COMMISSION OF INQUIRY INTO THE CONSTRUCTION WORKS AT AND NEAR THE HUNG HOM STATION EXTENSION UNDER THE SHATIN TO CENTRAL LINK PROJECT

CLOSING SUBMISSIONS FOR LEIGHTON

A. Introduction

1. These submissions address the following two matters arising after the completion of Part One of the Extended Inquiry ("**COI-2**") in June 2019, namely the:-

   (1) suitable measures proposed in the Verification Report; and

   (2) project management expert evidence.

B. Suitable measures

2. On 18 July 2019, MTRCL published the Verification Report on the as-constructed conditions of the NAT, SAT and HHS.

3. The Verification Report concluded at §6.4:-[1]

> Based on the Part 2 structural review and inspections carried out, MTRCL considers that for the purpose of the ongoing construction activities, the NAT, SAT and HHS are structurally safe.

[1] [BB16/9981].

4. Nevertheless, the Verification Report proposed suitable measures to be carried out in the following two locations (§6.2):-[2]

   (1) the HHS trough walls; and

   (2) the NSL slab in the SAT.

5. As with the Holistic Report, the Verification Report was carefully worded, and it did **not** state that without the suitable measures the HHS trough walls and NSL slab in the SAT are structurally unsafe, and they were **only** proposed for so-called **"code compliance"**:-[3]

   > Upon satisfactory completion of the structural modifications and remedial works, the NSL tunnel of the SAT and trough walls of the HHS will achieve the safety level required in the [Code of Practice for Structural Use of Concrete] for meeting the established good practice of engineering design.

6. Section B of Leighton's closing submissions for Part Two of the Original Inquiry ("**COI-1**") sets out why structural safety is not to be conflated with so-called "code-compliance". It explains why there is no legal reason for the Government to rigidly insist upon satisfaction of all the requirements set out in the Hong Kong Code of Practice for the Structured Use of Concrete ("**Code**"). We refer the Commission to and adopt that analysis for present purposes.

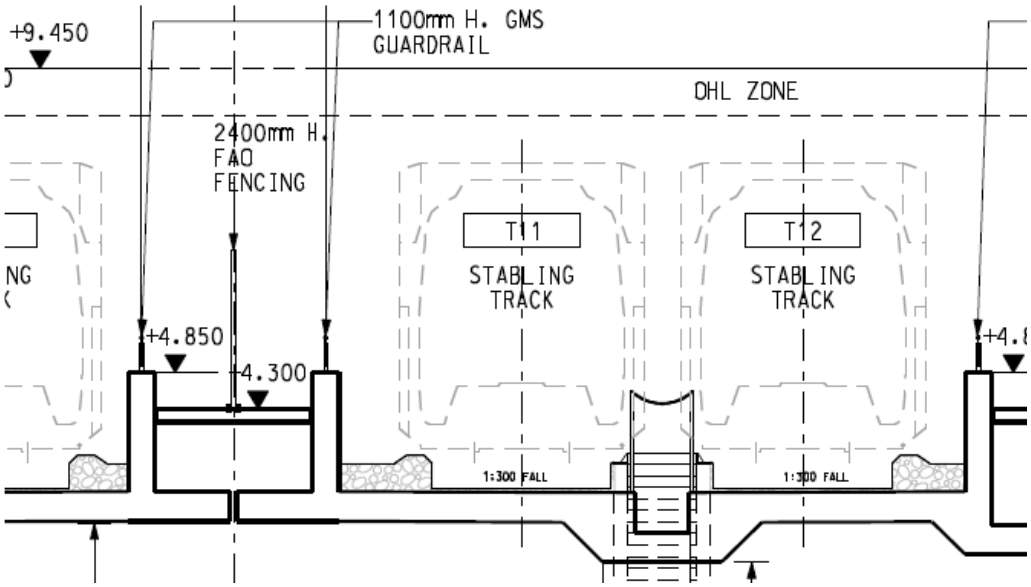
7. Leighton has complied with all applicable statutory, regulatory and legal requirements. Similarly, Leighton maintains that the structure complies with the Contract. Please refer to §15 to 17 of Leighton's closing submissions for Part Two of COI-1.

[2] [BB16/9981].
[3] [BB16/9981].

