

COMMISSION OF INQUIRY
INTO THE CONSTRUCTION WORKS
AT AND NEAR THE HUNG HOM STATION EXTENSION
UNDER THE SHATIN TO CENTRAL LINK PROJECT
(“the SCL Project”)
(“THE COMMISSION”)

(formerly COMMISSION OF INQUIRY INTO THE DIAPHRAGM WALL AND
PLATFORM SLAB CONSTRUCTION WORKS AT THE HUNG HOM STATION
EXTENSION UNDER THE SHATIN TO CENTRAL LINK PROJECT)

CLOSING ADDRESS FOR THE EXTENDED INQUIRY [COI 2]
BY COUNSEL FOR THE COMMISSION

**(in respect of the Substantive Hearings for Statistical Expert Evidence,
Project Management Expert Evidence and Structural Engineering Expert
Evidence commencing on 23 September 2019, 4 October 2019 and 2
January 2020 respectively)**

References below to, for example, [ER(COI 2)1/Tab 1] are references to the bundle number/tab number of the documents prepared for the Substantive Hearings, references to, for example, [AA1/1] are references to the bundle number/page number of the documents and references to, for example, [T6/84:9-15] are references to the Transcript Day 6/page 84 at lines 9 to 15.

A. INTRODUCTION

1. These Submissions follow on from the Commission’s legal team’s written Closing Address for the Extended Inquiry dated 26 July 2019. Those earlier submissions dealt with the factual evidence called in the Extended Inquiry (or COI 2), between 28 May 2019 and 17 June 2019,

during which period 33 factual witnesses were called.

2. These Submissions consider the further evidence heard by the Commission not only following on from the factual evidence but also following the submission by MTRCL of the Verification Report dated 18 July 2019, namely the Project Management Expert Evidence, Statistical Expert Evidence and further Structural Engineering Expert Evidence adduced and called in respect of the COI 2 issues.

3. For the avoidance of any doubt, however, §§3 to 9 of the Commission’s legal team’s Closing Submissions in respect of COI 1 under the headings ‘*Safety, fitness for purpose, execution in accordance with the Contract and code compliance*’, ‘*Requests to the Involved Parties*’ and ‘*The Extensive Investigation of the Structures*’ are equally relevant to the COI 2 issues and are repeated. A list of the structural engineering expert reports and other structural engineering reports/ assessments specific to COI 2 is appended below:

(A) Structural Engineering Expert Reports

1.	Professor Don McQuillan President of the Institution of Structural Engineers Director of RPS Consulting Engineers		
	(i) Expert Report (COI 2)	06.12.2019	ER(COI2)1/#11
2.	Dr James Lau Managing Director and Chairman of James Lau & Associates Limited		
	(i) COI Structural Engineering Expert Report	10.12.2019	ER(COI2)1/#13
3.	Dr Mike Glover Arup Fellow (ARUP)		
	(i) Extended Inquiry Structural Engineering Expert Report	06.12.2019	ER(COI2)1/#12

4. Mr Nick Southward Executive Director of Tony Gee & Partners LLP Managing Director of Tony Gee (Asia) Ltd		
(i) Structural Engineering Expert Report (COI 2)	18.10.2019	ER(COI2)1/#10

(B) Other Structural Engineering Reports/Assessments

1. Siu Yin Wai & Associates Ltd (“SYW”)			
<p>Commissioned by MTRCL to consolidate all available construction records to form a set of objective evidence of the as-constructed works and the verification of the as-constructed conditions of the structures for NAT, SAT and HHS, focussing on the identification and scrutiny of four main aspects, viz. (1) site supervision records, (2) material testing records, (3) design changes, and (4) quality assurance records. Findings of each part of the aforesaid study and assessment / recommendations by SYW are set out in SYW’s Part 1 Study Report (referred to in item (i) below)</p> <p>Also commissioned by MTRCL to carry out the following tasks: (1) checking of the design calculations for the NAT & SAT structures and (ii) visual inspection of the structures in particular where coupler installations are identified during the verification study (carried out during the preparation of the above Part 1 Study Report). Findings of the overall structural assessment of SYW are set out in SYW’s Part 2A Study Report (referred to in item (ii) below)</p>			
(i)	Part 1 Study Report - Verification of As-constructed SCL, HUH Station NAT, SAT and HHS Structures	24.05.2019	BB19/12114-BB20/12527
(a)	Appendix A	Summary of Information Boxes for NAT, SAT & HHS	BB19/12132-12172
(b)	Appendix B	Summary of Review Findings on Material Testing Records for NAT, SAT & HHS	BB19/12173-12206
(c)	Appendix C	Location of Couplers used against accepted plans for NAT, SAT & HHS	BB19/12207-12231
(d)	Appendix D1	Summary of Findings for Verification of As-Constructed Conditions of NAT	BB19/12232-12320
(e)	Appendix D2	Summary of Findings for Verification of As-Constructed Conditions of SAT	BB20/12321-12374
(f)	Appendix D3	Summary of Findings for Verification of As-Constructed Conditions of HHS (Accommodation Blocks)	BB20/12375-12427
(g)	Appendix D4	Summary of Findings for Verification of As-Constructed Conditions of HHS (Trackslabs, Troughwalls and Underpasses)	BB20/12428-12510
(h)	Appendix D5	Summary of Findings for Verification of As-Constructed Conditions of HHS (North Fan Area)	BB20/12511-12527
(ii)	Part 2A Study Report - Verification of As-constructed SCL, HUH Station	14.06.2019	BB20/12528

	NAT, SAT and HHS Structures		-12652
2. Atkins			
<p>On 19.07.2019, Atkins prepared a report setting out its findings upon review of the previous design submissions (namely the “Base Case”) for NAT & SAT tunnels, the reinforced concrete structures for EWL, NSL and also Shunt Neck for access to the stabling sidings (referred to in (i) below) (“Atkins Study Report”). This report also examines rebar utilizations as set out in previous submissions to Buildings Department (BD) as a first stage, and reassesses the “updated design” based on newly updated assumptions and approach to reflect information available with completion of the construction.</p> <p>On 27.09.2019, Atkins made an amendment submission for, inter alia, primary structures in SAT which incorporates the findings and assumptions set out in Atkins Study Report (referred to in (ii) below).</p>			
(i)	Atkins Detailed Design for Hung Hom Station and Associates Tunnels NAT and SAT Revised Structural Assessment	19.07.2019	BB19/11611-12112
(ii)	Atkins BD (Buildings Department) Consultation Document HUH-1 - HUH Station Primary Structure and Excavation & Lateral Support Part 1 to 4: SAT, Area A and HK Coliseum (Rev AN) [Volume 1]	27.09.2019	AA2/490-754
3. AECOM			
<p>Commissioned by MTRCL to conduct a structural review for utilization of the following structural elements of HHS: (a) rebars with couplers in use at different locations in HHS, (b) shear capacity for the structural elements with single leg shear links at different locations in HHS, and (c) reinforced concrete structures at different locations in HHS constructed after September 2016. Findings of AECOM are set out in its draft report (referred to in (i) below) (“Draft AECOM Review Report”).</p> <p>Following the issuance of the Draft AECOM Review Report and the publication of the Verification Report, AECOM made an amendment submission in respect of the criteria for the trough wall, on-grade slab and underpass corridor design in the HHS development (referred to in (ii) below).</p>			
(i)	Draft AECOM Review Report for the Utilization of the Hung Hom Stabling Sidings Structures Rev 0	28.06.2019	BB17/10097-10943
(ii)	AECOM BD (Buildings Department) Submission B3.13A1 - Structural A&A Works - Package 8 - Track Slabs + Underpass Corridor - Calculation Rev F Volume 1 of 2	30.08.2019	DD18/18484-18732
4. ARUP			
<p>Appointed by MTRCL in April 2019 to conduct an independent assessment and review under Stage 2 of the Verification Proposal [BB18/10947/§1.2], i.e. to conduct structural review and devise schematic remedial works and long-term monitoring scheme of structural performance for the as-constructed NAT, SAT and HHS structures, where and to the extent if necessary, and the following report is prepared by ARUP accordingly:</p>			
(i)	ARUP Report - Holistic Study to Verify As-constructed Condition of NAT, SAT & HHS (Volume 1 - Final Independent Report on Findings)(Rev. B)	08.07.2019	BB18/10944-11299

