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<p>1 Tuesday, 15 January 2019 2 (10.04 am) 3 PROF AU TAT KWONG, FRANCIS (on former oath) 4 Cross-examination by MR BOULDING 5 MR BOULDING: Good morning, sir. Good morning, Professor 6 Good morning, Prof Au. 7 A. Good morning. 8 Q. I'm acting for MTR and notwithstanding the fact that 9 many of the matters I wanted to discuss with you have 10 been covered by my learned friends already, there are 11 one or two remains matters that I'd like to have 12 a little discussion with you about. 13 A. Right. 14 Q. First of all, I'd like to look at your report, please, 15 and if you would be kind enough to go to ER1, tab 7, at 16 page 3, we see there, do we not, the first page of your 17 opinion? 18 A. Yes. 19 Q. And in 1.2, you are dealing with a topic of "Sampling 20 method as stated in holistic proposal"; correct? 21 A. Yes. 22 Q. Then you say in 1.2.3: 23 "When non-compliant cases are discovered during the 24 investigation, it is necessary to further assess the 25 effects on the strength and other properties ..."</p>	<p>1 standard that the sampling has been carried out so far. 2 Q. Exactly. But what I'm suggesting to you is that that 3 quality standard is not, is it, a recognised measure of 4 what the strength or the structural integrity of the 5 coupler connection is; that's right, isn't it? 6 A. Well, actually the requirement sort of implied by the 7 BOSA specification is even more than that; okay? 8 I think 40 millimetres engagement. 9 Q. We're talking about 37 millimetres, aren't we? That's 10 what government has imposed upon -- 11 A. Yes. So that is used in the sampling approach. But if 12 you refer to the BOSA requirement, they have been 13 talking about 40, ten threads. 14 Q. But as you say in your paragraph 1.2.3, when you've got 15 a non-compliant case, it's necessary to further assess 16 the effects on strength; correct? 17 A. Correct, and other things as well. 18 Q. Right. Staying with strength, we will see, will we not, 19 that even at 60 per cent engagement of the rebar into 20 the coupler, the full strength of the rebar is 21 established; that's correct, isn't it? 22 A. Just in respect of strength. 23 Q. And that means, I suggest, that when that strength is 24 achieved, that means that the assembly, the coupler 25 assembly, is safe; that's correct, isn't it?</p>
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<p>1 And so on, and so forth. 2 A. Yes. 3 Q. When you are referring to non-compliant cases, I take it 4 that you are referring to the extent of the rebar 5 engagement into the couplers? 6 A. Correct. 7 Q. That's on the basis of the government's pass of 8 37 millimetres or more; correct? 9 A. Correct. 10 Q. That has been referred to me as being a quality 11 requirement or a quality standard. You would go along 12 with that description, would you? 13 A. I believe so. 14 Q. And this quality requirement or quality standard is not, 15 is it, a recognised measure of what the strength of the 16 rebar-coupler connection is; that's correct, isn't it? 17 A. Well, I think when we are talking about the acceptance 18 of the coupler, we should -- well, we should require the 19 coupler assembly to satisfy the requirement prescribed 20 by BOSA, the manufacturer of the coupler. 21 Q. Yes, and that's what we have been talking about which is 22 the quality, the quality requirement, or the quality 23 standard, the 37 millimetres; correct? 24 A. Well, the 37 millimetres has taken into account certain 25 tolerance of the test. Yes, I think that has been the</p>	<p>1 A. I think we have to be careful on this point, because so 2 far the test results of the partially engaged couplers 3 is not sufficient, just based on one sample. Then 4 apparently the strength of the reinforcing bars used is 5 a bit unsure, because -- well, I just came to know of 6 that yesterday, that on the test report 460 megapascals 7 hasn't been stated, if I'm correct. 8 Q. No, but they used 500 megapascals. 9 A. I'm not sure, but even 500 hasn't been stated over 10 there. 11 Q. Let me put this to you: if they used 500 megapascals 12 instead of 460, you would get an even better result in 13 terms of strength by using the 460 megapascals, wouldn't 14 you? 15 A. Yes. 16 Q. Thank you. Now, let's have a look at the BOSA 17 documentation. I wonder if you could go to H44527.1. 18 I trust that you've seen this table before, Prof Au? 19 A. Yes, yes. 20 Q. We can see that it's produced by BOSA, the manufacturer 21 of the coupler; that's correct, isn't it? 22 A. Yes, correct. 23 Q. And headed, "Thread strength calculation table"; do you 24 see that? 25 A. Sorry?</p>

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<p>1 Q. And if we just look at the "Remarks" first --</p> <p>2 A. Yes.</p> <p>3 Q. -- "1. The above calculation is based on the assumption</p> <p>4 that the threads are complete with full integrity.</p> <p>5 There will be deviation in the calculated number of</p> <p>6 threads if the actual threads are not complete with full</p> <p>7 integrity due to the quality of the steel bar quality at</p> <p>8 the threaded ends.</p> <p>9 2. The above design data is based on specified</p> <p>10 strength of material used.</p> <p>11 3. Factor of safety calculated above is based on</p> <p>12 specified tensile strength and not yield strength of</p> <p>13 material used.</p> <p>14 4. Conclusion: For complete threads with full</p> <p>15 integrity, the number of threads that is required to</p> <p>16 achieve the specified tensile strength is six."</p> <p>17 Do you see that?</p> <p>18 A. I can see that.</p> <p>19 Q. That is clear, is it not, BOSA's conclusion, the</p> <p>20 manufacturer of the coupler, BOSA's conclusion, based</p> <p>21 upon this table: six threads gives the specified tensile</p> <p>22 strength; correct?</p> <p>23 A. Now, the --</p> <p>24 Q. Well, is that correct? Please answer my question before</p> <p>25 you go off on a frolic of your own.</p>	<p>1 A. Now, that column is based on calculation. That is not</p> <p>2 based on test.</p> <p>3 Q. Well, it's based on calculation by the manufacturer.</p> <p>4 A. It's based on calculation.</p> <p>5 Q. With that figure of 755.87 kilonewtons --</p> <p>6 A. Yes.</p> <p>7 Q. -- you then divide that, do you not, by the area of the</p> <p>8 rebar to get the stress; correct?</p> <p>9 A. Yes.</p> <p>10 Q. And we can see that based on the manufacturer's</p> <p>11 calculation, that is 601.5 megapascals?</p> <p>12 A. Yes.</p> <p>13 Q. Giving a factor of safety of 1.14?</p> <p>14 A. Yes.</p> <p>15 Q. Then we can see what their conclusion is?</p> <p>16 A. Now, that is also based on calculation.</p> <p>17 Q. Okay. Calculations by the manufacturer?</p> <p>18 A. Yes, calculation by the manufacturer, yet to be</p> <p>19 substantiated by testing.</p> <p>20 Q. But at the moment you are not in a position to tell the</p> <p>21 Commissioners that there's any doubt about these</p> <p>22 calculations, ie they're wrong or they're misconceived,</p> <p>23 anything like that, are you?</p> <p>24 A. Now, actually it is more complicated than that. As far</p> <p>25 as I can remember, the column showing the threaded</p>
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<p>1 A. It's too fast to jump to a conclusion. Actually, you</p> <p>2 can look at -- right, the second-last column, that shows</p> <p>3 the steel bar specified tensile strength.</p> <p>4 Q. You're talking about -- that's the stress, that's the</p> <p>5 column --</p> <p>6 A. That's the stress.</p> <p>7 Q. That's the stress?</p> <p>8 A. That's the stress. Well, which column are you talking</p> <p>9 about, please?</p> <p>10 Q. I thought that was the column you were talking about.</p> <p>11 A. Yes.</p> <p>12 Q. But I would like you to look down the number of threads,</p> <p>13 and if you look down the number of threads, you get six;</p> <p>14 do you see that?</p> <p>15 A. Yes.</p> <p>16 Q. Then you've got the pitch 4 millimetres below thread?</p> <p>17 A. Yes.</p> <p>18 Q. Then we look across and then there's the thread</p> <p>19 effective diameter, the shear strength, and then you've</p> <p>20 got the thread strength?</p> <p>21 A. Yes.</p> <p>22 Q. So at six threads, it's right, is it not, that you get</p> <p>23 a load of 755.87 kilonewtons?</p> <p>24 A. Now, I believe --</p> <p>25 Q. Is that right?</p>	<p>1 strength is based on proportion, just multiplying, let's</p> <p>2 say, the number for one thread by the number of threads.</p> <p>3 Let's say the first one is 125.98 kilonewtons. The</p> <p>4 second one is 251.96. Just multiplying the first one by</p> <p>5 2, and so on. But the actual behaviour of a threaded</p> <p>6 bar inside coupler is more complicated than that,</p> <p>7 because when the bar is loaded, not all of the threads</p> <p>8 are equally stressed. The threads closer to the outside</p> <p>9 would be more highly stressed. So this is just based on</p> <p>10 simplified assumption.</p> <p>11 Now, if we do test to verify, I'm sure that there</p> <p>12 would be a bit deviation, and -- now, just imagine, if</p> <p>13 you have a very, very long coupler, okay, and your</p> <p>14 engaged length increases from zero to 100 to let's say</p> <p>15 10 metres or whatever, then -- now, I don't think it is</p> <p>16 correct to assume that the strength provided by the</p> <p>17 threads of the coupler is proportional to the</p> <p>18 engagement, because the load carried by the threads is</p> <p>19 not uniform.</p> <p>20 Q. Prof Au, let me ask you this: you haven't done any</p> <p>21 calculations yourself at the moment, have you, to show</p> <p>22 that what BOSA are calculating here is incorrect; that's</p> <p>23 right, isn't it?</p> <p>24 A. Now, for this --</p> <p>25 Q. You haven't done any calculations yourself to show that</p>

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1 what BOSA have done here is incorrect?
 2 A. I have read a paper recently on the distribution of
 3 stress of threaded rods inside a coupler or something
 4 like that. I mentioned that yesterday. Then somehow
 5 the results, based on a finite element software called
 6 Abaqus has shown that actually the distribution of
 7 stresses in a threaded rod inside a coupler or a nut is
 8 not uniformly distributed. So that should apply to this
 9 case.
 10 CHAIRMAN: Sorry, Professor, just so I can understand --
 11 putting it bluntly then, if I'm an ordinary contractor
 12 and I accept what's here from the manufacturer at face
 13 value, what is there may potentially be misleading?
 14 A. Yes.
 15 CHAIRMAN: So BOSA's own documentation may be potentially
 16 misleading and affect safety issues?
 17 A. Yes.
 18 CHAIRMAN: All right.
 19 MR BOULDING: But anyway, you've read a paper --
 20 A. Yes.
 21 Q. -- but you've not carried out any calculations of your
 22 own?
 23 A. No.
 24 Q. Thank you. If we look at Dr Glover's report, please,
 25 ER1, tab 6, page 7, and if you could go to

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1 paragraph 6 -- and here we're talking about percentage
 2 strength utilisation -- and you can see that Dr Glover
 3 says:
 4 "Figure 1 describes a typical stress-strain
 5 relationship for the rebar used on this project, and is
 6 annotated to illustrate the relationship of certain
 7 terms used in the design process, as explained below."
 8 A. Yes.
 9 Q. Then across the top, the horizontal axis, it's right, is
 10 it not, that we have the plastic range of the steel?
 11 A. Yes.
 12 Q. And that -- ie the ductility?
 13 A. Yes.
 14 Q. And then on the vertical axis we have the elastic range
 15 of the steel; correct?
 16 A. Yes.
 17 Q. And what this shows, does it not, is that the bar-breaks
 18 at 650MPa when you've got six threads engaged; correct?
 19 A. Sorry, are you referring to the ultimate tensile
 20 strength of 650 megapascals?
 21 Q. Yes.
 22 A. So I think that refers to the rebar.
 23 Q. Yes, that's correct, the rebar.
 24 A. Yes.
 25 Q. So you're agreeing with me?

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1 A. Yes.
 2 Q. And if we look at the slight blip in the yellow line
 3 just below the 560, that shows, does it not, that the
 4 rebar has a yield stress --
 5 A. Yes.
 6 Q. -- of about 500MPa?
 7 A. Yes.
 8 Q. So you're still with me?
 9 A. Oh, yes.
 10 Q. Good. Then if we look on at what Dr Glover says, if you
 11 could go to paragraph 6.4, he says:
 12 "It will be noted from figure 1 that the design
 13 ultimate strength is substantially less than the 650MPa
 14 ultimate tensile strength, the maximum tensile stress
 15 that a material can withstand before breaking. The
 16 difference between the UTS and the design ultimate
 17 strength represents a large margin of reserve strength
 18 and robustness."
 19 And as an engineering statement that is correct, is
 20 it not?
 21 A. Now, we have to be careful with this. There is
 22 a certain margin of safety which is expected. This is
 23 required by the code. And on the term "robustness" I do
 24 have some comment. You may refer to my report.
 25 I have made the comment based on the meaning of

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1 robustness used in the design code rather than used in
 2 common language. Well, we have to be very careful with
 3 this statement.
 4 Q. We seem to have to be careful with everything, Prof Au.
 5 A. Yes.
 6 Q. But so far as that last sentence is concerned, what
 7 I suggest to you -- and Dr Glover is coming along to
 8 give evidence in a day or so -- is that he's absolutely
 9 right, "The difference between the UTS and the design
 10 ultimate strength represents a large margin of reserve
 11 strength and robustness" -- that's right as a statement?
 12 A. No. Strength there is a reserve. Robustness is
 13 a different issue.
 14 Q. So reserve of strength but you say robustness has to be
 15 considered in a different way?
 16 A. Oh, yes. Refer to the design code.
 17 Q. Let's have a look at 6.6:
 18 "Most elements in a structure are not operating at
 19 100 per cent of their capacity under their full
 20 operational loadings."
 21 Again, as an engineering statement, I suggest to you
 22 that that's correct, is it not?
 23 A. Yes, correct. That is expected, yes.
 24 Q. Thank you. And:
 25 "This can be a result of prudent design,

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1 standardisation or the fact that the critical loading
 2 conditions had now passed, for example because they
 3 occurred during construction and were not to be realised
 4 in the future."
 5 A. Yes.
 6 Q. Agreed? Thank you. And:
 7 "The measure of this over-provision is commonly
 8 referred to as the percentage strength utilisation of
 9 an element; the SLS stress will be proportionately
 10 lower."
 11 A. Yes.
 12 Q. Thank you. Then we see what the percentage strength
 13 utilisation equation is in 6.7; presumably that's
 14 something you'd go along with?
 15 A. Yes.
 16 Q. Thank you very much.
 17 6.10:
 18 "For this structure, these low levels of utilisation
 19 arise in great part from the phased nature of the
 20 construction. During construction, the EWL slab was
 21 free spanning between the diaphragm walls and subjected
 22 to severe construction loads; the slab was designed for
 23 these extreme conditions."
 24 And again presumably you would agree with what
 25 Dr Glover says there?

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1 A. Now, yes, of course --
 2 Q. Thank you.
 3 A. -- the construction loads must be taken into account,
 4 but whether these are the extreme conditions, I'm not
 5 sure. There may be other extreme conditions.
 6 Q. Okay. So subject to that perhaps reservation you agree
 7 with what Dr Glover says?
 8 A. Yes.
 9 Q. Thank you very much.
 10 Then going on to 6.13, he says, his opinion is:
 11 "These levels of utilisation confirm the structure
 12 has a comfortable level of robustness and redundancy."
 13 Again I suggest to you that that is the proper
 14 conclusion to draw, Professor.
 15 A. I don't agree. I don't agree.
 16 Now, there are two terms here. Robustness, as
 17 I have pointed out earlier, has another meaning; okay?
 18 Strictly speaking -- actually, you can refer to the
 19 Concrete Code, and if you refer to British Standard or
 20 whatever, there is certain explanation for robustness,
 21 and I think in my report I have referred to the case of
 22 the Ronan Point incident and that was the beginning of
 23 the design for robustness. So that is for robustness,
 24 as used in structural engineering.
 25 The other term, "redundancy", of course the

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1 technical meaning of that in structural engineering may
 2 be different from common usage. So the redundancy of
 3 a structure actually is something which is quite basic.
 4 So the course that I'm going to lecture in the afternoon
 5 actually covers that, so it can be covered in very
 6 elementary structural engineering books, textbooks.
 7 Q. It sounds as though Dr Glover ought to go to the lecture
 8 to be properly tutored.
 9 A. I would welcome, yes.
 10 Q. There we are. That's the difference between you;
 11 Dr Glover has got it completely wrong.
 12 Let's have a look at another document, H44520.
 13 CHAIRMAN: Could I just ask here -- I understand what
 14 "robust" means in layman's language. What does it mean
 15 in engineering terminology?
 16 A. Robustness or redundancy?
 17 CHAIRMAN: Robustness. Redundancy we've heard about and
 18 I understand that.
 19 A. Okay. Perhaps I can refer to the Ronan Point case,
 20 incident. I think that happened in the 1960s, if I'm
 21 correct.
 22 MR BOULDING: 1968.
 23 A. Yes, I think in the UK. Actually in a tall building
 24 explosion happened in one of the flats, and somehow it
 25 blew out the wall, and because of that the upper storeys

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1 fell down; okay?
 2 CHAIRMAN: Yes.
 3 A. And the weight of the debris was so heavy that all the
 4 storeys below it somehow collapsed. So that was the
 5 beginning of the study of robustness. Later on people
 6 realised that we cannot just provide -- well, just
 7 consider the normal loading cases. We have to refer --
 8 we have to provide something more, for example lateral
 9 ties, because things can go wrong. So if we provide all
 10 this, then there will be more robustness.
 11 The other case which I can remember vividly was
 12 a video which I received from Prof Paul Pang, I think
 13 some of you may know him -- he used to work in the
 14 Buildings Department -- he sent us a video showing the
 15 shelves inside a warehouse, and the shelves are all
 16 carrying certain heavy loads, and then somehow
 17 a lightweight truck touches one of the shelves and then
 18 the shelf began to fall down and then all of the shelves
 19 fell down.
 20 Now, that is related to robustness. So if we
 21 provide some additional bracing or horizontal ties or
 22 whatever, that would help a lot. So that is why there
 23 are certain design rules in the design code specifying
 24 that we need to provide certain percentage somewhere to
 25 ensure that things won't go wrong. Now, that is the

Page 17	1 meaning of robustness. And yesterday I mentioned 2 a paper which won me an award in 2016 and that was also 3 about robustness of precast segmental bridges. 4 MR BOULDING: Good. Well done. 5 CHAIRMAN: Could I just -- I'm sorry, I didn't mean to cut 6 across you, Mr Boulding. 7 MR BOULDING: No, sir, it's important that you -- 8 CHAIRMAN: Could I just ask you, it's clearly in engineering 9 terms now a very well-accepted principle that needs to 10 be adhered to. 11 A. Yes. 12 CHAIRMAN: And no doubt Atkins would have built that into 13 their design, would they not, a robustness element? 14 A. So if they have provided all the necessary reinforcement 15 specified by the code, even though it is not required 16 based on design calculations, I believe it will be 17 robust enough. 18 So when we try to assess whether a structure is 19 robust or not, we should not just look at the stress 20 level. Stress level is one thing, but then how are 21 various components tied together -- 22 CHAIRMAN: I appreciate that, and I'm not saying that Atkins 23 have got it right or wrong, because I'm taking tentative 24 steps on this, but my question was: surely Atkins would 25 have, in its overall design, sought to integrate into	Page 19	1 COMMISSIONER HANSFORD: So compliance with the code provides 2 robustness? 3 A. Yes. 4 COMMISSIONER HANSFORD: Is what -- 5 A. Yes. 6 CHAIRMAN: And has there been compliance with the code in 7 that regard? 8 A. I believe -- now, I haven't looked at all the design 9 drawings or whatever, but based on my observations so 10 far, I think the original design should be acceptable, 11 the original design. But then after omitting something 12 or changing something, that I'm not sure. 13 CHAIRMAN: We're talking about the through-bars now? 14 A. Okay. Well, two different things. When I answer -- 15 MR PENNICOTT: I think that was a question, sir. You were 16 asking the question, whether he was referring to 17 through-bars or something else. 18 CHAIRMAN: Yes. In this, you are referring to the 19 through-bars, because that's the change you're relating 20 to? 21 A. Yes, yes. 22 CHAIRMAN: All right. Good. Thank you. That helps me to 23 understand the concept and the difficulties. Thank you 24 very much. 25 MR BOULDING: Thank you very much, sir.
Page 18	1 that design the principle of robustness? 2 A. Yes, I believe so. So following the code would -- 3 CHAIRMAN: So that answers that. 4 A. Yes. 5 CHAIRMAN: So the next question -- you have to forgive, 6 lawyers like to take things directly and get a direct 7 answer; build the integrity of the structure on the 8 basis of direct answers -- if they have done that, are 9 you then saying that they may not have been fully 10 successful in integrating the concept of robustness into 11 the design? 12 A. Now, what I'm saying is that if -- okay, my point is 13 that just looking at the stress level cannot lead us to 14 a conclusion that it is robust. We have to look at the 15 other things. We have to look at whether or not certain 16 provision of reinforcement, ties or whatever, have been 17 completed. So the stress level is one thing but it is 18 not sufficient to conclude that it is robust. 19 COMMISSIONER HANSFORD: Prof Au, I think what you're telling 20 us -- or tell me if I've got this right -- is if it's 21 complied with the code, then it will be sufficiently 22 robust? 23 A. Correct, including those rules for detailing. 24 COMMISSIONER HANSFORD: Which is compliance with the code? 25 A. Yes.	Page 20	1 But again, so far as you are concerned, you haven't 2 carried out any calculations to date to establish that 3 the through-bar is not robust? 4 A. No, not myself. 5 Q. Thank you. And if we could go back to the document that 6 I was inviting your attention to -- it's H44520. 7 I think we need to get it on the screen for the 8 Commissioners. That's not H44520. That's it. 9 Splendid. 10 Here we've got, have we not, the lab tests which 11 were carried out by BOSA with the Buildings Department 12 witnessing what was carried out; correct? 13 A. I believe so. 14 Q. And the tests were carried out in the CASTCO Testing 15 Centre in Fanling; do you see that? It's on the top, 16 third line. 17 A. Yes. 18 Q. I understand that's a reputable testing centre. 19 A. Yes. 20 Q. And in circumstances where BD witnessed the test, you 21 would expect them to point out, would you not, if they 22 considered that the tests were invalid in any way? 23 A. One concern is the strength of the -- 24 Q. Can you answer the question first, please? 25 A. I beg your pardon?

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1 MR SHIEH: What was the question?
 2 MR BOULDING: In circumstances where BD were witnessing
 3 tests, you would expect them to point out, wouldn't you,
 4 if they thought that the testing procedure was invalid
 5 in any way?
 6 A. I believe so.
 7 Q. Thank you.
 8 Then if we look at the document, we've got some
 9 legends down at the bottom, have we not?
 10 A. Yes.
 11 Q. B, S and C, explaining what the letters in the "Mode of
 12 failure" column mean?
 13 A. Yes.
 14 Q. We can see, can we not, the left-hand column,
 15 "60 per cent threads engaged"; do you see that?
 16 A. Yes.
 17 Q. And we get a tensile strength of 705MPa in the rebar;
 18 correct?
 19 A. Yes, correct.
 20 Q. And that tells us, does it not, that the connection
 21 between the rebar and the coupler remains intact; that's
 22 right, isn't it?
 23 A. The results are not conclusive, because the trend of the
 24 results is very strange.
 25 Q. I'll put the question again.