8. In any event, and setting aside so-called "code compliance" (which the Commission is not concerned about if the HUH Extension is safe), we will demonstrate that none of the proposed suitable measures are justified and necessary for the purposes of structural safety. As a result, the Commission can conclude beyond any shadow of a doubt (as Professor McQuillan, Dr Glover and Mr Southward did in their Supplemental Expert Memorandum) that the as-built COI-2 structures (including the HHS trough walls and the NSL slab in the SAT) are safe and fit for purpose.[4]

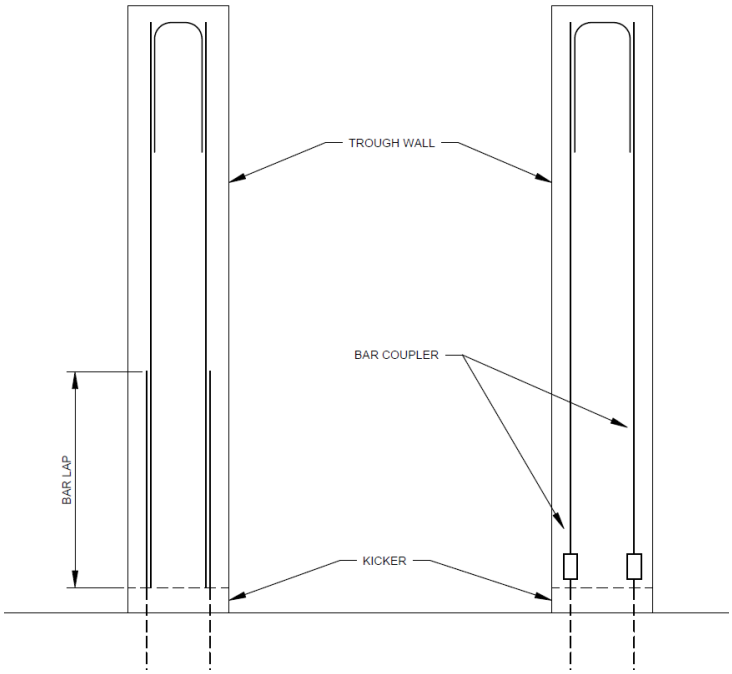
C. HHS trough walls

9. The trough walls are located at each side of the train tracks in the HHS area to contain the trains in case of derailment so that adjacent structures are not at risk of damage.



[4] Supplemental Memorandum of Agreement [ER(COI2)1/Item 15.1].

10. Leighton replaced some of the lapped connections at the kicker level of the trough walls with couplers to facilitate access. This is reflected in the following diagram:-



11. The Commission will recall from COI-1 that the lapping of rebar and use of couplers is interchangeable under the Code.[5]

12. A strength reduction factor of 35% has been adopted in areas where coupler connections have replaced lapped bars purportedly due to lack of full records of the coupler connection works:-[6]

> Due to the lack of full records of the coupler connection works, it is considered prudent to apply a strength reduction factor in areas where coupler connections have replaced lapped bars on account of uncertainty of workmanship. In the absence of any other alternative evidence or data, a strength reduction factor of 35% has been adopted. This is comparable to the strength reduction factor applied in respect of the NSL platform slab in the adjacent HUH Extension which is adjoining to NSL tunnel at SAT.

[5] Code §8.7.1 [H8/2946].
[6] Verification Report §4.2.6 [BB16/9976].

13. By applying a 35% strength reduction factor, couplers connections at the trough wall kicker level are deemed to have inadequate strength and therefore require suitable measures at the expansion joints between the walls:-[7]

> However, for HHS structures, the spare structural capacity at critical coupler locations of trough walls near movement joints of a total length of about 150m is less than the assumed strength reduction factor of 35%. Suitable measures are therefore required and illustrated in Appendix C.

14. It is submitted, however, that there is no justification to adopt a 35% strength reduction factor:-

(1) There was no opening up in the HHS. Any suggestion that the trough wall kickers are in any way deficient is purely a matter of speculative extrapolation.

(2) There is no basis to transpose the defective rate and strength reduction factor applied to the NSL slab to the HHS where the steel fixing work was done by a different subcontractor, and rebar fixing would be considerably easier due to:-[8]

(a) the couplers being fully visible such that alignment of the coupler could easily be determined by the steel fixers;

(b) the rebar being shorter, smaller and lighter than those used in the NSL slab; and

[7] Verification Report §4.5.2 [BB16/9978].
[8] Mr Southward's COI-2 Report §4.5.2 [ER(COI2)1/Item 10.1].