	(ii)	ARUP Report - Holistic Study to Verify As-constructed Condition of NAT, SAT & HHS (Volume 2 - Drawings)(Rev. A)	08.07.2019	BB18/11300-11610
5. EIC Activities PTY Ltd (“EIC”)				
Commissioned by Leighton and produced the following reports:				
	(i)	EIC Memorandum entitled “Hung Hom Station - EIC Response to MTR Final Verification Study Report for NAT, SAT and HHS”	23.08.2019	CC12/7296-7297
	(ii)	EIC Memorandum on “Design Principles” - review of the design principles and code requirements applicable to the capacity assessment adopted in the Stage 3 Assessment of the Verification Proposal	23.08.2019	CC12/7299-7365
	(iii)	EIC Memorandum on “EIC Response to MTR Holistic Assessment - Couplers” setting out EIC’s review of the “suitable measures” proposed for coupler connections in EWL in Area A and HHS. <u>Conclusion of EIC:</u> “Based on the assessment undertaken by EIC it appears no strengthening is required for Area A couplers and a substantial reduction is possible in the HHS location.” [CC12/7373]	29.08.2019	CC12/7367-7374
	(iv)	EIC’s “Response to MTRC Recommended Suitable Measures - Shear”	30.08.2019	CC12/7376-7479
	(v)	EIC’s Review of the Stage 3 Assessment Reports conducted by Atkins, Arup and AECOM	23.09.2019	CC12/7833-7842
	(vi)	EIC Memorandum entitled “Hung Hom Station - EIC Response to MTR Proposed Suitable Measures Shear - SAT Area”	11.10.2019	CC12/7846-7864
	(vii)	EIC Memorandum entitled “Hung Hom Station - EIC Review of Suitable Measures Proposed for Southern Approach Tunnel (SAT)”	24.10.2019	CC12/7868-7878
6. Professor Stephen Foster Professor and Head, School of Civil and Environmental Engineering - The University of New South Wales, Sydney, Australia				
	(i)	Report on “Mechanisms relating to shear strength of reinforced concrete thick one-way slabs in relation to Hung Hom Station, and the influence of reduced anchorage of shear reinforcement” produced as Appendix D to EIC’s “Response to MTRC Recommended Suitable Measures - Shear”	02.09.2019	CC12/7455-7478

4. As a general observation, it is to be noted that only limited intrusive opening up was carried out in the geographical areas with which COI 2 is concerned. Reliance is largely placed on extrapolating test results from the COI 1 investigations.

B. PROJECT MANAGEMENT

B1. Expanded ToR

5. The Expanded ToR [**AA1/1**] provides that:

“Regarding the MTR Corporation Limited (‘MTRCL’)’s Contract No. 1112 (‘Contract’) of the Shatin to Central Link Project:-

(a) ...

(2) in respect of the construction works at the North Approach Tunnels, the South Approach Tunnels and the Hung Hom Stabling Sidings,

...

(b) to review, in the light of (a) above,

(i) the adequacy of the relevant aspects of MTRCL’s project management and supervision system, quality assurance and quality control system, risk management system, site supervision and control system and processes, system on reporting to Government, system and processes for communication internally and with various stakeholders, and any other related systems, processes and practices and the implementation thereof; and

(ii) *the extent and adequacy of the monitoring and control mechanisms of **the Government**, and the implementation thereof; and*

(c) *in the light of (b) above, to make recommendations on suitable measures with a view to promoting public safety and assurance on quality of works.*” [emphasis added]

6. In the Extended Inquiry, the focus of project management issues is on sub-paragraph (a)(2) of the Expanded ToR (i.e. in respect of the construction works at the NAT, SAT and HHS areas).

B2. PM Experts

7. To assist it in its consideration of sub-paragraphs (b) and (c) of the Expanded ToR, the Commission re-appointed Mr Steve Rowsell (“**Mr Rowsell**”) as its independent project management expert¹.

8. MTRCL also re-appointed its independent project management expert namely Mr Steve Huyghe (“**Mr Huyghe**”) ².

9. Leighton appointed Mr George Wall (“**Mr Wall**”) as its independent

¹ Mr Rowsell’s expert report dated 23 August 2019 is at **ER(CO12)1/Tab 1.0**. His oral synopsis is at **ER(CO12)1/Tab 1.1**. He gave oral evidence to the Commission on 10 October 2019 [**CO12/T18/1-147**]. He was questioned by Leighton, PyPun, the Government and MTRCL.

² Mr Huyghe’s expert report dated 21 September 2019 is at **ER(CO12)1/Tabs 6, and 6.1 to 6.2**. His supplemental report dated 30 September 2019 is at **ER(CO12)1/Tab 6.3**. His oral synopsis is at **ER(CO12)1/Tab 6.4**. He also gave oral evidence to the Commission on 4 October 2019 [**CO12/T16/25-126**]. He was questioned by the Commission, Leighton and the Government.

project management expert³. Mr. Wall had not been called at the Original Inquiry hearing. The observations made about Mr Wall in §24 of MTRCL’s Closing Submissions are noted. It is accepted that factually the observations are accurate. It is submitted, however, that in the COI 2 PM Joint Statement referred to below and during the course of cross-examination, Mr Wall displayed a sufficient degree of independence from Leighton to dispel any perception of partisanship. Furthermore, whilst the observations made by MTRCL might have more direct relevance if there was a significant gulf in opinion between Mr Wall on the one hand and the other experts on the other, the reality is that, on analysis, there is not much between them. Indeed, it is submitted that the Commission will be better served by taking the positives from Mr Wall’s evidence rather than any perceived negatives.

10. As reflected in the “*Joint Statement of Project Management Experts*” dated 2 October 2019 [ER(COI2)1/Tab 9] (“**the COI2 PM Joint Statement**”) there is a considerable degree of common ground and consensus between Mr Rowsell, Mr Huyghe and Mr Wall in respect of the principal project management issues.
11. The COI2 PM Joint Statement was produced, following the exchange of expert reports, after an experts’ meeting held in London on 3 September 2019⁴.

B3. Directions

³ Mr Wall’s expert report dated 20 September 2019 is at ER(COI2)1/Tab 5. His oral synopsis is at ER(COI2)1/Tab 5.1. He gave oral evidence to the Commission on 8 October 2019 [COI2/T17/12-149]. He was questioned by the Commission, MTRCL and the Government.

⁴ §1 of the COI2 PM Joint Statement [ER(COI2)1/Tab 9]

12. By a letter dated 7 August 2019 from Messrs O'Melveny⁵, Leighton applied to adduce a number of expert reports including an expert report on project management issues by Mr Wall.
13. On 9 August 2019, Leighton was directed by the Commission to identify the areas and issues intended to be covered by Mr Wall⁶.
14. On 16 August 2019, Leighton responded and produced a statement setting out the precise issues proposed to be addressed by Mr Wall and provided his CV⁷.
15. DoJ acting for the Government and Messrs Mayer Brown acting for MTRCL respectively both made written submissions on Leighton's application⁸.
16. The Commission duly considered Leighton's application and its List of Issues, and also the submissions received from DoJ and Messrs Mayer Brown. Given that an expert report by Mr Rowsell (appointed by the Commission) would be made available to the parties on Monday, 26 August 2019, the Commission made the following directions in relation to expert evidence on project management issues on 21 August 2019⁹:
 - (1) Leighton's application to adduce project management expert evidence on matters as set out in its List of Issues was refused.