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1 A. I don't believe it. Now, I don't think we can base on
 2 this for our design. So just one sample for each case,
 3 and then the results are so strange.
 4 If the coupler is fully engaged, 100 per cent
 5 engaged, we would have expected that the strength is
 6 even higher, but now, presently, the higher strength is
 7 when the coupler is partially engaged. Now, apparently
 8 that shows the variability of the assembly. I won't
 9 trust that. Just one sample for each case.
 10 Q. Prof Au, again, have you done any calculations of your
 11 own?
 12 A. No.
 13 Q. And proceeding on the basis here -- I'll put the
 14 question again -- the figure of 705MPa tells us, does it
 15 not, that the connection between the rebar and the
 16 coupler remained intact in the test; that's right, isn't
 17 it?
 18 A. That's right, yes.
 19 Q. And thus served its intended purpose; correct?
 20 A. No. So, in addition to strength, we have to look at the
 21 performance of the coupler assembly in elongation,
 22 ability to survive, cyclic loading and so on.
 23 Q. I'll come to that. And the "B" in the "Mode of failure"
 24 column tells us, does it not, that at 60 per cent
 25 engagement it's the parent bar --

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1 A. Yes, correct.
 2 Q. -- and not the coupler which breaks?
 3 A. Correct.
 4 Q. What I suggest to you is that on the basis of these test
 5 results -- and you've told us you've got nothing of your
 6 own to contradict it -- this means, does it not, that at
 7 60 per cent engagement the rebar-coupler connection has
 8 adequate structural integrity?
 9 A. No.
 10 Now, looking at strength, it appears to comply, but
 11 then -- now, it doesn't mean that it can be comply with
 12 other things.
 13 Now, the other thing that we can sort of -- another
 14 question we can put forward is -- now, if the results
 15 are really that trustworthy, should we only partially
 16 engage all of the couplers by 60 per cent? Because the
 17 strength appears to be highest. Is it realistic? Is it
 18 reasonable?
 19 Q. Well, that's what the test is showing, I suggest to you,
 20 Prof Au.
 21 A. Well, now, if you have done any testing, if you do
 22 testing of a number of samples, which are identical, the
 23 results won't be exactly the same. There would be
 24 variations.
 25 Now, what I'm suggesting is looking at these

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1 results, I don't trust them, because it suggests that
 2 there is large variation, because it doesn't make sense.
 3 The trend is very strange.
 4 CHAIRMAN: Can I ask this -- sorry, Mr Boulding.
 5 MR BOULDING: Please go ahead, sir.
 6 CHAIRMAN: Mr Boulding perhaps will be able to assist me.
 7 Were these tests carried out in respect of one sample
 8 each?
 9 MR BOULDING: I couldn't tell you that, sir, without asking
 10 for instructions.
 11 CHAIRMAN: I take it each one has to be separate, because
 12 you're talking about a breakage point.
 13 MR BOULDING: Yes.
 14 CHAIRMAN: So the 30 per cent of threads engaged, that would
 15 have to be one sample, and then there would have to be
 16 another one, for each one to reach a destruction point.
 17 I'm just wondering if this was done with just one sample
 18 going through or a number of samples.
 19 MR PENNICOTT: Our understanding, and it is only
 20 an understanding, is that it was just one sample for
 21 each percentage.
 22 CHAIRMAN: All right. So what you're saying, Professor, is
 23 one sample, strange result, can't trust it?
 24 A. Correct.
 25 MR BOULDING: Well, I suggest to you that the peak we see at

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<p>1 60 per cent, which you say is the strange result, is the 2 consequence of the natural variation of the coupler 3 connections and the material properties. 4 A. No, that's wrong. I can tell you, if you are familiar 5 with the testing of samples inside laboratory -- let's 6 say if we have a number of samples which are supposed to 7 be identical, we test them, we would expect some natural 8 variations; okay? But there may be some outliers which 9 are very far away from the mean. 10 Now, I guess probably some of the results could be 11 outliers. 12 Q. So you are guessing? 13 A. Well, the results show that they are strange, strange 14 result. 15 COMMISSIONER HANSFORD: Prof Au, I'm puzzled by this because 16 if BOSA and CASTCO and BD who witnessed these tests had 17 considered this to be an unusual result, they would have 18 called for further tests. 19 A. Yes, I believe so. 20 COMMISSIONER HANSFORD: But they didn't. 21 A. I don't know why. 22 COMMISSIONER HANSFORD: So presumably they accepted this? 23 A. I'm not sure if they accepted. I'm not sure. 24 May I -- 25 COMMISSIONER HANSFORD: I'm puzzled by it.</p>	<p>1 A. I believe so, because they should have addressed not 2 only strength but also elongation, and so on. They 3 should have tested sufficient number of samples. 4 I think that is well accepted in the industry. 5 CHAIRMAN: Yes. 6 MR BOULDING: Anyway, I've got to suggest to you -- and it's 7 certainly Dr Glover's opinion of the matter -- that the 8 test that we've been discussing over the course of the 9 last ten minutes or so establishes that the 10 rebar-coupler connection has adequate structural 11 integrity and is safe. 12 A. No. No. So the results are unreliable. Just one 13 sample, it is not enough. 14 Q. Okay. We look forward to your calculation, Professor. 15 A. Well, actually, this is not based on calculation. This 16 is based on testing. 17 Q. Exactly. You've never done any tests, have you? 18 A. I have. I have been authorised signatory of our HOKLAS 19 accredited lab until some years ago we gave up that lab. 20 Q. So have you carried out this test yourself? 21 A. Yes. 22 Q. What are your results then? 23 A. The results normally -- the results fluctuate. So 24 that's why, when I look at the results, I don't trust 25 the results.</p>
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<p>1 A. May I add some further information? 2 MR BOULDING: Are you guessing or are you giving an opinion? 3 A. No, no, no. Well, it's an established practice. On 4 site, when we need to monitor the concrete strength, 5 normally we need to cast many cubes, and then after 6 28 days we crush them and then find out the strength. 7 We don't just test one cube because there could be 8 variations. That is the standard practice. So I'm very 9 surprised to find that just one sample is tested for 10 each case. 11 COMMISSIONER HANSFORD: But BD would be familiar with that 12 practice as well? 13 A. I believe so, but the problem is I don't think this is 14 the standard testing procedure, because this is 15 something which is unusual. BOSA -- well, the testing 16 of the coupler assembly should be tightened up entirely 17 and then tested. So this is something which is unusual. 18 I think this is not standard practice. 19 CHAIRMAN: All right. So this is a series of tests -- 20 A. Yes. 21 CHAIRMAN: -- conducted for the purposes, essentially, of 22 the Commission of Inquiry? 23 A. I believe so. 24 CHAIRMAN: And perhaps not thought out as deeply as it 25 should have been?</p>	<p>1 CHAIRMAN: All right. That's it. You are saying, "I have 2 not carried out tests myself that I have the results 3 for. I am concerned that only one sample is used for 4 each of the six tests; there should have been more"? 5 A. Yes. 6 CHAIRMAN: "Especially as the results are not entirely 7 predictable"? 8 A. Correct. 9 CHAIRMAN: So if there had been, shall we say, three samples 10 in each case, and then you had been able to look at the 11 results of the destructive issues there, then they would 12 be more persuasive? 13 A. Yes, I believe so. I think three samples would be the 14 absolute minimum to give us any confidence. The more 15 the better. 16 CHAIRMAN: All right. Thank you very much. 17 MR BOULDING: Thank you. 18 Then proceeding on the basis that I have put to you, 19 if we look at OU314 -- and here we've got the 67 testing 20 results, have we not, as of 12 January? 21 A. Yes. 22 Q. You will recall discussing these with Mr Pennicott 23 yesterday, won't you? 24 A. Yes. 25 Q. Proceeding on my basis and the opinion of Dr Glover,</p>

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1 that 60 per cent engagement represents safety, it would
 2 be right, would it not --
 3 A. No.
 4 Q. You haven't heard the question yet!
 5 A. I should pause a bit.
 6 Q. It would be right, would it not, that there are only two
 7 results on this sheet that would be regarded as
 8 "failures"; that's right, isn't it? Number 6, number 5
 9 and number 22?
 10 A. Are you referring to the 60 per cent engagement as the
 11 criterion?
 12 Q. Yes.
 13 A. Well, I don't accept 60 per cent, sorry.
 14 Q. And of course the slab on which these results -- the
 15 results comes from slabs which have now been completed,
 16 what, for something like two years?
 17 A. I'm not sure. Around that.
 18 Q. And during that period, the trains -- we've had trains
 19 running; correct?
 20 A. Yes, correct.
 21 Q. And it would be right, would it not, that after two
 22 years the slab is approaching its full loading?
 23 A. Well, it's hard to say so because --
 24 Q. Sorry, I've stopped you.
 25 A. Well, it is not normal running yet and it depends also

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1 on the design loading adopted.
 2 Now, we are just considering the working condition
 3 or what we call serviceability limit state, just that,
 4 the working condition.
 5 Q. It would be right, would it not, that two years after
 6 it's been completed we've seen no indications of fatigue
 7 in the sense of cracking, spalling of concrete; we've
 8 not seen anything like that, have we?
 9 A. Except for honeycombing, that type of thing, yes.
 10 Q. Well, that's something different.
 11 A. Yes, I haven't seen any. But I have just visited the
 12 site a few times. I'm not a site staff now.
 13 Q. I think if we had any evidence of fatigue, cracking or
 14 anything like that, it would have been put before the
 15 Commission of Inquiry, wouldn't it?
 16 A. I'm afraid you don't understand the term "fatigue
 17 cracking".
 18 Q. I'll come to your lecture this afternoon.
 19 A. Sorry, I should be away this afternoon for teaching.
 20 Q. If we look on in your report, page 4, paragraph 2.1,
 21 "Acceptance criteria and performance of reinforcing bar
 22 couplers":
 23 "Reinforcing bar couplers are proprietary products
 24 designed and manufactured to comply with the relevant
 25 design code or an alternative standard accepted by the

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1 Building Authority. Apart from satisfying certain
 2 strength requirements, the coupled bar assembly should
 3 also comply with certain requirements in respect of
 4 deformation characteristics."
 5 We have already discussed the 60 per cent engagement
 6 point, but so far as your point on deformation
 7 characteristics is concerned, it's right, is it not,
 8 that because of the increased stress in the assembly,
 9 there would be what is referred to as elongation in the
 10 coupler bar assembly?
 11 A. I beg your pardon. Can you repeat the last sentence?
 12 Q. Yes. Because of the increased stress -- you're
 13 referring to deformation characteristics; correct?
 14 That's what you're referring to here?
 15 A. Sorry, which sentence?
 16 Q. The first two sentences.
 17 A. Okay.
 18 Q. Do you want me to read it again?
 19 "Apart from satisfying certain strength
 20 requirements, the coupled bar assembly should also
 21 comply with certain requirements in respect of
 22 deformation characteristics."
 23 A. Yes.
 24 Q. It's right, is it not, that because of the stress in the
 25 assembly, there will be what is referred to as

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1 elongation in the coupler bar assembly; correct?
 2 A. Yes.
 3 Q. And, as I understand and Dr Glover understands your
 4 concern, this could be a crack propagator, correct;
 5 that's one of your concerns?
 6 A. Are you talking about the concrete structure or just the
 7 coupler assembly?
 8 Q. The coupler assembly.
 9 A. I think that has been caused by slipping inside the
 10 coupler.
 11 Q. Well, whatever the cause, what I do suggest to you is
 12 that these deformation characteristics, as you refer to
 13 them, would be very small, wouldn't they -- very small?
 14 A. We are talking about --
 15 Q. Will you answer my question.
 16 A. I am answering your question.
 17 Q. Good.
 18 A. We are talking about elongation in the range of
 19 0.1 millimetre, of course small, but then, even though
 20 it is small, it may cause cracking.
 21 Q. We know, do we not, that these very small deformation
 22 characteristics, 0.1 millimetre, will be studied in the
 23 test programme that MTR is just about to embark upon?
 24 Is that something you know?
 25 A. That I don't know.

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1 Q. You don't know? Okay.
 2 Staying with your paragraph 2.1, in the last
 3 sentence, you tell us:
 4 "It is often expected that the structural
 5 performance of a concrete member with coupled bar
 6 assemblies is not inferior to that with the equivalent
 7 continuous bars in all aspects."
 8 Now, what I've got to suggest to you is that's
 9 an incorrect statement, because it's never expected that
 10 a coupler connection will behaviour in the same way as
 11 a continuous bar.
 12 A. What I am saying in this statement is that it is not
 13 inferior to. If we replace continuous bar by coupler
 14 assembly and if the performance is inferior, I don't
 15 think that is acceptable.
 16 Q. What I'm suggesting to you is that a coupler connection
 17 will never behave in the same way as a continuous bar,
 18 will it?
 19 A. They may not be the same.
 20 Q. Thank you. That's because, I suggest, there's always
 21 some give in a coupler connection; that's right? That's
 22 always some give?
 23 A. Yes.
 24 Q. Albeit that we'd be talking, I suggest, about fractions
 25 of a millimetre?

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1 A. Well, are you talking about elongation?
 2 Q. Yes.
 3 A. Well, I think that is the problem. Now, the code
 4 specifies certain requirement on elongation and the
 5 coupler assembly must comply with that.
 6 Q. Then 2.3, you say here:
 7 "In appendix 1 of Paulino Lim's witness statement
 8 regarding BOSA's requirement, the equivalent strengths
 9 of coupled bar assemblies of the BOSA Seissplice system
 10 for 40 millimetre reinforcing bars having different
 11 engaged lengths are calculated and presented in Chinese.
 12 Based on BOSA's calculations, a splicing assembly having
 13 6 threads engaged (... as opposed to 40 millimetres ...)
 14 will be sufficient to develop the axial strength of
 15 reinforcement. It is however noted that strength is
 16 just one of the aspects of structural performance."
 17 Now, it would be right, would it not, that you would
 18 need to take account of utilisation levels when one is
 19 considering structural performance?
 20 A. Are you talking about strength utilisation factor of the
 21 structure or just this coupler assembly? Which are you
 22 referring to?
 23 Q. What are referred to as utilisation levels.
 24 A. Well, if you are referring to the utilisation level of
 25 the structure, sorry, well, still we have to make sure

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1 that the coupler assembly complies with the
 2 requirements.
 3 Q. But what I'm talking about is the fact that it's right,
 4 is it not, that elements of a structure are tested to
 5 100 per cent of their utilisation; that's right, isn't
 6 it? Elements of a structure are tested to 100 per cent
 7 of their utilisation?
 8 A. What do you mean by "element of structure"?
 9 Q. Well, all the elements of a structure.
 10 A. Are you talking about beams, slabs, columns or the
 11 coupler assembly?
 12 Q. The structure as a whole.
 13 A. Could you repeat your question, please?
 14 Q. Yes. Elements of structure are tested to 100 per cent
 15 of their utilisation; that's correct as a proposition,
 16 isn't it?
 17 A. I don't understand your question.
 18 Q. And the structures that we're talking about here do not
 19 perform generally above a utilisation of 50 per cent or
 20 less?
 21 A. Well, I've seen figures provided by different experts
 22 and there are variations. Well, most of them appear
 23 low, but then there are some figures which are quite
 24 high. I think there are some figures even above
 25 100 per cent.

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1 Q. Well, Dr Glover tells me, and I suggest to you, that the
 2 structures under consideration do not perform generally
 3 above a utilisation of 50 per cent, and sometimes less.
 4 A. Well, it may be true, yes.
 5 Q. Thank you. And if it be true, it would be right, would
 6 it not, that we would be doubly assured that the
 7 structure has the requisite structural integrity because
 8 it would never have to meet 100 per cent utilisation;
 9 that's right, isn't it?
 10 A. No, it is not right. You are just talking about
 11 strength. There are other aspects, the elongation, and
 12 so on, that would be related to the cracking, possible
 13 cracking of the structure, and then possible increase of
 14 deformation, deflection, and so on. We cannot just
 15 focus on strength. There are other aspects: deformation
 16 and ability to sustain cyclic loading.
 17 Q. I hear what you say about that.
 18 At paragraph 2.5 -- we have touched upon this table
 19 already. Table 2.4.1 replicates the table we looked at
 20 earlier, does it not, Prof Au?
 21 A. Oh, yes.
 22 Q. Just to pick up a point I don't think we quite bottomed
 23 out before, you say in 2.5:
 24 "However, the unusual trend observed (eg the maximum
 25 value occurring at 60 per cent engagement) suggests that

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1 variations of results can be quite large."
 2 Again, I would have to suggest that it's not in fact
 3 a large variation, being just the sort of natural
 4 variation you would expect to get in materials and the
 5 testing thereof?
 6 A. Sorry, no. Actually, I would have expected that the
 7 larger the engaged length, the larger the strength -- if
 8 that's the case, I would tend to believe, despite the
 9 fact that there is just one sample for each case. Now
 10 that the maximum strength appears at 60 per cent
 11 engagement, it is very strange. Now, how can we tell
 12 people that "we should not tighten all the couplers,
 13 just tighten to 60 per cent of the length"? It doesn't
 14 make sense.
 15 Q. We talked about that earlier. There's a difference
 16 between the quality requirement and the structural
 17 integrity requirement. We can check the transcript for
 18 that. That's where we started.
 19 A. Okay.
 20 Q. What I would suggest is that, for example, the
 21 difference between the 705MPa and the 693MPa is just
 22 a natural variation in the strength of the rebar.
 23 A. That's true. But then if you go further to
 24 100 per cent, it looks very strange. So if you fully
 25 tighten that up, it drops. So it looks very strange.

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1 How can we explain?
 2 Q. What I'd also suggest is that these variations are of no
 3 significance in the overall scheme of things.
 4 A. Well, they are significant. We cannot accept that kind
 5 of test results. So the test results do not display
 6 a reasonable trend. I think, as an engineer -- now,
 7 there must be more tests to come up with something more
 8 trustworthy.
 9 Q. All right. Just going back on our discussion about
 10 utilisation and my suggestion of low utilisation, it
 11 would be right, would it not, that when one talks about
 12 low utilisation, you would get a low or small amount of
 13 cracking? If you've got low utilisation of a structure,
 14 you get a small amount of cracking; correct?
 15 A. Well, I think your question is very strange. Well,
 16 allow me to say so. Of course the larger the loading or
 17 the utilisation, the larger the deformation, the larger
 18 the internal forces or whatever.
 19 Q. So I think you're agreeing with me.
 20 A. Yes. But whether cracking occurs depends on the design
 21 of the structure.
 22 Q. But generally, with low utilisation, you get low
 23 cracking and you would also get low deflection; that's
 24 right, isn't it?
 25 A. Yes, assuming that the structure has been constructed as

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1 designed, there is no defect or whatever.
 2 Q. And, on the other hand, with cyclic loading, which
 3 I think is a term that you introduced into our
 4 discussions, you would only get cyclic loading in
 5 circumstances where you get, for example, earthquakes?
 6 Earthquakes would give rise to cyclic loading, wouldn't
 7 they?
 8 A. Earthquakes certainly would give rise to cyclic loading,
 9 but remember we are talking about a railway station. It
 10 is true that when we design railway bridges, we need to
 11 check fatigue, we need to check cyclic loading, exactly.
 12 That is one of the additional reasons to support the
 13 need to look at the performance under cyclic loading.
 14 Q. And I think we could agree, couldn't we, that
 15 fortunately we don't have very strong earthquakes in
 16 Hong Kong, if indeed we have them at all? It's an area
 17 of low seismic activity, isn't it?
 18 A. I agree.
 19 Q. Just a small point. You were asked -- at paragraph 3.1,
 20 you're talking here, are you not, about the Code of
 21 Practice for Structural Use of Concrete 2004; correct?
 22 A. Yes.
 23 Q. You were asked about that by my learned friend Mr Shieh
 24 yesterday. I just wonder whether we could have a quick
 25 look at that: H2821.

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1 Do you remember being taken to this document by
 2 Mr Shieh yesterday?
 3 A. Yes.
 4 Q. And the discussion is recorded in the transcript that it
 5 was suggested to you that it wasn't a mandatory
 6 requirement?
 7 A. Yes.
 8 Q. Do you remember that suggestion to you?
 9 A. Yes.
 10 Q. What I just point out to you -- do you see the foreword,
 11 first paragraph:
 12 "This Code of Practice provides guidelines for the
 13 professionals and practitioners on design, analysis and
 14 construction of concrete structures. It was prepared by
 15 the consultant under the direction of the Buildings
 16 Department's steering committee for the consultancy
 17 study on structural use of concrete using limit state
 18 approach."
 19 What I suggest to you is that in addition to the
 20 various points put to you yesterday by my learned friend
 21 Mr Shieh to the effect that it was not mandatory, that's
 22 another indication, is it not, guidelines provides
 23 guidelines for professionals, but the contents of this
 24 code are not mandatory; that's right, isn't it?
 25 A. Actually, yesterday, I explained that this code lays

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1 down all the requirements. If you comply with the code,
 2 fine, that would be accepted by the Building Authority.
 3 Of course you can come up with your alternative design
 4 which does not comply, but you have to demonstrate, by
 5 whatever means, calculations, testing or whatever, to
 6 demonstrate that it is not inferior to the performance
 7 prescribed over here. And that requires a lot of work
 8 to demonstrate.
 9 So I explained yesterday already two cases are
 10 possible. The first one is you can come up with exactly
 11 the same performance, and then the next one is to come
 12 up with a performance higher than the level prescribed
 13 over here. But in most cases it would be higher; okay?
 14 So in this sense we can regard that as mandatory.
 15 Of course that sets the standard. It's up to you. If
 16 you follow, fine. If you don't follow, you demonstrate
 17 that it's not inferior to that.
 18 Q. Guidelines only?
 19 A. But I have mentioned that it must not be inferior to
 20 what is laid down over here.
 21 Q. Just to pick up a point so far as cyclic loading is
 22 concerned -- you referred to the fact, did you not, that
 23 we're talking about a railway station, and thus you have
 24 to take account of the effect of trains?
 25 A. Well, I am just telling you that a railway station is

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1 subject to cyclic loading, but as far as I understand
 2 there is no need to do the load combination to account
 3 for the cyclic effect.
 4 Now, of course we can do that, but normally that is
 5 not critical, but if we design steel bridges, now, that
 6 is a different issue, steel railway bridges; that would
 7 be very critical.
 8 Q. What I've got to suggest to you is because of the fact
 9 that the trains sit on the D-wall and not the slab, that
 10 would mean that the slab doesn't vibrate and thus the
 11 cyclic loading would be very low. That's what I suggest
 12 to you.
 13 A. So are you referring to the vibration caused by
 14 earthquakes?
 15 Q. No, trains.
 16 A. It would be very low because it's quite bulky, yes.
 17 Q. Thank you. Staying with paragraph 3.1.1 of your report,
 18 you refer to the Code of 2004, and we talked about that,
 19 and then you say:
 20 "Therefore, the proper connection of the bottom
 21 reinforcement of the EWL slab to the diaphragm wall by
 22 way of mechanical couplers was required and would also
 23 serve useful purposes."
 24 Now, as to your statement that connection by way of
 25 mechanical couplers was required, it would be right,

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1 would it not, that you do not in fact need type II
 2 ductility couplers? You do not need type II ductility
 3 couplers?
 4 A. I understand that --
 5 Q. Is that right or wrong?
 6 A. Let me explain. Now, Concrete Code 2004 has certain
 7 restrictions on the use of couplers, especially at
 8 certain locations. But as far as I understand, if you
 9 put couplers at such connections, that would be
 10 a requirement, to use ductility coupler. Now, that is
 11 as far as I understand -- that is a requirement by the
 12 Buildings Department.
 13 Q. Anyway, we know that but you nipped down for your
 14 sandwich on 18 December, all of the experts agreed that
 15 there was no requirement for ductility couplers. You
 16 have seen that in the joint statement?
 17 A. I saw that.
 18 Q. I wonder if we can discuss why that is a correct
 19 statement. If you would be kind enough to go to
 20 Dr Glover's report, and when you are there go to page 4,
 21 paragraph 4.5.
 22 A. Thank you.
 23 Q. Here Dr Glover says, 4.5:
 24 "A type II coupler has been designed for more
 25 extreme loading conditions where the connection is

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1 subjected to stress reversal (ie tension to compression)
 2 through a number of cycles of such stress reversals, as
 3 would be the case in very strong ground motions caused
 4 by large earthquakes. However, the Hung Hom Station box
 5 would not be subjected to such very strong ground
 6 motions under the low to moderate earthquake seismicity
 7 classification which it is predicted that Hong Kong
 8 might be subjected to."
 9 Presumably, that's a paragraph you would agree to,
 10 is it not, Prof Au?
 11 A. Now, I think the last part of the paragraph, yes, I do
 12 agree. In Hong Kong, the seismicity should not be too
 13 high. But then the use of the ductility coupler is
 14 a different issue. It cannot be just related to seismic
 15 design. So it is now a requirement.
 16 Q. Sorry, you say it's a requirement. Why is it
 17 a requirement?
 18 A. That is required by the Buildings Department. So if you
 19 use couplers at that location -- now, that has to be
 20 ductility coupler. That's what I have understood.
 21 Q. Why is it required by the Buildings Department? What's
 22 the authority for that?
 23 A. Well, now, as far as I can understand, Concrete Code
 24 2004 has certain rules for the location of the laps and
 25 the couplers.