(c) the assistance of gravity on the weight of the rebar made it easier to install the rebar into the couplers.

(3) As Professor McQuillan pointed out:-[9]

> This **obviously is an entirely different situation** from what happened approx. 3m from ground level in respect of the bottom rebar of the main EWL slabs where heavy T40 starter bars had to be screwed into couplers which had been exposed in the D-walls. In this HHS situation **a maximum diameter T25 bar is used**, **access to the couplers is unrestricted** and **gravity is working in favour** of the main wall rebar being inserted and tightened into the couplers. Why would any shortcuts be taken when the connections were so easy to inspect?

(4) See the illustration below:-

15. Dr Lau did not disagree with the above points of difference but, under cross-examination, he referred to the defects observed in the stitch joints and the unauthorised pouring of concrete in the VRV Room.[10] However, those are discrete and separate defects/incidents, and are of a different nature. Those occurrences do not justify transposing the NSL slab defective rate into the trough wall.

[9] Prof McQuillan's COI-2 Report §18 [ER(COI2)1/Item 11].
[10] [COI-1+2] Day 9:107(17)-(23).

16. There is also no justification to apply 35% over the **full height** of the trough walls. At most it should **only be applied to the coupler assemblies** with a 4% reduction applied to the rest of the walls (being the downgrade adopted to purportedly reflect missing rebar testing records).[11]

17. The Government when cross-examining Mr Southward suggested to him that when the trough wall is hit by a derailed train, there is a risk that the deformation of the trough wall may hit or damage a nearby column that supports the podium above.[12]

18. Mr Southward did not consider this as a relevant concern:-[13]

> I really don't think it's relevant, because of the energy that the wall has absorbed. Then also the wall itself behind, there's backfill everywhere, so in order for the wall to move, it will push against the soil and the backfill that is behind the wall. So any residual load/force that might or might not hit that column would be extremely small.

19. Dr Glover expressed the same view:-[14]

> It's the soil and because of the restraint from the slab above, you wouldn't get that particular yield line. That's why I raised the question. And because of the oversite concrete at the top and because of the soil, a lot of that impulse, because that's what it is, it's an impulse, is actually dissipated into the soil and also into the adjoining wall.

20. Professor McQuillan also concurred:-[15]

[11] Mr Southward's COI-2 Report §4.7.6 (p.14) [ER(COI2)1/Item 10.1]. The 4% general downgrade to T16 rebar or above is proposed at §4.3.2 of the Verification Report [BB16/9977].
[12] [COI-1+2] Day 8:82(6)-(13).
[13] [COI-1+2] Day 8:84(20)-85(2).
[14] [COI-1+2] Day 11:94(18)-(24).
[15] Prof McQuillan's COI-2 Report §24 (p.23) [ER(COI2)1/Item 11].

> In the event of a train impacting a trough wall the soil fill between the walls will absorb significant energy and restrict the deformation of the impacted wall section.

21. In addition, no consideration was given in the calculation to the actual strength of the concrete being higher than the specified design value. [16] See Leighton's COI-1 (Part Two) Closing Submissions for more details on this point.

22. The strength reduction factor to be applied to the HHS area should be 6.9% (or 6.5% if the "Missing Values Approach" is adopted) by reference to that applied to the NSL slab.[17]

23. If a yield line analysis is adopted, then even if one were to adopt a 35% strength reduction factor to the coupler connections, the trough walls could withstand train collision loads even if the coupler connections are reduced in strength to 58% (which is not actually the case).[18]

24. As Professor McQuillan noted:-[19]

> In other words, Mr Southward has hypothetically accepted MTRCL's hugely unjustified and conservative approach and has irrefutably proved, in spite of the very significant reduction factor, that the trough walls are safe and have significant reserve capacity. This removes any possible argument on the efficacy of partially engaged couplers.

[16] Mr Southward's COI-2 Report §4.6 (p.11) [ER(COI2)1/Item 10.1].
[17] Mr Southward's COI-2 Report §4.5.1 (p.10) [ER(COI2)1/Item 10.1]; Dr Wells' COI-1 Report §4.29 [ER1/Item 10]; Prof McQuillan COI-2 Report §21 [ER(COI2)1/Item 11].
[18] Mr Southward's COI-2 Report §4.7.7 (p.15) [ER(COI2)1/Item 10.1].
[19] Prof McQuillan's COI-2 Report §56 (p.31) [ER(COI2)1/Item 11].