⁵ [AA1/199-201]

⁶ [AA1/232]

⁷ [AA1/238, 243-244]

⁸ [AA1/252],[AA1/254-258],[AA1/259]

⁹ [AA1/261]

- (2) Any party (including Leighton) seeking to rely on expert evidence on project management issues in response to Mr Rowsell's expert report shall submit a responsive expert report to the Commission's solicitors by Friday, 13 September 2019.
 - (3) The expert report to be adduced by any party pursuant to paragraph 2 must be responsive to Mr Rowsell's report and shall be on project management issues strictly within the Expanded Terms of Reference.
 - (4) No further expert report on project management may be adduced without the leave of the Commission.
17. Following on from those directions, Mr. Rowsell's Report was made available to the Involved Parties on 23 August 2019 (a few days earlier than expected). On 20 September 2019, the Expert Report of Mr. Wall was submitted and on 21 September 2019, the Expert Report of Mr. Huyghe was submitted. Thereafter, on 24 September 2019¹⁰, and in the light of certain of the content of Mr. Wall's Expert Report, leave was given to MTRCL to adduce a supplemental expert report of Mr Huyghe in relation to how Leighton's PM procedures and performance may have caused or contributed to the work which is the subject-matter of the Extended Inquiry being executed other than "*in accordance with the Contract*" ("**Mr Huyghe's Report 2**").

B4. Mr Wall's Disagreements

¹⁰ [AA1/397-399]

18. Given the measure of agreement between the project management experts (“**PM Experts**”), a detailed analysis of their respective reports is neither necessary nor appropriate¹¹. Rather, the observations and submissions made below focus on the COI2 PM Joint Statement as supplemented by the PM experts’ oral evidence. As will be demonstrated below, although Mr Wall initially expressed a number of disagreements with his fellow experts, he clarified them during the course of cross-examination, with the result that there are no longer, it is submitted, any fundamental differences between the PM Experts.
19. As stated in §47 of the COI2 PM Joint Statement¹², initially Mr Wall did not agree with the joint opinions of Mr Rowsell and Mr Huyghe in §§4, 16, 17 and 26c of the COI2 PM Joint Statement.
20. Paragraph 4 of the COI2 PM Joint Statement states that “*Mr. Rowsell has reviewed Mr. Huyghe’s Report 2 and has taken it into consideration with regards to Joint Statement*”. Mr Wall’s disagreement appears to be that stated in paragraph 5, namely he disagrees that Mr Huyghe’s Report 2 should be considered. It is respectfully submitted that as leave was given to submit Mr Huyghe’s Report 2, there is no good reason why it should not be considered.
21. Under cross examination, Mr Wall clarified that he only disagreed with the sentence “.....and MTRCL continually requested that the RISC forms be provided.....” in §16 of the COI2 PM Joint Statement¹³.

¹¹ This approach aligns with that adopted by MTRCL (see §22 of MTRCL’s Closing Submissions for COI 2).

¹² [ER(COI 2)1/Tab 9]

¹³ [COI2/T17/50:21-51:3]

22. He then conceded that he agreed with the proposition that MTRCL had continually verbally requested that the RISC forms be provided by Leighton¹⁴.
23. Mr Wall also agreed that the RISC form process depicted by Mr Huyghe¹⁵ had actually been carried out¹⁶.
24. In his oral evidence, Mr Wall elaborated on his disagreement in respect of §17 of the COI2 PM Joint Statement. This concerned the steps to be taken to address the non-receipt of RISC forms. Mr Wall's view was that there was an adequate process in place such that there was no need to have a group discussion about alternative arrangements as suggested by Mr Rowsell and Mr Hyughe¹⁷. He suggested that an NCR could have been issued by MTRCL. Refusing to turn up at the inspection and enforcing the procedure would be the other options¹⁸.
25. Nevertheless, Mr Wall considered Mr Rowsell's and Mr Huyghe's methodology as stated in §17 of the COI2 PM Joint Statement was a reasonable one and was collateral to his suggested approach, though it was his personal view that it need not be adopted¹⁹.
26. In relation to Mr Wall's disagreement on paragraph 26(c) of the COI2 PM Joint Statement, he explained that it was his opinion that a method statement was required for the stitch joint interface but it was not

¹⁴ [COI2/T17/82:2-19]

¹⁵ Slide 6 of ER(COI2)1/Tab 6.4

¹⁶ [COI2/T17/83:12-84:7]

¹⁷ [COI2/T17/52:18-24]

¹⁸ [COI2/T17/52:25-53:9]

¹⁹ [COI2/T17/54:1-12]

necessarily required to be in a separate document²⁰. However, Mr Wall agreed that a specific stitch joint method statement would be helpful and beneficial²¹.

27. In the submissions below, the PM Experts' views will be summarised and grouped into the following topics:-

- (1) PMP and PIMs;
- (2) RISC Form and Inspection Procedures;
- (3) Interface risks;
- (4) Testing of Reinforcement; and
- (5) Mr Rowsell's Recommendations.

B5. PMP and PIMS

28. The PM Experts note that Leighton has indicated in its evidence that it is continually improving its systems to further enhance their effectiveness²².

29. They consider that it would be desirable for the standard content of the PMPs to cover additional project management aspects at a strategic level by²³:-

²⁰ [COI2/T17/34:12-23]

²¹ [COI2/T17/35:7-12]

²² §11 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]

²³ §13 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]

- (1) The inclusion of a section on resource planning and monitoring.
- (2) Training and development arrangements for project specific purposes.
- (3) The development of project communication strategies.
- (4) Coverage of interface risk planning and management.
- (5) A stronger focus on the role of senior leaders in establishing appropriate culture and behaviours.

B6. RISC Form and Inspection Procedures

30. The PM Experts agree that the RISC form procedures are set out in a range of documents including the 1112 Contract, the general specification, the particular specification, various PIMs documents and the PMP²⁴.
31. They suggest that training with regards to providing a more user-friendly RISC process procedure is strengthened to address the responsibilities of both MTRCL and Leighton. It is important that RISC form procedures are followed by the contractor and insisted upon by the Engineer²⁵.
32. The PM Experts agree that PIMs procedures do recognise that there may be a need for flexibility, and they set out a requirement that there will be a

²⁴ §15 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]

²⁵ §18 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]

cooperative approach when procedural problems arise. MTRCL did not insist on the minimum 3-day notice period for inspections even though they could have insisted upon it. They agree, however, that this notice period was not critical because MTRCL and Leighton staff were present on site and carried out on-going supervision. However, for quality assurance purposes, the degree of cooperation shared between MTRCL and Leighton should not have been extended to conducting inspections and allowing work to proceed without Leighton's submission of RISC forms²⁶.

33. The PM Experts consider the RISC form procedures should be improved by better use of technology solutions of the kind which Dr Peter Ewen has explained²⁷.
34. The PM Experts identified the likely contributory causes for the defects in the rebar fixing at the stitch joints in the NAT and they suggest improvements to address the project management issues²⁸:
 - (1) Investigate and introduce new technology-based RISC Form procedures which can be implemented by site staff more efficiently than the current procedures through the use of portable technology devices.
 - (2) Review its training strategies and plans to ensure that staff are provided with the necessary training required to perform their roles

²⁶ §21 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]

²⁷ §24 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]; see also §§45-72 of Dr Peter Ewen's witness statement [BB8/5164-5172].

²⁸ §26 and 27 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]

effectively. Training systems should be used to verify that individuals have the required skills, competences and experience to perform allocated roles and duties.

