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<p>1 Wednesday, 8 January 2020 2 (10.03 am) 3 DR MIKE GLOVER (on former oath) 4 MR CHOW: Good morning, Mr Chairman and Prof Hansford. 5 Good morning, Dr Glover. 6 Mr Chairman, this morning Dr Glover indicated to me 7 that he would like to further assist the Commission on 8 some details regarding the partial factor of safety, and 9 I indicated to him that I have no problem with that, 10 subject to the agreement of the Commission. 11 I understand he has already written up something on the 12 board. 13 A. Yes, behind. It's not there. 14 MR CHOW: Subject to the agreement of Mr Chairman and the 15 Commission. 16 COMMISSIONER HANSFORD: It would be helpful. 17 CHAIRMAN: All right, Dr Glover, we are happy for your 18 explanation, but please work on the basis that I'm like 19 the dumbest student in one of Einstein's classes trying 20 to understand the relativity theory. 21 A. You had a good mentor, sir, if it was the great man 22 himself. 23 I took the liberty of preparing it this morning, 24 because it takes time to write things up and it obscures 25 the view. What I wanted to try to do this morning is to</p>	<p>1 loads. So I've just called them -- apologise for the 2 algebra -- R and A. 3 So, when we are designing something and we have 4 reached let's call it the optimum design, the balance, 5 you end up with an equation which looks like this, and 6 I do apologise because it is algebra again, but the 7 resistance is divided by a material factor, gamma M, and 8 gamma m is taken as 1.5. I think you've heard that 9 before. That's not new, that's tradition. 10 Then that is divided by the actions. In other 11 words, you're trying to look at the ratio between the 12 two. But the actions are then multiplied by a load 13 factor, gamma F, which is taken as 1.4 for dead load. 14 So that's the equation, and if it's 1 you've actually 15 got it right on the balance. 16 COMMISSIONER HANSFORD: Sorry, can you just explain what you 17 mean by "right on the balance"? 18 A. It means that would be acceptable in terms of the codes. 19 It's a compliance calculation, in that sense. 20 Now, to try to help change the algebra into numbers, 21 I've invented some numbers which arrive at the same 22 situation. So I've said let's call the resistance 23 150 units. It doesn't really matter what they are but 24 150 units. And let's call the actions 71. Now, I've 25 selected those numbers because when I then put in 1.5 as</p>
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<p>1 get across some of the algebra involved, because 2 I recognise this room is a room of words. My world is 3 a world more of algebra. But I hope with some 4 arithmetic we can bridge the two, to explain some of the 5 concepts in this dreadfully opaque slide that I showed 6 yesterday, which all credit to Eurocode, they make it as 7 simple as they possibly can. 8 I want to focus on the gamma F and the gamma M 9 factors. Gamma F is the load factors, gamma M is the 10 material factors. I want to explain very simply how we 11 use them in design and also what the repercussions of 12 that are in a forensic situation. So that's my 13 objective. Fingers crossed that I'm successful with it. 14 It's my arithmetic that will fail, if anything. 15 The subject is -- leave aside issues about partial 16 factors of safety -- at the end of the day we as 17 engineers and the community at large are interested in 18 one thing: what is the reserve of strength? Is it 19 teetering on the brink or does it have a large margin of 20 strength, a large margin of capacity? So I talk about 21 reserve of strength. 22 In Eurocode language, they use two words. One is 23 called resistance, and that to you and I would be 24 strength, what is the strength of something, what is the 25 resistance. The other is the actions, the forces, the</p>	<p>1 the material factor and I put in 1.4 as the load factor, 2 I get back to 1. So we are starting from that base and 3 I'm now the designer. I'm in my design office. It's 4 gone to BD. They've looked at my calculations; tick in 5 the box. 6 Three years later, I've constructed the edifice. 7 Fortunately for Hung Hom, I've carried out umpteen 8 experiments, tests, investigations, measurements, and 9 I'm in a forensic situation. So I now have information. 10 So let's look at how that can potentially affect 11 that equation, because that's what it's all about. When 12 we talk about all these partial safety factors going 13 backwards and forwards in the banter -- and I do enjoy 14 the banter with Mr Chow -- I can see the eyes glaze over 15 but it's better if I try to explain it in physical 16 terms. 17 CHAIRMAN: Yes. 18 A. So if we go to the next stage, I'm now in a forensic 19 situation. I've got a 3 metre thick slab -- it is 20 3 metres and 20 millimetres thick -- and I'm thinking to 21 myself I've got this load factor of 1.5 gamma F, and 22 I could understand why I needed that at design stage 23 because I didn't know what was going to happen during 24 construction, because the 1.4 is intended to include 25 things like construction loading and people taking</p>

Page 5	<p>1 a rogue crane across the site. That's what it's for.</p> <p>2 But now that's gone, so I can look at the parameters</p> <p>3 that are before me and make judgments.</p> <p>4 Therefore, I'm going to look at gamma F, and when</p> <p>5 I explained to you yesterday -- badly, I think, but no</p> <p>6 matter -- gamma F is made up of two factors, one to do</p> <p>7 with dimensions and the other one to do with ignorance,</p> <p>8 how I analysed it and whatever. So if I just look at</p> <p>9 the first of these, dimensions, then the make-up of the</p> <p>10 1.4 originally is made up of 1.15, the dimensions one,</p> <p>11 and 1.2 for the analysis one. Hence, 1.15 times 1.2 is</p> <p>12 very, very nearly 1.4. The code drafters rounded it to</p> <p>13 a number. You wouldn't want to walk around the world</p> <p>14 with 1.38 in your mind all the time.</p> <p>15 So to all intents and purposes that's what it is.</p> <p>16 But now I've reached a situation where I know what the</p> <p>17 dimensions are, and I also know, very importantly, that</p> <p>18 this is a dead-load-driven design. In other words, the</p> <p>19 ratio between the live load that's going to come on and</p> <p>20 the dead load that's there today is dominated by dead</p> <p>21 load. So that's why I'm focusing on the dead load</p> <p>22 factor. I could do an equal analysis on the live load</p> <p>23 but it's just not worth going there for this purpose.</p> <p>24 So I'm saying I'm not going to take full advantage</p> <p>25 of the fact that it is 3 metres thick or 3,010 rather</p>	Page 7	<p>1 strength. That's the crux of the banter that's going</p> <p>2 backwards and forwards. People are saying, "You can't</p> <p>3 do that because you are reducing the safety on my</p> <p>4 structure", but good grief, that is the results in pure</p> <p>5 engineering mathematics, that's what it is. There's no</p> <p>6 emotion in it. I could go much, much further than this.</p> <p>7 I could start, as I said earlier, stripping away at the</p> <p>8 1.2, whatever.</p> <p>9 The thing I've got to assure you on on all this: it</p> <p>10 does not change what we call the SLS condition, the</p> <p>11 working load condition. The design for the working load</p> <p>12 condition, as I said yesterday, towards the end, is that</p> <p>13 actually, at the end of the day, the thing that really</p> <p>14 matters is how the structure performs on a day-to-day</p> <p>15 basis, provided it's got a satisfactory reserve of</p> <p>16 strength. So I haven't changed any of that. The</p> <p>17 working load stresses are exactly the same as they are.</p> <p>18 All I have done is demonstrate the structure has</p> <p>19 an enormous reserve of strength, rather than, we were</p> <p>20 led to believe by some parties, a decrease in the</p> <p>21 reserve of strength.</p> <p>22 I'm sorry to have taken the Commission's time on</p> <p>23 that.</p> <p>24 CHAIRMAN: No. It's helped a lot, actually. Thank you.</p> <p>25 A. But I just wanted to get some -- and it is for Mr Chow</p>
Page 6	<p>1 than 3,000. I want to leave something left. So rather</p> <p>2 than using 1.15, rather than using 1, I've said okay,</p> <p>3 let's go for 1.05 as a factor. I'm not going to touch</p> <p>4 the ignorance factor, the 1.2, although I feel on the</p> <p>5 basis of the enormous analysis that's been done, not</p> <p>6 just by individual parties but by different groups of</p> <p>7 consultants using different pieces of software -- but</p> <p>8 I'm not going to go there; I'm going to leave that as it</p> <p>9 is.</p> <p>10 So the net result of 1.05, leaving the 1.2, is that</p> <p>11 the gamma F reduces to 1.25.</p> <p>12 Now, how does -- and I've introduced it into the</p> <p>13 equation. Everything else remains the same. I haven't</p> <p>14 said it's got stronger. I haven't said the loadings</p> <p>15 have changed. But just by changing that, I get</p> <p>16 12 per cent reserve of strength.</p> <p>17 Go one stage further. All the test evidence would</p> <p>18 tell me that actually the concrete is a hell of a lot</p> <p>19 stronger than it was, and so I'm saying: okay, let's</p> <p>20 assume that it's 20 per cent stronger, because it</p> <p>21 appears to be 20 per cent stronger without any age</p> <p>22 factors. My resistance now has also increased by that</p> <p>23 20 per cent. It's gone up to 180.</p> <p>24 If I then put 180 into the equation, everything else</p> <p>25 remaining the same, I get 35 per cent reserve of</p>	Page 8	<p>1 to examine that if he wishes. I think the arithmetic is</p> <p>2 pretty basic, isn't it, for you and I, that is; yes?</p> <p>3 MR CHOW: Yes, it is.</p> <p>4 A. That's all I wanted to say, sir.</p> <p>5 CHAIRMAN: Can I just ask you one thing. You are talking</p> <p>6 there about the concrete strength resistance and how</p> <p>7 it's increased, and tests, so we're all agreed, are we,</p> <p>8 that tests have been done on the strength of the</p> <p>9 concrete, not of the reinforced concrete but just of the</p> <p>10 concrete?</p> <p>11 A. Oh, yes, I'm sorry. I used that as sort of an example.</p> <p>12 But the answer to your question is the 6,000-plus cubes</p> <p>13 that were carried out demonstrate that there was a shift</p> <p>14 of strength. The cores that were taken in the diaphragm</p> <p>15 wall that I have referred to yesterday show the type of</p> <p>16 correlation you would expect between the design</p> <p>17 strength, which actually was about 36, I think, and the</p> <p>18 reality on site, you know, the actual cube strengths,</p> <p>19 which were turning out at sort of -- I think the mean</p> <p>20 was 79 and the actual characteristic, this is the</p> <p>21 5 per cent or the 95 per cent passing was about 62.</p> <p>22 So that's what I'm referring to, the inherent</p> <p>23 strength within the structure.</p> <p>24 CHAIRMAN: That's right. I just wanted to make sure that,</p> <p>25 as I understand it, it's not disputed that there have</p>

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<p>1 been numerous cube tests done over the period of time, 2 and the strength of the concrete itself, as opposed to 3 all the rebars and various other things, is not in 4 dispute. That's meant -- 5 A. It doesn't appear to be. I think the real discussion 6 is: yes, that might be the case, but that's not what we 7 do. In other words, that they're quality assurance 8 tests and we don't include those. 9 CHAIRMAN: I appreciate that, yes. 10 A. So all I'm saying is if you -- but I'm not relying on 11 that, sir. I'm just trying to demonstrate. 12 CHAIRMAN: Thank you very much. 13 COMMISSIONER HANSFORD: Just on that final point, though 14 the question from the Chairman, if anyone were to 15 suggest that the concrete in these structures is somehow 16 of substandard strength, what would your response be? 17 A. Substandard? 18 COMMISSIONER HANSFORD: Yes. 19 A. First of all, I would say anybody can make a statement 20 like that. Could you show me why that is the case? 21 CHAIRMAN: Fine. What you know about this, about the box, 22 the station box and anything else, the other aspects of 23 the building that we've been looking at, has anything 24 been put before you -- 25 A. No.</p>	<p>1 CHAIRMAN: And the conditions that have been shown in 2 respect of the diaphragm walls show that everything is 3 okay as to the essential strength or resistance of the 4 concrete used in the diaphragm walls? 5 A. Absolutely, sir, and those cores demonstrate it beyond 6 any shadow of a doubt, I would think. 7 The other thing is -- I'm glad you've brought up the 8 diaphragm wall because I'm not really sure whether I did 9 it justice yesterday because this issue of the diaphragm 10 wall and cracking in it causing distress elsewhere in 11 the structure came as a completely -- I thought we had 12 dealt with the diaphragm wall a long time ago, but just 13 for the Commission's point of view, I see nothing wrong 14 at all with the diaphragm wall. Indeed, if you go 15 through the checklist of life, you will ask yourself: 16 was the design carried out satisfactorily, in accordance 17 with all the rules? Tick. Was it constructed by 18 a competent contractor? Tick. Do we have all the 19 documentation that we would expect? Tick. Was it 20 accepted by the approval authority? Tick. 21 So I was amazed that it even came up in the 22 presentations that took place, but I felt I had to go 23 the extra mile to demonstrate that cracking is not 24 an issue in the diaphragm wall, hence I showed those 25 slides yesterday which really was a little bit outside</p>
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<p>1 CHAIRMAN: -- has anybody said anything to you -- 2 A. No. 3 CHAIRMAN: -- or alleged to you that's resulted in your 4 investigation that the inherent strength of the concrete 5 itself is below par? 6 A. No, not at all, and I think using the honeycomb as 7 a metaphor or a facsimile for the strength is an error. 8 The honeycomb is indeed extremely poor workmanship. 9 I would use the word "extremely" because it can be 10 avoided. I think I said this at the first hearing: the 11 aggregate size was probably too large for the density of 12 reinforcement, and it seems as if an admixture, a simple 13 plasticiser, was not used to enable the flowability of 14 the concrete. 15 But that doesn't change the strength of the concrete 16 which would have been demonstrated by the cube 17 strengths. Even taking into account the fact that 18 conditions might have been slightly different one way or 19 the other, the cores from the diaphragm wall really 20 represent a very good comparison between what I would 21 say are the on-site curing situations. And I know 22 somebody is going to come back and say diaphragm walls 23 cure in a different way but when we talk about a 3 metre 24 thick slab, the conditions of curing are not that 25 different from a diaphragm wall.</p>	<p>1 of my brief in terms of discussing it, but I felt 2 slightly outraged, to be honest. 3 CHAIRMAN: Could I just ask you one other thing about 4 concrete. Dr Lau said, and I don't dispute it but I'd 5 just like your comment, if I could, that yes, the fresh 6 concrete goes in, you do your cube tests and it has 7 a certain strength. That strength increases as the 8 concrete settles and grows older, but then, like us, 9 I suppose, at 25 we are running around a rugby field; at 10 75, even being on the field would amount to a physical 11 activity. You know, we start to lose our strength, and 12 concrete is the same. 13 A. Yes, yes. No, that's not the case. It plateaus, sir. 14 It's true, you get a very rapid increase in strength. 15 It's like a -- it's a parabolic -- mathematically, it's 16 an asymptote, which means it gradually increases with 17 strength over time and just almost runs parallel to 18 something, so it flattens off. It's like the shape of 19 the curve that Mr Southward showed for the stress-strain 20 relationship of concrete. You get the sort of parabolic 21 shape at the beginning and then it flattens right off. 22 COMMISSIONER HANSFORD: With no decline? 23 A. With no decline, no -- I mean, when I say -- 24 CHAIRMAN: Even over 100 years? 25 A. No, and one of the reasons for that is OPC, ordinary</p>

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<p>1 Portland cement, hasn't been around for 100 years, but 2 what has been around is pozzolanic cement. If you 3 wander around Roman sites, for example, you can even 4 touch the concrete, and it is concrete, which was made 5 2,000 or 3,000 years ago, 2,500 years ago, and it's 6 still there. You would really have to give it a big 7 thump. And its chemistry, sir, is different. 8 So you have these two things working together, OPC 9 and the pozzolanic cement. 10 I could go into all sorts of things about the 11 fineness of the grain -- of the grinding of the cement, 12 it has a thing -- in other words the finer you make it, 13 the more surface area it gets so the quicker it will 14 set, and that's where you get the difference between, 15 shall we say, rapid hardening cement and very slow 16 cement. I'm not here for that, sir. 17 CHAIRMAN: No. Good. Thank you. Your comments have 18 helped. Thank you. 19 (The witness returned to the witness box) 20 CHAIRMAN: Mr Chow. 21 MR PENNICOTT: Before Mr Chow continues, just to make it 22 clear that -- I'm sure everybody behind me realises this 23 -- all the diagrams that the experts have been doing 24 from time to time are photographed at the end of the day 25 and then reproduced into the bundle, just in case --</p>	<p>1 honeycombing. 2 A. Mm-hmm. 3 Q. Given the extensiveness of the honeycombing that we 4 found in the EWL slab, do you agree that it is rather 5 unusual? 6 A. Well, I think the wording there -- it takes the words 7 out of my mouth -- "very unsatisfactory workmanship". 8 In fact, I've just introduced "very" -- yes, very 9 unsatisfactory, and I think totally avoidable, but 10 I still stay by what I said in terms of the strength 11 quality of the concrete. 12 Q. Provided the honeycombing is rectified? 13 A. Oh, yes, absolutely. As I referred to yesterday, any 14 cracking, for example, that you had observed of 15 an extreme nature, then you would deal with it, as 16 a rectification, but it's not a safety issue. 17 Q. Can I take it that if the honeycombing is not rectified, 18 it would have a detrimental impact on the strength of 19 the concrete? 20 A. Yes, but when I say "yes" to that, it does depend on the 21 degree of the honeycombing. If it's superficial, the 22 cover, for example -- and I think most of this was the 23 cover of the concrete, in other words below the lowest 24 bars -- then actually that has no -- that's cosmetic -- 25 and fire -- but it has no impact on the strength.</p>
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<p>1 CHAIRMAN: Good. 2 MR PENNICOTT: I just wanted to make that clear so that 3 everybody knows. 4 A. I hope I've got the arithmetic right. I know Mr Chow 5 will pick up any error. 6 Cross-examination by MR CHOW (continued) 7 MR CHOW: Thank you, Dr Glover. Are you sure you don't want 8 to sit down? 9 A. No, I'm better standing up, otherwise I will start 10 coughing. 11 Q. Thank you. It's really helps for you to set out all the 12 details regarding the partial load factors, but before 13 I move on to the next topic that I planned to do, may 14 I pick up on one or two questions raised by the chairman 15 earlier with you. 16 Do you remember the chairman mentioned whether you 17 have seen any evidence which may cast any doubt on the 18 quality of the concrete, and Mr Chairman mentioned 19 honeycombing? 20 A. Yes. 21 Q. What we can see from the evidence -- if I may just give 22 the page reference: bundle OU5, page 3262 -- 23 paragraph 3.5.11 of the holistic report. What is set 24 out in the report is that 19 per cent of the soffit of 25 the EWL slab being inspected are found to contain</p>	<p>1 COMMISSIONER HANSFORD: Fire resistance, you mean? 2 A. Yes, I'm sorry, fire resistance, yes. So people don't 3 like looking at reinforcement over their head, in that 4 sense. 5 So, no, I think you've got to take the honeycombing 6 in terms of its proper context. 7 MR CHOW: Yes. 8 A. And there's no doubt it has to be repaired, but it is 9 by and large -- I hate to use this language because it 10 sounds quite superficial but that's what it is -- it's 11 more like a plastering exercise, to make sure we've got 12 it back. 13 Q. Right. Earlier, you also mentioned about the possible 14 cause of this honeycombing. You mentioned about the 15 aggregate size perhaps is not appropriate. You 16 mentioned about perhaps they should have put in 17 a plasticiser to improve the -- 18 A. Flowability. 19 Q. -- flowability. So it is something to do with the 20 design mix; is that correct? 21 A. No, not -- no, because the design mix doesn't dictate -- 22 I will correct myself. The design mix is dictated in 23 terms of aggregate size. 24 Q. Yes. 25 A. But not the admixtures. The admixtures tend to be much</p>

Page 17	<p>1 more to do with the application. My observation that</p> <p>2 I would have thought the aggregate size should have been</p> <p>3 smaller was just an observation, but I think</p> <p>4 20 millimetre aggregate with some of the concentration</p> <p>5 of nine layers of reinforcement would have asked some</p> <p>6 questions. I mean, the contractor, concrete contractor,</p> <p>7 probably just picked up the specification and said, "Ah,</p> <p>8 it's one of those", and the ready mix arrived and they</p> <p>9 hadn't really interrogated what the impact of the</p> <p>10 concrete would be on the specific reinforcement that was</p> <p>11 in place. These things happen but I'm surprised it</p> <p>12 happened quite so often.</p> <p>13 Q. As a layperson, it's rather obvious to me that these</p> <p>14 honeycomb were discovered because they happened to be</p> <p>15 located at the soffit of the EWL slab. If there is</p> <p>16 honeycombing in the core of the concrete slab, then</p> <p>17 obviously there is no way that one would know the extent</p> <p>18 of the honeycombing.</p> <p>19 Now, the fact that we have an unusual large extent</p> <p>20 of honeycombing that appears at the soffit of the EWL</p> <p>21 slab, would it suggest to you perhaps you have to start</p> <p>22 asking about -- or questioning the quality of the</p> <p>23 concrete as a whole of the EWL slab, and it wouldn't be</p> <p>24 prudent for us to simply rely on the cube strength that</p> <p>25 we obtained from the ready mix that was delivered to</p>	Page 19	<p>1 But I have not used this in any of the assessments of</p> <p>2 the strength, and indeed I could start to add some of</p> <p>3 this in by just using a proportion of the concrete</p> <p>4 strength, for example, but I chose not to because, to be</p> <p>5 quite candid, there's so much reserve of strength in</p> <p>6 this structure that it can stand the test of applying</p> <p>7 some very, very silly rules in the loads that are</p> <p>8 applied.</p> <p>9 So I can see where you're coming from. I'd like to</p> <p>10 believe I'm a prudent engineer. Using my prudence,</p> <p>11 I didn't apply it in the design, but I feel I could</p> <p>12 quite easily put forward a case to use it, and I most</p> <p>13 certainly think that if people maintain the position</p> <p>14 that there are no shear links in certain areas, then</p> <p>15 I can equally use the argument that it's very obvious</p> <p>16 that the concrete is stronger.</p> <p>17 Does that help to bridge the gap?</p> <p>18 Q. I would like to ask one last question on honeycombing,</p> <p>19 just to make sure that everybody understands. Now, you</p> <p>20 said there is no real linkage between honeycombing and</p> <p>21 the strength of the concrete, but as a layperson, if we</p> <p>22 see a concrete cube full of honeycombing being tested</p> <p>23 under the same test, I would expect that the strength of</p> <p>24 that cube would be much smaller or lower than a concrete</p> <p>25 cube without any honeycombing. Am I wrong?</p>
Page 18	<p>1 site to say that, now, because the cube strength shows</p> <p>2 a much higher strength, irrespective of the quality of</p> <p>3 the concreting work for the EWL slab, we nevertheless</p> <p>4 use a much higher concrete strength for the purpose of</p> <p>5 forensic assessment?</p> <p>6 So my question is in view of the extensiveness of</p> <p>7 the honeycomb and the location of those honeycomb, would</p> <p>8 it be prudent or not to adopt the apparent higher</p> <p>9 strength of the concrete?</p> <p>10 A. I can understand your point, and I like the use of the</p> <p>11 word "prudent". I like to believe I'm a prudent</p> <p>12 engineer. You've got to weigh these things up. I must</p> <p>13 agree with you that for a layperson, they would most</p> <p>14 certainly see a link between honeycombing and somehow</p> <p>15 a weakness in the materials. But I'm saying, actually,</p> <p>16 I can't see the relationship between strength and</p> <p>17 honeycombing. I can most certainly see a link between</p> <p>18 workmanship and the honeycombing, most certainly, but</p> <p>19 I wouldn't have extrapolated all the way.</p> <p>20 The other thing I have to emphasise, and I should</p> <p>21 have emphasised this before, in all the assessments</p> <p>22 I have done of this structure, I have not taken</p> <p>23 advantage of any of this, other than when it came to the</p> <p>24 shear strength, because I think we were being posed with</p> <p>25 a silly situation, a silly problem to solve, that's all.</p>	Page 20	<p>1 A. Mr Chow, you and I can agree on that, that if you test</p> <p>2 a bunch of stones loosely glued together, it most</p> <p>3 certainly won't pass the test, yes.</p> <p>4 Q. So, in other words, can we infer that if there i</p> <p>5 honeycomb inside the core of the slab, then we should</p> <p>6 expect that the concrete strength at the location where</p> <p>7 there are honeycombs would be lower?</p> <p>8 A. Yes. Well, it's interesting. You and I know what</p> <p>9 causes the honeycombing, and the honeycombing is a lack</p> <p>10 of flowability of the concrete which is constrained</p> <p>11 because the spacing between the bars, et cetera, doesn't</p> <p>12 allow the concrete to flow. In the core of this slab,</p> <p>13 that is not the case, and particularly at the top of the</p> <p>14 slab where we are most concerned, it's very visual and</p> <p>15 very obvious.</p> <p>16 So extrapolating honeycombing at the base of the</p> <p>17 3 metre slab and then saying, "My goodness me, we've got</p> <p>18 to declare the concrete inadequate in strength", I'm</p> <p>19 sorry, I can't buy into that.</p> <p>20 Q. Other than the flowability of the concrete, would you</p> <p>21 agree that it also depends on the workmanship of the</p> <p>22 concreter, that they properly compact with the kind of</p> <p>23 rod, vibrator?</p> <p>24 A. The vibrators, yes. But there's no reason -- when</p> <p>25 you're dealing with a 3 metre thickness of concrete and</p>

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<p>1 the sort of mix we have, it's very flowable for what 2 I would say unconstrained situations, and I have no 3 reason to believe -- when I've observed the surface of 4 the concrete and whatever, there's been no evidence of 5 what I would expect to see if it hadn't been properly 6 vibrated in that sense. 7 I don't think the competence -- I don't think this 8 is an issue of the operative on site. I think, you 9 know, you've got to imagine he's standing 3 metres 10 above, in other words more than the height of this room, 11 and he's looking through some of the densest 12 reinforcement I've seen at the top. He's got nine 13 layers of reinforcement -- unimaginable, isn't it, 14 really? -- at the bottom, stacked like this 15 (demonstrating), 6 inches centre to centre. Actually 16 the space is more like 90 millimetres square. How 17 does -- he's got this poker, he's got this vibrator, and 18 he's doing his absolute damndest to get down there and 19 do it. That's what I'm saying. 20 So this is not an issue of the workmanship of the 21 individual involved. It is a question of the selection 22 of the materials that the operative had to deal with. 23 Now, I've made that sound like a statement. It's not. 24 It's an observation. But I think, if you add all those 25 things together, you will see that it does make sense.</p>	<p>1 So, Dr Glover, you are telling us that the 2 honeycombing at the soffit, at the bottom of these 3 3 metre slabs is not a workmanship issue, it's a result 4 of the density of the steel and the flowability of the 5 concrete? 6 A. That's my observation, sir, but I don't think the 7 operative really had a fighting chance. 8 COMMISSIONER HANSFORD: That's really helpful, because so 9 far in this Commission the word "workmanship" or "poor 10 workmanship" is being used quite widely, and I think 11 it's being used as shorthand, without really 12 understanding what it meant. 13 A. Poor selection of materials. 14 COMMISSIONER HANSFORD: Poor selection of materials for the 15 situation that we find ourselves in, with such dense 16 reinforcement at the low level of this slab. 17 A. Yes. 18 COMMISSIONER HANSFORD: But "workmanship" would be the wrong 19 title -- "poor workmanship" would be the wrong 20 classification of it, in your view? 21 A. Yes, very much so, and returning to something the 22 Chairman said about the couplers, it's easy to say the 23 operative's at fault, is slap-dash, it was a Friday 24 afternoon and he wants to get away. That's not the case 25 here. Workmen don't want to do that. It only comes</p>
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<p>1 But the answer to your question is: the concrete 2 strength, as exhibited by the cubes, is a very good 3 facsimile of the strength which is in the structure, and 4 the cubes or the cylinders, the cores that were taken of 5 the diaphragm wall are a good indicator of what you 6 would expect. 7 Q. Right. The other question that Mr Chairman just raised 8 with you -- 9 CHAIRMAN: Sorry, could I just ask, so that I know and that 10 we know when we come to do this report -- as 11 I understand it, there's no suggestion by Dr Lau that 12 the concrete strength itself is inadequate? 13 MR CHOW: That's correct, Mr Chairman. But the point, from 14 my recollection, Dr Lau's evidence that he has some 15 doubt as to the quality of the concrete and therefore he 16 does not advise to use a higher strength for the purpose 17 of structural assessment, notwithstanding the cube 18 strength that one obtained from the 5,000-odd cube -- 19 CHAIRMAN: All right. And his doubt as to the quality of 20 the concrete is based on ...? 21 MR CHOW: The extensiveness of honeycombing and the 22 workmanship. 23 CHAIRMAN: Okay. Good. 24 COMMISSIONER HANSFORD: Could I just pick something up here 25 because this is actually very useful to me.</p>	<p>1 back on them in the end so they want to do a good job. 2 What normally would have happened -- I'm sorry, I am 3 extending my response -- but you would have carried out 4 flowability tests. You would have done them off site. 5 You would have identified these -- you remember 6 I referred to the unknowns and how you rule them out -- 7 you deal with them early, and this was going to be 8 a problem, so you would have carried out flowability 9 trials off-site, using certain admixtures, aggregate 10 size, and you would have gone back to the approving 11 authority and said, "Look, I intend to do this", and 12 show the demonstration. But no, that wasn't. It was 13 just, "Just hammer on, this is the mix, here is the 14 ready mix truck". I am imagining it but you can see the 15 situation, and the poor old operative is there with 16 an army of vibrators, working through the night, the 17 programme is -- we're pushing on, we've got to get on, 18 he's doing his damndest. Just imagine it. He's up 19 there, he's looking through at least four layers and 20 there's nine layers below. Not only that, the 21 shuttering wasn't properly cleaned, you could see water 22 on it and latents in the photographs. So I think it was 23 just -- 24 COMMISSIONER HANSFORD: The cleaning of the shuttering is 25 a workmanship issue?</p>