25. The trough walls are therefore not only safe but have a significant reserve capacity in the event of a train impact.[20]

26. It follows that the proposed suitable measures to the HHS trough walls are not necessary for the purposes of structural safety.

D. <u>Shear Reinforcement</u>

27. Atkins contended that there is a shear failure zone in the 2,170mm thick base NSL slab in the SAT adjacent to the diaphragm wall that requires localized strengthening.[21]

28. Atkins should not have disregarded the presence of as-constructed shear links just because the photos taken from the MTRCL opening up investigations did not seem to show such shear links at the exposed bottom layer. In fact, there is no reason to doubt that shear links were installed (and significant evidence proving that they were installed was produced to the Commission). See Section D of Leighton's COI-1 (Part Two) Closing Submissions.

29. When calculating shear capacity, Atkins further failed to take into account:-[22]

    (1) the actual concrete strength being higher than the design value (see Leighton's COI-1 (Part Two) Closing Submissions);

[20] Prof McQuillan COI-2 Report §58 (p.31) [ER(COI2)1/Item 11].
[21] See diagram at [AA2/566].
[22] Mr Southward's COI-2 Report §5.3.1 [ER(COI2)1/Item 10.1].

(2) redistribution of shear force at the ultimate limit state;

(3) the soil underneath the slab directly reducing the shear from the base slab self-weight; and

(4) the internal hanger wall connecting the OTE and NSL slabs will also operate to resist any downward fall and transfer the load into the OTE slab.[23]

30. It follows that the shear capacity of the NSL slab in the SAT is more than adequate. As such, the SAT is safe and fit for purpose.[24]

E. Conclusion (on Structural Engineering Issues)

31. None of the suitable measures as analysed in Sections D and E above are necessary for the purposes of structural safety. The Commission should conclude that the HHS trough walls and the NSL slab in the SAT are safe and fit for purpose.

F. Project management

32. There are three main issues relating to project management arising from the project management evidence filed after the completion of Part One (Factual Evidence) of COI-2, namely:-

(1) Supervision;

[23] Mr Southward's COI-2 Report §5.3.2 (p.18) [ER(COI2)1/Item 10.1].
[24] Mr Southward's COI-2 Report §5.7 (p.23) [ER(COI2)1/Item 10.1]; Prof McQuillan's COI-2 Report §112 (p.46) [ER(COI2)1/Item 11].

(2) RISC form and inspection procedures / record keeping; and

(3) Rebar testing.

F1. Supervision

33. Leighton's position with respect to the supervision standards applicable to the installation of couplers (including the application of the Quality Supervision Plan, "**QSP**") is set out in its Opening and Closing Submissions for COI-1 (Part One) and COI-2 (Part One on Factual Evidence).[25] Leighton does not wish to repeat those submissions in their entirety. However, it is important to highlight a number of key points in light of the expert project management evidence adduced in COI-1 and COI-2.

34. Relevantly, Counsel for the Commission submitted that, while the project management experts may have a view about normal practice, the correct interpretation of the various clauses in the BD consultation letters that deal with supervision is primarily a legal issue.[26]

35. It bears emphasis that the BD consultation letters clearly impose a different set of conditions for:-[27]

[25] Leighton's Closing Submissions (Part One of COI-1) at §105-153; Leighton's Opening Submissions (COI-2) at §33-52; Leighton's Closing Submissions on Factual Evidence (COI-2) at §81-105.
[26] [COI-2] Day 17:7(9)-(24).
[27] Appendix IX of BD's letter dated 25 February 2013 [CC8/4400ff at CC4428] and RDO's letter dated 11 July 2013 [CC6/3873ff at CC6/3899] sets out the conditions for mechanical couplers with a ductility requirement. Appendix X of BD's letter dated 25 February 2013 [CC8/4400ff at 4432] [CC8/4428ff at 4432] sets out the conditions for mechanical couplers without a ductility requirement.

(1) couplers WITH a ductility requirement; and

(2) couplers WITHOUT a ductility requirement.

