the rebar; definitely not. I tell you, it's impossible, because as you touch the rebar, you know it, because of the loud metallic sound, the whole area will realise it. I am a drilling contractor. If I drill a hidden concrete underground with a rebar, I know right away, and no driller will allow the drilling bit to touch the rebar because it's going to damage his drilling bit which is expensive. Nobody will do that.
CHAIRMAN: Okay.
A. Next one.
Okay. It's time for me to stop here.
CHAIRMAN: Yes, Doctor. Thank you very much. I'm the one who should apologise for delaying you in your presentation, but it was in some respects a presentation that required me to sort of reassess certain matters which I had perhaps provisionally taken on board so I could give your presentation a full understanding within what I believe to be the correct context, and I know that over the next couple of days I'll be

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assisted by counsel's questions.
But thank you very much indeed.
A. I'm quite happy to assist the Commission, very happy.
CHAIRMAN: Good. Thank you very much. So what we will do is we will adjourn then until Monday morning at 10 am. All right? You are aware, obviously, Doctor, that as an expert witness you can't discuss your evidence.
MR PENNICOTT: Sir, that's not the appropriate -- on this particular occasion, it's the opposite.
CHAIRMAN: Ah. You're right. He hasn't yet finished.
MR PENNICOTT: And I have given an express undertaking to Mr Khaw that he can speak to Dr Lau.
CHAIRMAN: And that's the very reason, and I appreciate that, Mr Khaw. Thank you. My apologies.
Good. So we start at 10 am on Monday morning. Thank you.
Can I just see the legal team just for a second? There's just one issue of administration I just need to be able to discuss with them, very briefly.
MR PENNICOTT: Of course, sir.
CHAIRMAN: Thank you.
(5.19 pm)
(The hearing adjourned until 10.00 am on Monday, 6 January 2020)

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