- (3) Review responsibilities for ensuring that procedural non-compliances by Leighton are addressed promptly to remedy the position in accordance with the provisions of the contract and that there are effective problem escalation procedures to allow senior management to intervene when necessary.
 - (4) Review its arrangements for future projects to ensure site staff are provided with the latest working drawings and to ensure that all staff have ready access to them to support reliable surveillance and inspection of the works.
 - (5) Review the preparation of ITPs (inspection and test plans) to ensure that inspection proposals can be carried out effectively. Ensure that ITPs are reviewed and assured by people with adequate site experience.
 - (6) Review its lessons learnt procedures as incorporated in the PIMs manuals to ensure that when significant defects in the works or procedures are identified, there is always a proper and prompt investigation into the cause of problems.
35. The PM Experts also express the view that MTRCL should have considered alternative ways to address the issue of Leighton not following RISC form procedures, including meetings to discuss

alternative procedures and possibly issuing a NCR²⁹. In this regard, the PM Experts also suggest that MTRCL might introduce different grades of NCR (minor, medium and major non-conformances) requiring different responses as appropriate³⁰.

B7. Interface risks

36. The PM experts agree that interfaces between contracts are generally high risk areas for both MTRCL and Leighton and this should be recorded in project risk registers and receive close management focus³¹.

37. However, there was miscommunication between the Leighton staff who attended the interface meetings, and not all members of Leighton's and MTRCL's inspection teams received technical training in the installation requirements of the different types of couplers used at the interface joints³².

38. The PM experts agree that training will help prepare those involved in the construction process and operations to ensure the contractors and inspectors are aware of the risks and give them a clear understanding of how to resolve any potential difficulties³³.

B8. Testing of Reinforcement

39. The PM Experts suggest that MTRCL, in relation to its role in overseeing

²⁹ §28 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]

³⁰ §29 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]

³¹ §30 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]

³² §34 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]

³³ §35 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]

the implementation of steel testing by Leighton, consider the following³⁴:-

- (1) Use audit arrangements to provide assurance that MTRCL is confident that all material delivered to site is tested by the Leighton before being incorporated into the works.
- (2) Review the specification requirements for identifying steel awaiting test results and ensuring that it is segregated and not used in the works before test results are available.

B9. Mr Rowsell's Recommendations

40. The PM Experts agree with the recommendations for improving procedures suggested by Mr Rowsell (which are not repeated herein)³⁵.

C. STATISTICAL EXPERT EVIDENCE

C1. Directions

41. By a letter dated 7 August 2019 from Messrs O'Melveny [AA1/199-228], Leighton sought to adduce expert evidence from a statistician, Dr Barrie Wells ("**Dr Wells**") on rebar testing and coupler engagement/connections.
42. Having considered the Verification Report, the Commission concluded that it would be appropriate to explore certain aspects of its content to

³⁴ §42 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]

³⁵ §43 of the COI2 PM Joint Statement at [ER(COI2)1/Tab 9]; §§130 to 169 of Mr Rowell's expert report [ER(COI2)1/Tab 1.0]

better understand the conclusions reached and, in particular, the underlying justifications for the intention to carry out what are described as “*suitable measures*” to some of the structures.

43. The Commission made directions on 25 August 2019 [AA1/266-269] for statistical expert evidence to be heard between 23 and 27 September 2019³⁶.
44. Leave was given for Leighton to adduce an expert report of a statistician, Dr Wells, on the topics and matters stated in its solicitors' letters dated 7 August 2019³⁷ and 16 August 2019³⁸ and any other matters directly concerning the Verification Report.
45. MTRCL was directed to provide a report or reports by the statistician(s) responsible for carrying out the statistical analysis used in the Verification Report, explaining and justifying each analysis and, in particular, explaining and justifying the use of the analyses in the determination of the various reduction factors used in the Verification Report.
46. Leave was given to the Government to produce a report from a statistical expert concerning matters set out in the Verification Report.

C2. Statistical Experts

³⁶ Similar directions were also made in relation to the Holistic Report [OU6/3921-23].

³⁷ [AA1/199-228]

³⁸ [AA1/236-238] and list of issues of statistical expert evidence can be found at [AA1/239]

47. Leighton appointed Dr Wells as their statistical expert³⁹.
48. The Government appointed Professor Yin Guosheng (“**Professor Yin**”) as their statistical expert⁴⁰.
49. MTRCL produced a “*Report on Statistical Analysis in relation to the Final Verification Study Report on As-constructed Conditions of the North Approach Tunnels, South Approach Tunnels and Hung Hom Stabling Sidings*” dated 13 September 2019⁴¹. Whilst anonymous on its face, it transpired that this report was prepared by MTRCL’s project team, which includes Mr Neil Ng⁴² and Mr Nelson Yeung⁴³ who provided witness statements and gave evidence at the hearing.

C3. Coupler Connection Reduction Factor

50. There was no opening-up exercise carried out in relation to coupler connections at the NAT, SAT or HHS⁴⁴.
51. Paragraph 4.2.6 of the Verification Report [BB16/9976] states that, due to the lack of full records of the coupler connection works, a strength reduction factor of 35% has been adopted in respect of these areas.

³⁹ Mr Wells’ expert report dated 13 September 2019 is at **ER(COI2)1/Tab 2**, with Annexure A at **ER(COI2)1/Tab 2.2**. His oral synopsis is at **ER(COI2)1/Tab 2.1**. He also gave oral evidence via video link to the Commission on 25 and 26 September 2019 [**Combined/T3/35-88 & Combined T4/1-152**]. He was questioned by the Government and MTRCL.

⁴⁰ Professor Yin’s expert report dated 16 September 2019 is at **ER(COI2)1/Tab 4**. His responses to Mr Wells’ report (aide-memoire) are at **ER(COI2)1/Tab 4.1**. His oral synopsis is at **ER(COI2)1/Tab 4.2**. He also gave oral evidence via video link to the Commission on 27 September 2019 [**Combined/T5/3:23-157**]. He was questioned by the Government and the Commission.

⁴¹ **ER(COI 2)1/Tab 3**

⁴² Mr Neil Ng’s witness statement can be found at [**BB16/10082-10089**]

⁴³ Mr Nelson Yeung’s witness statement can be found at [**BB16/10090-10092**]

⁴⁴ **ER(COI2)1/Tab 4/§ 5.1**

52. It was revealed in MTRCL's "*Report on Statistical Analysis in relation to the Final Verification Study Report on As-constructed Conditions of the North Approach Tunnels, South Approach Tunnels and Hung Hom Stabling Sidings*" that it was the Task Force Group which made such a decision⁴⁵.
53. The Task Force Group consisted of Government representatives, the Expert Adviser Team, the Hong Kong Police Force and representatives of MTRCL⁴⁶.
54. The Task Force Group considered that it was appropriate to do so because:-
- (1) Options alternative to destructive investigation were to be preferred;
 - (2) The NSL slab of the SAT is a continuation of the NSL slab at the HUH. Under the statistical analysis carried out in the Holistic Report, the reduction factor for the NSL slab was 33.2%. The Task Force Group took 33.2% as a starting point and adopted 35% to give a greater, sufficient level of confidence;
 - (3) The coupler connection works and the site conditions in other areas of the NAT, SAT and HHS were less complicated than the NSL slab of SAT in terms of their construction. A reduction factor of 35% would be appropriate; and

⁴⁵ ER(COI 2)1/Tab 3/§§6-9

⁴⁶ [Combined/T2/19:24-20:2]

- (4) Extrapolating the results from the HUH to NAT, SAT and HHS would meet the timetable set by the Commission and enable an early agreement to be reached between the Government and MTRCL on the suitable measures required⁴⁷.
55. It therefore appears that MTRCL/Task Force Group's suggested extrapolation was one based more on pragmatism rather than evidence demonstrating any necessary correlation of the defective rate at the two areas (i.e. the EWL and NSL slabs at HUH vs the NAT, SAT and HHS).
56. Professor Yin considered that the decision to adopt the auxiliary information from nearby areas under the same contract was primarily an engineering or management decision, and there was no statistical consideration involved. He was not consulted by the Government on such non-statistical decision⁴⁸.
57. In essence, Professor Yin did not give any direct statistical opinion in relation to the reduction factor of 35% adopted for the NAT, SAT or HHS⁴⁹.
58. On the other hand, Dr Wells suggested that the reduction faction should be 9.4%⁵⁰ based the combined EWL and NSL reduction factors as recommended in his report under the Original Inquiry. Necessarily, however, this suggested 9.4% reduction factor is also based on

⁴⁷ ER(CO12)1/Tab 3/§§6-9

⁴⁸ ER(CO12)1/Tab 4/§5.1

⁴⁹ ER(CO12)1/Tab 4/§5.1

⁵⁰ ER(CO12)1/Tab 2/§4.5; see also ER(CO11)1/Tab 10/§§3.4 and 4.31

extrapolation.