36. Relevantly, the set of conditions for couplers with a ductility requirement impose higher supervision standards. In particular:-

(1) For couplers <u>with a ductility requirement</u>:-

(a) The RGBC (Leighton for the slabs) / RSC (Intrafor for the diaphragm walls) should assign a quality control coordinator (minimum **TCP T3 grade**) to provide "**full time on site supervision**" of the works and devise inspection checklists.

(b) A QSP of the Competent Person (MTRCL) and the RGBC (Leighton) is required to be submitted to BD prior to the commencement of the mechanical coupler works. The QSP should include the following details (among other things):-

> Frequency of quality supervision, which should be at least 20% of the splicing assemblies by the quality control supervisor of the Competent Person and "**full time continuous supervision**" by the quality control coordinator of the RGBC (Leighton) / RSC (Intrafor) "**of the mechanical couplers works**".

(2) For couplers <u>without a ductility requirement</u>:-

(a) The RGBC (Leighton) / RSC (Intrafor) should assign a quality control coordinator (minimum **TCP T1 grade**) to provide "**full time on site supervision**" of the works and devise inspection checklists.

(b) There is **no requirement for a QSP** or **"full time continuous supervision"** of the couplers works.

37. It is thus clear that the requirement for a QSP (and the requirement of "full time continuous" supervision under the QSP) applies **only** to couplers **with a ductility requirement**.

38. The specific phrase used in the BD consultation letters to describe the couplers is "Mechanical Couplers for Steel Reinforcing Bars for Ductility Requirement". They are couplers that are subject to a "ductility requirement" or are "required" to be ductile.

39. The consensus among the structural engineering and project management experts is that it is the location of the coupler that is important (and not the type of coupler actually used [28]) when determining whether a coupler is subject to a "ductility requirement":-

(1) See Mr Southward's COI-1 Report at §6.6.4 [29] where he explains that a ductility requirement is "where the design specifically requires the use of Type II ductility coupler".

[28] The COI has heard that there non-ductile couplers (see BOSA Manual for Type I Non-Ductility Coupler [A1/475]) and ductile couplers (see BOSA Manual for Type II Ductility Coupler [A1/556]).
[29] Mr Southward's COI 1 Report dated 11 October 2019 [Item 14.1, ER1].

(2) Dr Lau's evidence [COI-2] Day 9:150(5)-(11):-

Q. Whether or not certain couplers or assemblies are subject to a ductility requirement is a different question from whether in fact ductile couplers were used; correct?

A. Okay.

Q. You accept that?

A. I accept that.

(3) Mr Huyghe's evidence [COI-2] Day 16:115(8)-(15):-

Q. … would you accept that there is a difference between whether or not an area is subject to a ductility requirement on the one hand and whether or not ductile couplers were in fact used in an area on another –

A. Yes. You go by the drawings to determine where the ductile requirement is.

(4) Mr Wall's evidence [COI-2] Day 17:17(17)-(24):-

I'm of the view that the issue with regard to full-time and continuous supervision and the QSP only applied to couplers with a ductility requirement, as they were specified in the drawings. And, as I say, in relation to ductility requirement, this information or identifying where these types of couplers apply, you would need to go back and refer to the designer's drawings to establish where these locations are.

(5) Mr Rowsell's evidence[COI-2] Day 18:76(20)-(23):-

Q. Do you accept that when one decides whether a coupler is subject to a ductility requirement, one needs to go to the work drawings?

A. That's my understanding, yes.

40. The structural engineering experts in their evidence in Part One of COI-1 agreed that none of the couplers used in this Project should be subject to a ductility requirement because the levels of seismic activity or type of loads that they will be exposed to are not sufficient to justify it.[30]

41. More recently, Professor McQuillan confirmed that this view was supported by most, if not all, of the assessment reports prepared by the independent consultants. See §85 of his COI-1 Report:-

> Of interest, AECOM state at §6.3 on page 6-4 "…there is no requirement … to use couplers to address any ductility requirements on the slabs to D-wall connection." This corroborates my opinion on the need or otherwise for ductility-grade couplers as expressed at 2e, 67 and 68 above. This view will be later seen to be supported by most, if not all, the assessment reports.

42. The assessment as to whether a coupler in a particular location of the Project was subject to a ductility requirement (i.e. a coupler was "required" to be ductile) could only be made at the time of construction when supervision was required.