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<p>1 A. I would agree with that, but that would have been quite 2 superficial. You're familiar with these things. You 3 would have got that sort of watering effect on the 4 bottom. It wouldn't have caused the honeycombing. It 5 would have caused the local softening and lack of 6 hardness of the finish, in my opinion. 7 COMMISSIONER HANSFORD: Thank you. Just to round this off 8 in my mind. You are telling us that the honeycombing 9 can and should be repaired, and indeed it has been? 10 A. Yes. 11 COMMISSIONER HANSFORD: And that then remediates the 12 situation to the situation that was expected in the 13 design? It brings it up to the required standard? 14 A. It brings it up to a required standard, but the fact is 15 that in some of the latents, there would have been 16 a question about the lapping of some bars. They didn't 17 use couplers, they used lapping bars. 18 COMMISSIONER HANSFORD: Yes. 19 A. And a lapped bar transfers its strength from this bar 20 (indicating) to that bar (indicating) through the 21 concrete. 22 COMMISSIONER HANSFORD: Indeed. 23 A. And if the concrete is not there, clearly it can't do 24 that. 25 COMMISSIONER HANSFORD: Yes.</p>	<p>1 to decline. What is your view on his suggestion of 2 development of micro-cracks that caused the decline of 3 the strength? 4 A. Micro-cracks? I've got to think now what might have 5 been in his thinking there. We do get micro-cracks 6 during the curing period, due to shrinkage, and if you 7 have restraint then the concrete gets poured and it 8 manifests itself in cracks. But there's no evidence of 9 that. You would see it on the surface rather than in 10 the heart of the structure. 11 I'm not aware -- I mean, concrete is a ceramic. 12 I mean, do your plates have micro -- your plate is 13 a ceramic, concrete is a ceramic. Are you aware of any 14 micro-cracks in your plates? Do they suddenly 15 disintegrate? I'm just trying to find out what he 16 meant, because for something to crack, there has to be 17 an external influence on it or there has to be something 18 to do with the chemistry which is causing it, and I'm 19 not aware of that, and if I refer back to my analogy 20 with Roman concrete which makes up a very significant 21 constituent of modern concrete mixes, then I'm afraid 22 I can't help you answering that question. 23 Q. I believe Dr Lau also mentioned because of the loading 24 and the stress experienced by the concrete, it develops 25 micro-cracks, so that may be the distinction between the</p>
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<p>1 A. So those bars, in a situation -- and I only saw a couple 2 of situations where that would have occurred, where 3 there wasn't sufficient concrete between the two to get 4 the full transfer of load. But there are nine layers. 5 COMMISSIONER HANSFORD: Yes. 6 A. And the utilisation levels in the mid-span are something 7 in the teens. So remediation in this case is very 8 satisfactory, and it's almost back to where the designer 9 would have expected it to be, and I would say 10 utilisation levels are probably no higher than 11 20 per cent. 12 COMMISSIONER HANSFORD: Thank you. That's very helpful. 13 A. I wouldn't be making these statements in, shall I say, 14 a more highly stressed structure, but -- 15 COMMISSIONER HANSFORD: This is in relation to this 16 particular structure. 17 A. Exactly, and all my comments do relate to this 18 particular structure. 19 COMMISSIONER HANSFORD: Thank you. That's very helpful. 20 MR CHOW: Dr Glover, another issue that Mr Chairman has 21 discussed with you earlier is in relation to the 22 variation of the strength of the concrete over time. In 23 fact, Dr Lau also mentioned about development of 24 micro-cracks and this is the reason why he opined that 25 over time, after several years, concrete strength starts</p>	<p>1 plate -- 2 A. Oh, right. That's fair enough. I thought he was 3 thinking the poor old concrete sitting there, it's 4 minding its own business, and then suddenly over time it 5 starts to say, "I have a micro-crack." 6 No, micro-cracks in the sense of surface cracks are 7 very much part of reinforced concrete, because as 8 I think I said yesterday, reinforced concrete and people 9 -- this is a bit of a shock horror, but reinforced 10 concrete doesn't work unless it does crack, because it's 11 the flexing of the concrete which then allows the 12 concrete to bond onto the bar and for the bar to develop 13 its strain. But these are micro-cracks. When I say 14 "micro", you will be able to see some of them, but they 15 are spread out along a distance, and that's what we are 16 talking about. Do you think that's what he might have 17 meant? 18 COMMISSIONER HANSFORD: The suggestion -- 19 A. Those would be called micro-cracks and there would be 20 surface you would see them. 21 COMMISSIONER HANSFORD: I think the suggestion we had from 22 Dr Lau was over many years these micro-cracks would 23 result in the concrete being weaker. 24 A. No. I can't buy that one. I can appreciate if you get 25 cracks you might get corrosive materials in it and</p>

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<p>1 something nasty will happen. He did refer to 2 carbonation in 1950s -- or 50 year ago concrete and he's 3 absolutely right about that, and that's because the 4 concrete wasn't dense enough. I mean, I'm not talking 5 about heavy now, I'm talking about dense in terms of -- 6 if you think of concrete, it's a mixture of stones and 7 paste, and the density comes from can I get enough paste 8 and bits of sand into those parts? And that's where 9 admixtures have come in to a large extent and that's 10 where the pozzolanic material comes in. 11 Our concrete mixes now -- take this in the sense 12 that it's given -- the emphasis is on durability and 13 density rather than on strength, because strength, if 14 you like, is not something that we're worried about so 15 much anymore because we know we can achieve it, as the 16 concrete cubes demonstrate. And indeed, if you like, 17 our specifications on strength of concrete are 18 probably -- are behind in terms of where we are with 19 concrete technology. 20 So the emphasis for us nowadays is to make sure we 21 have a good, dense mix, to provide that durable cover, 22 because we do not want carbonation, and the carbonation 23 occurs because of this micro-cracking -- maybe this is 24 where he was. You get this micro-cracking occurring 25 because the reinforcement is straining. So you get</p>	<p>1 to insects. 2 Q. Before I go back to what I planned to do with you this 3 morning -- 4 A. Oh, dear. 5 Q. -- can I just seek clarification on what you have just 6 said on those partial factors of safety, just to clarify 7 what really your position is. 8 Now, so far as you are concerned, for the purpose of 9 giving your opinion, in answer to the Commission's 10 question as to whether the structure is safe or fit for 11 purpose, what you have in mind is the corresponding 12 partial load factors for forensic analysis; is that 13 right? 14 A. Yes, that's right. I was just trying to explain how 15 I would have approached any other structure, but what 16 I'm saying is I didn't take advantage of any of this. 17 Q. Certainly, yes. 18 A. But I wish I could, I mean -- but I didn't have to, 19 because it's safe and it's fit for purpose. 20 Q. Okay. Thank you. 21 A. But if you want me to, I will, and I'll demonstrate it's 22 got an even larger reserve of strength. 23 Q. It's very important that you clarify that, because as 24 Mr Southward told us yesterday there's no textbook 25 definition for safe, safety and fit for purpose. So</p>
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<p>1 a little crack and that allows the passage of carbon 2 dioxide to reduce the effectiveness of the cover, and 3 that's called carbonation. But actually, if you can 4 make that material which is in the cover dense enough, 5 then you reduce that. And there's a whole series of 6 modern tests that we use to do that on concrete. 7 MR CHOW: Just to wrap up this part of our discussion, so 8 your view is that as long as the structure is properly 9 built and so long as the structure will not experience 10 a loading which exceeds what the designer has allowed 11 for, then the structure can exist forever? 12 A. Yes. 13 Q. A concrete structure. 14 A. Yes. Well, as long as you don't have any corrosive 15 materials coming into it or whatever. I mean, there has 16 to be a sensible limit to it. But concrete itself, no, 17 I don't see -- 18 Q. All right. Okay. 19 A. There are no little termites out there, for example, 20 concrete termites. 21 Q. Right. 22 A. You're not going to bring that up, are you, concrete 23 termites? 24 Q. No, I'm not going to bring that up. 25 A. That's a relief. I'm afraid my knowledge doesn't extend</p>	<p>1 different engineers may have different reference line, 2 different benchmark, and the way I understand Dr Lau's 3 evidence, as far as he is concerned, he would only 4 consider the structure is safe if the structure provides 5 the same level of safety, ie the same factor of safety 6 as required by the code; whereas as far as you are 7 concerned, you consider that the factor of safety which 8 is somewhat lower than the factor of safety required by 9 the code but for the purpose of forensic analysis, so 10 long as it passes your forensic analysis and the 11 corresponding somewhat lower factor of safety, you would 12 consider the structure safe? 13 A. I'm afraid you've used a word which is an alert to me: 14 a lower factor of safety. No, I don't believe it 15 follows from this I end up with a lower factor of 16 safety, because actually all I've done is I've looked at 17 the actual situation, and the actual situation is the 18 resistance side has gone up. 19 Q. All right. 20 A. And so therefore, if I was to look at the factor of 21 safety of the structure as I understand it today, it 22 would be higher than the design, for this particular 23 structure. 24 So I don't want people running away with that 25 particular idea, because I could see that is a line that</p>

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<p>1 some people might misunderstand. You and I don't but</p> <p>2 other people might, so --</p> <p>3 Q. Right. One more clarification before I move on. The</p> <p>4 way you explained to us about forensic analysis, that is</p> <p>5 to do with the ultimate limit state; yes?</p> <p>6 A. Yes.</p> <p>7 Q. So even if you consider the forensic or you adopt the</p> <p>8 way that you did for forensic analysis, you still need</p> <p>9 to check the serviceability?</p> <p>10 A. Yes.</p> <p>11 Q. And, when you check the serviceability, you still need</p> <p>12 to apply the corresponding load factor and material</p> <p>13 factor as provided in the code; is that right?</p> <p>14 A. Yes, I did say that, actually. It doesn't affect the</p> <p>15 SLS condition at all, in which I don't have material</p> <p>16 factors, by the way, or load factors. You just take</p> <p>17 life as it really is, the loads as they are.</p> <p>18 So, no, this is to do with ULS, as you and I --</p> <p>19 again, I guess this is for other people, isn't it, not</p> <p>20 for you and I -- is it?</p> <p>21 Q. Yes.</p> <p>22 A. I hope it is.</p> <p>23 Q. (Overspeaking) ... for the Commission.</p> <p>24 A. Yes, good.</p> <p>25 Q. If I may then start with what I planned to do originally</p>	<p>1 to achieve the level of cover I would expect for the</p> <p>2 exposure that the structure would undergo. I hope that</p> <p>3 made sense, because it didn't come out as a flowing</p> <p>4 sentence.</p> <p>5 Q. Yes. And also, to ensure durability, you would have to</p> <p>6 ensure that the cracks that are going to develop in the</p> <p>7 structure would not be excessive, and to decide whether</p> <p>8 it's excessive, again you make reference to what is set</p> <p>9 out in the code. In this present case, it is</p> <p>10 0.3 millimetres.</p> <p>11 A. Yes, you've got to be careful about that, because</p> <p>12 I think the building code even in Hong Kong recognises</p> <p>13 that in some situations, exposures, for example, that</p> <p>14 the crack width calculation, provided you have obeyed</p> <p>15 certain detailing rules, is a deemed-to-satisfy</p> <p>16 criteria. People do see the crack width calculation as</p> <p>17 a science in itself but indeed it's black magic, and</p> <p>18 that's really why it's only ever been taken as</p> <p>19 an indicator, it's not absolute.</p> <p>20 So therefore, I think this is true of all codes that</p> <p>21 I'm aware of anyway, national codes, the crack width</p> <p>22 calculation, if that's what you're referring to, does</p> <p>23 not have to be executed in all situations; it's only in</p> <p>24 situations where there is a particular issue to address.</p> <p>25 Q. Right.</p>
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<p>1 this morning.</p> <p>2 A. Sorry.</p> <p>3 Q. The next topics that I would like to deal with, actually</p> <p>4 we have covered a little already, is about fit for</p> <p>5 purpose; right?</p> <p>6 In paragraph 5.8 of your first expert report, you</p> <p>7 said, in your opinion, the important aspect to be</p> <p>8 satisfied -- I'm starting from line 4 of paragraph 5.8.</p> <p>9 A. Yes.</p> <p>10 Q. "... the important aspect to be satisfied is whether the</p> <p>11 as-constructed structure is capable of being used and</p> <p>12 function as a station safely and without any physical</p> <p>13 restrictions on its operations and as anticipated by</p> <p>14 MTRCL. In that regard, the structure should be durable,</p> <p>15 safe, have sufficient strength, and not deflect or</p> <p>16 vibrate beyond those limits expected for a station ..."</p> <p>17 Now, I just want to seek your clarification. By</p> <p>18 "durable", in the context of post-construction</p> <p>19 assessment, are you saying that one has to ensure that</p> <p>20 we have enough concrete cover to ensure that it is</p> <p>21 durable, and to have enough concrete cover you would</p> <p>22 make reference to the requirement of the code; is that</p> <p>23 right?</p> <p>24 A. I have to think my way through this one, because</p> <p>25 I think -- yes, I would look at the relevant standards</p>	<p>1 A. And I think we are in a situation here -- and we are</p> <p>2 talking now specifically of couplers, I think -- where</p> <p>3 that's not the case. It gets a tick in the box and</p> <p>4 I thought Mr Southward's description of different</p> <p>5 things, when this question was asked, was entirely</p> <p>6 correct.</p> <p>7 So I'm happy with that.</p> <p>8 Q. Right, okay.</p> <p>9 A. Sorry, when I said "I'm happy with that", I hope you</p> <p>10 didn't mean to say that I'm happy with it has to be</p> <p>11 code-compliant.</p> <p>12 Q. "Ah, that is what I understand."</p> <p>13 A. I thought you might. What I'm saying is you've got to</p> <p>14 look at the environment and I believe what the code in</p> <p>15 this particular situation says makes sense, that this</p> <p>16 environment is benign and that the "deemed-to-satisfy</p> <p>17 rules" meant you didn't have to carry out that check</p> <p>18 anyway, and that's it, and if that's what the code says</p> <p>19 then that's okay.</p> <p>20 Q. The code, from my recollection, because I remember my</p> <p>21 learned leader has taken Mr Southward through details of</p> <p>22 the relevant part of the code, about different exposure</p> <p>23 conditions.</p> <p>24 A. Yes.</p> <p>25 Q. The code requires that the maximum allowable crack width</p>

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<p>1 is 0.3 millimetres. If the structure is exposed to</p> <p>2 exposure condition 1, then the code said one doesn't</p> <p>3 have to worry about durability, in excess of</p> <p>4 0.3 millimetres --</p> <p>5 A. Correct.</p> <p>6 Q. -- may not have any impact on long-term durability. But</p> <p>7 for other exposure conditions, then you have to ensure</p> <p>8 that the crack width under working condition should not</p> <p>9 exceed 0.3 millimetres. This is what the code said.</p> <p>10 A. Yes.</p> <p>11 Q. Are you happy with that as a reasonable requirement?</p> <p>12 A. I'm happy that we have a benign environment, whatever</p> <p>13 you want to call it, and as such cracking does not pose</p> <p>14 a risk. It's not a wetting and drying situation, and</p> <p>15 I think that is it, really, other than to observe that</p> <p>16 I have not seen any of this cracking, and the loading</p> <p>17 that the structure is currently experiencing is about</p> <p>18 90 per cent of the loading that could reasonably be</p> <p>19 expected, and if there had been any cracking it would</p> <p>20 have been apparent by now, even in an isolated area,</p> <p>21 even in one or two locations. But there's no evidence</p> <p>22 of this.</p> <p>23 Q. No.</p> <p>24 A. So I'm not sure where your questions go because if we</p> <p>25 don't watch out, we are not going to be talking about</p>	<p>1 would expect every day, is that the slab level is at</p> <p>2 plus 4, the actual sort of stable water table I think is</p> <p>3 around about 1, and it varies by about half a metre</p> <p>4 either side of that.</p> <p>5 Q. Right.</p> <p>6 A. If you have an extremely high tide, a storm surge or</p> <p>7 something, then I should imagine it could go as high as</p> <p>8 that, but I find the 2.8 -- did you mention? -- to be</p> <p>9 a bit extraordinary, and the lower figure must have been</p> <p>10 because of some local -- in fact, it would have been</p> <p>11 because of some local drawdown that the contractor would</p> <p>12 have been carrying out as part of the construction.</p> <p>13 But by and large you don't -- you don't design</p> <p>14 around those sorts of numbers because they are almost</p> <p>15 instantaneous. You know, you don't take those as</p> <p>16 long-term durability issues, I should say to you.</p> <p>17 You've got to take those loadings into account in your</p> <p>18 structural calculations, but when -- so, when we are</p> <p>19 looking at durability issues, we tend to look at the</p> <p>20 steady state and we take some fluctuations around it but</p> <p>21 we don't take extremes because, if you take extremes,</p> <p>22 you end up with extreme solutions which make no sense at</p> <p>23 all.</p> <p>24 So that's why I was trying to put the numbers that</p> <p>25 we were being given in perspective. They are not the</p>
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<p>1 this structure, we are going to be talking about clauses</p> <p>2 in codes, and I've already said that's not -- I'm not</p> <p>3 considering that. I don't want to give you a judgment</p> <p>4 on compliance. I'm just answering the question: is it</p> <p>5 safe, is it fit for purpose, does it pass those tests?</p> <p>6 And I'm saying yes. I don't want to discuss what the</p> <p>7 fine detail of a particular clause says in a code,</p> <p>8 because I don't think it's relevant, not because I don't</p> <p>9 think it's important in another arena. In this one,</p> <p>10 it's irrelevant.</p> <p>11 Q. Actually, at this point, I just want to clarify with you</p> <p>12 what you actually mean in paragraph 5.8. But as you</p> <p>13 mentioned about, we are not in a wet --</p> <p>14 A. Wet and dry.</p> <p>15 Q. Wet and dry. Perhaps it is a convenient moment that</p> <p>16 I have to raise this with you.</p> <p>17 A. Okay.</p> <p>18 Q. According to my instruction, there is a tidal variation.</p> <p>19 A. Yes, there is.</p> <p>20 Q. The tidal variation, according to Atkins' report, varies</p> <p>21 from minus 0.2mPD to plus 2.8mPD.</p> <p>22 A. Those -- I guess -- I can only imagine they come from</p> <p>23 historic records.</p> <p>24 Q. Yes.</p> <p>25 A. Because the sort of diurnal, in other words what you</p>	<p>1 sort of numbers that you would expect the structure to</p> <p>2 be subjected to in a long or medium-term condition.</p> <p>3 Something extraordinary would have to happen in</p> <p>4 Hong Kong for that to be the case; because, for example,</p> <p>5 for the water table to rise to 2.8 metres, when the sea</p> <p>6 level is about zero, just think what that means locally,</p> <p>7 whereas the level at the moment is 1 metre.</p> <p>8 You know, so I have to push back on that, I'm sorry.</p> <p>9 I mean, you are giving numbers in good faith. I'm not</p> <p>10 disputing your earnestness. But I have to equally put</p> <p>11 them into perspective, don't I?</p> <p>12 Q. May I just, for the purposes of the record, give the</p> <p>13 page reference for this. It's bundle AA, page 527.</p> <p>14 It's part of the Atkins report which provides the tidal</p> <p>15 variations from minus 0.2mPD to plus 2.8mPD.</p> <p>16 Regarding what you said about the top level of the</p> <p>17 EWL slab, my instruction is that it is not plus 4, it's</p> <p>18 only plus 2.85mPD. Would you disagree with that?</p> <p>19 A. I'm sorry, if that is the case -- let me take your</p> <p>20 number for now. I've been advised it's 4 but if you've</p> <p>21 got better advice then I'm not going to challenge that.</p> <p>22 Q. Thank you for your trust, but I can also give a drawing</p> <p>23 reference in which the level, the top level of the EWL</p> <p>24 slab is marked on those drawings. It's bundle H --</p> <p>25 A. Sorry, is that the level in the station or is that the</p>

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<p>1 level in --</p> <p>2 Q. The EWL slab.</p> <p>3 A. Yes, but is that the level in the station or is that the</p> <p>4 level at SAT, NAT, area A or whatever? Because, you</p> <p>5 see, in the station, it's at a level, and then when</p> <p>6 you've got --</p> <p>7 Q. Right.</p> <p>8 A. Of course, and I just wonder. But anyway, let's listen</p> <p>9 to what you have to say.</p> <p>10 Q. I assume it is for the station --</p> <p>11 A. I'm not sure.</p> <p>12 Q. I can further confirm that -- we have looked at it</p> <p>13 during the first stage of our COI, I think 2.85 is</p> <p>14 a figure which looks very familiar to me, so I suspect</p> <p>15 2.85 is the top of the EWL slab of the station.</p> <p>16 A. Okay.</p> <p>17 Q. Just for the purpose of the record, bundle H, page 552</p> <p>18 is a drawing on which someone marked the finish level of</p> <p>19 the EWL slab as plus 2.85.</p> <p>20 Assuming that the top level of the EWL slab is plus</p> <p>21 2.85 --</p> <p>22 A. Oh, we've got a drawing.</p> <p>23 COMMISSIONER HANSFORD: Can we just pause and see this</p> <p>24 drawing?</p> <p>25 MR CHOW: Sure.</p>	<p>1 A. I can see where the confusion has arisen, yes.</p> <p>2 Q. So let's assume the top level of the EWL slab is</p> <p>3 plus 2.84.</p> <p>4 A. Yes.</p> <p>5 Q. And given the tidal variation can go up to plus 2.8,</p> <p>6 with that tidal variation am I right in understanding</p> <p>7 that the top part of the EWL slab is subject to wet and</p> <p>8 dry conditions?</p> <p>9 A. The external face of the diaphragm wall?</p> <p>10 Q. Yes.</p> <p>11 A. Yes. The external face of the diaphragm wall could be,</p> <p>12 yes. But, I mean, you've got to remember, wetting and</p> <p>13 drying -- what wetting and drying means is something is</p> <p>14 wet, you know, you take a bucket of water and you throw</p> <p>15 it on it, and then you allow it to dry in oxygen, so</p> <p>16 it's got lots of oxygen coming into it, and then you dry</p> <p>17 it, and then in a short period after that you throw</p> <p>18 another bucket of water over it and you get more oxygen</p> <p>19 in it.</p> <p>20 In the ground, it's not like that. You see, the</p> <p>21 fact -- an interesting thing that people don't realise</p> <p>22 about waves, for example, the water doesn't move. All</p> <p>23 a wave is is a circular motion of a particle of water</p> <p>24 moving round and round. So because the tide actually</p> <p>25 moves up and down, we've got this thinking that there's</p>
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<p>1 A. Can you point me to the level itself? There's a ground</p> <p>2 level outside, isn't there?</p> <p>3 Q. Yes.</p> <p>4 COMMISSIONER HANSFORD: There's a point --</p> <p>5 A. I can't really see it.</p> <p>6 MR CHOW: Can we blow up a little bit, the top of the EWL</p> <p>7 slab.</p> <p>8 A. There's a level there, isn't there, on the ground? Can</p> <p>9 I see what that is. Yes --</p> <p>10 Q. 2.84.</p> <p>11 A. 4.4 is the existing ground, and then we've got</p> <p>12 a dimension of 5 -- no, that's the slab depth. Rail</p> <p>13 level -- yes, look, there's your 2.84.</p> <p>14 Q. Yes, 2.84.</p> <p>15 A. But this is -- I'm not sure where this section is but</p> <p>16 let's assume that that's -- because you see, what I'm</p> <p>17 referring to, you see that level there (indicating),</p> <p>18 4.03?</p> <p>19 Q. Yes.</p> <p>20 A. That level there (indicating), that was my reference</p> <p>21 point about the station being at 4.</p> <p>22 Q. I see. But to the left of it we see a level marked off,</p> <p>23 plus 2.84 --</p> <p>24 A. As I said, I'm quite happy to --</p> <p>25 Q. It looks like --</p>	<p>1 a huge in-flush of water, but it's not, it's a pressure,</p> <p>2 and the water locally just rises up and goes down. The</p> <p>3 level of oxygen in that water is not substantially</p> <p>4 changed.</p> <p>5 This is not the same as my bucket of water, drying</p> <p>6 it out with a hairdryer and then putting another -- it's</p> <p>7 not like that. So I'm not sure where you are going.</p> <p>8 Q. The short point I'm suggesting --</p> <p>9 A. We are talking about the outside wall of the diaphragm</p> <p>10 wall. I thought we were talking about cracks local to</p> <p>11 the couplers which are inside the structure, away from</p> <p>12 the wetting and drying. So can you get the connection</p> <p>13 between the two?</p> <p>14 Q. As I understand --</p> <p>15 A. Otherwise we are going to waste our time, aren't we,</p> <p>16 talking about the diaphragm wall?</p> <p>17 COMMISSIONER HANSFORD: Sorry, just pause there. You said</p> <p>18 "away from the wetting and the drying". It's just</p> <p>19 wetting.</p> <p>20 A. It's just wetting, and the ground is very humid.</p> <p>21 I really don't know. This is not --</p> <p>22 COMMISSIONER HANSFORD: Because it's not drying, is it?</p> <p>23 A. No.</p> <p>24 COMMISSIONER HANSFORD: Is that right?</p> <p>25 A. It's wet. You don't need standing water for something</p>