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<p>1 Q. We've been there. That's guidelines only and it's not 2 mandatory. 3 A. You have to demonstrate that it is not inferior to that, 4 not only in terms of strength but also ductility and 5 other things. 6 Q. And if you were to point out to the Building Authority 7 that Hong Kong is low to moderate earthquake seismicity 8 classification, you would say, "Buildings Department, 9 that is a jolly good reason, is it not, why we do not 10 need type II couplers"; that's correct, isn't it? 11 A. No. No. Well, actually, we are moving towards seismic 12 design. We are moving in that direction. 13 Q. And as Dr Glover says in paragraph 4.6, there are other 14 jolly good reasons for that. First of all, as we've 15 discussed already, the Geotechnical Engineering Office 16 of Hong Kong states in its recent note of 2015 that the 17 seismicity of Hong Kong is low to moderate; that's 18 correct, isn't it? 19 A. Correct. 20 Q. And, secondly, he's right to point out, is he not, as he 21 does in his second bullet point: 22 "Underground box structures have performed 23 exceedingly well in very strong earthquakes which is 24 reflected in the way these structures are designed 25 internationally."</p>	<p>1 impossible to develop ductile behaviour in the slab or 2 its connection to the walls since the wall would have 3 failed structurally under ultimate load conditions long 4 before the rebar in the slab would have reached its 5 yield stress ..." 6 Again, that is a correct statement, is it not? 7 A. Now, we have to be careful. What you are referring to 8 is the possible failure mode. It may occur at the wall, 9 but it is not the reason or excuse not to use ductility 10 coupler at the bottom of the EWL slab. 11 Q. There we are. For all those reasons, I suggest that 12 type II couplers were not required, as in fact all of 13 the experts agreed during the course of the meeting held 14 on 18 December. 15 A. I don't agree. 16 Q. You don't agree. 17 Then if we look at your paragraph 3.2.2, here you 18 are dealing, are you not, with the assessment of the NSL 19 slab? 20 A. Oh, yes. 21 Q. You say in 3.2.2: 22 "Moreover, the top reinforcement in NSL slab near 23 the east and west diaphragm walls may also be required 24 to take tension in the rare case of future dewatering in 25 the vicinity."</p>
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<p>1 Again, he is correct to make that statement, isn't 2 he? 3 A. I have no comment because I haven't read that particular 4 document. 5 Q. So you can't contradict him then, can you? 6 A. No. 7 Q. Then the third bullet point: 8 "Hong Kong reference documents also reflect the low 9 seismic risk associated with such structures. 10 Information note [again 2015] ... states in its key 11 messages '(c) The possibility of significant earthquake 12 damage to manmade slopes, retaining walls and 13 reclamations in Hong Kong is low'. " 14 Again, it's correct, is it not? 15 A. Yes. 16 Q. That's another reason, I suggest, why you do not need 17 type II couplers; correct? 18 A. We still need type II couplers. Why not? It is very 19 important, because we have to ensure that our structure 20 is strong and ductile and safe. 21 Q. Then the last reason -- and again I suggest it's a good 22 reason: 23 "Due to the disproportionately stiffer and stronger 24 EWL slab (3,000 millimetres deep) relative to the 25 diaphragm walls (1,200 millimetres thick), it would be</p>	<p>1 Now, first of all, it's right, is it not, that the 2 NSL slab is ground-bearing; correct? 3 A. Sorry? 4 Q. Ground-bearing? 5 A. Yes. 6 Q. So it rests on the ground? 7 A. But then very often we have to -- in this case the 8 ground would also deform, and it will be prudent to also 9 consider the load case that the slab is carrying its own 10 weight. 11 Q. But here we know, do we not, that the land upon which 12 the Hung Hom Station was constructed was reclaimed back 13 in the 1960s; that's right, isn't it? 14 A. Right. 15 Q. And when it was reclaimed, the ground was surcharged? 16 A. Yes. 17 Q. So we've had surcharging going on, what, for at least 18 50 years? 19 A. Yes. 20 CHAIRMAN: Sorry, Mr Boulding, just a quick lesson -- 21 surcharging? The only surcharging I know is financial. 22 WITNESS: Let me explain. Sir, may I explain? 23 COMMISSIONER HANSFORD: (Unclear words). 24 CHAIRMAN: Ah. Okay. Thank you very much. 25 COMMISSIONER HANSFORD: Sorry, will that do, Prof Au?</p>

Page 49	1 WITNESS: No problem. 2 COURT REPORTER: Sorry, I didn't hear what you said. 3 COMMISSIONER HANSFORD: I said it's had a load applied to it 4 for 50 years. 5 MR BOULDING: What I'm instructed is it's been surcharged 6 for 50 years with a depth of soil of some 15 metres? 7 A. Yes. 8 Q. And in those circumstances it would be right, would it 9 not, that the ground has been very well compacted? 10 A. Yes. 11 Q. And in those circumstances, what I suggest to you is 12 that the risk of settlement would indeed be very remote? 13 A. Now, it's very complicated. If we consider the part of 14 the station below the NSL slab, so the NSL slab is 15 supported by the soil underneath, but there are also 16 certain diaphragm walls on the two sides and -- well, 17 some other piles or whatever. 18 Now, in comparison, the stiffness of the diaphragm 19 wall and the piles would be a lot bigger than the soil. 20 Q. I thought you'd say that. And what I suggest to you is 21 that because of the long spans of the slab, the slab 22 would, to a very large extent, be unaffected by the 23 D-walls which support the end of the slab. Because of 24 the long span of the slab, the slab would be, to a very 25 large extent, unaffected by the D-walls?	Page 51	1 to take that one. 2 Paragraph 6.1.1. Here you deal with possible safety 3 concerns. 6.1, "Ductility in structural design". You 4 say: 5 "In general, ductility is a desirable quality of all 6 structures, irrespective of whether a structure is 7 designed for seismic resistance or not." 8 Just pausing there, it would be right, would it not, 9 that albeit that it might be a desirable quality, you 10 would get it naturally in reinforced concrete structure? 11 Reinforced concrete structure would have inherent 12 ductility in it, wouldn't it? 13 A. Okay. If you follow the code and all the rules for 14 reinforcement detailing, you probably will get the 15 ductility required. 16 Q. Thank you. 17 A. But if you don't follow that, just like one of the first 18 few slides I showed you, the plain concrete beam, if you 19 don't put in any reinforcement, it would be very 20 brittle; no ductility at all. So it depends how you 21 provide the reinforcement. 22 Q. And whilst ductility is desirable, presumably you would 23 agree with me that strength is absolutely essential? 24 A. Yes, of course. 25 MR BOULDING: Thank you, Professor.
Page 50	1 A. Sorry, I don't understand your question. 2 Q. Well, because of the fact you've got a long span of the 3 slab, and then it's joined up to the D-walls -- 4 A. Yes. 5 Q. -- and what I suggest to you is that if there was any 6 effect at all, it would only be in terms of minimal 7 flexing where the slab joined the D-wall. 8 A. Well, now, that is precisely the concern. The slab will 9 deflect downwards, while reversing the force carried by 10 the top reinforcement. That is the concern. 11 Q. It would be minimal, wouldn't it? 12 A. Well, we have to do calculations. 13 Q. Again, but you haven't got any calculations? 14 A. I haven't. 15 Q. Well ... 16 A. But then it doesn't mean we can ignore it. 17 Q. And so far as dewatering is concerned, we know, do we 18 not, that the Buildings Ordinances do not allow 19 dewatering to occur, do they? 20 A. Now -- well, there are certain restrictions. So that's 21 why -- well, where are we? I think I mentioned "rare". 22 Q. Yes. 23 A. So it's rare. But then, if it's rare, does it mean that 24 we can ignore it? 25 Q. There we are. I think I've taken that as far as I need	Page 52	1 WITNESS: Thank you. 2 CHAIRMAN: Anybody else have any questions? Any matters 3 arising? 4 Questioning by THE COMMISSIONERS 5 COMMISSIONER HANSFORD: I have one question, perhaps if 6 I could ask Prof Au. 7 Prof Au, in your witness statement, in 8 paragraphs 4.2 and 4.3 -- 9 A. Yes. 10 COMMISSIONER HANSFORD: -- you address the matter that's 11 been suggested by some of unscrewing threaded 12 reinforcement bars that are already in situ -- 13 A. Right. 14 COMMISSIONER HANSFORD: -- unscrewing them for testing, and 15 you conclude in your final sentences of both of those 16 paragraphs, firstly, it's "considered unnecessary and 17 therefore not recommended", and you go on to say it 18 "would mean that the structure will be damaged further". 19 A. Yes. 20 COMMISSIONER HANSFORD: And you still hold that view? 21 A. Yes, but then in case there is a need to address public 22 demand, then perhaps a small sample can be done, but 23 I don't think that is necessary. 24 COMMISSIONER HANSFORD: You consider that unnecessary -- 25 A. Correct.

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<p>1 COMMISSIONER HANSFORD: And you also think it would damage 2 the structure further? 3 A. Yes. 4 COMMISSIONER HANSFORD: Thank you. That's all. 5 CHAIRMAN: Anything arising? Yes, sorry. 6 MR CHOW: Mr Chairman, we have a few questions in 7 re-examination, but I see it is 11.20. I wonder if it's 8 a convenient moment to take the morning break so we can 9 come back and I can start. 10 CHAIRMAN: If you would prefer that. I'm quite happy to 11 finish and then we can have the break and start with the 12 next witness. 13 COMMISSIONER HANSFORD: That way, Prof Au can get to his 14 teaching appointment. 15 MR CHOW: But I'm afraid my re-examination will take longer 16 than 15 minutes, so that's the reason -- 17 CHAIRMAN: All right. If you would like to have the break 18 now, we will oblige. Thank you very much. 15 minutes. 19 (11.19 am) 20 (A short adjournment) 21 (11.41 am) 22 Re-examination by MR CHOW 23 MR CHOW: Good morning, Prof Au. 24 A. Good morning. 25 Q. I have a few questions for you arising from your</p>	<p>1 Q. I am going to ask you why, but before you answer this 2 question, for the benefit of the Commission and the 3 public as well, I think it is useful for us to set the 4 scene and go back a little bit in time to show what 5 actually happened leading up to the test and the test 6 result and the subsequent correspondence. 7 MR BOULDING: Sir, are we going to allow this sort of 8 leading question in the Commission of Inquiry? 9 CHAIRMAN: I don't know what the question is going to be at 10 the moment. 11 MR CHOW: I have not started to ask my question. Of course 12 I will not ask leading questions. 13 First of all, the first thing to happen is a table 14 setting out BOSA's calculation as to the corresponding 15 strength when different engaged lengths was being 16 investigated. 17 A. Right. 18 Q. Do you recall that? 19 A. Yes. 20 Q. That table we have looked at this morning. 21 A. Yes. 22 Q. It can be found at bundle H25, page 44527. 23 A. Right. 24 Q. If we can just briefly look at the table first. 25 A. Yes.</p>
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<p>1 discussion with various counsel yesterday and this 2 morning with Mr Philip Boulding. 3 The first topic I would like to discuss with you is 4 you will recall that yesterday Mr Pennicott had taken 5 you to or referred you to some test reports produced by 6 BOSA -- 7 A. Yes. 8 Q. -- regarding pulling-out test or tensile test on 9 couplers with different engaged lengths? 10 A. Yes. 11 Q. And some of the experts refer to those test reports and 12 suggest that new acceptance criteria should be 13 considered which is six threads being engaged would be 14 sufficient to develop the tensile strength or the design 15 strength of the reinforcing bar. Do you still recall 16 that? 17 A. Yes. 18 Q. And Mr Pennicott asked you to confirm whether you have 19 taken this into account when you formed your view as to 20 the percentage of failure of the various results under 21 the opening-up exercise. 22 A. Right. 23 Q. Your answer, you basically confirm that you have not 24 taken the test into account. 25 A. Right.</p>	<p>1 Q. This is in Chinese. 44527.1 is in English. So this is 2 the table on the basis of calculation; right? 3 A. Yes. 4 Q. Then we have the test results which can be found in the 5 same bundle, H25, page 44520. This one we have also 6 looked at. 7 A. Yes. 8 Q. In this table, the test was carried out on 21 November 9 last year, 2018. 10 A. Yes. 11 Q. In your report, paragraphs 2.1 to 2.5, you have given 12 your comment, your query, as to the reliability of these 13 test results; do you recall that? 14 A. Yes. 15 Q. You said the number of samples tested is not enough? 16 A. Correct. 17 Q. The result appears to be strange? 18 A. Yes. 19 Q. Which does not make sense? 20 A. Correct. 21 Q. And therefore, in your report, you form a view that it 22 is not reliable; do you recall that? 23 A. Correct. 24 Q. Then we have a press release given by BOSA in the 25 evening on 23 December last year.</p>

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1 A. Yes.

2 Q. Mentioning about the six threads being engaged, and

3 because of that press release, the Buildings Department

4 raised queries directly with BOSA, and the letter can be

5 found at bundle H26, page 45479.

6 Now, this is a letter dated 28 December from the

7 Buildings Department to BOSA Technology Holdings Ltd for

8 the attention of Mr Paulino Lim.

9 In this letter, the Buildings Department refers to

10 the press release issued by BOSA and raised a number of

11 queries and expects BOSA to address them; right?

12 A. Right.

13 Q. The first query in paragraph 2:

14 "We would like to seek your clarification on the

15 following issues mentioned in your press release".

16 Under paragraph 4 of the press release BOSA said:

17 "For BOSA's type 2 couplers for a 40mm diameter

18 coupler, the bars are designed to have a threaded length

19 of 44mm, or 10 threads full engagement. In other words,

20 the correct installation is to have 10 threads fully

21 engaged into the coupler."

22 Now, this is part of the press release by BOSA.

23 A. Yes.

24 Q. The question raised by the Buildings Department was:

25 "We noted the information in the statement is

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1 different from the dimensions table attached in the

2 quality assurance scheme submitted for the captioned

3 project."

4 And the Buildings Department seek clarification on

5 the minute dimension and how to measure the various

6 lengths, the width of one thread, that sort of thing,

7 but this is not very important for our present purposes.

8 It is the second part of the letter where the

9 Buildings Department refer to paragraphs 6 and 7 of the

10 press release, in particular the part where BOSA said:

11 "For a 40mm coupler, 10 full threads will provide

12 a design strength of 1,003 megapascals ... and

13 accordance with BOSA's design approach outlined above,

14 an engagement of 6 threads for example, may provide

15 a design strength of around 600 megapascals, exceeding

16 the specified yield strength of the bar, subject to

17 verification in accordance with structural engineering

18 principles."

19 Do you see that?

20 A. Yes.

21 Q. The query raised by the Buildings Department was:

22 "What is the correlation between threads of the

23 coupler/rebar and design strength with reference to the

24 performance requirements as stipulated in clause 3.2.8.4

25 of the Code of Practice for Structural Use of Concrete

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1 2013 (ie the performance [requirement] for permanent

2 elongation, static compression and tension test and

3 cyclic tension-and-expression test, et cetera)?"

4 Can you confirm that clause 3.2.8.4 of the Concrete

5 Code actually refers to requirements as to elongation?

6 A. Well, I need to check.

7 Q. You can take it from me that this is what clause 3.2.8.4

8 is about.

9 A. Yes.

10 Q. We can always verify it later on.

11 A. Yes, okay.

12 MR PENNICOTT: No doubt it will be explained why the

13 question was asked by reference to the 2013 Code of

14 Practice rather than 2004.

15 MR CHOW: Perhaps we can take a look at the version of the

16 Concrete Code for --

17 CHAIRMAN: Tell me, where are we going on this question?

18 I appreciate some questions require a very large

19 preamble. I'm just wondering what we're going to deal

20 with.

21 MR CHOW: Mr Chairman, the reason why I need to take Prof Au

22 to this letter is because the following letter, the

23 letter in response from BOSA, I need to set the scene

24 for people to understand under what circumstances BOSA

25 made its response subsequently.

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1 CHAIRMAN: All right.

2 MR CHOW: Perhaps at this point I don't need to go to the

3 Concrete Code as such and I can simply move on to the

4 following letter.

5 MR PENNICOTT: Sir, I'm not trying to stop Mr Chow going to

6 the letters if he wishes to, provided we are going to

7 get some precise questions and some answers that are

8 relevant to the Inquiry, but could I just put down

9 a marker that BOSA have been very cooperative to the

10 Commission and it would appear to government departments

11 as well. They are not an involved party at this

12 Commission of Inquiry. Nobody has ever suggested any

13 criticism should be directed at BOSA, and that's

14 of course a very important point in the context of this

15 Commission. They have been helpful, nobody has ever

16 pointed a finger at them, nobody has ever criticised

17 them, and they are not a party that can be subjected to

18 any criticism by the report of this Commission at the

19 end of the day, because they are not an involved party.

20 CHAIRMAN: Thank you.

21 MR CHOW: Chairman, I have no intention whatsoever to

22 criticise or point fingers at BOSA, but given the fact

23 that at the moment various experts refer to the test

24 result as something which entitled the change to the

25 acceptance criteria, and that is important to have

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<p>1 a look and understanding as to the position of BOSA in 2 relation to the testing they performed. 3 CHAIRMAN: All right. Fine. 4 MR SO: Mr Chairman, I do apologise. We wish to put down 5 a marker that those instructing me have confirmed that 6 in the beginning of this Commission of Inquiry, China 7 Technology did make an application that BOSA be made 8 an involved party but that request was not acceded to, 9 but we just wish to make a marker here and we are not 10 insisting that BOSA be made an involved party. 11 CHAIRMAN: Yes. 12 MR CHOW: Prof Au, then we have a formal response from BOSA 13 made to the Buildings Department on 7 January 2019. In 14 fact, this is a letter that you have actually referred 15 to in one of your slides as well. 16 A. Yes. 17 Q. Can I ask you to go and have a look at H26/45640. 18 A. Thank you. 19 Q. Do you recognise this letter? 20 A. Oh, yes. 21 Q. In your slide number 17 -- you still recall your 22 presentation? 23 A. Right. 24 Q. -- you put down "Couplers with only six threads engaged 25 may not be acceptable"; do you recall that?</p>	<p>1 "... we have provided such samples and conducted 2 tensile strength tests on them and representatives from 3 BD were invited to attend and witnessed such tests. We 4 also understand MTR has conducted various similar 5 tests." 6 Pausing here, can I ask you whether you have seen 7 any test report in relation to the tests carried out by 8 MTR? 9 A. No. 10 Q. Then we can move on: 11 "So far as we are aware this is the single type of 12 test that has been conducted on couplers with partial 13 engagement and the test results are shown in the photo 14 enclosed. Regarding these results, we could offer no 15 further comment other than that these test results are 16 consistent with our design strength as quoted in 17 paragraph 2(b) of your letter." 18 A. Right. 19 Q. And the following paragraph: 20 "Regarding your question on how a partially engaged 21 coupler would perform in permanent elongation test, 22 static compression and tension tests and cyclic 23 tension-and-compression tests, it is our opinion as 24 explained in paragraph 4 above, that it is unlikely that 25 such couplers, without being spliced butt-to-butt and</p>
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<p>1 A. Yes. 2 Q. Then in your slide number 8 you also refer to BOSA's 3 letter, that's the letter we are now looking at. 4 A. Yes. 5 Q. And you emphasised the requirement of "butt-to-butt"? 6 A. Yes. 7 Q. And also ten-thread engagement as what BOSA's position 8 was -- 9 A. Right. 10 Q. -- as per what BOSA put down in its letter on 7 January. 11 A. Yes. 12 Q. Can I ask you to take a look at the letter and tell us 13 which particular part of its letter would give you such 14 an understanding as to BOSA's position? 15 A. Actually, the last one, if it is not tightened to be 16 butt-to-butt, then the assembly will be loose. That 17 would be one important thing that we need to address. 18 Q. How about turn over the page to page 2. 19 A. Okay. So the first paragraph does say something, that 20 we do not have any test data on correlating partial 21 thread engagement of a coupler to its structural 22 performance. I think somehow we are moving to a certain 23 area that is unsure. So even the supplier isn't sure of 24 the performance of the coupler. 25 Q. Right. In line 6 of the same paragraph, BOSA said:</p>	<p>1 are therefore loose, will survive permanent elongation, 2 and cyclic tension-and-compression tests. 3 However, with sufficient partial engagement of 4 threads, such couplers should survive static compression 5 and tension tests in accordance with our design, subject 6 to sufficient tests to be conducted for verification." 7 Now, if I can then refer you to the second-last 8 paragraph on the same page, starting with, "However": 9 "However, in the event that full compliance cannot 10 be achieved such as these partially engaged couplers due 11 to various reasons, engineers will need to go back to 12 first principles of laws of mechanics to find out the 13 various objectives of each individual test stipulated in 14 the Code and determine if such objectives can still be 15 achieved without full compliance with these 16 deemed-to-satisfy requirements for a specific 17 structure." 18 A. Yes. 19 Q. "It is our opinion that permanent elongation test is for 20 crack control for achieving the required durability 21 performance in the Code." 22 Then if we can move on to the last page of the 23 letter, on the top of the page: 24 "Likewise, cyclic tension-compression-compression 25 test is to ensure structures will not fail under</p>

Page 65	1 reversible extreme loading. If deemed-to-satisfy 2 requirements of the Code cannot be complied with, the 3 structure under study should be analysed under actual 4 loading to determine if deviation from such compliance 5 can be justified, subject again of course to the 6 scrutiny of the Building Authority." 7 Now, we have looked at part of the details of this 8 letter. 9 A. Yes. 10 Q. Earlier, I indicated that I am going to ask you why you 11 have not taken into account the test result in 12 determining what acceptance criteria should be adopted. 13 A. Right. 14 Q. You have looked at this letter. Would this letter 15 contribute to your opinion? 16 A. Well, I tend to agree with this. So I believe there is 17 a need to do more tests and then to come back to the 18 principles of mechanics and to understand, well, how it 19 is going to perform under different types of loading. 20 So I think, in general, I tend to agree, and there 21 should be a lot more to do instead of just testing one 22 sample, in particular that the results look very 23 strange. 24 COMMISSIONER HANSFORD: Sorry, Prof Au, I've understood the 25 point about your view that further coupling tests are	Page 67	1 and both Mr Pennicott and Mr Connor yesterday. 2 A. Right. 3 Q. Yesterday, we have also looked at the additional 4 comments that you have made subsequent to that expert 5 meeting. 6 A. Right. 7 Q. Paragraph 3 has also been addressed by you in the 8 additional comments. 9 A. Right. 10 Q. Your additional comments can be found at bundle G20, 11 page 15046, paragraph 3. Then turn over the page. You 12 have two or three bullet points -- 13 A. Right. 14 Q. -- dealing with paragraph 3 of the joint expert memo. 15 A. Right. 16 Q. What you have put in these additional comments -- 17 basically, what you are saying is the internal stresses 18 generated inside the joint have to be checked -- 19 A. Right. 20 Q. -- numerically -- 21 A. Yes. 22 Q. -- and it is premature to jump to any conclusion, in 23 particular the adequacy of the joint? 24 A. Right. 25 Q. That is what you are trying to say in your additional
Page 66	1 needed because we only have one test here and that's 2 an extremely low sample. 3 A. Yes. 4 COMMISSIONER HANSFORD: And also that the results look 5 strange to you. 6 A. Yes. 7 COMMISSIONER HANSFORD: Which perhaps would be another 8 reason for having another sample. 9 A. Right. 10 COMMISSIONER HANSFORD: But are you suggesting different 11 tests should be carried out? 12 A. No. 13 COMMISSIONER HANSFORD: You are not? 14 A. I'm still referring to the standard test. 15 COMMISSIONER HANSFORD: Thank you. 16 MR CHOW: Having received this letter, the Buildings 17 Department wrote to MTR on 10 January. Are you aware of 18 that? 19 A. No. 20 Q. I will now move on to another topic. 21 A. Right. 22 Q. You remember there's a joint expert memo signed -- 23 A. Yes. 24 Q. -- among the experts, and paragraph 3 of the joint 25 expert memo has been thoroughly discussed between you	Page 68	1 comments? 2 A. Yes. 3 Q. If I can now refer you back to the signed joint expert 4 memo. 5 A. Right. 6 Q. Paragraph 3. I believe it's at the end of 7 Mr McQuillan's report. Unfortunately I don't have 8 a page number. 9 COMMISSIONER HANSFORD: Page 118. 10 MR CHOW: Thank you, Prof Hansford. 11 In paragraph 3, the last statement of paragraph 3, 12 the last sentence, where it is put down: 13 "Notwithstanding, all agreed the outcome would not 14 show the construction joint to be problematic." 15 A. Right. 16 Q. What you have put down in your additional comment, how 17 would this reconcile with this last sentence? 18 A. Actually, I didn't agree with that, and I raised concern 19 during the meeting. So I believe there is a need to 20 check numerically. 21 Q. You mean you don't agree with the last sentence of 22 paragraph 3, of the summary -- 23 A. That is based on guesswork. I didn't hold a view that 24 there shouldn't be any problem. We still need to wait 25 and look at the outcome of checking.

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1 Q. All right. Then I will move on to another matter, the
2 diagram which you have drawn yesterday which is still on
3 the whiteboard.
4 A. Yes.
5 Q. Yesterday, you tried to explain to us how you looked at
6 the internal stresses by way of free body diagrams.
7 A. Right.
8 Q. When you explained what you drew on the whiteboard, at
9 one point you mentioned about lack of lapping.
10 A. Yes.
11 Q. Can I ask you to clarify what lapping were you referring
12 to at that time? Which thing is lapping?
13 A. I was referring to the lapping of some additional L-bar
14 or U-bars with the vertical reinforcing bar, because
15 with additional lapping, then the change in the force
16 inside the vertical bars would be less abrupt.
17 So right now, in this arrangement, at the top, here
18 (indicating), of the vertical reinforcement, the
19 stresses will be effectively zero. So there is a rapid
20 drop in the stress, which means that there is very large
21 bond stress, this kind of stress (demonstrating with
22 fingers), and actually there is a certain possible
23 critical shear plane, over here (indicating whiteboard).
24 So we have to check. I think that is a concern.
25 Q. The U-bar you mention, I believe that we can all imagine

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1 what you are talking about is an inverted U-bar?
2 A. Something like that (indicating whiteboard).
3 Q. Right. But the L-bar you have just mentioned, it may
4 not be very clear what L-bar is referred to.
5 A. It may be something like that (indicating whiteboard).
6 Q. Okay. Thank you. Another topic. Paragraph 99 of
7 Mr McQuillan's expert report, about the clamping action;
8 do you recall that?
9 A. Yes.
10 Q. Where Prof McQuillan said because of the clamping action
11 no shear can be generated at the new construction joint;
12 do you recall that?
13 A. Yes.
14 Q. In response you said, in order to mobilise the clamping
15 action, one has to do a post-tensioning; do you recall
16 that?
17 A. Yes.
18 Q. What you said is, and I quite:
19 "So if we provide some tendons and do
20 post-tensioning, then there will be clamping action, but
21 if we just cast it in situ, there won't be any clamping
22 action that is useful."
23 A. Correct.
24 Q. What I want to ask you is about the word "useful". Are
25 you suggesting there may still be clamping action but

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1 for some reason not useful?
2 A. Well, actually, if we don't do post-tensioning, there
3 won't be any clamping action. There won't be any.
4 COMMISSIONER HANSFORD: Prof Au, my understanding from
5 yesterday was you were suggesting post-tensioning as
6 a possible remedial measure if the numerical
7 calculations demonstrated that there was a problem.
8 A. I was referring to something differently. Now, when
9 I talk about possible clamping action, I was talking
10 about some horizontal tendons, like that (indicating
11 whiteboard); okay?
12 COMMISSIONER HANSFORD: Yes.
13 A. So when I was talking about possible remedial works,
14 I was talking about something vertical, something like
15 that (indicating whiteboard), some bar anchors. So that
16 would help to strengthen the joint.
17 COMMISSIONER HANSFORD: Sorry, but my question -- my
18 understanding from yesterday was that post-tensioning
19 would only be required if the numerical analysis
20 demonstrated there was a problem.
21 A. Yes.
22 COMMISSIONER HANSFORD: Are you now saying that
23 post-tensioning is definitely required?
24 A. No, no, no.
25 COMMISSIONER HANSFORD: You're not?

