Final Report of Commission of Inquiry into the Construction Works at and near the Hung Hom Station Extension under the Shatin to Central Link Project

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March 2020

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(The Redacted Version)

With a view to avoiding any prejudice (actual or perceived) to the relevant criminal investigations and criminal prosecutions (if so decided to be justified after the relevant investigations), certain parts of paragraph 43 of the Executive Summary and paragraphs 227, 228, 229, 570, 621 and 633 of the main body of this Report have been redacted.

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List of abbreviations

B	
BD	Buildings Department
BIM	Building Information Modelling
D	
DEVB	Development Bureau
E	
EWL	East West Corridor / East West Line
G	
GKJV	Gammon-Kaden SCL 1111 Joint Venture
GPR NDT	ground penetration radar non-destructive test
H	
HHS	Hung Hom Stabling Sidings
HKC	Hong Kong Coliseum
HOKLAS	Hong Kong Laboratory Accreditation Scheme
HyD	Highways Department
I	
ITP	Inspection and Test Plan
K	
km	kilometre
M	
m	metre
mm	millimetre
MTRCL	MTR Corporation Limited
M&V	monitoring and verification
N	
NAT	North Approach Tunnels

NCR	Non-conformance Report
NEC	New Engineering Contract
NSL	North South Corridor / North South Line
NWDSM	New Works Design Standard Manual
O	
OTE	over track exhaust
P	
PAUT	phased array ultrasonic test
PIMS	Project Integrated Management System
Q	
QSP	Quality Supervision Plan
R	
RDO	Railway Development Office
RISC	Request for Inspection, Survey and Check
S	
SAT	South Approach Tunnels
SCL	Shatin to Central Link
SPV	Special Purpose Vehicle
SSP	Site Supervision Plan
T	
TCP	Technically Competent Person
THB	Transport and Housing Bureau
T&T	Turner & Townsend
U	
UK	United Kingdom

Executive Summary

The Shatin to Central Link Project

1. In May 2012, the Government entered into an agreement with the MTR Corporation Limited ('MTRCL') for the construction and commissioning of a railway network known as the 'Shatin to Central Link' ('SCL').

2. MTRCL, as the Project Manager, entered into a contract with Leighton Contractors (Asia) Limited ('Leighton') in terms of which Leighton, as contractor, would be responsible for the extension works to the existing Hung Hom Station. The works under the contract – Contract 1112 – were as follows –

a. To construct a station extension for the SCL lines encompassing concourse facilities. The core of the structure was to consist of two horizontal slabs, one above the other. The two horizontal slabs were to be set between vertical diaphragm walls, the slabs and the diaphragm walls being constructed of reinforced concrete in a rigid, box-like structure set into the earth: the 'station box structure'.

b. To construct the necessary north and south approach tunnels to the station extension.

c. To construct stabling sidings to be used to park and maintain trains not in use.

Reports of illicit building activities

3. In or about late May 2018, some 18 months after the station box structure had been completed (although not yet opened for use) alarming reports circulated that illicit activities may have taken place in respect of the steel reinforcement fixing works, specifically by way of cutting the threads from the steel reinforcing bars ('rebars'). It was suggested that these illicit activities may have been of such magnitude as to threaten the safety of the structure.

Appointment of the Commission of Inquiry

4. In light of these reports which led to such public disquiet, on 10 July 2018 the Chief Executive in Council appointed the Commission of Inquiry (the 'Commission') to inquire into the facts and circumstances surrounding the steel reinforcement fixing works and other works that may raise concerns about public safety in the station box structure: the 'Original Terms'. In addition, the Commission was mandated to examine the adequacy of management controls of the construction works and, if required, to recommend suitable measures with a view to promoting public safety and future assurance that construction works would be of the required standard.

5. The Commission commenced hearing evidence on 22 October 2018, closing submissions being made to it on the 28 and 29 January 2019.

6. The following day, on 30 January 2019, it was announced by the Government that there were concerns that further failings had been discovered in respect of construction works undertaken pursuant to Contract 1112. These concerns were focused on the as-constructed state of works situated in three areas, namely, the North Approach Tunnels ('NAT'), the South Approach Tunnels ('SAT') and the Hung Hom Stabling Sidings ('HHS'). Of particular concern was the fact that a large number of documents designed to confirm that the works had been carried out to the required standard – RISC forms, RISC standing for 'Request for Inspection, Survey and Check' – were missing.

7. On the basis that these new concerns fell within the ambit of Contract 1112, the Commission's Terms of Reference were extended to enable it to inquire into the facts and circumstances of problems surrounding the construction works in these areas: the 'Extended Terms'.

The interim report

8. Having regard to the fact that a full and final report would not now be issued for a number of months, the Commission issued an interim report which was submitted to the Chief Executive on 25 February 2019. There were two leading reasons for issuing an interim report. First, the Commission believed it would be in the public interest to make a number of recommendations to improve project management. Second, the Commission believed it would be

in the public interest to seek to allay public concerns as to the essential integrity of the station box structure. The Commission had heard a great deal of evidence in respect of this matter and, in light of the structure's conservative design which gave it a very large degree of redundancy and robustness, was sure that it was safe.

The Commission's inquiry under its Original Terms

The Holistic Report

9. In December 2018, in order to better ascertain the as-constructed state of the station box structure, MTRCL put a set of proposals before the Government. The proposals included the physical opening up of the station box structure at numerous locations in order primarily to understand the following: first, the as-constructed connections of the horizontal upper slab (the EWL[1] slab) to the vertical diaphragm walls and, second, the true extent of defective coupler connections securing the joints of both the EWL slab and the lower horizontal slab (the NSL[2] slab). Following the Government's approval, the opening-up works proceeded and a report – the Holistic Report[3] – was issued on 18 July 2019.

10. The authors of the Holistic Report worked independently of the Commission. That said, the results of the opening-up investigations were made public on a regular basis. The overall findings of the report were of considerable assistance to the Commission in discharging its mandate.

11. The Holistic Report found that there were deficiencies in coupler connections that were likely caused by poor workmanship. This was particularly the case in respect of bottom reinforcement layers, poor workmanship in that regard being difficult to identify during inspections. The report found that the deficiencies cast doubt on the quality of the supervisory and inspection control system. In the result, 'suitable measures' – essentially remedial building measures – were proposed in order to achieve the safety level

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1 East West Corridor / East West Line

2 North South Corridor / North South Line

3 'Final Report on Holistic Assessment Strategy for the Hung Hom Station Extension'

required in the Code of Practice for Structural Use of Concrete 2004, for meeting the requirements of the Buildings Ordinance, the established good practice of engineering design and MTRCL's 'New Works Design Standard Manual'.

12. Once these 'suitable measures' had been agreed with the Government, work commenced immediately to incorporate them into the station box structure. As at the date of the Commission's final report, much of the required work has already been completed.

Unauthorised changes to construction details

13. In the course of the inquiry, two changes to construction detail to the station box structure were discovered that had not been notified to the Government and had not therefore been officially approved. The changes were located at the connection between the upper horizontal slab (the EWL slab) and the east diaphragm wall. The first change was to the reinforcement at the top of the east diaphragm wall to accommodate a pipe for pouring concrete and other cast-in elements. The second change was to break down the top of the east diaphragm wall by some 450 millimetres ('mm') to 500 mm and replace the coupler connections therein with continuous rebars lapped to reinforcement in adjacent structural elements.

Allegations concerning the cutting of threaded rebars

14. A primary cause for the appointment of the Commission was the public concern that the integrity of the station box structure may have been undermined by the extensive illicit practice of cutting threads from rebars. On a consideration of the extensive evidence put before it, the Commission is satisfied of the following –

a. Although cutting of rebars did take place, it was not extensive. The evidence indicated that no more than 2% to 3% of the threaded rebars were cut. The extent of the practice of cutting, while illicit, did not constitute a threat to the integrity of the station box structure.

b. On a number of occasions, although those occasions cannot be quantified, cutting was done when workers ran out of Type A rebars and wished to convert Type B into Type A[4].

c. The cutting of rebars was not condoned by either Leighton or MTRCL.

d. The persons responsible for the cutting of rebars were employees of Fang Sheung Construction Company, the company with the contract to fix the steel reinforcement. There is no evidence that the workers were authorised or encouraged by their employer.

Is the station box structure safe and fit for purpose?

15. In the view of the Commission, its mandate in respect of this question has been a fundamental one. In this regard, in the body of its final report, the Commission has directed itself (in part) as follows –

> "The Commission has been required to determine, by looking into the facts and circumstances surrounding the construction works, whether there have been any failings in completing those works – for example, negligent conduct or illicit activity – and, if so, whether, first, those failings have arisen from a failure to meet contractual obligations, as opposed, for example, to a failure in design, and, second, whether such failings have rendered the works unsafe or unfit for purpose or have constituted failings of a lesser degree, failings which have not undermined the structural integrity of the works."

16. In determining the issue of structural integrity, the Commission heard a broad range of the detailed evidence. This included evidence of the opening-up investigations which were described in the Holistic Report together with evidence of a number of eminent experts in the field of structural and civil engineering. The Commission also had available to it a number of detailed technical analyses. As Dr Glover, an independent structural engineering expert observed during the inquiry –

[4] Type A rebars had approximately 10 / 11 threads while Type B rebars had about twice that number, approximately 20 / 21 threads.

> "Few structures have been subjected to the degree of post-construction survey, inspection and opening up, or subjected to the sophisticated independent analysis and testing which has been carried out on the structures [the station box structure] by a number of different parties."

17. In light of the findings of the Holistic Report, the Government, supported by one of the independent engineering experts, Dr Lau, was of the view that, without the implementation of suitable measures, the station box structure, as it stood, would not comply with the requirements of the Buildings Ordinance and applicable codes, those requirements reflecting the standards required in Hong Kong for purposes of ensuring safety.

18. In submissions to the Commission, counsel for MTRCL adopted a different approach. Counsel accepted that, on the forensic evidence, the station box structure was safe and fit for purpose without the need for suitable measures. The purpose of the Holistic Report had not been to address structural safety *simpliciter* but had been to ensure that the as-constructed works achieved compliance in light of issues concerning poor workmanship and missing records.

19. Three of the independent engineering experts – Professor McQuillan, Dr Glover and Mr Southward – were at all times of the firm view that there was no need for the application of suitable measures. Adopting an essentially 'forensic' approach as opposed to a 'compliance' approach, it was their joint opinion that the station box structure, as it stood, was safe and fit for purpose.

20. However, all four experts – Professor McQuillan, Dr Glover, Mr Southward and Dr Lau – agreed that the suitable measures would add to the robustness of the station box structure or, at least, would not result in the structure being any less safe. The general effect, therefore, of the suitable measures was either positive in the sense that they would, by way of compliance, ensure safety and fitness for purpose, or neutral in the sense that they would not in any way undermine safety and fitness for purpose. The consensus, as the Commission expressed it in the body of this final report was that –

> "… there was consensus among all the experts and the three involved parties (the Government, MTRCL and Leighton) that, whatever their conflicting views as to the

> need for remedial measures, with those measures in place, the station box structure will be safe and will also be fit for purpose."

21. In light of this, the Commission has come to the following determination, namely, that this consensus –

> "… reached after many months of investigation and debate, constitutes a compelling body of opinion. In light of that opinion, the Commission is fully satisfied that, with the suitable measures in place, the station box structure will be safe and also fit for purpose."

22. The Commission at all times recognised, however, that there had been failures in respect of the construction process. In this regard, it said –

> "In coming to this determination, however, the Commission recognises that in a number of respects, in the course of construction of the station box structure, there were unacceptable incidents of poor workmanship on site compounded by lax supervision and that in a number of respects also, management of the construction endeavour fell below the standards of reasonable competence."

Adequacy of supervision and of overall management systems

23. In giving evidence to the Commission, witnesses from both MTRCL and Leighton attempted to stress the essential efficacy of their respective project management systems including, importantly, the RISC form system, the Non-conformance Report ('NCR') system and other systems employed for the supervision and inspection of construction works. The Commission, however, heard extensive evidence of failures in these systems including improper record-keeping, perfunctory inspections and indeed an erosion of the RISC form system itself resulting in a disturbingly high number of these forms never being compiled. The Commission also heard evidence of wide-scale retrospective compilation of construction records, these records all too often being inaccurate. In this latter respect, the Commission found that retrospective compilation of records had led to glaring inaccuracies in an important report submitted by MTRCL to the Government on 15 June 2018, this report concerning the integrity of the station box structure.

24. The Commission was of the judgement, therefore, that both MTRCL and Leighton were responsible for serious deficiencies in their management and supervision systems.

25. That said, the Commission was also of the view that the Government, as overseer of the SCL project, had to bear a measure of responsibility. It is evident that the Highways Department had not been able to detect failings in a timely manner nor had it taken firm action in a number of cases to ensure that corrective actions were taken by MTRCL.

The Commission's inquiry under its Extended Terms

The issues

26. The issues that arose for consideration by the Commission under its Extended Terms may be summarised as follows –

a. missing RISC forms;

b. defective construction of the three stitch joints and the shunt neck joint in NAT;

c. unauthorised designed changes: lapped bar connections being converted into coupler connections; and

d. as ancillary matters: first, a failure to ensure quality testing of all rebars brought to site, and second, the need for suitable measures to be carried out to the trough walls in HHS and to shear links in the SAT NSL tunnel box.

The Verification Report

27. Primarily because of the disquiet caused by the large number of missing RISC forms in the NAT, SAT and HHS areas, MTRCL submitted a proposal to the Government – similar in form to its original Holistic Proposal – to verify the as-constructed condition of the structures in those areas. Based on those findings, MTRCL proposed to conduct a structural review and, if required, to identify 'suitable measures' to address any issues that presented

themselves. The proposal was accepted by the Government and the necessary investigations were carried out. The Verification Report[5] was issued on 18 July 2019.

Missing RISC forms

28. It was emphasised to the Commission that the RISC form process is a primary source of certification and therefore of fundamental importance in the supervision and inspection of works. It is a contractual requirement under Contract 1112 and, in the opinion of the Commission, demands full compliance. The Commission heard evidence that Leighton had given the completion of RISC forms a relatively low priority, citing the pressure of work, the need to maintain progress and the fact that the paper-based system was cumbersome. In its turn, MTRCL seemed not to have insisted on the correct procedure being followed, allowing this to happen, on the basis of a misplaced approach, essentially one of wishing to be seen to be collaborative and not wishing to be seen to delay progress. This led to many RISC forms not being produced which in turn created many of the difficulties that the inquiry had to address.

Defective construction of the 'stitch joints' and the 'shunt neck joint'

29. MTRCL observed excessive water seepage in a stitch joint at the NSL level interface between Contracts 1111 and 1112 not long after the joint was constructed. Grouting work by Leighton to seal and stop the seepage was unsuccessful. Leighton was required to investigate the underlying cause of the seepage by breaking back the concrete at this and the two other stitch joints, one at the EWL level of the interface between the two contracts and one internal to Contract 1112 itself. This revealed that in each stitch joint a number of rebars were not properly connected to the couplers. Remedial works have subsequently been carried out to these stitch joints under the strict supervision of MTRCL and there is no more water seepage.

30. Similarly, the shunt neck joint at the interface between Contracts 1111 and 1112 was observed to have developed minor cracking. On investigation it was discovered that there had been a failure to screw the rebars into the couplers.

[5] 'Final Verification Study Report on As-Constructed Conditions of the NAT, SAT and HHS'

31. It transpired that the failure in coupler connections at the interface stitch joints and the shunt neck joint was due to a mismatch between taper-threaded Lenton couplers used on the Contract 1111 side of the interface and parallel-threaded BOSA[6] rebars used on the Contract 1112 side of the interface. Lenton couplers and BOSA rebars are not compatible. The mismatch was found to be due to a breakdown in communication within Leighton when it came to ordering the correct material to use at the contract interface. The use of incompatible coupler components across the contract interface led to obvious problems. These incompatible materials should not have been installed – a clear case of unacceptably poor workmanship – and they should have been detected during inspections prior to concreting – a clear case of poor supervision and inspection.

Unauthorised design changes: lapped bar connections into coupler connections

32. A large number of reinforcement connections at construction joints between slabs and walls were changed by Leighton from the specified lapped bar connections to mechanical coupler connections, so as to provide temporary site access during construction. This change was not notified by Leighton / MTRCL to the Government and permission for the change was not given by the Government. Further, there were no proper quality or as-built records for the coupler connections. The Commission concludes that in this respect Leighton and MTRCL did not comply with the requirements of Contract 1112.

Failure to ensure that all rebars delivered to site were tested

33. It is a Government requirement that all deliveries to site of rebars be tested by a laboratory accredited under the Hong Kong Laboratory Accreditation Scheme ('HOKLAS'), this in addition to the certification provided by the steel manufacturers. The Commission heard that approximately 7% of the rebars delivered to site, around 4 000 tonnes, was not sampled and tested in this way. Records show that most of the untested rebars were used in the NAT and HHS areas. However, despite this failure of testing, the Commission has heard that all the rebars that were tested passed the HOKLAS tests and this represents the very large majority of all the rebars delivered. Additionally all of the rebars delivered had satisfactory

[6] BOSA Technology (Hong Kong) Limited

manufacturers' certification. Thus the Commission is satisfied that the reinforcement that was not HOKLAS tested does not threaten the integrity of the structures on this project.

The requirement for suitable measures – trough walls and shear reinforcement

34. The Verification Report proposed suitable measures to the trough walls in the HHS area in critical locations where the theoretical strength was considered to have been reduced due to unauthorised design changes or assumed poor workmanship. Three of the four independent engineering experts were of the opinion, supported by technical analysis, that these measures were simply unnecessary. However, the Government, with the support of Dr Lau, was of the view that the measures are required and they are being undertaken.

Are the NAT, SAT and HHS structures safe and fit for purpose?

35. As with the station box structure, the Government, and one of the independent engineering experts, Dr Lau, were of the view that, without the implementation of the 'suitable measures', the identified structures in the NAT, SAT and HHS areas would fail to comply with the requirements of the Buildings Ordinance and applicable codes, those instruments in Hong Kong reflecting the standards required to ensure safety and fitness for purpose.

36. MTRCL again submitted that the purpose of the Verification Report was not only to address structural safety *simpliciter* but was to ensure that the as-constructed works achieved compliance in light of issues concerning poor workmanship and missing records.

37. Three of the independent engineering experts – Professor McQuillan, Dr Glover and Mr Southward – were confident that the structures in question were already both safe and fit for purpose without the need for the suitable measures.

38. All the independent engineering experts, however, agreed that the suitable measures will not undermine the integrity of the structures and indeed, whether they consider them to be necessary or not, will add a measure of robustness to the structures.

39. There was therefore consensus that, with the suitable measures completed, the structures will be safe and fit for purpose.

40. On the basis of all the evidence heard by the Commission, it too is satisfied (so that it is sure) that, with suitable measures completed, the structures will be safe and fit for purpose.

Adequacy of MTRCL's and the Government's project management systems

Supervision and inspection of coupler connection works

41. Lack of clarity in respect to designated responsibility for formal inspections and for maintaining records led to many of the problems revealed in this inquiry. In particular, the operation of the RISC form system – for presenting and inspecting completed works – was found to be deficient, with many forms not completed or inspections not properly carried out.

MTRCL's senior leadership of the SCL Project

42. MTRCL had two distinct roles on the SCL Project, one as the Engineer with defined powers under the contracts and a separate role as the Project Manager. It was not always clear which of these two roles MTRCL personnel were fulfilling at any given time. MTRCL's senior leadership should have provided that clarity by allocating the distinct and separate roles to different designated individual or teams.

Non-conformance reporting

43. The project management systems of both MTRCL and Leighton set out the way in which substandard work or processes should be reported by means of NCRs. In the view of the Commission, MTRCL's NCR system is in need of a full review which should include the process of closing out NCRs [redacted]. If used properly, NCRs can provide valuable learning points on construction sites and facilitate continuous improvement.

The role of the design consultant Atkins

44. The Commission is of the view that it is not good practice for the same design firm to provide services both to the employer and the contractor, as was the case on this project. Such an arrangement carries with it the potential of both real and perceived conflict of interest.

45. The Commission is further of the view that it is important for a designer to have a site presence in order to quickly resolve any lack of clarity in the design intent.

As-built records

46. In all projects, MTRCL is obliged to submit as-built drawings and other records to the Government. This requires contemporaneous recording of what has been built. This was not always complied with on this project, which in the circumstances under investigation led to various problems, not least the uncertainty of what was actually built. The Commission considers it important to maintain contemporaneous records to demonstrate traceability and compliance.

Adoption of technology

47. MTRCL and its contractors and sub-contractors do not appear to have made proper use of available technology for systematic data collection and for producing contemporaneous records of quality inspections. In this respect, MTRCL appears to have 'fallen behind the curve'.

Government's sponsorship of rail enhancement projects

48. A large number of Government bodies had a part to play in the SCL Project. The Commission believes that the Government should critically address the way in which it executes its multiple roles in relation to railway enhancement projects and that active consideration should be given to creating an overall 'sponsor' role for all individual projects.

Collaborative culture

49. Finally, the Commission is of the view that there is in Hong Kong considerable scope for creating a more collaborative culture between the Government, MTRCL and contractors with the objective of achieving more successful project outcomes. By way of example, the Commission believes there would be great value in the Buildings Department ('BD') working much more closely and more collaboratively with MTRCL and its designers and contractors, with BD acting more as a project participant offering its advice and expertise.

Recommendations

50. This report makes recommendations for improving project management by MTRCL and for improving oversight by the Government in future projects. The Commission is pleased that MTRCL and the Government have already implemented many of the recommendations in its interim report and is continuing to address others.

Chapter 1

Introduction

The Shatin to Central railway link

1. In May 2000, the Government of the Hong Kong Special Administrative Region (the 'Government') unveiled a blueprint for the future expansion of Hong Kong's rail network. That blueprint – the Railway Development Strategy 2000 – sought to ensure the continued economic and social growth of Hong Kong and was integral to the Government's vision of making Hong Kong a 'world-class' city. Central to the planned strategy of the railway expansion was the construction of what is known as the 'Shatin to Central Link' ('SCL').

2. As illustrated in **Diagram 1**, SCL is divided into two sections. One section, shown in brown, red and purple in Diagram 1, creates an East West Corridor / East West Line ('EWL'), extending the existing Ma On Shan Line from Tai Wai (in Shatin) – via an interchange station at Hung Hom – to link up with the existing West Rail Line which has its terminus in Tuen Mun. The other section, shown in blue in Diagram 1, creates a North South Corridor / North South Line ('NSL'), extending the existing East Rail line from the boundary with the Mainland – via the same interchange station at Hung Hom – to Admiralty on Hong Kong Island.

3. SCL itself is some 17 kilometres ('km') long and – as illustrated in **Diagram 2** – it has 10 stations. Six of these stations are interchange stations linking SCL to Hong Kong's broader rail network.

The entrustment agreements

4. In order to construct the SCL Project, the Government entered into a series of entrustment agreements with the MTR Corporation Limited ('MTRCL'). The third entrustment agreement, the agreement for the actual construction and commissioning of the SCL Project, was entered into between the Secretary for Transport and Housing, representing the Government, and MTRCL in May 2012.

Diagram 1

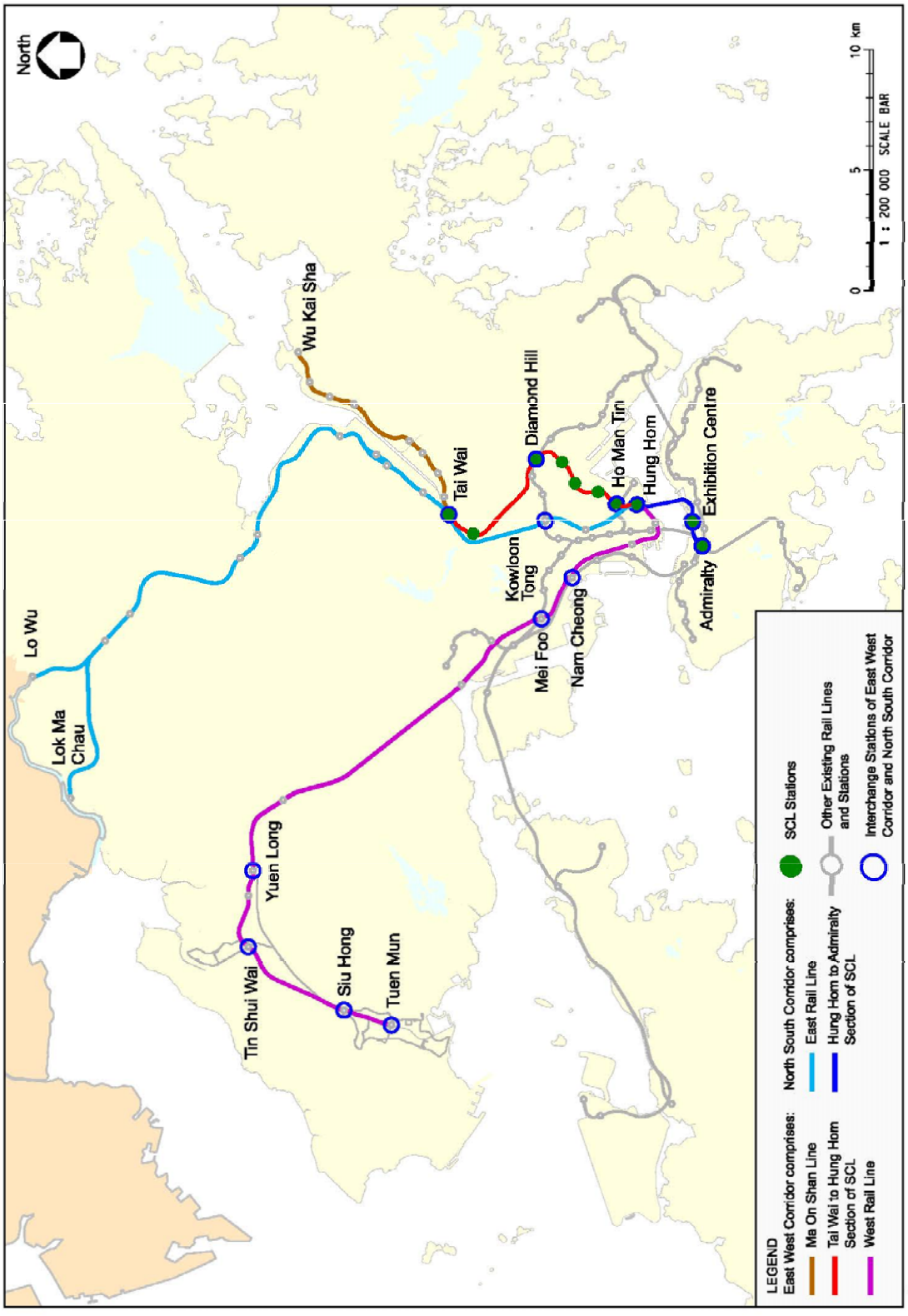
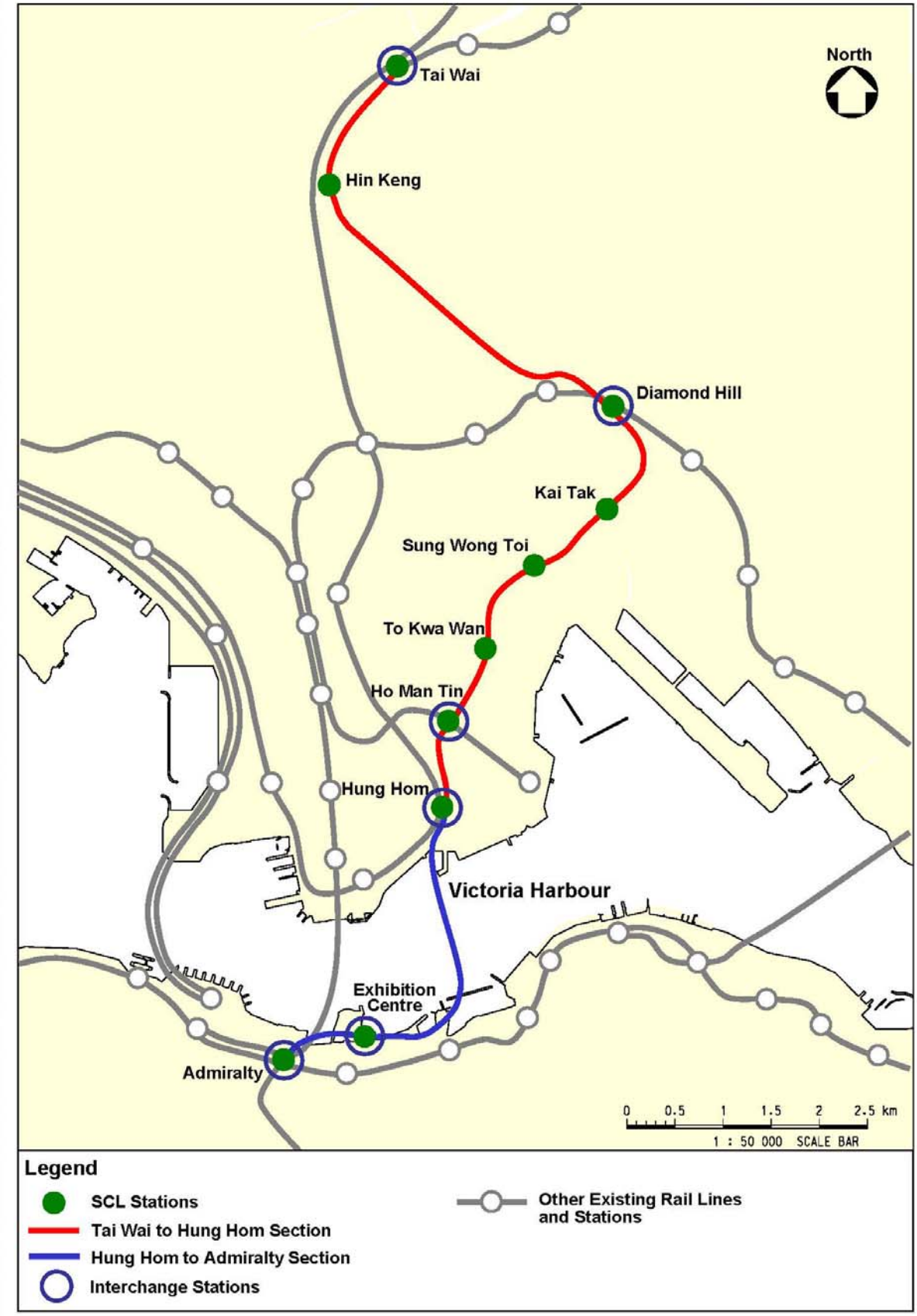