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<p>1 to be wet.</p> <p>2 CHAIRMAN: Mr Chow, perhaps you might put the question that</p> <p>3 you would like to put now and then we can see where that</p> <p>4 takes us.</p> <p>5 A. That would help.</p> <p>6 MR CHOW: What I'm getting at is that from my understanding</p> <p>7 of Dr Lau's evidence, you will recall that yesterday or</p> <p>8 the day before, when he talked about the crack</p> <p>9 distribution within the joint, he mentioned about the</p> <p>10 cracks on the outside of the diaphragm wall, and to him</p> <p>11 there's a concern of water getting in and causing</p> <p>12 corrosion to the reinforcement inside.</p> <p>13 Yesterday, in your presentation, you mentioned one</p> <p>14 would need oxygen, water and iron to cause corrosion.</p> <p>15 A. Yes, and a constant flow, by the way, of oxygen and</p> <p>16 water, not the same water.</p> <p>17 Q. Not the same water.</p> <p>18 A. Yes. The key is, for something to cause corrosion,</p> <p>19 there needs to be a constant supply of the things that</p> <p>20 make the corrosion. If you deny one of them, you don't</p> <p>21 get it. So if you deny oxygen, you don't get corrosion.</p> <p>22 Put a nail into water at home, for example, and leave it</p> <p>23 there, and carry out with a number of different ones,</p> <p>24 you do it over a number of days and take the nail out</p> <p>25 and see what the degree of corrosion is, and you will</p>	<p>1 A. Just ask me what it is, otherwise we are going around in</p> <p>2 circles.</p> <p>3 Q. All right. According to Dr Lau's theory, there are</p> <p>4 cracks on the outside of the diaphragm wall, and because</p> <p>5 of the tidal variation there is a concern for excessive</p> <p>6 crack width, because that will cause corrosion to the</p> <p>7 steel inside the diaphragm wall, and at that zone, the</p> <p>8 tidal variation zone, that is the region where we have</p> <p>9 the connection. Do you agree with me that that is</p> <p>10 a concern?</p> <p>11 A. No. And I repeat what I've just said, just to make sure</p> <p>12 that everybody understands why that is: the diaphragm</p> <p>13 wall has been designed in accordance with all of the</p> <p>14 standards required. It's been constructed in accordance</p> <p>15 with all the standards. It has all of the quality</p> <p>16 assurance tests. It has been passed by the approval</p> <p>17 authorities. It's undergone the highest level of</p> <p>18 inspection. If you start to question that, Mr Chow,</p> <p>19 then you should question every single diaphragm wall in</p> <p>20 Hong Kong. Is that what you're doing? Because if you</p> <p>21 want to go into that, then I'm quite happy to do that,</p> <p>22 but that's what you are saying.</p> <p>23 I submitted yesterday some non-linear finite element</p> <p>24 analyses which demonstrate it is implausible for the</p> <p>25 scenarios that are being described to occur, and apart</p>
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<p>1 find that it will plateau.</p> <p>2 Q. Just to use your example, if I drop the nail in the</p> <p>3 water for a certain number of hours in the day, and then</p> <p>4 I bring it out into the air, and the next day I do</p> <p>5 exactly the same thing over a period of a year, are you</p> <p>6 suggesting the nail would not rust?</p> <p>7 A. No, that's not correct.</p> <p>8 Q. So the nail will rust because it's subject dry and wet</p> <p>9 conditions?</p> <p>10 A. Yes, when you take the nail out, it will be wet, and it</p> <p>11 absorbs oxygen, it will start again.</p> <p>12 Q. Very well. So for the part of the EWL slab structure,</p> <p>13 which is subject to tidal variation, so during a certain</p> <p>14 period of hours in a day, it is in direct contact with</p> <p>15 seawater or saline water; is that correct?</p> <p>16 A. It never dries.</p> <p>17 Q. It never dries.</p> <p>18 A. The environment in that level, there's always a level of</p> <p>19 dampness just because of the poor water pressures in the</p> <p>20 soil.</p> <p>21 Mr Chow, please, ask me the question and I'll answer</p> <p>22 it. Do I believe there is a crack that could sensibly</p> <p>23 connect into the CJ; is that what you are asking me?</p> <p>24 Because I think that's what you are.</p> <p>25 Q. I am not asking you about the CJ yet.</p>	<p>1 from that I fall back again on what I've just said about</p> <p>2 the quality of construction of the diaphragm wall.</p> <p>3 Now, if you want the Commission to open up the</p> <p>4 discussion onto the diaphragm wall, that's for the</p> <p>5 Commission to decide, not for me, but I've just told you</p> <p>6 what my position is. And I'm sorry to be quite so</p> <p>7 strident, but it's a non-issue and we have some</p> <p>8 important issues to discuss and I'd rather move to</p> <p>9 those.</p> <p>10 So I didn't mean to be offensive but I just wanted</p> <p>11 to be clear.</p> <p>12 Q. Not at all. I don't mind at all.</p> <p>13 CHAIRMAN: Could I just ask you here, so we know where we</p> <p>14 are going, because I appreciate you are saying,</p> <p>15 according to Dr Lau, his investigations have indicated</p> <p>16 the likelihood of cracks on the outside of the diaphragm</p> <p>17 walls. That's what you say.</p> <p>18 MR CHOW: Yes.</p> <p>19 CHAIRMAN: Those cracks, being on the outside, would be in</p> <p>20 direct contact with the earth, and because of tidal</p> <p>21 variations, so the water levels in the soil become</p> <p>22 greater and lesser, there is a concern for excessive</p> <p>23 cracking which may lead to corrosion to the steel inside</p> <p>24 the diaphragm wall.</p> <p>25 Now, has government taken any steps by way of</p>

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<p>1 remedial action to deal with that particular problem?</p> <p>2 MR BOULDING: Sir, can I just intervene, and I apologise for</p> <p>3 this, but it is important to point out that Dr Lau has</p> <p>4 not carried out investigations to come up with that</p> <p>5 particular conclusion. It's all theory.</p> <p>6 CHAIRMAN: All right.</p> <p>7 MR SHIEH: One can be concerned about anything under the</p> <p>8 sun.</p> <p>9 CHAIRMAN: Absolutely, which is why what I want to try to</p> <p>10 find out is starting from square one, so to speak.</p> <p>11 Nothing has been done, no remedial actions have been</p> <p>12 taken, based on Dr Lau's opinion?</p> <p>13 MR CHOW: Mr Chairman, from my recollection of Dr Lau's</p> <p>14 evidence, he seems to suggest that the installation of</p> <p>15 dowel bar would somehow reduce the stress level inside</p> <p>16 the connection and that would help. And I would</p> <p>17 understand his evidence as suggesting that because of</p> <p>18 the addition of the dowel bar, it will reduce the crack</p> <p>19 width, and therefore improve the situation and that</p> <p>20 would help or mitigate or reduce the concern with</p> <p>21 corrosion.</p> <p>22 CHAIRMAN: All right. One of my major concerns obviously is</p> <p>23 that we don't bypass these things unwittingly. So</p> <p>24 what's being said then is that Dr Lau is concerned,</p> <p>25 based on his knowledge and his expertise, not on actual</p>	<p>1 I think it's patently obvious that adding a dowel which</p> <p>2 contributes something like 1 per cent, less than</p> <p>3 1 per cent, to the strength of something is not</p> <p>4 a mitigation. And indeed the installation of such</p> <p>5 a dowel, with all the good intentions that it has,</p> <p>6 causes vibration and all the other bits and pieces.</p> <p>7 So I don't see the link, as a professional engineer.</p> <p>8 You might wish to ask the same question of Mr Southward</p> <p>9 or Prof McQuillan, but I don't see the link, I'm sorry.</p> <p>10 It might be a lack of understanding on my part, but for</p> <p>11 the life of me I just can't understand.</p> <p>12 MR CHOW: All right.</p> <p>13 CHAIRMAN: Could I follow that up. What you are saying is</p> <p>14 that the dowel remedy, if I can call it that, you don't</p> <p>15 see it as being of any significant assistance to</p> <p>16 whatever problem may be --</p> <p>17 A. To whatever the list of remedies that are being sought,</p> <p>18 I don't see that it contributes. This particular one,</p> <p>19 this cracking of the diaphragm wall, it has no</p> <p>20 relationship whatsoever.</p> <p>21 CHAIRMAN: Then that's my second question: are you yourself</p> <p>22 on what you know of the structure overall, particularly</p> <p>23 the external side of the D-walls, concerned about the</p> <p>24 issue of possible corrosion over an extended period of</p> <p>25 time to the steel inside the D-walls?</p>
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<p>1 investigation, that there are cracks on the outside of</p> <p>2 the diaphragm wall, and because of tidal variations,</p> <p>3 they may become excessive.</p> <p>4 COMMISSIONER HANSFORD: No, because of tidal variations,</p> <p>5 water may seep into them.</p> <p>6 CHAIRMAN: Yes, thank you, causing corrosion. But he is of</p> <p>7 the view that this perceived long-term problem of</p> <p>8 corrosion will be satisfactorily dealt with by what I'll</p> <p>9 call the dowel bar remedy.</p> <p>10 MR CHOW: That's what he said, yes.</p> <p>11 COMMISSIONER HANSFORD: I think probably then it might be</p> <p>12 useful for the Commission to get Dr Glover's view on</p> <p>13 that --</p> <p>14 MR CHOW: Yes.</p> <p>15 COMMISSIONER HANSFORD: -- sort of scenario.</p> <p>16 MR CHOW: Yes. Perhaps I can ask Dr Glover --</p> <p>17 COMMISSIONER HANSFORD: Yes.</p> <p>18 MR CHOW: Dr Glover, you recall that part of Dr Lau's</p> <p>19 evidence is that there is a need to install dowel bars,</p> <p>20 and the reason that he gave in evidence is that because</p> <p>21 of the cracks on the outside of the wall and the</p> <p>22 installation of dowel bar will improve the situation, so</p> <p>23 as to somehow eliminate the concern. What is your view</p> <p>24 on that?</p> <p>25 A. Mr Chow, you know I don't want to say this; right? But</p>	<p>1 A. No. The diaphragm wall has been designed competently,</p> <p>2 constructed very competently, lots of photographic</p> <p>3 records of what was constructed. We now have the</p> <p>4 benefit of the cores of the concrete which demonstrates</p> <p>5 it's very dense. Remember my comment earlier about</p> <p>6 density of concrete being the most important thing in</p> <p>7 terms of corrosion protection. No, I don't have</p> <p>8 concern.</p> <p>9 MR BOULDING: Sir, I don't want to be pedantic but it is</p> <p>10 an important point. My learned friend Mr Chow put the</p> <p>11 question on the basis -- and perhaps I can read:</p> <p>12 "Dr Glover, you recall that part of Dr Lau's</p> <p>13 evidence is that there is a need to install dowel bars,</p> <p>14 and the reason that he gave in evidence is that because</p> <p>15 of the cracks on the outside of the wall ..."</p> <p>16 Now, it's important to point out that his evidence</p> <p>17 was not that there were in fact cracks but there might</p> <p>18 be cracks. I see the professor is nodding.</p> <p>19 COMMISSIONER HANSFORD: Yes.</p> <p>20 MR BOULDING: It's an important point, in my submission.</p> <p>21 COMMISSIONER HANSFORD: Yes. I think his evidence -- please</p> <p>22 correct me if I've got it wrong -- is that there is</p> <p>23 a risk that cracks might occur.</p> <p>24 MR BOULDING: That's my recollection as well, including that</p> <p>25 of my learned junior.</p>

Page 53	<p>1 CHAIRMAN: Thank you. Yes.</p> <p>2 MR CHOW: It also refers to a number of diagrams from finite</p> <p>3 element analysis which show the pattern of the cracks.</p> <p>4 I think this is as far as we can go.</p> <p>5 A. If I could just put that diagram into perspective, and</p> <p>6 I'm sure Dr Lau wasn't intending to mislead anybody, but</p> <p>7 if you looked on that diagram -- it was from Atkins,</p> <p>8 I think, wasn't it? It's quite clear -- at the bottom,</p> <p>9 it says "ULS conditions", in other words failure</p> <p>10 conditions. That was misleading, to show that slide.</p> <p>11 The other thing is Atkins do acknowledge that that</p> <p>12 analysis was done in a bit of a hurry and they hadn't</p> <p>13 completed it, whereas the analysis I showed you</p> <p>14 yesterday has had the opportunity of more consideration.</p> <p>15 So I would say it's a pity that that is in the</p> <p>16 bundle but if anybody ever was to refer to it, I think</p> <p>17 they've got to look at it and see that it's related to</p> <p>18 the failure mechanism of the structure and not at all</p> <p>19 what the working life cracking pattern would be. So it</p> <p>20 was very misleading to show that slide, without putting</p> <p>21 that -- I wouldn't say caveat but that explanation, and</p> <p>22 that explanation, as far as I'm aware, was not made.</p> <p>23 Q. Yes. I actually take your point. I will take your word</p> <p>24 for it. If it is referring to ultimate limit state,</p> <p>25 then perhaps it has to be made clear.</p>	Page 55	<p>1 A. So it shouldn't -- to use that as a basis for saying,</p> <p>2 "Oh, my goodness me, it's all going to crack", is</p> <p>3 misleading, to the extreme.</p> <p>4 COMMISSIONER HANSFORD: The purpose of my intervention is to</p> <p>5 make sure the chairman understands what is being said.</p> <p>6 A. Sorry, yes. First of all, does Mr Chow agree with what</p> <p>7 I said was correct?</p> <p>8 COMMISSIONER HANSFORD: Sorry, can I just continue?</p> <p>9 So what this is telling us is this is the cracking</p> <p>10 pattern at ultimate limit state, the theoretical</p> <p>11 cracking pattern at ultimate limit state; yes? The</p> <p>12 ultimate limit state is the condition at failure, and</p> <p>13 the analysis has shown that it never reaches anything</p> <p>14 like the loading required for failure, ultimate limit</p> <p>15 state.</p> <p>16 A. Correct.</p> <p>17 COMMISSIONER HANSFORD: In layman's terms, is that correct,</p> <p>18 Dr Glover?</p> <p>19 A. It is, and we don't -- we are only interested in</p> <p>20 cracking patterns at the ultimate limit state, to</p> <p>21 understand the failure mechanisms. We check crack width</p> <p>22 at what we call SLS, which is the working load level,</p> <p>23 and the crack pattern which is appropriate to that was</p> <p>24 the one that I showed yesterday.</p> <p>25 COMMISSIONER HANSFORD: Yes.</p>
Page 54	<p>1 COMMISSIONER HANSFORD: Can I suggest we don't take the</p> <p>2 word, we have a look at it.</p> <p>3 MR CHOW: Yes, please.</p> <p>4 COMMISSIONER HANSFORD: Can we go to Dr Lau's presentation.</p> <p>5 A. I've got my fingers crossed that my memory is good.</p> <p>6 Was it in his report?</p> <p>7 COMMISSIONER HANSFORD: I thought it was in the presentation</p> <p>8 but I will stand corrected.</p> <p>9 MR CHOW: I think it is in his presentation as well.</p> <p>10 COMMISSIONER HANSFORD: Yes, I thought it was.</p> <p>11 A. There it is. It's that one.</p> <p>12 MR CHOW: Maybe page 44.</p> <p>13 A. Yes. If you look at the bottom, the left-hand branch of</p> <p>14 it --</p> <p>15 Q. Yes, that's right. Actually --</p> <p>16 A. -- it does say "ultimate limit state".</p> <p>17 Q. Yes, figure 5.4 does state that it's the crack pattern</p> <p>18 at ultimate limit state.</p> <p>19 MR PENNICOTT: Yes.</p> <p>20 CHAIRMAN: Okay. Can you help me?</p> <p>21 A. Ultimate limit state, sir, is the ultimate design, in</p> <p>22 other words it's about to collapse. Crack patterns are</p> <p>23 irrelevant for ultimate state of collapse. We don't</p> <p>24 even ...</p> <p>25 COMMISSIONER HANSFORD: Can I just --</p>	Page 56	<p>1 A. And it was the one between -- I showed three images.</p> <p>2 One was at ultimate limit state and the other two were</p> <p>3 related to various levels of service, and you saw the</p> <p>4 levels of cracking were very limited and they were</p> <p>5 indeed concentrated at the bottom of the EWL slab and</p> <p>6 there was no sign of distress in the higher-up parts.</p> <p>7 I'm sorry to give a long answer but I wanted to be</p> <p>8 precise.</p> <p>9 COMMISSIONER HANSFORD: No, no. We need a long answer.</p> <p>10 CHAIRMAN: All right. Thank you. That makes a lot of</p> <p>11 sense. Thank you very much.</p> <p>12 MR CHOW: Dr Glover, can I just finish my question on</p> <p>13 paragraph 5.8 before the morning break.</p> <p>14 A. Please.</p> <p>15 Q. In paragraph 5.8, you also mention about "not deflect or</p> <p>16 vibrate beyond those limits expected for a station".</p> <p>17 A. I'm sorry, Mr Chow.</p> <p>18 Q. The last part of paragraph 5.8, you list out a number of</p> <p>19 factors that you consider. The last factor is "to</p> <p>20 ensure that the structure will not deflect or vibrate</p> <p>21 beyond those limits expected for a station".</p> <p>22 A. Yes.</p> <p>23 Q. Now, the limits expected, it's concerned about</p> <p>24 expectation, do you agree that it would relate to</p> <p>25 a particular expectation in the locality at which the</p>

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<p>1 structure is located?</p> <p>2 A. Are you referring specifically -- okay, generally, yes,</p> <p>3 but when it comes to deflection, we have checked all the</p> <p>4 deflections in the structure, taking account of all</p> <p>5 sorts of factors, but deflection just isn't -- I mean,</p> <p>6 if you remember the conversation we had about</p> <p>7 monitoring, it's not an issue. Vibration, we've carried</p> <p>8 out dynamic analyses to find out if there is anything</p> <p>9 that could disturb.</p> <p>10 So, as far I'm concerned, it satisfies those</p> <p>11 requirements.</p> <p>12 Q. So again in relation to these two aspects, you would</p> <p>13 check against the requirement set out in the local code,</p> <p>14 in our present case the Concrete Code?</p> <p>15 A. Yes, in terms of deflection it's a slam dunk, I think</p> <p>16 the Americans call it. Why, do you think there's</p> <p>17 a concern? Oh, good.</p> <p>18 Q. I'm just seeking clarification from you.</p> <p>19 A. I'm sorry. Right. Okay. I confirm that.</p> <p>20 MR CHOW: Mr Chairman, this is a convenient moment for the</p> <p>21 morning break.</p> <p>22 CHAIRMAN: Yes, certainly. Thank you very much.</p> <p>23 15 minutes.</p> <p>24 (11.25 am)</p> <p>25 (A short adjournment)</p>	<p>1 Q. So the proper description of that is bedding-in?</p> <p>2 A. It's bedding-in, yes, of the threads.</p> <p>3 Q. According to the test results, we observe that for the</p> <p>4 one that shows the worst situation is this so-called</p> <p>5 permanent elongation can go as far as over</p> <p>6 0.5 millimetres.</p> <p>7 A. I mean, the record is the record, but when we carry out</p> <p>8 such experiments as that, one always uses the mean. We</p> <p>9 never use the extremes, for reasons I have explained</p> <p>10 previously.</p> <p>11 Q. All right.</p> <p>12 A. You can use the extreme if you wish, but I prefer to</p> <p>13 stick with the convention, which is the average, and the</p> <p>14 average is I think something like 0.28, which is quite</p> <p>15 dramatic, dramatically different. One might be three</p> <p>16 hairs' breadth and the other one is two. But that's</p> <p>17 what we're talking about.</p> <p>18 When we start bandying numbers around, it's very</p> <p>19 important that we bring it back to something tangible</p> <p>20 that people can understand. 0.1 is -- a hair is wider</p> <p>21 than 0.1. It does depend on ethnic group, mind you, but</p> <p>22 that's generally -- I won't say which is which, but mine</p> <p>23 is probably around about 0.1.</p> <p>24 COMMISSIONER HANSFORD: Perhaps the other comparison is the</p> <p>25 number of sheets of paper.</p>
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<p>1 (11.46 am)</p> <p>2 MR CHOW: Dr Glover, I would like to move on to another</p> <p>3 topic, the partially engaged coupler connections.</p> <p>4 It looks like the experts are in agreement that</p> <p>5 there is initial slip if the coupler connections have</p> <p>6 not been fully tightened.</p> <p>7 A. On the basis of the laboratory tests, yes. That's</p> <p>8 self-evident, yes.</p> <p>9 Q. According to the test results, the permanent</p> <p>10 elongation -- now, I would put the term "permanent</p> <p>11 elongation" carefully because I understand that the</p> <p>12 expert view is that this so-called permanent elongation</p> <p>13 actually represents mainly the extent of the initial</p> <p>14 slip.</p> <p>15 A. Well, it's bedding-in of the thread, basically. When</p> <p>16 you do up a bolt or whatever, one or two of the threads</p> <p>17 are actually in contact and the others aren't, and this</p> <p>18 is because of the machine tolerances. If there wasn't</p> <p>19 the tolerance, you wouldn't be able to do it up.</p> <p>20 So what you are seeing is the initial plasticity of</p> <p>21 the points that are in contact closing up and then all</p> <p>22 of the threads come into action.</p> <p>23 So that's what it is. It's not slip. It's</p> <p>24 a bedding-in of the thread, but if you want to call it</p> <p>25 "slip" then I'm happy with that.</p>	<p>1 A. Yes, that's a good one.</p> <p>2 You have to have good eyesight to measure.</p> <p>3 COMMISSIONER HANSFORD: I know. I can't --</p> <p>4 A. You can't. You can't physically measure 0.1mm with the</p> <p>5 naked eye. In fact, if you have a pen, the old Rotring</p> <p>6 pens, the ink pens, 0.1 -- you remember those? 0.1, it</p> <p>7 always clogged up. You could never use it sensibly</p> <p>8 because it was just too thin.</p> <p>9 Sorry about that.</p> <p>10 MR CHOW: I think the concern here in relation to this</p> <p>11 so-called permanent elongation is the effect on this,</p> <p>12 using your term, bedding-in on the crack width, when it</p> <p>13 is loose in the structure.</p> <p>14 Yesterday you also mentioned about strain</p> <p>15 compatibility.</p> <p>16 A. Yes.</p> <p>17 Q. Let's see if I understand you correctly. What you are</p> <p>18 basically saying by reference to strain compatibility is</p> <p>19 that when all these coupler connections are cast in the</p> <p>20 concrete, for the sake of discussion, let's assume</p> <p>21 30 per cent of those are not properly tightened at the</p> <p>22 time of pouring of the concrete, this initial slip or</p> <p>23 bedding-in effect would not manifest itself, because we</p> <p>24 still have another 70 per cent of the properly done</p> <p>25 couplers which are holding the concrete together. In</p>

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<p>1 layman terms, is that what you are talking about?</p> <p>2 A. Yes. That's a good model.</p> <p>3 Q. Just for the sake of discussion, if the working load</p> <p>4 starts to increase, at some point, notwithstanding the</p> <p>5 70 per cent of the properly connected couplers, at some</p> <p>6 point one would start to mobilise the remaining</p> <p>7 30 per cent --</p> <p>8 A. Yes.</p> <p>9 Q. -- of the not properly connected couplers, and at that</p> <p>10 stage, even with a very small force, this bedding-in,</p> <p>11 the effect of this bedding-in, will start to kick in;</p> <p>12 right?</p> <p>13 A. Mm-hmm.</p> <p>14 Q. As far as I understand, at the moment, no one has ever</p> <p>15 looked into the combined effect of this phenomenon; is</p> <p>16 that correct?</p> <p>17 A. I'm not aware of any experimentation in that respect.</p> <p>18 It is, as I observed earlier, a question of looking at</p> <p>19 each situation. People have not raised this issue in</p> <p>20 the past, I think that's true to say. But no, there's</p> <p>21 no -- there has not been any comprehensive research</p> <p>22 carried out on the issue that you described. You can</p> <p>23 re-create it mathematically, as you and I can do,</p> <p>24 but ... yes.</p> <p>25 Q. But the situation that I've just described, it is real,</p>	<p>1 in the EWL slab, and the reason given by him is because</p> <p>2 the working conditions between these two groups of</p> <p>3 couplers are different.</p> <p>4 Now, from the evidence that we received perhaps</p> <p>5 during the first round of the Commission's Inquiry, we</p> <p>6 know that when BOSA produced the couplers -- the</p> <p>7 threaded rebars and the couplers, they are well</p> <p>8 protected. Do you recall there are two types of cap,</p> <p>9 the blue cap and the red cap?</p> <p>10 A. Yes.</p> <p>11 Q. The red is for I think the ductile couplers, with the</p> <p>12 corresponding threaded bar, and the blue is for the</p> <p>13 non-ductile cap.</p> <p>14 So we see that the condition when it is produced</p> <p>15 from factory is rather good. The Commission probably</p> <p>16 has also seen a video recording of a visit to a factory,</p> <p>17 BOSA's factory, in which, during the visit, BOSA</p> <p>18 demonstrated how the threading process was done, and</p> <p>19 right after the thread was produced there is a device,</p> <p>20 cylindrical device, to control -- to screw it in and</p> <p>21 control -- I believe that device is to ensure that the</p> <p>22 thread length is of a certain length.</p> <p>23 From the video, we observe that the process of</p> <p>24 screwing this device into the threaded bar is quite easy</p> <p>25 and quite smooth. In other words, as a layman</p>
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<p>1 it's not far-fetched situation?</p> <p>2 A. Yes, as I said, I think it's a good model. It does</p> <p>3 depend on how quickly that slack is taken up, you know,</p> <p>4 that bedding-in.</p> <p>5 Q. Certainly, yes.</p> <p>6 A. But the answer to your question is there is no research</p> <p>7 that I'm aware of into this phenomenon.</p> <p>8 Q. I would like then to move on to a slightly different</p> <p>9 angle regarding these defective couplers. Now, you</p> <p>10 recall that in area A and area HKC, we have these</p> <p>11 different types of so-called configuration --</p> <p>12 A. Yes.</p> <p>13 Q. -- where we have a starter bar coming out from a capping</p> <p>14 beam, and the starter bars are to be connected with the</p> <p>15 other horizontal reinforcement by way of couplers;</p> <p>16 right?</p> <p>17 A. Correct.</p> <p>18 Q. Now, you mention, as an engineer, you will first</p> <p>19 approach it by looking at the physical process of</p> <p>20 forming these coupler connections.</p> <p>21 A. Mm-hmm.</p> <p>22 Q. I'm sure you are aware of the view of Dr Lau. Dr Lau is</p> <p>23 of the view that we should take those couplers that we</p> <p>24 have described, taken out from capping beam, as</p> <p>25 a separate family of data from the rest of the couplers</p>	<p>1 understands it, if the threaded bars and the couplers</p> <p>2 are freshly from the factories, and if it is well</p> <p>3 protected, then one should not have any problem in</p> <p>4 screwing in; it should be quite easy.</p> <p>5 So do you agree that that will be similar to the</p> <p>6 situation of the couplers in the capping beam, because</p> <p>7 the couplers taken out from the capping beam and the</p> <p>8 threaded bar have never been embedded in concrete, so</p> <p>9 the condition of the thread and the couplers should be</p> <p>10 very good; do you agree with that?</p> <p>11 A. Most certainly.</p> <p>12 Q. Whereas for the other group of couplers which had been</p> <p>13 cast in concrete, concrete in the diaphragm wall, the</p> <p>14 evidence that we received from the earlier round of</p> <p>15 Inquiry is that Leighton has to expose it by way of some</p> <p>16 equipment, high-pressure water jet, and after this</p> <p>17 process, the steel fixers told us that certain couplers</p> <p>18 were damaged. Some are misoriented. And we actually</p> <p>19 see photos showing a stack of damaged couplers being</p> <p>20 removed.</p> <p>21 From that, would you agree that the working</p> <p>22 condition would be very different? The condition of the</p> <p>23 couplers, the condition of the threaded bars for the</p> <p>24 rest of the EWL slab would be very different from the</p> <p>25 condition of the threaded bars taken out from the</p>