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1 A. No.
2 COMMISSIONER HANSFORD: So my understanding is correct?
3 A. Yes.
4 COMMISSIONER HANSFORD: Thank you.
5 MR CHOW: Still on the question of clamping action.
6 A. Right.
7 Q. In Prof McQuillan's report, the professor has prepared
8 a diagram at page 42 of his report, to explain the
9 clamping action.
10 A. Right.
11 Q. I would like you to briefly refer to the diagram that
12 you have drawn in your report.
13 A. Right.
14 Q. At page 12, please. Yes.
15 The figure 6.4.3.5.1 on page 12 also indicates the
16 reinforcing details inside the joint.
17 A. Right.
18 Q. And also in the OTE down-stand structure as well.
19 A. Right.
20 Q. By reference to the reinforcing detail, I would now like
21 to go to Mr McQuillan's diagram at page 42.
22 A. Right.
23 Q. Regarding the clamping action, can you tell us that the
24 blue part of the structure which forms a cap above the
25 diaphragm wall --

Page 73	1 A. Right. 2 Q. -- is the blue part of the structure reinforced in such 3 a way to enable it to perform or act as a clamp? 4 A. Well, I doubt if it can do this. Well, unless -- so, 5 first of all, there may not be any natural clamping 6 action. Now, actually, we are most concerned about the 7 horizontal shear force in the additional construction 8 joint. I think considering the so-called clamping 9 action is unnecessary and it will just complicate the 10 matter. We should focus on that. 11 So if one would like to consider that and prove that 12 it can serve the purpose, then please, do a calculation. 13 So just looking at that, I don't think it can serve the 14 purpose of reinforcing the shear resistance at the 15 additional construction joint. 16 Q. Thank you. Yet another topic. Yesterday, Mr Connor 17 asked you questions in relation to paragraph 6.4.3.6 of 18 your report, in which you refer to section 3.8 of the 19 Concrete Code. 20 A. Yes. 21 Q. Perhaps it's easier for you to look at paragraph 6.4.3.6 22 on page 13 of your report. 23 A. Right. 24 Q. Here you mentioned "the principles underpinning the 25 design of ... beam-column joints as described in	Page 75	1 Q. Perhaps for the sake of completeness and for the benefit 2 of the Commission and the public at large, can you just, 3 if you are able to, make reference to the relevant parts 4 of the books so that we can make copies and perhaps 5 insert it as one of the appendixes to your expert 6 report? 7 A. Okay. Now, actually, section 13.8 is on beam column 8 joints. 9 Q. Do you have a page number? 10 A. Page 716, starting from that page. 11 Q. I see. And it goes all the way to ... 12 A. It's very long, actually. 13 Q. It doesn't matter. We can make copies. As long as you 14 identify the relevant part for the benefit of the 15 Commission. 16 A. All the way until almost the end of the book. So it's 17 an advanced topic, actually. 18 Q. So it's up to page 758? 19 A. Yes, correct. 20 Q. Thank you. 21 Yesterday, you also mentioned -- 22 CHAIRMAN: Sorry, I hope I'm not going to be asked to read 23 this, am I? 24 MR CHOW: No. 25 CHAIRMAN: I'd like to be told about it rather than -- I'm
Page 74	1 section 6.8 of the Concrete Code". 2 A. Right. 3 Q. You said those principles should also apply for 4 analysing the stress inside the connection. 5 A. Right. 6 Q. Do you recall that? 7 A. Yes. 8 Q. You mentioned about the book Park and Paulay; do you 9 recall that? 10 A. Yes. 11 Q. In front of you, we have prepared two copies of the Park 12 and Paulay. One we have already handed up to the 13 Commission, and you can take a look -- because yesterday 14 you have not mentioned the name of the book, you just 15 mentioned the author. 16 A. Correct, yes. 17 Q. I just want you to take a look to see if this is the 18 book you are referring to. 19 A. Yes. 20 Q. You also mentioned that the way we should calculate or 21 analyse the stress inside the connection is explained in 22 this book. 23 A. Yes. 24 Q. And you could even identify the chapters. 25 A. Yes.	Page 76	1 happy if it's an audio book but not one that I actually 2 have to read myself. I'm just wondering what the 3 purpose is. Is it a general reference to support what 4 Prof Au has said? 5 MR CHOW: Basically, because yesterday -- 6 CHAIRMAN: It identifies his source? 7 MR CHOW: Yes, to support the way he analysed the problem, 8 he sees how a stress should be determined inside the 9 joint, because all along Prof Au has been using free 10 body diagrams to explain what the proper way should be 11 to look at the problem, and in fact my next question 12 is -- at one point yesterday, Mr Connor cross-examined 13 you on something and then you started talking about 14 checking the internal stress. 15 A. Yes. 16 Q. You also mentioned about making use of free body 17 diagrams -- 18 A. Yes. 19 Q. -- to analyse; it's pretty common, you said. 20 A. Yes. 21 Q. The relevant part of the book in Park and Paulay, would 22 it have covered also the use of free body diagrams? 23 A. Yes. 24 Q. So is it also included in part of your pages that you 25 have just mentioned?

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<p>1 A. Oh, yes. For example, on page 727, it shows also 2 a typical beam-column joint, and then in figure 3 13.58(a) -- now, the central rectangle is acted upon by 4 a number of forces, and that is what I am talking about, 5 free body diagram. 6 This free body diagram represents the entire joint, 7 but to understand what happens inside, we have to look 8 at other smaller free bodies and then try to understand 9 what's going on inside. 10 Q. I see. So the method of using free body diagram to 11 analyse internal stresses in any continuum material is 12 not something that you invented yourself, it's something 13 in basic engineering textbook; is that right? 14 A. This book was published in the year 1975, over 40 years 15 ago. 16 Q. Thank you. 17 Yesterday, you were also asked by Mr Shieh for 18 Leighton -- 19 A. Yes. 20 Q. -- regarding the clamping action and also the cap at the 21 top of the diaphragm wall, and you were referred to 22 a diagram at page 28 of Mr Southward's report. 23 A. Right. 24 Yes. 25 Q. Thank you. Mr Shieh actually asked a very fair question</p>	<p>1 whether there are problems. 2 CHAIRMAN: All right. And my understanding is that you have 3 your postulation and there are other postulations -- 4 A. Right. 5 CHAIRMAN: -- but you can satisfied that those postulations 6 needn't worry us, if you conduct certain mathematical 7 calculations as opposed to laboratory tests? 8 A. Both are possible, but of course laboratory tests would 9 be very time-consuming. 10 CHAIRMAN: Yes, so mathematical calculations would, you 11 think, satisfy you that these postulations in fact are 12 not realistic? 13 A. Well, actually following the book by Park and Paulay, 14 I think the last chapter or whatever, I think that 15 should be the initial step. If the results show that 16 the stresses are very low, there is no need to worry, 17 fine. But then if the stresses are fairly high, then 18 there is a need to look at what happens. And regarding 19 the criteria, that would be difficult, because normally 20 people won't check it afterwards, they normally start 21 from something standard, and if they try to satisfy 22 equilibrium at the very beginning, then normally there 23 is no problem. 24 So, in that book, there are certain standard 25 details. If people follow the details, normally the</p>
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<p>1 from a layman's point of view. Given that the diaphragm 2 wall was being capped above by a new structure, how can 3 it slide? Yesterday, you tried to explain that cracks 4 will form at the new interface. 5 A. May form. 6 Q. May form. 7 A. Yes. 8 Q. If it fails, it may form. 9 A. Yes. 10 Q. Then, after the formation of the cracks on the 11 construction joint, further cracks on each side of the 12 diaphragm wall along the vertical direction may also 13 develop. 14 A. Right. 15 Q. My question is that for a structure to be considered as 16 starting to fail, does it have to slide physically? 17 A. Well, actually, this is just a postulated failure 18 mechanism. There may be many possible failure 19 mechanisms. Actually, in this case, what we should be 20 careful with would be the internal behaviour of the 21 joint, whether it is going to fail by other means. 22 Because failure of the joint is brittle, it's very 23 dangerous; we can't see it. So this is just one of the 24 possible modes of failure that we need to address. 25 There should be others that we need to check, see</p>	<p>1 connection will be okay, but if someone tries to omit 2 something, wow, that would be a concern. To prove that 3 it still works is very difficult. But then at least the 4 simplified check is the first step. 5 CHAIRMAN: All right. Good. Thank you. 6 MR CHOW: Can I further ask this: if cracks that you have 7 described yesterday develop, would it give rise to a 8 safety concern? 9 A. Now, the problem is -- of course, yes, if a joint fails, 10 it may fail by cracking and crushing of concrete. So 11 the crushing of concrete is even more dangerous because 12 it would be very brittle, so it would fail all of 13 a sudden. So that's why the connection is something 14 that is very important. 15 Q. Then, lastly, I would like to move on to a few areas 16 that you have been cross-examined on this morning. 17 A. Right. 18 Q. This morning, when you were discussing with my learned 19 friend Mr Boulding about the concept of robustness, you 20 were asked by the Chairman that we are only talking 21 about the change on top of the diaphragm wall now, and 22 you said "yes". 23 A. Yes. 24 Q. But one of the other areas that we have to investigate 25 in this Inquiry is the proper installation of the</p>

Page 81	1 couplers. 2 A. Yes. 3 Q. Would the quality of the installation of couplers go to 4 the issue of robustness as well? 5 A. Let's say the amount of defective couplers is very high, 6 then I think there is a concern, if it is very high. 7 But so far I don't think it has reached that level yet, 8 taking into account the amount of partial engagement, 9 I think still there is a possibility of trying to assess 10 the structural behaviour based on that. I think that is 11 possible. Probably, that is a sensible thing to move 12 ahead. 13 COMMISSIONER HANSFORD: Is it possible, Prof Au, to quantify 14 what that level is? 15 A. Level of robustness? 16 COMMISSIONER HANSFORD: No. You said you don't think it's 17 reached that level yet. 18 A. Okay. So you are referring to robustness. It's just 19 based on impression. Just based on impression. 20 COMMISSIONER HANSFORD: I know. But is there anything 21 more -- I mean, that's based on an impression. 22 A. Yes. 23 COMMISSIONER HANSFORD: But is there anything more 24 definitive than just an impression? 25 A. Well, regarding robustness, it is difficult. It is	Page 83	1 A. Yes. 2 Q. Mr Ho responds to Mr Aidan Rooney's statement, where 3 Mr Rooney said "the NSL track slab is a ground-bearing 4 slab with structural connections to the diaphragm walls 5 at the east and west sides of the NSL track slab", and 6 Mr Ho points out that "according to the accepted plans 7 and the supporting calculations, the NSL track slab is 8 a suspended slab supported on piles and also on the 9 diaphragm walls at east side and west side respectively. 10 Therefore, the NSL track slab is not a 'ground-bearing 11 slab' as asserted by Mr Rooney." 12 Can you recall having read that or you have never 13 seen this before? 14 A. I have read that letter but not the whole thing. I have 15 heard about that. I tend to agree with that, because if 16 we ignore that situation, it would be dangerous. So 17 that is a possibility anyway. 18 Q. In what way would it be dangerous? 19 A. Because if there is future dewatering, when the 20 groundwater table drops below the NSL slab, then -- the 21 soil may not be as stiff as the diaphragm walls and 22 certainly there would be some downward loading acting on 23 the slab. It is just prudent to design for this 24 possible load case. 25 Q. Then you were further asked or suggested that the train
Page 82	1 difficult. 2 So I referred earlier to a paper in -- well, that 3 won me an award. Even in that paper, we classified the 4 robustness into I think three categories or whatever. 5 We couldn't quantify that. But then looking at the 6 behaviour, we can have an idea. 7 But I think that so far the structure hasn't reached 8 any serious concern of lack of robustness, so far. 9 COMMISSIONER HANSFORD: Okay. We'll take that. Thank you 10 MR CHOW: Thank you. 11 Prof Au, do you recall that Mr Boulding also asked 12 you about the NSL slab? 13 A. Right. 14 Q. And he suggested to you that the NSL slab sits on 15 ground. 16 A. Right. 17 Q. I wonder whether you have had a chance to look at the 18 Buildings Department's Mr Humphrey -- 19 A. Humphrey Ho? 20 Q. -- Ho's second statement, in which he also talks about 21 the NSL slab. Can I refer you to bundle H, page 40064. 22 I'm sorry, I don't have the more detailed bundle number. 23 I believe it's at the very end, the second statement, 24 page 40064. 25 H20. Paragraph 32.	Page 84	1 actually sits on the diaphragm wall and not on the slab. 2 Do you recall that? 3 A. Yes, I recall that. 4 CHAIRMAN: That's the EWL, East-West slab. 5 MR CHOW: Yes, the EWL slab. But from my recollection, it's 6 also suggested the NSL slab is also in a similar 7 situation, where train sits on -- 8 A. No, no. The NSL, of course, if it's not directly on the 9 diaphragm wall. I think even for the EWL slab -- well, 10 there is a certain eccentricity, it's slightly offset. 11 I think we have to take that into account. 12 Q. That must be my fault. My apologies. 13 Lastly, do you recall that this morning, 14 Prof Hansford mentioned or indicated that the Buildings 15 Department has witnessed the test carried out by BOSA. 16 A. Right. 17 Q. And the Buildings Department, if there is any objection, 18 then should have raised it; right? 19 A. Yes. 20 Q. Do you recall that? 21 A. Right. 22 Q. As far as you know, what was the Buildings Department's 23 involvement in that test? 24 A. I'm not aware of the details, but I think in this 25 situation, the Buildings Department may not need to

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<p>1 object. They simply do carry out the test, whatever 2 test, but later on whether they accept, that is another 3 issue. But of course they can sign -- I mean, they can 4 sort of verify that they are present. But then whether 5 it is accepted, I don't know. That may be a different 6 issue. 7 COMMISSIONER HANSFORD: Presumably, Prof Au, if the 8 Buildings Department were present for the test, if 9 they'd had any concerns about the test, they would have 10 raised them? 11 A. I think if they were aware of that, I believe they would 12 have raised, but then very often the witness may not be 13 aware of everything. So later on, when they receive the 14 report, they have to check. I think it would be fair 15 for them to check everything, whether they can decide to 16 accept or not. 17 COMMISSIONER HANSFORD: Exactly, and then at that stage, if 18 they had concerns, to raise them? 19 A. Oh, yes. 20 MR CHOW: Thank you, Prof Au. I have no more questions for 21 are. 22 WITNESS: Thank you. 23 MR CHOW: Thank you. 24 CHAIRMAN: Prof Au, thank you very much indeed. You have 25 been of very great help to us. Thank you for preparing</p>	<p>1 is Prof Yeung, that's China Technology's expert. 2 CHAIRMAN: Good. Thank you. 3 MR SO: Chairman, with your leave, I call Prof Albert Yeung. 4 PROF YEUNG TAK CHUNG, ALBERT (affirmed) 5 Examination-in-chief by MR SO 6 Q. Mr Yeung, for the benefit of the Commission, can you 7 kindly state your full name? 8 A. Tak Chung Albert Yeung, Y-E-U-N-G. 9 Q. Can you also state your professional address, please? 10 A. Department of civil engineering, University of 11 Hong Kong, Pok Fu Lam, Hong Kong. 12 Q. I understand that you are now provided with a copy of 13 your expert report. Can I take you to page 47 of your 14 expert report, which is page 49 of the PDF file, of 15 bundle ER1, tab 8. Prof Yeung, that's your signature? 16 A. Yes, it is. 17 Q. On the next page, you have also signed on the 18 declaration that you give to this Commission. 19 A. Yes, it's correct. 20 Q. The expert report is dated 7 January 2019? 21 A. Correct. 22 Q. Do you confirm the facts stated in this expert report to 23 be true? 24 A. Yes, I confirm. 25 Q. And insofar as opinion is concerned, do you confirm that</p>
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<p>1 your report and for the earlier work done. Thank you. 2 Your evidence is now completed. 3 COMMISSIONER HANSFORD: We hope you make your lecture or 4 time. 5 WITNESS: I think so. Thank you. 6 (The witness was released) 7 MR CHOW: Just one minor point. I understand that the two 8 books we managed to obtain to show to Prof Au and also 9 to the Commission are from the library. 10 CHAIRMAN: We noticed that. Don't worry. In fact we were 11 looking at the last time it was taken out! 12 MR CHOW: We will ensure that copies of the relevant part 13 will be provided to the Commission. 14 MR PENNICOTT: Very good. Sir, on a slightly more serious 15 note, the sketch that Prof Au has prepared, what I was 16 proposing was to ask Mr Ko to, as it were, remove it to 17 the legal commission's lawyers' room. I will ask 18 somebody in there to just annotate the fact that it was 19 prepared by Prof Au on a particular day. It may be we 20 can give a transcript reference, actually write it on 21 there. Then we will get some photographs taken from it. 22 Then we will bring the diagram back into the room, just 23 in case we need to look at it again, if that's okay. 24 CHAIRMAN: That's excellent. Thank you very much. 25 MR PENNICOTT: Sir, on that basis, I think the next witness</p>	<p>1 those opinions are honestly held by you? 2 A. Yes, I confirm. 3 Q. Prof Yeung, I understand that you have prepared a set of 4 PowerPoint slides to assist this Commission in your oral 5 synopsis. 6 A. Yes. 7 Q. Can I trouble you to now give your oral synopsis to the 8 Commission? 9 A. How much time would I have before lunch? 10 Q. I am given to understand it's ten minutes. 11 MR PENNICOTT: Sir, that's a very fair question for 12 Prof Albert Yeung to ask, because certain 13 representations were made to me yesterday which 14 I confess I had overlooked to draw to your attention. 15 It is a fact that when Prof Au gave his synopsis 16 yesterday, it lasted just short of an hour, and 17 of course that raised some questions from behind me as 18 to what the other experts would be given in terms of 19 time, because we had obviously indicated, as Mr So has 20 rightly said, ten minutes. 21 Now, clearly I've had a very quick look at 22 Prof Yeung's slides, which I think run to 24 slides, and 23 it seems to me pretty obvious that that's not going to 24 be a synopsis that's going to be accomplished in ten 25 minutes.</p>

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1 Sir, I'm in your hands. It seems to me that Prof Au
 2 having been given a fair degree of latitude -- of course
 3 it did involve questions from yourself and
 4 Prof Hansford, so that was bound to extend it --
 5 CHAIRMAN: And he was the first.
 6 MR PENNICOTT: And he was the first.
 7 CHAIRMAN: So he's ploughing a new furrow, so to speak.
 8 MR PENNICOTT: Indeed.
 9 CHAIRMAN: As far as laypersons like myself are concerned.
 10 MR PENNICOTT: Yes, and if I may say so, I think it's fair
 11 enough, in the light of what happened yesterday, for
 12 Prof Yeung to ask the question as to how long he's got.
 13 Sir, I'm in your hands. I think it's simply not
 14 going to be workable to limit this to ten minutes for,
 15 frankly, anybody, any of the experts.
 16 CHAIRMAN: I agree.
 17 MR PENNICOTT: Therefore a degree of latitude ought to be
 18 given. I do think we should make a start, if I may say
 19 so, before lunch, but I don't think -- the Chairman will
 20 obviously give directions -- Prof Yeung should feel
 21 constrained to just have ten minutes.
 22 Sir, perhaps you could give some indication.
 23 CHAIRMAN: Peter?
 24 COMMISSIONER HANSFORD: We are in Prof Yeung's hands, but it
 25 seems to me that certainly the first section of your

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1 presentation, Prof Yeung, is some basics and perhaps you
 2 can give us those basics before lunch, and then we can
 3 digest them and come back to more details after lunch.
 4 A. Shall I give some background on myself first?
 5 CHAIRMAN: Yes, we'd like you to do that. Thank you very
 6 much.
 7 A. I went to the University of Hong Kong and graduated in
 8 1982, so a year after Prof Au, with first class honours,
 9 and then I joined a consulting firm by the name of
 10 Binnie & Partners. For those in UK may be familiar with
 11 it. We are looking for some of the water treatment
 12 works, service reservoirs, and that's the very first
 13 time I got exposed to some sort of seismic design. Even
 14 though back in the 1980s it's not required in Hong Kong
 15 for normal domestic residential buildings, because water
 16 treatment works and services reservoirs are very
 17 important structures and from the government's
 18 standpoint, that is from the Water Supplies Department's
 19 standpoint, if anything happened to Hong Kong, any
 20 disaster, we cannot lose water supply because that will
 21 make things even worse.
 22 So that's one example of how a specific organisation
 23 may impose those special requirements even though it's
 24 not mandatory.
 25 I left the company in 1984 and went to the

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1 University of California at Berkeley on a Rotary
 2 Foundation international scholarship to pursue my
 3 master's degree, and then afterwards I stayed in the
 4 University of California at Berkeley and worked under
 5 the famous professor James K Mitchell, who is one of the
 6 household names for those who like to work on ground
 7 improvement, soil behaviour and so, then I received my
 8 PhD in geotechnical engineering and geo-environmental
 9 engineering in 1990.
 10 Afterwards I went to Boston and started my academic
 11 career there, Northeastern University, and at the same
 12 time also set up my own consulting business.
 13 A year later, I moved down to Texas, to Texas A&M
 14 University, because a large university, also we have a
 15 state research institute in transportation, so I had
 16 chance to do full-scale experiment, like a simple case
 17 like a car crash, how would a car crash a barrier, how
 18 would we respond to it, and stayed in Texas for seven
 19 years or eight years.
 20 My former boss at Binnie & Partners -- because at
 21 that point the company was acquired by an American
 22 company and my former supervisor ended up becoming the
 23 managing director of the company. So he called me up
 24 and said, "Do you want to return to Hong Kong?", because
 25 at that time he got a huge project in Lamma Island,

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1 thinking about a huge reclamation and the government has
 2 concern about dredging. So we are thinking about doing
 3 some sort of ground improvement, like one of the
 4 techniques we mentioned earlier, surcharging. That's
 5 why my former boss wanted me to come home, to be in
 6 charge of the project.
 7 I came back to Hong Kong in 1998 and started work on
 8 that project and also some other projects, and also
 9 I worked for the KCRC looking at all the slopes from
 10 Hung Hom to Lo Wu.
 11 In the year 2000, for those in Hong Kong may realise
 12 there's a huge piling scandal in Hong Kong. Two
 13 buildings in Tin Shui Wai got tilted, and that exceeded
 14 the requirements of the Housing Department. The Housing
 15 Department decided to rectify it. So I led my team with
 16 CM Wong & Associates and Prof Harry Poulos of Australia.
 17 The three teams worked together, we ended up rectifying
 18 the building. It's kind of like a world-class project,
 19 but that's a 41-storey tall building, 123 metres high,
 20 we needed to correct it from tilting, back to
 21 an acceptable standard. That's the chance I get
 22 underneath the foundation and so, but this is probably
 23 all the story I can tell you because the project remains
 24 confidential.
 25 After that one, I started working on some of the

<p style="text-align: right;">Page 93</p> <p>1 expert witnessing cases for the company, also for ICAC, 2 a number of clients, and afterwards I decided to change 3 my career into the government and become Assistant 4 Secretary for Financial Services and the Treasury. So 5 that's one thing I declare in my report. At that time, 6 Mr Frederick Ma, the Secretary for Financial Services 7 and the Treasury, was -- technically we serve together, 8 at the same time. 9 Afterwards, I returned to academics, that's why 10 I joined the University of Hong Kong in 2003, at the 11 same time also doing some of my private practice, 12 working on different type of research projects, also on 13 expert witnessing, consulting projects for contractors 14 and so. 15 So, in a short run, that's basically what I have 16 done in the last 30-something years. I do look into 17 very difficult projects and also some of those like in 18 the case we are talking about now, an underground 19 structure, how an underground structure reacts with the 20 soil and also the rock. So this is something we call 21 the soil structure interaction. We are looking into the 22 geologic material. 23 CHAIRMAN: Good. Thank you very much. 24 COMMISSIONER HANSFORD: Just a question, Prof Yeung. So 25 your area of professional and academic expertise is</p>	<p style="text-align: right;">Page 95</p> <p>1 off to their girlfriends will call something very 2 complicated called equilibrium and then they will throw 3 up an equation, summation, or there's something equal to 4 zero, but the concept itself is very simple. What we 5 mean by equilibrium is the force pulling up equals the 6 force pulling down, and the force pushing to the left 7 equals the force pushing to the right. 8 So now you look at on the left-hand side is 9 a complete specimen. That's exactly -- next to it is 10 what Prof Au mentioned about a free body. So this one 11 takes a little bit of imagination now. Suppose now you 12 cut a part of that material in your mind, and that's the 13 way now we can find out what are the internal stresses 14 actually in the material. So from the outside you see 15 the two forces, one is pulling up, one is pulling down, 16 but what are the stresses? Really in the material we 17 need to do something like what we show here as a free 18 body diagram, cut it open by imagination, so you expose 19 the internal stresses, and then these stresses also need 20 to be equilibrium with the applied forces, and that's 21 how you get those stresses. 22 What will fail material is these internal stresses, 23 when they exceed a certain threshold. So on the 24 left-hand side, what I try to show you is a tensile 25 force, tensile stresses. On the right-hand side is what</p>
<p style="text-align: right;">Page 94</p> <p>1 what? 2 A. Geotechnical engineering, geo-environmental engineering. 3 At the same time now, I also start to work on something 4 in the information technology business. 5 COMMISSIONER HANSFORD: Thank you. Okay. 6 CHAIRMAN: Yes. Perhaps we can start looking at your 7 slides. 8 A. Okay. First is, those who are in engineering or 9 professors, try to excuse me because some of the 10 concepts may be very basic, but I think yesterday we got 11 advised by Mr Shieh we should assume them to be 12 a five-year-old intelligent kid and try to give them 13 some idea what engineering is about. 14 So what I try to start is -- because we've been 15 talking a lot now, since Prof Francis Au was in the 16 witness box, about different types of stresses, internal 17 stresses and so. I think many who are not in 18 engineering probably get confused enough, how can we get 19 internal stresses and so into a material? So I try to 20 clarify that a little bit to make sure everybody is more 21 or less on the same platform when we move forward. 22 Next slide, please. This one is, on the left-hand 23 side, you can see a specimen, and then you can apply 24 a force to it, say upward force and downward force. In 25 engineering terms, engineering students trying to show</p>	<p style="text-align: right;">Page 96</p> <p>1 we mean by shear force now. You get a material, then 2 you try -- on the top, you try to push it to the right, 3 and the bottom try to put it to the left, and that 4 becomes a shear. Then you cut a part of it, cut the top 5 half of it, you will find out now inside this free body, 6 you will have shear stresses. And shear is not too 7 difficult to understand, it's just like you cutting your 8 hair. You cut your hair, that's a shear. That's why 9 sometimes a pair of scissors, we also call it a shear. 10 So that's the way you cut that material. This is the 11 basic concept in shear stresses and tensile stresses. 12 Next, please. Here we see a simple test, we try to 13 find out what is the tensile strength of material, so 14 you can easily see now this one is we try to climb on 15 the top and clamp it at the bottom and then try to pull 16 it. So similar to the slide you see in the previous 17 one, you are pulling a force from the top, from the 18 bottom, and then the tensile stress will be existing 19 within this material. When the tensile stress, which 20 tensile strength material, the material fails, so this 21 is a simple concept about tensile failure, something we 22 have been talking a lot now in this Commission, about 23 a reinforcement bar, coupler assembly, so this is 24 exactly what we are talking about. 25 Next, please. The next one is talking about some of</p>