43. At that time, the key authorities that were available to Leighton to make that assessment were the working drawings and the Code. Unless the working drawings specified a ductility zone, there would be no need for the enhanced level of supervision that applies to the installation of a coupler with a "ductility requirement".

44. As explained in Leighton's Closing Submissions for Part One of COI-2, there was only one location in the Project (i.e. Area A of

[30] Joint Expert Memorandum §1 [ER1]; MTRCL Closing Submissions (Part One) at §63.

the NSL) where the intersection of the diaphragm wall and the slabs was shown to be within a "ductility zone" on the drawings.[31]

45. Mr Southward acknowledged this fact:-[32]

> Leighton have analysed all of the drawings available at the time of construction of the D-walls and slabs. They have found that none of these drawings showed "ductility zones" across the slabs, with the exception of drawings for the NSL area A. These drawings also did not specify the use of ductile couplers in any other way.

46. Mr Rowsell accepted that the higher supervision standards apply to limited locations (namely, where there are couplers with a ductility requirement):-[33]

> The requirement for "full-time continuous" applies to areas of high risk where there is deemed to be a need for a quality supervision plan, and that only applies to fairly small parts of the work, and the government has recognized that these are high-risk areas. They want to be sure that in these high-risk areas the works are properly built, they are properly supervised, and that you need a full-time and continuous presence.

47. This is consistent with Mr Wall's view that it would be uneconomical to have a grade TCP T3 supervisor for every ten workers at all times watching the coupler works:-

> I think, from my perspective, in the context of the construction industry in Hong Kong, it is uneconomical and impractical. I mean, we can always say that, yes, you can spend more, you can provide more; you could always do more. But, as I say, in the context of the industry as it stands and the way that it generally operates, I am of the view that it is impractical and uneconomical … In terms of the pricing that you have for works, the availability of engineers, the resources that you generally have or are expected to have on construction projects. **So, if we are talking about full-**

[31] Also see Leighton's Closing Submissions (COI-1) at §130; Leighton's Opening Submissions (COI-2) at §38-50; and Leighton's Closing Submissions on Factual Evidence (COI-2) at §94-100.
[32] [COI-2] Day 7:63(9)-64(3).
[33] [COI-2] Day 18:39(15)-(23).

> **time and continuous supervision, perhaps we might, as I believe Leighton has provided, you might have an engineer working for or supervising a piece of work. That would no longer be acceptable; you might have to have two or three engineers working or looking after a particular piece of work so that one of them can take bathroom breaks, one can stop for lunch, one can go on leave. I think that is not the reasonable expectation.[34]**

48. It follows that the higher supervision standards (including the requirement for a QSP and the provision of "full time continuous" supervision under the QSP) did not apply to the couplers installed by Leighton in the Project (with the exception of the couplers used at the intersection of the diaphragm wall and slab in NSL Area A[35]).

49. The submission made by Counsel for the Commission [36] that the QSP applies to ductile couplers in all locations (and not just ductile couplers within a ductility zone) is therefore wrong. Counsel for the Commission erroneously referred to the actual text of the QSP itself when making that submission.

50. With respect, that approach is flawed and seeks to apply the QSP on an *ultra vires* basis with regard to the BD consultation letters. The correct approach is to first determine if a coupler is subject to a ductility requirement under the BD consultation letters. If a coupler is not subject to a ductility requirement, the QSP is irrelevant and has no application to the coupler (regardless of the text of the QSP).

51. The lower supervision standards referred to in §36(2) above (full time supervision by TCP T1 grade or above supervisor) therefore

[34] [COI-2] Day 17:57(25)-58(22).
[35] NSL Area A is not the subject of COI-1 or COI-2 and no relevant evidence has been received by the Commission with respect to supervision of the installation of couplers in NSL Area A. The Commission is therefore invited not to draw any conclusions regarding supervision in NSL Area A.
[36] See §184 of the Closing Submissions by Counsel for the Commission (COI-1).

applied to the installation of all couplers on the Project (with the exception of NSL Area A as noted above).

52. Leighton complied with these supervision standards because:-

(1) it deployed full-time qualified engineers of TCP T1 grade or above to supervise the rebar fixing. Leighton's construction engineering team consisted of many highly experienced engineers who worked full-time on site and supervised the works by making multiple site visits every day (which included routine and formal inspections); and

(2) either (i) its records either evidence such supervision or (ii) if certain records are not available, other evidence confirms that the necessary supervision occurred.