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<p>1 capping beam?</p> <p>2 A. Yes. I have made the point, I think a couple of times,</p> <p>3 that my expectation of area A, that the performance</p> <p>4 would be of the same type of family but it would be</p> <p>5 superior, and that's really why I said I could not</p> <p>6 believe the 68.5 per cent failure rate for something</p> <p>7 which, the way you've just described it and indeed the</p> <p>8 way Dr Lau described it in his report, should be better,</p> <p>9 and there is no -- the evidence says it is better, but</p> <p>10 please continue.</p> <p>11 So I agree with you that area A is a better</p> <p>12 situation than you would have expected anywhere else.</p> <p>13 Is that what you want to --</p> <p>14 Q. No.</p> <p>15 A. It's not what you --</p> <p>16 Q. We will come to that later on.</p> <p>17 A. All right.</p> <p>18 Q. At the moment, I just want to see whether you agree with</p> <p>19 me that because of the difference in condition of the</p> <p>20 couplers and the threaded bars, these two sets of data</p> <p>21 have to be treated as two separate families and should</p> <p>22 not be combined for the purpose of statistical</p> <p>23 assessment?</p> <p>24 A. Let's continue. I've already said that geometrically</p> <p>25 it's different. The same coupler is being screwed</p>	<p>1 Q. All right.</p> <p>2 Then I would like to discuss with you the way to</p> <p>3 assess -- now, given that these couplers coming out from</p> <p>4 the capping beam are two-sided couplers, I think the</p> <p>5 term that you use is double-sided couplers.</p> <p>6 A. Yes.</p> <p>7 Q. I believe you would agree with me that there are two</p> <p>8 weak points on each side, potential weak points; right?</p> <p>9 A. Yes.</p> <p>10 Q. So, for the assessment of probability of defective</p> <p>11 couplers, if one considers that so long as there is one</p> <p>12 weak point which failed, would you consider that coupler</p> <p>13 connection as defective?</p> <p>14 A. Correct. It's pretty standard probability theory and</p> <p>15 it's a question of arithmetic, yes.</p> <p>16 Q. So if we have two weak points, given that -- perhaps we</p> <p>17 can take the example that you used, in paragraph 7.29 to</p> <p>18 7.32, where -- this is the calculation that you did by</p> <p>19 combining purpose (i) and purpose (ii) couplers --</p> <p>20 A. Yes.</p> <p>21 Q. -- in area A.</p> <p>22 A. Mm-hmm.</p> <p>23 Q. For the purpose of the record, of course, we are advised</p> <p>24 by an expert in statistics that one cannot mix</p> <p>25 purpose (i) and purpose (ii), but I do not want to go</p>
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<p>1 together. I believe it's the screwing together of the</p> <p>2 operative which is the key factor, and I think he should</p> <p>3 have done better in that environment than he would have</p> <p>4 done anywhere else.</p> <p>5 So I think I'm saying to you the operation is the</p> <p>6 same, basically, it's a screwing action of an operative,</p> <p>7 and therefore I would expect to find greater similarity</p> <p>8 in the performance, but I would have expected it to be</p> <p>9 shifted slightly up in terms of a better performance.</p> <p>10 Q. Right.</p> <p>11 A. Is that what you want me to say?</p> <p>12 Q. Because it's easier to be screwed in?</p> <p>13 A. Yes, yes, I keep saying it; it's a better situation,</p> <p>14 yes.</p> <p>15 Q. So you wouldn't expect the defective rate to be the</p> <p>16 same, as you have just mentioned, the couplers --</p> <p>17 A. Sorry, I didn't say that. I said I would have expected</p> <p>18 them to be of a similar distribution but better. That's</p> <p>19 what I said. So I would have expected area A to be</p> <p>20 superior in performance generally.</p> <p>21 Q. So you would expect the defective rate would be lower as</p> <p>22 compared with the general defective rate in the rest of</p> <p>23 the EWL slab?</p> <p>24 A. I would have an expectation that it would be marginally</p> <p>25 superior, yes.</p>	<p>1 into a detailed discussion with you --</p> <p>2 A. It would be fortunate for you that we don't, I think!</p> <p>3 Q. I don't want to get into --</p> <p>4 A. I understand.</p> <p>5 Q. I don't think it would be helpful.</p> <p>6 A. I'm sorry, I didn't mean to say that in a disparaging</p> <p>7 way, but I just think it wouldn't be to your advantage.</p> <p>8 Q. What I would like to discuss with you is rather the</p> <p>9 methodology, the arithmetic that you did. Assuming it</p> <p>10 is proper, as what you have done, to combine purpose (i)</p> <p>11 and purpose (ii), what you did in this section,</p> <p>12 paragraphs 7.29 to 7.32, is that you find, for example,</p> <p>13 on the slab side, there is a failure rate of two out of</p> <p>14 18 samples.</p> <p>15 A. Yes. I mean, it's a statement of fact.</p> <p>16 Q. Yes, which works out to be about 11 per cent; right?</p> <p>17 A. Yes.</p> <p>18 Q. So the pass rate for that side of the couplers is about</p> <p>19 89 per cent?</p> <p>20 A. No, I don't say that. That's what is called the nominal</p> <p>21 rate, in other words that's what you observe, but you</p> <p>22 then have to apply extreme probability theory to</p> <p>23 establish what the likelihood of that is and it will</p> <p>24 always be worse than that.</p> <p>25 Q. I'm trying to work out for the benefit --</p>

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<p>1 A. I'm trying to help you as well.</p> <p>2 Q. -- of the Chairman and Prof Hansford. So on the basis</p> <p>3 that there are two failures out of 18 samples on the</p> <p>4 slab side, you then work out your so-called nominal</p> <p>5 failure rate, which works out to be 11 per cent.</p> <p>6 A. Yes.</p> <p>7 Q. Then on the basis that on the capping beam side there</p> <p>8 are two failures out of 11 samples, the failure rate</p> <p>9 would be about 18.2 per cent?</p> <p>10 A. Mm-hmm.</p> <p>11 Q. So what you did, by applying the probability theory, in</p> <p>12 order to determine the overall failure rate, you</p> <p>13 multiplied these two percentages. Now --</p> <p>14 A. No, I didn't. I don't multiply them, no.</p> <p>15 Q. You don't directly multiply them. First of all --</p> <p>16 A. No, sorry, I don't use those actually at all, those</p> <p>17 numbers. They are just indicators. I take the total</p> <p>18 data set and then you apply it to the probability</p> <p>19 distribution. I just gave those for example. In fact,</p> <p>20 they are all good news. They are all just demonstrating</p> <p>21 how superior area A is to everywhere else.</p> <p>22 So I don't multiply them together. I take that as</p> <p>23 a data set and then I put that into the binomial</p> <p>24 theorem, and that's what gives me the probability of any</p> <p>25 one bar being in exceedance of 37 millimetres or 32 or</p>	<p>1 side --</p> <p>2 A. Yes, I agree. There's no argument.</p> <p>3 Q. -- to determine the overall probability, you need to</p> <p>4 multiply or combine the corresponding --</p> <p>5 A. Yes. It's P1 times P2 is the joint probability and</p> <p>6 that's standard probability theory. In fact, it's</p> <p>7 arithmetic --</p> <p>8 Q. It's good enough for me for the present purpose.</p> <p>9 Prof Hansford, you wanted to ...?</p> <p>10 COMMISSIONER HANSFORD: I'm happy.</p> <p>11 MR CHOW: So if I may now go to paragraph 7.38, please. In</p> <p>12 paragraph 7.37 and 7.38, what you do here is you take</p> <p>13 the pass rate for 32mm engagement length, and then --</p> <p>14 under paragraph 7.38, you take that for a single-sided</p> <p>15 connection, a pass rate of 88 per cent, which means</p> <p>16 12 per cent failure rate, and then the second bullet</p> <p>17 point you said:</p> <p>18 "For a two-sided connection in areas A and HKC,</p> <p>19 a pass rate of 77 per cent ..."</p> <p>20 So, basically, the 77 per cent is the multiplication</p> <p>21 of 88 per cent and 88 per cent?</p> <p>22 A. Yes.</p> <p>23 Q. That is what you --</p> <p>24 A. I hope that works -- yes, that is the intention.</p> <p>25 Q. Do you accept that by doing this kind of simple</p>
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<p>1 wherever I want.</p> <p>2 Q. Yes, 37 millimetres.</p> <p>3 A. Yes, 37 millimetres is the one, because -- sorry, you</p> <p>4 ask the question.</p> <p>5 Q. In paragraph 7.32, you arrive at a pass rate of</p> <p>6 72 per cent; right?</p> <p>7 A. Correct, yes.</p> <p>8 Q. When I run the numbers, it does appear to me that what</p> <p>9 you did is basically you combined the passing rate of</p> <p>10 the two sides and you arrive at 72 per cent as</p> <p>11 a combined pass rate.</p> <p>12 A. No, no, no. 72 per cent would apply to the failure rate</p> <p>13 of one side, one bar. That's what the 72 per cent is,</p> <p>14 I believe. I'm trying to remember what this is here.</p> <p>15 So, once you work out the probability on one side then,</p> <p>16 as you correctly say, the probability would be the</p> <p>17 multiplication of the probability on this side, 70 per</p> <p>18 cent, times 70 per cent on the other side, which gives</p> <p>19 you 50 per cent, 0.5. So the probability of a failure</p> <p>20 of that connection is, for a 37 millimetre engagement,</p> <p>21 is 49 per cent.</p> <p>22 Q. I see.</p> <p>23 A. And so --</p> <p>24 Q. This is the point I am trying to elicit from you.</p> <p>25 Basically, because there are two weak points on each</p>	<p>1 probability calculation, the result that you obtained</p> <p>2 would not be of a confidence level of 95 per cent as</p> <p>3 an expert in statistics would expect?</p> <p>4 A. No. Sorry, I would challenge that, because the data set</p> <p>5 is such that the data set is the data set. No, I'm</p> <p>6 sorry, that was a leap of logic which, I'm sorry,</p> <p>7 I didn't quite follow. But no matter. I think my</p> <p>8 statement is I don't agree.</p> <p>9 Q. Okay. I will now move on a new area, the shear links.</p> <p>10 A. Okay.</p> <p>11 Q. When Mr Southward was questioned, you were in this</p> <p>12 courtroom so you have heard details --</p> <p>13 A. Correct.</p> <p>14 Q. -- in relation to the investigation, and my learned</p> <p>15 leader has also shown to Mr Southward the method</p> <p>16 statement for the investigation. Do you recall that</p> <p>17 part of the exchange?</p> <p>18 A. I do.</p> <p>19 Q. We know from the method statement that the process for</p> <p>20 the investigation is that, first of all, one would open</p> <p>21 up a square shape of 300 by 300 millimetres, and then,</p> <p>22 according to the method statement, if one finds a shear</p> <p>23 link, then depending on the location of the shear link,</p> <p>24 one would then further open up two perpendicular strips</p> <p>25 of area with a width of 200 millimetres. Do you recall</p>

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<p>1 that part of the evidence?</p> <p>2 A. (Nodded head).</p> <p>3 Q. And also the method statement, at the end, says that if</p> <p>4 no shear link is found, then one can consider further</p> <p>5 dig into an upper layer; do you recall that?</p> <p>6 A. I do.</p> <p>7 Q. I note that in your report, basically, your view is that</p> <p>8 this L-shaped opening-up approach is appropriate in the</p> <p>9 circumstances?</p> <p>10 A. Yes, I would agree.</p> <p>11 Q. Am I right to take it that when you say "appropriate",</p> <p>12 you would no doubt agree that with this sort of</p> <p>13 opening-up, if shear link has been installed as per the</p> <p>14 design, it would have been picked up under such</p> <p>15 an opening-up scheme?</p> <p>16 A. I would agree, the L shape is an appropriate response.</p> <p>17 You don't have to open up a square. I think it does</p> <p>18 depend on the width of the L, and I did comment,</p> <p>19 I think, not adversely, but make the observation that</p> <p>20 I wasn't sure whether the width of the Ls was wide</p> <p>21 enough. But the principle I think is sound, of</p> <p>22 an L shape investigation.</p> <p>23 Q. An objective fact that we see today is -- you know there</p> <p>24 are altogether 40 locations; right?</p> <p>25 A. (Nodded head).</p>	<p>1 the honeycomb areas were areas tending towards the</p> <p>2 middle of the span, you know, where the shear is</p> <p>3 nominal, and that's why we got the honeycombing because</p> <p>4 we got all this reinforcement there which didn't allow</p> <p>5 the concrete to go through. And in those situations the</p> <p>6 shear links would be really pretty nominal, even though</p> <p>7 the drawings might have shown them.</p> <p>8 If my memory serves me well, in the mid-span, we</p> <p>9 were generally talking about four layers of</p> <p>10 reinforcement in each direction, in other words a stack</p> <p>11 of eight or nine bars, and it is perfectly acceptable,</p> <p>12 from an engineering viewpoint, that in those situations</p> <p>13 where you've got multiple layers of reinforcement, that</p> <p>14 the shear link can be anchored to one of the upper</p> <p>15 levels.</p> <p>16 I can only tell you that as evidence in terms of</p> <p>17 that would not be wrong to do that, because the standard</p> <p>18 designs that are drawn is it's always a beam with just</p> <p>19 a single row of reinforcement in the bottom, with a link</p> <p>20 going around it. But when you've got many layers of</p> <p>21 reinforcement, that diagram engineeringly is still</p> <p>22 correct if the link goes to one of the upper levels.</p> <p>23 So, as you said, I would take it in stages in that</p> <p>24 conversation, so in the honeycomb areas, I would think</p> <p>25 to myself that the steel fixers, because I know from the</p>
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<p>1 Q. 22 of the 40 locations were actually honeycomb areas,</p> <p>2 and someone took the opportunity to inspect the</p> <p>3 condition and configuration of the shear links as well.</p> <p>4 These 22 locations, in terms of size, they are not</p> <p>5 limited to the L-shaped opening. Some of them -- I can</p> <p>6 take you to one or two of them -- are of a size of over</p> <p>7 1 metre. I think one of them is over 2 metres. And</p> <p>8 because, at that time, we see that there may be</p> <p>9 a problem of shear link, and then MTR has decided to</p> <p>10 carry out further opening-up, so further 80 numbers of</p> <p>11 locations were opened up, and it was only for that</p> <p>12 80 numbers that we are doing 300 by 300 and then 200</p> <p>13 strip.</p> <p>14 The result, overall picture that we have from these</p> <p>15 observations of the 40 locations is that out of</p> <p>16 40 locations, 16 of them showed no shear link at all.</p> <p>17 Would it cause any concern to you as to whether</p> <p>18 shear link was actually installed at those locations,</p> <p>19 given the number, given the overall picture?</p> <p>20 A. I'll take that in stages. My first reaction would be</p> <p>21 that's not what I expected. I would then have to ask</p> <p>22 myself some questions about it. I would have to ask</p> <p>23 myself the question as to what is the reinforcement that</p> <p>24 I'm looking at, and without -- with all due respect,</p> <p>25 obviously these 40 locations, that's quite numerous, but</p>	<p>1 photographs that I've seen that the link was attached at</p> <p>2 the top, and it was a fishing trip, and that's really</p> <p>3 why we don't get the alignment as well, and that's also</p> <p>4 the reason why it's not tied with the wire, because it</p> <p>5 was fixed after. It was -- the bar, 3 metres long,</p> <p>6 I can only imagine, was actually put down</p> <p>7 (demonstrating) and he fiddled between the steel, and</p> <p>8 that's why the tab isn't 100 long because you couldn't</p> <p>9 get them in. They made them 70 long so they could just</p> <p>10 fish it in and pull it around (demonstrating).</p> <p>11 So he would have anchored into whatever one he could</p> <p>12 get to. That's my supposition. But I agree with you</p> <p>13 that if you don't see something and you expected</p> <p>14 something, then it's right that an alarm bell should go</p> <p>15 on. I don't dispute that.</p> <p>16 Q. I believe Dr Lau actually agrees with you on this point,</p> <p>17 that the shear link doesn't have to be hooked to the</p> <p>18 lowest layer of the reinforcing bar. It can be hooked</p> <p>19 in some inner layer, so long as it passes the --</p> <p>20 A. That's right. Absolutely. It's a strut-and-tie action,</p> <p>21 yes.</p> <p>22 Q. Given that in the method statement there is a specific</p> <p>23 requirement that if no shear link is found, then the</p> <p>24 contractor should expose or continue to dig into the</p> <p>25 inner layer. Are you aware of any reason why, during</p>

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<p>1 the investigation, notwithstanding the failure to 2 observe any shear link, but MTRC's contractor failed to 3 continue to expose further layer of the reinforcement, 4 just to ensure that that is shear link? 5 A. It's very difficult. The instruction is very simple: 6 dig deeper. You've got so many layers of reinforcement, 7 and the clear distance between each of the bars is 8 probably no more than 80 or 90 millimetres, and it's 9 a square, and you're being asked to go through layer 10 after layer, and it becomes -- well, it is impractical, 11 because what you are looking for is something that is 12 spaced at 300 centres, 1 foot, in each direction. Well, 13 how do you know that you're mining in the right 14 location? 15 I'm not saying there's any right or wrong in it, but 16 the simple instruction of "dig deeper" reaches 17 a practical impossibility, so you reach an impasse, 18 I accept that, you reach an impasse where there is no 19 evidence on the one hand, it's impractical to keep 20 boring in to try and find it, so you reach a situation 21 where there's uncertainty, and I accept that 22 uncertainty. 23 But that's where we rely on photographic evidence, 24 and whatever evidence we can pull to hand. Does that 25 help you? I'm not sure if it does.</p>	<p>1 DS7. 2 A. I'm sorry, I haven't got the right one. DS7? 3 Q. It's on the screen. 4 A. I see, it's not the photograph, it's a diagram. 5 Q. It's a report. From this report, if we go down from the 6 top, we see -- a little bit up, please -- there's a box 7 with a tick which says honeycomb was observed and the 8 approximate size is 2.3 metres by 1.8 metres, and the 9 depth is 285 millimetres, it's almost 1 foot deep into 10 the slab. 11 Then if we scroll down -- further down, please -- 12 down to the shear links, you see there's a box; yes? 13 The box which records the condition of the shear links. 14 Now, the design requirement is T20 bars at 150mm 15 spacing, in both directions, and for these areas of 16 2.3 metres by 1.8 metres, only one T12 shear link was 17 found. 18 Now, given that the depth of these honeycombs, which 19 is about a foot deep, would it cause -- well, perhaps 20 look at another honeycomb. Bundle ER2, tab 17.10, the 21 same tab, but the second file, page 72. This is the 22 record of another honeycomb area designated as DS19. 23 Now, we see the size of the honeycomb is 2.5 metres by 24 2 metres by 260mm, which is about 10 inches, slightly 25 more than 10 inches, deep into the slab.</p>
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<p>1 Q. Yes, it does, except that I have some concern. Please 2 help me. 3 Now, if we can't find in shear link upon opening-up, 4 and then we assume that there must be shear link which 5 is hooked at the upper layer, then a layman will think 6 what's the point of doing opening-up investigation? If 7 we don't find it, then we automatically assume that they 8 are there but hooked at the inter-layer, then what's the 9 point of doing the opening-up? 10 A. I agree. You are just demolishing more and more 11 structure, because -- 12 Q. Right. 13 A. I would then immediately fall back on whatever records 14 can I bring to bear? 15 Q. Okay. 16 A. Because I would say there's a limit to what you can do 17 in terms of opening-up without actually destroying the 18 structure. 19 Q. All right. Can I then refer you to a few photographs of 20 the honeycomb, because I notice that some of the 21 honeycomb goes quite deeply into the slab. Some of them 22 go as much as almost 300 millimetres inside the slab. 23 Can the photo in bundle ER2, tab 17.10 -- tab 17.10 24 has actually three files. The first file, page 27. 25 This is one of the honeycomb areas that is designated as</p>	<p>1 If we then scroll down to look at the records 2 regarding the shear links observed, again the 3 requirement is T16 shear links at 150mm spacing, and for 4 this area of 2.5 times 2 metres, only one T16 shear link 5 was found. 6 This shows two things: first of all, our belief that 7 if shear link does not show when we remove the concrete 8 cover, we assume that they must have been hooked at 9 inner layer. But these two honeycomb locations suggest 10 that perhaps it is otherwise. 11 The other thing is when we talk about lack of tie, 12 because of the lack of tie after concreting, we can't 13 control the spacing, it may have been moved by the 14 concreter, but if you are looking at an area of 15 2.5 metres wide by 2 metres wide and there is only one 16 shear link found, would this phenomenon be attributable 17 to the fact that shear link was not tied at the bottom 18 and it was moved accidentally? 19 A. Well, the first thing is they clearly weren't tied at 20 the bottom, because of the way in which they were 21 installed. That's not fatal and I think you and 22 I accept that that's not fatal. It's a little bit 23 misleading to say the depth is whatever it is, 24 260 millimetres, because I think people would imagine 25 this area, being the size you have described, 2 metres</p>

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<p>1 square and a foot deep -- well, that's not the case, is 2 it? We had these chasms, as it were. 3 So unfortunately -- I can see why you are saying 4 what it is, but I couldn't take that chasm as being 5 a reasonable judgment of what was happening elsewhere. 6 Q. Right. 7 A. Because if it had been linked at a higher level and 8 you're correct there's this chasm or this hole which is 9 locally a foot deep and you don't see one, that's not to 10 say that there isn't one quite close by. 11 So I can understand where you're coming from and 12 I can understand the alarm bell going off in your head, 13 but it's not conclusive. It is not conclusive. 14 Q. Fair enough. 15 A. But I sympathise with the concern. 16 I think all these areas are in the mid-span, aren't 17 they, generally, or -- it's not relevant. It was 18 an idle question. 19 Q. I can't tell for sure. What I can tell you is we have 20 a plan showing the location of the honeycombing -- 21 A. Oh, yes, I appreciate that. 22 Q. -- it's spread all over the place. 23 A. But I think you'll find they were mostly actually at the 24 great concentrations of reinforcement at mid-span where, 25 to be quite candid, I wasn't concerned. I'm much more</p>	<p>1 the hole? 2 A. Correct. In fact, it depends on geometry. But arching 3 effect, I don't think there's any challenge that it 4 happens, particularly when you've got aspect ratios like 5 this, a 3 metre deep slab. 6 I'm thinking of flying buttresses, for example, and 7 they don't suffer from shear. They are direct axial 8 forces. 9 Q. If I may, I will move on to trough walls. In your 10 second report, where you talk about trough walls, 11 paragraph 5.9, you list out a number of factors. You 12 list out the difference between the configuration of the 13 reinforcement, the condition, the location of the trough 14 wall, how it is different from the other station box 15 structures, and on that basis you believe -- you think 16 that one should have a greater confidence on the quality 17 of the coupler connections in the trough wall. 18 Yesterday, you also mentioned about smaller bar 19 diameter, visible, touchable, inspectable. 20 A. Absolutely. You've got it right. Yes, that's exactly 21 what I said. 22 CHAIRMAN: Sorry, can I just ask, a trough wall -- I mean, 23 to me, a trough conjures up images of farm animals, and 24 so putting a head into a trough. So that's a long wall 25 so it seems to me like it's a wall with one side, left,</p>
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<p>1 concerned where there is a real shear demand, and there 2 aren't that many, are there? 3 Q. Can I quickly finish off another topic, about arching 4 effect. 5 A. Arching, yes. 6 Q. Do you recall that Dr Lau showed a few slides with 7 openings? 8 A. Yes. 9 Q. As a matter of principle, if a slab is supported on two 10 ends, if there's an opening in between, we can't expect 11 any arching effect; do you agree with that statement? 12 A. If you looked at it in two dimensions, you're absolutely 13 correct. But these structures aren't two-dimensional. 14 You have a hole and then either side of that you've got 15 a rib. If you like, the architecture of cathedrals 16 demonstrates this, that you have thrust lines and in 17 between you have voids and then you have cross-arches. 18 So the fact you have a hole doesn't change the 19 arching principle, because the arching principle occurs 20 where you don't have a hole, and then in between you get 21 counter-arches onto those main ones. 22 Barrel vault is a classic. You can put a hole in a 23 barrel vault and it won't fall down, as long as you've 24 got that primary. So yes. 25 Q. So what you are saying is it all depends on the size of</p>	<p>1 and then another side? 2 A. It is. It's a U shape. So you've got the walls of the 3 U shape. 4 CHAIRMAN: Why do you have trough walls? 5 A. That's a good question. 6 CHAIRMAN: As opposed to block walls, you know. 7 A. Oh, right. Generally -- this is a siding and I don't 8 know why they have any walls, to be honest. There must 9 be some operational requirement. 10 CHAIRMAN: Okay. 11 A. Because normally in a siding you would just have the 12 trains themselves. The way that derailments are 13 normally dealt with, if you are concerned about them, is 14 you have what's called a derailment kerb, which is 15 a second rail, so that if the train does come off -- 16 because of the geometry of wheels on trains, they do 17 have a habit of rolling up under certain conditions, but 18 the check rail is to get the derailment. So that's the 19 way you normally deal with derailment issues. 20 I've never really understood why they have the 21 trough walls. I thought it might be because they wanted 22 a walkway to be able to get access, because obviously if 23 you are at track level and you are maintaining a train, 24 you might want to have access to it, like a walkway on 25 the side. I don't know why it's there. It could be</p>

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<p>1 that there was concern about protecting the columns. 2 MR CHOW: The columns, yes. 3 A. But then you would focus on protecting the column rather 4 than building a trough wall. But, sir, I don't know 5 where it came from. 6 CHAIRMAN: Thank you. 7 A. It's not a function of a siding. You don't have trough 8 walls in every siding. So the concern must have been 9 protection of the columns, which I think you have 10 alluded to in the past. 11 MR CHOW: Right. 12 A. And I'm saying you would have dealt with that in 13 a different way. 14 Q. Sure. We will come to that. One of the issues 15 considered by the Commission in this second round of 16 Inquiry relates to the problem with the stitch joint and 17 the shunt neck joint. I understand it's not part of 18 your brief but are you aware of the conditions of -- the 19 steel fixing conditions of the original stitch joint or 20 the shunt neck joint? 21 A. I'm not aware first-hand. I have received third-party 22 statements about the workmanship at the stitch joints, 23 yes. 24 Q. Can I just quickly show you the picture showing the 25 condition of the coupler connections in the original</p>	<p>1 reinforcement. So the reinforcement used in the shunt 2 neck joint is a small -- compared with the platform slab 3 is a very small diameter, T20. 4 If we go back a few pages and look at the condition 5 of the connection. Perhaps 728. Now, what we see from 6 728 is actually the bar was not properly screwed into 7 the couplers. Now, if it is not as clear as I describe, 8 perhaps we can look at the description set out in the 9 report at page 721, paragraph 3.5, where it describes 10 what was observed at that time: 11 "At the chipped off locations at both East Wall and 12 West Wall surfaces, rebars were found connected to the 13 reserved couplers at the shunt neck structure built 14 under [contract] 1111. However, as seen from the photos 15 taken at the East Wall, rebars fixed by [contract] 1112 16 appeared smaller in size than the rebars fixed by 17 [contract] 1111. The connection appeared to be 18 a slot-in connection rather than a threaded-in 19 connection. The connection location could not be 20 considered as a proper construction ..." 21 If we then take a look at another situation, the VRV 22 room -- are you aware of the problem with workmanship, 23 coupler connection workmanship -- 24 A. I'm aware of stated problems, yes. 25 Q. As far as layman is concerned, the working condition for</p>
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<p>1 stitch joint. Bundle DD2, pages 725 to 729. 2 Page 725 shows the location. You see, at the right 3 side, do you see the line separating the two contracts, 4 contract 1111 and contract 1112 -- 5 A. Yes, I do. 6 Q. -- on the lower part, on the right side? 7 A. Yes. 8 Q. The shunt neck joint, do you see the arrow pointing at 9 the dotted line? This is the shunt neck joint at the 10 interface between the two contracts; do you see that? 11 A. Yes. 12 Q. The shunt neck joint here is on the EWL level; do you 13 see that? 14 A. Yes. 15 Q. First of all, the first point I would like to make is: 16 the working condition of the shunt neck joint here is 17 quite similar to the trough wall. It's an open area, 18 with good daylight, visible, touchable, inspectable; 19 right? The bar diameter is only 20mm; small diameter. 20 If we look at page 731, 731 shows the reinforcing 21 details. Can I borrow the gadget where I can point, to 22 help out? Thank you very much. 23 You see this (indicating), you see a T20 here -- 24 A. Yes. 25 Q. -- where my hand is? T20 shows the horizontal</p>	<p>1 the slab in the VRV room again is under open area, 2 smaller diameter of reinforcement, inspectable, 3 touchable, all that, as in the trough wall. But 4 nevertheless Leighton managed, in the case of the shunt 5 neck wall, to pour concrete. So apparently they managed 6 to pass the hold-point inspection. I appreciate there 7 is some issue between MTR and Leighton as to whether 8 hold-point inspection was actually taking place, but 9 what we see as a layman is when Leighton, with such 10 a good working condition, handled with smaller diameter 11 bars, managed to produce couplers of that level of 12 quality. 13 In view of all this, can you explain why we can, in 14 the case of a trough wall, have higher confidence that 15 the quality of connection in the trough wall is of 16 a better quality? Can you clarify? 17 A. Sorry, that's the question? Well, each -- you've only 18 shown me the one photograph which is the interface 19 between two contracts, and clearly there has been 20 malpractice, really, in that position. You can't say 21 otherwise. They are two separate contracts, which means 22 one contractor came along, I guess Leightons came -- 23 well, contract 1112, looking at this drawing, must have 24 come after contract 1111, so 1111 had put the coupler 25 in, had used what looks like perhaps a 25 millimetre bar</p>