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<p>1 the shear now. So on the left-hand side is more drastic</p> <p>2 type of things, it's kind of like in a fault line, when</p> <p>3 they start to slip, and that's one of the generations</p> <p>4 for an earthquake. Then on the right-hand side, there</p> <p>5 are two simple examples, they got tightened together by</p> <p>6 a bolt. On the top you see two plates tied by a bolt,</p> <p>7 and the bottom you see three plates tied together by</p> <p>8 a bolt. Now you can easily imagine you apply a force P</p> <p>9 to the left and a force to the right, so one force on</p> <p>10 the top plate, one force on the lower plate, you will</p> <p>11 introduce a shear force on the bolt itself.</p> <p>12 So this is what I want to demonstrate to you what</p> <p>13 a shear force looks like. We will come back to this</p> <p>14 a little bit later when we talk about those bending,</p> <p>15 internal shear or a horizontal joint type of problem.</p> <p>16 Next slide, please. The next one we try to talk</p> <p>17 about is what we call the stress-strain now. You can</p> <p>18 see from here now, as you are applying the stress to</p> <p>19 a material, the material will get longer. The concept</p> <p>20 is not that difficult to understand. It's like when we</p> <p>21 look at our two Commissioners sitting on the chair, when</p> <p>22 you sit on your chair, the first thing you should feel</p> <p>23 now is your cushion goes down a little bit, under your</p> <p>24 weight, your cushion starts to deform. Then by</p> <p>25 deforming that cushion, the load goes down to the chair.</p>	<p>1 that's why in most design purposes, we don't want to</p> <p>2 design the steel beyond the yield point.</p> <p>3 Then also on the same graph now you will see what is</p> <p>4 a tensile strength. So tensile strength is the maximum</p> <p>5 stress that your sample can sustain. At that point, you</p> <p>6 can easily see now that point goes well beyond the yield</p> <p>7 point. If you let go at some point before you reach the</p> <p>8 peak, the material will come back but with a certain</p> <p>9 permanent elongation that cannot be recovered. So</p> <p>10 that's what I'm talking about in those 0.1 mm</p> <p>11 requirement and so.</p> <p>12 Next one, please. In terms of steel now, we got</p> <p>13 a number of different grades in engineering terms, we</p> <p>14 got a 460, 500, 500C, and what those numbers really are,</p> <p>15 those numbers are referring to the yield point. So</p> <p>16 that's what we call the upper yield point on the</p> <p>17 previous slide. At the same time, this one has a very,</p> <p>18 very important significance. We choose the number so</p> <p>19 that no more than 5 per cent of the sample we test will</p> <p>20 have a yield point less than that. That means, if</p> <p>21 I take 100 grade 460 specimen and I test all of them, no</p> <p>22 more than five can have a yield point less than 460.</p> <p>23 COMMISSIONER HANSFORD: Prof Yeung, do we need to, for the</p> <p>24 purposes of this, understand the difference between 500B</p> <p>25 and 500C, or is that not really relevant?</p>
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<p>1 So now the structure of the chair will feel the stresses</p> <p>2 inside it. Then eventually that loading will go down to</p> <p>3 the floor. So that's exactly, when you look at</p> <p>4 a structure, how the force gets transformed downwards.</p> <p>5 Everything will get deformed when you apply a load to</p> <p>6 it. Steel is no exception, as you can see from here</p> <p>7 now.</p> <p>8 In the initial part, you will see as you apply a</p> <p>9 stress, your deformation starts to increase, so this</p> <p>10 part is more or less linear. So it depends on your</p> <p>11 material, looking at steel, looking at plastic, they may</p> <p>12 deform in a different way.</p> <p>13 But then steel has a certain special characteristic,</p> <p>14 you can see from here now, if you keep increasing the</p> <p>15 stress, the strain will keep increasing, up to a certain</p> <p>16 point, you see in the drawing, called an upper yield</p> <p>17 strength. At this point you will find out the stress</p> <p>18 will start to drop. In engineering application, that's</p> <p>19 where we call the yield point. Yield point is one thing</p> <p>20 very important now, if you load something beyond the</p> <p>21 yield point, and then when you let go the load, it won't</p> <p>22 come back to the origin so you will create a permanent</p> <p>23 deformation. If you load up the steel and let go the</p> <p>24 load before you reach the yield point, it will come back</p> <p>25 to the origin. So something very important now is</p>	<p>1 A. They are different types of steel, but I think for this</p> <p>2 Commission we only talk about 500 and 460.</p> <p>3 COMMISSIONER HANSFORD: Thank you.</p> <p>4 A. And the next one comes up with some useful numbers</p> <p>5 I think this Commission has been seeing over and over</p> <p>6 again. So if you look at that 460, if you multiply that</p> <p>7 by 1.15, that's what you see all the time now about this</p> <p>8 529. So 529 is increase 460 by 15 per cent.</p> <p>9 What that really comes from is that comes from the</p> <p>10 CS2, Construction Standard of Hong Kong, back to 1995.</p> <p>11 So that's how we decide what the tensile strength is.</p> <p>12 From the yield point, you add another 15 per cent to it.</p> <p>13 So that's the old Construction Standard.</p> <p>14 When you are looking at the problem we have in hand</p> <p>15 now, talking about ductility, talking about coupler</p> <p>16 assembly, if you look at the testing requirement, we</p> <p>17 need that coupler to have a tensile strength to be</p> <p>18 25 per cent more than the yield strength. So that's why</p> <p>19 I showed you there are two numbers here, for the 460</p> <p>20 steel, the tensile strength needs to be greater than</p> <p>21 575MPa. If you are looking at 500 steel, you need to be</p> <p>22 greater than 625. So those are something very important</p> <p>23 when we move into talking about the ductility</p> <p>24 requirement.</p> <p>25 Also in this particular Commission, we are talking</p>

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<p>1 about 40mm bar all the time, so what I did is I take the 2 stress, multiply by the area of a 40mm diameter bar and 3 that's how we come up with the three numbers, 4 664.8 kilonewton, 722.6 kilonewton and 785.4 kilonewton. 5 So those correspond to the tensile strength of the 6 material. 7 So what I really means is a 40mm bar can take up so 8 much load before it fails in tension. 9 COMMISSIONER HANSFORD: Prof Yeung, I can't remember if it's 10 come up elsewhere in the Commission so far but can you 11 tell me when Hong Kong changed from 460 to 500? 12 A. In fact, it's not only Hong Kong. The problem actually 13 is if you look at the old CS2, the Construction Standard 14 of Hong Kong, it was published in 1995, you find the 460 15 in it. If you look at the new one we are looking at for 16 now, it's 2012, in that one you don't see 460 anymore 17 now. So in between the certain evolvement, and what 18 happened is, in the market, the manufacturer actually 19 changed all the steel to 500, and simply because -- 20 COMMISSIONER HANSFORD: When did they do that? 21 A. You are talking about now more than ten years ago, but 22 then because the Hong Kong Code has not been changed 23 into 500, so what happened is those manufacturers would 24 not particularly make the steel for one small market 25 like Hong Kong. So what they do is they are actually</p>	<p>1 Prof Yeung has made reference to, and it may be that 2 despite the fact that all the contractual documents 3 refer to 460, as a matter of fact something else may 4 have happened. 5 COMMISSIONER HANSFORD: That's what I suspected. 6 MR PENNICOTT: So, sir, we are a little bit, I have to say, 7 in the dark. One can make certain deductions from 8 looking at certain documents that it must have been 500. 9 But on the drawings, in the specification, in the bills 10 of quantities, and by reference to CS2:1995, you will 11 find the references to 460, not to 500. 12 COMMISSIONER HANSFORD: I understand that, but as I think 13 you have just suggested, Mr Pennicott, Leighton, and 14 presumably also Intrafor, ought to know what steel was 15 delivered to them. 16 MR PENNICOTT: One would have hoped so. 17 COMMISSIONER HANSFORD: It would be quite useful, perhaps, 18 for us to be advised of that. 19 MR PENNICOTT: Yes, sir. I don't want to belabour the point 20 too much but you may recall in the evidence that there 21 was an audit, the only audit done by the Buildings 22 Department and Pypun, in January 2014. 23 COMMISSIONER HANSFORD: Yes. 24 MR PENNICOTT: It's interesting, if one looks at the results 25 of that exercise, on the face of the documents you would</p>
Page 102	Page 104
<p>1 selling the 500 steel to Hong Kong and say it's 400 -- 2 460. 3 COMMISSIONER HANSFORD: So what you are telling us is, 4 Prof Yeung, in the last ten years all the steel produced 5 for Hong Kong -- in fact for everywhere -- has been 500? 6 A. That's correct. 7 COMMISSIONER HANSFORD: Thank you. 8 MR PENNICOTT: Sir, I will be asking Mr Yeung some questions 9 about that particular topic a bit later. 10 COMMISSIONER HANSFORD: That's fine. 11 MR PENNICOTT: But I am bound to say that it would be very 12 helpful to us if we actually knew -- and presumably 13 Leighton apart from anybody else ought to be able to 14 tell us -- what bar was used, both in respect of the 15 bars for the diaphragm walls and the bars for the slabs. 16 COMMISSIONER HANSFORD: Yes. 17 MR PENNICOTT: I think as Prof Yeung has correctly 18 identified, unfortunately, so far as the contract is 19 concerned between the MTRC and Leighton, there is no 20 doubt that it's the Code of Practice 2004, for concrete, 21 and as Prof Yeung has just described it, the old 22 Construction Standard, that is the CS2:1995, that as 23 a matter of contract applies between MTR and Leighton. 24 Unfortunately, the work appears to have been carried 25 out during this sort of transitional period that</p>	<p>1 have thought that a 460 bar or a series in fact, about 2 27 460 bars were tested. However, having discussed it 3 with the Commission's expert, in terms of the results 4 that were thrown up by that testing, you might conclude, 5 despite the fact that it says 460, it was more likely to 6 have been a 500 bar. But that's speculation on my part 7 and just a deduction from the results that that document 8 shows. 9 COMMISSIONER HANSFORD: Okay. What I'm unclear of at this 10 point is how critical that is to the conclusions this 11 Commission may be asked to reach. 12 MR PENNICOTT: I think there's one that's probably common, 13 that if a 500 bar was used, that's stronger than a 460. 14 COMMISSIONER HANSFORD: I've got that. Indeed. Thank you. 15 MR PENNICOTT: Sorry, Professor. 16 A. That's fine. Indeed, to add a few points, you will find 17 out Code of Practice normally evolves with time. So you 18 can find out, if you look into the Code of Practice in 19 2004 or CS2:1995, when they try to test the coupler, you 20 may not have those cyclic test and all those things. 21 But then eventually you will find out now, in the QSP 22 submitted by BOSA, they actually quote another standard 23 in there, so that's what they call the AC133, if you 24 look into that QSP. The AC133 practically is the later 25 CS2:2012, because these things start to evolve and you</p>

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<p>1 see how people using a good thing, pretty much transfer 2 that into your code. That's pretty much what's 3 happening. 4 So you try to compare what BOSA is doing, they are 5 actually doing most of the stuff according to the 6 CS2:2012, rather than the 1995 version, simply because 7 that additional requirement for AC133. Also, at the 8 same time, in the QSP, BOSA also add in one particular 9 requirement. It's the bar-break criteria. That means 10 when you try to pull, you need to have the bar to break 11 and not the coupler to break. 12 COMMISSIONER HANSFORD: But from what I've just heard from 13 you, Prof Yeung, and indeed from Mr Pennicott as well, 14 it seems that perhaps we've had a design with 15 an expectation of one particular type of steel, but 16 actually the construction was with a higher grade of 17 steel. That appears to be the situation, and I just 18 don't know how that affects the conclusions this 19 Commission is going to be asked to reach. 20 But perhaps we'll leave that at the moment and 21 perhaps the other experts might address that as well. 22 WITNESS: Okay. 23 CHAIRMAN: Yes. I'm thinking, Professor, it seems to me 24 we've stopped for a brief discussion on matters and we 25 are close to five past one now, so we might break for</p>	<p>1 structures will be designed for seismicity, so that's 2 why we need type II mechanical coupler. It's also 3 stated in the QSP submitted by BOSA and then later 4 submitted to the BD by MTRC. I think we have a lot of 5 questions so far talking about what is mandatory, what 6 is required. I think once you submit your drawing to 7 the BD and once BD approve it, and then you apply for 8 consent to commence work, that drawing becomes a legal 9 document. 10 So I think by the Buildings Ordinance, chapter 123, 11 you need to follow what is approved to construct 12 whatever you need to construct, unless you want to 13 submit amendment to it. 14 So once you get to that point, that becomes 15 a requirement. 16 If you look at the QSP, the testing regime proposed 17 by BOSA, and they also need to adopt the AC133, and that 18 is where the 125 per cent comes from. It's not from the 19 CS, because what we talked about, CS at that point, 20 1995, do not have that requirement. That's the reason 21 why BOSA need to supplement the requirement by the 22 AC133. As what I mentioned this morning, the AC133 23 requirement is technically the same as CS2:2012. 24 Next slide, please. The number of threads being 25 engaged, I think we get a lot of discussion on this</p>
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<p>1 lunch and then you know the spot you are in as far as 2 you can launch yourself from that position when we 3 return. 4 WITNESS: Okay. 5 CHAIRMAN: Good. 6 Although you are an expert witness, you are in the 7 course of giving your testimony, and all witnesses, 8 expert or not, are required, when they are in the middle 9 of giving their testimony, to not discuss their 10 testimony with anybody else; okay? 11 WITNESS: Fully understood. 12 CHAIRMAN: Good. Thank you very much. We will return then 13 at 2.20. Thank you. 14 (1.03 pm) 15 (The luncheon adjournment) 16 (2.24 pm) 17 CHAIRMAN: Professor. 18 A. Okay. So I think these are the numbers we see all the 19 time in this Commission, so this sort of explains where 20 the factors come from, where the numbers come from. 21 Next slide, please. The next one we are looking at 22 is what type of coupler is really required for this 23 contract. This one is an MTR project, so MTR follow 24 their own design standard manual, and the standards 25 design manual states, starting from 2009, all the new</p>	<p>1 chart, and actually this chart I try to show all the 2 data we have so far. So this chart may need a little 3 bit more explanation. 4 The first thing we want you to look at is the solid 5 circle. The solid circles basically are the calculation 6 that we saw this morning, done by BOSA. So what BOSA 7 did they assume a tensile strength of 529, as in the 8 number I showed you earlier, it's 1.15 times 460. Based 9 on that tensile strength, they deduced the shear 10 strength of the threads. So the calculation they did is 11 something -- a very simple scenario is -- they simply 12 assumed the threads engaged each other, when you try to 13 pull them, they just shear off all the teeth or all the 14 threads. That's exactly how they calculate. So that's 15 why they need the shear strength of the material. 16 That's exactly what you see now, from one turn, two 17 turns, three turns, all the way to ten threads get 18 engaged, and you see the straight line as what Prof Au 19 mentioned this morning. It is simply a linear 20 relationship between the available -- the tensile stress 21 you can do in the bar to the number of threads engaged, 22 but that may or may not be true, because BOSA simply put 23 in a very simplistic model for the calculation. 24 Then now you can look at the open circle. The open 25 circles are the experimental results from the five ones</p>

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1 that we saw so far. So you can see now I try to adopt
 2 the same symbol you have seen in those reports, so "S"
 3 stands for slipout at four threads, and then the "C"
 4 stands for the failure in the coupler, and then the "B"
 5 stands for the fracture in the bar.
 6 When you look at this circle, look at the first one
 7 with "S", it looks like it's very close to the
 8 theoretical calculation, but in fact now is, if you
 9 think about more detail, the solid circle is based on
 10 a tensile strength of 529, and this bar may actually be,
 11 as what we've been discussing so far, 500 with a tensile
 12 strength of 625. And if you use those numbers to
 13 recalculate, BOSA's calculate, those red dots should be
 14 a whole lot higher because you get a higher shear
 15 strength, so for each thread get engaged, they can take
 16 more stresses.
 17 So from there onwards we can simply look at the
 18 experimental data, assuming they are all correct, and
 19 then you can already verify that the model they use for
 20 calculation is not really accurate.
 21 The second thing you can see now is for the last
 22 one, and they purposely try to test the coupler
 23 strength, so they put in a very, very strong bar with
 24 a 900MPa, and this one, they test it, the coupler
 25 strength, they got 788-something. From this chart now,

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1 assuming everything is okay, you can still see now, for
 2 the three samples, that failed by fracture in the bar
 3 itself, the number fluctuates. And more important now,
 4 you can see now the two couplers, one coupler fracture
 5 at 6-something, the other one at 780-something. So that
 6 shows you now the variability of the material itself and
 7 so on.
 8 If we move forward, try to look at the data in more
 9 detail, you will find out now there are more questions
 10 we want to ask.
 11 Next slide, please. This is what I just talked
 12 about, this is what they assume and do all the
 13 calculations, and what we find out is the experimental
 14 data is actually smaller than what they calculate or in
 15 fact the threads are weaker than they assume in the
 16 calculations.
 17 Next, please. When you look at the original report,
 18 a few things you should notice now is -- number one, you
 19 can still see the stamp "preliminary" so this is not
 20 finalised yet. And as we talked about this morning,
 21 CASTCO may be a reputable lab in Hong Kong and in
 22 Hong Kong, as all of us may realise, we've got a system
 23 called HOKLAS. So HOKLAS try to certify all the
 24 designs, but in all the reports now submitted by CASTCO
 25 we did not see their stamp it. So we are not quite sure

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1 what system they followed to run the tests and what's
 2 the procedure, how did they go along with that one, how
 3 did they need to report it, and also in the report
 4 I don't even see a picture of the failed sample.
 5 COMMISSIONER HANSFORD: Sorry, I don't quite understand
 6 something you've just told us. You said the report is
 7 stamped "preliminary".
 8 A. Yes.
 9 COMMISSIONER HANSFORD: Is there an expectation we are going
 10 to receive a final report?
 11 A. I think that's the normal practice, but so far I haven't
 12 seen a final report.
 13 MR SO: Professor, if I can assist, the preliminary report
 14 actually turned up yesterday. It's in bundle H25,
 15 H44521, if we can take a look at the actual worksheet of
 16 it. They are consistent in five different worksheets
 17 for each sample, H44521 all the way to H44526.
 18 COMMISSIONER HANSFORD: There's nothing on my screen yet.
 19 MR PENNICOTT: H25/44521.
 20 COMMISSIONER HANSFORD: Sorry for the interruption. I just
 21 wanted to understand this point.
 22 A. Now --
 23 COMMISSIONER HANSFORD: Hang on. We haven't got there yet.
 24 MR PENNICOTT: The screens are all blank.
 25 COMMISSIONER HANSFORD: The interruption continues.

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1 MR SO: Professor, I don't want to lead you into give
 2 evidence, or give evidence myself over the bar table,
 3 but if you can take a look at the bottom of the sheet,
 4 can you explain yourself to the professor and to the
 5 Commission?
 6 A. So this is a stamp we see now in the lower right-hand
 7 corner, "Preliminary report".
 8 COMMISSIONER HANSFORD: Right.
 9 A. Also on top now, you see the "Specified yield strength
 10 of bar", and there's no number recorded there. It was
 11 typed "900" and then it got crossed out and somebody
 12 initialled it.
 13 COMMISSIONER HANSFORD: Okay. I understand what you're
 14 saying. I'm just puzzled as to why this is preliminary
 15 and just wondering whether there's an expectation of
 16 receiving something that's less preliminary. Maybe I'll
 17 just leave that hanging at the moment. Please --
 18 MR SO: I can't assist in any way.
 19 COMMISSIONER HANSFORD: Okay. Thank you. Please continue.
 20 A. Also, if you look at the five sheets now you find out
 21 for those who try to run on a coupler, with normal
 22 running with different percentage of threads engaged and
 23 we don't see the strength of the bar, I think except for
 24 the very last page, there's an H44526, I think this is
 25 the one they purposely tried to put in a very strong bar

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1 and tried to fail the coupler.
 2 Here is another problem now I have. When they say
 3 the coupler failed, do they mean the body of coupler
 4 failure or they simply say the thread, the inside thread
 5 of the coupler failure? Because these bars are supposed
 6 to be very strong bars; I don't expect the thread of
 7 this bar would fail. So the failure mode will remain
 8 unknown and also now they should have a final report and
 9 typically they should have a picture of the failed
 10 sample so we can look at it to see what happened.
 11 So these are some observations I make from this
 12 calculation and then also the lab data. The tensile
 13 strength of the test bar is unknown, so I probably
 14 assume it's something like 500MPa bar. Then, from this
 15 one, we can compare now, the strength of coupler
 16 assembly is lower than the calculated value.
 17 So that shows one thing very important now is the
 18 model being used by BOSA for the calculation may be too
 19 simplistic. And also from here now you can see for the
 20 three bars that fail in the bar, it varies from 663 to
 21 705. So it's quite a variability in the material.
 22 Then more important now, you can look at the two
 23 couplers' failure, one is 630, one is 788. So you can
 24 also see now the huge variability, even for two samples.
 25 If I can go back to the chart, so go back to

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1 slide 12, and by looking at this one now, even though
 2 you have no doubt on all the data, you will find out
 3 now, if I want to achieve 625MPa for a 500 bar, and you
 4 can see from here now is, you need more than six
 5 threads, even from this set of data, that we still do
 6 not have full confidence in. You can see the three Bs,
 7 they are all on the right side of "6".
 8 Next slide, please. By looking at this data now, we
 9 have a couple of questions we need to ask. When you see
 10 the result, the first question I ask is: where do the
 11 samples come from? How representative are these samples
 12 to what we have constructed in the site? So there is no
 13 evidence or any indication where these samples come
 14 from. Then the number of samples, so far I have seen
 15 only one set of samples. So can we rely on -- because
 16 on this site we are talking about more than 20,000
 17 couplers -- can we rely on one set of samples and try to
 18 make deduction on the behaviour of these 20,000
 19 couplers?
 20 Then this one is the standard of testing, we don't
 21 know, we don't know what's the testing protocol or maybe
 22 as the Chairman suggests now, they may try to do this in
 23 particular for the Commission, without thinking through
 24 all the detail. Because if we look at all the testing
 25 protocol, we spent years to develop them on every small

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1 detail. Also, we can look at the accuracy of reporting,
 2 as what I mentioned just now is, we don't even know what
 3 is the strength of the bar they are using and there's no
 4 document on how the sample fail except you get
 5 a letter B, a letter S. What do they mean by slipout?
 6 I still don't understand. Are they failing the threads
 7 or the bars simply slip out from the engagement, or have
 8 they really sheared the thread yet? So that will be
 9 a different failure mode that will shed more light on
 10 how we should do the calculations.
 11 On the other hand is talking about how many threads
 12 we need is this letter we extract from 7 January, from
 13 the BOSA letter. So they put it here very clear, say:
 14 "Please note further if rebars are not spliced
 15 butt-to-butt, the coupler assembly will be loose."
 16 And also they try to answer a question by the
 17 Buildings Department and they say:
 18 "Regarding your question on how a partially engaged
 19 coupler would perform in permanent elongation test [that
 20 is part of the AC133 test], static compression and
 21 tension tests and cyclic tension-and-compression tests,
 22 it is our opinion as explained in paragraph 4 above,
 23 that it is unlikely that such couplers, without being
 24 spliced butt-to-butt and are therefore loose, will
 25 survive permanent elongation, and cyclic

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1 tension-and-compression tests."
 2 So although now BOSA has not done the tests yet,
 3 it's from their experience, and so they consider this
 4 one may not be able to satisfy the requirement for
 5 a type II mechanical coupler. Those are what we need
 6 for the cyclic tension/compression test and permanent
 7 elongation test.
 8 But they did also make a statement there:
 9 "... with sufficient partial engagement of threads,
 10 such couplers should survive static compression and
 11 tension tests in accordance with our design, subject to
 12 sufficient tests to be conducted for verification."
 13 So even though they are not very confident on the
 14 small number of tests now, even though they show they
 15 might be able to survive the static compression and
 16 tension tests. So that's some of my observations from
 17 here.
 18 Next slide, please. The next one I want to talk
 19 about is the measurement of embedment depth. If we look
 20 at the test we are using now is, we try to send in
 21 an ultrasound wave to the end of the bar and let it
 22 reflect, pick up a reflection. So actually what we
 23 measure is from the point of measurement to the end of
 24 the bar. We are not trying to measure how many threads
 25 get engaged. So that's one thing I think everybody

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1 should be clear about. We are measuring how long the
 2 bar should be embedded into the coupler, but we don't
 3 know how many threads are actually engaged, but then how
 4 much tensile force can be transmitted depends on how
 5 many threads get engaged. So this is something we may
 6 need to allow for certain allowance here.
 7 Also, BOSA will say now we need ten full threads
 8 engagement for correct installation. In fact they also
 9 mention they need 40mm.
 10 Next, please. So, at the same time now, they also
 11 mention, in their bars, they got a 2mm chamfer at the
 12 end. That means, at the chamfer location, they cannot
 13 start putting the thread. So basically, if they need
 14 ten threads, each one with a 4mm pitch, plus that 2mm
 15 chamfer, you need an embedment length of 42mm.
 16 So, now, looking at the equipment they are using
 17 now, we are saying we've got a plus/minus 3mm. So
 18 currently the government try to accept 37, but when we
 19 accept 37 in the measurement, what we really mean is the
 20 actual embedment length is between 34 and 40. So you
 21 got a 50 per cent chance they are higher than 37,
 22 towards the 40mm, and at the same time they've got
 23 an equal 50 per cent chance they are less than 37 and
 24 acting towards 34.
 25 But one thing very important now is there's no

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1 chance the embedment length is greater than 40, because
 2 you measure 37, you are ranging from 34 to 40. Even
 3 though it measures 40, there's still a 50 per cent
 4 chance it's less than 40.
 5 COMMISSIONER HANSFORD: Sorry, Prof Yeung, how does that
 6 reconcile with your previous slide that said required
 7 embedment length 42 millimetres?
 8 A. What I try to -- the point is if you want to get ten
 9 threads engaged, the actual embedment length needs to be
 10 42.
 11 COMMISSIONER HANSFORD: But it can't because the coupler --
 12 if you have butt-to-butt connection --
 13 A. You get 44 inside. The total length is 88, so each side
 14 gets 44.
 15 COMMISSIONER HANSFORD: I understand.
 16 A. But then coming to what we are measuring now, if we take
 17 40, there's still a 50 per cent chance we are smaller
 18 than 40. So that's why I'm not supporting the idea of
 19 using 37. The 37, you can be as short as 34, and that's
 20 exactly what the plus or minus 3 means.
 21 For the next slide, we are talking about the top of
 22 the connection between the diaphragm wall and the EWL
 23 slab, and for this picture I need to give credit to
 24 Mr Southward. I take this picture directly from his
 25 report. This report is very illustrative in the sense

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1 that you can see three different types of bars. When
 2 I went to engineering school the first thing I learned
 3 is to do engineering drawing, and the first thing I was
 4 told by my professor is even though you try to do
 5 a sketch, try to do things in scale. So I think
 6 Mr Southward may think the same way.
 7 If you look at this one now, it's very interesting,
 8 if you look at the thickness of the diaphragm wall, it
 9 should be about 1.2 metres; we all know that. Then if
 10 you look at these bars now, they are probably a little
 11 bit more than 1 metre on one side and a little bit more
 12 than 1 metre on the other side. So one thing now I do
 13 not have evidence is: is this really the bar
 14 configuration? That means the bar is not really
 15 continuous but one bar with two lap lengths on the other
 16 side and then the steel from the EWL actually have a lap
 17 now with a bar sticking out from the diaphragm wall.
 18 The second thing I'm looking at now are the blue
 19 bars. The blue bars are supposed to be vertical bars in
 20 the diaphragm wall, and my question is where do they
 21 stop? Are they stopped below this horizontal bar or
 22 they are stopped at the same level as the top horizontal
 23 it bar, as indicated in the drawing? I think this is
 24 the one thing we need to verify on site in the
 25 opening-up exercise.