North
Wu Kai Sha
Tai Wai
Diamond Hill
Ho Man Tin
Hung Hom
Exhibition Centre
Admiralty
Kowloon Tong
Mei Foo
Nam Cheong
Lo Wu
Lok Ma Chau
Yuen Long
Tin Shui Wai
Siu Hong
Tuen Mun
0
5
10 km
1 : 200 000 SCALE BAR
LEGEND
East West Corridor comprises:
Ma On Shan Line
Tai Wai to Hung Hom Section of SCL
West Rail Line
North South Corridor comprises:
East Rail Line
Hung Hom to Admiralty Section of SCL
SCL Stations
Other Existing Rail Lines and Stations
Interchange Stations of East West Corridor and North South Corridor

Diagram 2


North
Tai Wai
Hin Keng
Diamond Hill
Kai Tak
Sung Wong Toi
To Kwa Wan
Ho Man Tin
Hung Hom
Victoria Harbour
Exhibition Centre
Admiralty
0 0.5 1 1.5 2 2.5 km
1 : 50 000 SCALE BAR
Legend
SCL Stations
Tai Wai to Hung Hom Section
Hung Hom to Admiralty Section
Interchange Stations
Other Existing Rail Lines and Stations

5. In terms of the entrustment agreements, the Government undertook the funding of the entire project on the basis that, upon completion, it would become the owner of the asset. In respect of the future operation of the railway, it was agreed that MTRCL would be granted a concession for its operation.

6. As Project Manager, MTRCL was entrusted to procure, co-ordinate, administer, manage and supervise the design and construction of all necessary works (including necessary testing of plant and materials, and ensuring quality of workmanship) to bring about the timely completion of the project. In doing so, MTRCL was obliged to follow its own project management system – 'Project Integrated Management System' ('PIMS') – which is certified ISO 9001 compliant[7] and has been used to manage railway projects in Hong Kong for many years.

7. For its part, in order to ensure due compliance by MTRCL of its obligations under the entrustment agreements, the Government adopted what has become known as the 'check the checker' approach. In terms of this approach, the Highways Department ('HyD'), an executive arm of the Government's Transport and Housing Bureau ('THB'), operating through a hierarchy of committees and regular oversight gatherings, has monitored progress of the construction of the project. The Government is assisted in the appraisal, monitoring and audit of the activities and processes of MTRCL by an external 'monitoring and verification' ('M&V') consultant.

8. It appears that the approach of 'check the checker' was adopted on the basis that at the time MTRCL's project management processes were trusted, being known to be thorough and effective. By way of illustration, in a review document prepared in 2008, Lloyd's Register Rail (Asia) Limited commented[8] –

> "MTRCL's processes are known to be robust and in line with industry best practice. They are regularly reviewed and audited by outside bodies and have been proven

[7] ISO 9001 is an international standard – not confined to engineering – that defines quality management. Organisations use the standard to demonstrate the ability to consistently provide products and services that meet customer and regulatory requirements.

[8] 'Review of Institutional Arrangements for the Hong Kong Section of the Express Rail Link'

and refined through the delivery of many high quality railway projects by MTRCL in Hong Kong and abroad."

9. Integral to the 'check the checker' approach, the Government has been assisted in its appraisal, monitoring and audit of the activities and processes of MTRCL by PYPUN-KD & Associates Limited ('PYPUN') as the M&V consultant.

10. PYPUN was appointed in terms of an agreement dated 20 August 2012, being required to provide "monitoring and verification services in relation to the work undertaken by MTRCL (including submissions by its consultants, contractors or agents to MTRCL) during the construction, testing and commissioning phase of the project so as to provide assurance that the MTRCL's obligations stated in terms of the entrustment agreements… have been properly fulfilled."

11. PYPUN's monitoring responsibilities were to focus on "cost, programme and public safety of the Project". Those responsibilities, however, did not include a requirement to carry out "site supervision or any checking of detailed design of the works".

12. The Government's project management fees paid to MTRCL for the entire SCL Project have amounted to approximately HK$8 billion.

13. It is the Commission's understanding that PYPUN's monitoring and auditing fees have amounted to a sum of approximately HK$180 million.

14. It has been reported that SCL is Hong Kong's most expensive rail project; certainly it is a project of daunting proportions which has had to deal with many challenges. To give an indication of its size, as at 3 March 2020 the revised project estimate for the entire project was over HK$90 billion.

Contract 1112

15. In fulfilling its mandate as Project Manager, MTRCL entered into numerous major civil engineering contracts. The focus of this report is limited to just one of those contracts. It is Contract 1112, a 'target cost' contract

entered into between MTRCL and Leighton Contractors (Asia) Limited ('Leighton'), as contractor, on 7 March 2013.

16. In his report, Mr Steve Rowsell, one of the independent project management experts who assisted the Commission, set out the principal features of 'target cost' contracts. Such contracts incentivise the contractor to deliver the works at a lower actual cost. Payment is made to the contractor on the basis of the actual costs incurred together with a fee for its overheads and profits. However, built into the contract is a 'pain / gain mechanism' under which, in the present instance, the Government (not MTRCL) and the contractor (Leighton) share any savings under the target or share any additional costs over the target. In fact, in the contract – Contract 1112 – there was a cap on the Government's exposure to additional costs at 10% of the initial target cost. As Mr Rowsell points out, invariably 'target cost' contracts require the use of open book accounting arrangements to justify and demonstrate the contractor's entitlement to payment and also include provisions for disallowable costs in respect of which the contractor does not receive payment.

17. As to the scope of the contract, it provided for extension works to the existing Hung Hom Station. There were four principal extension works which may be described as follows: first, to construct the necessary works to enable the rail lines of EWL and NSL to run through the station so that passengers may board and disembark; second, to provide for extended concourse facilities; third, to construct stabling sidings; and fourth, to construct the North Approach Tunnels ('NAT') and the South Approach Tunnels ('SAT').

18. An illustration of the 'Hung Hom Station Extension' works is shown in **Diagram 3** –

a. The *existing* Hung Hom Station is in grey.

b. Next to it – the linear design marked out in blocks of colour – is the *extension* to the Hung Hom Station. The blocks of different colours mark out different physical areas of the construction works.

c. Shown in red to the south of the station extension is SAT. Shown in purple to the north of the station extension is NAT.

d. The single block of works coloured green is the Hung Hom Stabling Sidings ('HHS'), an area for the parking, cleaning and maintenance of trains, also enabling trains to change tracks for deployment.

19. The new Hung Hom Station Extension makes provision for two platform and track slabs, one above the other. They are shown in **Diagram 4**, in a red circle, the circle being labelled 'underground extension'. Of the two horizontal slabs shown within the red circle, the upper slab provides for trains running along the EWL section of SCL while the lower one provides for trains running along NSL.

20. Conceptually, as **Diagram 5** illustrates, the two horizontal slabs, the EWL slab and below it the NSL slab, are set between vertical diaphragm walls. The slabs and the diaphragm walls are constructed of reinforced concrete. What is constructed therefore is a rigid, box-like structure set into the earth: the 'station box structure'.

21. The construction of this station box structure took approximately three years to complete. Work was commenced in or about May 2013 and, for all effective purposes, was completed in late 2016.

22. By May 2018, some 18 months *after* the station box structure had been completed, although the Hung Hom Station Extension was not yet open to the public, rail tracks had been laid upon both the upper EWL slab and the lower NSL slab and trains had been used to conduct test runs. While there was some water seepage, there was no evidence of any structural distress. In short, visually, there appeared to be no cause for concern as to the essential integrity of the works[9].

[9] During the course of its inquiries, the Commission studied a report prepared by MTRCL with the assistance of an Expert Adviser Team for the SCL Project. In that report – 'Final Report on Holistic Assessment Strategy for the Hung Hom Station Extension' ('Holistic Report') – when dealing with water seepage, the following was said on page 36: "For an underground structure as massive, deep and extensive as the Hung Hom Extension works, it is not uncommon that a certain degree of water seepage may occur at the diaphragm wall joints."

Diagram 3

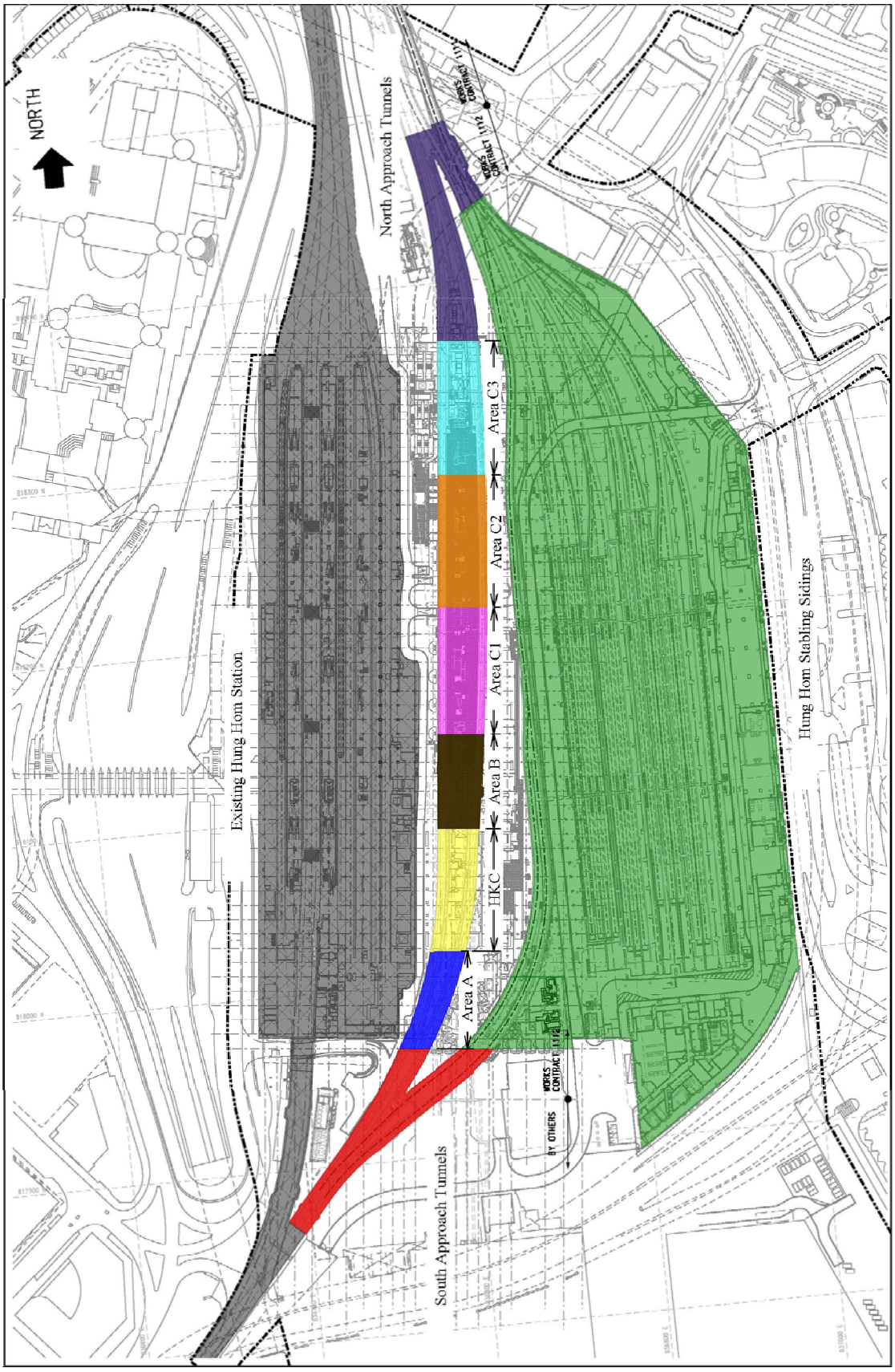

NORTH
North Approach Tunnels
Existing Hung Hom Station
Hung Hom Stabling Sidings
South Approach Tunnels
Area A
HKC
Area B
Area C1
Area C2
Area C3
WORKS CONTRACT 1112
BY OTHERS

Diagram 4

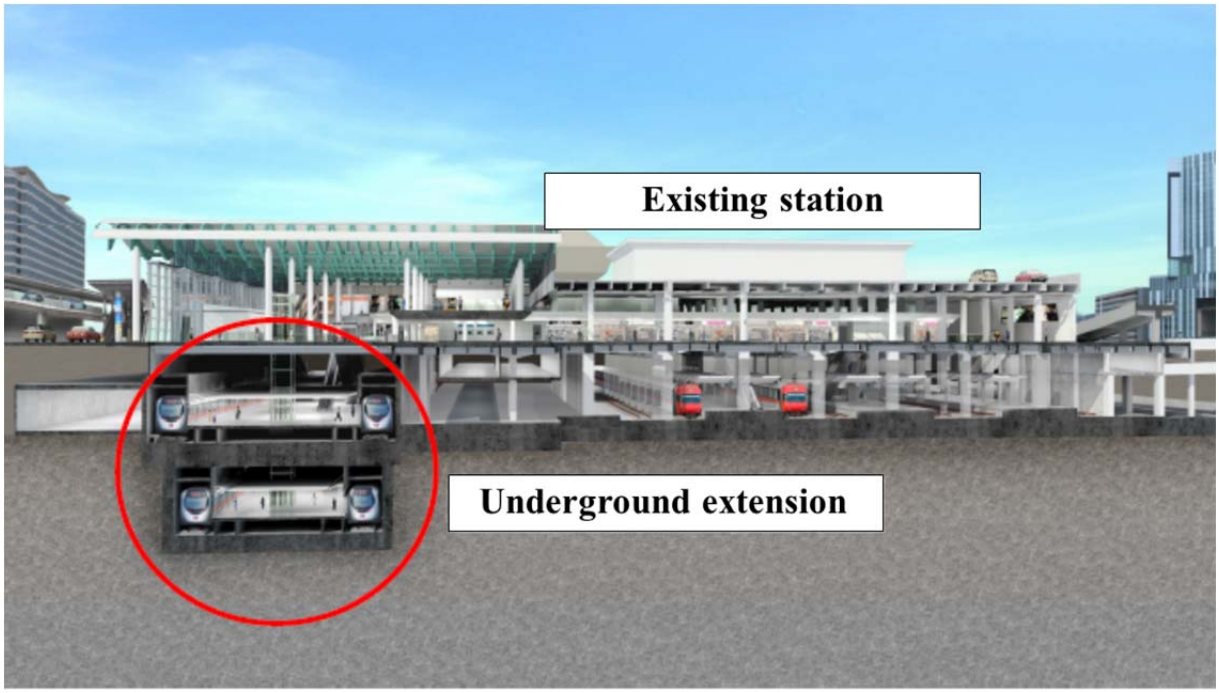
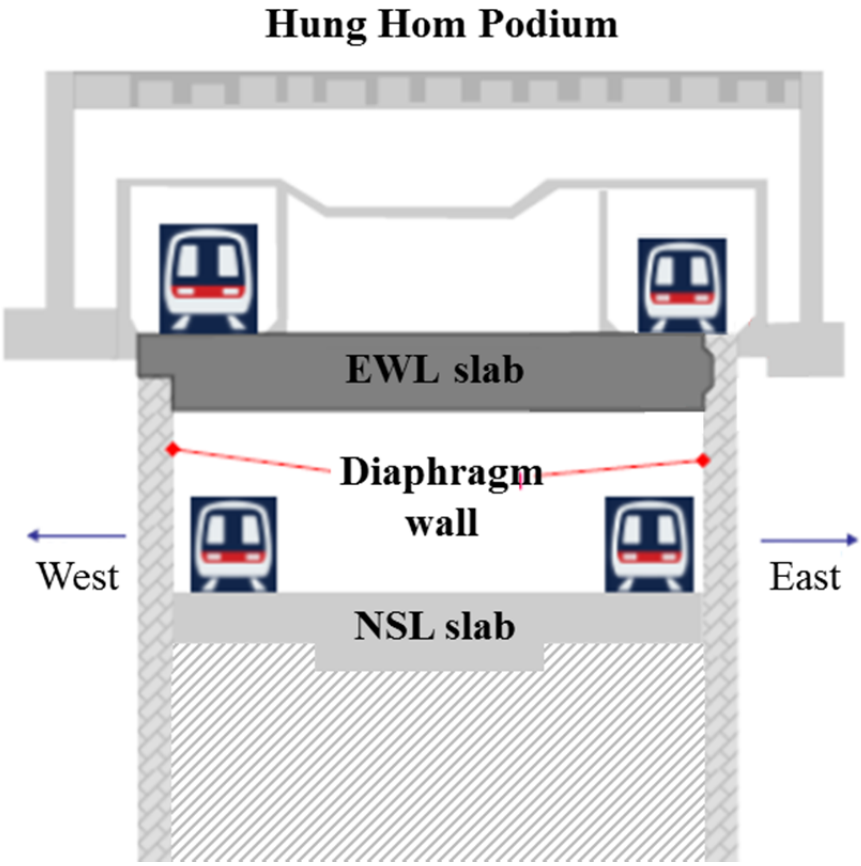


Diagram 5



The sudden rise in public concern

23. At or about the end of May 2018, however, alarming reports began to appear in a number of Hong Kong newspapers questioning the structural integrity of the station box structure.

24. Media reports spoke of an apparent failure at the time of construction to ensure that the massive slabs, especially the upper EWL slab, had been securely connected at its joints by means of mechanical coupling devices – known as 'couplers' – and also an apparent failure to ensure that the slabs themselves had been securely anchored into the diaphragm walls, that is, the vertical diaphragm walls, using the same couplers. One newspaper said the following in a headline (in English translation): "Steel reinforcing bar connections at the Hung Hom Station Extension tampered with to cover up defects".[10]

25. Certain media reports focused on the assertion that during construction there may have been a systematic and widespread cutting of threads from the end of the steel reinforcing bars ('rebars') set into the concrete. The purpose of this illicit exercise would have been to avoid the need to fully screw the rebars into the couplers (or indeed to screw them in at all). As it was put by one newspaper (in English translation) –

> "According to information source, nearly 20% of couplers in two main walls of the newly-built platform of the said station were either damaged or dislocated and cannot be screwed tightly with the steel bars supporting the platform slab. It is suspected that Leighton Contractors (Asia) Limited had not replaced the problematic components, but instead arranged workers to cut short the steel bars, thus creating the false impression that the steel bars had been successfully connected with the couplers. An engineer commented that such act of contriving proper connection would substantially reduce the tensile strength of steel bars, which in turn would affect the load-bearing capacity of the structure, and in serious case would lead to collapse of the entire floor."[11]

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[10] *Ming Pao*, 31 May 2018

[11] *Apple Daily*, 30 May 2018

Appointment of the Commission of Inquiry

26. The possibility that the station box structure may be unsafe caused such public disquiet that on 10 July 2018 the Chief Executive in Council appointed the authors of this final report, Michael John Hartmann (as Chairman) and Professor Peter George Hansford, to constitute a commission of inquiry (the 'Commission') pursuant to the provisions of the Commissions of Inquiry Ordinance, Chapter 86 (the 'Ordinance'). The Commission was formed to conduct an inquiry in respect of the station box structure only. Its instruments of appointment are attached to the report as **Annexure A**. The original Terms of Reference directed that the inquiry was to be focused on the following works –

> "the diaphragm wall and platform slab construction works at the Hung Hom Station Extension under the MTR Corporation Limited ('MTRCL')'s Contract No. 1112 ('Contract') of the Shatin to Central Link Project"

27. Some seven months later, however, when further concerns were raised as to works carried out to construct NAT, SAT and HHS – such works also falling under Contract 1112 – the Chief Executive in Council determined it to be in the public interest to extend the Commission's Terms of Reference to include these latter works. Extended Terms of Reference were therefore issued on 19 February 2019.

28. While this report will speak to the Commission's consolidated mandate, for purposes of clarity the Terms of Reference given to the Commission on 10 July 2018 will be referred to as the 'Original Terms' and those given on 19 February 2019 as the 'Extended Terms'.

29. The Commission's Original Terms were defined as follows –

> "(a) (i) to inquire into the facts and circumstances surrounding the steel reinforcement fixing works, including but not limited to those works at locations that have given rise to extensive public concern about their safety since May 2018;
>
> (ii) to inquire into the facts and circumstances surrounding any other works which raise concerns about public safety; and

(iii) to ascertain whether the works in (i) and (ii) above were executed in accordance with the Contract. If not, the reasons therefor and whether steps for rectification have been taken;"

30. As part of its inquiry, under the Original Terms, the Commission was to conduct a review into –

"(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; "

31. Finally, in light of its inquiry and review, the Commission was to submit to the Chief Executive "recommendations on suitable measures with a view to promoting public safety and assurance on quality of works".

Appointment of a supporting legal team

32. On the same date as the appointment of the Commission, that is, on 10 July 2018, Messrs Lo & Lo were appointed as solicitors for the Commission. Later in the same month, Ian Pennicott SC, QC was appointed as leading counsel for the Commission, and two junior counsel, Solomon Lam and Calvin Cheuk, were appointed as counsel for the Commission. The supporting legal team assisted the Commission throughout the inquiry under both the Original and Extended Terms.

Appointment of experts to assist the Commission

33. In order to discharge its mandate under the Original Terms, the Commission engaged two independent experts, both from the United Kingdom ('UK') –

a. Professor Don McQuillan was engaged by the Commission on 13 September 2018 to provide expert evidence in respect of structural engineering matters. Professor McQuillan, President of the Institution of Structural Engineers[12], a Fellow of the Institution of Civil Engineers and a Fellow of the Chartered Institution of Highways and Transportation in the UK, has over 40 years of experience in the engineering field. He specialises in forensic engineering and project managing multi-disciplinary projects. Professor McQuillan is a director of RPS Consulting Engineers, and a Royal Academy of Engineering Visiting Professor of Engineering Design at Queen's University Belfast. He submitted his expert report to the Commission on 7 January 2019 and gave evidence before the Commission on 18 January 2019.

b. Mr Steve Rowsell was engaged by the Commission on 17 September 2018 to provide assistance in respect of matters of project management. A Fellow of the Institution of Civil Engineers and a member of its Procurement Panel as well as a Past President of the Chartered Institution of Highways and Transportation in the UK, Mr Rowsell has worked for over 40 years in the public and private sectors on major transport infrastructure projects (in both the highways and rail sectors). Mr Rowsell has served as Head of Procurement in the UK£15 billion 'Crossrail' underground railway project in London. He is a director of the consultancy Rowsell Wright Limited. He submitted his expert report on 20 December 2018 and gave evidence before the Commission on 10 January 2019.

34. Both Professor McQuillan and Mr Rowsell were further engaged to assist the Commission in discharging its mandate under the Extended Terms. In this latter respect –

a. Professor McQuillan submitted his expert report to the Commission on 6 December 2019 and gave evidence before the Commission on 8 and 9 January 2020.

[12] Professor McQuillan was a Senior Vice President of the Institution of Structural Engineers when he was engaged by the Commission and succeeded as President from January 2020.

b. Mr Rowsell submitted his expert report to the Commission on 23 August 2019 and gave evidence before the Commission on 10 October 2019.

Site visits

35. In respect of the Original Terms, two site visits were conducted to enable the members of the Commission to directly acquaint themselves with the physical parameters of their mandate. The first visit was conducted on 21 September 2018 by the Chairman, who was accompanied by counsel and solicitors for the Commission. The second visit was conducted on 21 October 2018 by the two Commissioners. On both occasions, representatives of MTRCL gave a briefing, followed by a site walk and a debriefing.

The involved parties

36. The involved parties under the Original Terms included –

a. THB, HyD, Development Bureau ('DEVB') and Buildings Department ('BD') (Government);

b. MTRCL;

c. Leighton;

d. Intrafor Hong Kong Limited ('Intrafor');

e. China Technology Corporation Limited ('China Technology');

f. Fang Sheung Construction Company ('Fang Sheung');

g. Atkins China Limited ('Atkins'); and

h. PYPUN.