59. Given the above, it is, first of all, important to consider whether, as a matter of principle, it is reasonable to extrapolate statistical data of the EWL and NSL slabs to the NAT, SAT and HHS.
60. In this regard, as mentioned, Professor Yin explained that whether the analysis can be extrapolated to elsewhere is primarily a “*common sense*” or “*engineering*” matter, rather than a statistical matter⁵¹ (although Professor Yin’s evidence was given in respect of the extrapolation of the capping beam coupler connection results to Area A, it is submitted that it is reasonable to apply the same logic in respect of the extrapolation of the general coupler connection results to the NAT, SAT and HHS).
61. Evidence adduced at the Original and Extended Inquiries shows that:-
 - (1) Different areas were completed at different times. EWL Slab rebar fixing works were carried out between 5 May 2015 and 11 August 2016⁵², NSL Slab rebar fixing works were carried out between 21 December 2015 and 26 May 2016⁵³. NAT rebar fixing works were carried out between 13 January 2016 and 27 May 2018⁵⁴. SAT rebar fixing works were carried out between 19 November 2015 and 23 February 2017⁵⁵. HHS rebar fixing works were carried out between 1 December 2014 and 8 July 2017⁵⁶;

⁵¹ [Combined T5/28:4-7]; [Combined T5/142:4-146:18]

⁵² [B5/2902]

⁵³ [B5/2905]

⁵⁴ [BB9/6363]

⁵⁵ [BB13/8816]

⁵⁶ [BB16/9781-9794]

- (2) They involved different steel fixing sub-contractors. EWL Slab, NSL Slab and SAT rebar fixing works were carried out by Fang Sheung⁵⁷. NAT and HHS rebar fixing works were carried out by Wing & Kwong⁵⁸;
 - (3) While there were allegations of and evidence showing rebar cutting at some areas at HUH, the same cannot be said in respect of NAT, SAT and HHS; and
 - (4) As appears to be generally accepted, the coupler connection works and the site conditions in most areas of NAT, SAT and HHS were less complicated than the NSL slab of SAT and generally the EWL and NSL slabs at HUH, in terms of their construction.
62. In such circumstances, it is submitted that there is little or no justification to extrapolate the statistical analysis of the EWL and NSL slabs at the HUH to the NAT, SAT and HHS. Whilst the motivation of the Task Force in adopting the extrapolation approach is not questioned, it is submitted that it was a fundamentally flawed decision.
63. Consequently, the Commission cannot rely on the same to conclude that 35% reduction factor should apply to the assessments on the NAT, SAT and HHS structures.
64. An additional reason that the Commission cannot adopt the 35%

⁵⁷ [B1/15]

⁵⁸ [EE1/60/§8]

reduction factor is that it was derived from certain “*acceptance criteria*”, which it is respectfully submitted are not justified (see Section C3.1 of our Closing Address for the Original Inquiry).

C4. Untested Rebars

65. The statistical experts also commented on the issue of untested rebars. However, it appears that nothing turns on this.

D. STRUCTURAL EXPERT EVIDENCE

D1. Suitable Measures

66. Atkins is the detailed design consultant in respect of the NAT and SAT structures and a small portion of the HHS structures. AECOM Asia Company Limited (“**AECOM**”) is the detailed design consultant in respect of the HHS structures.

67. According to the Verification Report, MTRCL had engaged Atkins, AECOM, Siu Yin Wai & Associates Limited (“**SYW**”) and Arup to assist in the verification study for the NAT, SAT and HHS structures⁵⁹.

68. First of all, as mentioned in Section C3 above, the 35% reduction factor was (unjustifiably) applied to coupler connections in the NAT, SAT and HHS structures.

69. In the structural review, suitable measures were only required at HHS

⁵⁹ §1.6 of the Verification Report [BB16/9960-9961]

trough walls since the spare structural capacity at critical coupler locations of the HHS trough wall kickers near movement joints of a total length of about 150m was concluded to be less than the assumed strength reduction factor of 35%⁶⁰.

70. Secondly, due to the missing rebar testing records i.e. untested rebar, strength reduction factors of 4% and 13% were adopted by MTRCL for rebar of a diameter of 16 mm or above and rebar of a diameter of 12 mm and below respectively, by taking into account the percentage of failed samples in the past 9 years recorded in MTRCL's HOKLAS accredited laboratory⁶¹.
71. These 4% and 13% reduction factors were used in the shear capacity review of the NAT, SAT and HHS structures. It is now known, however, that in the shear capacity review, all as-constructed shear links were disregarded.
72. After the shear capacity review, only the NSL tunnel box at the SAT allegedly required suitable measures to be implemented to enhance shear strength⁶².

D2. Structural Engineering Experts

73. The Commission re-appointed Professor Don McQuillan (“**Professor**

⁶⁰ §4.5.2 of the Verification Report [BB16/9978]

⁶¹ §4.3.2 of the Verification Report [BB16/9977]

⁶² §4.5.4 of the Verification Report [BB16/9978]

McQuillan”) as its structural expert⁶³.

74. The Government appointed Dr James Lau (“**Dr Lau**”) as their independent structural expert⁶⁴.
75. MTRCL re-appointed Dr Mike Glover (“**Dr Glover**”) as their independent structural expert⁶⁵.
76. Leighton re-appointed Mr Nick Southward (“**Mr Southward**”) as their independent structural expert⁶⁶.
77. The structural engineering experts signed a memorandum of agreement/disagreement dated 20 December 2019 [**ER(COI2)1/Tab 14.1-14.3**].
78. They also signed a ‘Supplemental Memorandum of Agreement’ on 30 December 2019 [**ER(COI2)1/Tab 15.1-15.2**].

D3. Directions

79. By a letter dated 7 August 2019 from Messrs O’Melveny to Messrs Lo & Lo [**AA1/199-201**], Leighton sought leave to adduce structural

⁶³ Professor McQuillan’s expert report dated 6 December 2019 is at **ER(COI2)1/Tab 11**. His oral synopsis is at **ER(COI2)1/Tab 11.2**. He gave oral evidence to the Commission on 8 and 9 January 2020 [**Combined/T11/126 to T12/52**]. He was questioned by the Government, Leighton and MTRCL.

⁶⁴ Dr Lau’s expert report dated 12 December 2019 is at **ER(COI2)1/Tab 13.1-13.3**. His oral synopsis is at **ER(COI2)1/Tab 13.4**. He also gave oral evidence to the Commission on 5, 6 and 7 January 2020 [**Combined/T8/96 to T10/53**]. He was questioned by the Commission, Leighton and MTRCL.

⁶⁵ Dr Glover’s expert report dated 6 December 2019 is at **ER(COI2)1/Tab 12**. His oral synopsis is at **ER(COI2)1/Tab 12.2**. He also gave oral evidence to the Commission on 7 and 8 January 2020 [**Combined/T10/53 to T11/126**]. He was questioned by the Commission, Government and Leighton.