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<p>1 or something, I don't know. But the coupler looks to be 2 a bit larger than was required. 3 Q. Yes, what's described in the paragraph, a smaller 4 diameter -- 5 A. Yes, and visually it looks like that, and somebody just 6 pushed the bar in. 7 Q. Right. 8 A. Is that correct -- 9 Q. Yes, yes. 10 A. -- or did they try and screw it? The photograph is not 11 that good. 12 COMMISSIONER HANSFORD: Sorry, I think we are missing 13 a piece of the information here, aren't we? Because we 14 now know that the coupler in contract 1111 -- 15 MR CHOW: Is different. 16 COMMISSIONER HANSFORD: -- was in fact a tapered coupler, 17 a Lenton coupler, and this appears to be an attempt to 18 connect a cylindrical threaded bar to a tapered coupler. 19 MR CHOW: Yes, I appreciate that. But the point I'm trying 20 to make is working conditions are similar to the trough 21 wall, touchable in open area, small-bar diameters, 22 inspectable, yet what we obtained is a defective 23 product. 24 A. Yes, but I think for different reasons, aren't they? 25 Q. Yes.</p>	<p>1 formal inspection process. My question is, in view of 2 what Leighton is capable of doing, even with 3 an inspection process, what is the basis for us to have 4 confidence of the quality of the coupler connection for 5 the trough walls? 6 A. That's the question? 7 Q. Yes. 8 A. Clearly, these two couplers are not correct. I don't 9 know to what extent that's true of the volume of the 10 effects, but clearly that isn't, and the fact that 11 Leightons -- it was brought to Leighton's attention and 12 they continued I think is clearly not correct. 13 And I can understand that's why you have the concern 14 that you do, but that doesn't explain to me why -- for 15 the trough walls, for example, because they seem to be 16 the key issue, why some even nominal opening-up couldn't 17 have taken place to give some assurance, because what 18 you've shown me and what I understand is, those are the 19 sorts of things which would set the alarm bells ringing, 20 and for that reason I do understand the actions that 21 might have been taken. But some of the question marks 22 I would have pursued would have tried to answer some of 23 those questions. 24 Q. Yes. 25 A. And that wasn't done, to the best of my knowledge.</p>
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<p>1 A. It's becoming clearer now, this is -- there is no way 2 I would defend such a situation, but somebody should 3 have said, "This isn't right." But that doesn't affect 4 the steel fixer who's going to connect this coupler. 5 Your VRV room is probably more appropriate. 6 Q. Absolutely. 7 A. Oh, good. So can we leave this one aside because it 8 doesn't seem to be appropriate? 9 Q. Yes. Let's have a look at BB8, page 5793, please. 10 Here we see that -- ultimately concrete was poured. 11 We see we have, luckily, photo records that shows that 12 the threaded bars were not properly screwed in. For 13 your information, in this particular instance, it was 14 spotted by MTRC's inspector. The steel fixing works 15 were condemned by MTRC, but nevertheless Leighton 16 proceeds to pour concrete. 17 But the point is the working condition for the steel 18 fixers on that occasion is similar -- I would say, using 19 your description, touchable, under open area, visible -- 20 but it does not assist at all. We still have these 21 defective coupler connection that was done by the steel 22 fixers. 23 The two examples I have just shown you would have 24 an inspection process. The trough walls that we are 25 talking about, as far as I understand, there were no</p>	<p>1 So superficially, you know, there's something here. 2 I would have gone a bit further. 3 Q. Right. In fact I intended to ask you whether you are 4 aware of any reason why MTRC failed to do any opening-up 5 exercise to ascertain the quality of the coupling 6 connection for the trough wall. 7 A. I don't know. I didn't give advice on that. I wasn't 8 asked for advice. 9 Q. Okay. Can I then now move on to the last topic I would 10 like to discuss with you, about the design of the trough 11 wall, the yield line analysis done by Mr Southward. You 12 have given some comment in your report about whether the 13 yield line assumed was the proper one, but we don't have 14 an answer for the time being and we are not going to 15 have an answer -- 16 A. No. 17 Q. -- even with our discussion. 18 A. No. 19 Q. What I'm trying to get your agreement on is that, as 20 a matter of principle, if one uses a yield line 21 analysis, we are getting into an area of plastic design; 22 right? 23 A. Yes, absolutely. 24 Q. And the yield line that we assume, we assume that at the 25 time of failure, coming back to our case, we assume that</p>

Page 93	<p>1 when the train hits onto the trough wall, a yield line</p> <p>2 will be formed; right?</p> <p>3 A. Yes.</p> <p>4 Q. Assuming the pattern suggested by Mr Southward is</p> <p>5 a correct, basically, if one wants to visualise what</p> <p>6 actually happened, it's that the section of the concrete</p> <p>7 along the yield line will undergo plastic deformation?</p> <p>8 A. It hinges.</p> <p>9 Q. It hinges, like a door hinge?</p> <p>10 A. That's right.</p> <p>11 Q. Mr Southward was asked whether he has checked the</p> <p>12 deformation. I would take it -- perhaps a more proper</p> <p>13 description would be the lateral displacement of the</p> <p>14 wall when this so-called hinge of yield line is formed,</p> <p>15 and Mr Southward said he was checking ultimate limit</p> <p>16 state and therefore, as a matter of rules, he doesn't</p> <p>17 have to check the lateral displacement; right?</p> <p>18 But do you agree with me that if there's a column at</p> <p>19 close distance from the trough wall, then it is not the</p> <p>20 normal situation -- if one uses a plastic design, one</p> <p>21 has to ensure that when the hinge is formed, the piece</p> <p>22 of triangular wall above the hinge line will not flip</p> <p>23 sideways so as to touch or damage the column; you agree</p> <p>24 with this? Someone has to look into this?</p> <p>25 A. I would agree with you that with any impact -- and my</p>	Page 95	<p>1 A. And unfortunately, because the oversite concrete was</p> <p>2 cast against the column, the column also shares; all</p> <p>3 right?</p> <p>4 Q. Yes.</p> <p>5 A. But the yield line that you then get has got a lot more</p> <p>6 energy absorption than the hinge, because the amount of</p> <p>7 energy is related to the length of the yield line and</p> <p>8 its rotation.</p> <p>9 Q. Rotation, yes.</p> <p>10 A. But once you start to bring in other constraints, the</p> <p>11 actual amount of energy which is absorbed through the</p> <p>12 yield line increases enormously.</p> <p>13 Q. Dr Glover --</p> <p>14 A. So all I'm saying is, I'm not making a judgment as to</p> <p>15 whether the calculation is correct or wrong, other than</p> <p>16 to say it is not the appropriate model to consider, and</p> <p>17 nor is this elastic cantilever. The fact that the</p> <p>18 elastic cantilever passes the test to me demonstrates</p> <p>19 there isn't an issue, because once you start to look at</p> <p>20 the plastic design, you will find it will pass. That's</p> <p>21 all I'm saying.</p> <p>22 Q. Right. Dr Glover, let's see if we can better assist the</p> <p>23 Commission by separating these two. I appreciate that</p> <p>24 you have a further point, saying that we have soil</p> <p>25 behind the wall and we have a slab --</p>
Page 94	<p>1 experience is much more to do with ships smashing into</p> <p>2 things, but it's the same principle. Indeed, when I was</p> <p>3 much younger, we were involved in train impacts related</p> <p>4 to nuclear flasks, so I do have a bit of experience.</p> <p>5 These are dynamic problems and you have to -- it's</p> <p>6 based on energy absorption. I would rather move my</p> <p>7 answer to the fact that the model is wrong anyway.</p> <p>8 Q. Right.</p> <p>9 A. I believe in the use of a yield line for a situation</p> <p>10 like this. I wouldn't call it a yield line. An energy</p> <p>11 absorption, a plastic thing. And because of the other</p> <p>12 aspects which haven't been taken into account into the</p> <p>13 model, you would not get the sort of movements, the</p> <p>14 idealised idea of this door hinge, because</p> <p>15 I understand -- your description is good, understanding,</p> <p>16 but the parameters of the model are not correct.</p> <p>17 Q. Right. You are talking about all the soil behind and --</p> <p>18 A. It's the soil and because of the restraint from the slab</p> <p>19 above, you wouldn't get that particular yield line.</p> <p>20 That's why I raised the question. And because of the</p> <p>21 oversite concrete at the top and because of the soil,</p> <p>22 a lot of that impulse, because that's what it is, it's</p> <p>23 an impulse, is actually dissipated into the soil and</p> <p>24 also into the adjoining wall.</p> <p>25 Q. Yes.</p>	Page 96	<p>1 A. Yes.</p> <p>2 Q. -- right, which shares a loading. But let's, for the</p> <p>3 time being, assuming -- I'm trying to assist the</p> <p>4 Commission to have a clearer picture -- assuming we</p> <p>5 don't have any soil, we don't have a concrete slab</p> <p>6 behind it -- because this is not what Mr Southward</p> <p>7 assumed, I'm just at the moment trying to focus on the</p> <p>8 theory --</p> <p>9 A. Yes. I'm trying to give evidence, I'm sorry, Mr Chow --</p> <p>10 Q. Of course.</p> <p>11 A. -- and I'm giving my evidence not on the basis of</p> <p>12 whether the calculation is valid or otherwise, except to</p> <p>13 say I don't agree with the calculation.</p> <p>14 So to ask me whether it has repercussions, I don't</p> <p>15 think you are going to get the answer you want, because</p> <p>16 all I'm going to say is: I wouldn't have done it that</p> <p>17 way and I don't have a judgment of what was done in</p> <p>18 terms of its consequences.</p> <p>19 All I would say is the fact that the designer,</p> <p>20 AECOM, was happy with a cantilever design which</p> <p>21 satisfied all of the criteria, and then he applied</p> <p>22 a 35 per cent reduction factor and it didn't work, I am</p> <p>23 saying there are other devices at work that would have</p> <p>24 compensated for that loss of strength of the</p> <p>25 35 per cent, which are not taken account of in the</p>

Page 97	<p>1 calculation.</p> <p>2 That's my -- it is a superficial judgment, I agree,</p> <p>3 but I think I'll be found to be correct. But if you</p> <p>4 took into account, even the cantilever model, with the</p> <p>5 35 per cent reduction factor, but you recognise there</p> <p>6 was soil and there was a slab -- because it seems a bit</p> <p>7 sort of other-worldly, isn't it, to say, "Ah, yes, let's</p> <p>8 assume the soil isn't there and the slab isn't there"?</p> <p>9 Well, it is. So don't you analyse what's there? And</p> <p>10 then have arguments like, "Oh, someone might come along</p> <p>11 and dig it out" -- well, I mean, that doesn't -- the</p> <p>12 other thing, if you really want me to get into detail</p> <p>13 here, the impact load which is being given is just too</p> <p>14 large.</p> <p>15 Q. Dr Glover, I can assure you, I will get into</p> <p>16 a discussion with you regarding the soil later on.</p> <p>17 A. I'm sorry. In the fullness of time.</p> <p>18 Q. Let me finish this part first.</p> <p>19 A. Yes.</p> <p>20 Q. For the sake of our discussion, if there is no soil and</p> <p>21 concrete slab behind, on the basis of our discussion</p> <p>22 earlier, you would accept that for someone who carries</p> <p>23 out design with yield line, in these particular</p> <p>24 circumstances where we have a column very close to the</p> <p>25 trough wall, you would have to check the lateral</p>	Page 99	<p>1 A. I didn't call -- I might have called it a slab, but on</p> <p>2 other occasions I've called it oversite concrete,</p> <p>3 because what it is, you see. I think I've said that on</p> <p>4 other occasions, and in a dynamic problem you would</p> <p>5 include that in it. But I agree it doesn't have</p> <p>6 an official title called "slab".</p> <p>7 Q. All right. Perhaps it's helpful for us to call up the</p> <p>8 relevant drawings. Bundle DD8, page 11248.</p> <p>9 Now, on the right side of this drawing, it shows --</p> <p>10 actually, you see there's a vertical dotted line.</p> <p>11 I believe it shows the centre line of the column.</p> <p>12 A. Yes.</p> <p>13 Q. And we see the two trough walls on each side of the</p> <p>14 column; right?</p> <p>15 A. Mmm.</p> <p>16 Q. This is the information given to the government, and</p> <p>17 this is what is shown in the accepted design.</p> <p>18 In the accepted design, we only see there are -- it</p> <p>19 looks like we have soil backfill --</p> <p>20 A. Mmm.</p> <p>21 Q. -- between the trough walls, but we don't see any</p> <p>22 concrete slab.</p> <p>23 In addition to the concrete slab that you said,</p> <p>24 which might help to transfer the loading, my</p> <p>25 understanding is that during a site visit amongst the</p>
Page 98	<p>1 displacement where the train hits the trough wall? Are</p> <p>2 we in agreement on that?</p> <p>3 A. I think, if that was the design objective, you would</p> <p>4 have to ask yourself those questions. You would have</p> <p>5 to, yes. But the fact that there is soil there, the</p> <p>6 fact that unfortunately, the oversite concrete is in</p> <p>7 concrete with the wall, so why was that done? And</p> <p>8 interestingly enough, I don't want to sort of -- no,</p> <p>9 I won't. I won't go there.</p> <p>10 Q. Let's discuss about the soil and the concrete slab.</p> <p>11 This is really the last area that I would like to</p> <p>12 explore with you.</p> <p>13 A. Great. Good. We can continue the conversation</p> <p>14 afterwards, can't we?</p> <p>15 Q. Of course.</p> <p>16 A. I enjoy the conversation.</p> <p>17 Q. You mentioned about there is soil behind the trough</p> <p>18 wall, and the soil would help to resist the impact load,</p> <p>19 and also there's a concrete slab which would share the</p> <p>20 impact load between the two trough walls.</p> <p>21 A. Mmm.</p> <p>22 Q. Now, the government can only act on the information that</p> <p>23 we have on the drawings. On the drawings, there is no</p> <p>24 concrete slab.</p> <p>25 Can I show you the relevant drawings.</p>	Page 100	<p>1 experts, someone observed there is a concrete surface on</p> <p>2 top, in between the trough walls, and I believe that one</p> <p>3 of the MTR staff informed the expert that these are lean</p> <p>4 concrete.</p> <p>5 A. Yes.</p> <p>6 Q. In other words --</p> <p>7 A. It's oversite concrete, yes.</p> <p>8 Q. -- there's no reinforcement and the concrete strength is</p> <p>9 not guaranteed, it's not supposed to be structural, and</p> <p>10 there is no information as to the thickness of the</p> <p>11 so-called lean concrete layer.</p> <p>12 A. Yes.</p> <p>13 Q. To make use of this so-called concrete slab -- assuming</p> <p>14 it is really lean concrete, because it's the only</p> <p>15 information we have today, as it's not on the drawing,</p> <p>16 it's not part of the design -- do you agree it would be</p> <p>17 rather risky to rely on the lean concrete, without</p> <p>18 knowing the thickness, and knowing that there is no</p> <p>19 reinforcement in that layer of lean concrete, to</p> <p>20 transfer the impact load to the other side of the wall;</p> <p>21 would you agree with this statement?</p> <p>22 A. I agree entirely, but when you are looking at</p> <p>23 a particular problem area and you are trying to appraise</p> <p>24 it, then you take into account all of the parameters.</p> <p>25 I think you and I would agree that this is a compressive</p>

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<p>1 situation and if the concrete could be shown to be there</p> <p>2 and of a certain thickness, then in a dynamic situation</p> <p>3 you would include it.</p> <p>4 I would observe, though, if that concrete goes in</p> <p>5 front of the column, then it should have been dug out,</p> <p>6 shouldn't it, if you are worried about contact</p> <p>7 between -- I mean, you've got to take your solutions</p> <p>8 through, haven't you, as we discussed yesterday? If you</p> <p>9 are worried about the column, then really it should have</p> <p>10 been isolated.</p> <p>11 Q. All right.</p> <p>12 A. And it's not, so you haven't really helped the</p> <p>13 situation -- sorry, not you; whoever.</p> <p>14 Q. Now, about the soil backfill behind the wall.</p> <p>15 Obviously, the main concern is the risk of damaging the</p> <p>16 columns, and the most critical locations is where the</p> <p>17 distance between the existing column and the trough wall</p> <p>18 is very close.</p> <p>19 According to Dr Lau, the columns that we -- perhaps</p> <p>20 let's go to look at drawings -- bundle DD19, page 19058.</p> <p>21 This is a drawing that I think Mr Southward has been</p> <p>22 shown. We see on the right-hand side a vertical solid</p> <p>23 line (indicating). Do you see that?</p> <p>24 A. Yes.</p> <p>25 Q. You see the marking "MJ"; do you see that?</p>	<p>1 column in that location, between the column and the</p> <p>2 trough wall, is about 60 millimetres.</p> <p>3 Do you agree with me that under normal</p> <p>4 circumstances, even if there is soil between the column</p> <p>5 and the trough wall, with a gap of only 60 millimetres</p> <p>6 or even less, the soil would have been placed loosely,</p> <p>7 could not have been properly compacted; right?</p> <p>8 A. Mmm.</p> <p>9 Q. And would you agree with me that for someone who needs</p> <p>10 to rely on the resistance of soil to help to resist any</p> <p>11 impact load, the soil first of all has to be properly</p> <p>12 engineered, has to be properly placed, properly</p> <p>13 compacted, so as to provide the necessary resistance?</p> <p>14 A. Its resistance comes from another of aspects. I don't</p> <p>15 want to get into the dynamics now. But one of them</p> <p>16 is -- it's just its mass. You know because it's</p> <p>17 an inertia problem, dynamics is all about something</p> <p>18 coming in and mobilising the motion of other things. So</p> <p>19 it's not just compaction, it's also the mass.</p> <p>20 Q. All right.</p> <p>21 A. The other thing I was saying -- you see, the trouble is,</p> <p>22 it's an artificial loadcase, isn't it? I mean, when</p> <p>23 I look at this diagram showing this line loading acting</p> <p>24 at the top of a wall, it's very idealised. And what you</p> <p>25 are doing, quite correctly, is you are applying</p>
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<p>1 A. Yes, I can. Thank you.</p> <p>2 Q. The MJ, in engineering drawings or construction</p> <p>3 drawings, usually signifies -- stands for movement</p> <p>4 joint?</p> <p>5 A. Mm-hmm.</p> <p>6 Q. And this vertical line, the solid dark vertical line,</p> <p>7 shows the alignment of the movement joint; do you see</p> <p>8 that?</p> <p>9 A. Yes, I do.</p> <p>10 Q. Okay. If we then go down a little bit in the drawing,</p> <p>11 and then if we come to here (indicating) -- so we have</p> <p>12 a situation where a movement joint is very close to --</p> <p>13 you know the dark circle shows the existing column;</p> <p>14 correct?</p> <p>15 A. Yes. Sorry, yes, I do.</p> <p>16 Q. And the sort of rectangular -- these two lines here</p> <p>17 (indicating), where my hand is, is the trough wall, just</p> <p>18 next to the column; do you see that?</p> <p>19 A. Yes, I do.</p> <p>20 Q. So because of this movement joint here, so we have</p> <p>21 a situation similar to by Mr Southward at page 13 of his</p> <p>22 report, do you see that, with the triangular thing?</p> <p>23 A. Yes, I do.</p> <p>24 Q. So we have a similar situation here.</p> <p>25 According to Dr Lau, the gap between the existing</p>	<p>1 an idealised situation to a specific one.</p> <p>2 I'm saying you are extrapolating it too far, because</p> <p>3 if you were to take that line load, for example, and</p> <p>4 apply it to this particular situation, you would see</p> <p>5 that that line load extends well beyond the column. You</p> <p>6 know, it's -- so beyond the column all the aspects that</p> <p>7 I was just describing would be in play, wouldn't they?</p> <p>8 Q. Right.</p> <p>9 A. All I can answer -- I'm sorry, I know you are trying,</p> <p>10 and you are being very helpful, actually -- but I can</p> <p>11 only come back to you and say I can see mathematical</p> <p>12 models which would take your idealised loading and would</p> <p>13 demonstrate that it would be all right.</p> <p>14 Q. Okay. My last question is -- now, I appreciate that</p> <p>15 there is a suggestion that in real life the train that</p> <p>16 gets into the HHS area would be empty, it would travel</p> <p>17 in low speed, and also the impact load would not be</p> <p>18 acting perpendicular to the wall. These are some</p> <p>19 considerations that perhaps one can give a little bit of</p> <p>20 leeway in terms of checking the capacity.</p> <p>21 A. Yes.</p> <p>22 Q. In that situation, am I right in saying that if one uses</p> <p>23 a lower impact load, because of these considerations,</p> <p>24 and find that the trough wall is of an adequate</p> <p>25 capacity, one can only say that this trough wall is safe</p>

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<p>1 if the impact load that is going to be experienced in</p> <p>2 the case of a derailed train is less than what is set</p> <p>3 out in the design code?</p> <p>4 A. Yes. It goes back to the core of the whole</p> <p>5 investigation. A forensic looks at not what the stated</p> <p>6 requirements were from the client, in terms of safety,</p> <p>7 that is.</p> <p>8 Q. Mm-hmm.</p> <p>9 A. One looks at what the realism is.</p> <p>10 I did some rough calculations, actually, and for the</p> <p>11 life of me I'm trying to remember them, but this force</p> <p>12 here would still represent something like half the line</p> <p>13 speed of the train, and it just wouldn't be travelling</p> <p>14 at that speed. It just can't physically do that.</p> <p>15 So to answer your question, satisfying the stated</p> <p>16 requirements is an issue, but if you are asking me for</p> <p>17 my opinion as to whether there is a safe -- I won't even</p> <p>18 use "fitness for purpose" here -- but if it's safe, then</p> <p>19 I say it's safe.</p> <p>20 But I take on board your point that from</p> <p>21 a compliance point of view, it probably doesn't, or is</p> <p>22 to be tested. But from a "safe" point of view --</p> <p>23 CHAIRMAN: I apologise for interrupting -- "safe" in what</p> <p>24 respect? Because we've got a column, but we've also got</p> <p>25 the trough walls and we've got trains.</p>	<p>1 designed and, as a consequence, you have this issue.</p> <p>2 But if you didn't apply that 35 per cent reduction, it</p> <p>3 satisfies all the requirements.</p> <p>4 CHAIRMAN: Would that be right?</p> <p>5 MR CHOW: Yes, because under the original design, Atkins is</p> <p>6 based on the elastic design and, if there's no problem</p> <p>7 with the coupler connection, the trough wall is able to</p> <p>8 resist the design loading, the impact load.</p> <p>9 CHAIRMAN: All right. So you are saying essentially,</p> <p>10 therefore, it is a workmanship problem at the end?</p> <p>11 MR CHOW: With the couplers.</p> <p>12 CHAIRMAN: With the couplers.</p> <p>13 MR CHOW: Yes.</p> <p>14 CHAIRMAN: So then they are the cause of what we are now</p> <p>15 debating?</p> <p>16 MR CHOW: That's correct, Mr Chairman, yes.</p> <p>17 May I ask one last question, about this train</p> <p>18 getting into HHS will be running at low speed and that</p> <p>19 it would not hit at a right angle to the trough wall.</p> <p>20 If a layperson comes to you and asks, "Under normal</p> <p>21 circumstances, the train will never hit the trough wall,</p> <p>22 it will only in a situation where there is an accident.</p> <p>23 How about, when there's an accident, the train running</p> <p>24 in normal speed got into the wrong track and</p> <p>25 accidentally get into HHS? Can we rule out this</p>
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<p>1 A. I think I'm being invited to put forward what I would</p> <p>2 consider to be the proper design problem, rather than</p> <p>3 address -- you know, saying, "If I apply this load,</p> <p>4 I would get that result."</p> <p>5 CHAIRMAN: Yes.</p> <p>6 A. So I'm saying that I recognise that protection of the</p> <p>7 column is fundamental. How would I have approached it</p> <p>8 as a designer to avoid that problem? I wouldn't have</p> <p>9 applied this force, for example, and I wouldn't have</p> <p>10 used that analogy, and I would have used all the parts</p> <p>11 that make up the structure to do that, and on that basis</p> <p>12 I believe it is safe.</p> <p>13 I'm not going -- and I hope I've never even strayed</p> <p>14 into saying it complies with the client's requirements,</p> <p>15 et cetera. I'm not saying that.</p> <p>16 MR CHOW: Right. There's one last question --</p> <p>17 CHAIRMAN: Sorry to interrupt.</p> <p>18 Do I understand -- so what we're talking about here,</p> <p>19 really, is a design problem? We are not talking about</p> <p>20 a poor workmanship problem?</p> <p>21 A. No. It's the repercussions of application of</p> <p>22 a reduction factor. If the structure had been -- no,</p> <p>23 nobody is questioning the construction. People are</p> <p>24 saying, other than the couplers have to have a reduction</p> <p>25 factor applied to them, that weakens the structure as</p>	<p>1 possibility when it comes to accident?" What is your</p> <p>2 answer to that?</p> <p>3 A. Well, I would have to look at the signalling system,</p> <p>4 because switch and crossings are controlled by the</p> <p>5 signalling system.</p> <p>6 Q. Yes.</p> <p>7 A. So somehow -- the train driver can't suddenly press</p> <p>8 a button to change the switch and crossings to go into</p> <p>9 the siding. It's dictated by the signalling system, not</p> <p>10 by him. And the possibility of that is extremely</p> <p>11 remote, because the signalling system is tied to so many</p> <p>12 other points.</p> <p>13 Q. So, in other words, what you are suggesting --</p> <p>14 A. And that is a bit of -- you do come up with some nice</p> <p>15 questions!</p> <p>16 Q. Are you suggesting that --</p> <p>17 A. In railway terms, it's called wrong-roading. You know,</p> <p>18 you shouldn't be doing it, in other words.</p> <p>19 Q. So are you suggesting that actually the design load</p> <p>20 specified in MTRC's design manual is too high; it should</p> <p>21 be lower than --</p> <p>22 A. No. But this a special -- no, in the manual, it doesn't</p> <p>23 cover this situation. This was, I understand, I stand</p> <p>24 to be corrected, that this was a factored-down loading</p> <p>25 from what the loading would be on the line. On the</p>

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<p>1 line, they consider this as impact loads, but the load 2 is higher than this, because the train is travelling 3 higher. I understand that operations said, "Okay, it 4 would be silly to apply the full line load, we will 5 apply a different one", and they reduced it. But what 6 I'm arguing, on the basis of just shear dynamics, it's 7 still higher than I would have arrived at. 8 Q. I stand to be corrected as well. My understanding is 9 this impact load is actually specified by MTR in MTR's 10 New Works Design Manual. So if there is any suggestion 11 that this specified load is too high, unrealistic, 12 should have been revised -- 13 A. No. I think you will find the line -- as I say, I stand 14 to be corrected on this, but I'm trying to help the 15 Commission here -- I think within the manual there is 16 an impact loading, and it's for line speed and it's 17 higher than this, and this is a special situation, and 18 I think this was a special advice. I don't believe this 19 is in the manual. This was a project, 20 a contract-specific loading. But as I say, I stand to 21 be corrected. 22 You certainly wouldn't be applying line speed here. 23 Q. All right. 24 A. Can I also say the energy of a train is related to the 25 square of the velocity. So, if you are doing a dynamics</p>	<p>1 so we've got the normal time. Is that all right? 2 MR PENNICOTT: Let's make it 2.30. 3 CHAIRMAN: We'll keep it at 2.30 because we are going to 4 finish at 4.30 this afternoon. 5 MR PENNICOTT: Yes, sir. 6 CHAIRMAN: Thank you. 7 (1.10 pm) 8 (The luncheon adjournment) 9 (2.32 pm) 10 CHAIRMAN: Mr Shieh, my apologies for getting the orders a 11 little muddled up just before lunch. 12 MR SHIEH: It's perfectly fine, Mr Chairman. I intend to 13 stay a bit low-key during this part of the hearing. 14 Cross-examination by MR SHIEH 15 Q. Dr Glover, good afternoon. 16 A. Good afternoon. 17 Q. Could I refer you first of all to your own report just 18 to lay the groundwork, paragraph 7.11. 19 Here you said you are in agreement with Mr Southward 20 on various things, and specifically at (ii) you say: 21 "I acknowledge and support the point that 22 Mr Southward has made in sections 6.7 and 6.8, [which 23 is] that 28 millimetre engagement has been shown to 24 satisfy the strength requirements of CoP ..." 25 But you then went on in the next sentence to say:</p>
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<p>1 problem -- so that's really why, if you say the train is 2 travelling at half the speed, then actually that would 3 be a quarter less force. The trains here will be 4 travelling at a fraction of the line speed. 5 So I'll leave it to you to do the mathematics. So 6 you can see the forces are pretty incidental. 7 MR CHOW: Thank you very much, Dr Glover. Thank you for 8 your patience. I have no more questions for you. 9 WITNESS: Thank you very much. 10 MR CHOW: It's a pleasure. 11 CHAIRMAN: Excellent. Thank you very much. Thank you, 12 Mr Chow. 13 So, Mr Khaw, I'm not suggesting you do it now, but 14 will there be questions for -- I'm sorry, Mr Boulding, 15 yes, of course. 16 MR SHIEH: I have one question. 17 MR BOULDING: It's Mr Shieh next. 18 MR SHIEH: I can save it until after lunch. 19 CHAIRMAN: Okay. 20 WITNESS: Does that mean -- 21 CHAIRMAN: I'm sorry, I had overlooked you. My apologies. 22 Thank you very much indeed. So we will just have some 23 more questions after lunch. 24 WITNESS: Okay. 25 CHAIRMAN: But it shouldn't be too long. We'll make it 2.40</p>	<p>1 "However, my selection of 32 millimetre engagement 2 is based on the fact that it has been shown beyond 3 reasonable doubt to pass any test that can be sensibly 4 applied, albeit I acknowledge that neither 28 ... nor 5 32 ... meet the contract requirements." 6 Let's leave contract requirement to one side because 7 we are not concerned with "code compliance"; right? 8 28 millimetres, although we have been working on the 9 basis of one thread equals 4 millimetres -- 10 A. Mm-hmm. 11 Q. -- because of the 2 millimetre chamfer and the 12 2 millimetre half-thread allowance, 28 millimetres 13 translates to six threads; correct? 14 A. Correct. 15 Q. I don't think I need to look up Mr Southward's actual 16 report, but Mr Southward actually says whether you use 17 28 millimetres, that is six threads, or 32 millimetres, 18 ie seven threads, they pass the requisite strength 19 requirement, static tension test; right? 20 A. That's correct. 21 Q. Now, you have somehow preferred -- if it's not the 22 correct word, tell me -- you prefer 32 millimetres 23 because it has been shown to -- shown beyond reasonable 24 doubt? 25 A. Correct. It is beyond reasonable doubt.</p>