37. The following parties, although not considered to be 'involved parties', participated in the proceedings before the Commission in order to give assistance to it –

a. Hung Choi Company Limited ('Hung Choi');

b. Rankine Engineering Company Limited; and

c. BOSA Technology (Hong Kong) Limited ('BOSA').

The setting of rules to govern procedure and practice

38. A preliminary hearing, essentially administrative in nature, was held on 24 September 2018. At that hearing, pursuant to section 4(1)(m) of the Ordinance, the Commission set down rules to govern its procedure and practice. The rules are annexed to this report as **Annexure B**.

The hearing of evidence

39. In respect of the Original Terms, the Commission commenced hearing evidence on 22 October 2018. The last day on which evidence was given was 18 January 2019. Closing submissions were made on 28 and 29 January 2019.

40. Allowing for short adjournments, the longest being over the Christmas and New Year period, the Commission sat for a total of 46 days. In that time, it heard the evidence of 65 witnesses who testified as to matters of fact and seven witnesses who were accepted as independent experts.

41. Three of the witnesses of fact gave their evidence by way of video link: one from England, two from Australia.

42. The Commission decided not to cross-examine 14 factual witnesses but their witness statements were admitted as evidence.

43. A list of the witnesses who testified before the Commission in respect of the Original and / or Extended Terms, together with the dates of testimony, is at **Annexure C**.

The 'Holistic Assessment Strategy'

44. In December 2018, several weeks after the Commission had begun hearing evidence, MTRCL submitted a set of proposal to HyD – 'A Holistic Proposal for Verification & Assurance of As-constructed Conditions and Workmanship Quality of the Hung Hom Station Extension (EWL Platform Slab, NSL Platform Slab and the Connecting Diaphragm Walls)' (the 'Holistic Proposal'). As the Commission understands it, the Holistic Proposal was put forward in light of two concerns: first, concern as to the actual quality of workmanship in the construction of the station box structure and, second, concern that Leighton, the contractor, had adopted revised – unauthorised – building designs. The central purpose of the Holistic Proposal was therefore to verify the 'as-constructed' condition and workmanship of the station box structure and to assure the structural integrity of the Hung Hom Station Extension.

45. The Government accepted the proposal and a task force was put together. The task force included representatives of MTRCL, BD, HyD and a small group known as the 'Expert Adviser Team for the SCL Project' (the 'Expert Adviser Team').

46. The task force was entirely independent of the Commission and not in any way answerable to the Commission. That said, investigative information obtained by the task force was made public and its overall findings were of very considerable assistance to the Commission in discharging its mandate.

47. By way of an overview, the Holistic Proposal was divided into three stages –

a. *The first stage (the desktop exercise).* This consisted essentially of consolidating all available documentary evidence, such as construction records, and comparing them with Leighton's amendment drawings.

b. *The second stage (physical examination by means of opening up).* This consisted essentially of four different exercises –

   i. First, certain sections of the EWL slab were opened up. This was where, in the opinion of the task force, the evidence as to

what had actually been constructed was insufficient. The purpose of this first exercise was therefore to verify the as-constructed conditions.

ii. Second, randomly selected areas of where the EWL and NSL slabs connected with the diaphragm walls were opened up in order to assess the workmanship of the coupler connections buried in the concrete in those areas, doing so by way of physical inspection and a test known as 'PAUT': the phased array ultrasonic test. The number of areas to be opened and their locations were based on a statistical approach, using random sampling.

iii. Third, construction records related to the diaphragm walls were studied in order to confirm the structural integrity of the structures.

iv. Fourth, physical investigation of the following took place: the examination of honeycombing in the EWL slab soffit, the examination of certain gaps, the examination of possible sub-standard workmanship in shear links and the examination of certain horizontal construction joints.

c. *The third stage (structural assessment).* The purpose of this exercise was to use the information obtained in the first and second stages, employing statistical analysis where necessary, in order to determine the structural integrity of the station box structure and, insofar as may be necessary, to identify the nature and extent of remedial works that may be required.

48. Physical investigating work, including opening up the concrete to check the integrity of coupler connections, was still in progress when the Commission completed hearing evidence pursuant to its Original Terms in January 2019. Indeed, it was a principal reason why the Commission determined that it was not possible to issue a final report in early 2019 and that an interim report only should be issued.

49. The ‘Final Report on Holistic Assessment Strategy for the Hung Hom Station Extension’ (the ‘Holistic Report’) was completed in July 2019, some four months after the Commission had issued its interim report.

50. In the Holistic Report, it was recommended that certain extra construction works were required in order to rectify the poor workmanship issues that had been discovered and, importantly, as it was expressed by counsel for the Government, in order to achieve the safety level required in the Code of Practice for Structural Use of Concrete 2004 (the ‘Code’), for meeting the requirements of the Buildings Ordinance, Chapter 123 and the established good practice of engineering design.

51. The extent of the required extra construction works – the ‘suitable measures’, as they were called – were materially reduced from those that had been originally determined. The decision to reduce the extent of the works lay in the decision to base calculations on a set of revised design assumptions. The revised criteria, it was decided, complied with MTRCL’s ‘New Works Design Standard Manual’ (‘NWDSM’) and also met the requirements of the Code.

52. Based on the revised assumptions, these suitable measures included the installation of drilled-in bars, local thickening of slabs, reinstating shear links, adding columns and grouting work.

53. The detailed design for the implementation of the suitable measures was accepted by the Government and work was commenced.

54. As the Commission understands it, it is anticipated that all the suitable measures will have been completed by about the end of June 2020, that is, within three months of the submission of this final report to the Chief Executive.

55. More will be said of the decision to undertake suitable measures and its consequences later in this report.

An initial extension of time

56. The Original Terms of the Commission required it to submit a report to the Chief Executive within six months, that is, by 9 January 2019. However, various factors came together to make it impossible for the Commission to discharge its responsibilities within the given timeframe. The main factors may be summarised as follows –

a. The identification of a suitable second Commissioner, that is, a person with a well-recognised engineering background, to sit with the Chairman of the Commission, proved to be a challenging exercise. Almost all of the persons in Hong Kong with suitable engineering background were either not available due to prior commitments or might be excluded because of conflict of interest. In the end, a Commissioner was appointed from overseas, that is, Professor Hansford. However, because of prior commitments, Professor Hansford was unable to come to Hong Kong to attend hearings until 22 October 2018 and had to be away from Hong Kong for two periods of time during the hearings in 2018.

b. Difficulty was also encountered in identifying suitable experts who did not have any conflict of interest to assist the Commission in the inquiry. The assistance of an independent expert in structural engineering and another in project management was considered essential. Again, to avoid actual or perceived conflict of interest, two overseas experts, that is, Professor McQuillan and Mr Rowsell, were eventually identified and offered appointment. As the negotiation of terms and compliance with appointment procedures took time, Professor McQuillan and Mr Rowsell were not appointed until 13 and 17 September 2018 respectively.

c. As the Commission took forward its investigations, it became clear that the number of issues and their complexity, as well as the number of witnesses to be called to give evidence at hearings, would require substantially more time than originally expected.

57. It was, however, calculated that all evidence could be completed and final submissions made by about 25 January 2019. Thereafter, the

Commission would require one month to write its report. On this basis, on 21 November 2018, the Chairman of the Commission wrote to the Chief Executive to seek an extension of time to 26 February 2019 to submit the Commission's report. The request was approved by the Chief Executive in Council on 4 December 2018.

Uplifting of proceedings to the Commission's website

58. To enable the public to remain fully informed on a daily basis of the proceedings before the Commission, the transcript of all testimony given by witnesses of fact was uplifted to the Commission's website[13] together with their written statements. Equally, the transcript of all testimony given by the expert witnesses was uplifted together with their expert reports. This was subject to one limitation. Annexures to statements and reports were not uplifted on the basis that they were often so voluminous as to make it impracticable.

59. The same procedure of uplifting evidence was followed in all later hearings of the Commission.

New concerns in respect of Contract 1112

60. On 30 January 2019, the day after the Commission's hearings under the Original Terms had been completed, it was announced by the Government that further failings had been discovered in respect of construction works under Contract 1112. The concerns were focused on the as-constructed state of works situated in three areas: NAT, SAT and HHS. Of particular concern was the fact that a very large number of documents designed to confirm that the works had been carried out and had been carried out to the required standard were missing. These documents were known as RISC forms, 'RISC' standing for 'Request for Inspection, Survey and Check'.

61. At a meeting of the Legislative Council Subcommittee on Matters Relating to Railways held on 1 February 2019, MTRCL disclosed that only 27% of the RISC forms for steel reinforcement works in NAT, 64% of the forms for steel reinforcement works in SAT and 37% of the forms for steel

[13] https://www.coi-hh.gov.hk

reinforcement works in HHS had been located. In short, well over 50% of the RISC forms had never been generated or were missing.

62. The lack of records caused considerable disquiet, not only as to possible failings in monitoring and control mechanisms but as to the quality and extent of work actually done and, by way of logical deduction, whether any issues as to safety arose.

63. On 1 February 2019 and 5 February 2019 respectively, the Secretary for Transport and Housing and the Chief Executive said that the Government would not agree to the commissioning of SCL unless, and until, safety of construction was assured.

64. On the basis that these further concerns all fell within the ambit of Contract 1112, it was determined that the best way forward was to extend the Commission's Terms of Reference. The Chief Executive in Council approved the Extended Terms on 19 February 2019.

65. The Extended Terms enlarged the Commission's mandate to "the construction works at NAT, SAT and HHS". In this regard, it directed the Commission –

> "(i) to inquire into the facts and circumstances surrounding any problem relating to the steel reinforcement fixing or concreting works, including but not limited to any lack of proper inspection, supervision or documentation of such works undertaken, any lack of proper testing of the materials used for such works and of proper documentation of such testing, and any deviation of such works undertaken from the designs, plans or drawings accepted by the Highways Department or the Building Authority;
>
> (ii) to inquire into the facts and circumstances surrounding any works or matters which raise concerns about public safety or substantial works quality; and
>
> (iii) to ascertain whether the works and matters involved in [(i) and (ii)] above were executed in accordance with the Contract. If not, the reasons therefor and whether steps for rectification have been taken;"

66. In light of its inquiries, the Commission was also to review –

"(i) the adequacy of the relevant aspects of the 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;"

67. Finally, as with the Original Terms, the Commission was to make recommendations on suitable measures to promote public safety and assure the quality of works.

68. The Commission was given a further six months to enable it to submit its final report: that is until 30 August 2019.

The 'Verification Study'

69. Of direct relevance to the Commission's Extended Terms is the fact that in May 2019 MTRCL submitted a further set of proposals to the Government to carry out a comprehensive investigation in order to verify the as-constructed conditions of NAT, SAT and HHS – 'Verification Proposal of As-constructed Conditions of NAT, SAT and HHS' ('Verification Study'). The proposals were accepted by the Government.

70. There were two parts to this study: first, the verification of construction records with a view to identifying any gaps in site inspection records, material testing records and design change records, and the verification of the as-constructed conditions of the structures; and second, a structural review conducted with the aim of identifying suitable measures, if required, to ensure structural integrity.

71. More will be said of the Verification Study later in this report.

The Commission's interim report

72. The original terms of appointment of the Commission included the power, if the Commission thought it advisable to do so, to submit to the Chief Executive an interim report. Having regard to the fact that a final report would not be issued for a number of months, the Commission considered it appropriate to issue an interim report. That report was submitted to the Chief Executive on 25 February 2019. There were two leading reasons for issuing the interim report. Those reasons may be summarised as follows –

a. *Making recommendations to improve project management.* Failings in workmanship and supervision in the construction process, some of a serious nature, had been identified. The nature of those failings had arisen in the course of evidence and, in greater or lesser measure, they extended from individual steel fixers to senior management. The Commission's mandate, however, was not simply to identify failings and then sit back. Its mandate included making recommendations to correct those failings and to improve management of the building process. In this latter regard, experts in the field had given evidence and, in light of that evidence, the Commission considered it to be in the public interest to make recommendations based on lessons learnt and to do so without delay. Recommendations were therefore included in the interim report and a number were promptly adopted. In response, in the closing submissions in respect of the Original Terms, it was confirmed that MTRCL had already established a cross-disciplinary steering group to oversee the implementation of the Commission's recommendations[14]. In addition in submissions made on behalf of the Government, the following was said[15] –

> "The Government welcomes the Commission's recommendations in its Interim Report on strengthening the existing supervision, monitoring, control and management systems of the Government.

[14] See written submissions dated 17 January 2020

[15] See written submissions dated 17 January 2020

Since the making of the Interim Report, the Government has been proactively implementing the improvement measures suggested by the Commission and Mr Steve Rowsell [i.e. the Commission's project management expert]."

b. *Seeking to allay public concern as to the essential integrity of the station box structure.* While certain of the failings in workmanship and in supervision identified by the Commission were serious, on a consideration of all the evidence put before it, the Commission was nevertheless sure that the failings were not so profound as to render the station box structure unsafe. To the contrary, despite those failings, the Commission was satisfied that the structure remained safe. In this regard, the Commission had had the benefit of hearing evidence from a number of recognised engineering experts, all of whom gave constructive, helpful evidence. Not all the experts were in full agreement in respect of all matters. However, on a careful consideration of their opinions, read in conjunction with all relevant evidence, the Commission concluded that the structure – especially in light of its conservative design which gave it a very large degree of redundancy and robustness – was safe.

73. Concerning the issue of structural integrity set out in sub-paragraph (b) above, the Commission heard a good deal more evidence on the subject in the course of the hearings under the Extended Terms. That evidence, however, has not in any way served to alter the Commission's findings made in the interim report that the station box structure is safe.

Further site visits

74. Two site visits were conducted to enable the members of the Commission to directly acquaint themselves with the physical parameters of their mandate under the Extended Terms. One visit was conducted on 2 April 2019 by the Chairman, who was accompanied by counsel and solicitors for the Commission. The other visit was conducted on 24 May 2019 by both Commissioners. On both occasions, representatives of MTRCL gave a briefing, followed by a site walk and a debriefing.

Further extensions of time

75. In extending the Commission's Terms of Reference, the Chief Executive in Council required it to submit its final report by 30 August 2019. As it transpired, however, further extensions of time were to be required to enable the Commission to discharge its mandate.

76. A principal reason why further extensions were required lay in the fact that MTRCL's two reports – the Holistic Report and the Verification Report – were of crucial importance in enabling the Commission to submit its final report. That final report, however, could not be submitted until all involved parties had themselves been given a reasonable opportunity to study MTRCL's two reports and – through their counsel and, if relevant also through their experts – had been given an opportunity to make representations to the Commission. Regrettably, however, there were understandable difficulties in obtaining the immediate services of counsel and experts, all of whom, as busy practitioners, had committed themselves to other work and who therefore required time to make themselves fully available.

77. As it was, however, the two MTRCL reports were not received until 18 July 2019. Those reports both contained findings that all the relevant structures, that is, the Hung Hom Station Extension box structure, NAT, SAT and HHS were safe – but safe only for the "purpose of ongoing construction activities", those construction activities constituting "suitable measures" – the nature and extent of such works, it seems, being finally determined by MTRCL and the Government.

78. It should be said that the nature and extent of the "suitable measures" that were required were in large measure the consequence of statistical analysis.

79. In light of these events, it became administratively impossible before the then extended report submission deadline of 29 November 2019 to bring all the parties back before the Commission in order for the following procedures to be completed: to allow all evidence to be considered, to permit final submissions to be made by counsel and, finally, for the Commission itself to be given time to write its report. The Commission therefore sought one final extension of time until 31 March 2020 to submit its final report and that request was approved by the Chief Executive in Council.

The involved parties under the Extended Terms

80. The involved parties under the Extended Terms are listed below, those already an involved party under the Original Terms are marked with an asterisk –

a. Government*;

b. MTRCL*;

c. Leighton*;

d. Fang Sheung*;

e. PYPUN*; and

f. Wing & Kwong Steel Engineering Co Limited ('Wing & Kwong').

81. During the works, employees of Loyal Ease Engineering Limited ('Loyal Ease')[16] were designated to work for Wing & Kwong and some of them gave evidence before the Commission during the substantive hearing.

Hearing evidence in respect of the Extended Terms

82. In respect of the Extended Terms, the Commission held a preliminary hearing on 6 May 2019 to set down the rules of procedure and practice for the substantive hearing. This set of rules of procedure and practice is at **Annexure D** to this report. For the substantive hearing, the Commission sat for a total of 32 days to hear the evidence of 37 factual witnesses and nine witnesses who were accepted as experts, one expert testifying by video link from England. The Commission decided not to cross-examine three factual witnesses but their witness statements were admitted as evidence. A list of these three witnesses is at Annexure C.

[16] Loyal Ease was a 'labour-only' sub-contractor to Wing & Kwong.

83. The substantive hearing was in effect held for three separate periods of time. First, factual evidence was heard in May and June 2019. Second, in September and October 2019, evidence related to matters of dispute concerning statistical analysis and to matters of project management was heard. Third, evidence as to matters of structural engineering was heard in January 2020. Final closing submissions were made on 22 and 23 January 2020.

Chapter 2

Considerations of law

The nature and purpose of commissions of inquiry

84. First, and fundamentally, it is to be understood that a commission of inquiry constitutes neither a criminal proceeding in which guilt and innocence are determined nor a civil action in which rights are adjudicated. A commission of inquiry has no power to establish either criminal culpability or civil responsibility for damages. In this regard, it has been said that the report of a commission of inquiry is sterile of legal effect. In *Canada (Attorney-General) v Canada (Commission of Inquiry on the Blood System)*[17], the Supreme Court of Canada noted that –

> "… although the findings of a commissioner may effect public opinion, they cannot have either penal or civil consequences. To put it another way, even if a commissioner's findings could possibly be seen as determinations of responsibility by members of the public, they are not and cannot be findings of civil or criminal responsibility."

85. What then is the function of a commission of inquiry? Section 2 of the Commissions of Inquiry Ordinance states that –

> "The Chief Executive in Council may appoint one or more Commissioners… to inquire into the conduct or management of any public body, the conduct of any public officer or *into any matter whatsoever which is, in his opinion, of public importance*." [emphasis added]

86. In terms of the Ordinance, it is for the Chief Executive in Council, having given a commission its mandate, to direct to whom and when the commission will – having conducted its investigation – submit a report containing its findings[18].

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[17] [1997] 3 SCR 440, paragraph 34

[18] See section 3 of the Ordinance

87. A commission of inquiry is therefore essentially an investigative, fact-finding body. Its powers (given to it under the Ordinance) are inquisitorial. A commission has powers not only to make findings of fact but also to give statements of opinion derived from those findings. More than that, integral to its mandate, is the invariable power to make recommendations which, if adopted by the Executive and / or Administration, seek to ensure that any failings or shortcomings identified in the commission's report are avoided in the future.

88. A commission is obliged of course to give reasons for its findings and those reasons must be adequate and intelligible. But a dense thesis is not required.

89. Today, in common law jurisdictions, commissions of inquiry are very much part of the fabric of public life. When any matter of public concern – or, as the Ordinance expresses it, 'any matter whatsoever of public importance' – arises, a commission constitutes the means by which an independent but public investigation of relevant happenings can be undertaken and, if relevant, recommendations made so as to restore public confidence.

90. While an inquiry by a commission – a public inquiry – is not equivalent to a criminal or civil trial, and while evidence given by any person before a commission is not admissible against that person in any later civil or criminal proceedings[19], it does not follow that a commission is prohibited from making any adverse findings against individual parties. A commission has the power to make findings of misconduct based on factual findings provided they are necessary to fulfil the purpose of the inquiry as contained in the Terms of Reference. As the Supreme Court of Canada put it in the matter cited in paragraph 84 above –

> "I doubt that it would be possible to meet the need for public inquiries whose aim is to shed light on a particular incident without in some way interfering with the reputations of the individuals involved."

[19] See section 7 of the Ordinance

91. In *Goodman International v Hamilton*[20], the Supreme Court of Ireland held that commissions of inquiry, while they are not involved in the administration of justice and have no power to determine criminal or civil liability, should not be inhibited from making findings or recommendations merely because of a potential impact on criminal or civil proceedings.

92. In the present case, while the Commission has been careful not to seek to determine criminal or civil liability, in order to give a full and fair account of its investigation it has had to identify certain courses of conduct which it has considered to be worthy of criticism. In the result, some damage to the reputation of public bodies, corporations and individuals has been the price that has had to be paid in order to analyse and report upon events that have caused such extensive public disquiet in respect of the on-going construction of key infrastructure works.

93. It should also be said that during the course of the inquiry, allegations of significant blameworthy conduct were made by certain parties against others. In light of the Commission's Terms of Reference, such allegations were inevitable. The Commission, however, has striven to ensure that all parties subject to such criticism have been dealt with in a fair manner. The fairness of the inquiry proceedings has at all times been a paramount consideration.

The Commission's Terms of Reference

94. Under Hong Kong law, commissions of inquiry must act in accordance with their terms of reference, those terms being the mandate given to them by the Chief Executive in Council. They have no power to act outside of their mandate. In its consultation paper *Effective Inquiries*[21], the British Government emphasised that –

> "Terms of reference are a crucial factor in determining [an inquiry's] ambit, length, complexity, cost and, ultimately, its success."

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[20] [1992] 2 IR 542

[21] For the reference to this citation see *Public Inquiries* by Jason Beer QC (Oxford University Press), first published in 2011, page 73.

95. As stated in Chapter 1, the Commission's Original Terms were given to it on 10 July 2018, the Extended Terms were given to it on 19 February 2019. The Extended Terms read as follows –

"Regarding the MTR Corporation Limited ('MTRCL')'s Contract No.1112 ('Contract') of the Shatin to Central Link Project –

(a)(1) *in respect of the diaphragm wall and platform slab construction works at the Hung Hom Station Extension,*

(i) to inquire into the facts and circumstances surrounding the steel reinforcement fixing works, including but not limited to those works at locations that have given rise to extensive public concern about their safety since May 2018;

(ii) to enquire into the facts and circumstances surrounding any other works which raise concerns about public safety; and

(iii) to ascertain whether the works in (1)(i) and (ii) above were executed in accordance with the Contract. If not, the reasons therefor and whether steps for rectification have been taken;

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

(i) to inquire into the facts and circumstances surrounding any problem relating to the steel reinforcement fixing or concreting works, including but not limited to any lack of proper inspection, supervision or documentation of such works undertaken, any lack of proper testing of the materials used for such works and of proper documentation of such testing, and any deviation of such works undertaken from the designs, plans or drawings accepted by the Highways Department or the Building Authority;

(ii) to inquire into the facts and circumstances surrounding any works or matters which raise concerns about public safety or substantial works quality; and

(iii) to ascertain whether the works and matters involved in (2)(i) and (ii) above were executed in accordance with the Contract. If not, the reasons therefor and whether steps for rectification have been taken;

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

(i) the adequacy of the relevant aspects of the 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…" [emphasis added]

96. In looking to the ambit of the two mandates, it helps first to consider the circumstances as they were understood to be at the time when they were given to the Commission.

97. It may be said that the majority of public inquiries in Hong Kong have been set up to investigate the true nature and cause of events that have already quite clearly occurred; for example, the causes behind the known collision of vessels with loss of life or the causes behind the discovery of excessive levels of lead in the drinking water supply to public rental housing developments. In the present inquiry, however, when the Commission was given both its original mandate and its extended mandate, there was at the time, in respect of each considered separately, no clear and obvious evidence that the construction works in question were in imminent danger of collapse nor that there had been such a flagrant and extensive avoidance of contractual obligation, or obligations under the various building codes, that it was manifest that no trust could be placed in the integrity of the construction works.

98. The original mandate given to the Commission – the mandate concerning the diaphragm wall and platform slab construction works – required the Commission to undertake three primary tasks which may be summarised as follows: first, to inquire into the facts and circumstances surrounding the steel

reinforcement fixing works "which have given rise to extensive public concern about their safety"; second, to inquire into the facts and circumstances surrounding other works "which raise concerns about public safety"; third, to ascertain whether the works made the subject of the first and second tasks were executed in accordance with Contract 1112; if not, the reasons why and whether steps for rectification have been taken.

99. The extended mandate given to the Commission – the mandate concerning the North and South Approach Tunnels and the Stabling Sidings – was to similar effect. It also required the Commission to undertake three primary tasks which may be summarised as follows: first, to inquire into the facts and circumstances surrounding problematic construction works and lack of proper documentation; second, to inquire into the facts and circumstances surrounding any works or matters which raise concerns about public safety or quality of works; third, to ascertain whether the works made the subject of the first and second tasks were executed in accordance with Contract 1112; if not, the reasons why and whether steps for rectification have been taken.

100. In respect of the original and extended mandates given to the Commission, the first and second tasks were clearly independent substantive tasks that required an independent determination of the relevant facts and circumstances and were not to be considered merely for purposes of determining whether or not there had been contractual compliance. In this regard, it is to be remembered that the Commission has no power to determine contractual liability. It is an inquisitorial body required to look into matters of "public importance". That matter of public importance, stated so in the Terms of Reference, was extensive public concern as to the structural integrity of the construction works which had been made the subject of the Commission's consideration.

101. In light of the Commission's findings made in respect of the three tasks given to it pursuant to the original and extended mandates, the Commission was then required to conduct an important review. By way of brief summary, that review required the Commission to look to the adequacy of management and supervision systems as well as monitoring and control mechanisms.

102. Pursuant to both of its mandates, the Commission has been required "to inquire into the facts and circumstances surrounding" identified construction

works that, in the first place, have already "given rise to extensive public concern about their safety" and, in the second place, by reason of investigations made, now "raise concerns about public safety".

103. The requirement to inquire into "the facts and circumstances surrounding" an event or a series of events could not be broader in its meaning or intent. It requires determination of all material relevant matters, both as to what happened in the construction of the works and the consequence of those happenings: for example, have they (deservedly or undeservedly) raised concerns as to the structural integrity of the works?

104. In discharging its mandates, therefore, in those places where reference was made to 'safety' or 'public safety', the Commission has had to inquire into all surrounding circumstances of relevance and in doing so, has had to consider the fundamental question: 'If there has been negligence or illicit activity in the construction of the works, has it been of such extent as to raise real concerns as to the structural integrity of those works?'

105. It is this Commission's obligation to conduct a public inquiry, an inquiry that concerns a matter of public importance, and that matter goes directly to the issue of public safety.

106. The Commission has been required to determine, by looking into the facts and circumstances surrounding the construction works, whether there have been any failings in completing those works – for example, negligent conduct or illicit activity – and, if so, whether, first, those failings have arisen from a failure to meet contractual obligations, as opposed, for example, to a failure in design, and, second, whether such failings have rendered the works unsafe or unfit for purpose or have constituted failings of a lesser degree, failings which have not undermined the structural integrity of the works.

107. Section (b) of the Terms of Reference give to the Commission two additional tasks: first, to investigate and assess 'the adequacy' of relevant aspects of MTRCL's management and reporting systems, and their implementation in the construction works and, second, to investigate and assess 'the extent and adequacy' of the Government's own monitoring and control mechanisms employed in the construction works.