⁶⁶ Mr Southward’s expert report dated 18 October 2019 is at **ER(COI2)1/Tab 10.1-10.6**. His oral synopsis is at **ER(COI2)1/Tab 10.7**. He gave oral evidence to the Commission on 2 and 3 January 2020. [**Combined/T7/58 to T8/95**]. He was questioned by the Commission, MTRCL and the Government.

engineering expert evidence (amongst other expert evidence) in the Extended Inquiry. By a letter written on 9 August 2019 from Messrs Lo & Lo to Messrs O'Melveny [AA1/231-233], Leighton was requested to identify the structural engineering issues in respect of the Extended Inquiry.

80. Messrs O'Melveny responded on 16 August 2019 and provided the requested List of Issues and explanation for the Extended Inquiry [AA1/236-239].
81. Both MTRCL [AA1/234-235] and the Government [AA1/251] submitted that, given Leighton's position, they should be allowed to file responsive structural engineering expert reports, rather than filing their structural expert reports at the same time as Leighton.
82. On 29 August 2019, the Commission gave directions with regard to the filing of structural engineering expert evidence (COI 2) [AA1/277-278]. Leighton's structural engineering expert report was to be filed on 30 September 2019. The responsive structural engineering expert evidence on behalf of MTRCL and the Government and the structural engineering expert report on behalf of the Commission (COI 2) were to be filed on 6 December 2019.
83. Leighton sought an extension of time for filing its structural engineering expert report on 17 September 2019 [AA1/330-331]. The Commission granted approval on 20 September 2019 such that Leighton was to submit its structural engineering expert report on 11 October 2019 [AA1/347-349].

D4. Structural Experts' Agreed and Disagreed Items

84. In relation to the HHS trough walls, Dr Glover, Mr Southward and Professor McQuillan agree that Yield Line Analysis is valid in the Ultimate Limit State and is not linked to a shear assessment where stirrups and ties would be required. On this basis, there is no safety issue with the HHS trough walls. Dr Glover, Mr Southward and Professor McQuillan do, however, recognise the need for column protection but are satisfied that the existing trough walls and their surrounds provide the necessary protection⁶⁷.
85. Dr Lau disagrees with the other experts because, he says, the podium columns require to be protected against accidental impact. He has adopted AECOM's analysis.
86. In relation to the SAT NSL level shear capacity, Dr Glover, Mr Southward and Professor McQuillan agree that there is adequate shear capacity. In the one potential "hotspot" identified by EIC, failure cannot occur because of the load redistribution in the three dimensional structure. The "hotspot" is in an area where only nominal/minimum shear reinforcement is needed⁶⁸.
87. Dr Lau generally disagrees because of his concern that there may be no shear links present. As for the "hotspot" the shear failure would be "brittle" and load redistribution cannot occur.

⁶⁷ Memorandum of agreement dated 20 December 2019 [ER(CO12)1/Tab 14.1-14.3/§4]

⁶⁸ Memorandum of agreement dated 20 December 2019 [ER(CO12)1/Tab 14.1-14.3/§4]

88. Dr Glover, Mr Southward and Professor McQuillan agree that the as-built COI 2 structures are safe and fit for purpose. Dr Lau disagrees with the above and is of the opinion that without the implementation of suitable measures the as-built COI 2 structures are neither safe nor fit for purpose⁶⁹.

D5. The meaning of safety and fitness for purpose

89. Although different experts may express the meaning of safety and fitness for purpose in slightly different terminology, there does not seem to be any real disagreement between them⁷⁰.

90. In short, a structure such as the HUH, including the NAT, SAT and HHS, should be considered safe and fit for purpose if it is capable of being used and functions as a station safely and without any physical restrictions on its operations and as anticipated by MTRCL during its intended design life (i.e. 120 years in this case).

91. As explained by Dr Glover⁷¹ and Professor McQuillan⁷², safety and fitness for purpose may be distinguished from code compliance. This position is consistently maintained by MTRCL⁷³ and Leighton⁷⁴.

D6. Shear Links at SAT

⁶⁹ Supplemental Memorandum of Agreement dated 30 December 2019 [ER(COI2)1/Tab 15.1-15.2]

⁷⁰ See the formulation of Dr Glover at [ER(COI2)1/Tab 12.1/§3.5]; the formulation of Professor McQuillan at [ER(COI1)2/#15.1/§50]; and the agreement of Dr Lau with them [Combined/T9/53:23-54:19].

⁷¹ [ER(COI2)1/Tab 12.1/§§3.6-3.8]

⁷² [ER(COI2)1/Tab 11/§9]; [ER(COI1)2/Tab 15.1/§§50-51]

⁷³ [Combined /T6/27:3-4]

⁷⁴ [Combined /T6/49:23-25]

92. The areas that allegedly require suitable measures for shear links at the SAT NSL level is shown in pink colour between D-wall panels EH1 and EH4 at **AA2/1050**. The cross section can be found at **AA2/580**.
93. It is pointed out by Mr Southward that shear links in the SAT slab were completely discounted in Atkins' "*separate Assessment Report*"⁷⁵. This can be seen in Atkins' Report dated and submitted to BD on 27 September 2019⁷⁶.
94. Professor McQuillan pointed out that Atkins' NAT and SAT Revised Structural Assessment Report dated 19 July 2019 confirmed that the SAT NSL base slab had adequate reserve shear capacity, even if 4% and 13% reduction factors were applied in the assessment, before MTRCL took the decision to totally disregard the structural contribution of the as-constructed shear links at a later stage⁷⁷.
95. Therefore, it is submitted that the most important factor is whether shear links should be disregarded in the assessment.
96. The photos in Mr Southward's PowerPoint slide 47⁷⁸ clearly show that shear links were installed in the NSL slab of SAT.

⁷⁵ [**AA2/483+**], §5.2 of Mr Southward's report [**ER(COI2)1/Tab 10.1**]

⁷⁶ §10.8 at **AA2/563**

⁷⁷ [**BB19/11693**]; §77 of Professor McQuillan's report [**ER(COI2)1/Tab 11**]

⁷⁸ [**ER(COI2)1/Tab 10.7**], location of these photos is confirmed by Leighton's Man Sze Ho in his 3rd Witness Statement [**CC13/8165**].

97. Also, other photos in Mr Southward's PowerPoint slide 48⁷⁹ show that shear links were generally installed in the SAT structure. The photographs are consistent with the factual evidence.
98. The factual evidence in the Original Inquiry (when the shear link issue first arose, although the precise issue had not then been identified) and the Extended Inquiry indicates that shear links were installed and checked in general over all areas under Contract 1112:-
- (1) MTRCL's Construction Engineer at the HHS, Kong Sebastian Sai Kit said he checked the arrangement of shear links (if any) according to the most up-to-date working drawings during the hold point inspections⁸⁰;
 - (2) MTRCL's Construction Engineer at the EWL Slab, Louis Kwan, said that he had checked shear links in his formal inspection of the rebar⁸¹;
 - (3) Leighton's engineer for the EWL and NSL slabs, Man Sze Ho, also said that he checked the depth, length and spacing of shear links⁸²;
 - (4) Leighton's engineers for the SAT EWL area, Raymond Tsoi, Sean Wong and Saky Chan confirmed that all formal joint inspections for rebar fixing and pre-pour checks were carried out and approved

⁷⁹ [ER(CO12)/1/Tab 10.7], location of these photos is confirmed by Leighton's Man Sze Ho in his 3rd Witness Statement [CC13/8165].

⁸⁰ §9 of the witness statement of Kong Sebastian Sai Kit [BB8/5244-5245]

⁸¹ [COI1/T29/61:22-63:5]

⁸² [COI1/T22/42:4-23]

by MTRCL in the areas they were responsible for⁸³.