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<p>1 Q. My question is this. The relevant test strength is 2 529 megapascals. 3 A. Yes. 4 Q. Which, and again I hope you remember, is passed by 5 six threads and seven threads in the tests. 6 A. Correct. 7 Q. So does it not suggest that in terms of strength, six 8 threads is good enough, because six threads, the minimum 9 stress in order to break a six-thread threaded rebar, 10 has been shown to be, I think, 565; do you remember? 11 A. Yes. 12 Q. That is higher than 529, so that would pass the strength 13 test. So does it not suffice in terms of strength that 14 six threads could withstand the requisite test to be 15 applied? 16 A. Yes, if one is just considering the straight tension 17 and, as far as I'm concerned, that would be adequate in 18 practically every situation that one finds on the 19 structure. The one caveat I would put on that is that 20 in area A, when we looked at the requirement to 21 redistribute -- in other words, there is an implied 22 requirement for some degree of plasticity in the 23 reinforcement, and as I showed on the steel 24 stress-strain relationship, the 529 figure comes about 25 from a straight linear approach. In other words, it's</p>	<p>1 say the difference between 28 and 32 was just a few 2 percentage points, are you saying that there are very 3 few bars where the engagement is somewhere between 28 4 and 32? 5 A. Correct. In fact, if I could refer you to -- I don't 6 want to do this unnecessarily, but annex 1 to my report. 7 COMMISSIONER HANSFORD: Yes. 8 A. I give all the numbers there for different engagement 9 lengths. 10 COMMISSIONER HANSFORD: Yes, you do. 11 A. And you see the difference between 32 and 28 is really 12 very small. Once you are getting down to 12 per cent 13 failure rates, I think from memory, for 32, and you're 14 down perhaps at 9 and 10 per cent for 28, quite 15 honestly, it's just not worth having the argument as to 16 whether there's plasticity or not. Just go for 32 and 17 you've used a ductile coupler, you've passed all the 18 tests, so you are allowed to do as much redistribution 19 as you like. 20 COMMISSIONER HANSFORD: That answers my question. 21 MR SHIEH: So I can put it quite bluntly: 32/seven threads 22 is a "nice" point for the purist, whereas for the 23 practical-minded pragmatist, six threads/28 millimetres 24 would be good enough? 25 A. As long as you can deal with the issue of, "Ah, but you</p>
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<p>1 the limit of the elastic range. If you go beyond that, 2 that's when you start to move into allowing a little bit 3 of plasticity, but it's a very moot point. I took the 4 32 because, as I said, I wanted to be able to 5 demonstrate beyond any shadow of a doubt that 32 would 6 pass any criteria, and I'm sure you will get people, 7 potentially, saying, "Ah, you've assumed some 8 redistribution, so therefore you must be assuming 9 there's some plasticity, and so therefore I want 10 a connection which has that degree of plasticity in it", 11 and it is a moot point and I'm being very defensive on 12 it. 13 Why I didn't sort of defend the 28 more strongly or 14 attempt to was quite simply: was there any requirement 15 to do that? Because when I look at the statistics, if 16 you look at the distribution of failure rates, you find 17 the difference between 28 and 32 is really just a few 18 percentage points, and rather than get myself bogged 19 down in an argument as to whether there was plasticity 20 or not, quite honestly the difference between 9 per cent 21 and 12 per cent failure rate is just not worth the 22 fight. 23 So it's a combination of reasons as to why I took 24 32, but I understand your point about 28. 25 COMMISSIONER HANSFORD: So I can understand that, when you</p>	<p>1 assume some redistribution, therefore you are assuming 2 some plasticity going on." That's all I'm saying to 3 you. 4 MR SHIEH: Thank you very much. 5 Re-examination by MR BOULDING 6 MR BOULDING: Good afternoon, Dr Glover. It's a long time 7 since I threw you to the wolves, but to be fair to them 8 they have given you a full opportunity to explain 9 yourself. In the light of that I only have one topic 10 upon which you might be able to give the learned 11 Commissioners further assistance. 12 Do you remember giving evidence yesterday about cube 13 tests and core tests to establish the strength of 14 concrete? 15 A. Yes, I do. 16 Q. I wonder if we can just remind ourselves of the 17 transcript for yesterday, Day 10, and if we could go to 18 page 74. I'd like to pick it up at line 22, just to 19 remind you the evidence you gave. You return to the 20 witness box and say: 21 "I would also want to add two things and I'm not 22 sure how to deal with these, in what order. I think 23 I'll deal with the cylinder strength first. 24 Dr Lau referred to he would have great confidence or 25 greater confidence in our hypothesis of increased</p>

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<p>1 strength if there had been cylinders taken and tested." 2 Then Prof Hansford said, "Cores", and you answered: 3 "Yes, cores, but the cylinders. 4 I tried to find some for the structure, but 5 unfortunately -- or fortunately, whichever way you look 6 at it -- the cube strengths were always so high that 7 nobody had to go back and do some investigations and do 8 some corings. But we are fortunate in the sense that 9 the standard regulations in Hong Kong require diaphragm 10 walls to be cored, to ensure that we have this vertical 11 core of concrete all the way through. 12 So we have lots and lots of cube strengths, core 13 strengths, for this project, not in the EWL slab, not in 14 the NSL, but in the diaphragm wall. And these are 15 summarised, I think, in a number of the reports but 16 particularly in the AECOM report ..." 17 Then you go on. 18 I wonder whether we can look at some of the evidence 19 that was put before the learned Commissioners in the 20 first hearing. For that purpose, I'd like to look at 21 a statement from Mr Michael Fu. We can pick that up at 22 B13679. I think that's B16/13679. 23 There we see a reply statement, and if we can scroll 24 down a bit we see that he's the construction manager, do 25 we not, for MTR? Paragraph 1; do you see that?</p>	<p>1 got a letter of 17 July and I wonder if we can scroll 2 down. I hope that at B17/14220, there do we see 3 a concrete core test report, Dr Glover? 4 A. Yes. 5 Q. Is this something you have seen before? 6 A. No. 7 Q. Could you take the opportunity to scroll down and look 8 at the results we see there, in particular at the bottom 9 of the page, do you see the little box entitled, "Load 10 at failure (kN)"? 11 A. Yes, I do. 12 Q. Would you look at the results therein and tell me what, 13 if anything, they tell you about the strength of the 14 concrete? 15 A. They show a very consistent pattern -- or individually 16 they fit very well within the distribution we discussed 17 yesterday, which is a mean of around about 80 and 18 an absolute minimum of 60. I could see that that would 19 fit in that distribution extremely well. 20 Q. And in terms of design strength, is that a strength that 21 you would regard as being satisfactory? 22 A. I would regard -- in isolation, you would say that's 23 going to be a high strength, but I would need to look at 24 the data more closely. I would say a safe design load 25 there would be -- stress would be 60, agree on that</p>
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<p>1 A. Sorry, I do apologise. Yes, I can. 2 Q. Then if you would be kind enough to go on to 3 paragraph 16. That's on B13682. He tells the learned 4 Commissioners: 5 "As explained in paragraphs 14 to 17 of the second 6 witness statement of Mr Louis Kwan (ConE 2) (which 7 I have reviewed), three random concrete core samples 8 were taken from the top of the EWL slab track slab in 9 October 2017, and another three core samples were taken 10 from the top of the NSL track slabs in December 2017, 11 and those core samples were then tested at MTR's HOKLAS 12 accredited project laboratory in Tseung Kwan O." 13 Then 17: 14 "The core test reports dated 2 November 2017 (EWL 15 track slab) and 18 January 2018 (NSL track slab) were 16 formally submitted by Leighton to MTR under CSF no. 1112 17 [and then it gives a reference number] on 26 January 18 2018. These core test reports demonstrate that the 19 compressive strength of the concrete tested is 20 satisfactory and, more importantly, that there was no 21 honeycomb concrete at the core locations. These test 22 reports were submitted to the BD's Mr Lok Pui Fai by 23 MTR's letter [of] 17 July ..." 24 I wonder whether we can have a look at that letter 25 together. That's, I trust, at B17/14210. There we've</p>	<p>1 basis. On the basis that I'm just imagining the shape 2 of the bell curve, with a mean at about 80, then I would 3 think the 95 per cent pass rate would really be around 4 about 60. It looks consistent with that. 5 Q. Then looking back at Mr Fu's statement, if I may, 6 paragraph 18, this is B13683, and he tells the learned 7 Commissioners: 8 "More recently, in July 2018, MTR instructed 9 Leighton to carry out concrete core tests on the EWL 10 track slab, for the purposes of the load test proposed 11 by CM Wong & Associates. These tests were carried out 12 by Fugro Technical Services Ltd, and the preliminary 13 test results of the six core samples were circulated by 14 MTR's Mr Raymond Chow and copied to me on 31 July 2018 15 Once again, the test results showed that the compressive 16 strength of the core samples was satisfactory, and there 17 was no indication of honeycomb concrete at the core 18 locations." 19 I wonder if we can just look at that. I hope we 20 find the document dated 31 July at B17 and page 14236. 21 There do we see the email which is referred to by Mr Fu, 22 Dr Glover? 23 A. Yes. 24 Q. If you would be kind enough to scroll down, I hope we 25 find the results to which Mr Fu refers at 14238. There</p>

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<p>1 do you see the results starting at 14238, and take the</p> <p>2 opportunity --</p> <p>3 A. 71.</p> <p>4 Q. 71. And I think they go down through to 14243, just for</p> <p>5 the sake of completeness.</p> <p>6 A. Sorry, just one second.</p> <p>7 Q. Yes.</p> <p>8 A. Yes. Sorry.</p> <p>9 Q. Scroll down. Do we there see another result?</p> <p>10 A. Yes, and they are very consistent, not just in the</p> <p>11 strength but looking at the other parameters.</p> <p>12 Q. Right. Go down to 243.</p> <p>13 A. Yes.</p> <p>14 Q. There do we see further results?</p> <p>15 A. Yes. Yes. Yes. Yes. Yes.</p> <p>16 Q. Now, what, if anything, do they tell you, Dr Glover,</p> <p>17 about the strength of that concrete that was tested?</p> <p>18 A. They would tell me that they are slightly less than the</p> <p>19 ones I saw earlier. I'd have to look at it more</p> <p>20 closely. I mean, not dramatically so, but these are</p> <p>21 certainly towards the -- they're shifted, as it were, to</p> <p>22 the left, but not hugely. I mean, 59, you know, would</p> <p>23 always stand out, but actually, if you took that with</p> <p>24 the family, you would expect that.</p> <p>25 Because remember, we expect to have one failure in</p>	<p>1 proper connection of couplers by --</p> <p>2 A. Of this particular coupler?</p> <p>3 COMMISSIONER HANSFORD: Of this particular coupler.</p> <p>4 A. Yes, because I think you've got -- because of patents</p> <p>5 and all sorts of other things, they've all got their</p> <p>6 little touches.</p> <p>7 COMMISSIONER HANSFORD: Yes.</p> <p>8 A. But this is about as simple a coupler as you will get.</p> <p>9 It hasn't got the sophistication of a Lenton coupler.</p> <p>10 This issue of butt-to-butt, I'm not convinced of it.</p> <p>11 There has been no evidence -- can I be outrageous? Yes,</p> <p>12 I can, because I'm normally slightly outrageous.</p> <p>13 I don't believe the general workmanship on this site in</p> <p>14 terms of the operatives, whatever, in terms of forming</p> <p>15 the connections, was substantially substandard. I don't</p> <p>16 think there was anything where the workers were of</p> <p>17 a lower quality. There is no doubt that sometimes</p> <p>18 people didn't fix it as well as they possibly could, but</p> <p>19 I think, if you take it as an average across Hong Kong,</p> <p>20 it would probably be reasonably representative, perhaps</p> <p>21 at the lower end.</p> <p>22 Now, what does that mean? That means that in all of</p> <p>23 the diaphragm walls or the slabs or whatever which are</p> <p>24 throughout the construction in Hong Kong, you would have</p> <p>25 a very high proportion of partially engaged couplers.</p>
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<p>1 every 20 anyway, and they don't get anywhere near the</p> <p>2 sort of limits that I would be expecting. But no.</p> <p>3 In summary what I'm saying is these results appear</p> <p>4 to be slightly less than the first three you showed me,</p> <p>5 but they are very consistent with the strength in the</p> <p>6 works being substantially larger than the design</p> <p>7 strength of 40, substantially. I mean, this is not sort</p> <p>8 of measuring a few percentage points. These are</p> <p>9 significantly larger. And the fact they have been taken</p> <p>10 at different locations, different times, is -- and you</p> <p>11 take that with a family of 6,000 other cubes being</p> <p>12 taken, it's very good evidence. In fact, I would think</p> <p>13 it really reaches the point where it's almost beyond</p> <p>14 doubt that you've got a situation where the concrete in</p> <p>15 the works is indeed substantially stronger than the</p> <p>16 design strength that was achieved, or was set out in the</p> <p>17 design of 40.</p> <p>18 MR BOULDING: Thank you very much, Dr Glover.</p> <p>19 Mr Chairman, Prof Hansford, I don't know whether</p> <p>20 you've got any questions.</p> <p>21 COMMISSIONER HANSFORD: I have one question. I think you</p> <p>22 can predict what it might be, Dr Glover.</p> <p>23 Questioning by THE COMMISSIONERS</p> <p>24 I'm interested in your views for the future. How do</p> <p>25 you think -- what could be put in place to ensure the</p>	<p>1 Particularly from a strength point of view, I'm not at</p> <p>2 all concerned about that, because of the evidence of the</p> <p>3 tests that we have.</p> <p>4 So the issue really is this one of permanent</p> <p>5 elongation, and again, if you look at as-constructed</p> <p>6 buildings, particularly large infrastructure, I've never</p> <p>7 heard reports of this cracking, this large cracking. So</p> <p>8 I believe it's one of those things that the laboratory</p> <p>9 seems to throw up a question mark, but in practice</p> <p>10 there's all sorts of reasons why it's not happening.</p> <p>11 That doesn't mean to say that there shouldn't be</p> <p>12 some studies on this. I think there should be because</p> <p>13 it puts people's minds at rest. But if butt-to-butt or</p> <p>14 something approaching butt-to-butt is important and is</p> <p>15 essential, then I think there are two things that have</p> <p>16 to happen.</p> <p>17 One is you have to be able to establish what the</p> <p>18 free -- I'm thinking now of the situation where it's</p> <p>19 cast into a capping beam.</p> <p>20 COMMISSIONER HANSFORD: Yes.</p> <p>21 A. In other words, you can't see the other side.</p> <p>22 COMMISSIONER HANSFORD: Yes.</p> <p>23 A. So a simple device is to establish what the depth is,</p> <p>24 and it doesn't have to be to the nearest micron. It's</p> <p>25 just I have three threads, four threads, five threads --</p>

Page 125	<p>1 what is it? If it is small, then the hand should go up 2 and the inspector should come and say, "Yes, I agree, 3 this is a defective coupler", and a decision has to come 4 out of it. 5 So I think measurement is important in that 6 situation. Once you know what that distance is, then 7 you know how much it's got to go in. 8 The other thing is, I think this thing about taking 9 it so it's tight, that's not an engineering term. 10 I think the idea of this -- and I think Dr Lau mentioned 11 it -- a torque wrench. In other words, there should be 12 a minimum specified exertion, and -- you know what 13 a torque wrench is. It actually is a wrench but it has 14 a dial which you've got to get to that level. 15 So I think those two things: measurement, and 16 a scientifically arrived-at effort of screwing it in. 17 That's for the capping beam situation. For the free-air 18 coupler, I think it's pretty self-evident -- the 19 operator is in control of the dimensions, but I still 20 think the torquing by a controlled effort is certainly 21 something which should be done, and I believe Lenton 22 couplers require that. That's the vehicle ones. 23 Is that -- 24 COMMISSIONER HANSFORD: That's very helpful. Thank you very 25 much.</p>	Page 127	<p>1 part of the Commission, part of the Inquiry. Could we 2 first of all look at the first one. It's at ER2, 3 tab 15.1. Is that the front sheet of your COI 1 report? 4 A. It is, yes. 5 Q. Dated 6 December. 6 If we go to page 10, please, is that your signature? 7 A. Yes, it is. 8 Q. Confirming the date of 6 December. 9 Prof McQuillan, I understand that there's one 10 erratum to this report which we'll find at tab 15.2, 11 I hope. Is that the erratum that you wish to make to 12 the report we've just looked at? 13 A. It is, yes. 14 Q. Then the second report, could we go to ER1 in the 15 COI 2 file, and tab 11, please. Prof McQuillan, is that 16 the front sheet to the COI 2 report? 17 A. Yes. 18 Q. If we go again to page 10, that's your signature? 19 A. It is. 20 Q. Then, in addition to those two reports, Prof McQuillan, 21 there is a joint statement and a supplementary joint 22 statement. Could we again just look at those, pick up 23 the references, stay in the same file, ER1(COI2), 24 tab 14.3, and is this the joint statement of the experts 25 made on 20 December 2019?</p>
Page 126	<p>1 CHAIRMAN: Good. Doctor, thank you very much indeed. Thank 2 you. 3 WITNESS: Thank you very much. 4 (The witness was released) 5 MR PENNICOTT: Sir, we now come to the Commission's 6 structural engineering expert, Prof McQuillan. I see 7 the time and I was going to propose that obviously we 8 will call Prof McQuillan. As you will appreciate, he 9 has a presentation to do. I suspect that that's going 10 to last the best part of an hour, possibly a little bit 11 longer, and so what I suggest we do is we have this 12 presentation and then we don't start the 13 cross-examination, particularly as we've got to leave at 14 4.30 in any event, if that's satisfactory to the 15 Commission. 16 CHAIRMAN: Yes. 17 MR PENNICOTT: Can I call Prof McQuillan? 18 PROF DON MCQUILLAN (on former oath) 19 Examination by MR PENNICOTT 20 MR PENNICOTT: Prof McQuillan, as with Dr Glover, we won't, 21 as it were, take the oath again, as you did last time, 22 and we will regard you as being on the oath that you 23 took on the last occasion you were in the witness chair. 24 Can I then just run through the position on your 25 reports, if I may. You've prepared two reports for this</p>	Page 128	<p>1 A. It is, yes. 2 Q. Yourself and Dr Glover in London, and Dr Lau and 3 Mr Southward in Hong Kong? 4 A. That's correct. 5 Q. This is the typed-up version, and I think it's all 6 accepted that that was signed up by all four of you? 7 A. It was. 8 Q. Then at 15.2 in the same file, this is the supplemental 9 memorandum of agreement, signed more recently. If we 10 can scroll down, please. That's signed by all four of 11 you? 12 A. That's right. 13 Q. Prof McQuillan, so far as the reports and joint 14 statements that we've just looked at contain expressions 15 of your views and opinions, are they opinions honestly 16 held by you? 17 A. I confirm that. 18 Q. So far as the reports and statements contain matters of 19 fact, are they true to the best of your knowledge and 20 belief? 21 A. Yes. 22 MR PENNICOTT: Prof McQuillan, at that point, I will sit 23 down and allow you to make your presentation. 24 Presentation by PROF MCQUILLAN 25 A. Thank you. Thank you for the opportunity.</p>

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<p>1 As I proceed, the Commission will note a lot of</p> <p>2 commonality and repetition with the evidence given by</p> <p>3 Dr Glover in particular. That commonality is not in any</p> <p>4 way contrived, and in fact my summary was drafted before</p> <p>5 I heard the evidence, obviously, of the other experts.</p> <p>6 I just make that a point.</p> <p>7 I make no apology for the fact that Dr Glover,</p> <p>8 myself and also Mr Southward, we all appear to be</p> <p>9 singing off the same hymn sheet.</p> <p>10 The severity and impact of some of the issues that</p> <p>11 have been raised I feel have been overstated in previous</p> <p>12 evidence and I hope to put these into meaningful</p> <p>13 perspective, if I can.</p> <p>14 Could I say that those of us who visit universities</p> <p>15 and teach the students, we are expected to explain in</p> <p>16 simple language, if we can, concepts which are sometimes</p> <p>17 difficult to understand. There has been a lot of heavy</p> <p>18 technical stuff in the previous evidence. Hopefully</p> <p>19 I've tried my best to explain that in simple terms.</p> <p>20 The directions of the Commission to the engineering</p> <p>21 experts, quite simple: are the structures safe, first of</p> <p>22 all, and secondly, are they fit for purpose? I know, as</p> <p>23 somebody has already said, that means different things</p> <p>24 to different people.</p> <p>25 I always look at it in the sense: are the structures</p>	<p>1 It could do that excessively under the applied loading.</p> <p>2 So finishes could be damaged, if that happens; glass</p> <p>3 partitions attached to the underside of the beam could</p> <p>4 break, in which case the beam would not be deemed fit</p> <p>5 for purpose.</p> <p>6 The Hung Hom Station structures, however, are of</p> <p>7 necessity very robust. They can carry the full range of</p> <p>8 loading and, as has already been discussed, they have</p> <p>9 already carried 95 per cent of the total load. The</p> <p>10 figure of 90 per cent that we remember is dead load, but</p> <p>11 you must remember that there has been commissioning of</p> <p>12 the empty train sets, and so I'm saying that that</p> <p>13 probably accounts for probably 5 per cent of the</p> <p>14 residual 10 per cent dead loading. So that's how</p> <p>15 I arrive at the 95 per cent.</p> <p>16 In addition, the slab deflections are minimal, and</p> <p>17 last time I demonstrated that by standing up and giving</p> <p>18 you an indication of how thick the slab was. Dr Glover</p> <p>19 has done that today already. So the slab deflections</p> <p>20 are minimal because of the depths involved. Cracking is</p> <p>21 non-existent.</p> <p>22 CHAIRMAN: Sorry, what do you mean in layman's terms,</p> <p>23 Professor, as to deflection of something like a slab?</p> <p>24 Because I see a slab as being -- it's joined to the</p> <p>25 diaphragm walls. I can't see where it would deflect.</p>
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<p>1 safe, that means failure has to be the key</p> <p>2 consideration, in the ultimate limit state sense. Are</p> <p>3 they fit for purpose? Different words have been used to</p> <p>4 describe this, but for me function is the key</p> <p>5 consideration. Is it good enough to do the job it was</p> <p>6 designed to do, without compromising durability and</p> <p>7 longevity?</p> <p>8 As I've already said, item 1 is really a ULS issue,</p> <p>9 whereas fit for purpose is really a serviceability limit</p> <p>10 state issue.</p> <p>11 This isn't really an attempt to teach Granny to suck</p> <p>12 eggs but just to illustrate my understanding of the two</p> <p>13 terms, if you consider a simple beam, it could be</p> <p>14 concrete, it could be made of steel, it could be timber</p> <p>15 or it could be another material, but it has a defined</p> <p>16 size and it has a defined span.</p> <p>17 The beam has a strength capacity which is a function</p> <p>18 of its span and its size, the member properties, the</p> <p>19 materials and the loading that it carries. So it's</p> <p>20 quite simple. If the load applied to that beam is less</p> <p>21 than or equal to its capacity, the beam is deemed to be</p> <p>22 safe. Conversely, if the load applied exceeds the</p> <p>23 capacity, the beam is bound to fail.</p> <p>24 However, although the beam could be safe, it could</p> <p>25 deflect or it could sag, and this is just one example.</p>	<p>1 A. At mid-span -- so if you can imagine that slab being</p> <p>2 much, much thinner, imagine it was only, say for</p> <p>3 example, half a metre deep, and supposing that</p> <p>4 half-metre depth was able to sustain the loading, its</p> <p>5 deflection, its sag -- let's call it a sag at</p> <p>6 mid-span -- would be excessive.</p> <p>7 CHAIRMAN: I have it. Thank you very much.</p> <p>8 A. So the cracking is non-existent, and that proves that</p> <p>9 the partially engaged couplers have functioned as</p> <p>10 intended. I will come back to this topic later, but any</p> <p>11 movement in the coupler assemblies under load take-up</p> <p>12 would already have manifested as cracking at the top of</p> <p>13 the EWL slab at the D-wall connections, and you've heard</p> <p>14 already from the other experts, we have visited the</p> <p>15 site; we've never seen any such cracking.</p> <p>16 The internal environment is dry, and it's not humid</p> <p>17 either, and so no rebar corrosion is possible in any</p> <p>18 event.</p> <p>19 So the HUH structures are therefore, in my opinion,</p> <p>20 both safe and fit for purpose, based on the</p> <p>21 understanding that I have described to you.</p> <p>22 I make the point in my reports that a structure can</p> <p>23 be safe and fit for purpose and yet be only partially or</p> <p>24 totally code compliant -- sorry, non-code compliant,</p> <p>25 whichever way you want to look at it. I also make the</p>