53. Even if somehow for the sake of argument the higher supervision standards for couplers with a ductility requirement applied to all couplers used in the Project (which is denied), Leighton complied with those standards because:-

(1) it also deployed full-time qualified engineers of TCP T3 grade or above to supervise the rebar fixing; and

(2) the level of supervision provided by these highly experienced engineers satisfied the requirement of "full time continuous" supervision (adopting the meaning noted below for this phrase). These engineers worked full-time on site and supervised the coupler works by making multiple site

visits every day (which included routine and formal inspections).

54. As to the meaning of "full-time continuous" supervision:-[37]

(1) All experts agree that it does not mean man-marking.[38]

(2) Mr Wall's view (which was accepted by Mr Huyghe[39]) is that it does not mean that there is someone watching the rebar fixers carrying out coupler installation 100 per cent of the time.[40] Mr Wall opined that the level of supervision provided by the relevant Leighton engineers was "full time continuous" supervision.[41]

(3) As to the alleged requirement for a minimum ratio of "1 supervisor to no more than 10 workers":-

(a) This requirement must be read in context. It appears in clause G3.9.1 of the General Specification under the section heading of "Healthy and Safety".[42] Clause G3.18.18 refers to the supervisory staff as "Senior Construction Supervisor, Construction Supervisor, General Foreman, Foreman, Supervisor and Ganger".

[37] The Commission has indicated that it will not be bound by its findings in its Interim Report and is open to hearing further submissions on this topic: [COI-1+2] Day 8:69(8)-(15).
[38] See Joint Statement of Project Management Experts at §26 [ERI]. Also see Mr Rowsell [COI-2] Day 18:38(15)-(16), Mr Huyghe [COI-2] Day 16:114(13)-(17) and Mr Wall [COI-2] Day 17:66(5)-(11).
[39] See Mr Huyghe [COI-2] Day 16:114(18)-(21): "it does not mean that there has to be a supervisor who is present 100 per cent of the time when works are being done."
[40] [COI-2] Day 17:18(1)-(6).
[41] Mr Wall's Expert Report §76 [ER(COI2)1/Item 5].
[42] [C3/2000ff at 2040].

(b) Mr Wall opined that there is a clear distinction in the contract between the two different types of supervisor contemplated: those under the umbrella of gangers, foremen etc here under Clause G3.9.1, and those TCP supervisors in respect of coupler connections.[43]

(c) As noted above, the BD consultation letters (being the source of the requirement for the QSP and the provision of "full time continuous" supervision) impose specific obligations for the supervision of the installation of couplers. In particular, the quality control coordinator must be at least a grade T1 or T3 TCP depending on whether the coupler is subject to a ductility requirement (i.e. they are more qualified that the supervisory staff required for clause G3.9.1 of the General Specification). There is also no express requirement for a specific ratio of quality control coordinators to rebar fixing workers. If one was intended, it should have been expressly stated in the BD consultation letters or the QSP (which are separate and distinct instruments to the General Specification).

(d) Having regard to the above, the correct interpretation is that the ratio it is a general requirement for health and safety purposes (in the sense of health and safety on site as opposed to structural safety of the completed structure) and **not quality assurance**. It

[43] [COI-2] Day 17:117(2)-(15).

therefore does not relate to the supervision of coupler works under the BD consultation letters.

(e) In any event, if the alleged supervision ratio did apply to the coupler works, then Leighton satisfied that requirement. This is illustrated by the Summary of Rebar Fixing Workers and Leighton Rebar Supervision prepared by Leighton [44] which confirms the ratio of Leighton's qualified, full-time engineers (who were deployed to supervise the installation of reinforcement) to rebar fixing workers was better than 1:10 in all areas of the Project and at all relevant times.

(f) This requirement would have been further bolstered by the supervision of Gangers and Foremen employed by the relevant subcontractor.

F2. RISC form and inspection procedures

55. The factual evidence confirms that all formal joint inspections for rebar fixing and pre-pour checks at the NAT, SAT and HHS were carried out by MTRCL and Leighton, even if such inspections were not always documented in a RISC form.[45]

[44] See [CC12/7481] and Expert Report of George Wall at §73 [ER(COI2)1].
[45] See Leighton's Closing Submissions on Factual Evidence (COI-2) §3-4; 35-47; 52-71.