99. More specifically, Leighton's engineer for the SAT NSL area, Alan Yeung, confirmed that all formal joint inspections for rebar fixing and pre-pour checks were carried out and approved by MTRCL in the areas he was responsible for⁸⁴.
100. In the pre-pour checklist, Alan Yeung specifically endorsed that rebar fixing had been checked before pouring concrete⁸⁵.
101. At **BB13/9222**, records in respect of the construction of the SAT NSL Bays 1 and 2 can be found. These are the areas where suitable measures are to be carried out. For these 2 bays of track slab, however, there are contemporaneous RISC forms for both rebar⁸⁶ and pre-pour checks⁸⁷ with the support of photos⁸⁸. There are also pre-pour checklists⁸⁹ available.
102. MTRCL also recognised that it was significantly easier to fix rebar at the NAT, SAT and HHS structures than that encountered in the EWL slab of HUH Extension, where the slab was typically 3m thick and the reinforcement in the top and bottom levels of the slab was relatively congested, with up to eight levels of T40 reinforcement bars at each level. MTRCL also considered it unlikely that there were any significant defects

⁸³ §23 of Raymond Tsoi's witness statement at [CC6/3796]; §22 of Sean Wong's witness statement [CC6/3806]; §22 of Saky Chan's witness statement at [CC6/3845].

⁸⁴ §26 of Alan Yeung's witness statement at [CC6/3825]

⁸⁵ [BB13/9219.1276] and [BB13/9219.1445]

⁸⁶ [BB13/9219.1278] and [BB13/9219.1449]

⁸⁷ [BB13/9219.1266] and [BB13/9219.1444]

⁸⁸ [BB13/9219.1281-1283; 9224.2576-2595] and [BB13/9224.2770-2792]

⁸⁹ [BB13/9219.1276] and [BB13/9219.1445]

in the fixing of the shear links in the NAT, SAT and HHS structures⁹⁰.

103. Therefore, the assumption in the Verification Report and Dr Lau's concern that no shear links were installed (particularly at the areas with suitable measures) cannot be justified in the light of the factual evidence available before the Commission, both photographic, construction records and witness evidence.

104. In any event, as explained by Mr Southward, if one takes into account the redistribution of shear force 3-dimensionally⁹¹ and the soil below the NSL slab⁹², there is a further assurance in respect of shear capacity.

105. It is submitted that the Commission should be satisfied so as to be sure that there is no concern on the shear capacity of the as-constructed SAT NSL structures.

D7. HHS Trough Walls

106. It is noted that by reason of perceived coupler deficiencies (albeit elsewhere) only the trough walls in the HHS area are in issue. The suitable measures are in the form of wall thickening and additional horizontal concrete struts near the movement joints⁹³. The extent and location of the suitable measures at HHS trough walls can be found at **AA2/1052**.

⁹⁰ §§3.2.8 and 3.2.9 of the Verification Report [BB16/9970]

⁹¹ §5.3.2 of Mr Southward's Report [ER(CO12)1/Tab 10.1]

⁹² No. 52 of Mr Southward's Slides [ER(CO12)1/Tab 10.7]

⁹³ §32 of Dr Lau's report [ER(CO12)1/Tab 13.1]

107. The reason and justification for suitable measures being required for the HHS trough walls is simply the application of a 35% reduction factor, as previously discussed.
108. It is noted that the structural engineering experts have considered AECOM's calculations in forming their opinions. AECOM's calculations are particularly important since it was the original designer of the HHS trough walls⁹⁴.
109. It appears that Dr Lau has relied on AECOM's calculations included in its BD submission [DD18/18482+] after applying the 35% reduction factor, which suggested that suitable measures were required.
110. Whereas, Professor McQuillan has pointed out that AECOM has produced an earlier version of its draft review report on 28 June 2019 (before the Verification Report) which shows that the maximum utilization is 90% for HHS trough walls when there is no 35% reduction factor applied⁹⁵. Dr Glover also relied on this AECOM's conclusion⁹⁶.
111. Therefore, the difference between Dr Lau and Professor McQuillan/Dr Glover is on the issue as to whether a 35% reduction factor should be applied.
112. As submitted in Section C3 hereinabove, there is simply no engineering justification to apply by way of extrapolation the reduction factor of 35% in the structural assessment of the NAT, SAT and HHS structures.

⁹⁴ §1.6(c) of Verification Report at [BB16/9961]

⁹⁵ §§ 25 and 26 of Professor McQuillan's report [ER(COI2)1/Tab 11.1/24]

⁹⁶ §5.5 of Dr Glover's report [ER(COI2)1/Tab 12.1/8]

113. Mr Southward and Professor McQuillan are also of the opinion that the 35% defective rate is not applicable to HHS trough walls since:-

- (1) there is no opening up investigation carried out in HHS area;
- (2) the type of construction is different in HHS trough walls i.e. smaller size and weight of the rebar and vertical wall⁹⁷.

114. Dr Glover states that the strength reduction factor of 35% was applied entirely from a compliance perspective and was not derived from any engineering considerations, and hence there is no engineering justification for the application of such a strength reduction factor to the HHS⁹⁸.

115. Dr Lau's concerns on the HHS trough walls are in relation to overstressing, local failure, excessive deflections or collapse⁹⁹, in relation to certain parts of the trough walls at the HHS, if a train derailed and incidentally hit them at the expansion joint. With the reduction factor of 35%, Dr Lau says that the utilization would be more than 1 and therefore not acceptable. The concern is not in respect of elongation and cracking.

116. However, Dr Lau's concerns on partially engaged couplers are in relation to elongation at the working stress of rebar and cracking in concrete¹⁰⁰:-

⁹⁷ §50 of Professor McQuillan's report [ER(COI2)1/Tab 11/29]; §4.5.2 of Mr Southward's report [ER(COI2)1/Tab 10.1/10-11]

⁹⁸ §5.4 of Dr Glover's report [ER(COI2)1/Tab 12.1/8]

⁹⁹ §32 of Dr Lau's report [ER(COI2)1/Tab 13.1/11]

¹⁰⁰ [Combined/T9/1:21-24]

“We don't want the coupler to have excessive elongation at working stress. As I said, it will cause cracking in the concrete because of the elongation.”

117. It appears that Dr Lau’s concern on the HHS trough walls does not relate to elongation and cracking due to partial engagement of coupler connection. There appears to be no connection, therefore, between Dr. Lau’s underlying concerns in respect of the coupler connections and the suitable measures being carried out (and nearly completed) at the HHS trough walls.
118. Therefore, even Dr Lau’s concerns cannot support the extrapolation of a 35% reduction factor from the HUH to HHS trough walls.
119. Apart from the structural engineering expert evidence adduced in the Extended Inquiry, there are other renowned consultants engaged by MTRCL who have carried out reviews to the HHS structures.
120. As mentioned earlier, if a 35% reduction factor has not been applied, it is AECOM’s opinion that the maximum utilization (from train collision loads for all three types of wall and all adjacent top vertical movement joints) would have been 90% for the HHS trough walls ¹⁰¹.
121. SYW Part 2A Study Report concluded that¹⁰²:-

(1) visual inspections revealed no major anomalies or any significant

¹⁰¹ Table 3 of AECOM’s draft report at [BB17/10105]

¹⁰² [BB20/12528-12652]

structural defects giving cause for concern of safety¹⁰³;

- (2) the effects of the couplers installed in the HHS trough walls are considered to be very insignificant in view of their being relatively simple on-grade structures and the very limited retained height;¹⁰⁴
- (3) it may be concluded that the HHS structures are safe and free of any significant structural defects¹⁰⁵.