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1 That's one thing -- next slide, please -- if you
 2 look at this one now, the one on the right is currently
 3 what we open up, and that's where we see two bars. But
 4 at the same time, in that two bars, I don't see the
 5 vertical bar so far. So maybe that vertical bar -- or
 6 the vertical bar actually stops well below that
 7 horizontal bar.
 8 At the same time now, on the proposed further
 9 opening-up location I show in this figure, you can see
 10 on the left that I colour yellow, and that's a very
 11 important thing, we need to see whether this bar is
 12 actually a straight through-bar instead of a lap at that
 13 location. I think about it is for good reason, because
 14 the original design is supposed to be a coupler there,
 15 they will hook up a lap bar and then the bar from the
 16 other side will lap right there. So, if the worker has
 17 already started cutting up all the bars, they might try
 18 to create a lap right there. So that's one thing we
 19 need to confirm now is, this is a really straight
 20 through-bar? The only way we can confirm it is try to
 21 open up the location shown in yellow in this figure, so
 22 we can look at that one to make sure there is no lapping
 23 of bar at that location, to confirm it's a through-bar.
 24 At the same time, the current location still useful,
 25 that we can check up where did the vertical bar stop; do

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1 they stop below all the horizontal bars or they are
 2 really like this drawing and stopping on the top -- to
 3 the top of the structure of the diaphragm wall?
 4 The other thing is we are talking about these
 5 construction joints and this picture is what I took from
 6 the proposal of MTRC. On the left-hand side, if you
 7 look at the original design, the diaphragm wall is right
 8 there and the EWL slab will key into the diaphragm wall
 9 full shear key, so it's not just connected to
 10 a construction joint. So this one, they already think
 11 about it in the original design.
 12 Next slide, please. The next one is I try to
 13 explain quite a complicated concept, when we are talking
 14 about how the bending will induce shear stress inside
 15 a member. To make life simple, I try to look at
 16 a couple of cantilevered boards you see on the top. If
 17 you look at the three boards, they are in parallel to
 18 each other, they are horizontal. So you can look at
 19 this one now, look at each one of them, when they are
 20 horizontal, without any load, without any deformation,
 21 the top and the bottom are of the same length. You can
 22 see they are parallel lines, the top and the bottom,
 23 same length.
 24 If you look at the lower left-hand corner, if you
 25 put a P on it, it will start to bend. Once they start

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1 to bend, you can easily see if these three boards are
 2 not tied together, you can see the second bar will try
 3 to extend a little bit out from the first one. The
 4 reason for that is when you start to bend that, for each
 5 bar on the top is under tension and the bottom is under
 6 compression, so the bottom is shorter and the top is
 7 longer, and that's why the top of the second one will be
 8 longer than the bottom of the first one.
 9 Now, if you try to tie them together before you bend
 10 it, what's going to happen? What that would mean is, if
 11 you think about it from the second figure, that means
 12 the bottom of the first board will get lengthened a bit
 13 and then the top of the second board will get shortened
 14 a little bit, so that they've got the same length. So
 15 that's where the shear stress occurs. Through that
 16 shear stress, you change the length of the boards so
 17 they can bend together.
 18 I think that is a good explanation for you to
 19 appreciate, if you get things like this, when they try
 20 to bend, that soon will happen, you get shear stress
 21 inside. If these three boards, when you start with,
 22 already are one board, the shear stress will be inside
 23 the board itself. But if you think about like in a
 24 construction joint, you got a weak spot in there, and
 25 that's where he we start to worry about whether the

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1 shear stress can be transmitted. I think that's what we
 2 are talking about why we need calculation for the
 3 construction joint in the diaphragm wall.
 4 Another thing very important is, I think as Mr Shieh
 5 mentioned yesterday, a big chunk of concrete and that's
 6 not really a true picture of it, it's not a big chunk of
 7 concrete; those are actually three chunks of concrete.
 8 One thing very important I think we need to understand
 9 is when concrete hardens, that is a chemical process.
 10 That means once it's hardened, you can't add water to it
 11 and it will dissolve again because a chemical reaction
 12 is not reversible.
 13 Once you form a construction joint, when you pour
 14 the next pour of concrete on it, in engineering terms,
 15 that new concrete may not bond to the old concrete, or
 16 in lawyers' terms they are not glued together, unless
 17 that surface, you need to do a special preparation on
 18 it, like you need to expose all the aggregate and so, so
 19 they can bond together, but you need a special treatment
 20 on it.
 21 COMMISSIONER HANSFORD: Which is the normal process for
 22 a construction joint, isn't it?
 23 A. Which is normal process for a construction joint, yes.
 24 COMMISSIONER HANSFORD: Thank you.
 25 A. So if you can see enough evidence that has been done,

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1 that may not be a problem, and otherwise you may try to
 2 do a check now, to see whether, if that shear strength
 3 of that layer gets reduced, can the structure still
 4 remain safe?
 5 This is the last one, try to demonstrate the same
 6 concept to you, so when you get two stacked together, if
 7 the interlayer surface is not bonded together, you can
 8 see what happens on the left. If you get it bond
 9 together, you can see the led line there, and that's how
 10 you use the shear stress, to make sure the two will bond
 11 together and then they bend together and become
 12 a stronger element.
 13 So it's the same concept as what I tried to explain
 14 in the previous slide and that's exactly why we are
 15 talking about when you try to bend an element, you get
 16 shear stress inside. I hope everybody got the idea.
 17 It's a simple illustration.
 18 CHAIRMAN: Thank you very much.
 19 MR SO: Prof Yeung, just before I pass the ball to another
 20 counsel, I wish to raise a last matter with you.
 21 Can you be brought to OU314, please. Professor,
 22 this is the result of the opening-up up until 12 January
 23 2019. I use this version because Prof Au was given this
 24 version yesterday.
 25 A. Okay.

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1 Q. Prof Yeung, what is your expert opinion in light of
 2 these opening-up results?
 3 A. These results now, we can see from here, on the fourth
 4 column -- the fourth column says "Purpose". As you can
 5 see from the MTRC proposal, they did say about the
 6 opening-up for two purposes. Purpose number one is try
 7 to confirm the as-constructed detail, and purpose number
 8 two is try to confirm the workmanship and also to see
 9 whether some of the threaded bars have been cut or not.
 10 You can look at this one now, to say the engagement
 11 length, most of them are less than 40. So what that
 12 means is it's less than the number recommended by BOSA,
 13 and also that means now you do not have that spliced
 14 butt-to-butt as required by BOSA.
 15 So depending how many are here -- probably I don't
 16 have the calculator to do a calculation -- and also the
 17 second one you can do from this number, if you look at
 18 the second column -- sorry, the sixth column and the
 19 seventh column, that means the last two columns, you can
 20 actually deduce the total length of the threaded section
 21 of the bar. So because you know what's embedded inside
 22 and what's the number of threads exposed, and also we
 23 know the pitch of the thread is 4, 4mm. So by taking
 24 the number of threads exposed times four, you know what
 25 is the total length of thread outside the coupler.

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1 Using that one, added to the one embedded in the
 2 coupler, you can find out what's the total length of the
 3 threaded section. Theoretically, there should be 44 to
 4 48, according to BOSA, because they say design for 44,
 5 with 4mm tolerance possible, and then from here you can
 6 find out the total length to see how they fit in that
 7 range, and then you can see now whether the threaded
 8 section is shorter than the design, and there may be
 9 possibility it has been cut. But at this point I don't
 10 want to use that term because we cannot find the cut
 11 section to prove they actually cut, because it can also
 12 be a manufacturer defect, they did not make the thread
 13 long enough or whatsoever. But by looking at these
 14 numbers, we can check out whether the total length of
 15 the threaded section fits the specifications.
 16 COMMISSIONER HANSFORD: Just on that last point, Prof Yeung
 17 are you saying that there is any indication here of
 18 anything being cut?
 19 A. May I refer to my analysis?
 20 COMMISSIONER HANSFORD: My question is: can you see if
 21 there's any indication from these two columns as to
 22 whether there's anything cut?
 23 A. I would say that shorter than 44. Whether they are cut
 24 or not, I don't know. If you look at --
 25 COMMISSIONER HANSFORD: So you are saying they could be

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1 shorter than 44, but then you have also told us about
 2 tolerances.
 3 A. Yes.
 4 COMMISSIONER HANSFORD: So my question is: can you see
 5 definitively whether anything here is cut?
 6 MR SO: Perhaps, Prof Yeung, can I draw your attention to
 7 sample 48, for example.
 8 A. Sample 48, okay.
 9 Q. We saw here the engagement length is 33.98.
 10 A. Yes.
 11 Q. And the number of exposed threads is zero.
 12 A. Zero.
 13 Q. So, according to your expert analysis, what will be the
 14 conclusion?
 15 A. This one, we measure 33.98; right? Let us be fair to
 16 the measurement. 33.98 is close to 34; right?
 17 COMMISSIONER HANSFORD: In fact it's pretty difficult to
 18 measure 33.98, isn't it?
 19 A. So let us say it's 34.
 20 COMMISSIONER HANSFORD: Let's call it 34.
 21 A. Then we understand, we may get an error of plus or minus
 22 3mm; right? So, when you measure 34, the maximum length
 23 will be 37, if I give them all the benefit of the doubt;
 24 right? 37 is still 7mm shorter than 44. I'm not
 25 talking about the tolerance 48 and so. Let's take the

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1 shortest possible length of the thread that we expect
 2 and give them the longest possible length as we measure.
 3 Then you are still 7mm short.
 4 In my report, I try to do the analysis, what's the
 5 minimum possible length, the maximum possible length of
 6 the threaded section and what's the average.
 7 COMMISSIONER HANSFORD: So is the answer to my question that
 8 on that particular sample, there is, in your view,
 9 a possibility of it being cut?
 10 A. Yes.
 11 COMMISSIONER HANSFORD: Thank you.
 12 MR SO: Thank you. Prof Yeung, the remaining procedure
 13 would be like this. Counsel for the Commission will get
 14 to ask questions to you first, and counsel from other
 15 parties may or may not have questions for you. The
 16 Chairman and the professor would, when they deem fit,
 17 ask you questions. Please remain seated. Thank you.
 18 Examination by MR PENNICOTT
 19 MR PENNICOTT: Prof Yeung, good afternoon.
 20 A. Good afternoon.
 21 Q. As I think you know, my name is Ian Pennicott, I'm one
 22 of the counsel to the Commission. I know we've met
 23 before.
 24 A. Yes.
 25 Q. Thank you very much for coming along to give evidence to

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1 the Commission, and thank you for your report.
2 Prof Yeung, can you just for the record tell us when
3 you were first contacted by or on behalf of China
4 Technology to give evidence to the Commission?
5 A. Probably second week of December.
6 Q. Right. So between about 7th and 10th, 12th --
7 A. About 14th, because I got accepted by the Commission on
8 the 14th.
9 Q. Well, you got accepted by the Commission. I know in
10 your report you have this notion that there's an expert
11 panel. Well, there isn't.
12 A. Okay.
13 Q. The Commission has, as you know, its own expert, in
14 Prof McQuillan, and various parties have their experts
15 as well, and you have been appointed by China
16 Technology --
17 A. Mm-hmm.
18 Q. -- and you were obviously accepted by the Commission as
19 an independent expert. Nobody is querying your
20 independence, Prof Yeung.
21 Can I ask you this next. In your report, in
22 a couple of places, you make reference to the fact that
23 you have not seen certain photographs that were taken on
24 the two visits that the experts made to the site. Do
25 you recall that?

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1 A. I have seen those on the 17th. I'm saying I did not see
2 those on the 19th.
3 Q. Do you know why you haven't seen them? Were they not
4 given to you, made available to you, by China
5 Technology's solicitors?
6 A. China Technology passed the photographs of the 17th,
7 some of the 17th photographs, to me. I'm not sure those
8 they are all the photographs that we took on that day,
9 because there was only one person taking all the
10 photographs.
11 Q. I understand that. So far as the 19 December
12 photographs, what about those? You haven't been given
13 those at all?
14 A. No.
15 Q. For the record, they are photographs that have been made
16 available to everybody, all the firms of solicitors
17 acting for the parties.
18 But you haven't seen them; you still haven't seen
19 them?
20 A. No.
21 Q. All right.
22 A. There are not too many on that day, because actually, to
23 inspect that location, it's only Mr Wade and I climbed
24 down to that air duct to look at it.
25 Q. All right, and Mr Wade took the photographs?

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1 A. Yes. He was appointed by the Chairman to take the
2 photographs.
3 Q. By Prof McQuillan?
4 A. That's right.
5 Q. All right. Can I just ask you a couple of questions
6 about ductility.
7 A. Mm-hmm.
8 Q. In particular I wonder if you would be good enough to
9 first of all look at Prof McQuillan's report. I assume
10 you've had an opportunity of reading Prof McQuillan's
11 report; is that right?
12 A. Very quickly.
13 Q. And what about the other reports, from Dr Glover and
14 Mr Southward?
15 A. I did.
16 Q. Okay, good.
17 Could you therefore go, please, to Prof McQuillan's
18 report. It's a similar point, or it's the same point in
19 fact that I put to Prof Au yesterday -- I have no idea
20 whether you were here at the time. If you go to
21 paragraph 89 on page 38, please.
22 A. Yes.
23 Q. What Prof McQuillan says there is this:
24 "The following summary facts inform my opinion".
25 And for present purposes I'm just interested in 1

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1 and 2. He says:
2 "There is no requirement for the structures to be
3 specifically designed for seismicity provided the design
4 is code-compliant in respect of the ductility and bottom
5 steel continuity clauses."
6 I assume you agree with that?
7 A. I don't.
8 Q. What part of it do you not agree with?
9 A. I think, for seismicity, currently in Hong Kong we do
10 not have a code requirement for it, but this one, for
11 the MTR station, they are following the MTR standard
12 manual themselves, and that's why they base on that to
13 do the design, submit it to the Buildings Department and
14 get approved, and that set of drawing become the legal
15 document they are supposed to follow to construct.
16 Q. So you are relying on the material that was submitted by
17 MTR to the Buildings Department. So as a matter of what
18 was approved you say they had to follow those
19 requirements?
20 A. Those are the choice of MTR for their design requirement
21 and they submit it. Once you get approved and they
22 apply for consent to commence work, that is legally
23 binding.
24 Q. Okay, but can we just read the words very carefully
25 here:

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1 "There is no requirement for the structures to be
2 specifically designed for seismicity ..."
3 Just pausing there, they didn't have to do the
4 design is the point, but they did, to some extent?
5 A. That's exactly what I mentioned to this Commission this
6 morning. When I started as a young engineer, designing
7 a water treatment works in a service reservoir, it's
8 WSD's choice that they think the structure is so
9 important, they design for it. I think the same for
10 this station. I think you need to imagine how many
11 people will go through that station every day. The
12 MTR's concern is not overconservative.
13 Q. Then the more important point is this, because it goes
14 to the joint statement that was agreed, paragraph 2:
15 "The geometry of the connection between the EWL slab
16 and the east D-wall, however, precludes any ductility.
17 The structural 'plastic' deformation which might occur
18 during seismic activity will develop lower down the
19 D-wall. Ductile-grade couplers are not therefore
20 required where used in the EWL slab to D-wall joint."
21 The point there, and it's the same point made by
22 Dr Glover, is that if there's seismic activity, the
23 D-wall, to put it rather bluntly, will go first, before
24 the slab. Do you agree with that general proposition?
25 A. That will depend on the failure mode, and depend on the

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1 loading on the slab at that moment. There's a lot of
2 different combinations. I'm not saying absolutely they
3 are right or they are wrong, but other possibilities do
4 exist.
5 Q. Okay. That's fine.
6 In your report, Prof Yeung, if we could just go to
7 that, please, you spend some time looking at the Code of
8 Practice for Concrete 2013 --
9 A. Mm-hmm.
10 Q. -- and CS2:2012. See, for example, paragraph 76 of your
11 report on page 17. Do you see that, Prof Yeung?
12 A. You mean paragraph 76?
13 Q. Yes. You say in the last sentence there:
14 "... recommendations of CoP 2013 and CS2:2012 on
15 reinforcement steel bars should be followed."
16 Do you see that?
17 A. Yes.
18 Q. As I understand it, you do accept, do you not, that so
19 far as the contract between MTRC and Leighton is
20 concerned, in fact the relevant code is the Code of
21 Practice 2004, so far as this concrete is concerned,
22 concrete structure is concerned, and it's CS2:1995 that
23 is also applicable, as a matter of contract between
24 those two parties; do you accept that?
25 A. Yes.

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1 Q. There is therefore a necessity, can I suggest to you,
2 that analysis, insofar as it's required, should take
3 place by reference to those two documents, not the later
4 documents, and I'm just wondering why it is that you
5 seem to have focused very much on the later documents
6 which actually, as a matter of contract -- and I'm not
7 going to get into a debate with you about the
8 contract -- don't actually apply.
9 A. The issue is what we discussed this morning, the steel
10 they actually use on site are 500, and the requirement
11 of grade 500 steel did not exist in the 2004 Code of
12 Practice or the CS2:1995.
13 Q. But you can't, whatever might happen with the steel
14 that's available, actually alter the contractual
15 requirements for loading, for tensile strength, and so
16 forth. You might have to interpret the contract in the
17 light of the steel that's available, but it's not the
18 other way around. You can't change the codes that
19 you're referring to.
20 Again, as I say, I don't want to get into a debate
21 with you, but I'm just concerned that I don't want to
22 spend time asking you questions by reference to contract
23 documents that simply don't apply. Do you understand?
24 A. I understand.
25 Q. You might say to me, I don't know if you do, "Well,

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1 Mr Pennicott, in fact, whether you look at the 2004 or
2 2013 document, it doesn't make any difference." Is that
3 your position?
4 A. They do.
5 Q. They do make a difference?
6 A. They do make a difference.
7 Q. Okay. As clearly does the CS2:1995 and the 2012?
8 A. Yes.
9 Q. Okay.
10 A. Also, if you look at the 2004, you may not find the
11 requirement of couplers.
12 Q. Yes, exactly.
13 A. But then the problem is now, in this contract, they also
14 require couplers.
15 Q. Yes.
16 A. And then, now we are going to come into what you have
17 mentioned about a contractual problem. If you look at
18 the coupler, where are we going to go? Then that's why
19 they generate that QSP.
20 Q. I agree, and I don't have any problem with that,
21 Prof Yeung. If you want to look at the QSP, which
22 I accept has the requirement for couplers, and that's
23 where it's generated, that's fine. I have no problem
24 with that. But what I do have a problem with is looking
25 at other documents that simply don't apply to the

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<p>1 contract. Do you understand? 2 A. I understand. 3 Q. And you are right, insofar as the QSP is concerned, that 4 requires the couplers, the ductility couplers, because 5 that -- it's required because that's what was submitted 6 to the Buildings Department and approved? 7 A. Yes. 8 Q. And that is the basis upon which those ductility 9 couplers were used? 10 A. And also those are basis also from the design standard 11 manual of MTRC. 12 Q. Indeed. I accept that. 13 I think in your slides -- I think possibly this is 14 the easiest way of dealing with this topic, Prof Yeung, 15 if I may. 16 A. Mm-hmm. 17 Q. Could we look at the slide that has the graph on it with 18 the BOSA-calculated -- yes, there we go -- I'm afraid 19 I -- 20 A. You are talking about 12? 21 Q. Is it number 12? 22 A. Yes. 23 Q. Thank you very much. That's very helpful. 24 In terms of the testing that BOSA did in conjunction 25 with CASTCO -- and, as we understand it, witnessed by</p>	<p>1 MR PENNICOTT: If you haven't got the hard copy -- they are 2 all there. 3 COMMISSIONER HANSFORD: We will just note that for the 4 record. 5 MR PENNICOTT: Yes, thank you very much. 6 Just go, please -- because I think you indicated 7 earlier, Prof Yeung -- one point you made was in 8 relation to the coupler that was loaded to 9 destruction -- 10 A. Mm-hmm. 11 Q. -- you hadn't seen any photograph and you weren't sure 12 precisely what had happened. I think that's right, is 13 it? 14 A. Yes. 15 Q. If you go to 44518, do you see the bottom photograph 16 there, "Destructive test coupler"? 17 A. Yes. 18 Q. And if you go to the next page, I think you've also got 19 it open there, Prof Yeung, you can see again a coupler. 20 It just seems to have sheared, broken, right down the 21 middle; do you see it? 22 A. I think that's a tensile failure of the coupler body 23 itself. 24 Q. Okay. That's right. We agree that's right. So you can 25 now see the type of failure that occurred, from these</p>
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<p>1 the Buildings Department -- in November 2018, what 2 documents have you seen in relation to those tests? 3 A. I've seen those preliminary report, that's six pages, 4 and also looked at one of the letters from BOSA to the 5 BD that includes pictures of the specimen before 6 testing. 7 Q. Right. Have you seen, for example, the 84 photographs 8 that were taken on the occasion of those tests being 9 carried out? 10 A. No. 11 Q. Would you like to see them? 12 A. Certainly. 13 Q. Let's go to H25. As soon as I can find them, of course. 14 If you go, please, to H25/44485. You've helpfully been 15 given a hard copy, Prof Yeung, which will make life 16 a bit easier for us. 17 Just flick through these photographs. They run for 18 a number of pages. They run up to 44519, and there are, 19 as I just indicated, 84 photographs. You haven't seen 20 these before? 21 A. No, I haven't. 22 MR PENNICOTT: I'm sorry, sir, we are just catching up on 23 the screen. 24 COMMISSIONER HANSFORD: Is it something you suggest we flick 25 through on the screen?</p>	<p>1 photographs? 2 A. Is this the one that they are using a 900MPa bar? 3 Q. I believe so, yes. 4 A. Or the other one, because we've got two coupler 5 failures. 6 Q. It's the same. 7 A. You mean the two fail in the same row? 8 Q. There's just one to destruction, as I understand it. 9 A. I'm looking at the one with the 50 per cent of threads 10 engaged. 11 Q. Sorry, can you just tell me where you're looking? 12 A. If you look at this page -- 13 Q. Ah, the last page, the table. 14 A. -- you've got two with a coupler failure, and the one 15 you have just shown me, which one is it, the last one or 16 the second one? 17 Q. I understand it's the last one, Prof Yeung, yes. And 18 I deduce that because if you go back to 44517 -- do you 19 see that? 20 A. Okay. 21 Q. If you look at the test results, the bottom photograph, 22 just pick up the figure of 990.41 kilonewtons; do you 23 see that? 24 A. Yes. 25 Q. If you go to the table on page 44520, you will see that</p>

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1 was the tensile load applied to the last item or the
 2 last test?
 3 A. Yes.
 4 Q. All right. If we go, as it were, back in the
 5 photographs to 44514, we can see in the bottom
 6 photograph, this is the test that was carried out at
 7 70 per cent of the thread; do you see that?
 8 A. Yes.
 9 Q. And as we know it was the bar that broke in that
 10 circumstance, and we've got a photograph of it there.
 11 A. Yes.
 12 Q. The point you were making earlier is that normally, on
 13 these types of tests, you would expect to see the bar,
 14 you would expect to see the photograph of the result,
 15 and so forth. So you would accept -- I know we haven't
 16 looked at all of them, but you would accept that that's
 17 in fact what happened and there is a proper record of
 18 this test or these tests?
 19 A. Yes. I assume these are taken by the staff of BD.
 20 Q. I frankly don't know. It looks as though -- it's got
 21 the Buildings Department logo at the top left-hand
 22 corner. I suspect you might be right.
 23 But this is what you would expect to happen in terms
 24 of these tests, these sort of photographs illustrative
 25 of what tests were carried out?

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1 A. And also the graph that you see, that should also go in
 2 the final report too.
 3 Q. All right.
 4 Prof Hansford, I think, asked you this earlier. So,
 5 from your perspective and from your experience of this
 6 type of test -- and you've pointed out to us, rightly,
 7 that the six sheets of paper have the words "Preliminary
 8 report" in the bottom right-hand corner -- you would
 9 expect to see some sort of final report, would you?
 10 A. I do, after they check everything, they confirm the
 11 results and so, and with all this documentation in it.
 12 Q. Right. Well, a couple of months have nearly gone by
 13 since these tests were taken, but I'm afraid I can't
 14 show you any final report. This is what we have to work
 15 with.
 16 A. Does that mean then they follow the standard procedure,
 17 somebody will verify, check the result, before they use
 18 the final report?
 19 Q. I'm afraid I can't answer your questions, Prof Yeung,
 20 particularly because I don't know the answer. All
 21 right.
 22 A. Then that will cast doubt on the validity of the
 23 results.
 24 Q. Well, we've got what we've got, Prof Yeung, and we have
 25 to make of it what we can.