108. Finally, in light of section (b) of the Terms of Reference, the Commission has been required to "make recommendations on suitable measures" with a view to promoting two matters, first, "public safety" and, second, "quality of works". It speaks for itself that, in respect of this specific mandate, no recommendations of any value can be made unless the Commission has first been able to consider the quality of the construction works performed and, second, if there have been shortcomings in the execution of those works; particularly, whether they have endangered public safety.

The Holistic Proposal and the Verification Proposal

109. In conducting its inquiries pursuant to both its Original and Extended Terms, the Commission was very considerably assisted by two investigations carried out by the Government and MTRCL. The first investigation – the Holistic Proposal – sought by way of an exhaustive record check and the physical opening up of parts of the structure to assess the as-constructed condition of the station box structure. The second investigation – the Verification Proposal – sought, in a manner very similar to the Holistic Proposal, to assess the as-constructed condition of the construction works that fell for consideration by the Commission under its extended mandate.

110. The two investigations were entirely independent of the Commission and not in any way answerable to it. That said, the information obtained under both investigations, and the findings made in light of that information, were made public and, in order to discharge its own mandates, those findings, in the view of the Commission, had to be considered by it. In this regard, the Commission has taken into account the judgement of *Ellicott J in Ross v Costigan*, a decision of the Federal Court of Australia –

> "In determining what is relevant to a Royal Commission inquiry, regard must be had to its investigatory character. Where broad terms of reference are given to it, as in this case, the Commission is not determining issues between parties but conducting a thorough investigation into the subject matter."

111. In the reports made pursuant to both investigations, it was recommended that certain discrete construction works – described as 'suitable measures' – should be undertaken in order to cater for poor workmanship issues discovered and to achieve levels of safety required in the Code, that is, the Code

of Practice for Structural Use of Concrete 2004, in order to meet the requirements of the Buildings Ordinance and to satisfy established good practice of engineering design. The Government agreed that the 'suitable measures' should be undertaken and work in respect of those measures was commenced. As mentioned elsewhere in this final report, many of the suitable measures, if not already complete, are nearing completion.

112. It was not, of course, a matter for the Commission to determine whether the suitable measures should be undertaken or not. It was not a matter for the Commission to look to each intended engineering measure in order to rule on its efficacy: that had never been part of its intended mandate. That said, in the view of the Commission, the general nature and extent of those measures – and their overall intended consequence – was a matter for the Commission's deliberation. There were two reasons for this –

a. The Commission was mandated (under both its Original and Extended Terms) to ascertain whether the construction works under consideration had been executed in accordance with the Contract; if not, the reasons therefor and whether steps for rectification had been taken. Clearly, the suitable measures were intended to constitute 'steps for rectification'. Their general nature, therefore, and their general intended effectiveness, were clearly matters that the Commission was required to take into account.

b. More profoundly perhaps, was the question of whether, and, if so, to what degree, the suitable measures, once completed, would have any effect on the safety and / or fitness for purpose of the structures that were the subjects of the Commission's mandates.

113. In respect of this second reason, it was very much the position of the Government that the concept of safety and / or fitness for purpose must be considered as being integral to statutory and regulatory compliance. That, however, was not a position adopted by other involved parties who submitted that safety was to be determined on an independent, forensic basis and not simply on the basis that it was compliant.

Determining material issues

114. During the course of the hearings, involved parties were specifically asked to assist the Commission in presenting further evidence if they believed that it may assist the Commission in discharging its mandate[22]. The Commission is grateful to all those who gave evidence or referred the Commission to other sources of evidence. It has been of great assistance in helping the Commission to discharge its mandate. That said, however, the Commission at all times has sought to provide a lucid report to the Chief Executive that complies with its mandate. That has inevitably required an exercise in determining what matters are of such materiality to the investigation that they must be included in this report and what matters need not be included. The fact, therefore, that certain matters may not have been included in this report does not mean that they have not been considered. Nor does it mean that they have not been taken into consideration in the compilation of this report.

Standard of proof

115. While parties before a commission of inquiry may not be required to discharge any formal burden of proof, a commission must come to its determinations according to the measure of objective standards. That said, in the course of its inquiry it is not bound to a single standard. It may, for good reason, be flexible in this regard.

116. In this inquiry, the Commission will reach its determinations generally on the balance of probabilities. This is the standard adopted in the civil courts of Hong Kong and is a standard adopted in earlier Commissions of Inquiry in this jurisdiction. The balance of probabilities standard, as applied in this inquiry, will mean that the Commission is satisfied an event has occurred if it considers that, on the evidence, the occurrence of the event was more likely than not.

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[22] By way of example, in respect of the Original Terms, the standard wording of the requests commenced in the following manner: "If [your company or institution] believes that there are witnesses (other than the person(s) above) who are also in a position to assist or testify on the above subject matters, [your company or institution] is at liberty to serve witness statements of such persons as well. In fact it would positively assist the Commission's task if [your company or institution] can proactively identify relevant witnesses other than the above person(s) and provide any witness statements in advance."

117. In respect of one issue, however, that is, the primary issue of structural integrity – safety – the Commission will adopt a higher standard of proof. The Commission recognises that it would not be in the public interest – indeed it would manifestly be contrary to public interest – if it was to go no further than to determine that the structural works which are the subject of this expanded inquiry are more likely than not to be safe or unsafe. What (by clear inference) the Terms of Reference require, and what the public seeks, is an unequivocal assurance of safety or a clear statement of concern as to lack of safety. Accordingly, whatever language may conveniently be used in context, any and all findings as to structural safety will be made on the basis that, having given anxious consideration to all relevant evidence, the Commission is satisfied so that it is sure of such findings.

The status of the interim report

118. In receiving its mandate, the Commission was given authority, if it thought fit, to submit an interim report. For the reasons set out in Chapter 1[23], the Commission determined that an interim report was in the public interest and that report was submitted to the Chief Executive on 25 February 2019.

119. This final report, however, is not to be read as an extension to the interim report. This report – written after *all* evidence had been heard and *all* submissions made – stands on its own as the final, full report in respect of the Commission's extended mandate. In so far as any of the matters contained in the interim report have been included in this final report, they are to be taken into account as part of the Commission's final findings.

[23] See paragraphs 72-73 of Chapter 1

Chapter 3

The 'station box structure'

Steel reinforcement

120. The Original Terms were limited to the diaphragm wall and platform slab construction works at the Hung Hom Station Extension under the MTRCL's Contract 1112 of the SCL Project, specifically to the 'steel reinforcement fixing works' which had been the subject of such public concern and 'any other works' within or connected to the station box structure which raised concerns as to their structural integrity.

121. Considered in its fundamentals – as will be explained later in this chapter – the construction works necessary to build the station box structure consisted of the building of vertical structures, that is, diaphragm walls, and between those walls the building of horizontal structures, that is, platform and track slabs, those slabs spanning the distance between the diaphragm walls. Two horizontal slabs were built: an upper slab, the EWL slab, and a lower slab, the NSL slab. The fundamental building blocks of the 'station box' – that is, the diaphragm walls and the two horizontal slabs – are made of reinforced concrete.

122. Reinforced concrete is concrete in which steel is embedded in such a manner that the two materials bind together, acting to resist a range of stresses. On its own, concrete is a material that is strong in compression but weak in tension. Steel, by comparison is a material that is strong in tension. In large structures, by casting steel reinforcing bars – commonly called 'rebars' – into the concrete, the resulting 'reinforced concrete' is able to absorb tensile, shear and compressive stresses.

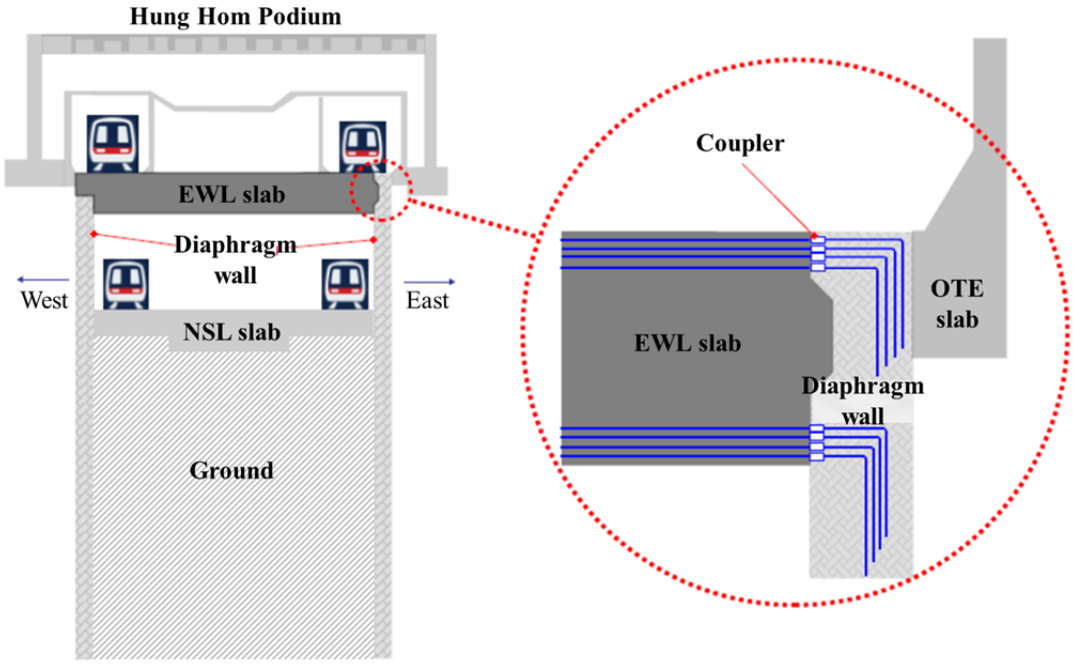
123. In the construction process, the steel reinforcement works would be completed first, the steel fixers working to set designs. **Photograph 1** gives an indication of the dense framework of rebars – several layers thick – that had to be fixed in the construction of the horizontal slabs.

Photograph 1

124. A further pictorial illustration of the required density of rebars is shown in **Diagram 6**. What this diagram, in fact, illustrates can best be understood by having regard to the small inset diagram contained within the red dotted circle. This shows the manner in which the EWL slab was *originally* connected to the east diaphragm wall[24] and connected also to an over track exhaust – 'OTE' – slab. The steel reinforcement in the east diaphragm wall itself is depicted in the centre of the main illustration.

[24] There was in fact a later change to the manner of connection, not by the use of couplers but by the use of through bars. This is a development considered later in this report.

Diagram 6



The construction of the 'station box structure'

125. The integrated diaphragm wall and slab works – the station box structure – have required the construction of the following connected structures –

a. construction of diaphragm walls, these walls running essentially parallel to each other over a distance of some 430 metres ('m');

b. construction (by means of a top down process) of an upper slab (the EWL slab) spanning the distance between the diaphragm walls – over 20 m – and running approximately the same distance as the diaphragm walls; and

c. construction of a lower slab (the NSL slab), this structure also spanning the distance between the diaphragm walls and running approximately the same length as those walls.

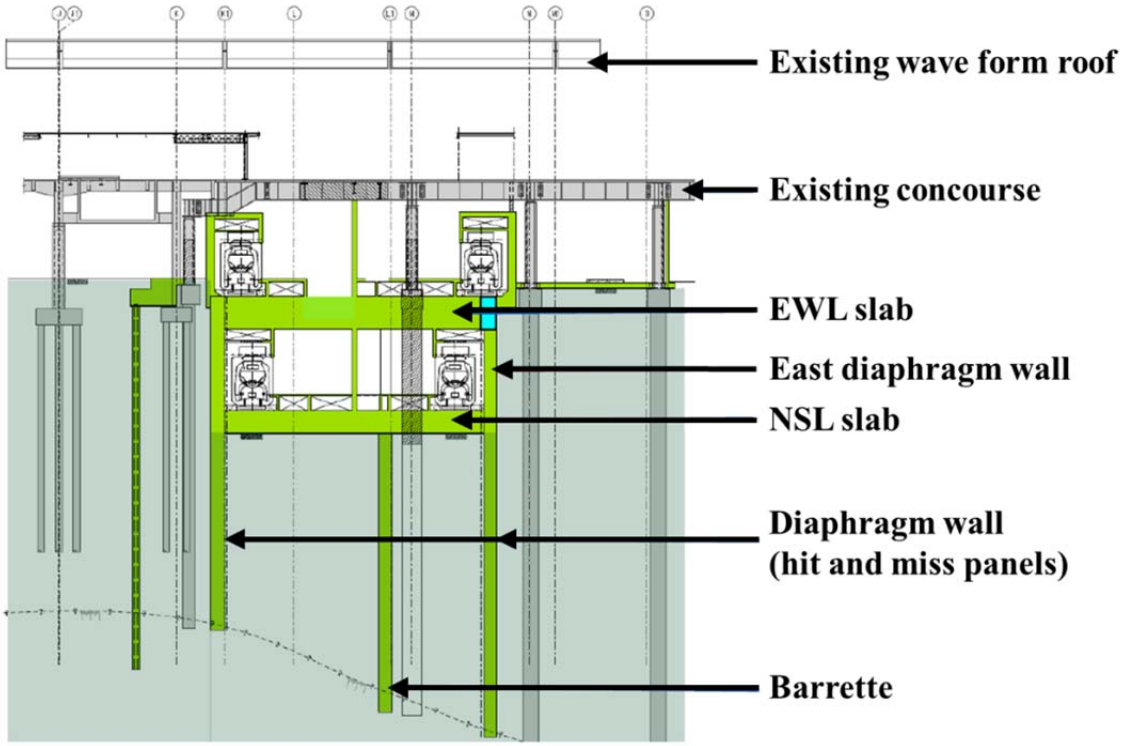
126. The 'top down process' referred to in sub-paragraph (b) above describes a method of constructing an underground box whereby, following

completion of the sides of the box (the diaphragm walls), a top slab is constructed first, in this case the EWL slab. Following construction of the top slab, the soil is excavated below the slab down to the level of the bottom slab. During this stage, the diaphragm walls are supported by temporary propping. When the excavation is complete the bottom slab is constructed, in this case the NSL slab. Finally, the temporary propping is removed as the horizontal force is taken up by the new bottom slab.

127. In the context of this report, a matter that needs to be emphasised is that, according to the structural engineering experts, this phased 'top down process' meant that, for a material period of time in the construction process, the EWL slab was effectively "free spanning" between the diaphragm walls and, in the result, subjected to severe stresses. While the slab was, of course, designed for these extreme conditions, the fact that – some 18 months after completion of the construction work – there were no signs of distress, of cracking or distortion, indicates that, at the time of its most critical loading condition, the EWL slab had not been overstressed. The construction of the lower NSL slab together with loadbearing columns and walls has since that time provided a more benign loading environment. Put simply, the upper EWL slab came through its most testing period of stress without any signs of distress.

128. The following **Diagram 7** gives an indication of the overall structure. The top of the upper EWL slab is located approximately at existing ground level. The top of the lower NSL slab is located some 10.6 m below existing ground level. The EWL slab and the NSL slab span the distance – of over 20 m – between the diaphragm walls.

Diagram 7



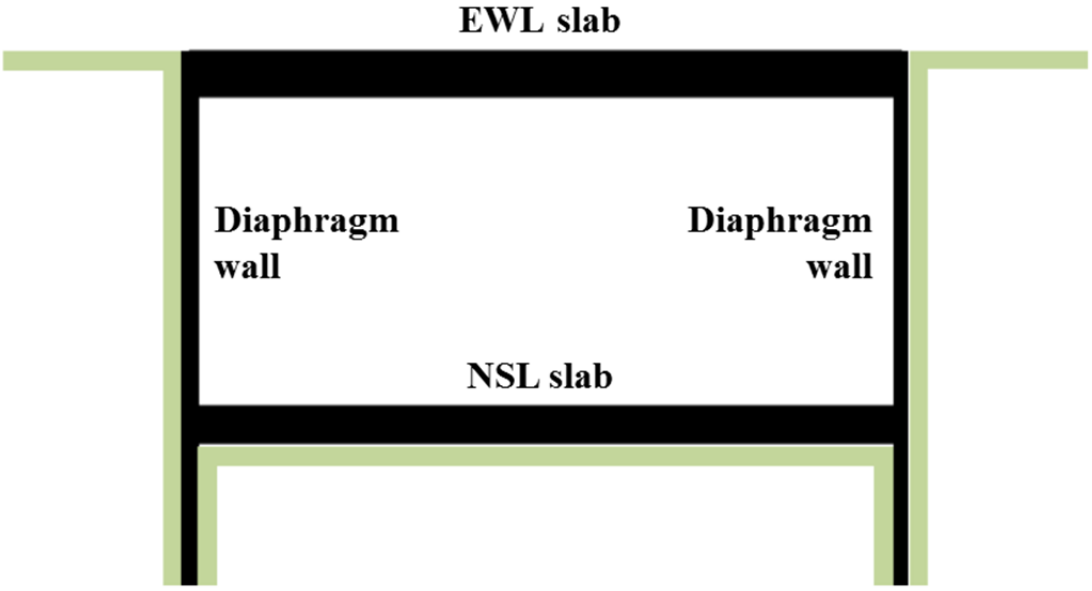
129. It will be seen that the rail lines on the upper EWL slab sit either fully or partially on top of the diaphragm walls so that the diaphragm walls help to support their weight[25].

130. The upper EWL slab is typically 3 m thick and was described during the Commission hearings as an 'enormous' structure. The lower NSL slab is typically 2 m thick. The reason for the slabs being so thick is to provide bulk to resist the head of ground water dispersed by the new underground box structure.

[25] When the structural engineering experts testified before the Commission, it was agreed that, having regard to the design and size of the diaphragm walls and the two horizontal slabs, and taking into account the redundancy built into the overall structure (the prudent over-engineering) the weight of the trains with passengers would add very little stress to the structure: perhaps 10%.

131. Conceptually, as the next diagram – **Diagram 8** – illustrates, what has been constructed is a rigid, box-like tunnel set into the earth. Dr Mike Glover, who testified before the Commission in his capacity as a structural engineering expert, said that box structures of this kind have been shown universally to be capable of surviving very heavy ground movement, remaining effectively in their elastic zone[26].

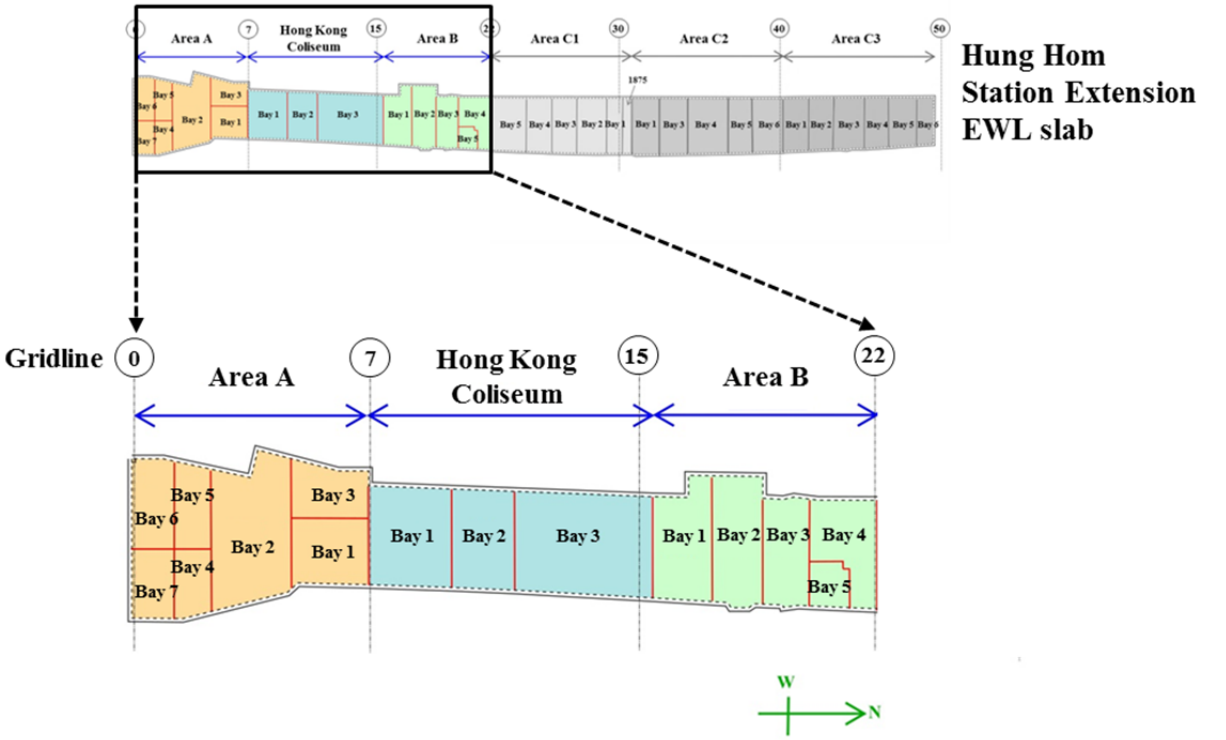
Diagram 8

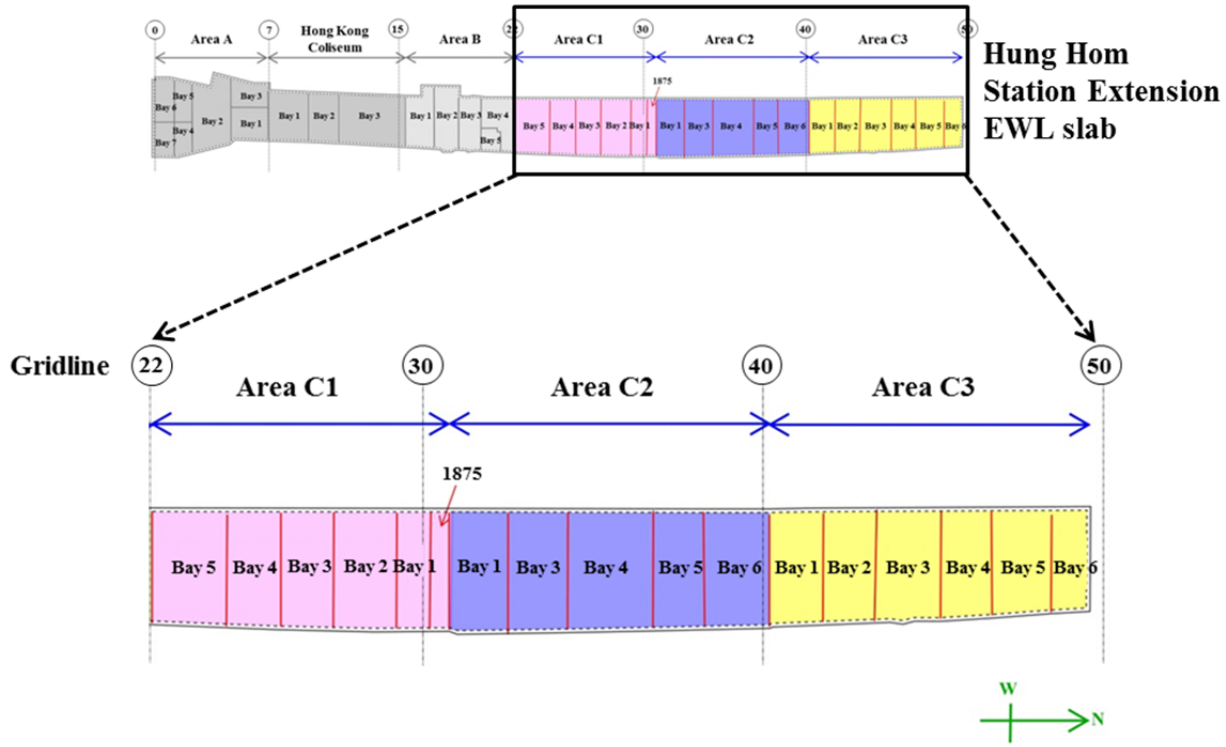


132. To better understand the physical extent – that is, the shape and length – of the EWL slab (and, by indication, the NSL slab below it), the following diagram – **Diagram 9** – sets out the division of the EWL slab for construction purposes into six separate 'areas', each area being divided into separate bays. The 'areas' are Area A, Hong Kong Coliseum, Area B and Areas C1, C2 and C3.

[26] See the testimony of Dr Glover, Day 43 of the substantive hearing under the Original Terms

Diagram 9


Area A
Hong Kong Coliseum
Area B
Area C1
Area C2
Area C3
Hung Hom Station Extension EWL slab
Gridline
0
7
15
22
Bay 5
Bay 6
Bay 2
Bay 4
Bay 7
Bay 3
Bay 1
Bay 1
Bay 2
Bay 3
Bay 1
Bay 2
Bay 3
Bay 4
Bay 5
W
N

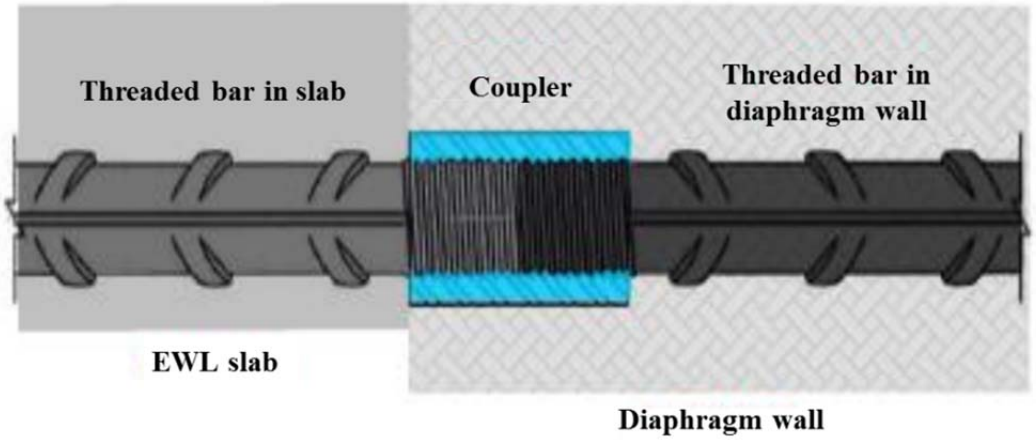

Area A
Hong Kong Coliseum
Area B
Area C1
Area C2
Area C3
1875
Hung Hom Station Extension EWL slab
Gridline
22
30
40
50
Bay 5
Bay 4
Bay 3
Bay 2
Bay 1
Bay 1
Bay 3
Bay 4
Bay 5
Bay 6
Bay 1
Bay 2
Bay 3
Bay 4
Bay 5
Bay 6
W
N

Use of couplers in the station box structure

133. In the main, the technical design for the fixed and secure connections of the reinforced concrete structures making up the station box structure – essentially the diaphragm walls and the upper and lower slabs – required the steel reinforcement in one structure be connected to the steel reinforcement in another by the use of mechanical couplers.

134. In the context of this report, a coupler may be described as a mechanical device used to connect two rebars at their ends. The diagram that follows – **Diagram 10** – depicts a typical coupler connection: the coupler device shown in blue connects a rebar embedded into a diaphragm wall with a rebar embedded into the EWL slab.

Diagram 10



135. As already indicated, both the upper EWL slab and the lower NSL slab are very large structures. In respect of their connection to the diaphragm walls, both slabs are rigidly connected to those walls at each side with ‘shear keys’ and couplers.