122. At the same time, Arup concluded in its report that¹⁰⁶:-

- (1) The general utilization levels in the structural members at HHS under consideration do not exceed 63% in bending except for some trough walls due to a collision load that Arup considers is conservative and could be reduced to a much lower value;
- (2) the HHS elements where couplers have been used are fit for purpose and do not require remedial measures or enhancement works.

123. Furthermore, Mr Southward has also demonstrated by yield line analysis (an alternative structural analysis) that the strength at the trough walls of HHS can be reduced by as high as 58% and the trough walls can still have sufficient load capacity¹⁰⁷. This means that the trough walls will still be safe and fit for purpose after applying the 35% reduction factor.

¹⁰³ §3.1(ii) of The SYW Part 2A report at [BB20/12533]

¹⁰⁴ §3.1(iv) of The SYW Part 2A report at [BB20/12533]

¹⁰⁵ §3.2 of The SYW Part 2A report at [BB20/12533]

¹⁰⁶ §11.3(v) & (vi) of Arup's report at [BB18/10976]

¹⁰⁷ §4.7.8 of Mr Southward's report [ER(COI2)1/Tab 10.1]

124. Professor McQuillan¹⁰⁸ and Dr Glover¹⁰⁹ also agreed with Mr Southward's yield line analysis and considered the trough walls to be safe and fit for purpose.
125. There are also various other beneficial factors such as the substantial soil backfill behind the trough walls and the concrete slab between the trough walls, which can contribute to the strength of the trough walls resisting any derailed train¹¹⁰.
126. Given the above, it is submitted that the Commission should be satisfied so as to be sure that the trough walls at the HHS are safe and fit for purpose.

E. OTHER MATTERS

E1. Supervision and the QSP

127. It is observed that at §§33 to 54 of Leighton's Closing Submissions (COI 2) further detailed submissions are made on the topic of its supervision responsibilities with specific regard to the installation of ductile and non-ductile couplers. It is assumed from previous discussions that this is an attempt to invite the Commission to review and revise its determinations at (generally) §§269 to 276 of the Commission's Interim Report, which Leighton is perfectly entitled to do. It is recognized that the task of review and revision is not made any easier by virtue of the fact that parts of a

¹⁰⁸ [ER(COI2)1/Tab 11.1/§58]

¹⁰⁹ [Combined/T11/94:9-10; 169:18-24][ER(COI2)1/Tab 12.1/§5.12]

¹¹⁰ §5.14 of Dr Glover's report [ER(COI2)1/Tab 12.1]

number of relevant paragraphs in the Interim Report have been redacted.

128. The Commission's legal team stands by its earlier submissions and, in particular, does not accept that it seeks to apply the terminology, as contemporaneously interpreted by MTRCL and Leighton (and understood by the Government) on an *ultra vires* basis (whatever that may mean). As previously submitted, and not challenged by Leighton, the new point taken is a post-the event lawyers' point.
129. A few matters are, however, common ground.
130. Firstly, Leighton's supervisory obligations, whether by reference to the QSP or otherwise, is a matter of contractual interpretation and therefore primarily a legal issue. It is conceivable, however, that matters of estoppel and waiver may be raised.
131. Secondly, since the nature of the issue is a matter of contractual interpretation, determinations by the Commission will not be binding as between MTRCL and Leighton in any future proceedings.
132. Thirdly, given the nature of the issue, the view of the experts (structural engineers or project management, whilst no doubt interesting) are not of direct relevance.
133. Fourthly, it is agreed that, in principle, there is a distinction between couplers with and without a ductility requirement. (For the avoidance of doubt, however, it is not accepted that ductile couplers were only required in areas specifically marked as "ductility zones".)
134. Fifthly, it is accepted that the assessment as to whether a coupler in a

particular location of the works was subject to a ductility requirement should be made at the time of construction when supervision was required.

135. It is, however, disagreed that the so-called ‘key authorities’ that were available to Leighton to make the assessment were limited to the working drawings and the Code. Those ‘authorities’ needed to be read together with (a) the QSPs [**H9/4262+**] which were a contractual requirement and were in fact provided pursuant to the BD acceptance letters and, at the very least formed part of the general factual matrix against which the couplers were installed and (b) the approved/accepted drawings which show that ductile couplers were required at the D-wall and slab joint in **H2/440** and more specifically in Area B [e.g. **H3/701, H4/725 and 731**], Area C [e.g. **H3/708 and H4/843**] and HKC [e.g. **H4/734**] as well as Area A [e.g. **H3/684**]. The underlying factual premise of Leighton’s contention, namely that there was only one ‘ductility zone’ to which the QSP could relate, is incorrect.
136. With regard to the meaning of “*full-time and continuous supervision*” and “*full-time supervision*” it is submitted that the views of Mr Rowsell should prevail. Insofar as those views were tested again in the COI 2 hearing, the Commission’s legal team gratefully adopts the synopsis of Mr. Rowsell’s oral evidence contained in §90 of the Government’s Closing Submissions for COI 2.
137. Finally, §§239 to 247 of the Commission’s legal team’s written Closing Address for the Extended Inquiry dated 26 July 2019 are referred to. Those paragraphs recognize a potential distinction between the areas the subject matter of the Original Inquiry and the Extended Inquiry and, in

particular, the HHS where lapped bars were replaced with ductile couplers. As will be recalled, this change was not notified to BD, in consequence of which neither a QSP was called for and nor were there any BD accepted drawings showing couplers of any type. These facts, of course, may give rise to a series of potentially different points concerning supervision. Whilst it is accepted that, on the basis of the structural engineering expert evidence, this change was of no structural significance, it certainly justifies a finding that the works were not executed in accordance with Contract 1112.

E2. Drill-in bars

138. Reference is made to §§12 to 15 of the Government's Closing Submissions where (a) the change from lapped bars to couplers at certain construction joints in the NAT, SAT and HHS structures (b) the change from Type 2 couplers to T25 drill-in bars in the NSL track slab of the SAT are succinctly dealt with. Although ultimately of no structural significance, the Commission may wish to make mention of these matters in the Final Report.

E3. Pypun's obligations

139. The Government and Pypun continue to have their differences as to the scope of Pypun's services in so far as quality generally and the auditing of RISC forms, in particular, are concerned. Pypun has submitted further detailed submissions on the subject matter, although much of its earlier submissions are incorporated. The Government's Closing Submissions for COI 2 do not mention Pypun further. The Commission's legal team

has made some brief observations pertaining to the RISC form aspect in §§199 to 202 of its Closing Submissions dated 26 July 2019. Further, it is noted from Table B attached to the Government's Closing Submissions (at item (3)) that the "check the checker" mechanism is generally under review.

F. CONCLUSION

140. For the reasons above, taking into account all the factual, statistical and structural engineering evidence available to the Commission, it is submitted that there can be no reasonable doubt and the Commission can be satisfied so as to be sure that the as-constructed structures at the NAT, SAT and HHS are safe and fit for purpose.
141. It is also noted that the suitable measures at the SAT NSL and HHS trough walls will be implemented in any event.
142. After the implementation of suitable measures, it is submitted that the NAT, SAT and HHS structures will presumably be further improved.
143. Looking forward, Dr Glover, with whom Professor McQuillan agrees, has recommended regular visual inspections of those areas with the high assessed stress levels (instead of installation of any monitoring system such as fibre-optics or the like, which was previously recommended to the Commission¹¹¹, because its highly sensitive nature may trigger many false alarms) to assuage any residual public concerns¹¹². It is submitted that the Commission should adopt such recommendation.

¹¹¹ [ER(COI 2)1/Tab 12.2/Slide 35]

¹¹² See the Interim Report, §§386-388, 391-392, 459-462.

144. The Commission is also invited to consider the recommendations for improving procedures suggested by Mr Rowsell¹¹³ which are supported by the other PM experts.

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¹¹³ §§130 to 169 of Mr Rowell's expert report [ER(COI2)1/Tab 1.0]