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1 The next point is this. Mr So took you to the
 2 results that have been coming out on an almost daily
 3 basis of the opening-up that has been carried out at the
 4 station and which you have witnessed some, a limited
 5 amount.
 6 A. (Nodded head).
 7 Q. Really the position is this, isn't it, Prof Yeung: if
 8 one just looks at the results and in particular focuses
 9 on the engagement length in the table -- do you want to
 10 have a look at it again?
 11 A. Yes.
 12 Q. We've actually got the very, very latest results. Mr So
 13 I think probably sensibly took you to the one that
 14 Prof Au looked at, and perhaps we will go back to that
 15 one. It's at 314 in the bundle, OU314.
 16 In terms of compliance, in terms of working out how
 17 many of the tests comply or don't comply, fail or don't
 18 fail, it all depends upon your starting point. Your
 19 starting point, as I understand it, is essentially
 20 40 millimetres.
 21 A. Correct.
 22 Q. The Highways Department/government appears to be content
 23 to take a figure of 37 millimetres.
 24 A. That's what appears to be.
 25 Q. Both of those figures, as we've seen with Prof Au,

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1 ignore the strength tests that BOSA and CASTCO carried
 2 out and that we've just been looking at, in the sense
 3 that if you accept that at 60 per cent engagement you
 4 get a factor of safety of 1.14, that's strong enough,
 5 and therefore, as a matter of strength, if you can take
 6 26 millimetres, then all bar two, as we've seen with
 7 Prof Au, of these samples pass. So it all depends on
 8 when your starting point is.
 9 A. You make a very important point in terms of keyword. If
 10 you consider only strength and that is not BOSA
 11 mentioned in its letter of 7 January 2019 -- because
 12 they say when you are not butt-to-butt, you will not be
 13 able to pass the elongation test, will not be able to
 14 pass the cyclic test, although that's their opinion,
 15 they haven't tested it, they don't evidence to show
 16 either way.
 17 Q. We can see that, and what they say will have to be
 18 weighed up along with all the other evidence as well,
 19 Prof Yeung.
 20 But in terms of simply working out percentages, as
 21 I say, it depends on where you start?
 22 A. It depends the criterion used.
 23 Q. All right. I'm happy with that.
 24 Lastly, Professor, from here -- in your report --
 25 perhaps we could just look at this briefly -- you spend

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1 quite a bit of time discussing the question of laps.
2 Could I ask you, please, to go to paragraph 126 of your
3 report. That's at page 39.
4 A. Yes.
5 Q. You say there:
6 "The confirmation that the top reinforcement steel
7 bars are through-bars and not laps ..."
8 Where have you got this whole idea that there might
9 be laps and not through-bars? Where does that come
10 from?
11 A. If you look at the original design, here is a diaphragm
12 wall, the very, very first original design by Atkins,
13 there's supposed to be a bar in here with coupler at the
14 end, and then what they do is they will screw in the bar
15 here (demonstrating with hands), with enough lap length
16 and then put another bar right next to it. So this is
17 where the lap is, right in the location that I showed in
18 figure 6 in the original design.
19 Q. Right.
20 A. So it depends on the progress on site, because when you
21 prepare those bars, you starting the cutting of bar at
22 the right length well ahead of time. So that's why
23 I get a feel that may be the case. That's why I want to
24 say, if we are opening up, trying to confirm this
25 detail, if we do some opening like what I show in

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1 figure 6, we can confirm this is a real through-bar and
2 everybody is happy.
3 Q. Can you confirm that that evidence that you have just
4 given comes from your analysis of the original design
5 drawings and not from your client, Mr Jason Poon?
6 A. No, that's also from my experience of building diaphragm
7 walls in Macau.
8 Q. I say that because advisedly, Prof Yeung, to give you
9 the opportunity of dealing with it, Mr Poon, when he
10 gave evidence many, many days ago, raised this question
11 of the potential of laps.
12 A. Mm-hmm.
13 Q. What that led to was the MTRC producing some evidence
14 and in particular a witness statement from
15 a Mr Derek Ma. Have you read that witness statement?
16 A. No.
17 Q. In which he deals with this whole question of laps,
18 saying that it simply didn't happen and that the
19 through-bars were the through-bars. That's not evidence
20 you've looked at? You haven't looked at that evidence?
21 A. You mean about Derek Ma's statement; right?
22 Q. Yes.
23 A. Did you see -- I haven't seen that statement. I haven't
24 seen his witness statement. But do you see any, like,
25 in this case, open up, you see the through-bar without

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1 the lap? It's very simple, take out a 250 by 250 box.
2 Q. I understand what you are saying, Prof Yeung. I firstly
3 want to find out where the whole notion of this came
4 from, and now you've explained it and I understand that,
5 but so far as the Commission is concerned it doesn't
6 want to be chasing -- it's got enough on its plate to
7 consider without having to look at matters which frankly
8 I thought had been dealt with and finished, and since
9 there wasn't any cross-examination of Mr Ma on that
10 particular topic --
11 A. Because also --
12 Q. -- I rather thought we could move on, and I suspect the
13 MTRC and others were thinking the same.
14 A. I also saw a similar picture in Mr Southward's report,
15 but that one -- if you want to show a very long bar,
16 that picture should show a very long bar and maybe put
17 a cut line there, as what an engineer will do, to
18 indicate it's a very long bar. But that one you can see
19 now is more or less the one I'm talking about, there may
20 be a lap for another bar on the EWL slab.
21 That's what I think, if we want to confirm the
22 as-built condition, we can pick some opening in there
23 and everybody is happy about it.
24 MR PENNICOTT: Understood.
25 Sir, I have no further questions. It's 3.30 so

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1 perhaps that would be an appropriate moment, sir.
2 CHAIRMAN: Yes, certainly. 15 minutes.
3 (3.29 pm)
4 (A short adjournment)
5 (3.51 pm)
6 CHAIRMAN: Yes.
7 MR CONNOR: No questions from me, sir. Thank you.
8 Cross-examination by MR SHIEH
9 MR SHIEH: Good afternoon, Professor.
10 A. Good afternoon.
11 Q. A few areas to explore with you. Without the need to
12 turn up any documents first, the works, the contract in
13 this case, were contracted for by reference to
14 grade 460?
15 A. Grade 460, yes.
16 Q. So using -- even if on the facts some grade 500 rebars
17 were used, it is not required by the contract; you would
18 take that, yes?
19 A. Yes.
20 Q. And the designs were done on the basis that grade 460
21 would be used; correct?
22 A. Yes.
23 Q. In your report, you refer to the Concrete Code 2004; do
24 you remember that?
25 A. I refer to both, yes.

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1 Q. Can I ask you to look at the code at H8/2818. That is
 2 the 2004 Concrete Code.
 3 A. Correct.
 4 Q. Can you look at clause 3.2.8.2. That's at page 2853.
 5 A. Yes.
 6 Q. If you want to see that this is indeed 3.2.8.2, look at
 7 the previous page, at the bottom, 3.2.8.2; do you see
 8 that?
 9 A. Yes.
 10 Q. Then over the page, at the top:
 11 "the coupled bar assembly tensile strength should
 12 exceed 287.5 newtons per square millimetre for grade
 13 250, and 483 newtons per square millimetre for grade
 14 460."
 15 Do you see that?
 16 A. Yes.
 17 Q. I know you have something to say as to whether or not
 18 this code were the only standard that applies, but
 19 assuming that we only look at the standard prescribed by
 20 this code, a tensile strength of 483 newtons per square
 21 millimetre for the coupled bar assembly would be enough?
 22 A. You mean refer to table 3.3?
 23 Q. No, the sentence above 3.3.
 24 A. So table 3.3 gives us --
 25 Q. It's not a table.

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1 A. Yes, it's a table.
 2 CHAIRMAN: Where's the table?
 3 COMMISSIONER HANSFORD: It's a bullet.
 4 MR SHIEH: The top of ...
 5 A. Okay. Got it.
 6 Q. According to this code and simply looking at this code,
 7 if we are using grade 460 steel rebars, then the
 8 requirement was that the coupled bar assembly need have
 9 a minimum tensile strength of 483 newtons per square
 10 millimetre; correct?
 11 A. According to this code.
 12 Q. Thank you. But you say this is not the only standard
 13 that applies, right, in your view?
 14 A. That is what, in the QSP, I think MTR choose to put in
 15 additional requirement.
 16 Q. I know.
 17 Then we look at the QSP. I think the devolution of
 18 this point can be seen from your expert report, at
 19 paragraph 76. Let me see if I get you correctly. At
 20 paragraph 76, internal page 17, you say:
 21 "Although grade 460 reinforcement steel might be
 22 adopted in the design of the Hung Hom Station Extension
 23 prior to 2013, all the reinforcement steel bars
 24 available in the Hong Kong market by 2013 is grade
 25 500B ... Therefore, recommendations of CoP 2013 and

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1 CS2:2012 on reinforcement steel bars should be
 2 followed."
 3 Then you went on to say:
 4 "In fact, BOSA ..., the supplier of type II
 5 mechanical couplers ... issued a clarification ... in
 6 response to a media report stating that the tensile
 7 strength of the coupler assembly manufactured by BOSA
 8 was not less than 625 megapascals in compliance with the
 9 requirements of the BD of the Hong Kong SAR government.
 10 The tensile strength requirement of the coupler assembly
 11 of 625MPa indicates that the characteristic strength of
 12 the reinforcement steel bar is 625 divided by 1.25
 13 equals 500 megapascals."
 14 The way in which you divided -- the reason why you
 15 divided that by 1.25 comes in later. I think it's by
 16 reference to the QSP.
 17 A. The QSP.
 18 Q. The QSP, yes. But let's go through that process of
 19 deriving how you get your theory from.
 20 So you say that if we apply -- if we proceed on the
 21 basis that grade 500 rebars are used, then you say the
 22 coupler assembly should have a tensile strength of no
 23 less than 625 megapascals?
 24 A. Correct.
 25 Q. What I'm suggesting to you is this. If in fact grade

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1 500 were used, it is an optional extra; it is a bonus.
 2 The project need not be built by reference to standards
 3 applicable for 500. Do you accept that?
 4 A. Correct.
 5 Q. Can I then invite you to look at your paragraph 85 at
 6 page 21. You say:
 7 "Appendix A of the QSP made reference to [the
 8 Concrete Code 2004 [which was the one we looked at] ..."
 9 A. Correct.
 10 Q. "... as it referred to grade 460 ... However, it also
 11 made reference to [acceptance standard] 133 ...
 12 published by the International Code Council to
 13 supplement the deficiencies of the 2004 Code ..."
 14 Yes?
 15 A. Correct.
 16 Q. So that's why I say, correct me if I am wrong, if you
 17 simply look at the Code 2004, you may get a certain
 18 number representing the minimum coupler tensile
 19 strength, but because of this route of appendix A of the
 20 QSP -- sorry, because of this route of the reference to
 21 AC133, it brought in what may be a higher standard. Is
 22 that a fair way of describing your view?
 23 A. Also more tests.
 24 Q. More tests?
 25 A. I think you got a fair way to describe it, yes.

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<p>1 Q. You then set out at paragraph 86 your interpretation of 2 AC133, and you appended AC133; yes? 3 A. Yes. 4 Q. Then you said at paragraph 87 that the table in AC133 is 5 actually similar to or the same as the content of the 6 subsequent code, the 2013 Code, 3.2.8.4. 7 A. Correct. 8 Q. So if we look at 3.2.8.4, which is set out in your next 9 paragraph, paragraph 88 -- 10 A. Yes. 11 Q. -- then we see a whole host of requirements and tests 12 and standards, et cetera; yes? 13 A. Yes. 14 Q. If you look at the bottom of page 22 -- 15 A. Mmm. 16 Q. -- basically, there are two subparagraphs where we get 17 this concept of 125 per cent; yes? 18 A. Yes. 19 Q. It's really 3.2.8.4 subparagraphs (b) and (c); yes? 20 A. Yes. 21 Q. These both bring in the concept that the requisite 22 tensile strength of the coupler assembly should be 23 1.25 times that -- 24 A. The yield strength. 25 Q. -- of the yield strength of the bar used?</p>	<p>1 500 reinforcement steel bars are being used for the 2 construction of the Hung Hom Station Extension, 3 resulting in the requirement of a minimum tensile 4 strength of the coupler assembly of 625 megapascals ..." 5 Do you see that? That is why you used that figure 6 of 625? 7 A. That's correct. 8 Q. But as a matter of minimum, if the contract only 9 required 460, should the calculation be done on the 10 basis only of 460 multiplied by 1.25? 11 A. But then, when they run the test -- if you put yourself 12 in the place of the contractor, when you run the test, 13 you assume it's a grade 460 bar, and then, when you run 14 the test, you get another requirement the bar-break 15 first, and then when you are running, running, actually 16 you end up with your coupler fail first, if you use 17 a weaker coupler, weaker than the bar. That's from 18 a practical consideration, because you require to have 19 a bar-break failure mode in the contract. 20 Q. Let's concentrate on the requirement of the coupler 21 assembly strength, because that is the relevant quantity 22 to look at when we look at the significance of how many 23 threads you need to screw in. Do you understand? 24 A. I got your point. 25 Q. If we look at the question of the strength of the</p>
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<p>1 A. Yes. 2 Q. If you turn over the page, you then express your view at 3 paragraph 89: 4 "... the coupler assemblies must develop in mean 5 tension the greater of ..." 6 Then you gave two extreme figures, the upper end and 7 the bottom end of some tensile strengths. 8 A. Because in appendix A, they also put in a requirement of 9 bar-break first. 10 Q. Right. 11 A. So if on site they use a grade 500 bar and when they run 12 the test, they need to make sure the bar will fail 13 first. That's a requirement in the QSP. 14 Q. I have a rather simple mind, so let's use 500 times 15 1.25, you see, because 500 is grade 500, yield strength 16 grade 500, times 1.25? 17 A. Correct. 18 Q. So that would give a theoretical required minimum 19 tensile stress of the coupler assembly, if we apply 20 those two paragraphs? 21 A. Correct. There are some leeway. You can have some 22 sample less than that. 23 Q. Right. So that is why, again, at paragraph 91, at the 24 bottom, you said, the third line from the bottom: 25 "As elaborated earlier, it is very likely that grade</p>	<p>1 coupler assembly, would you accept that if the contract 2 was contracted by reference to and designed by reference 3 to using grade 460 rebars, then for the coupler assembly 4 to be regarded as pass the contractual requirement, then 5 it would be good if the coupler assembly were to achieve 6 460 times 1.25? Forget about bar-break first. 7 A. Forget about bar-break first? 8 Q. Forget about bar-break first. 9 A. Don't look at the real test first. On a theoretical 10 basis, yes. 11 Q. Thank you. 460 multiplied by 1.25 would be 575? 12 A. Correct. 13 Q. The unit would be megapascals? 14 A. Yes. 15 Q. But of course I know you have done some calculations by 16 reference not to 460 times 1.25. You have done 17 calculations by reference to 500 times 1.25, which 18 yielded the figure of 625. 19 A. Yes. 20 Q. May I then ask you to look at your report at 21 paragraph 93. You refer to Mr Yim's statement in the 22 MTR press conference, where he stated that "it was 23 structurally adequate for the reinforcement steel bar to 24 engage only six full threads of the coupler, ie 25 60 per cent of all the threads recommended by the</p>

<p style="text-align: right;">Page 157</p> <p>1 manufacturer. His postulate fails in two aspects: (1)</p> <p>2 the tensile strength of the coupler assembly of</p> <p>3 1,003 megapascals has not been proven</p> <p>4 experimentally ..."</p> <p>5 1,003 megapascals would be assuming complete</p> <p>6 screwing in?</p> <p>7 A. Yes, by the MTR.</p> <p>8 Q. "... and (2) even if (1) can be proven experimentally</p> <p>9 and the tensile strength of the coupler assembly is</p> <p>10 proportional to the extent of engagement, the engagement</p> <p>11 of six threads is still inadequate to provide a tensile</p> <p>12 strength of 625 megapascals ..."</p> <p>13 That is your thesis. If you set the required</p> <p>14 tensile strength higher, then you need more threads to</p> <p>15 be screwed in; yes? Do you accept that?</p> <p>16 A. I say 60 per cent is not adequate, but as we've been</p> <p>17 talking all along today, and also sometime yesterday we</p> <p>18 close that out, the tensile strength is not the only</p> <p>19 factor you need to consider for the acceptance of the</p> <p>20 coupler assembly.</p> <p>21 Q. I understand. You say there are other qualities or</p> <p>22 attributes which may have to be taken into account,</p> <p>23 elongation, et cetera. We'll debate that separately --</p> <p>24 others may debate that separately. But let's focus on</p> <p>25 strength. In terms of strength the concept is the</p>	<p style="text-align: right;">Page 159</p> <p>1 basically, of the strength of its system.</p> <p>2 A. The threads.</p> <p>3 Q. Yes.</p> <p>4 A. Based on a simplistic model.</p> <p>5 Q. If you look at "Number of threads" -- yes, if you look</p> <p>6 at "Number of threads" on the left, 6 --</p> <p>7 A. Yes.</p> <p>8 Q. At six threads, and incidentally, the table here was by</p> <p>9 reference to using grade 460; do you accept that?</p> <p>10 A. Yes.</p> <p>11 Q. Because you can see that the steel bar specified tensile</p> <p>12 strength was 529. If you divide that 1.15, you get 460;</p> <p>13 correct?</p> <p>14 A. But only 1.15, as you said.</p> <p>15 Q. I know. But this was prepared on the basis that the bar</p> <p>16 used was grade 460?</p> <p>17 A. But that won't satisfy the ductility of 1.25.</p> <p>18 Q. I know. But this was prepared on the basis that -- it</p> <p>19 may not satisfy some other test, but in BOSA's mind,</p> <p>20 when it prepared this, it was preparing it on the basis</p> <p>21 that grade 460 would be used?</p> <p>22 A. Correct.</p> <p>23 Q. Now, look at "Number of threads". At six threads</p> <p>24 engaged, all the way to the right --</p> <p>25 A. Counsel, I think you can rotate that page so it's not so</p>
<p style="text-align: right;">Page 158</p> <p>1 higher the tensile strength that is required,</p> <p>2 contractually or by reference to whatever code, then the</p> <p>3 more number of threads will have to be screwed in;</p> <p>4 that's the concept, yes?</p> <p>5 A. Not necessarily so, because if you use a stronger bar,</p> <p>6 the bar thread is also stronger, proportionally. So it</p> <p>7 doesn't matter you use which one to calculate. You may</p> <p>8 end up with the same number of engagement threads.</p> <p>9 Q. Well, actually, if the contract is designed by reference</p> <p>10 to 460, and a certain set of numbers are arrived at as</p> <p>11 to how many threads you need, if I happen to use</p> <p>12 a better or stronger rebar, maybe I need to screw in</p> <p>13 less; right?</p> <p>14 A. But then you fail the bar-break criteria in the test.</p> <p>15 Q. Yes, but I'm focusing on the coupler assembly strength.</p> <p>16 A. Theoretically -- yes.</p> <p>17 Q. Let's look at some actual numbers; right? What you say</p> <p>18 is that by using your 625 megapascals as the requisite</p> <p>19 tensile strength required for the coupler assembly, six</p> <p>20 threads would not be enough?</p> <p>21 A. Yes.</p> <p>22 Q. Let's look at the BOSA table, at Prof McQuillan's</p> <p>23 report, page 84, internal page 84 of Prof McQuillan's</p> <p>24 report.</p> <p>25 This is a table of BOSA, telling people its view,</p>	<p style="text-align: right;">Page 160</p> <p>1 difficult to read.</p> <p>2 Q. There's something wrong with my iPad because I tried</p> <p>3 rotating it and I couldn't, for some reason.</p> <p>4 At six threads, it's 601.5 megapascals; yes?</p> <p>5 A. Yes.</p> <p>6 Q. So it doesn't reach 625, which is the minimum tensile</p> <p>7 stress, according to your method of calculation, because</p> <p>8 you need 500 times 1.25; yes?</p> <p>9 A. That's correct.</p> <p>10 Q. But let's give it one more thread, seven threads; that</p> <p>11 would be enough, yes? Correct?</p> <p>12 A. According to this calculation.</p> <p>13 Q. We can debate whether this calculation is correct until</p> <p>14 the cows come home, but I'm just testing something</p> <p>15 arithmetically. Assuming -- on the basis of BOSA's</p> <p>16 calculation or its own laboratory view of the quality of</p> <p>17 its couplers --</p> <p>18 A. I would put it this way. This is one of, you may say,</p> <p>19 a numerical model put together by BOSA for calculation</p> <p>20 purposes. As what I show in my presentation, BOSA's</p> <p>21 presentation has already proved this table is not</p> <p>22 correct. If you still remember, what I present for that</p> <p>23 five data that BOSA has done already proved this table</p> <p>24 is overestimating.</p> <p>25 Q. We can discuss the interpretation of that graph that you</p>

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1 have produced, but my question is a simple one. If we
 2 look at BOSA's own representation as to the strength of
 3 its couplers, six threads won't give you 625, but seven
 4 threads would give you enough; do you accept that?
 5 A. According to this calculation.
 6 Q. According to this calculation. Seven threads, on the
 7 basis of 4 millimetres per thread, would be
 8 28 millimetres?
 9 A. Correct, plus 2mm chamfer, so you get 30.
 10 Q. I will come to chamfer now, if you want to talk about
 11 chamfer, because -- so that we actually know the
 12 dynamics of this, the higher the tensile strength, the
 13 more threads, in theory, that one has to screw in in
 14 order to reach that requisite tensile strength; yes? Do
 15 you accept that, all things being equal?
 16 A. You need to look at the problem in a way that if you get
 17 a stronger bar, you always get stronger thread. You use
 18 a weaker bar, you get a weaker thread. Look at this
 19 calculation, you can see from here, if look at the
 20 fourth column, the shear strength is 264.5; right?
 21 Q. I do need a new iPad because I kept shaking it and it
 22 wouldn't rotate.
 23 A. Actually, you rotate the PDF.
 24 Q. It doesn't matter. Just go ahead.
 25 A. If you look at this one, look at the fourth column, you

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1 get 264.5.
 2 Q. Yes.
 3 A. That comes from 50 per cent of the 529.
 4 Q. Yes.
 5 A. So if you use a higher tensile bar, that number will be
 6 increased at the same time; right?
 7 Q. Yes.
 8 A. So, if you check that out, you find out, for the same
 9 number of threads, it doesn't really matter what tensile
 10 strength you put in, for the same number of threads, you
 11 get the same factor of safety.
 12 Q. I understand.
 13 A. The problem is because this model by itself has been
 14 proven to be incorrect by their own experiment.
 15 Q. I wouldn't debate with you whether it has been "proven
 16 to be incorrect", because that, I'm quite sure, will be
 17 taken up by others. But as I say, I'm a very simple
 18 person and I just want to say, simply looking at this,
 19 if seven threads would reach 625, then the practical
 20 implication is you would need 28. You would also add 2
 21 to represent the chamfer, so that would mean 30; agree?
 22 A. Agree.
 23 Q. So let's look at chamfer. You say that according to
 24 BOSA, at the end of a thread there is a 2 millimetre
 25 chamfer?

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1 A. Correct.
 2 Q. A chamfer basically means that it's a sloped part which
 3 doesn't actually operate by engaging the thread; yes?
 4 A. Yes, to make the engaging easier.
 5 Q. So sometimes it would be in a sloped form, like a cone?
 6 A. Actually, the chamfer is a 45 degree cut.
 7 Q. Like a cone? It ends up like a cone, ice cream cone;
 8 agree?
 9 A. Yes. Your geometry is good.
 10 Q. Yes, it's a cone, an ice cream cone.
 11 Look at bundle H25, page 44856.
 12 A. Yes.
 13 Q. It says "T2" on top. T2, type 2, would be ductile?
 14 A. Yes.
 15 Q. And then below that we have "type A" and "type B".
 16 Easily confuses everyone. Type 1/type 2 is
 17 non-ductile/ductile; type A/type B is short and long --
 18 A. Yes.
 19 Q. -- to put it bluntly?
 20 A. Right.
 21 Q. So T2 is the type of bars that we should be looking at
 22 for ductile; yes?
 23 A. Correct.
 24 Q. Looking at type A and type B, I need to be enlightened
 25 but I don't seem to see any sloping or protruding or

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1 chamfer-looking feature at the threaded end.
 2 A. If you look at the middle one.
 3 Q. I'm looking at the top and the bottom.
 4 A. Yes, but if you look at the middle one, that's why they
 5 make the chamfer first before they make the thread.
 6 Q. Yes, but once the thread is done, you don't actually see
 7 any wastage of 2 millimetres.
 8 A. No, but your thread cannot get on the chamfer.
 9 Q. I will ask my question again. It may start off with the
 10 middle bar --
 11 A. Yes.
 12 Q. -- but once the threads are created on the bar and we
 13 look at the threaded rebar that's created, my point is
 14 that, look, the threaded bars in the form at the top and
 15 the bottom are the rebars that are screwed into the
 16 coupler; correct?
 17 A. Correct.
 18 Q. And your point of there being a 2 millimetre chamfer is
 19 that even though in theory there may be 2 millimetres
 20 there, but that 2 millimetres simply won't engage, so it
 21 won't have any threading effect, so you have to ignore
 22 2 millimetres. That's your thesis; correct?
 23 A. As you mentioned, when you make the chamfer, what will
 24 happen is -- this is original diameter (demonstrating
 25 with hands), right, and then you make the chamfer. Then