136. In Diagram 6 – an illustration depicting the same physical location as Diagram 5, Chapter 1 – the shear key is seen as an indentation into the diaphragm wall where the wall connects with the EWL slab.

The supply of couplers

137. BOSA entered into a contract with Leighton in May 2013 to supply its own proprietary products, namely threaded rebars (rebars supplied by Leighton and threaded by BOSA) and couplers. More specifically, it contracted to provide all necessary labour, supervision, plant, equipment and materials for the supply of couplers and the threading of rebars, including the supply of necessary samples, reports, quality plans and the like. It is important to note that BOSA provided seminars to instruct those who would undertake the work of connecting the rebars into the couplers. In October 2013, BOSA set up a fabrication yard on site.

Classification of rebars and couplers

138. BOSA supplied two types of rebar[27], 'Type A' and 'Type B'. Type A rebars had approximately 10 / 11 threads while Type B rebars had about twice that number, approximately 20 / 21 threads.

139. During the course of the Commission hearings, there was evidence that it may have been an occasional practice, if for any reason Type A rebars were in short supply on site, to convert Type B rebars to Type A rebars by cutting away the 'excess' threads. While (understandably) this was not a practice recommended by BOSA, provided the shortened threads could be screwed into a coupler, the Commission is satisfied it would not have presented any safety risk.

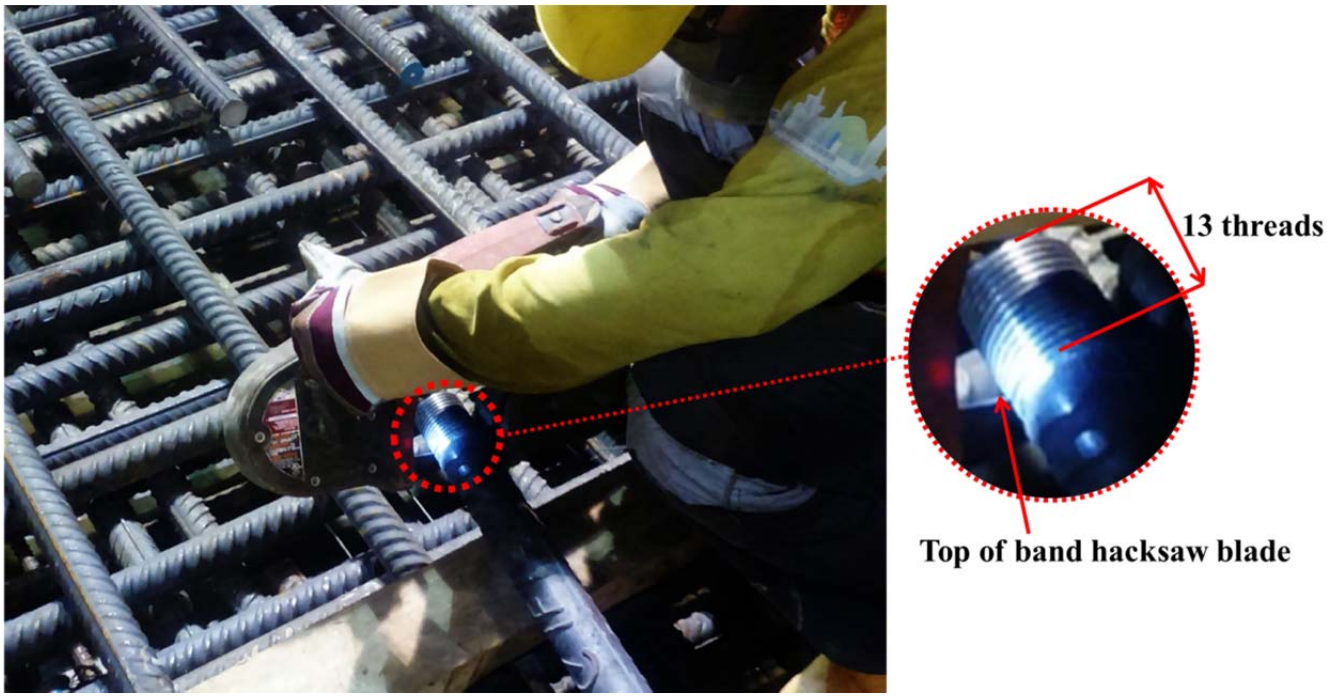
140. A photograph taken by Poon Chuk Hung, Jason ('Jason Poon') of China Technology – **Photograph 2** – a photograph which took on considerable significance during the hearings – appears to show a worker using a cutting machine to trim 10 or 11 threads from a Type B rebar to convert it into a Type A rebar[28]. An analysis of the photograph (duly enlarged) was made by Professor McQuillan, the Commission's expert on matters of structural engineering, to demonstrate that the photograph was not simply of a Type A

[27] Rebars were supplied to BOSA by Leighton. BOSA threaded the Type A and Type B rebars and provided them to the site for steel fixing by Fang Sheung.

[28] This photograph was one of three or four photographs taken one evening by Jason Poon showing the cutting of threads and almost immediately thereafter the installation of what may well be the same rebar into the diaphragm wall.

rebar having its 10 / 11 threads reduced so that it need not be fully screwed into a coupler but was rather of a conversion from Type B to Type A taking place. The photograph appears below.

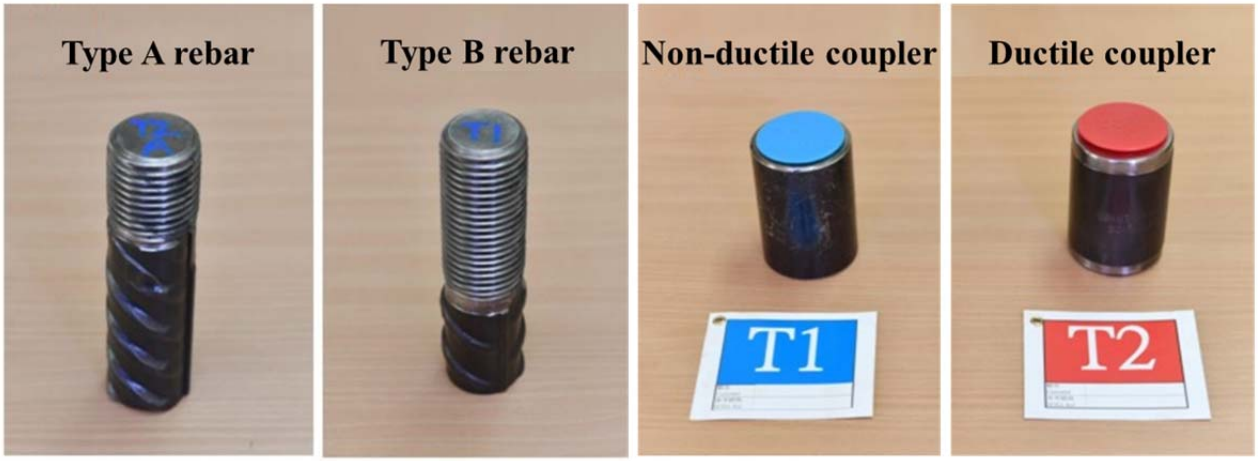
Photograph 2



141. BOSA also supplied two types of couplers, Type I and Type II, being non-ductile and ductile couplers respectively. The Commission heard evidence that, in order to avoid error, *only* ductile couplers – 'Seisplice' couplers – were ordered by Leighton.

142. The following photograph – **Photograph 3** – shows Type A and Type B rebars and Type I and Type II couplers. Type II couplers had red protective caps, whereas Type I couplers would have blue protective caps.

Photograph 3



The diaphragm walls

143. The first construction process requiring the use of rebars connecting into couplers was the reinforcement for the diaphragm walls which were constructed by Intrafor.

144. The diaphragm walls are 1.2 m thick and are constructed in a series of panels which vary in width from about 2.8 m to 6.5 m. The length (or depth) of the panels also vary as the diaphragm walls are formed of 'hit' and 'miss' panels. The 'hit' panels are required to be founded on bedrock and the depth of the bedrock naturally varies. The 'miss' panels are, in practical terms, in-fills between the 'hit' panels and are taken to a shallower depth.

145. Reinforcement is provided by a series of reinforced steel cages[29]. Each cage, when fabricated, is lowered into its excavated site. Each cage, however, must be connected to the next cage and this is achieved by the use of Type B couplers[30].

[29] The Commission was informed that the grade of steel used in all the reinforcing works in the station box structure was 460.

[30] 'Type B couplers' means Type B rebars screwed into couplers.

Reinforcement in the horizontal slabs

146. The next process of construction which required the use of couplers was the installation of the steel reinforcement for the two horizontal slabs. In this regard, the following stages of construction may be better understood by having regard to Diagram 6 –

a. On the inside of the east diaphragm wall (also known as the excavation side), the reinforcement cages incorporate horizontal rows of couplers designed to connect with rebars set into the EWL slab and the NSL slab.

b. Remaining on the inside of the east diaphragm wall, both the EWL slab (3 m thick) and the NSL slab (2 m thick) contain horizontal rows of rebars towards the top of the slab ('top mat') and further horizontal rows of rebars towards the bottom of the slab ('bottom mat').

c. Moving now to the west diaphragm wall, the diagram shows a different design. Here, part of the upper EWL slab rests on top of the diaphragm wall. To accommodate this, vertical couplers are incorporated into the top reinforcement cages of the diaphragm wall panels.

d. There is no change in the manner in which the lower NSL slab connects to the diaphragm wall and here, therefore, the rebars which connect with the wall follow the same formation as in sub-paragraph (b) above.

Construction joints on the two horizontal slabs

147. The next stage of construction requiring the use of rebars being spliced with couplers was the formation of construction joints connecting the bays of poured concrete on the EWL and NSL slabs. Diagram 9 gives an indication of the various areas and bays.

Putting the construction process into a time frame

Design plans

148. Atkins was engaged by both MTRCL and Leighton. It was first engaged by MTRCL as a detailed design consultant in January 2010. Later, in April 2013, it was engaged by Leighton as a design consultant. To address any concerns as to conflict of interest, Atkins set up two teams (Team A for MTRCL and Team B for Leighton). The issue of conflict of interest will be addressed later in this report.

149. Atkins was responsible for preparation of the engineering designs for the construction of the diaphragm walls and both the EWL and NSL slabs.

The diaphragm walls

150. Intrafor was engaged as a sub-contractor by Leighton on a 'construction only' basis for the construction of the diaphragm walls, barrettes and associated works. Intrafor executed its construction works in accordance with Atkins' design plans provided to it by Leighton. Intrafor engaged Hung Choi as its sub-contractor for the steel fixing works.

151. Intrafor commenced work at the site in May 2013. It installed the prefabricated steel reinforcement cages for the first panel of the diaphragm wall (EM 98) in July 2013. Once the cages and their connections had passed inspection, it was permitted to pour the concrete. It then proceeded to build the rest of the panels, doing so between August 2013 and June 2015. The final panel (EH 78) was completed on 27 June 2015.

152. Following the completion of the final panel, Intrafor carried out pumping tests to draw down the groundwater level to permit excavation without flooding. This work was done between the end of June 2015 and January 2016. This marked the completion of Intrafor's work.

153. Intrafor had no involvement with the actual construction of the EWL and NSL slabs. Intrafor's only responsibility concerning the two horizontal slabs was to install, inside the diaphragm walls, a number of starter bars with couplers attached, these starter bars and couplers enabling Leighton (as main

contractor) to connect the steel reinforcement of the two horizontal slabs to the diaphragm walls. The starter bars with couplers attached had to be protected by Intrafor so that they would not be damaged when concrete was poured.

154. When the diaphragm walls were completed, in order to make the connections, Leighton had to do the following –

a. expose the couplers by breaking out some of the concrete on the face of the diaphragm walls and removing the polystyrene and cardboard protection placed there by Intrafor;

b. remove the protective plastic caps from the couplers, making sure that the couplers were clear of all foreign materials; and

c. screw the threaded rebars of the horizontal slabs into the couplers.

155. At this juncture, it is appropriate to state that there has been no suggestion made during the course of the Commission hearings, let alone any evidence put forward, to suggest that the rebars (or their threads) used to fabricate the reinforcement cages for the diaphragm walls were ever cut in any illicit manner or that the connections within the cages or the connections between the cages are in any way deficient[31]. In summary, the Commission has no reason to question the structural integrity of the diaphragm walls.

The two horizontal slabs

156. China Technology was engaged as a sub-contractor by Leighton in May 2015 to erect the formwork and undertake the concrete placing for the construction of both the EWL slab and the NSL slab. The sub-contract required it to provide 'all necessary labour, supervision, plant, equipment and materials' to undertake the formwork and the concrete placing. It commenced work in terms of the sub-contract in July 2015.

[31] In about May or June 2018, a video and photographs were circulated in the media, the suggestion being made that they were evidence of improper coupler connections within steel reinforcement cages in the course of fabrication. It appears that the material was recorded in or about July 2013. Early in the Commission hearings, the material was examined. It suffices to say that, considered in its accurate context, the material was not evidence in any way whatsoever of improper fabrication of cages or improper installation or splicing of couplers.

157. Fang Sheung entered into three sub-contracts with Leighton in order to install the steel reinforcement for the two horizontal slabs. This involved all necessary bar cutting, bending and fixing works on the slabs. It further involved connecting the joints between the slabs making up the EWL and NSL slabs and connecting the slabs to the diaphragm walls. The first sub-contract was entered into in April 2014. The sub-contracts were 'construction only' contracts.

158. Fang Sheung was not responsible for any of the technical designs nor for the purchase of construction materials, that is, the rebars and couplers.

159. Should any couplers be damaged, it was further the responsibility of Leighton, at its expense and using its own labour, to repair or replace them.

160. The evidence put before the Commission indicated that, if a coupler was intact and set at the correct angle, and if there was a reasonable amount of working room, a rebar – 4 m in length – would take only about 30 seconds to be fully screwed into a coupler. Obviously, if a coupler was not set at the right angle, if its threads were damaged or if it contained concrete debris or dust, the installation process would take much longer. The same would apply if the threads of the rebars to be installed into the couplers were damaged or if the rebars themselves were overly congested.

The order of work by China Technology and Fang Sheung

161. China Technology and Fang Sheung worked in close proximity to each other. China Technology was required to erect the initial formwork. Fang Sheung would then install the steel reinforcement. Once that was completed, China Technology would erect the remaining formwork, remove any debris and clean out the bay ready for concreting. Finally China Technology would pour the concrete.

162. The Commission heard evidence from Khyle Rodgers, a Leighton Superintendent, that in respect of each bay the process of construction was largely driven by the rebar fixers, that is, by Fang Sheung. China Technology would have to wait until the rebar fixing had been completed and approved before it could complete its formwork and pour concrete. Equally, however,

the quicker the rebar fixing was completed in each bay, the quicker China Technology had to work and the more people it had to put on the job.

163. China Technology had no responsibility for ensuring the adequacy of the steel reinforcing works undertaken by Fang Sheung. This was the responsibility of Leighton and MTRCL.

164. In order to give an indication of the overall chronology of events, the recorded concrete pour dates for the EWL slab given to the Commission show that China Technology began in July 2015 and completed pouring in August 2016.

The use of hand-held cutting machines

165. The public concern that arose in May 2018 was focused on assertions that during the installation of the steel reinforcement works there had been systematic and widespread cutting of threads from the end of rebars. That cutting, of course, insofar as it may have taken place, had to be carried out with the use of powered machinery: not the sort of machinery, even though hand-held, that could easily be concealed.

166. What must be understood, however, is that cutting machinery had a legitimate place on the work site for any number of purposes. By way of example, rebars may need to be cut in order to create openings in the steel reinforcement provided for in the design plans.

167. The use of powered cutting machinery to cut rebars was never a concern. The concern arose only in respect of the cutting of BOSA's *threading* at the end of rebars.

Chapter 4

Changes in design

168. During the course of the Commission hearings, considerable attention was paid to the changes of design and construction detail that was implemented at the top of the east diaphragm wall in Areas B and C, which comprises 76 panels, essentially between grid lines 15 and 50.

169. On the evidence before the Commission, there were two distinct changes. The Commission notes however that, in the event, neither of these two changes compromised the structural safety of the completed works[32]. The history of the two changes may be summarised as follows.

The first change

170. In respect of construction detail, the originally accepted design was as follows –

a. The diaphragm wall was to have 'U' bars at the top of the wall, spaced out uniformly.

b. On the excavation side of the diaphragm wall, in the EWL slab, there were to be two horizontal rows of rebars in the top mat. These rebars were to be connected to the diaphragm wall by couplers. It was through these couplers that the reinforcement continued into the diaphragm wall and bent downwards in order to provide the necessary anchorage.

c. On the other side of the diaphragm wall, in the OTE slab, there was to be one horizontal row of rebars in the top mat. These rebars were to be similarly connected to the diaphragm wall by couplers. And through these couplers the reinforcement continued into the diaphragm wall and bent downwards to provide anchorage.

[32] The structural safety implications of the changes in design are discussed in Chapter 8 of this report.

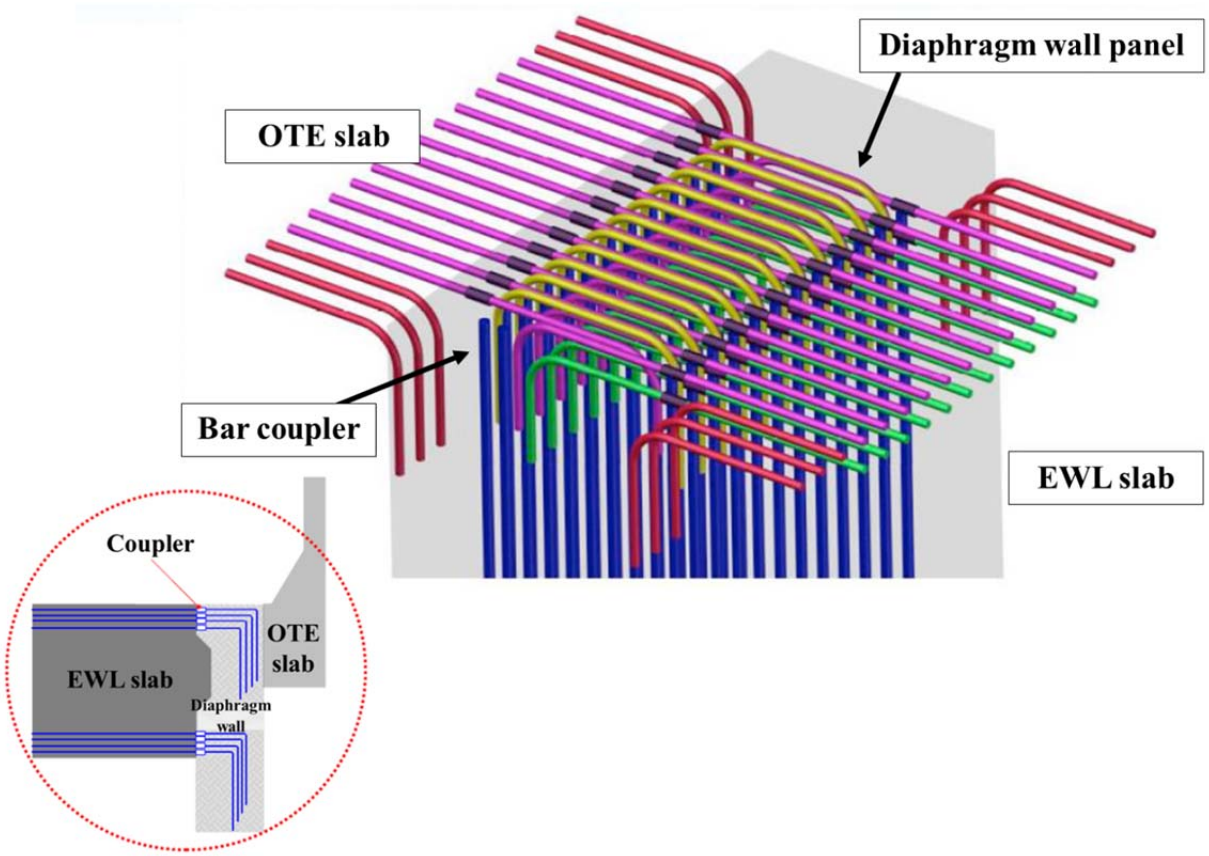
d. All of the reinforcement was designed with uniform spacing between rebars.

171. This originally intended arrangement of the reinforcement is illustrated in Diagram 6 in Chapter 3 of this report.

172. In about July 2013, when the construction of the diaphragm walls began, Leighton and Intrafor proposed a change to the arrangement of the rebars, leaving out the 'U' bars because of the need to accommodate a pipe to permit pumping of the concrete into the diaphragm walls (a so called 'tremie pipe').

173. This originally intended arrangement of the reinforcement is illustrated in **Diagram 11** below, which gives a vivid impression of the density of the rebars set into the concrete structures.

Diagram 11



174. MTRCL's construction management team had knowledge of this proposal and agreed with it. Atkins Team A (working for MTRCL) and

Team B (working for Leighton)[33] were also aware of and agreed with the change, the 'first change' was therefore implemented on the site.

175. There was, however, a problem. Seemingly due to miscommunication, MTRCL's design management team did not know about the change. In the result, there was no consultation submission made by MTRCL to BD.

176. It was only in about January 2015 that the MTRCL design management team came to know of the existence of this change and only in about April 2015 that BD came to know. In a letter dated 21 May 2015 from BD to MTRCL full clarification of the position was required.

177. One consequence of the first change was a clash between the EWL rebar and the diaphragm wall rebar because the diaphragm wall rebar arrangement was changed from two to three rows to four rows, so as to permit the use of a tremie pipe. Further to technical queries raised by Leighton in 2015, one option considered by MTRCL and Atkins was the use of approximately 4 000 T25 (25 millimetres ('mm') diameter) drilled-in bars across the diaphragm wall in substitution for the T40 coupler connections. However, this option was abandoned in favour of monolithic construction of the top of the east diaphragm wall, the EWL slab and the OTE (see 'The second change' below).

The second change

178. The 'second change' is rather more complicated.

179. Apparently in anticipation of BD's reaction to the first change, in February 2015 Atkins Team B produced a remedial proposal that they only intended to be applied to two diaphragm wall panels – panel numbers EH105 and EH107. This proposal entailed breaking down the top portion of those two particular diaphragm wall panels and adding the required number of rebars as per the accepted design drawings.

[33] The role of Atkins is discussed in Chapter 13.

180. It appears that iterations of this change proposal were considered, and that by May 2015 Atkins Team B suggested that between gridlines 22 and 40 a way of implementing the 'first change' was to –

a. trim down the top portion of the relevant diaphragm walls;

b. use 'through bars' to replace the couplers; and

c. concrete the EWL slab, the top of the diaphragm wall and the OTE slab concurrently, that is in one piece.

181. By late May or early June 2015, it appears that Atkins (in this case, through both Teams A and B) had come out with another and different proposal to deal with the 'first change'. This new proposal did *not* require the trimming down of the top of the diaphragm wall *or* the attendant use of 'through bars'. Instead, the proposal was to cast the EWL slab and the OTE slab at the same time, leaving the diaphragm wall intact. By doing so, this would ensure "monolithic behaviour" between the various components, thereby providing the missing anchorage that had resulted from the omission of the 'U' bars.

182. This latest proposal was apparently discussed between MTRCL's design management team, Atkins and BD in June 2015, and was included in the permanent design report sent by MTRCL in July 2015 for BD's consideration.

183. Unfortunately however, when Atkins Team B produced the temporary works design report on or about 17 June 2015, the previous proposal – which included the trimming down of the top of the diaphragm walls – was left in the report.

184. It appears to the Commission that the sequence of events described in the previous five paragraphs caused confusion on site.

185. At around the same time, there were various other construction difficulties encountered with the horizontal couplers at the top of the east diaphragm wall. As a result, MTRCL's construction management team and Leighton agreed to adopt Atkins' previous proposal to trim down the top portion of the diaphragm walls; use through bars to replace the couplers; and concrete the EWL slab, the top of the diaphragm wall and the OTE slab in one piece.

This they implemented to 66 of the 76 east diaphragm wall panels between grid lines 15 and 50. This became the 'second change'.

186. The remaining 10 panels had local constraints – such as accommodating underpinning, culverts or air ducts – that prevented the trimming down of the top of the diaphragm wall. Hence the couplers remained in these few panels.

187. It appears that MTRCL's construction management team was under the impression that MTRCL's design management team would update the working drawings and would obtain approval for the change from BD: part of the consultation process. However, as stated earlier, the design management team did not know about the second change, indeed they only became aware of it in or around July 2018, well after media reports had caused such disquiet in the community as to the manner of coupler installation.

188. Formal permanent works submissions made by MTRCL to BD did not include the second change because MTRCL's design management team was simply unaware of it. MTRCL's construction management team and Leighton took the position that the second change was a minor change and no prior acceptance from BD was necessary. For the reasons set out later in this report, a direct consequence of this was to have serious ramifications.

Chapter 5

Steel reinforcement fixing: allegations of illicit conduct

The media reports

189. As the Commission has noted in the introduction to this final report, it was in May 2018, approximately 18 months after the construction of the diaphragm walls and the EWL and NSL slabs making up the station box structure had been completed, that alarming reports appeared in the media to the effect that the structure may not be safe. The structure itself was conservatively designed. Rail tracks had been laid on both the EWL and NSL slabs and trains had made test runs. There was no cracking, no indications of movement, no overt signs of stress.

190. What then gave the reports credibility? At the core of the reports was the assertion that, in the construction of the EWL and NSL slabs and the slab and diaphragm wall connections, construction workers responsible for steel reinforcement fixing had – on a planned and extensive basis – cut the threading from rebars in order to avoid having to make engagement in the couplers: making it look therefore as if there had been proper and secure engagement when in fact there had been minimal engagement or no engagement at all. This had been done, it was suggested, because a large number of couplers were found to be damaged or pushed out of alignment and, in order to avoid the very considerable extra work involved in repairing or replacing these couplers, it was easier to cut short the threading on the rebars to fake proper and secure engagement.

191. One media report[34] suggested that about 20% of couplers may have been damaged or dislocated, making the full installation of rebars difficult or impossible.

192. The same media report said that it was suspected that Leighton had been responsible for this illicit activity, failing to replace problematic couplers and instead arranging for workers to cut short the rebars.

[34] See paragraph 25 in Chapter 1

193. Implicit in the reports was that this illicit activity – for it was considerably more than poor workmanship – had been knowingly ignored or not identified because of poor supervision and had then been covered up by the concrete pours.

194. Expressed in layman's terms, it was alleged that the steel reinforcement fixing had been carried out in such a way that there was now an inherent but hidden weakness at the joints of the interlocked structures.

195. Whoever, or whatever, may have been the original source of the media reports, it emerged that Jason Poon, Managing Director of China Technology led the march of concern. His company, China Technology, had been one of the main sub-contractors in the construction of the station box structure, responsible for formwork before and after the steel fixing work and then the pouring of concrete.

196. As such, Jason Poon would have had a direct and valid interest in seeking to ensure that the steel fixing works – over which, and into which, he would have to pour concrete – were fully and correctly placed and secured.

Allegations of illicit or corrupt activity

197. When Jason Poon appeared before the Commission, he at first testified that the cutting of threads from rebars had been a systematic activity, one that went beyond sporadic acts of poor workmanship. Initially, he went so far as to suggest that it had been the result of corrupt practice and he gave evidence as to how, in his view, that corrupt practice was carried out.