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<p>1 point in my report that the trend nowadays is on 2 performance-based design instead of prescriptive code 3 requirements. This avoids building in unnecessary 4 reserve capacity, such as is generated by the Hong Kong 5 Code of Practice and indeed the British and European 6 codes and other limit state design codes. 7 Performance-based design is already a well-known 8 technique, for example in fire safety engineering where 9 bespoke solutions are produced from first principles. 10 COMMISSIONER HANSFORD: Prof McQuillan, for the purposes of 11 the Commission, could you explain performance-based 12 design? 13 A. So the British -- if you take the Code of Practice and 14 if you take its associated code on recommended live 15 load, for example, and take, in conjunction with that, 16 the client's performance requirements which may go in 17 tandem, what you're normally doing in terms of live 18 load, and the same happens for the rail loads on this 19 job, you read them off a table, essentially. There's no 20 attempt made to actually look at the specific loading 21 and what that implies. 22 So performance-based design is really putting 23 instrumentation on a structure like a bridge, monitoring 24 its performance over a long period of time to see how 25 you can translate that performance into the actual</p>	<p>1 because the Original Inquiry focused on areas B and C, 2 comprising hundreds of metres in length of heavy civil 3 engineering work. Those have now, in essence, been 4 given a complete clean bill of health in spite of all 5 the investigation, the testing and the assessment which 6 has been carried out, thus corroborating the 7 Commission's interim report, if you like. Despite this, 8 the station extension and the railway lines are still 9 not open to the public, and we are sitting here today 10 discussing the safety and fitness for purpose of a small 11 outstanding section of the works, a very small section 12 of the work by comparison; that is, namely, areas A, SAT 13 and HHS. 14 So the two principal factors that this Inquiry is 15 hinging on is the fact that MTR's assessments -- and 16 when I say "MTR" I'm obviously including their design 17 engineers -- have totally disregarded any structural 18 contribution from, number 1, the partially engaged 19 coupler assemblies and, number 2, the shear link rebar. 20 So those two components may as well not be there, and 21 that's how the assessments have been carried out. In my 22 opinion, hugely conservative and extremely brutal. 23 In addition, no opening-up at all has been carried 24 out in the areas in question to verify and substantiate 25 these allegations of defects. The EWL slab soffit in</p>
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<p>1 loading that it's actually sustaining as opposed to 2 theoretically designed for, and inevitably we're going 3 to find that there's a gap between the two, between the 4 design load under the codes as is now and what the 5 actual load is that the structure is subjected to. 6 Does that explain it adequately? 7 COMMISSIONER HANSFORD: Thank you. 8 A. I also highlight again, as mentioned by others -- I'm 9 doing it in a much simpler way, I hope -- that the codes 10 already contain these factors of safety, partial safety 11 factors, and these cater for uncertainties in materials 12 and loading. 13 To put it quite bluntly, even if a structure was 14 designed to be 100 per cent efficient to the code, if 15 you could do that so that there's no excess fat, 16 Dr Glover has admirably illustrated that the structure 17 still has a capacity of strength, a reserve capacity. 18 That is why, when a structure is retro-analysed or 19 retro-assessed, it is permissible, as he has 20 demonstrated, to use actual material properties. For 21 example, the actual concrete strengths that we have been 22 talking about, in some cases the actual rebar strengths, 23 if you go to that length to prove them, instead of using 24 the specified mark-ups that the code gives you. 25 I then wanted to just set the scene, if you like,</p>	<p>1 area A in particular was, despite the fact we were told 2 it has been upfilled with mass concrete, it is still 3 accessible if needs be. This is also despite the fact 4 that sections of the works in question were constructed, 5 as we've heard, at different times compared with areas B 6 and C. We must also bear in mind that the type of 7 construction in areas A, SAT and HHS is easier and much 8 less complicated. 9 So inevitably I have to spend longer on this issue 10 than the other four, as have the other experts. I have 11 seen the threaded bar ends both with a chamfer and more 12 recently without a chamfer, and the diagram shows the 13 chamfers but it really doesn't matter much. Every 14 threaded bar -- and I think this is an important point 15 to make -- that I have measured, including those in 16 BOSA's factory when I visited them, and the recent batch 17 shown to us downstairs, measure at the very most 18 44 millimetres. Despite BOSA's published information, 19 I have never yet seen a type A bar with 48 millimetres 20 of thread. In fact, when you look at appendix B3 of the 21 holistic report, it indicates that with a few 22 exceptions, for example test 11 of the NSL slab might be 23 an exception, the maximum threaded length is 24 44 millimetres. Otherwise, the enhanced PAUT results 25 lack credibility and would be deemed to be inadequate</p>

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<p>1 and misleading.</p> <p>2 In respect of test 11 of the NSL slab, it shows --</p> <p>3 you can take my word for it, if you wish -- a length of</p> <p>4 47.7 millimetres, but it should be remembered from the</p> <p>5 Original Inquiry that there was evidence of type B bars</p> <p>6 occasionally being cut and used in lieu of a type A bar.</p> <p>7 I also suggest that if one looks closely at</p> <p>8 appendix B3 of the holistic report, the following</p> <p>9 assemblies appear to show the use of cut type B bars,</p> <p>10 and I'm referring to the EWL test numbers 27, 30, 33,</p> <p>11 34, 37, 38, 42, 49, 51, 63, 64, 74, 75, 84 and 85.</p> <p>12 I may have missed a few in the reckoning.</p> <p>13 It is highly improbable, in my opinion, therefore,</p> <p>14 that any type A/48 millimetre threaded rebar was used.</p> <p>15 Can I repeat that? It's improbable because I haven't</p> <p>16 seen any evidence that there is a type A rebar with</p> <p>17 48 millimetres used in this particular project. I don't</p> <p>18 think it's even made.</p> <p>19 The important point, however, to note -- and this</p> <p>20 came up at the end of Dr Glover's evidence or</p> <p>21 cross-examination -- the definition of "engagement".</p> <p>22 The testing labs are all using a consistent terminology</p> <p>23 in the context of the enhanced PAUT testing. So ten</p> <p>24 threads, as we've heard, equates to 44 millimetres</p> <p>25 engagement, and that is made up of the multiplication of</p>	<p>1 with variable wind load and direction, so one minute one</p> <p>2 side of the building is in tension; the next minute,</p> <p>3 that side of the building is in compression.</p> <p>4 However, that is not the situation in these HUM</p> <p>5 structures, except of course for the D-walls.</p> <p>6 In this context, I would like you to -- if you could</p> <p>7 pull up the reference on the screen, OU6/4139, just to</p> <p>8 give you a flavour for what Atkins are saying.</p> <p>9 It should come up as section 16 on page 102.</p> <p>10 MR PENNICOTT: That's right.</p> <p>11 A. I'll just paraphrase this, if I can.</p> <p>12 At 16.9.2, Atkins are explaining that the ductility</p> <p>13 requirements of the Hong Kong Code of Practice were</p> <p>14 derived for aboveground building structures.</p> <p>15 Then if you drop down to 16.9.3, please, from there,</p> <p>16 and including 16.9.5, if you just scroll up a little</p> <p>17 bit -- okay -- I'm quoting here the behaviour of</p> <p>18 an underground structure such as HUH Station, subjected</p> <p>19 to seismic excitation, is different from that of</p> <p>20 an aboveground structure. The design of the</p> <p>21 slabs/diaphragm wall joints is governed by static load</p> <p>22 combinations and not due to seismic demand. The issue</p> <p>23 as to whether type 2 ductile couplers have been</p> <p>24 installed at the slab joint connection to the diaphragm</p> <p>25 walls is not of significant engineering concern, since</p>
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<p>1 ten threads, each at 4 millimetres, and it doesn't</p> <p>2 matter whether you take a 2 millimetre half-thread plus</p> <p>3 a 2 millimetre end chamfer or simply 4 millimetres at</p> <p>4 the end, the last 4 millimetres closest to the inside of</p> <p>5 the coupler, that is reckoned as being non-effective</p> <p>6 thread. So equally, if ten threads equates to</p> <p>7 44 millimetres, nine threads equates to 40 millimetres,</p> <p>8 and so forth.</p> <p>9 A lot has been said already about the tensile tests</p> <p>10 on partially engaged couplers. Six threads, as you've</p> <p>11 heard, will pass the basic strength requirement but not</p> <p>12 that of a ductile coupler. It's a moot issue I'll come</p> <p>13 back to later, but some of the tests show that</p> <p>14 six-thread engagements will not satisfy the higher 575</p> <p>15 Newton per square millimetre test. It's not an issue.</p> <p>16 I have played safe and I have simply, by way of using</p> <p>17 almost like a sensitivity analysis, decided to use</p> <p>18 7.5 millimetres as in the Original Inquiry, and these</p> <p>19 all fail in bar-break mode which is a requirement of the</p> <p>20 ductile coupler.</p> <p>21 I then want to say a little bit about ductile grade</p> <p>22 couplers. They are only -- apart from the small issue</p> <p>23 of plasticity, they are only required in structures</p> <p>24 which experience cyclical load reversal. So, for</p> <p>25 example, a tower block, like you have here in Hong Kong,</p>	<p>1 the detailing rules applied for the station design were</p> <p>2 written for a different type of structure.</p> <p>3 Thank you for that. If we could go back to the</p> <p>4 presentation.</p> <p>5 Based on my 7.5 threads as almost like a sensitivity</p> <p>6 analysis, my acceptable criteria, my overall actual</p> <p>7 combined failure rate is only 6.9 per cent. But to</p> <p>8 allow for an approximate 95 per cent confidence level --</p> <p>9 and I will frankly acknowledge I have absolutely no</p> <p>10 interest in statistics, I don't know anything about</p> <p>11 statistics, I try to stay away from them -- but I have</p> <p>12 operated my 6.9 per cent failure rate by approximately</p> <p>13 35 per cent, which is consistent with the mark-up values</p> <p>14 of 31.6 per cent for the EWL and 34.4 per cent for the</p> <p>15 NSL slabs respectively, which MTR have used. If I do</p> <p>16 that, if I mark up my 6.9 by 35 per cent, I'm arriving</p> <p>17 at approximately a 10 per cent strength reduction</p> <p>18 factor, which to put in context compares with</p> <p>19 approximately 35 per cent applied by MTR.</p> <p>20 A lot has been said about the PET, as we will refer</p> <p>21 to it, the permanent elongation test, and we've all</p> <p>22 acknowledged that to allow any sort of machine screw or</p> <p>23 a bolt or a stud to be screwed into a female coupler,</p> <p>24 there has to be tolerance, otherwise it just wouldn't</p> <p>25 fit.</p>

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<p>1 In the laboratory, it has been demonstrated by CEEK 2 that when the tensile load is initially applied, so at 3 very low load take-up, the slack is taken out or, as 4 Dr Glover said, the threads bed in. Therefore, for 5 a partially engaged coupler assembly in the laboratory, 6 PET is not measuring irrecoverable elongation or stretch 7 as the test is designed to do. It is instead primarily 8 measuring the take-up of the slack, as I call it, in the 9 threads. 10 In the test conducted -- and, Commissioner, you have 11 stolen my thunder, I'm afraid. 12 COMMISSIONER HANSFORD: I do apologise. 13 A. -- the failures were equivalent in thickness to three or 14 four sheets of normal writing paper. 15 COMMISSIONER HANSFORD: I must confess I had read that 16 before I said that. So, Prof McQuillan, you can keep 17 the credit for that. 18 A. Thank you, sir. I know that's jovial, but to put things 19 in perspective, if a crack in the concrete at the top of 20 the EWL slab was to actually form, it would only be 21 a fraction of 1 millimetre in width. And I noticed when 22 Dr Glover was talking you did take out your scale rule 23 and you showed the chairman what that meant. 24 It would in any event be hidden by the track form 25 concrete above it, so in my reckoning you have been told</p>	<p>1 the thread? 2 A. Exactly. So all it takes is for something inside the 3 coupler to cause the threads to lock or to bed in, and 4 then providing it has the necessary tensile strength in 5 the assembly, in other words a minimum of six threads, 6 it will pass the test. 7 COMMISSIONER HANSFORD: So, therefore, the permanent 8 elongation, ie the bedding-in, the permanent 9 elongation is not prevented by it being butt-to-butt; 10 it's prevented by there being something that locks it? 11 A. Yes. To put that in a slightly different way and 12 rephrasing what I said earlier, the PET has -- the test 13 results that have been given for partially engaged 14 couplers are indicating that the measured movement is 15 not so much the stretch or elongation. It's really the 16 taking up of the slack. 17 COMMISSIONER HANSFORD: Yes. 18 A. I think that's a very important point to get across. 19 COMMISSIONER HANSFORD: Yes. 20 A. We'll come back to it in a moment as well. 21 So, bearing in mind that I've never seen a type A 22 bar with 48 millimetre threads, I've produced this what 23 I call a coupler engagement calculator. It just allows 24 you to read off, very simply. This is repeated in 25 paragraph 58 in my report.</p>
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<p>1 all structures contain cracks, this one is out of sight, 2 out of mind, and it should be highlighted in any event 3 that the filling and sealing of cracks, if deemed 4 necessary, isn't rocket science. It's 5 straightforward and there are plenty of products that 6 can be applied. 7 It has been agreed by all, however, that only fully 8 engaged butt-to-butt couplers will pass the PET in 9 laboratory conditions, and I stress "laboratory 10 conditions". That is what Highways Department's 11 acceptance criteria intend. So, in other words, to be 12 code compliant, bars need to pass PET. There's no 13 simple way around that. 14 It is highly significant, however, that CEEK have 15 proved, with their series of tests, that if a coupler 16 contains grit and the bar is only partially engaged but 17 rotated to refusal, it will pass PET. That is because, 18 as we've already described, the slack in the threads has 19 already been taken out. 20 COMMISSIONER HANSFORD: Sorry, just to understand that 21 point, can we go back a slide, please. 22 A. Yes. 23 COMMISSIONER HANSFORD: Just to understand that point, you 24 are saying that PET can be passed, the PET test can be 25 passed without it being butt-to-butt if there is grit in</p>	<p>1 It assumes, first of all, two bars, each with 11 2 threads, and that is ten threads plus the non-effective 3 end 4 millimetres. And I'm assuming first of all that 4 these two bars are centred inside the 88 millimetre long 5 coupler. 6 Highways Department's two-thread -- let's call it 7 HyD for short -- HyD's two-thread allowance exposure, if 8 you look down the fourth column from the left to where 9 you see the "2" -- and I don't know, can I use this 10 thing? -- there (indicating), so I'm pointing at the 11 "2", you will see that it has a gap -- if you focus your 12 eye on that fourth column from the left, on the 13 2 millimetre exposed threads, you will see, as you read 14 across, that there is a gap in the middle of that 15 coupler between the two bars of 12 millimetres. So just 16 to make sure you're focused, if you go over to the 17 left-hand column and read down to a length engaged of 18 38; scroll across to where it says two exposed threads; 19 go further across and you will see there's 20 a 12 millimetre gap in the centre of that coupler. 21 So it will fail the PET, but it has satisfied HyD's 22 criteria. 23 Then equally, if you look at HyD's allowable minimum 24 37 millimetres engagement, so that is actually 25 an effective thread of 8.25 millimetres, which is the</p>

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<p>1 top row, reading from the bottom, in red.</p> <p>2 So, if you read across, it actually fails on the</p> <p>3 criteria because 2.25 threads are exposed, and so you</p> <p>4 have to move up a row, and the minimum engagement has to</p> <p>5 actually be 38 millimetres, which is 8.5 threads, to</p> <p>6 satisfy the other criterion of a maximum of two threads</p> <p>7 exposed.</p> <p>8 However, as shown, this will also fail, in other</p> <p>9 words the 37/38 millimetres, will also fail the PET,</p> <p>10 because of the gap in the middle.</p> <p>11 COMMISSIONER HANSFORD: And not only that. Presumably of</p> <p>12 clearly it's not butt-to-butt.</p> <p>13 A. That's why there's a big gap in the middle, yes,</p> <p>14 12 millimetres.</p> <p>15 Sorry, let me go back. What about the scenario</p> <p>16 where one bar is fully screwed into the coupler which</p> <p>17 more or less simulates what we're talking about in this</p> <p>18 Inquiry, because of the D-walls? This is just one of</p> <p>19 the couplers retained by the Commission, and I think the</p> <p>20 original copy is in the room here if anybody wants to</p> <p>21 check. The photograph -- one end of the bar, at the</p> <p>22 left, is fully screwed in, hand-tight. And the</p> <p>23 measurement shows that there is only an available</p> <p>24 internal dimension of 44 millimetres.</p> <p>25 So what about the hypothetical scenario of having</p>	<p>1 engaged coupler assemblies which do not pass PET should</p> <p>2 not therefore be structurally disregarded, provided they</p> <p>3 achieve the full tensile capacity. That's what we're</p> <p>4 here discussing today, the fact that perfectly good</p> <p>5 partially engaged couplers have been discredited and</p> <p>6 discounted from the structural assessments.</p> <p>7 PET is therefore not a relevant test, principally</p> <p>8 because by way of repetition and summary. In the lab,</p> <p>9 the PET is carried out in free air and unrestrained,</p> <p>10 whereas in situ, the coupler assembly will behave</p> <p>11 completely differently because it's encased in concrete,</p> <p>12 and any thread slack is taken up post-installation</p> <p>13 because of the self-weight of the bar. I'll show you</p> <p>14 a diagram of that later.</p> <p>15 To repeat, there has been no evidence of any</p> <p>16 cracking even though the slabs have experienced most of</p> <p>17 the loading. The upper surface of the EWL is in</p> <p>18 an internal controlled environment so there is no risk</p> <p>19 of water ingress. This point has been rehearsed over</p> <p>20 and over again today. Rebar corrosion, even if --</p> <p>21 there's no risk of water ingress and corrosion even if</p> <p>22 cracking did occur, but of course it won't.</p> <p>23 And if cracking was to occur, for example at the</p> <p>24 bottom of the NSL slab which hasn't been mentioned</p> <p>25 because it can behave in the same way, upside down,</p>
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<p>1 only 40 millimetres inside the coupler which is</p> <p>2 represented by this mythical 48 millimetre bar if it was</p> <p>3 screwed in? I produced that little table to show the</p> <p>4 result. Even though I don't think it's possible for</p> <p>5 that to be done.</p> <p>6 So the 38 millimetre -- that's the third row down</p> <p>7 from the top -- or 8.5 threads, then the one above that,</p> <p>8 the 39 millimetre with 8.75 thread engaged lengths, they</p> <p>9 also both fail PET because there's still a gap in the</p> <p>10 middle.</p> <p>11 Mr Southward's evidence included photographs of this</p> <p>12 situation that I've just described. In other words,</p> <p>13 what I'm saying confirms the photographs that he had</p> <p>14 shown were one bar fully engaged to refusal and</p> <p>15 a continuation bar was screwed into a coupler so that</p> <p>16 two threads were showing. The coupler was then cut open</p> <p>17 and his measurements concur with my central gap; QED.</p> <p>18 So we're asking ourselves the question and I think</p> <p>19 Dr Glover had a slide with the same title on it: is PET</p> <p>20 relevant? I put it to you that coupler assemblies could</p> <p>21 comply with HyD criteria and yet fail PET.</p> <p>22 The HyD acceptance criteria therefore -- and I want</p> <p>23 to underline this; I've put it in bold -- sanction the</p> <p>24 use of partially engaged couplers, whether they like it</p> <p>25 or not. It therefore follows logically that partially</p>	<p>1 corrosion cannot occur because, as you've already heard</p> <p>2 today, you need the three elements: you need oxygen, you</p> <p>3 need water and you need steel. Therefore, I put it to</p> <p>4 you that in these structures, durability and longevity</p> <p>5 are not compromised.</p> <p>6 That's the little diagram I referred to. So when</p> <p>7 these guys are screwing in a 6 metre long starter bar to</p> <p>8 refusal and it's not fully engaged, if it's perfectly</p> <p>9 aligned and the weight is supported, you could actually</p> <p>10 feel the wiggle in the threads or the slack. Once these</p> <p>11 guys insert it and let it go, the end of that bar is</p> <p>12 going to try to sag, dip at the end, and in so doing,</p> <p>13 it's trying to pull out of a coupler, and in so doing,</p> <p>14 if you think about it, it's actually locking the</p> <p>15 threads.</p> <p>16 So to me there is absolutely no issue with slackness</p> <p>17 of threads once these starter bars are engaged. The</p> <p>18 problem just dissipates.</p> <p>19 Then we come to the question -- this is really the</p> <p>20 reason why of -- the entire station areas B and C have</p> <p>21 passed. The only area that has failed is the EWL slab</p> <p>22 in area A, and that is because of this issue of the</p> <p>23 doubly defective coupler assemblies.</p> <p>24 I use the term to describe the couplers adjacent to</p> <p>25 the D-wall which have partially engaged bars on one or</p>

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<p>1 both sides, and I would just like to draw your attention 2 to the fact that again, as with the Original Inquiry, 3 it's simply the couplers in the top of this slab that 4 are the ones in question, because they are the only ones 5 in tension. The bottom rebar assembly is in 6 compression. 7 In my opinion, what the holistic assessment has done 8 is to double-count or should I say double-discount these 9 double couplers, and this of course has the effect of 10 approximately doubling the strength reduction factor, 11 SRF. So instead of the normal average that they have 12 computed of 35 per cent, say -- I know it differs 13 slightly from the EWL to NSL -- instead of that average 14 of 35, it's effectively been doubled to 68.3. 15 I think it's quite significant that Dr Glover's 16 strength reduction factor -- and he is a statistician as 17 well -- he has arrived at 23 per cent, just to put it 18 into perspective, compared with his average of 19 12 per cent. 20 In such a situation -- I'm coming at this purely 21 from an engineering perspective. I don't trust 22 statistics. The quotation was made in the statistical 23 enquiry, Mark Twain's famous quotation: "Lies, damned 24 lies, and statistics". I'm a bit sceptical like that. 25 So I'm just looking at this almost from an engineer's</p>	<p>1 what the other eminent consultants are saying. We're 2 talking about the leading companies in Hong Kong here. 3 We're talking about the best brains in the industry and 4 their views on the matter. 5 So looking first at Atkins stage 3, partially 6 engaged coupler assemblies are ignored. This is 7 unrealistic, and -- I've used the word "hugely" 8 previously -- it's hugely conservative, because the 9 contribution of partially engaged couplers has been 10 completely ignored. Yet Atkins might say 11 apologetically, to their credit, make the point that 12 partially engaged couplers do contribute to structural 13 capacity. They say that a minimum of six threads is 14 okay for ULS condition. That's failure. They say that 15 a minimum of seven threads will satisfy the 16 serviceability limit state criteria. 17 COMMISSIONER HANSFORD: It's the other way around on the 18 slide. 19 A. It's the other way around. Yes. I've got it wrong on 20 the slide, actually. It should be six threads for ULS; 21 it should be seven threads for SLS. My apologies for 22 that. They agree the non-compliant PET results are 23 because slack has been taken up in the threads. 24 CHAIRMAN: Sorry, just to assist me, do Atkins say why they 25 have ignored partially engaged coupler assemblies?</p>
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<p>1 perspective sanity check, let's call it a sanity check, 2 and I'm saying: how can this possibly be? I recognise 3 that the probability of finding double couplers with 4 partial engagement on both sides is high, but bear in 5 mind that partially engaged couplers we are postulating 6 are perfectly safe. 7 I cannot understand how the failure rate doubles 8 because you are only ever going to achieve a failure, 9 even if it was to occur, on one side of a coupler. So 10 it's the concept of the weakest link in the chain. If 11 you put a coupler like this into a lab test and you 12 had -- in fact, the tests, I've already done it in the 13 lab -- only one side of the assembly is ever going to 14 fail. Two of them cannot fail exactly at the same 15 moment in time. 16 So I'm putting it to you, and there's nothing 17 hinging on this because I'm quite happy to take 18 Dr Glover's 23 per cent failure rate because it shows 19 the situation to be safe. I'm saying that based on my 20 analysis, I would apply the same structural reduction 21 rate, strength reduction factor, to area A as I would to 22 the rest of the structure. 23 I'm moving on now to do a quick summary or synopsis 24 of my review of the other reports. I think it's very 25 important for the Commission just to get a flavour for</p>	<p>1 A. Because they were simply acting on the recommendations 2 of the holistic report in their stage 3 assessment. 3 CHAIRMAN: Okay. Thank you. Yes, that's right. 4 A. So AECOM, they used the original design parameters, and 5 they looked initially at the effect of partially engaged 6 couplers with a minimum of seven-thread engagement. 7 Their strength reduction factor was 5.1 per cent. They 8 then also did a kind of sensitivity analysis and played 9 safe, and this time they used a minimum engagement 10 length of 37 millimetres. Their conclusions were that 11 the structures were still safe. 12 They then carried out a sensitivity analysis 13 themselves, and this time they used not the original 14 design parameters but the updated ones, and they used 15 the strength reduction factors that MTR had imposed on 16 them via the holistic report, and they found the 17 structures were still safe. 18 However, then came this issue of the double coupler 19 in area A, and what I'm thinking is that when they said 20 the structures were safe, that they hadn't got wind of 21 that at that particular stage. 22 So my conclusion to this whole issue of the coupler 23 issue is that the structures are safe and fit for 24 purpose. 25 Anticipating your question at the end,</p>

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<p>1 Mr Commissioner, stealing your thunder in reserve. 2 COMMISSIONER HANSFORD: Touche! 3 A. It's interesting that in BOSA's technical literature 4 they have this recommendation. It's really a product 5 quality control check. I don't think they are intending 6 this to be used every day in life by workers on the 7 site. But based on this, a possible recommendation 8 might be -- and this is now almost in addition to what 9 Dr Lau and Dr Glover have proposed -- I'm suggesting 10 that before every starter bar is installed -- and 11 I think Dr Glover has covered the first one -- the 12 inside of a coupler dimension is measured. I'm 13 suggesting that it's quite easy to record that with 14 a photograph and that can be whizzed back to base. 15 I made the point in the Original Inquiry that even 16 when you're working in car engines with a torque wrench, 17 it's recommended practice to lubricate the threads, and 18 I'm suggesting the inside of the coupler is lightly 19 sprayed with WD40 if you have that in Hong Kong or some 20 similar light oil, and I'm suggesting that the QSP and 21 other relevant documentation is amended accordingly. 22 However, that comes at a cost, and before anybody 23 would rush off and make this a firm recommendation, it's 24 obviously important to consult with all the relevant 25 stakeholders, but it kind of tightens up the whole</p>	<p>1 the slab simply drops, and it happens suddenly and it 2 happens as a brittle failure. 3 So how do you prevent that from happening, and 4 you've heard all this talk about shear links, maybe 5 someone wants to ask: why do you need shear links as 6 well? This is the answer: to prevent the shear failure 7 occurring at any one of those potential failure planes, 8 you stitch across it, is probably the simplest word, 9 using these vertical bars. It's a bit like mending 10 a tear on a piece of cloth; the thread is sort of 11 stitching the two sides together. And when longitudinal 12 reinforcement is present, to provide the bending 13 strength, it partially also contributes to the shear 14 capacity. That's maybe a point to come back to at the 15 SAT. 16 So let's look at the alleged -- in terms of the 17 alleged defects, we're talking now about area A. No 18 opening-up or minimal opening-up was done in area A to 19 substantiate these alleged defects. The thinner slab in 20 area A -- and we are talking about a 1 metre depth this 21 time -- is more conducive to placing the shear links, so 22 a much easier task. Dr Glover was telling you and 23 illustrating, as he stood, how difficult it would be to 24 retro-install those 3 metre long shear links from the 25 top of the EWL slab. It becomes quite complicated.</p>
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<p>1 procedure. I'm not even saying this will ensure you get 2 butt-to-butt. I haven't even considered that as 3 a necessity or a requirement. I'm just saying on site, 4 with these heavy bars, the best way to try to get it in 5 as tight as you can is to take these precautions. 6 We come to the next issue which is the shear link 7 reinforcement. Again, I don't wish to appear 8 patronising here but there may be someone in the room 9 from a non-technical background who's dying to ask the 10 question: what is a shear failure? Probably everybody. 11 CHAIRMAN: (Raising hand) I realise I have been given 12 instruction on this, but as a non-technical person the 13 instruction dissipates very quickly, and so something 14 that you can give now, Professor, which I can then write 15 down and goes into the record, would be of assistance. 16 A. Thank you, Chairman. What I've done in that diagram is 17 show you a simple picture. It could be a concrete slab 18 or it could be a concrete beam, supported, as we have in 19 this situation, by a wall at each side. If that beam or 20 slab has no reinforcement in it, what tends to happen is 21 that there are two potential shear plane failures, and 22 I'm pointing to that line (indicating) and I'm pointing 23 to that one (indicating), and it tends to be at an angle 24 of 45 degrees. If the load applied exceeds the shear 25 capacity of that non-reinforced section, the centre of</p>	<p>1 COMMISSIONER HANSFORD: Why do you say retro-install? 2 A. Because the reinforcement was built from bottom up and 3 it's more likely, he explained, that they were dropping 4 them down through at the end. 5 COMMISSIONER HANSFORD: Yes. 6 A. In spite of all of that, in spite of no investigation 7 and in spite of the more conducive conditions in area A, 8 the strength reduction factor is, to put it in stark, 9 blunt terms, is 100 per cent. In other words, zero 10 contribution from the as-placed shear links. 11 Again, I'm just letting the Commissioner and the 12 Chairman have a flavour for what the other experts or 13 non-experts in this case have had to say about the 14 matter. Atkins disregarded the shear links but they 15 admit it's very conservative. And although they use -- 16 they go ahead and they base their assessment on the 17 actual design concrete strength. Notwithstanding they 18 admit that the actual concrete strength as placed and as 19 hardened could be used to reduce shear enhancement work, 20 and they also admit that partial contribution of -- 21 I use "non-compliant" in the sense that they don't 22 exactly meet the requirements of the code in terms of 23 the detailing -- the partial contribution of those shear 24 links could be included in the shear capacity 25 assessment.</p>