<p style="text-align: right;">Page 165</p> <p>1 at this part, at the chamfer, the diameter actually gets 2 smaller. As you say, it's a cone. Then your thread 3 needs to have a certain constant diameter, so it must be 4 on the straight part of the bar. 5 Q. My question is I don't see any cone under type A and 6 type B here. These are the actual threaded bars used. 7 A. But if you start to count the threads -- because some of 8 those actually may get into some of the so-called what 9 they call the starting thread, may get into part of the 10 chamfer and cover that one up, so you may not see it. 11 Q. But if you look at type A, for example, type A, if you 12 look at the top part of type A, there is the beginning 13 of the thread. 14 A. You look at where does it start? It doesn't start at 15 the edge. 16 Q. At the top, left, top left-hand corner. I don't see any 17 sloping or cone. 18 A. Because that sloping part actually comes into -- you 19 look at the thread, you get a ridge on the top, right, 20 and that one actually goes on that one. 21 UNIDENTIFIED SPEAKER: It's a physical item there. Maybe 22 you can show us. 23 MR SHIEH: Can I just show it to the professor so he can 24 show us where the chamfer is? 25 A. Do you want to see it? It's right here.</p>	<p style="text-align: right;">Page 167</p> <p>1 A. Yes, this is a type B. 2 COMMISSIONER HANSFORD: Does anyone else want to see? 3 MR SHIEH: It's all right. 4 Professor, the significance of a chamfer is that if 5 there indeed is a 2 millimetre chamfer which is sloped, 6 then for the purpose of examining how many millimetres 7 of embedment, we would need to take off 2 millimetres 8 because those 2 millimetres of chamfer did not count as 9 part of the engaged length; is that correct? 10 A. I think you may not need the whole 2mm, because some of 11 the ridge of the thread actually takes up some of the 12 chamfer, so you may not lose 2mm. 13 Q. At most 2? 14 A. At most 2, but I don't think you get 2. 15 Q. Let's say at most 2? 16 A. Yes, yes . 17 Q. Thank you. Let's look at the opening-up bundle at 18 page 338. Other people have been looking at 315, 19 I think. I don't know why I'm looking at 338. It's 20 a more up-to-date one, I think, so I've been looking at 21 338. 22 COMMISSIONER HANSFORD: We may as well look at the most 23 up-to-date one. 24 MR SHIEH: Up-to-date one, yes. 25 Now, Professor --</p>
<p style="text-align: right;">Page 166</p> <p>1 MR SHIEH: That's non-ductile. We need type 2. 2 MR CHEUK: This is type 2. 3 COMMISSIONER HANSFORD: You need to screw the piece out. 4 A. I need the project director of MTR. (Demonstrating 5 screwing the coupler). 6 You see? 7 MR SHIEH: Can I see that? 8 A. That's the way you can make a screw, that will get in 9 more easier, if there's more chamfer there. 10 MR CHEUK: It's very small. 11 MR SHIEH: It would obviously be a matter of interpretation. 12 I think the most important persons to see that must be 13 Mr Chairman and Prof Hansford. (Handed). 14 COMMISSIONER HANSFORD: I'm wondering if this 2 millimetres 15 is actually significant. 16 MR SHIEH: I will be saying that it isn't, but since the 17 witness has got it -- because I'm going to be take him 18 to a table, because ultimately if we look at the 19 opening-up table and see -- 20 COMMISSIONER HANSFORD: I'm very happy to go here, it's just 21 that we've spent a lot of time and I'm wondering if 22 2 millimetres has any significance. 23 MR SHIEH: The witness was keen to mention 2 millimetres of 24 chamfer so I went straight to the chamfer. 25 COMMISSIONER HANSFORD: That's fine. I understand entirely.</p>	<p style="text-align: right;">Page 168</p> <p>1 A. Yes. 2 Q. -- this is a table from the record of result of 3 opening-up; do you see that? 4 A. Yes. 5 Q. As we discussed just now, I think between Mr Pennicott 6 and you, whether you call something a pass or a no pass 7 depends on what pass mark you apply? 8 A. Or the passing criterion. 9 Q. Or the passing criterion you apply. 10 We've been through the significance of the number of 11 threads and the interpretation of the BOSA table, but 12 what I'm now trying to do with you is to apply some 13 numbers to the table and hopefully we will agree on the 14 interpretation. If you look at the "engagement length" 15 section, the second column from the right. 16 A. Yes. 17 Q. You see there are two single-digit items, which are 18 items 5 and 22. 19 A. Correct. 20 Q. Those would fail, whether we use 30 or 24 or 26 or 28. 21 A. Or even 10. 22 Q. Those would fail. So those two, let's take them away. 23 A. Mm-hmm. 24 Q. Now, you can do the counting but I've done my own 25 counting. Out of these 75 samples, if we apply 24,</p>

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<p>1 being 6 times 4 -- do you understand? 2 A. Yes. 3 Q. Six threads with 4 millimetres each, if we apply 6 times 4 4 equals 24, if we use 24 as what I would call the 5 structural -- the strength pass mark? 6 A. The tensile strength pass mark. 7 Q. Yes, the tensile strength pass mark, all pass except 8 those two? You can count if you want. 9 A. If you use 24. 10 Q. If I use 24. If I use 26, ie the 24 plus the chamfer, 11 it's still the same? 12 A. Yes. 13 Q. In fact, if I use 7, seven threads, 7 times 4 would be 14 28? 15 A. Correct. 16 Q. Even if I use seven threads, it would still be the same; 17 only two fail. I have counted, but you can count 18 yourself. There are a number of 28-point-something, but 19 if you use 28, they pass. For example, at item 40. 20 A. Yes, 28.5. 21 Q. Item 40, if you use 28, it passes. So my point is even 22 if you use 28, 7 threads times 4, all pass except two? 23 A. And you take the number as it is, without thinking about 24 the error of measurement. 25 Q. I know, the 3 millimetres and all that, and maybe manual</p>	<p>1 75 fail, looking at the matter as is; do you accept 2 that? 3 A. That's 6 per cent; right? 4 Q. 6.666 per cent, and the pass rate, depending on how you 5 put it, the pass rate would be 93.333? 6 A. If you look at Prof Lam's[?] calculation -- because your 7 6.66 per cent is in the sample, and then plus another 8 error for the population, and then that was -- what 9 I mean is out of that 20,000-something couplers, about 10 10 per cent failed, even using your method of 11 calculation. 12 Q. Yes, but I have a number of different permutations. 13 A. Yes, I'm assuming your 30. 14 Q. You are assuming my 30? 15 A. After your 30, your 30 is 6.66 per cent in the sample, 16 and then you need to plus a margin of error for the 17 population, so you end up to be about 10 per cent. 18 Q. I understand. As to whether we pick seven threads or 19 six threads, as to whether we add on the 2 millimetres 20 of chamfer or only 1 millimetre, those are all things we 21 don't need to debate, because others may discuss with 22 you or they may have already been discussed. But what 23 I'm trying to demonstrate is exactly why these things 24 matter in the overall scheme of things. You move a bit 25 of number here, you may change the pass rate; that's</p>
Page 170	Page 172
<p>1 error. 2 A. 3 millimetres, your 28.54 will fail if you move it to 3 the other side. 4 Q. Yes, I know, 50 per cent both ways. 5 A. That's right. 6 Q. Let's leave all those to one side because if we start 7 getting into those then we will get all kinds of 8 different permutations. But we look at the number as 9 is. 10 A. Okay. 11 Q. If you use 28, all pass except those two. If you apply 12 28 plus the 2 millimetre chamfer, then there would be 13 three more fails? 14 A. Yes. 15 Q. And I'm telling you that that would be item number 2, 16 because that's 29.65, that's below 30; there would be 17 the two single-digit items, and there would be item 18 number 40, which is 28.50, which would be below 30? 19 A. Yes. 20 Q. And also item number 72, which is 28.79, again below 30. 21 All the rest would be above 30. 22 A. 30, yes. 23 Q. So, Professor, my point to you really is that even 24 assuming that we use seven threads, even if we were to 25 add the 2 millimetre chamfer at the highest, five out of</p>	<p>1 what I'm trying to illustrate. 2 A. Okay. 3 Q. Finally, can I ask you to look at paragraph 100 of your 4 expert report. There, you quoted: 5 "... Mr Frank Chan, Secretary for Transport and 6 Housing emphasised in his response to the oral questions 7 raised by the honourable Yiu Si Wing during the special 8 meeting of the Panel ... that safety of absolute 9 certainty was required for the operation of the railway. 10 His exact wording was '(Chinese spoken)." 11 For Mr Chairman and Prof Hansford, basically, 12 literally, he said, "We have to guarantee that the 13 operation of the railway is 100 per cent safe." 14 "In his opening remarks at the meeting of the 15 subcommittee ... of the Panel ... Mr Frank Chan stated 16 again repeatedly and clearly that safety is the top 17 priority of the administration. In accordance with his 18 statements, the actual embedment length should not be 19 less than 40 millimetres. As a result, the measured 20 embedment length should not be less than 43 millimetres 21 to achieve the target -- safety of absolute certainty." 22 Did you write this yourself? 23 A. Yes. 24 Q. What has Frank Chan to do with structural engineering? 25 I know he studied structural engineering, but apart from</p>

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1 that, what does Frank Chan and Yiu Si Wing have to do
2 with structural engineering?
3 A. I think he is as a government official and Frank Chan is
4 also an engineer himself and he understands the concept
5 of safety and the concept of reliability. In fact I can
6 tell you he studied electrical engineering.
7 Q. I know.
8 A. They talk about reliability probably more than civil
9 engineers do.
10 Q. I know.
11 A. So that's his statement, if you want to make sure --
12 actually, in the next paragraph, I think that statement
13 is too tough. If you want 100 per cent safety, there's
14 no such thing.
15 CHAIRMAN: Sorry, the last sentence is a little ambiguous to
16 me. Did Mr Frank Chan actually say -- did he quote the
17 figure of 40 millimetres, or is this your deduction
18 saying, "In accordance with what he has said, we must
19 achieve this sort of figure"?
20 A. That's my deduction based on what he said, if I want to
21 achieve 100 per cent absolute certainty for safety.
22 CHAIRMAN: Then it must be 40 millimetres plus 3.
23 A. That's right. Then we are sure we get 40.
24 CHAIRMAN: All right.
25 MR SHIEH: I'm going to go through this reasonably quickly.

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1 Mr Chairman and Prof Hansford may know where I'm getting
2 at. If it's simply a matter of your own expertise,
3 calculation, strength, whatever, it shouldn't really
4 depend on what a political minister said to a political
5 body; right?
6 A. No. I think it's the level you want to achieve, and
7 it's something very simple, just like you are
8 an engineer and a layman talks to you saying, "I want to
9 take the elevator, get to my floor in 18 seconds", you
10 design accordingly. This client may know nothing about
11 elevators but the engineer takes the instruction and
12 moves forward. This is what you get from the minister,
13 he says, "I want the railway operation to be
14 100 per cent safe."
15 Q. What if he said in a metaphorical way, "I want
16 200 per cent safe", you would then say everything failed
17 because Frank Chan wanted 200 per cent?
18 A. Then you tell the minister that's not going to be
19 achievable.
20 COMMISSIONER HANSFORD: (Unclear words).
21 CHAIRMAN: I think, from our point of view, that reading,
22 using a little hyperbole, is simply this is a railway,
23 it's a public utility, safety is a priority; it must be
24 safe. If it's safe, it's safe. It doesn't become safer
25 by being 127.5 per cent safe.

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1 MR SHIEH: I'm going to my real point, which is statements
2 of that nature, trawling through statements made by
3 ministers in a political arena, only serves as
4 sound bites. It has no place in a report of an expert
5 character. Do you accept that?
6 A. No. That's why I moved into paragraph 101. I think
7 that is something really too stringent. That's why
8 I moved back to 40.
9 CHAIRMAN: Again, I'm interrupting -- I apologise -- from
10 your perspective, this is what I would like to hear,
11 from your perspective, as an engineer, as an expert in
12 these things, what would be safe? Do you see what
13 I mean? That I'm prepared to listen to, along with all
14 the other evidence, as opposed to very natural hyperbole
15 by a political figure in the light of public concern.
16 A. I got your point. That's why I would take 40. On the
17 average, I know 40 means I can be between 37 and 43, but
18 then on the average I got 40, and that also follows
19 recommendation of the manufacturer. I would take the
20 37. If the real embedment is only 37, but the
21 measurement shows 40, I would still take it.
22 MR SHIEH: Right. I suggest to you that 24 millimetres/six
23 threads is already structurally safe. Do you accept
24 that?
25 A. You only satisfy in your -- that's exactly what I've

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1 been talking about all afternoon. That table was
2 calculated by a simplistic model, and then BOSA has
3 already demonstrated by their own laboratory work that
4 method of calculation has overestimated the strength of
5 the threads, as what I present in my graph.
6 Q. Lastly, did Mr Jason Poon give you that reference to
7 Frank Chan and Yiu Si Wing?
8 A. No, actually, because if you know my background, I used
9 to be an AO2, so I know how to track down those
10 meetings. In fact, I know better than Jason Poon how to
11 file all those things in LegCo.
12 Q. But you know he likes it?
13 A. I don't really care whether he likes it or not, I'm
14 an independent expert.
15 MR SHIEH: No further questions.
16 MR SO: What is the sound bite?
17 CHAIRMAN: Yes, thank you.
18 Cross-examination by MR BOULDING
19 MR BOULDING: Good afternoon, Professor.
20 A. Good afternoon.
21 Q. I represent MTR, and whilst my friends have covered much
22 of the ground I wanted to cover, there are just a couple
23 of matters I would like to take up with you.
24 I'd like to stay, if I may, with the question of
25 acceptance criterion of the embedded length in the

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<p>1 coupler. For that purpose, I wonder if we can go, 2 please, in ER1, tab 8, that's your report, and if we can 3 start at page 24. 4 A. Yes. 5 Q. This is the section where you deal with that, and going 6 on to paragraph 96, you tell the Commission: 7 "The acceptance criterion recommended by the 8 manufacturer is shown in figure 4. It can be deduced 9 from figure 4 that the minimum embedment length is 10 40 millimetres and the minimum number of threads engaged 11 should be ten." 12 I just want to see if I understand that. You're 13 talking about figure 4 on page 26, are you not? 14 A. Correct. 15 Q. We can see what is said there by the manufacturer, BOSA; 16 correct? 17 A. Correct. 18 Q. You'll know, won't you, that this guidance, this 19 recommendation, was in play at the time the works were 20 carried out; correct? 21 A. This is in their -- this is the recommendation, yes. 22 Q. Yes. It's the sort of thing that an inspector or 23 a worker who wanted guidance, if he happened to have it 24 in his back pocket, he might pull it out and have a look 25 at it?</p>	<p>1 side of the recommendation; that's correct, isn't it? 2 A. Correct. 3 Q. So if one has a maximum of two threads as being 4 acceptable, on the basis that there are ten threads on 5 the rebar, that means, does it not, that eight threads 6 have to be engaged? 7 A. No. 8 Q. Why is that? 9 A. Because this one, they are talking about the maximum 10 tolerance. They manufacture with 44. Maximum tolerance 11 will be 48, and that's why you get the two threads 12 coming out. You still get 40 going in, because this 13 total length is 88. So assuming both bars get the 14 maximum tolerance, that means the threads on the two 15 bars, both 48, the bottom one goes in 48, total length 16 88, instead of 40 on the top, so that's why still ten 17 threads go in. 18 Q. I don't think that's correct, Professor. We've got ten 19 threads on the bar; correct? 20 A. If they are maximum tolerance, they get 48mm long, so 21 they got 12 threads, for those with maximum tolerance. 22 Q. That's not the situation. This is prepared on the basis 23 of ten threads, and we have looked at the calculation 24 prepared by BOSA -- 25 A. How would this one relate to this one?</p>
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<p>1 A. So they can look at it easily. 2 Q. Exactly. We know, do we not, that the rebar which has 3 to go into the couplers has ten threads on it; correct? 4 A. 10 to 11. 5 Q. In fact, if you have a look at BOSA's table, H44527.1, 6 this is a table Mr Shieh discussed with you, and you can 7 see the BOSA calculation table there, can you not? 8 A. Yes. 9 Q. And the calculation stops at ten threads, does it not? 10 A. Yes. 11 Q. It was for that reason, amongst others, that I suggested 12 to you, that it was ten threads that were on the end of 13 the rebar to go into the coupler. 14 But in any event, let's look at this recommendation 15 together. We can see, can we not, that we go from zero 16 tolerance to what BOSA regard as their maximum 17 tolerance; correct? 18 A. Correct. 19 Q. Looking at the summary: 20 "1. After connection has been fully tightened, one 21 should see a maximum of two full threads to ensure 22 a proper installation." 23 Correct? 24 A. Correct. 25 Q. That is shown in the photograph on the far right-hand</p>	<p>1 Q. It's the same manufacturer, for a start. 2 What I'm suggesting to you is that each of the 3 threads has a pitch of 4 millimetres, doesn't it? 4 A. That's correct. 5 Q. If you've got an acceptable situation of two threads 6 being exposed, that would give you 2 times 4 equals 8, 7 would it not? 8 A. No. 9 Q. 2 times 4 four equals 8? 10 A. What I'm saying is this bar is not of 44 -- the length 11 of the threaded section is not 44 with maximum 12 tolerance. You are talking about the first one, the one 13 on the most left. 14 Q. I'm talking about the one on the far right. 15 A. The one on the far right, each threaded section is not 16 44. 17 Q. No, it's 40. 10 times 4 equals 40. 18 A. What they mean by maximum tolerance is their threaded 19 length is longer than the design. 20 Q. Well, with respect, they don't. What I suggest to you 21 is what they mean is that with a rebar with ten threads 22 on it, each thread is 4 millimetres, that's the pitch. 23 If you have two threads exposed, which is acceptable, 24 you've got eight engaged. 8 times 4 gives you 25 32 millimetres.</p>

<p style="text-align: right;">Page 181</p> <p>1 A. I would refer you to figure 3 in my report on page 25, 2 for all those dimensions. 3 Q. Well, even in paragraph 95 you say that the number of 4 full threads is between 10 and 11 -- well, I say 10 -- 5 and at 10, I'm got to suggest to you that 10 times 4 6 would equal the 40. 7 A. Because we say the threaded section is 44mm. 8 Q. With respect, I've got to suggest to you that's simply 9 incorrect. 10 A. And that's what is shown in the figure. 11 Q. Well, that's not what's shown on the BOSA calculation, 12 though, is it? Because the BOSA calculation refers to 13 there being ten threads. This was at H44527.1. 14 A. I think this is -- probably they are being conservative, 15 they stopped at ten. But then in reality that's what -- 16 the configuration of the threads are shown in figure 3 17 of my report on page 25. 18 Q. What I've got to suggest to you is the engagement is 19 32 millimetres and nothing like the 40 millimetres or 20 even 43 millimetres that you are contending for. 21 A. So how long is the other one? How do you do a splice 22 butt-to-butt then? 23 Q. Well, the butt-to-butt fact would not be a requirement 24 during the course of the contract, would it? The 25 butt-to-butt reference comes in in the letter of 2019;</p>	<p style="text-align: right;">Page 183</p> <p>1 Q. All right. Anyway, my suggestion to you is that your 2 contention that it ought to be 40 millimetres or 3 43 millimetres is simply nonsense. 4 A. I leave your opinion to you. 5 Q. There's one other matter that I would like to take up 6 with you. That's paragraph 84. 7 Here, you are dealing with the strength of the 8 coupler assembly, and you refer, do you not, in 9 paragraph 84, to appendix A of the QSP? 10 A. Yes. 11 Q. You say that it provides that: 12 "The application is permitted for inter-storey 13 columns provided that the following performance criteria 14 are met". 15 Then you proceed, as I understand and read your 16 report, to draw certain conclusions from that in the 17 ensuing paragraphs; correct? 18 A. You mean in the following paragraph or -- 19 Q. Yes, the following paragraphs, paragraphs 85 and 86 20 onwards. 21 A. Yes. 22 Q. Thank you. The situation, I suggest, is that this part 23 of appendix A of the QSP, which is specifically for 24 inter-storey columns does not apply here because it is 25 intended to cover a situation, for example, where you've</p>
<p style="text-align: right;">Page 182</p> <p>1 that's correct, isn't it? 2 CHAIRMAN: Sorry to interrupt. Both of these have ten. 3 MR BOULDING: That's the basis of my question, sir. 4 And the butt-to-butt reference comes in, does it 5 not, for the first time in 2019? 6 A. Can you check the manual of BOSA? 7 Q. Yes. 8 A. Because I was told by BOSA years ago it needs to be 9 butt-to-butt. 10 Q. Well, the fact of the matter is that if you are 11 inspecting or if you are a conscientious worker and you 12 happen to have this recommendation in your report, in 13 your back pocket, and you pull it out and you can see 14 that there are two threads not engaged, you would say to 15 yourself, "Job done." 16 A. No. 17 Q. "I don't have to go any further and check for 18 butt-to-butt." 19 A. Unless you don't want to read point number 1, has to be 20 fully tightened. If there's still gap inside there, you 21 can still tighten it; it will still go in. 22 Q. So you say that fully tightened means butt-to-butt; is 23 that your evidence? 24 A. If you fully tighten until butt-to-butt, your bar cannot 25 go in anymore.</p>	<p style="text-align: right;">Page 184</p> <p>1 got a multi-storey building where sway and other stress 2 reversals would occur? That's correct, isn't it? It's 3 intended -- the reference to inter-storey columns is 4 intended to be a reference to a structure like 5 a multi-storey building where sway and stress reversals 6 would occur; that's correct, isn't it? 7 A. I think this is the only one in the QSP for the 8 installation of coupler in this contract. 9 Q. Well, it might be, but obviously you don't follow it 10 blindly; you've got to see what it applies to, haven't 11 you? And if it says that the application is permitted 12 for inter-storey columns, what I suggest is that it's 13 not intended to cover the situation we had here which is 14 a stiff underground box. That's what we are talking 15 about here, isn't it, a stiff underground box? That's 16 what the structure is, isn't it? 17 A. The diaphragm wall also functions as columns, actually. 18 Think about that structural form. 19 Q. We've all seen the section through the structure, and 20 what I have to suggest to you is that it's a stiff 21 underground box which would not suffer from sway or 22 indeed undergo stress reversals. Presumably that's 23 something you would agree? You've got a stiff 24 underground box here and it wouldn't experience sway or 25 indeed undergo stress reversals; that's correct, isn't</p>

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1 it?

2 A. Where do you find that stress reversal?

3 Q. It's something I'm suggesting to you.

4 A. That's what you suggest. It's not in writing here.

5 Q. I know, but I'm suggesting that to you as a matter of

6 engineering experience, engineering practice, that we

7 are talking about a stiff underground box here, whereas

8 appendix A of the QSP is referring to inter-storey

9 columns, and that's something different from a stiff

10 underground box; that's right, isn't it?

11 A. In what aspect?

12 Q. What is set out here, because it's directed at

13 inter-storey columns, is inapplicable to the sort of

14 structure we have here, which is a stiff underground

15 box, which does not experience sway or undergo stress

16 reversals.

17 A. I don't see why you say it doesn't under stress

18 reversal, because the ductile coupler is mainly for

19 seismic design for vibration and so. I don't see why

20 you say there's no stress reversal.

21 Q. I'm saying there's no stress reversal in the structure

22 we're talking about because it's a stiff underground

23 box. So therefore this part of appendix A of the QSP

24 which applies specifically to inter-storey columns is

25 inapplicable.

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1 A. I don't agree to that.

2 MR BOULDING: Thank you very much.

3 CHAIRMAN: Are there any further questions?

4 MR CONNOR: Nothing, sir.

5 MR CHOW: Yes.

6 CHAIRMAN: Could I ask how long you're likely to be,

7 Mr Chow?

8 MR CHOW: Maybe ten minutes, sir.

9 MR PENNICOTT: I haven't publicised this but I appreciate

10 you have a meeting this evening and that you wanted to

11 go at 4.50.

12 CHAIRMAN: I was happy to leave it until the 5.00 full hour,

13 but I'm a bit stuck after that.

14 MR PENNICOTT: Yes. I'm in your hands. I'm bound to say

15 that whilst I have no intention whatsoever of preventing

16 Mr Chow from asking some questions, the government have

17 not given us notice that they wanted to cross-examine

18 Prof Yeung so far as my table is concerned that I was

19 given. So I did have that in mind as well, to allow

20 Mr Boulding to continue.

21 MR CHOW: Can I just say this. We did indicate to

22 Mr Pennicott that we did not intend to ask any questions

23 arising from what Prof Yeung has put down in the report,

24 but what I intend to do, I only have a few questions and

25 it relates to the answers that Prof Yeung has given.

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1 MR PENNICOTT: As I say, I'm not stopping him but I think in

2 the circumstances perhaps we could come back tomorrow

3 morning.

4 CHAIRMAN: Yes. I do apologise. I've got a meeting. It's

5 one where I suspect I don't have to be there on the dot,

6 but I do have to be there reasonably after the dot. So

7 I think if we are now only about three minutes to five,

8 we can close for the day.

9 Prof Yeung, I'm so sorry that we have to ask you to

10 come back tomorrow.

11 WITNESS: It's fine with me.

12 CHAIRMAN: But we will start tomorrow again at 10.00. You

13 are still in the course of giving your evidence and

14 I sincerely trust that we don't have to detain you for

15 too long. Thank you very much indeed.

16 WITNESS: Thank you.

17 MR SO: Before we adjourn, sorry I have to detain you for

18 a while because I have instructions to make,

19 an observation we have just had.

20 The observation is in regard to the exchange between

21 Mr Shieh and professor at [draft] page 177 of the

22 transcript, lines 1 to 14. I'm glad to understand and

23 have assurance from Mr Pennicott of the Commission this

24 morning that there were no objections and slightest

25 doubt as to the independence of Prof Yeung towards China

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1 Technology. But I just wish to clarify the Commission's

2 stance or Leighton's stance as it stands now, because as

3 what Mr Shieh indicated at [draft] page 176, he is going

4 to a real point when he was cross-examining Prof Yeung,

5 and I do not know whether it is just a slip of the

6 tongue or whether it is an intention that Leighton now

7 doubts the independence of Prof Yeung, and if not, it is

8 our respectful submission that those exchanges simply

9 could not help us to go anywhere and the implication

10 that Prof Yeung is doing something or knowing whether

11 Jason Poon likes a particular thing or not, and

12 particularly this might bring Prof Yeung's independence

13 and integrity into question. I simply want to know

14 what's the position of the Commission and Leighton.

15 MR SHIEH: I'm not seeking to disqualify him on the ground

16 of lack of independence, but these matters all go to

17 weight, in the same way as the demeanour and attitude

18 and all kinds of things occurring while a witness is

19 giving evidence and in writing his report can be all

20 matters that go to weight, but I'm not seeking to

21 disqualify the professor as an expert.

22 CHAIRMAN: Was this related to Mr -- I think in the area of

23 Mr Frank Chan?

24 MR SHIEH: Yes.

25 CHAIRMAN: That's very much a collateral area. It's got

1 nothing to do with the expertise of Prof Yeung, which
2 has not been challenged other than on the basis of
3 professional challenge between experts as to what weight
4 to be given.

5 The issue raised was, as Mr Shieh says, entirely
6 oblique to that. It went, I suppose, to the matters
7 that Mr Shieh himself has raised. I don't see that it's
8 an issue.

9 I can understand you rising to your feet just to
10 make sure. Certainly, as far as the Commission is
11 concerned, we are satisfied absolutely in the
12 professor's independence and his independence as
13 an expert witness.

14 MR SO: I'm grateful for that. I just put that as a matter
15 of record as to our stance.

16 CHAIRMAN: Good. And as a matter of record the answer is
17 there.

18 Thank you very much indeed. Professor, tomorrow
19 morning, I look forward to seeing you.

20 WITNESS: See you tomorrow.

21 (4.59 pm)

22 (The hearing adjourned until 10.00 am the following day)

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