198. It is to be emphasised, however, that Jason Poon did not persist with allegations of corruption. Counsel for China Technology, in a comprehensive set of final submissions, made no reference to these allegations. To the contrary, in saying that the cutting of threads had occurred, although not suggesting to what extent, it was submitted that it had been due to a combination of factors relating to the quality of couplers, poor workmanship, tight time schedules and the poor quality of supervision by the staff of both Leighton and MTRCL.

199. As to the extent to which couplers were considered to be damaged and / or pushed out of alignment and the extent therefore to which rebars were cut in order to give the false appearance of secure engagement, Jason Poon did not at any time suggest to the Commission that it had been widespread.

Initial confusion caused by the wearing of Leighton work clothing

200. In his evidence to the Commission, Jason Poon was originally convinced that the workers who he (and his work colleagues) had witnessed undertaking the illicit activity of cutting threads from rebars were (or had to be) employees of Leighton, either full-time or daily paid. In this regard, for example, he said the following –

> "Throughout the whole process, according to what was reported to me by employees of [China Technology] or what I saw myself on the Hung Hom Station Construction Site, it was staff members of Leighton who were cutting the threaded rebars."

201. The assertion that it was Leighton employees appears to have been based on Jason Poon's understanding that different teams of workers employed by different employers wore different uniforms. Accordingly, it was only Leighton workers, either employed full-time or on a daily basis, who wore Leighton uniforms. It transpired, however, that Leighton supplied its uniforms to the workers of a number of sub-contractors including the sub-contractor responsible for the steel fixing works, Fang Sheung. Once aware of this fact, Jason Poon accepted that he could not be certain that it had been Leighton workers who he had witnessed cutting the threads from rebars and that it may well have been workers employed by Fang Sheung.

A chronology of events

202. From about mid-2015, China Technology kept an office close to the Contract 1112 work site. Employees of the company were regularly on site, often working in proximity to the steel fixers. Jason Poon, who testified over a period of six days, said that he first learnt that steel fixing work was being done in an illicit manner when, during 'lunch box' meetings in his company's site office, he was told by China Technology employees that steel fixing workers wearing Leighton work clothing had been seen using cutting machinery to

severe the threads from the end of rebars. Jason Poon said that in August 2015 he witnessed it happening himself. On this occasion, he saw three men wearing Leighton reflective vests cutting the threads from the end of rebars. He attempted to intervene but was ignored. In the months that followed, he said, he witnessed the same thing happening on three more occasions.

203. Jason Poon testified that from about August 2015 to about the end of 2016, a period of some 17 months, he made persistent attempts – in repeated conversations – to warn senior officers of both Leighton *and* MTRCL of what he and his company's employees had seen[35]. However, when they gave evidence before the commission, each and every one of these senior officers – from both organisations – denied receiving any such warning.

204. While, on behalf of Leighton and MTRCL, it was conceded that, in respect of such a massive steel fixing job, there would have been the occasional incidents of poor workmanship, for example a failure to properly and securely fix rebars into couplers, any suggestion that this constituted systematic conduct was rejected.

205. On behalf of Leighton and MTRCL, it was said that, at best, Jason Poon's assertions constituted a gross exaggeration, at worst, a fabrication. It was said that the genesis of the assertions had been a desire to obtain commercial advantage in ongoing commercial disputes between China Technology, a sub-contractor, and Leighton, the contractor and paymaster. It was suggested that it was no mere coincidence that Jason Poon's allegations arose and / or were resuscitated at those moments in time when, on any objective assessment, he must have believed that it would be to his commercial advantage in his dispute with Leighton.

206. For his part, Jason Poon was not himself able to point to unassailable physical evidence. He spoke, however, of both himself and a number of China Technology employees witnessing a course of conduct which, when considered

[35] Jason Poon gave evidence of making reports – all verbal – to the following people: Malcolm Plummer, Project Director of Leighton; Anthony Zervaas, also a Project Director of Leighton; So Yiu Wah, Gabriel, General Superintendent of Leighton; Khyle Rodgers, Superintendent of Leighton, Aidan Rooney, General Manager of MTRCL; and Dr Wong Nai Keung, Philco, Projects Director of MTRCL. The Commission's detailed consideration of the contradictory evidence concerning these various incidents is contained in Chapter 5 of the interim report.

together with photographic evidence in his company archives, had amounted to a systemic conduct endangering the integrity of the station box structure.

207. It should be said that the photographic evidence held in the company archives upon which Jason Poon placed such reliance in his dispute with Leighton was not presented to the Commission. It was Jason Poon's evidence that, in eventually reaching a settlement of the commercial disputes, he had been persuaded by Leighton, having signed a confidentiality agreement, to destroy those photographic records.

208. The Commission was, however, presented with a photograph taken by Jason Poon on the evening of 22 September 2015. It showed a workman in a Leighton reflective vest using a cutter to trim the threading on a rebar. The fact that Jason Poon had taken such a photograph was evidence that at the time he had clearly been concerned by the activity. Jason Poon said that the trimmed bar was then seemingly inserted into a coupler in the diaphragm wall. The photograph has been reproduced in Chapter 3 of this report: Photograph 2. The photograph was examined by Professor McQuillan who was able to demonstrate that it showed a worker not simply cutting off all the threads but rather converting a Type B rebar into a Type A rebar. While not necessarily to be condoned, this practice does not prevent a proper and secure engagement.

209. The first *documentary* evidence of Jason Poon articulating his concerns was contained in an email sent by him to Anthony Zervaas, Leighton's Project Director, on the morning of 6 January 2017. The email was one of a string of emails in which the progress of work by China Technology and payments due to it were in dispute. In the email, Jason Poon said that, in checking back over photographic archives (which had not earlier been fully studied), he had discovered the true extent of the negligent and / or illicit manner in which the steelwork fixing had been carried out.

210. Jason Poon's assertions were to the following effect; namely, that along the shear face of the EWL slab, and also along the shear face of the transverse construction joints between pour bays on the whole EWL slab, it was common to find that couplers had been damaged, particularly their internal threading, or had been pushed out of alignment. In these instances, Leighton workers had cut away the threading at the end of the rebars, placing the rebars

against the couplers so as to make it appear that there had been a proper and true installation when there had not.

211. These activities, said Jason Poon, had been deliberately conducted in the period between the day shift and the night shift when there was "vacant supervision", that is, none at all. Jason Poon further alleged that China Technology employees had witnessed the fact that there had been no inspection process to ensure secure installation of the rebars into the couplers.

212. As to the asserted failure to ensure efficient supervision and inspection, Jason Poon was unequivocal in his assertion that, while there had been formal inspections, hour-by-hour supervision had been almost entirely lacking on site. By way of illustration, in the course of his evidence before the Commission, he said –

> "There's no one, no supervisor from Leighton on site watching the works… They did not supervise the carrying out of the works. There were people there but they would not watch the works. They would just sit in their own foremen's office; they would go out for tea. And other than when the MTRCL came, they wouldn't show up."

213. In his email of 6 January 2017 addressed to Anthony Zervaas, Jason Poon wrote that, in light of these matters, he doubted the structural safety (and life span) of the EWL slab – the upper slab – especially in a number of structurally critical areas. He then went on to say (in unnerving terms) that if in the future the EWL track – carrying a passenger train – was to fail, there would be a public crisis.

214. It is understandable that, when Anthony Zervaas received the email, he was deeply concerned. He replied that same day –

> "It is quite alarming that you have not brought this issue to our attention earlier particularly as the alleged malpractice occurred in September 2015 *[some 15 months earlier]*.
>
> Please be advised that an investigation has commenced to review the allegation(s) made in your email." [emphasis added]

215. As indicated earlier in this report, the EWL slab was a massive structure running a very considerable distance. If, on any credible basis, there were concerns as to its safety, those concerns had to be fully investigated.

216. The following day, 7 January 2017, Jason Poon sent a further email to Anthony Zervaas saying that it had been Leighton's unfair commercial approach which had led to an extensive review by his company of its internal records. Jason Poon added that, because of Leighton's unfair commercial dealings, further findings of serious nonconformity may be discovered.

A missed opportunity: Leighton's report of January 2017

217. Leighton appointed Stephen Lumb, Head of Engineering, to conduct the investigation into Jason Poon's allegations[36]. By January 2017, of course, what had, or had not, happened were historical matters. In light of this fact, while matters required early investigation, there did not appear to be the need for a highly concentrated timeframe. Despite this, just one week was given to investigate the matter and write the report.

218. Although Jason Poon's allegations were the sole reason for writing the report[37] and, although Jason Poon in his email to Anthony Zervaas had spoken of a cache of photographic records – a photographic archive – supporting his allegations, no attempt was made to contact him nor any China Technology employees. Jason Poon himself knew nothing of the report.

219. In the absence of the ability to examine the steel fixing works at first hand, China Technology's photographic archives were, without exaggeration, the key to everything. Nor could Jason Poon volunteer them. As the Commission has just said, he knew nothing of the report.

220. As it was, only one reference was made in the report to the cutting of threads from rebars and that was an incident that had given rise to a Non-conformance Report ('NCR'), the NCR arising out of the discovery of cut

[36] The report bore the heading: 'Review of EWL Slab Rebar Installation and Checking Procedure'.

[37] The introduction to Leighton's report spoke specifically of the fact that the report was being written in light of allegations of possible malpractice in the fixing of the rebars to connect the EWL slab and the diaphragm wall.

rebar threads on 15 December 2015. More will be said of this in the next chapter.

221. It appears that essentially the report looked instead to "rebar installation procedures and site practices for the EWL slab"[38]. These, of course, were procedures and practices which should have been fairly well understood already. In addition, on an ordinary reading, Jason Poon in his email had clearly been speaking, not of the procedures and practices themselves, but rather of the manner in which they had been ignored or undermined.

222. The Commission appreciates that at the time Leighton would have been suspicious of Jason Poon's motives. They were in conflict as to commercial matters. No doubt there was bad blood. But that said, the Commission cannot understand how such serious allegations – allegations going to the integrity of the station box structure and possible loss of life or limb – could at that time have been so easily dismissed.

A further missed opportunity: the subsequent MTRCL report

223. On 8 February 2017, MTRCL itself published a report. The purpose of the report was to examine the construction records in order to confirm whether the steel reinforcement and the couplers for the EWL slab had been installed in accordance with the relevant quality assurance and quality control regimes. Clearly, this report also was a result in some way of Jason Poon's warning.

224. Again, the same question arises. If the purpose was to confirm that steel reinforcement works had been carried out in accordance with governing controls, in the circumstances of this case the best contrary evidence was apparently to be found in the photographic archives of China Technology. It appears, however, that China Technology was not contacted.

225. Wu Ka Wah, Carl ('Carl Wu'), MTRCL Co-ordination Manager and author of the report, was not specifically informed that there had been allegations that threads had been cut from rebars in the steel fixing works.

[38] See the introduction to Leighton's report

226. While the report recommended that the systematic maintenance of specific records would act as a robust demonstration of compliance, it concluded that steel reinforcement and couplers for the EWL slab had been installed in accordance with the relevant quality assurance and quality control regimes, this despite the fact that, according to Carl Wu, he understood that certain of the necessary records were missing.

227. [redacted]

The Commission's findings in respect of the two reports

228. [redacted]

229. [redacted]

Ending of the contractual relationship between Leighton and China Technology

230. As to the ongoing commercial relationship between China Technology and Leighton, a revised payment schedule was agreed and there was an increase in the final account payment. Works then continued.

231. In September 2017, however, some nine months later, the commercial conflict was reignited. On 11 September 2017, a warning letter was sent to China Technology as to work progress. This was followed two days later by a formal notice issued under the general conditions of the sub-contract. Jason Poon not only contested the criticisms but returned to his allegations of illicit activity in the securing of the joints making up the station box structure. Jason Poon reminded Anthony Zervaas of his earlier warning and demanded

that this matter be investigated as one of urgency. On 15 September 2017, Jason Poon proposed that –

> " … ALL transverse shear keys interfacing the diaphragm wall panels and ALL longitudinal construction joints between construction bays must be 100% inspected and assured for structural safety. We [are of the opinion that] all damaged and malpractice couplers, including installing without torque test and cheating practice [by] Leighton direct [staff] cutting away most of the threads, estimating over 30,000 [pieces] involved, must be tackled…"

232. According to Anthony Zervaas, in a telephone conversation that same day with Jason Poon, he informed Jason Poon that the matter had been investigated but no evidence to support Jason Poon's allegations had been found.

233. Shortly after that – that same day – Anthony Zervaas was copied into an email that Jason Poon had sent to the Secretary for Transport and Housing, Chan Fan, Frank, JP, seeking an urgent meeting together with representatives of Leighton and MTRCL in order to discuss an issue of public concern related to the execution of works under Contract 1112.

234. The following day there was a further meeting between Jason Poon, Anthony Zervaas and Karl Speed, Leighton's General Manager. At this meeting, agreement was reached. A termination agreement was signed and, in addition, Jason Poon signed a confidentiality agreement. On 18 September 2017, Jason Poon emailed THB to say that the matter had been resolved.

235. In the hearing before the Commission, some time was spent considering the contents of the confidentiality agreement. It was a standard form contract but extensive in its coverage. It does not appear to have been a document generally signed by Leighton sub-contractors. During the course of his testimony, Karl Speed said that, as he understood it that the time, the agreement was needed because of China Technology's false accusations.

236. As earlier indicated in this chapter, it was Jason Poon's assertion that, having reached a final agreement with Leighton and signed a confidentiality agreement, and having been assured that his warnings as to the station box

structure would be investigated, he was persuaded by Anthony Zervaas and Karl Speed that he should destroy his photographic archives. This, he said, he did.

237. Both Anthony Zervaas and Karl Speed denied in the strongest terms making any request for the destruction of any photographic archives.

238. These events, however, did not fully terminate the contractual relationship between the parties. There was a further sub-contract (related to another contract) which, for a number of reasons not directly relevant to this report, Leighton terminated in April 2018.

239. According to Anthony Zervaas, in late May 2018 he was emailed by Jason Poon who claimed that he had been approached by the media and may have to release details of "persisting malpractice by others". Anthony Zervaas said he replied to say that Leighton was not aware of any such malpractice. He received a response in ambiguous terms from Jason Poon indicating, it would seem, that as Leighton had confirmed there was no malpractice, he would be free to communicate with the media.

240. It was within days that media articles began to appear suggesting that, because of illicit activity in steel fixing works, the Hung Hom Station Extension box structure may not be safe.

Chapter 6

How extensive was the cutting of rebars?

241. In his email dated 6 January 2017 sent to Leighton's Anthony Zervaas, Jason Poon spoke in sobering terms of the public crisis that would arise if the upper EWL slab should fail under the weight of a moving train.

242. As the Commission saw it, it was Jason Poon's belief, initially at least, that the core reason for this inherent weakness in the rebar-coupler installations lay in the fact that, on a systematic and planned basis – with, it seems, the knowledge of Leighton – whenever any difficulty in effecting an effective engagement of rebar into coupler presented itself, workers would not take the time to repair the coupler or replace it but would resort to cutting the threads from the rebars to make it appear as if there had been an effective installation when there had not.

243. Such assertions, however, did not persist. As the Commission understood it, by the conclusion of his evidence, it was Jason Poon's position that the cutting of threads from rebars – while it may have attracted public attention – was one aspect only of a broad range of what were essentially workmanship failures, including failures to remove concrete dust from the internal threads of couplers to enable effective engagement, failures in respect of couplers pushed out of alignment to reset them, again to allow effective engagement.

244. Jason Poon emphasised that, from what he witnessed, the deficient manner of the steel fixing resulted from poor, if not entirely absent, supervision by both Leighton and MTRCL.

245. It is significant that Jason Poon also spoke of a failure to ensure that each and every rebar, even if its threads remained fully intact, was fully screwed into its coupler so that its end lay against the end of the rebar inserted into the other end of the coupler: as the term was used during the enquiry: 'butt to butt'.

246. The issue of 'butt to butt' installation took on considerable significance later in the hearing – indeed, considerably greater significance than the issue of

the cutting of threads from rebars – especially in light of the Holistic Report. More will be said of the issue later in this report.

247. As to the important question of the extent to which rebars had been cut, at no time did Jason Poon suggest to the Commission that it had been widespread. At the time when he and his co-workers witnessed the illicit activity, he said that he had not considered it to be such a serious issue in the sense that it undermined the integrity of the structures. In this respect, when asked why he would pour concrete if he thought there was a real danger, he replied –

> "… no, I don't think we have reached that critical stage yet."

248. He further said –

> "… I thought there was about 5 per cent of the bars cut, that was my estimate. That's always been the estimate. I also believe that if we're just talking about cutting threads then it's *within the safety margin*." [emphasis added]

249. It was therefore Jason Poon's evidence that, as he saw it, it was *not* the cutting of rebars itself that caused the danger but rather the defective workmanship, of which the rebar cutting was one aspect only.

250. But that still raises the question: why would Jason Poon have agreed to pour concrete if he believed that the defective manner of steel fixing work presented a structural danger? Why wait for a year?

251. The answer given by Jason Poon was that he had not, until shortly before he sent the email of 6 January 2017, appreciated the true degree of the threat to the structural integrity of the station box structure. That knowledge, he said, had come when, in seeking data to support China Technology in its commercial conflict with Leighton, he had gone through his company's photographic archives.

252. However, as stated in the preceding chapter, it was Jason Poon's evidence that, believing that a final agreement had been reached between himself and Leighton and that Leighton would ensure that remedial measures

were put in place to ensure the long-term integrity of the station box structure, he had destroyed the archives: doing so at the specific request of Leighton.

253. Leighton denied that it had ever made any such request.

254. In the result, of course, the Commission was denied a potentially important source of evidence.

Evidence of China Technology employees

255. It was Jason Poon's evidence that he first came to learn that workmen in Leighton clothing were cutting the threads from rebars when he was informed of that fact by co-workers. Four of those co-workers – employees of China Technology – gave evidence to the Commission. Having considered their evidence, the Commission was satisfied – on balance – that over a period of several months they had witnessed some five incidents[39]. On a couple of those occasions one or two rebars was seen being cut. On other occasions, it appeared likely that what was in fact witnessed was the conversion of Type B rebars into Type A rebars.

256. Bearing in mind that these limited number of events had been witnessed over a period of several months, the Commission was satisfied that, to the degree to which the activities constituted illicit conduct, they were isolated and sporadic.

Uncontested evidence

257. Between September 2015 and December 2015, a period of some four months – but not at any time thereafter – Leighton and MTRCL supervision and / or inspection staff made the following discoveries of rebars that had been cut or had not been properly installed –

a. At least eight rebars were discovered with their threads cut. Remedial action was taken in respect of all of these.

[39] The evidence of the China Technology employees was considered in detail in Chapter 6 of the interim report.

b. Five or six rebars were discovered that were fully intact but had not been connected; three of the rebars that were discovered in a lower layer of the mat could not be installed before concreting took place. Remedial action was taken in respect of the remaining two or three.[40]

258. One discovery was considered to be of sufficient seriousness to warrant the issue of an NCR. On 15 December 2015, Wong Kai Wing, Andy ('Andy Wong'), who had been employed by MTRCL as an assistant inspector of works for over four years), while conducting his own surveillance of the EWL slab, came across two threaded lengths of steel on the floor that had clearly been severed from rebars. There was a wire cutting machine nearby. Andy Wong said that he had never seen rebars cut in this way before. He was shocked.

259. At the same time, Andy Wong came across a cluster of five rebars at the bottom layers of the EWL slab that were not properly installed into their couplers. Three were not installed at all while two were only partially installed. The threaded ends of all five rebars had been cut.

260. On reporting the matter, Andy Wong was instructed to liaise immediately with Leighton to ensure that rectification measures were taken. Remedial measures were immediately undertaken by workers from Fang Sheung who were assisted by daily-paid labourers employed by Leighton. To ensure the problem was not widespread, a search of the area was conducted.

261. Because of the seriousness of what had been discovered, NCR-157 was issued.

Findings of the Holistic Report

262. One investigation carried out pursuant to the Holistic Proposal – the investigation being formulated on the basis of statistical principles – required the opening up of randomly selected rebar-coupler connections in the EWL and NSL slabs for examination. The examination was conducted using an ultrasonic measuring device, the test itself being called PAUT. When the

[40] The evidence of Leighton and MTRCL staff concerning their discoveries was considered by the Commission in Chapter 6 of the interim report.

couplers were exposed, PAUT was used to measure the engagement length of threaded rebars into their couplers.

263. In the two slabs, a total of 183 samples with valid PAUT results were examined: 90 in the EWL slab and 93 in the NSL slab.

264. Of those 183 samples, there were a total of 48 defective samples. Ten samples were found to be defective in the sense that the rebars were either cut short and / or not installed into a coupler. In respect of the 10, the threading on five rebars had been cut or trimmed. Two of those rebars, although cut, had been installed into their couplers, suggesting that they had been cut because of difficulties otherwise in engaging; three had not been engaged at all. The remaining five samples had not been cut but were unconnected in the sense that they had not been engaged into a coupler.

265. In summary, in respect of that exercise, out of the 183 samples less than 3% of the threaded rebars had been cut.

266. In assessing the importance of these findings, the following was said in the Holistic Report –

> "These findings indicate that *the cutting of the threaded ends of rebar is real although not extensive*, but other deficiencies in coupler connections are more widespread." [emphasis added]

Evidence given on behalf of Fang Sheung

267. Fang Sheung's obligations under its sub-contracts required the company to install steel reinforcement for the EWL and NSL slabs. This involved not only all necessary bar bending and fixing works but also carrying out the work of installing rebars into couplers in order to connect the concrete sections making up the EWL and NSL slabs and connecting the EWL and NSL slabs to the diaphragm walls. When public disquiet arose as to the possibility that threads had been cut from rebars on a systematic and planned basis, the management of Fang Sheung found themselves very much in 'the eye of the storm'.

268. Two senior members of the company gave evidence. Regrettably, the Commission had difficulty obtaining constructive assistance from either. It was evident that both men were, first and foremost, seeking to protect their individual reputations and the reputation of their company.

269. However, by the time final submissions were made, fault for the cutting – admitted only to be a rare occurrence – was accepted. Indeed, counsel for the company was open in admitting responsibility, as she said –

> "when [faced] with a difficult task, workers embarked on a foolish course of cutting threaded rebars. It is submitted that the workers, albeit reckless, were not malicious and were acting out of a misconceived sense of responsibility to get the job done... [However] evidence reveals that the cutting of the threaded rebars would be exceedingly rare."

How prevalent was the cutting of rebars?

270. On a consideration of all the evidence put before it, the Commission is satisfied of the following –

a. Although cutting of rebars did take place, it was not extensive. The evidence indicates that no more than 2% to 3% of the threaded rebars were cut. The extent of the practice of cutting, while illicit, did not constitute a threat to the integrity of the station box structure.

b. On a number of occasions, although those occasions cannot be quantified, cutting was done when workers ran out of Type A rebars and wished to convert Type B into Type A.

c. The cutting of rebars was not condoned by either Leighton or MTRCL.

d. The persons responsible for the cutting of rebars were employees of Fang Sheung, the company with the contract to fix the steel reinforcement. There is no evidence that the workers were authorised or encouraged by their employer.

Chapter 7

The Holistic Report

The purpose of the Holistic Report

271. When public concerns as to the viability of coupler connections first arose in May 2018, the suggestion that there had been a cutting short of threaded rebars lay at the centre of the concerns. However, as the Commission has concluded at the end of the previous chapter, while the cutting of rebars did take place, it was never extensive and did not (of itself) at any time threaten the integrity of the station box structure.

272. In its place, however, a broader issue concerning coupler connections arose. This was the issue of whether steel fixers, in the process of installing rebars into couplers, had ensured adequate thread engagement, that is, whether the rebars that had been installed into the couplers had been engaged to the required length so as to ensure the necessary strength of the unit. The issue of adequate thread engagement was brought to full light in the Holistic Report issued on 18 July 2019.

273. As stated earlier in this report,[41] the strategy for assessing the as-constructed state of the Hung Hom Station Extension – the Holistic Proposal – was put to the Government by MTRCL in December 2018. The overall purpose of the proposed exercise was to verify the as-constructed state of the construction works and to assure the structural integrity of the Hung Hom Station Extension. More specifically, the physical opening up of the station box structure at numerous points served two purposes. The first, by way of physical examination, was to come to some certainty as to the true extent of the alleged severing of threads from rebars[42]. The second was to verify the as-constructed condition of the connections – essentially the coupler connections – that connected the joints of the EWL and NSL slabs to each other and connected the slabs themselves to the diaphragm walls.

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[41] See paragraph 44 onwards in Chapter 1

[42] As cited in the previous chapter, the Holistic Report showed it to be not extensive.

274. The Government approved the Holistic Proposal and a task force was put together. That task force included representatives of MTRCL, BD, HyD and the Expert Adviser Team.

275. The task force was entirely independent of the Commission. Its findings however were made public, were spoken to in submissions by counsel before the Commission and were considered in depth in drawing up this report. In short, its findings were of great assistance to the Commission in discharging its mandate.

276. As indicated earlier in this report, the work of the task force was divided into three stages which may be summarised as follows –

a. *Stage 1.* A desktop exercise to identify gaps in the as-built record information of EWL slab to diaphragm wall connections. Where there were gaps, site examinations and tests would be conducted to verify the as-built condition.

b. *Stage 2a.* A physical opening-up exercise to verify the as-constructed EWL slab to diaphragm wall connections against the relevant contractor's amendment drawings (as-constructed).

c. *Stage 2b.* An opening-up exercise to expose randomly selected coupler assemblies for non-destructive measurement of the engaged length by way of PAUT or physical measurement.

d. *Stage 2c.* A review of the as-constructed diaphragm wall records.

e. *Stage 2d.* An investigation of miscellaneous workmanship defects, for example, shear link misplacement, honeycombing, gaps at the top of columns and walls.

f. *Stage 3.* A structural assessment in order to determine whether suitable measures were required, such measures being based on the findings in Stages 1 and 2.

277. As a result of the Stage 1 and Stage 2a exercises, a total of 24 locations of EWL slab to diaphragm wall connections were required to be opened up to

demonstrate the accuracy of the as-built records. It was found that at eight of those locations the as-constructed works were inconsistent with the amendment drawings (as-constructed).

278. For the purpose of the Stage 2b exercise, a total of 28 locations with a minimum of 84 rebar to coupler connections at each of the EWL and NSL slabs were randomly selected.

279. The opening up of randomly selected coupler assemblies for measurement pursuant to the Stage 2b exercise gave rise to a need for statistical analysis. In order to determine the construct of that analysis, there were discussions with Professor Guosheng Yin and other academics at the University of Hong Kong. It was agreed to employ binomial statistics to analyse the overall impact of the observed coupler connections. Binomial statistics allow results to be categorised as either a *fail* or *pass* when considered in the light of certain acceptance criteria. Samples which do not meet the acceptance criteria are treated as failures and described as 'defective'.