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<p>1 Then I look at the AECOM --</p> <p>2 CHAIRMAN: Sorry, did they explain -- I've been through the</p> <p>3 report but I can't remember whether they explain why</p> <p>4 they disregarded all shear links.</p> <p>5 A. For the same reason as I gave in my previous answer: the</p> <p>6 outcome of the holistic report. So they were simply</p> <p>7 implementing the recommendations of the holistic report,</p> <p>8 which said, "Disregard all shear link rebar."</p> <p>9 COMMISSIONER HANSFORD: That was their brief?</p> <p>10 A. That was their brief. I'm not criticising Atkins for</p> <p>11 what they did, by the way. I'm just saying they were</p> <p>12 acting on instructions.</p> <p>13 CHAIRMAN: Would this be valid, in other words, to say,</p> <p>14 "Well, we've got photographs of certain shear links, we</p> <p>15 can't believe that everybody forgot and they all had</p> <p>16 a bad day at the office and even the inspectors forgot</p> <p>17 over a period of time, but because it's uncertain, let's</p> <p>18 just work on the basis they are not there at all and see</p> <p>19 what comes out of it?"</p> <p>20 A. That's exactly what has happened, Chairman, yes. That's</p> <p>21 why I describe it as hugely conservative.</p> <p>22 CHAIRMAN: Yes.</p> <p>23 A. So AECOM, in their assessment report, although they use</p> <p>24 the design concrete strength, they also advocate using</p> <p>25 actual strength. So I'm afraid Dr Lau is very much out</p>	<p>1 So non-compliant links are only a potential issue</p> <p>2 when it comes to these very minimal locations. Then</p> <p>3 Arup went on to suggest some mitigation features or</p> <p>4 measures to compensate for the shear link</p> <p>5 non-compliance, including using the actual concrete</p> <p>6 strengths, and Dr Glover has explained that very</p> <p>7 adequately today, and in light of the new core test</p> <p>8 evidence in the EWL slab, that becomes a very valid</p> <p>9 consideration.</p> <p>10 Arup also advocated using arch action, but they</p> <p>11 didn't.</p> <p>12 They then carried out a sensitivity analysis on</p> <p>13 concrete strengths with the shear links disregarded.</p> <p>14 They found that, for example, a modest increase in</p> <p>15 strength from 40 megapascals to 45 megapascals resulted</p> <p>16 in a 10 per cent increase in shear capacity, and so it</p> <p>17 probably increases linearly up to the 60 megapascals</p> <p>18 that we've been hearing about.</p> <p>19 Still, with shear links disregarded, Arup then</p> <p>20 carried out a safety check, and we've heard about this</p> <p>21 yesterday, using, as is allowed, by the way, using lower</p> <p>22 and more realistic load factors. I have written that</p> <p>23 wrongly. Arup then concluded that the structures had</p> <p>24 more than adequate shear capacity. QED.</p> <p>25 Then we come to an Australian consultant that were</p>
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<p>1 on a limb here when he says you cannot use the actual</p> <p>2 strength in the assessment.</p> <p>3 Then Atkins carried out what's called a sensitivity</p> <p>4 study. There were these 18 openings in the -- let me</p> <p>5 just go back to my notes here. 18 locations on the EWL</p> <p>6 slab soffit but none in area A, although I wrote that</p> <p>7 when I only had the discovery to work on. I think there</p> <p>8 is evidence that there may be one or two openings in</p> <p>9 area A now.</p> <p>10 Of those 18 openings, only four of them required</p> <p>11 shear links, and even then it was found that the</p> <p>12 original design provision of shear links, had you</p> <p>13 assumed it was valid, had you assumed that the original</p> <p>14 shear was contributing, then they said that there was no</p> <p>15 problem.</p> <p>16 Then we come to Arup and I'm just really --</p> <p>17 Dr Glover has given you most of it but I'm just</p> <p>18 summarising it, to put it in context. Arup carried out</p> <p>19 an FEA without incorporating mitigating effects such as</p> <p>20 arch action, and they used the specified design concrete</p> <p>21 strengths. They found that only a few locations in</p> <p>22 area A and at one location at an air duct in area B</p> <p>23 required any shear links at all, and then only</p> <p>24 nominal -- by nominal we mean the code minimum</p> <p>25 requirements.</p>	<p>1 hired by Leighton, EIC. Theirs was probably -- perhaps</p> <p>2 the most extensive and sophisticated approach to looking</p> <p>3 at this, the most thorough in terms of their review of</p> <p>4 the shear capacities, and they used what's called</p> <p>5 a hierarchical mitigation approach to consider factors</p> <p>6 such as shear enhancement, axial compression, actual</p> <p>7 concrete strength, reduced partial safety factors,</p> <p>8 reduced anchorage length, partial engagement of shear</p> <p>9 links because of the little non-compliances, and also</p> <p>10 what we call modified compression field theory, and</p> <p>11 I don't even pretend to have read what that is.</p> <p>12 I don't need to elaborate on all of those, but what</p> <p>13 they are basically saying is that they start from the</p> <p>14 top down and they look at the effect of one of these</p> <p>15 mitigating factors, and it will partially if not totally</p> <p>16 eliminate the shear under-capacity. Okay? If it</p> <p>17 doesn't work at that stage, they go to the next one on</p> <p>18 the list and it will have some contribution. So they</p> <p>19 work their way down through and they find that all of</p> <p>20 these taken together will more than compensate for any</p> <p>21 perceived lack of shear deficiency in the structure.</p> <p>22 So a lot has been talked about the strength of</p> <p>23 concrete, should it be as designed, should it be as</p> <p>24 actual?</p> <p>25 Even if you don't take it to its full extent, you</p>

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<p>1 only have to take a small bit of that as a contributor 2 to reducing the shear under-capacity. 3 So I'm not going to elaborate on all of these but 4 just if you take, for example, axial compression -- and 5 they don't even mention arching action -- I've used this 6 little illustration in my report. I would show this in 7 a university class, to let the students get a feel for 8 it. If you have ten standard bricks sitting on a plank 9 and you try to casually lift them, you can't lift them 10 because in that situation you have nine vertical shear 11 planes. There's a zone of weakness at the interface of 12 each brick. So how do you lift them? You simply clamp 13 your hands together on the ten bricks, squeeze as tight 14 as you can and you will find you can actually lift them 15 off the plank. 16 So that illustrates the concept of axial 17 compression, and that is also necessary to a certain 18 extent in arching action, because you need a compressive 19 force at either side. 20 So then I'm giving you what EIC say about -- their 21 conclusions. They use the original design parameters, 22 but the actual concrete strengths, and they identified 23 only two locations, at SP37 and SP47, which in theory 24 required shear capacity enhancement. That's based on 25 the fact that shear links have been disregarded.</p>	<p>1 and it was very much to prevent slippage across what he 2 claimed was a highly stressed construction joint. In 3 other words, he was suggesting the dowel bars as 4 a structural strengthening mechanism. 5 No one is challenging the fact now that the stresses 6 in the CJ are extremely low. There is no evidence of 7 slippage. That has been confirmed by the core tests. 8 Failure of the D-wall, if it ever happened, and it 9 won't, at the sort of load levels we are operating at, 10 Dr Glover has explained that it would occur in the 11 D-wall, at the underside of the EWL slab connection. 12 The connections are therefore safe, and the issue 13 with the CJ is purely one, as you've heard, of defective 14 workmanship, identified in just a few locations. The 15 retro-installation of the vertical dowel bars is 16 therefore not premised on structural integrity 17 considerations or structural safety. 18 The experts' memorandum of agreement December last, 19 states that Dr Glover, Mr Southward and myself, we've 20 agreed that although there is no impact on structural 21 performance or safety, that no rectification is 22 therefore required. It might be prudent, in order to 23 allay public safety concerns, to remediate the 24 construction joint in those few locations where 25 substandard workmanship was found defective, but only in</p>
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<p>1 They also took partial shear link engagement into 2 account, so in other words if the shear link doesn't 3 comply fully with the code, they are saying it still has 4 a contribution to make. It mightn't be 100 per cent, it 5 might be like 70 per cent, but they consider it valid 6 based on work that a Prof Foster, who is 7 a world-renowned expert on shear, has carried out at one 8 of the Australian universities, they are quite happy to 9 take the partial contribution of the shear links into 10 account. When they did that, they identified only one 11 location, at SP37, and then when they took Dr Foster's 12 modified compression field theory into account, they 13 reckoned the structures were safe, no remedial work, no 14 enhancement at all, was necessary. 15 They do make the point that if they then apply the 16 updated design parameters, the situation will become 17 even safer. 18 So my conclusion on issue 2 is there is more than 19 adequate shear capacity, as demonstrated by all the 20 brains who have looked at this, and the structures are 21 safe and fit for purpose. QED. 22 We come on to the thorny issue of the horizontal 23 construction joint in the D-wall. Prof Au, in his 24 evidence to the Original Inquiry, recommended the 25 insertion of these retro-installed vertical dowel bars,</p>	<p>1 those locations. 2 The way to remediate the CJ is to pressure-inject 3 grout. If you want to fill any perceived voids, if you 4 want to be seen to be doing something, just fill the 5 crack with grout, as you would with any other crack. So 6 the retro-fitting of the dowel bars, in my opinion, is 7 completely unjustified for the reasons they have 8 explained it necessary. I fail to understand why they 9 have been agreed. 10 The retro-installation of dowel bars requires, as we 11 have seen, the coring of deep holes, down into the 12 D-wall, with a possibility of cutting shear 13 reinforcement, and by comparison pressure-grouting 14 requires much smaller diameter holes, so less chance of 15 hitting steel. 16 I agree with Dr Lau, one of the few agreements, that 17 a concrete drill bit and a hammer action, a percussive 18 drill, you will know when you've hit the steel, because 19 we've all done it at home. 20 COMMISSIONER HANSFORD: Sorry, you said there's a risk of 21 cutting shear reinforcement? 22 A. Yes. 23 COMMISSIONER HANSFORD: Is that reinforcement only there 24 to -- 25 A. It's the lengths in the D-wall we're talking about.</p>

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<p>1 COMMISSIONER HANSFORD: Right.</p> <p>2 A. Because the main reinforcement is in the form of</p> <p>3 vertical bars, so you would be drilling parallel to</p> <p>4 those. The only horizontal steel you're going to</p> <p>5 encounter is the actual shear links in the D-wall.</p> <p>6 COMMISSIONER HANSFORD: Is there a risk of hitting the</p> <p>7 vertical bars?</p> <p>8 A. No, because you are drilling parallel to them.</p> <p>9 COMMISSIONER HANSFORD: How do you know?</p> <p>10 A. Because, if I can use my hands, if that's the D-wall</p> <p>11 (demonstrating), the main bars are inside the extremity</p> <p>12 slightly.</p> <p>13 COMMISSIONER HANSFORD: Yes, I understand.</p> <p>14 A. So you are drilling down parallel.</p> <p>15 COMMISSIONER HANSFORD: Yes, I understand.</p> <p>16 A. But what I do not agree with Dr Lau on is a that coring</p> <p>17 machine will bounce off steel and you will know the</p> <p>18 difference; okay?</p> <p>19 That photograph is one of a number of a series that</p> <p>20 I personally watched being extracted recently from</p> <p>21 a concrete wall and I was doing it --</p> <p>22 COMMISSIONER HANSFORD: This is not Hung Hom?</p> <p>23 A. This could be anything.</p> <p>24 COMMISSIONER HANSFORD: And this wasn't Hung Hom?</p> <p>25 A. No, this is back in the UK.</p>	<p>1 screen. First of all, the function of the stabling</p> <p>2 sidings. You've already heard some of this. It's</p> <p>3 a non-public area. The trains that are being stabled</p> <p>4 are travelling empty and at very low speed as they</p> <p>5 approach. The HHS walls are intended to contain a train</p> <p>6 in the event of derailment collision and, where</p> <p>7 relevant, to protect the adjacent podium columns.</p> <p>8 Again, there are much more amenable working</p> <p>9 conditions, lighter rebar, greater visibility for</p> <p>10 inspection. That means that there was much less chance</p> <p>11 of getting it wrong. And yet without any opening-up to</p> <p>12 prove the defects, a global 35 per cent SRF was applied.</p> <p>13 There are numerous record photographs, when these walls</p> <p>14 were being constructed, of good-quality coupler</p> <p>15 connections at the HHS wall kicker level.</p> <p>16 I've shown just one of a number of examples, and</p> <p>17 even though it lacks a little bit of definition on the</p> <p>18 screen, you can see that those couplers appear perfectly</p> <p>19 sound, easily inspected. The weight of the rebar,</p> <p>20 because it's a smaller rebar, is a lot easier to handle</p> <p>21 The bars are being dropped in vertically so there are no</p> <p>22 alignment problems as with horizontal bars. This had</p> <p>23 a much better chance of getting it right, and yet the</p> <p>24 contribution of those have been reduced by 35 per cent.</p> <p>25 Again -- and I'm going through this process for</p>
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<p>1 COMMISSIONER HANSFORD: Okay.</p> <p>2 A. So I was witnessing these series of cores being</p> <p>3 extracted on behalf of the group of experts who were</p> <p>4 involved in the case. I was there to witness it. It's</p> <p>5 typical of any project. What I've pointed out there,</p> <p>6 with the two little Xs, are two layers of rebar, one</p> <p>7 longitudinal, one transverse, and the operator of the</p> <p>8 core machine has no idea at all whether the</p> <p>9 diamond-tipped coring tool was cutting through hard</p> <p>10 granite aggregate or the rebar. The torque exerted by</p> <p>11 the machine was such that it never even slowed down when</p> <p>12 cutting through the two layers of steel. So I perceive</p> <p>13 no actual difference. I think that illustrates the</p> <p>14 point that some of us are making that there is the risk,</p> <p>15 with coring as opposed to drilling, of actually cutting</p> <p>16 steel reinforcement.</p> <p>17 So my conclusion for issue number 3, and you can see</p> <p>18 I'm kind of speeding up as we get through this, the</p> <p>19 structures are safe and fit for purpose, the issue is</p> <p>20 very much one of workmanship, as has been stressed. No</p> <p>21 intervention is required, and I have in my report</p> <p>22 stressed that you're best to let sleeping dogs lie,</p> <p>23 nothing needs to be done and it's risky doing anything.</p> <p>24 That brings us on to the issue in COI 2 of the HHS</p> <p>25 coupler connections. Again, pardon the typo on the</p>	<p>1 every issue -- I'm looking at what the other experts and</p> <p>2 other consultants have to say about these issues. So</p> <p>3 AECOM, as instructed by MTR, have applied the</p> <p>4 35 per cent SRF. They've used a very basic,</p> <p>5 conservative analysis method that you've heard about,</p> <p>6 which is the cantilever. Everything passed except for</p> <p>7 the panels adjacent to the vertical movement joints</p> <p>8 where they were found to be under-capacity.</p> <p>9 You've already heard from Dr Glover how they carried</p> <p>10 out an FEA. What they did, instead of considering the</p> <p>11 load spreading down at the conventional 45-degree angle</p> <p>12 through the walls, they played tunes with that. They</p> <p>13 looked at 30-degree angles, et cetera. However, they</p> <p>14 found that the maximum utilisation, even with the joint</p> <p>15 incorporated, was 92 per cent, and they found the trough</p> <p>16 wall satisfactory, notwithstanding, as you've heard from</p> <p>17 Dr Glover, Arup suggest a lot of mitigation factors that</p> <p>18 could be taken into account which would significantly</p> <p>19 enhance the reserve capacity.</p> <p>20 He's mentioned the reduction in live load, because</p> <p>21 there's no passengers running on these trains. The MTR</p> <p>22 criteria ask you to take the collision angle of the</p> <p>23 train at right angles to the wall, which doesn't make</p> <p>24 a lot of sense when the train is actually moving. It's</p> <p>25 going to be more of an inclined impact angle. He has</p>

<p style="text-align: right;">Page 169</p> <p>1 described the energy absorbed by the train itself, and 2 like me he considers that the earth fill, even though it 3 may not be compacted, still has a very significant 4 energy-absorbing contribution to make. 5 Can I just say, as another incidental point, the 6 soil -- and I've shown the little concrete paving bit at 7 the top as non-structural. It really is just to cap the 8 soil and provide a platform for personnel to walk on. 9 If the soil was going to be dug out, as Dr Lau has told 10 us, I'm afraid they have to close down the operation in 11 those sidings because it would be unsafe for men to walk 12 in that area. There would be no ability to maintain the 13 trains or anything. 14 COMMISSIONER HANSFORD: And also to remove the soil 15 presumably you would have to take the capping concrete 16 off? 17 A. You would, yes. 18 Let's just go on. You have heard from Mr Southward 19 already. He used what I consider, assuming the soil was 20 removed, a more relevant ultimate limit state analysis, 21 the yield line analysis, and as he has described, it is 22 the most applicable method in terms of a cantilever 23 upstand because it's taken from the analogous bridge 24 parapet work that has been done in America. 25 COMMISSIONER HANSFORD: Just so we can understand that -- so</p>	<p style="text-align: right;">Page 171</p> <p>1 happens", and he has proved that the trough walls have 2 more than adequate capacity. He then kind of does 3 a sensitivity analysis and his conclusion is in fact 4 they could cope with a 58 per cent strength reduction 5 factor, if I'm quoting him correctly. 6 So in conclusion, these structures are safe and fit 7 for purpose. A lot has been said about the need to 8 protect the podium columns. I'm quite sure that 9 a designer like AECOM would have fully taken this into 10 account when they were designing these trough walls, the 11 accidental impact on the columns. So my premise is 12 that, on the basis of everything I've seen, the walls 13 are safe and therefore there isn't any danger to these 14 podium columns whatsoever. 15 Which takes me nicely on to the final theme, and 16 that is the shear link reinforcement in the NSL slab in 17 the South Approach Tunnel. Again, the shear links have 18 been completely disregarded in the assessment of shear 19 capacity, so a 100 per cent strength reduction factor 20 applies. We make the point again, this is despite the 21 lighter type of construction, the more amenable working 22 conditions and the ease of installing the shear links. 23 Again I'm letting you see -- I know it's getting 24 a bit boring but these are the other non-expert and 25 expert reports. It's useful to see how many people are</p>
<p style="text-align: right;">Page 170</p> <p>1 that is being used for demonstrating that bridge 2 parapets, when struck by a vehicle, are safe? 3 A. It's actually the code that is used, as I understand. 4 I think Mr Southward gave that evidence. So that's how 5 you design a bridge parapet for vehicle impact loading. 6 COMMISSIONER HANSFORD: That's really what I meant. 7 A. Yes. So if the soil is removed -- I agree with 8 Dr Glover if the soil is there, the analysis is 9 inappropriate, it wouldn't fail like that -- but if the 10 soil isn't there, in that hypothetical situation, then 11 I agree that Mr Southward's analysis is perfectly valid. 12 I think the point that has been lost with all of 13 this, and I will repeat it -- he can probably do it much 14 better -- he hasn't in any way tried to argue against 15 the 35 per cent strength reduction factor. He's 16 accepted that, if you like, as a hypothetical situation. 17 He has also taken into account something that hasn't 18 yet been mentioned and that is the markdown in tensile 19 strength of the rebar, and this is all linked with the 20 perceived fact that not enough rebar had been tested on 21 arrival at site. 22 COMMISSIONER HANSFORD: Yes. 23 A. So that was another imposition by the verification 24 report. Mr Southward has taken both of those into 25 account and said, "Let's just accept them and see what</p>	<p style="text-align: right;">Page 172</p> <p>1 on the same wavelength when it comes to these issues. 2 So Atkins, in their revised structural assessment, 3 they admit to a conservative method of analysis, and 4 even with a 35 per cent strength reduction factor in the 5 couplers they concluded that both strength and shear 6 capacities were adequate. But I'm thinking, I'm quite 7 sure in my own mind, that was premised on them taking 8 into account the full contribution of the shear links at 9 that stage, when they carried out their assessment. 10 They concluded that the SAT NSL was okay for shear 11 before that markdown was applied. 12 COMMISSIONER HANSFORD: What leads you to that conclusion, 13 that they -- sorry, if we can go back -- assume premised 14 on the full contribution of shear link. 15 A. So what they were doing at the top, because they were 16 looking at the shear contribution of the main bending 17 steel, if I could call it that -- 18 COMMISSIONER HANSFORD: Yes. 19 A. -- they applied the 35 per cent reduction as for the 20 rest of the structures, but at that stage they were 21 still assuming that the shear links were fully 22 contributing, and this is basically just setting the 23 scene, if you like, to show that the thing was perfectly 24 safe, on that premise. 25 They obviously then got an instruction to say,</p>

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<p>1 "Disregard the shear links", which brings me on to the 2 next slide. 3 COMMISSIONER HANSFORD: Okay. 4 A. So they then have to submit to the Buildings Department 5 for approval, and in this case they apply the tensile 6 strength markdown for the rebar -- that's a fairly minor 7 issue -- but the main point is they disregard all the 8 shear reinforcement. They use the actual concrete 9 strength, and they find that there is one potential 10 shear failure zone, and this is in the base slab which 11 happens to be over 2 metres thick. 12 I contend that this mode of failure cannot occur, 13 and Dr Glover showed you the diagram showing the 14 difference between a basement at low depth in Hong Kong 15 and the box tunnel sunk a way down into the completely 16 decomposed granite layer, that soil is already 17 over-consolidated. Don't forget that, as he explained 18 and I concur with him, to build these structures in the 19 first place, the groundwater table was reduced to 20 a level of minus whatever it was, 16-18 metres. So the 21 ground has already been subjected to that. 22 As both Mr Southward and Dr Glover have explained, 23 you've got to look at this in three-dimensional mode. 24 So what you have is a wedge of already consolidated, 25 compressed soil, overlying bedrock, contained by D-walls</p>	<p>1 said, contains a lot of record photographs taken during 2 construction, and shear links are clearly seen in the 3 completed rebar mats. I haven't replicated them here. 4 You can find them in my COI 2 report, if you wish to 5 look at them. There are shear links seen in the 6 completed rebar maps in the NSL roof slab and also in 7 the mezzanine slab. I wasn't able to find any for the 8 base slab, but that doesn't mean that those photographs 9 don't exist; okay? 10 And on the basis of that, SYW concluded the 11 structures are also safe. 12 Then we have Mr Southward's report. He correctly 13 makes point that in localised areas where shear 14 reinforcement is required, and it is only a few areas, 15 it only needs to be nominal. That means it only needs 16 to be the minimum specified by the Hong Kong Code of 17 Practice. 18 He makes the point very sensibly that because the 19 links actually provided have a greater cross-sectional 20 area than the minimum required, then the shear capacity 21 is provided and it actually is code compliant, even 22 though that's an issue we shouldn't be considering. 23 So my conclusions -- and we are near the end, you 24 will be pleased to know -- on issue 5: Atkins' shear 25 assessment -- I use the word again -- was hugely</p>
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<p>1 on both sides. There isn't a pup's chance that if you 2 were able even to excavate down to that level, you would 3 ever find a gap below it. 4 What I'm saying is that the punching shear mode that 5 has been predicted by Dr Lau -- sorry, that he concurs 6 with but which was predicted by Atkins, it simply cannot 7 occur because that layer of decomposed granite acts 8 almost like concrete, if you like. It prevents the 9 punching shear failure. 10 EIC again used their hierarchical approach to shear 11 reassessment, to look at the shear capacities, and 12 unequivocally they concluded that the structures have 13 adequate capacity. 14 I'm not quite sure how SYW came into the equation; 15 there were another set of consultants. 16 COMMISSIONER HANSFORD: Who are they? 17 A. The full name is -- somebody help me. 18 MR KHAW: Siu Yin Wai. 19 A. I have abbreviated as "SYW". They were also engaged by 20 MTR to carry out a slightly different function. I think 21 their main function was to look at all the records and 22 piece together all the information, but they were asked 23 to do some other work. 24 COMMISSIONER HANSFORD: Yes, I recall. 25 A. So their report, of course, on the basis of what I've</p>	<p>1 conservative because no investigation was carried out to 2 confirm the shear link defects; the shear link 3 contribution has been totally disregarded; the design 4 concrete strength has been used; the modelling and 5 analysis was too simplistic and did not properly 6 represent the SAT structural behaviour. 7 Just for the record, again, I want to say I'm not 8 angling at Atkins, I'm not criticising Atkins. They 9 were obviously under instruction. 10 There is adequate shear capacity and the structures 11 are both safe and fit for purpose. 12 So my summary opinion on COI 1 and COI 2. First of 13 all, my summary opinion expressed in my first report in 14 respect of areas B and C remains unchanged. Those 15 particular structures are both safe and fit for purpose 16 as-constructed. That includes, of course, the issue of 17 the CJ. 18 Having reviewed areas A, HHS and SAT -- and bear in 19 mind that even though NAT was assessed it was found 20 satisfactory -- I am satisfied, without any doubt, that 21 the structures overall are safe and fit for purpose 22 as-is; there is no reason why the station should not be 23 open to the public; I am aware the public have been told 24 that remedial works were necessary, they will be 25 expecting such, so to allay public concern I recommend,</p>

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<p>1 as I did in the original hearing, that long-term 2 monitoring of structural performance be carried out. 3 I have kept that suitably vague. I am on the same 4 wavelength as Dr Glover, as you've heard, visual 5 inspection probably is satisfactory, so I have kept it 6 loose. 7 COMMISSIONER HANSFORD: So you are not suggesting here the 8 form of monitoring; you are saying long-term monitoring? 9 A. Correct. So that should be carried out except for the 10 trough walls, because there's no need to monitor them. 11 They should never have to come into operation unless 12 there's a train derailment. 13 And we are suggesting that long-term monitoring, 14 even though no significant results are to be expected, 15 and we stressed that at the original hearing. 16 I've gone one step further because we know that 17 enhancement works are already being carried out, 18 suitable measures are already being implemented. I know 19 it's an area we are not asked to stray into, if the 20 structures are safe, but I'm suggesting that if that 21 work is being implemented, there's no need for even 22 monitoring, apart from maybe the odd casual visual 23 inspection, because the structures are then going to be 24 much safer than we are saying they are at present. 25 Thank you for your patience. That concludes my</p>	<p>1 MR BOULDING: They are Siu Yin Wai Associates Ltd, apologies 2 for the pronunciation, and they are referred to in the 3 verification report which is BB9960 in the bundle, and 4 on that page, paragraph 1.6(a) tells you exactly what 5 they did. I hope that's helpful. 6 CHAIRMAN: That's excellent. Thank you very much indeed. 7 Good. 8 I will ask the Secretariat to inform those who do 9 some of the backup work and who get paid I think on 10 a daily basis that they won't be needed on Friday; all 11 right? 12 MR PENNICOTT: Yes. 13 CHAIRMAN: Which will mean that if by 4.55 tomorrow evening 14 we are still in full flow, I'll become agitated; all 15 right? Thank you very much. 16 MR PENNICOTT: And I'll become liable. 17 CHAIRMAN: Probably. Thank you very much. Tomorrow, 10 am 18 (4.26 pm) 19 (The hearing adjourned until 10.00 am the following day) 20 21 22 23 24 25</p>
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<p>1 rather lengthy but necessary summary evidence. 2 COMMISSIONER HANSFORD: Just on your final point there, 3 I recall in oral evidence way back, about a year ago, 4 the reference was made to belt and braces. 5 A. Yes. 6 COMMISSIONER HANSFORD: What I think you are saying in your 7 final bullet there is now with not only the belt and 8 braces but also the piece of string added, you see no 9 need for any monitoring? 10 A. And probably adhesive tape as well. 11 COMMISSIONER HANSFORD: Thank you. 12 CHAIRMAN: Good. Excellent. That's actually fairly good 13 timing, it's heading for 4.30 and you have finished, so 14 we will adjourn until tomorrow. 15 MR PENNICOTT: Yes, sir. 16 CHAIRMAN: 10 am? 17 MR PENNICOTT: Yes, sir. 18 CHAIRMAN: And we are satisfied we will finish tomorrow? 19 MR PENNICOTT: Very satisfied, yes. 20 CHAIRMAN: All right. Good. The only reason I mention -- 21 MR PENNICOTT: Subject to Mr Chow. 22 CHAIRMAN: Ah, yes. 23 MR BOULDING: Sir, can I just hopefully answer a query? 24 I think there was a query as to quite who SYW were. 25 CHAIRMAN: Yes.</p>	<p>1 INDEX 2 PAGE 3 DR MIKE GLOVER (on former oath)1 4 Cross-examination by MR CHOW (continued)14 5 Cross-examination by MR SHIEH111 6 Re-examination by MR BOULDING116 7 Questioning by THE COMMISSIONERS122 8 (The witness was released)126 9 PROF DON MCQUILLAN (on former oath)126 10 Examination by MR PENNICOTT126 11 Presentation by PROF MCQUILLAN128 12 13 14 15 16 17 18 19 20 21 22 23 24 25</p>