56. Whilst the project management experts hold differing views on MTRCL's and Leighton's role in the adoption of the "alternative procedures"[46] to the RISC forms, it is ultimately a question of fact.

57. Leighton maintains its position that MTRCL and Leighton worked on the basis and (in effect) agreed that RISC forms did not need to be submitted prior to formal inspections being completed in order to not hold up the work progress. That is to say, MTRCL varied the RISC form procedure.[47]

58. Mr Rowsell and Mr Huyghe acknowledged that MTRCL continued to carry out inspections in the absence of RISC forms and accepted that MTRCL should have taken action if it wanted the RISC form procedure to be followed.[48]

59. Ultimately, the project management experts agree that the RISC Form procedures required on the Project were time consuming and inefficient [49] (which explains why MTRCL varied the procedure) and made suggestions on how these procedures can be improved.[50]

60. Leighton is continually improving its systems to further enhance their effectiveness. A summary of the steps that Leighton is taking is set out in §§66 to 71 of Leighton's Closing Submissions in Part

[46] This term has been used to describe the approach taken (e.g. use of WhatsApp messages to arrange and record inspections): Joint Statement of Project Management Experts at §19 [ER(COI2)1].
[47] Leighton's Closing Submissions on Factual Evidence (COI-2) at §55.
[48] See Joint Statement of Project Management Experts at §17 [ER(COI2)/1] and Mr Huyghe [COI-2] Day 16:94(23)-95(14).
[49] See Joint Statement of Project Management Experts at §24 [ER(COI2)1].
[50] See Joint Statement of Project Management Experts at §27 [ER(COI2)1].

One of COI 2. The project management experts have encouraged these efforts.[51]

F3. Rebar testing

61. Dr Wells opined that Leighton had complied with the applicable standards for rebar testing. Specifically:-

(1) Dr Wells assessed the adequacy of rebar testing by reference to the relevant quality control standards, including CS2:1995 and CS2:2012 and other national and international standards (e.g. ISO standards), which is necessary for context and clarity on points of detail not addressed in CS2:1995 and CS2:2012: see Dr Wells' COI-2 Report §§3.1-3.2.

(2) ISO 3951-2:2013 allows for a reduced sample size for testing/inspections should consistently good quality be achieved. Dr Wells was satisfied, by reference to the actual rebar testing results for the Project (ALL of which passed), that the condition of "consistently good quality" had been achieved. He went one step further and applied a rigorous statistical analysis to measure the level of confidence with which this condition was met. He concluded that the level of confidence in the untested rebar (i.e. that it would have passed the test criteria specified in CS2:1995 and CS2:2012) is 10 times greater than what is required by those standards: see Dr Wells' COI-2 Report §§3.4-3.9.

[51] See Joint Statement of Project Management Experts at §11 [ER(COI2)1].

(3) Dr Wells also emphasized that the "untested rebar" were not, in fact, untested: they had been tested by the manufacturer. CS2:1995 and CS2:2012 specify that the purchaser's testing is a verification of the manufacturer's tests: see Dr Wells' COI-2 Report §3.11. All the rebar used in the Project passed the manufacturer's tests.[52]

62. The strength reduction factors of 4% and 13% adopted by the Verification Report are simply not credible. The analysis used to calculate these figures assumes that all rebar which was not re-tested should be treated as if it were within the worst 0.05% of all rebar tested by MTRCL's HOKLAS accredited laboratory in the last 9 years across all projects (i.e. not just the Project).[53]

63. In Dr Wells' view, the figures are "an incredibly unlikely worst-case scenario."[54]

64. In addition, the structural engineering experts have not expressed any concern whatsoever about the small percentage of rebar that was not re-tested.

65. The Commission should therefore be satisfied that Leighton has complied with the relevant quality assurance standards with respect to rebar testing on the Project.

66. The Commission should also note that CS2:1995 states that the long-term goal is to reach the situation existing in most other

[52] Karl Speed witness statement §§5-8 [CC11/7287-7288].
[53] Dr Well's COI-2 Report §3.6-3.17.
[54] [Part Two] Day 3/61:12-14.

countries where the national standards do not require purchaser's testing if manufacturer's testing has been completed: see Dr Wells' COI-2 Report §§3.3-3.4.

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