280. For a coupler connection to meet the acceptance criteria, there needed to be a maximum of two full threads exposed, this being a requirement given in BOSA's installation manual[43]. In addition, the engagement length of the threaded rebar inside the coupler needed to be at least 40 mm or 37 mm as measured by PAUT. The figure of 37 mm was selected because the PAUT equipment was found to have an accuracy tolerance of 3 mm, and so a PAUT measurement of at least 37 mm was deemed to indicate that the engagement was likely to be at least 40 mm. Accordingly, any coupler assemblies with less than a 37 mm engagement were considered to be only partially engaged and therefore defective. They were therefore, in the analytical exercise, disregarded as having no contribution whatever to structural performance.

281. A total of 102 samples in the EWL slab and 99 samples in the NSL slab were examined. Of these, 90 in the EWL slab and 93 in the NSL slab yielded valid results for the purpose of statistical analysis.

[43] During the course of hearings before the Commission, it became very apparent that on the construction site, below ground and working under artificial light, the visual exercise of determining whether exactly two threads – and only two – were exposed presented real difficulties both for steel fixers and inspectors.

282. The binomial analysis, with a 95% confidence level, resulted in the application of strength reduction factors when assessing structural performance of 36.6% for the EWL slab and 33.2% for the NSL slab.

283. During the course of the opening-up works under Stage 2b, the coupler connections on the side of the EWL slab only were measured. This approach did not distinguish general coupler connections from the capping beam coupler connections found mainly in Area A and Hong Kong Coliseum ('HKC')[44].

284. During the review of the investigation results, it was decided that the exposed coupler connections at the capping beam side of the EWL slab should also be taken into account. In the result, a formula was used to account for, first, the combined defective rates of the coupler connections at both the slab side and the capping beam side and, second, the small sampling size in the capping beam area. By application of this formula, a strength reduction factor of 68.3% was calculated.

285. General coupler connections were therefore given a defective rate / strength reduction factor of 36.6% at the EWL slab or 33.2% at the NSL slab, while 68.3% was applied in respect of the capping beam coupler connections.

286. In addition, although there had been no physical opening up of any part of Area A, the same strength reduction factor of 68.3% was applied. This was done on the assumption that similar conditions and similar levels of workmanship would be found in this area.

287. The validity of the statistical approach adopted under the Holistic Proposal was a matter of considerable contention. In this regard, the Commission heard evidence from Professor Yin, the expert called by the Government, and Dr Barrie Wells (from the UK), an expert called by Leighton. Their opinions differed in a number of fundamental respects.

288. In addition, Dr Glover, who was called by MTRCL to give structural engineering expert evidence, gave evidence in order to support the statistical

[44] Where a capping beam is used, the coupler connection is placed within the EWL slab instead of at the junction between the EWL slab and the diaphragm wall. In the result, the two sides of the coupler assembly are exposed.

analysis carried out by Ove Arup & Partners Hong Kong Limited ('Ove Arup'). According to Dr Glover, on the basis of the Ove Arup calculations –

a. for a single-sided connection, that is, a general coupler connection, the pass rate should be 88%; and

b. for a two-sided connection, that is, a capping beam coupler connection, the pass rate should be 77%.

289. The Commission's findings in respect of the statistical analysis conducted pursuant to the Holistic Proposal are set out in the following chapter: Chapter 8.

290. The exercise under Stage 2c consisted of reviewing the construction records of the diaphragm walls. This review concluded that site supervision and the relevant inspection regime had been satisfactorily followed. No issues of poor workmanship were identified. In the result, it was not found necessary to open up any portion of the diaphragm walls.

291. When the Holistic Report was issued on 18 July 2019, it was commented that the opening-up exercise had revealed irregularities in rebar and coupler connections. This, it was said –

> "… was likely caused by unsatisfactory workmanship which, particularly for the bottom reinforcement layers, would have been difficult to identify during inspection of construction works."

292. It was further observed that –

> "The high percentage of improper coupler connections discovered at the same location has cast doubt on the quality control system that was in place dealing with these works."

293. As to the need for extra building works to make good any failings in the original construction works, the Holistic Report said –

> "It is proposed that suitable measures are carried out to cater for the poor workmanship issues found and to achieve the safety level required in the Code for

meeting the requirements of the [Buildings Ordinance] and established good practice of engineering design. The NWDSM should also be complied with."

294. The Stage 2d exercise involved the investigation of honeycombing and gaps at wall / column / hanger wall and workmanship in shear links and horizontal construction joints. The following irregularities were revealed –

a. Approximately 12% of the inspected area had shallow honeycombing (i.e. less than 50 mm deep) and approximately another 7% had deeper honeycombing (i.e. 50 mm to 350 mm deep).

b. Thirty-one gaps between the wall / column / hanger wall and the EWL slab soffit were identified which were either unfilled or filled with improper materials. Reinforcement and coupler connection issues were identified in some of these gaps.

c. The opening-up works also revealed shear link irregularities at 18 locations. These included missing shear links, smaller bar sizes and insufficient anchorage lengths. These irregularities did not conform to the design and reflected construction and supervision issues.

d. Irregularities in respect of horizontal construction joints in connections between the EWL slab and the diaphragm wall were found at two out of four locations where video rigid scope investigation was carried out.

e. Other defects found included corrosion of the unscrewed threaded rebars, water seepage / ponding at some opened-up locations at the EWL and NSL slabs and defective coupling works at the locations between the soffit of the EWL slab and the diaphragm wall, which was the subject matter of NCR-157.

295. In the inquiry under the Original Terms, Professor Francis T K Au (structural engineering expert engaged by the Government) expressed concerns about the internal stresses at the top-of-wall construction joint created by the construction detail change. Professor Au was of the view that further structural calculations should be carried out. Counsel for the Government told the Commission that the analysis formed part of the Stage 3 structural assessment, and that "by the time when the Commission receives the stage 3

structural assessment final report, then the concerns of [Professor] Au should have been addressed".

The 'suitable measures'

296. In the Holistic Report, the structural integrity of the station box structure appeared to be accepted on a provisional basis only –

> "Based on the *Updated Design*, and after consideration of the as-constructed conditions and irregularities discovered in Stage 2, and taking account of the on-site inspections, MTRCL considers that *for the purpose of the ongoing construction activities, the station is structurally safe*. MTRCL further proposes that suitable measures should be taken to achieve the safety level required in the Code. The NWDSM should also be complied with." [emphasis added]

297. The suitable measures fell into four categories and were outlined as follows –

a. For coupler assemblies, works (by drilled-in bars and local thickening of the slab) are proposed to some connections between the capping beam and the EWL slab at Area A, involving a length of approximately 65 m.

b. To cater for the poor shear link workmanship, works such as reinstating the shear links, localised thickening of the slabs / walls, and / or adding load bearing walls and columns are proposed. The potential extent is not more than 2.5% of the total floor area in Areas A, B and C and HKC. The Commissions understands that the suitable measures are now limited to the EWL and NSL slabs in Area A.

c. For construction joints between the EWL slab and diaphragm walls, suitable measures to the eastern diaphragm wall in Areas B and C by drilled-in bars are proposed, involving a length of approximately 60 m.

d. At locations where water seepage is of concern, it is recommended to carry out grouting or other water seepage prevention measures.

298. As counsel for Leighton pointed out in the course of submissions to the Commission: the Holistic Report was carefully worded. It did not state that without the suitable measures the station box structure was structurally unsafe. Rather, they appear to have been proposed for the purpose of so-called 'code compliance'.

299. In this regard, as it was expressed in the Holistic Report: "'suitable measures' means actions which are deemed necessary to address the issues identified in this Report and *achieve the safety level required in the Code for meeting the requirements of the [Buildings Ordinance] and the established good practice of engineering design*". [emphasis added]

300. Having received the Government's approval, the execution of suitable measures pursuant to the Holistic Report was started and, as mentioned earlier in this report, it is anticipated that the necessary works will be completed in full within two to three months of the issue of the Commission's final report.

301. In speaking of ensuring the structural integrity of the Hung Hom Station Extension, that is, the station box structure, counsel for the Government submitted to the Commission that safety is a broad concept. Accordingly, in the view of the Government, the issue of whether the station box structure is safe can only be meaningfully answered by reference to some objective building standards. In the present case, those standards are to be found in the Code and the Buildings Ordinance. It is those instruments which reflect the level of structural safety required to be achieved in all building structures in Hong Kong. The Code and the Buildings Ordinance are therefore intrinsically linked to the levels of structural safety required to be achieved in Hong Kong. Counsel for the Government further submitted that the Government would only consider a structure to be safe if both its design and construction complied with the Buildings Ordinance and the applicable codes, not only in respect to loads or strength but also in respect of serviceability, durability, fire resistance and the like.

302. Dr James Lau, the expert in structural engineering called by the Government in respect of the Holistic Report and the Commission's Extended Terms, was firm in his opinion that, in considering the level of factor of safety, the standards and requirements laid down in the applicable codes shall be met as they reflect the community's expectation and consensus reached among

industry practitioners over many years that took into account the circumstances that prevail in Hong Kong.

303. It should be said that, although MTRCL had played a central role in the preparation of the Holistic Report, in final submissions to the Commission, counsel for MTRCL, was unequivocal in confirming that MTRCL considered the as-constructed station box structure to be safe and fit for purpose. In this regard, counsel said –

> "It is MTRCL's firm position that the as-built works are safe and fit for purpose. MTRCL does not agree with [Dr] Lau's conclusion that the structures are unsafe without the Suitable Measures. [Dr] Lau's opinion is effectively premised on Compliance."

304. Counsel continued by explaining what the Commission saw as the rationale behind MTRCL's support of the need for 'suitable measures' –

> "It bears emphasis that insofar as any criticism is levelled against the *'correctness'* or the conservatism of the Holistic Report from a structural engineering perspective, the purpose of the Holistic Report is not to address structural safety *simpliciter* but to ensure that the as-constructed works achieve Compliance in the light of the issues concerning [Leighton's] poor workmanship and missing records."

305. Three of the witnesses who gave expert evidence on structural engineering – Professor McQuillan, Dr Glover and Mr Southward – were of the opinion that the 'suitable measures' were simply not necessary. It was their opinion that the statistical analysis was, if not erroneous in a number of respects, based on overly conservative assumptions and considerations. All three were of the view that the station structure, as it stood, was safe and fit for purpose.

306. Professor McQuillan was of the view that the Holistic Report conflated the prime issues of safety and contractual compliance under an umbrella of 'code compliance'. As he put it, elements of a structure, or even an entire structure itself, can be safe even though not 100% code compliant. Dr Glover and Mr Southward shared his opinion.

307. In the view of the Commission, on the basis that the suitable measures are being implemented, the critical issue – in the broader public interest – is that,

wherever the balance of justification may lie in respect of the suitable measures, once they have been completed, the Government will have undertaken discrete works in order to be satisfied of the following: first, the station box structure will then, on a very conservative assessment, be safe and fit for purpose; and second, it will be fully compliant with the Buildings Ordinance and the relevant codes. In short, in the judgment of the relevant agencies of the Government, the station box structure will then have satisfied all requirements as to safety and fitness for operation and be ready in the ordinary course of events for commissioning.

308. In the later stages of the inquiry, it was suggested to the Commission that, as the Government would consider the station box structure to be code compliant and safe once the suitable measures had been completed, there was no further purpose in the Commission itself proceeding further in order to seek to be assured – on the basis of independent forensic considerations – that it was in fact safe and fit for purpose.

309. The Commission, however, while it accepted that the Government's independent decisions would be of considerable persuasive value, did not consider that they relieved the Commission of its obligation either to confirm its decision reached in its interim report that the station box structure is safe or to qualify that decision. The Government in this public inquiry has been but one party. Its actions may be right, they may be wrong. They are certainly subject to scrutiny. In the opinion of the Commission, therefore, to abandon its obligation in this regard would be to undermine its own mandate, one given to it in the public interest.

Chapter 8

The 'station box structure': is it safe and fit for purpose?

Extensive investigations

310. In his expert report, Dr Glover, who gave structural engineering expert evidence on behalf of MTRCL, made the following observation –

> "Few structures have been subjected to the degree of post-construction survey, inspection and opening up, or subjected to the sophisticated independent analysis and testing which has been carried out on the structures [the station box structure] by a number of different parties."

311. This was a view which all of the independent engineering experts endorsed[45]. From the documentation submitted to the Commission, it is apparent that extensive assessments and analyses have been carried out by reputable engineering companies. These assessments and analyses have themselves been discussed and debated by the experts appointed by the parties to the inquiry. A summary of the various expert reports, assessments and analyses is annexed to this report as **Annexure E**.

312. It must also be noted that the task force constituted pursuant to the Holistic Proposal, itself containing engineering professionals, has overseen the holistic assessment and endorsed the Holistic Report.

313. In his final submissions, counsel for the Commission, in the light of all the evidence presented, was sufficiently confident to make the following statement for consideration by the Commission –

> "The structures [making up the station box structure] have massive reserves of strength and even adopting the most conservative assumptions only very few discrete areas require, according to MTRCL and the Government, limited so-called 'suitable measures'. All of the tests and investigations carried out have generated a very high level of assurance and confidence in the structures such that even if

[45] This is a reference to the expert witnesses who assisted, or continued to assist, the Commission in the inquiry under the Extended Terms, that is, after the issue of the interim report.

other miscellaneous matters might be raised subsequently, there is simply no threat whatsoever to the safety and fitness for purpose of the structures."

The meaning of 'safety' and 'fitness for purpose'

314. Although different experts may express the meaning of 'safety' and 'fitness for purpose' in slightly different terminology, there did not appear to be any material disagreement between the independent engineering experts who were asked to comment on the definitions. For present purposes, the Commission agrees with the definition suggested by counsel for the Commission, namely, that a structure such as the station box structure 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"; in the present case, the design life being 120 years.

The interim report: consideration of safety in that report

315. The inquiry under the Original Terms took place between July 2018 and January 2019, the interim report being issued a month later in February 2019. On the basis of the evidence presented to it during this part of the inquiry, while the Commission found that there had been isolated and sporadic incidents of failing securely to install rebars into couplers, it was satisfied that this failure had not been widespread nor systematic. In the result, with regard to the diaphragm walls and the slabs that together made up the station box structure, two key questions remained –

a. Was the upper EWL slab effectively and safely connected to the diaphragm walls?

b. Was the change to the top of the east diaphragm wall and EWL slab – where it connected with the OTE slab – safe?

316. To assist it in answering these questions, the Commission received invaluable assistance from five independent engineering experts. In addition to Professor McQuillan, the Commission's appointed expert, whose brief biographical note is to be found in Chapter 1, sub-paragraph 33(a), they were –

a. Professor Francis T K Au, a chartered structural engineer and Head of the Department of Civil Engineering at the University of Hong Kong – engaged by the Government. Professor Au has nearly 40 years of experience, the vast majority of which has been in teaching and research in structural engineering;

b. Dr Mike Glover, OBE, a chartered structural engineer and an Ove Arup Fellow – engaged by MTRCL. Dr Glover has over 50 years of experience in major infrastructure and building projects, including the new HSBC building in Hong Kong in the late 1970s and early 1980s, the Channel Tunnel Rail Link in the UK (1995-2007) and the new Queensferry Bridge in Scotland (2007-2017);

c. Dr Albert T Yeung, a chartered civil and geotechnical engineer and an Associate Professor in the Department of Civil Engineering at the University of Hong Kong – engaged by China Technology. Dr Yeung has more than 30 years of experience as a geotechnical and pavement engineer;

d. Mr Nick Southward, a chartered civil engineer, Executive Director of Tony Gee and Partners LLP and Managing Director of Tony Gee (Asia) Limited – engaged by Leighton. Mr Southward has 30 years of experience in the design of bridges and viaducts for railways and roads in Hong Kong, the Middle East, Asia, Australia and the UK.

317. Leighton further instructed COWI UK Limited ('COWI') to undertake an independent structural analysis and assessment of the connection of the EWL slab to the diaphragm walls at the Hung Hom Station Extension.

318. After all factual evidence had been heard, the independent engineering experts gave evidence to the Commission over five days from 14 to 18 January 2019.

The first agreed expert memorandum

319. Prior to giving evidence, following visits to the Hung Hom Station Extension site, the experts met on 18 December 2018 to discuss issues relating

to the structural integrity of the station box structure. Also present at that meeting was Mr Colin Wade, a colleague of Dr Glover's from Ove Arup.

320. It is today a well-accepted practice, when a number of independent expert witnesses are to testify in proceedings, for those experts to come together as peers in order to discuss the matters in respect of which they are briefed, to listen and to debate, and, if possible, to reach an agreed opinion. It was always for the Commission, of course, to determine what evidence it accepted and what evidence it did not. Obviously, however, agreed evidence reached after due consideration by a body of experts is invariably of considerable persuasive value.

321. In the present case, there was an open discussion between the experts which took place over a period of some four hours. The contents of the discussion were 'without prejudice' and accordingly no minutes were taken. Again, this is an accepted practice, enabling the experts to talk openly and freely.

322. The agreed and signed memorandum – the first Joint Statement – is attached to this report as part of **Annexure F**. In essence, all of the independent experts agreed on all matters, save only that –

a. Professor Au expressed concerns about the internal stresses at the top-of-wall construction joint created by the construction detail change. However, notwithstanding this reservation, all of the experts (including Professor Au) agreed that this would not show the construction joint to be problematic.

b. Mr Southward was unable to comment on the implications of any of the miscellaneous workmanship issues but this was purely on the basis that it was beyond his terms of brief.

323. On 22 December 2018, a few days after the first joint meeting of experts, Professor Au had some further comments that he set out in a note to the Commission. In essence, Professor Au's comments related to his view that further structural calculations should be carried out in order to justify the views that he and the other experts expressed and agreed at the meeting.

324. The contents of the first Joint Statement are discussed below.

General Code requirements

325. The initial topic in the first Joint Statement related to the Code requirements for reinforcement concrete design in Hong Kong.

326. Dr Glover explained to the Commission that early in his career he had been involved in assisting the Cement and Concrete Association in drafting the first limit state code for reinforced concrete, which was published in 1972 as CP110. The Hong Kong Code is a direct descendant.

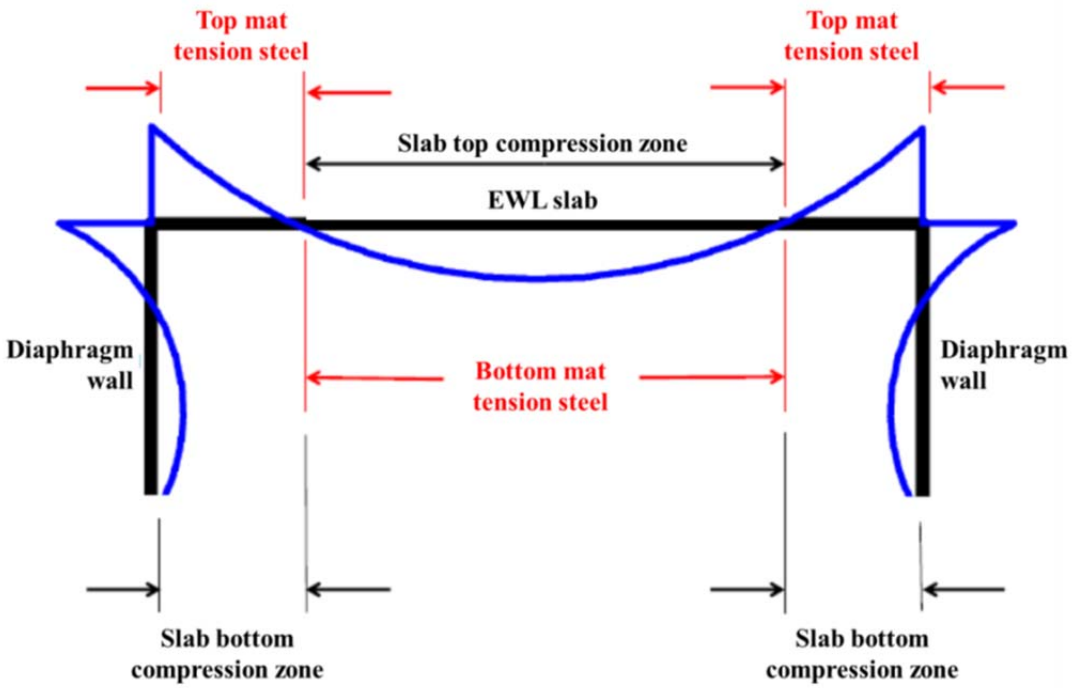
327. Dr Glover explained to the Commission the reasons for not requiring ductility couplers. He told the Commission that Hong Kong is not a high seismic area – it is accepted to be an area of low to moderate seismicity. In any case, to assume that a substantial rigid box sitting in the ground (which is the case with the Hung Hom Station Extension box structure) would be seismically sensitive would be incorrect. Dr Glover pointed out that similar underground structures across the world had survived earthquakes without significant distress.

328. As it was, Leighton chose to use ductility couplers on the Hung Hom Station Extension project as their additional cost was insignificant.

329. During the inquiry, the Commission heard evidence as to why 'permanent elongation' and 'cyclic tension and compression' tests, which are needed for couplers that may be used in certain circumstances, were of no relevance to the particular circumstances of the Hung Hom Station Extension box structure. This subject was also considered during the inquiry under the Extended Terms, as discussed further below.

330. Professor McQuillan explained to the Commission the nature of the forces operating on the EWL slab and why the interface between the slab and the diaphragm wall would always be in tension at the top of the slab and would always be in compression at the bottom of the slab. He illustrated this with **Diagram 12**.

Diagram 12



331. The Commission was advised by the experts that, in order to comply with the Code, the amount of reinforcement steel in the bottom of the EWL slab needed to be at least equivalent to 50% of the reinforcement steel in the top of the slab.

332. The independent experts agreed as follows –

> "All agreed there was no requirement for ductility couplers.
>
> All agreed that an amount equivalent to 50% of the top tensile steel was required in the bottom of the EWL slab to be carried through in the [diaphragm] wall[,] i.e. less than 50% of the bottom steel at the interface was required for Code compliance."

Bottom mat reinforcement in the EWL slab

333. The second topic in the first Joint Statement related to the steel reinforcement in the bottom mat of the EWL slab.

334. This point was addressed by Professor McQuillan (as discussed above) and is further illustrated by two additional diagrams he provided in his first expert report. They appear below as **Diagrams 13 and 14**. Professor McQuillan described how the shear key (an indentation formed in the edge of the diaphragm wall) resists shear forces at the interface between the slab and the diaphragm wall.

Diagram 13

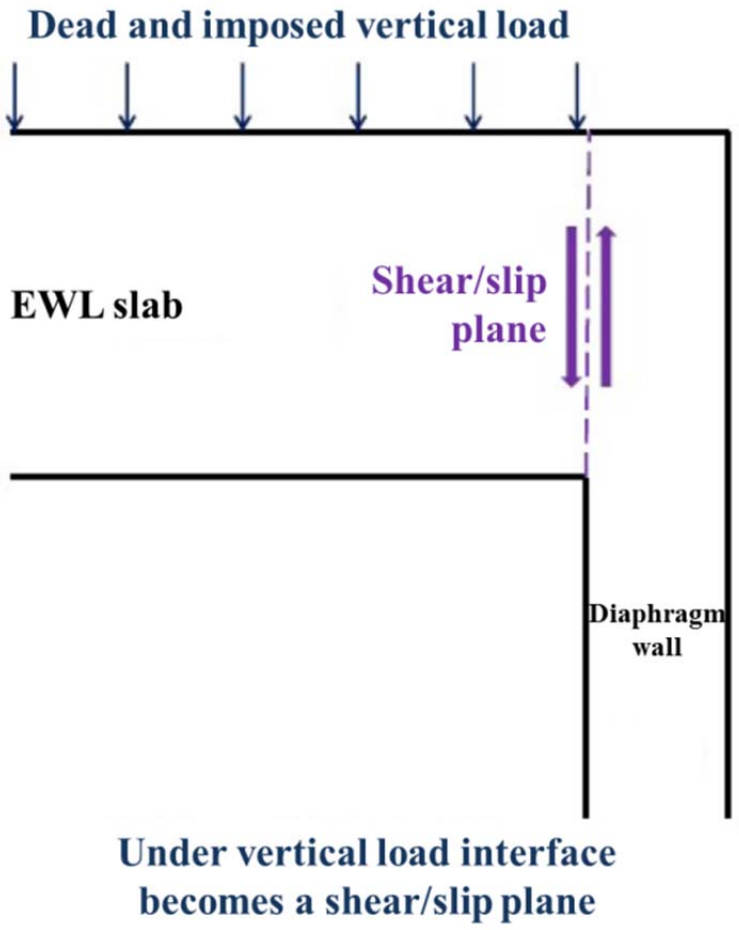
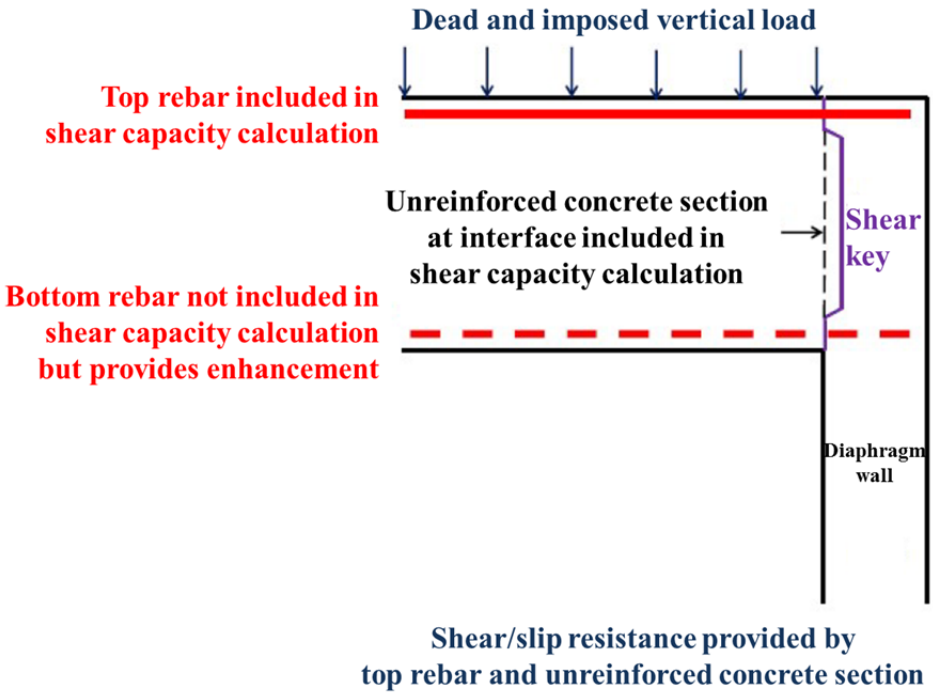


Diagram 14



335. The independent experts agreed as follows –

> "All agreed that, irrespective of the code requirement the EWL slab does not, in theory, rely on steel at the interface, at the bottom, for flexure and shear capacity."

Change to top of the east diaphragm wall

336. The third topic in the first Joint Statement related to the change to the detail that took place with regard to the top of the east diaphragm wall.

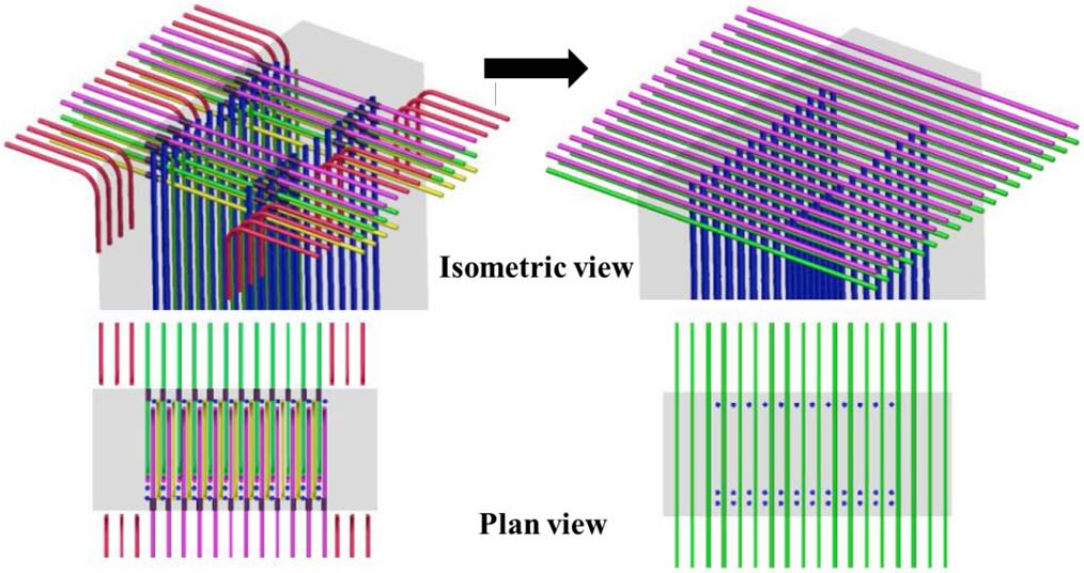
337. The independent experts advised the Commission that cutting down of a diaphragm wall is normal construction practice, not dissimilar to the cutting down of the top of a pile when forming a pile-cap, or cutting into a diaphragm wall to form an indentation or shear key.

338. The experts also advised the Commission that a change from couplers to through bars would have no adverse structural implications. Indeed they advised that it would actually create a superior detail, as (a) it would remove a potential point of weaknesses (if any of the coupler assemblies should in any

way be incorrectly connected), and (b) it would result in more reinforcement steel being provided across the top of the diaphragm wall connecting into the slabs either side.

339. Mr Southward explained to the Commission how the change to through bars resulted in additional reinforcement being provided. He illustrated this with a diagram – **Diagram 15** – which appears below.

Diagram 15



340. The independent experts agreed as follows –

> "The cutting-down of a [diaphragm] wall is a normal part of the construction process with the methodology governed by the specification and is analogous to the construction of a shear key.
>
> All agreed that the change from couplers to through bars in the top of the east [diaphragm] wall was a better detail and provided more steel across the interface (subject to a review of the internal stresses at the top-of-wall construction joint relating to the 'first change' and its rebar detailing). Notwithstanding, all agreed the outcome would not show the construction joint to be problematic."

341. The phrase in brackets, "subject to a review of the internal stresses at the top-of-wall construction joint relating to the 'first change' and its rebar

detailing", is a reference to the reservation expressed by Professor Au at the first joint meeting. This was explored extensively under the Original Terms and the Commission notes that three of the independent engineering experts – Professor McQuillan, Dr Glover and Mr Southward – considered that a review of the internal stresses was unnecessary. The experts did however agree that carrying out such a review, which the Commission understands to be a numerical checking exercise, would remove any residual doubt in this area.

342. In any event, Professor Au advised the Commission that the review of the internal stresses could be carried out in a very short period of time, just a few days, provided it was done or supervised by someone of suitable expertise. The Commission understands that such a review was subsequently carried out and considered in the Holistic Report.

Miscellaneous defects

343. The fourth topic in the first Joint Statement related to miscellaneous workmanship defects that were discovered: 'spalling' and 'voiding' of concrete (referred to as 'honeycombing'), gaps, misaligned shear links and the like.

344. The independent experts explained to the Commission that the workmanship defects of spalling and honeycombing were not uncommon on construction sites, particularly where there are deep slabs with congested reinforcement. They were of no structural significance provided local repairs were made to replace the missing cover to the reinforcement. The Commission understands that such repairs have been carried out.

345. Similarly, the experts explained to the Commission that the few instances of misaligned shear links (that is the steel linking the upper mat of rebars to the bottom mat), that they were aware of at that point in time, would have no detrimental effect on the shear capacity of the thick EWL and NSL slabs.

346. The independent experts agreed as follows –

> "All agreed except Nick Southward (not part of his brief) that miscellaneous workmanship issues [e.g.] spalling, voiding, gaps etc. were all repairable.

> The main discussion related to mis-aligned shear links. All agreed this was of no structural significance in the context of the slab rebar."

Load testing

347. The fifth topic in the first Joint Statement related to the load test that had been proposed as part of the Holistic Proposal.

348. The independent experts explained to the Commission that load testing the as-built structure was inappropriate as (a) any deflection from a load test of this thick structure would be virtually undetectable, and (b) the structure had already experienced its worst (that is, largest) loading conditions during the construction process when it was supported in its temporary condition[46]. Now that the box structure had been completed, together with internal walls propping between the bottom NSL slab and the top EWL slab, the current loads on the structure were significantly less than they were during construction.

349. In addition, the experts advised the Commission that train and passenger operations would add only a small amount of load to the structures, less than 10%, and that most of this load would be transferred directly into the diaphragm walls, which are more or less directly under the track positions.

350. The Commission further notes that the experts considered long-term monitoring (or inspection) of the structure to be a preferred way of allaying any residual concerns of the public with respect to safety.

351. The independent experts agreed as follows –

> "All agreed that a load test was unnecessary because it would yield no meaningful result and long-term monitoring would be a better approach to allay public concerns."

[46] The Commission heard that the most severe loading case occurred when the EWL slab had been cast and before the NSL slab was cast. The NSL slab acts as a permanent strut between the diaphragm walls.

Opening up (pursuant to the Holistic Proposal)

352. The sixth and final topic in the first Joint Statement related to the opening-up exercise, which by that time was underway as part of the Holistic Proposal.

353. The independent experts advised the Commission that the design of the EWL and NSL slabs was "conservative" and provided a high degree of under-utilisation as compared to that required to properly withstand the loads incurred by the structure. The experts also referred to this under-utilisation as "redundancy" or "spare capacity". In layman's terms, these descriptions demonstrate that the structure has been specifically designed so as to increase its structural reliability. In this regard, for example Atkins, Ove Arup and COWI all agreed that there is at least 40% spare capacity at the top mat of the EWL slab at the connection with the diaphragm wall.

354. The Commission does not regard the partial redundancy of the reinforcement as being a criticism of the designer, Atkins. On the contrary, the Commission understands why it is prudent for a designer to specify reinforcement strictly in accordance with the Code, even in circumstances where conditions requiring such reinforcement may not apply. The Commission recognises that the conservative design of the station box structure has, in the present case, in the general public interest, been of real benefit.

355. The independent experts explained to the Commission that, because the bottom level reinforcement in the EWL slab at the connection with the diaphragm walls is not required to take tensile load and is only provided for Code compliance, 50% of the coupler connections have no structural significance. As the Commission understands it, up to 50% of the coupler connections in the bottom of the EWL slab could be sub-standard without affecting structural integrity.

356. The Commission notes that the independent experts were of the opinion that the opening up at the bottom of the EWL slab was unnecessary and furthermore caused a hazard to workers: which should, if possible, be avoided. The Commission further notes that the independent experts were of the opinion that invasive investigation – that is opening up – of the diaphragm walls and the

NSL slab pursuant to the Holistic Proposal should also be reviewed as they saw little value in it continuing.

357. Finally, the experts considered the proposed ground penetration radar non-destructive test ('GPR NDT') to be, in their words, "inaccurate, time consuming and inappropriate".

358. The independent experts agreed as follows –

> "In terms of the current opening-up regime all agreed, based on the 'redundancy' of the couplers in the bottom of the EWL slab, that further opening-up was unnecessary. Focus should be directed to the top of the east [diaphragm] wall to verify the as-built drawings and the details which are of structural significance.
>
> Moreover, it was noted during the site inspection that the EWL soffit slab openings were creating safety hazards for the staff on-site.
>
> Also the decision to expose the third and fourth layers of rebar is impractical and will cause major disruption to the slabs.
>
> All agreed that the GPR NDT was inaccurate, time consuming and inappropriate when opening-up has to be carried out anyway.
>
> All agreed that invasive investigation of the [diaphragm] walls and NSL slab should also be reviewed."

359. Under the Holistic Proposal, the engagement of the couplers exposed in the opening-up works was checked by physical inspection and / or PAUT, which is a non-destructive test. The inaccuracy of the PAUT results was demonstrated subsequently when the police checked the actual length of the engaged threaded section of rebars and found serious discrepancies between the physically measured lengths and the PAUT results. As a result, as indicated earlier in this report[47], the Government and MTRCL decided to apply a ± 3 mm tolerance to the PAUT results.

[47] See paragraph 280 in Chapter 7

360. The subject of partial engagement of threaded rebar into coupler was explored with the independent experts during the inquiry. Professor McQuillan, Dr Glover and Mr Southward shared the view that partial engagement of coupler assemblies, as revealed in the results of the opening-up exercise, would not affect the structural integrity of the EWL and NSL slabs. This matter was explored in depth in the inquiry under the Extended Terms after the issue of the Holistic Report.

Summary of key considerations when assessing structural safety

361. On hearing all of the expert evidence in the inquiry under the Original Terms, and after receiving interim closing submissions from counsel for all the involved parties, the Commission was of the view that the following considerations were directly relevant to the question: is the station box structure safe and fit for purpose? The considerations may be summarised as follows –

a. The preponderance of expert evidence was that there is no safety related issue in relation to the changed detail at the top of the east diaphragm wall.

b. All the evidence before the Commission demonstrated that there is significant redundancy in the structure.

c. Due to the change in detail at the top of the east diaphragm wall – with over 80% of the couplers in Areas B and C having been replaced by through bars – the actual number of couplers subjected to tensile forces has been reduced to a relatively small number. Through bars are now taking the tensile forces and so, for the large part of the EWL slab, any defective coupler connections would have no structural significance.

d. As the connection between the bottom of the EWL slab and the diaphragm walls is always in compression, the couplers there have no structural significance. Again therefore, any defective coupler connections at the bottom of the EWL slab are of no structural consequence.

e. Defects such as honeycombing are not matters of safety and can all be, and indeed have been, repaired.

f. The Hung Hom Station Extension box structure – the diaphragm walls and the EWL and NSL slabs – have been in place for over three years (in the case of some parts, up to five years) and there are no signs whatsoever of distress which would give rise to any safety concerns. Furthermore, the structure has already sustained its most severe loading conditions – that is during the construction stages in 2015 and 2016.

Looking to the conclusions of the independent experts

362. In his first expert report, Dr Glover had no concerns as to the safety of the station box structure. Among other observations, he said –

> "It is evident so far as I am concerned that the structure of the station box has large degrees of redundancy and robustness and, consequently, a comfortable margin of safety which supports my opinion that the *structure is safe for its intended lifespan."* [emphasis added]

> "The structure of the Hung Hom station box shows no signs of distress, cracking or distortion to indicate that it has been overstressed during the critical construction stage… The future operation loads and the extra supports provided by the NSL loadbearing columns and walls represent a more benign loading environment, which provides yet further confidence in the safety of the existing construction."[48]

363. Mr Southward in his first expert report said –

> "There is a significant amount of structural redundancy in the design of the station box structure and such redundancy means that the limited amount of couplers with threaded lengths less than the minimum do not pose any concern for the overall structural safety and integrity of the station box structure."[49]

364. Professor McQuillan observed first –

[48] See page 13 and page 16 of Dr Glover's report

[49] See page 6 of Mr Southward's report

> "It follows therefore that for the EWL slab to function structurally and safely, no bottom couplers are required i.e. they could all be defective. It also follows that to be code-compliant, up to 50% of the coupled connections could be defective."[50]

365. He further observed –

> "In conclusion, on the basis of all the evidence available, I am satisfied and in no doubt that the structural integrity of the EWL slab has not been compromised as a result of changes of detail and sub-standard workmanship incidents, and that there are no safety issues or concerns… The same opinion applies in respect of the [diaphragm] walls and lower NSL slab."[51]

Interim determination as to 'safety'

366. Although opening-up work pursuant to the Holistic Proposal was still ongoing, on the basis of all the evidence received and considered at that time, including evidence from the independent engineering experts, the Commission was confident, that is, it was sure, that the Hung Hom Station Extension diaphragm wall and platform slab construction works are safe.

367. In coming to this determination, the Commission recognised that failures in workmanship, supervision and management of the construction project had been identified. The Commission was satisfied, however, that these failures were not so profound as to undermine the structural integrity of the station box structure.

368. The Commission was, however, of the view that additional confidence in the safety of the station box structure could be obtained by carrying out a finite element analysis in order to examine internal stresses at the connections between the diaphragm walls and EWL / NSL slabs. The Commission understands that a test of this kind was carried out and considered in the Holistic Report.

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[50] See page 39 of Professor McQuillan's report

[51] See page 49 of Professor McQuillan's report

Further consideration of the issues of 'safety' and 'fitness for purpose'

369. Pursuant to the Holistic Proposal, the station box structure was subject to further examination and analysis, including, as part of a statistical analysis, the opening up of the construction works at random locations. The report that followed recommended that additional construction work – 'suitable measures'[52] – take place in order to "cater for the poor workmanship issues found and to achieve the safety level required in the Code for meeting the requirements of the [Buildings Ordinance] and the established good practice of engineering design"[53]. The necessary work to complete the 'suitable measures' then commenced.

370. The Holistic Report was released in July 2019. Having considered its contents, the Commission sought clarification from the Government and MTRCL on the conclusion concerning structural safety as stated in the Holistic Report. The Commission also asked involved parties to indicate if they wished to adduce further structural engineering evidence on three major topics, namely, coupler connection, shear links and horizontal construction joint between the EWL slab and diaphragm wall panels in Areas B and C, as well as other minor defects.

371. In August 2019, the Department of Justice, acting for the Government, suggested to the Commission that, in light of the fact that an agreement had been reached between the Government and MTRCL to undertake 'suitable measures', no further evidence on matters related to the assessment performed by MTRCL or the 'suitable measures' themselves need be given.

372. As the Commission saw it, however, a great many issues – issues of workmanship, supervision, inspection, issues of project management – had arisen in the course of the inquiry, all of these issues having relevance, direct or

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[52] According to the Holistic Report, "'[s]uitable measures' means actions which are deemed necessary to address the issues identified in [the Holistic] Report and achieve the safety level required in the [Code of Practice for Structural Use of Concrete] for meeting the requirements of the [Buildings Ordinance] and the established good practice of engineering design. [MTRCL's New Works Design Standard Manual] should also be complied with. The term covers a wide range of actions and may include structural modifications, remedial works, long-term monitoring of the structure and the surrounding areas, and the restrictions / precautionary arrangements on future modifications to the structure, and future usage of the site and development in its vicinity."

[53] See paragraph 4.1.8 of the Holistic Report

indirect, to the overall standard of design and construction. These were issues which the Commission had been mandated to inquire into not only in the immediate public interest but also in the longer-term interests of restoring public confidence.

373. It appeared to be the case that the Government (only) had determined that "for the purpose of the ongoing construction activities" the station box structure was "structurally safe" but not otherwise. Put simply, that unless the remedial works which they had devised were completed, the station would remain unsafe and unfit for use.

374. However, as the Commission saw it, this did not appear to be the position of MTRCL. As stated earlier in this report, in submissions to the Commission counsel for MTRCL was unequivocal in confirming that MTRCL considered the as-constructed station box structure to be safe and fit for purpose without the need for 'suitable measures'. As counsel put it, the purpose of the Holistic Report was not to address structural safety *simpliciter* but was to ensure that the as-constructed works achieved compliance in light of issues concerning poor workmanship and missing records.

375. As stated earlier in this report, while the Commission accepted that the Government's independent decisions would be of considerable persuasive value, it did not consider that they relieved the Commission of its obligation either to confirm its decision reached in its interim report that the station box structure is safe or to qualify that decision, more especially in light of the fact that there was now a potential issue that raised the question of whether statutory and / or regulatory compliance of itself was to be equated with structural integrity. As the Commission has noted, the Government in this public enquiry has been but one party. Its actions may be right, they may be wrong. They are certainly subject to scrutiny.

376. Recognising at all times the primacy of the issue of 'safety' or 'public safety', the Commission determined that further evidence should be heard. In October 2019, the Commission directed that –

> "[The structural engineering] experts should focus on whether the as-constructed works are safe and fit for purpose from a structural engineering perspective; and only if they are considered not safe or fit for purpose that such experts should then

> provide their opinion on whether the 'suitable measures' (as agreed in the Holistic Report or Verification Report, or subsequently) are necessary for safety from a structural engineering perspective; and
>
> [The structural engineering] experts shall not be required to look into the question of whether the suitable measures (as agreed in the Holistic Report or Verification Report, or subsequently) are required for statutory or code compliance."

377. In order to assist the Commission, it received evidence from four independent engineering experts, three of whom had assisted the Commission under the Original Terms and they were Professor McQuillan, Dr Glover and Mr Southward.

378. In addition the Commission received the valuable assistance of Dr James Lau, a chartered structural and civil engineer and Managing Director and Chairman of James Lau & Associates Limited. Dr Lau has over 50 years of experience in civil, geotechnical and structural engineering, including construction, design and research. Dr Lau was engaged by the Government.

379. The four independent engineering experts conducted a joint site walk and inspection of the Hung Hom Station Extension site on 21 September 2019. Also present was Dr Glover's colleague from Ove Arup, Mr Colin Wade. This was followed by a Joint Meeting of Experts on 23 September 2019, held on a 'without prejudice' basis.

380. The same four independent engineering experts held a further Joint Meeting of Experts, on the same 'without prejudice' basis, on 20 December 2019. This latter meeting was held by means of a video conference, with Professor McQuillan and Dr Glover in London, and Dr Lau and Mr Southward in Hong Kong.

381. The agreed and signed memorandum – the second Joint Statement – and a supplemental memorandum of agreement are attached to this report as part of Annexure F. These statements record general agreement between Professor McQuillan, Dr Glover and Mr Southward, but with Dr Lau disagreeing on many aspects.

382. In summary, while three of the independent engineering experts – Professor McQuillan, Dr Glover and Mr Southward – agreed that the as-built structures are safe and fit for purpose, Dr Lau disagreed and was of the opinion that without the implementation of 'suitable measures' the as-built structures would be neither safe nor fit for purpose.

383. These independent engineering experts gave evidence to the Commission over six days from 2 to 9 January 2020.

The issue of inadequate thread engagement

384. Put at its highest, it would be fair to say that the appointment of the Commission came about in the wake of deep public concern that, in the construction of the station box structure, there had been widespread cutting of threads from rebars, the concern (in some quarters) reflecting a fear that this form of illicit activity may have been so widespread as to threaten structural collapse. When the Commission first began its hearings, there was little, if any, suggestion that the greater threat to structural integrity may lie in inadequate thread engagement. The issue of inadequate thread engagement only emerged after some reports of excessive cutting of threads from rebars had been proved to be very greatly exaggerated.

385. All four experts agreed that, purely on a strength basis, partially engaged threads in couplers were still capable of meeting design standards. However, they disagreed on the number of engaged threads required.

386. At the joint meeting, Professor McQuillan, Dr Glover and Mr Southward agreed that a minimum of seven engaged threads would provide the necessary strength.

387. Dr Lau, however, advised the Commission that, while he had no concerns regarding the strength capability of partially engaged couplers, his principal concern was the inability of partially engaged couplers to meet the specified permanent elongation test. He contended that a permanent 'stretch' of the coupler assembly could result in some very small cracks occurring.

388. The other three experts did not agree. They were of the opinion that there would be no permanent stretch and in any event micro-cracking around

couplers, if it did occur, would not compromise the long-term durability of the structure.

389. In respect of this issue, the Commission heard much disputed evidence regarding the necessity or otherwise of achieving 'butt-to-butt' connection between respective threaded rebars inserted into each end of a coupler. In this regard, the Commission notes that, while a requirement for 'butt-to-butt' connection was included in a footnote to some (only) of BOSA's installation instructions, there was a single, clear instruction from BOSA that threaded rebars should be inserted so that there would be a maximum of two threads exposed outside the coupler assembly.

390. As the Commission understood it, therefore, provided rebars were screwed into couplers so that a maximum of two threads were exposed this would be considered to be a proper engagement. The Commission heard considerable evidence which confirmed this point. This is illustrated in **Diagram 16** below.

Diagram 16

391. However, some independent experts demonstrated to the Commission that BOSA's criteria for correct installation – that is up to two visible threads outside the coupler assembly – would not ensure a 'butt-to-butt' connection. The independent experts further demonstrated to the satisfaction of the Commission that the Government imposed criteria of 40 mm embedment ± 3 mm tolerance would not ensure a 'butt-to-butt' connection. This is illustrated in **Diagrams 17, 18 and 19**.

392. The Commission notes that, during the period of construction, no complaint was raised by any party relating to any suggested failure to achieve 'butt-to-butt' connection in the couplers. This issue emerged during the inquiry in the debate between parties regarding the adequacy or otherwise of partially engaged couplers.

393. The independent experts agreed as follows[54] –

> "[Professor McQuillan, Dr Glover and Mr Southward] agree that, on the basis of all the testing carried out to-date, a partially-engaged coupler assembly with a minimum of 7 threads (32 mm) satisfies the strength criteria.
>
> [Professor McQuillan, Dr Glover and Mr Southward] agree that the permanent elongation tests carried out in the laboratories to-date are more indicative of the 'bedding-in' of the threads of a partially-engaged coupler assembly at low tensile load, rather than a measure of permanent elongation i.e. 'stretch'.
>
> [Professor McQuillan, Dr Glover and Mr Southward] agree that there is an incompatibility with BOSA's inspection protocols and their intent to achieve a full butt-to-butt connection. Anything less than a full butt-to-butt will not pass the permanent elongation test e.g. 2 threads exposed will not pass the test.
>
> [Professor McQuillan, Dr Glover and Mr Southward] agree that HyD's acceptance criteria, based on BOSA's criteria, therefore unwittingly sanction the use of partially engaged coupler assemblies because anything less than locked, full butt-to-butt coupler assemblies will fail the permanent elongation test.

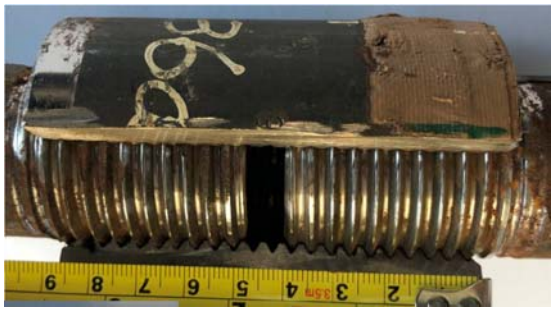
[54] The original notes reduced the names of the four experts to initials. However, for ease of reference in this report, the full names appear.

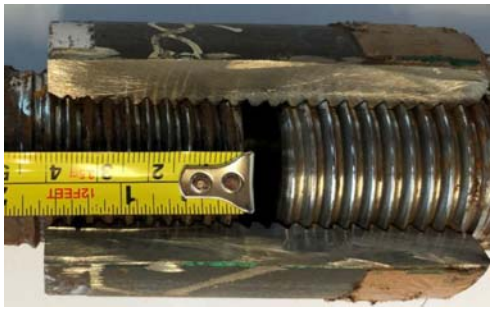
[Dr Lau] disagrees with the above points i.e. only fully engaged couplers i.e. full butt-to-butt and locked should be used in the structural assessment."

Diagram 17

Diagram 18

Diagram 19





Shear link reinforcement and utilisation

394. Shear link reinforcement comprises vertical rebars linking the top reinforcement mat with the bottom mat. Its purpose is to resist shear forces in the structure. A concern arose in the inquiry when the investigation of honeycombing identified irregularities in the shear links. Localised areas at the EWL slab soffit were opened up to investigate the workmanship and the as-constructed condition of the shear link installation. The opening-up exercise failed to reveal in some areas the existence of correctly installed shear links.

395. The Commission heard evidence from the independent engineering experts regarding the necessity or otherwise for shear link reinforcement in certain areas, irrespective of whether it was indeed installed.

396. The Commission was shown photographs of steel fixing in progress, in which shear links were clearly visible. **Photograph 4** gives an indication of the shear links as pointed out by the red arrow. However, the Commission

could not be certain that such photographs accurately represented those areas where shear links had not been revealed in the opening-up exercise.

Photograph 4

397. Dr Lau took a strong position and assumed that, where it was not revealed in the limited opening-up exercise, the shear reinforcement must have been omitted during the construction. This was the position adopted in the Holistic Report.

398. The Commission heard evidence that the concrete as installed was significantly stronger than had been specified in the design. Evidence was also provided that the concrete would increase in compressive strength over time. Professor McQuillan, Dr Glover and Mr Southward advised the Commission that this additional concrete strength reduced the need for shear link reinforcement as, to a large extent, the concrete itself was capable of resisting the shear forces.

399. The Commission further heard evidence that when analysing an as-built structure forensically, not only is it appropriate and legitimate to consider the actual material properties in the structure, the actual loading conditions (present and future) should be considered.

400. The Commission was satisfied that in carrying out this forensic, post-construction analysis, no reduction in safety factors was applied by the

independent experts. In other words, the analysis was based on the structure being at least as safe as was the case in the original design.

401. The independent experts agreed as follows –

> "[Professor McQuillan, Dr Glover and Mr Southward] agree that in the areas where nominal / minimum shear reinforcement is required, there is some 25% overprovision, or more, in the shear links installed.
>
> [Professor McQuillan, Dr Glover and Mr Southward] agree that the shear links provided should not be disregarded in their entirety.
>
> [Professor McQuillan, Dr Glover and Mr Southward] agree that the actual proven concrete cube strengths should be used in the structural shear assessment and furthermore strength gain with time is a legitimate consideration.
>
> [Professor McQuillan, Dr Glover and Mr Southward] agree there are other beneficial factors which could be considered, [e.g.] compressive action and arch action.
>
> [Professor McQuillan, Dr Glover and Mr Southward] agree that the codes allow, when retro-analysing (forensically) a structure, the safety factors to be reviewed e.g. to use actual loads and actual material properties.
>
> [Dr Lau] does not agree with the other experts generally. He is concerned that there may not be any shear links in areas where shear reinforcement is required."

The horizontal construction joint

402. The Commission has discussed earlier in this chapter the horizontal construction joint at the east diaphragm wall connection with the EWL slab, in the section headed 'Change to top of the east diaphragm wall'.

403. In paragraph 4.4.5 of the Holistic Report, MTRCL proposed the installation of drilled-in dowel bars along a 60 m length of the east diaphragm wall in Areas B and C.

404. Professor McQuillan advised the Commission of his concern that this remedial measure risked damaging the as-constructed structure as existing reinforcement could be accidently cut during the drilling operation for installation of the dowel bars. This risk was explored in the inquiry and the Commission heard the precaution that MTRCL was proposing, by drilling a pilot hole to locate the existing reinforcement. The Commission was satisfied that this should reduce the risk of damage to the structure.

405. With regard to the horizontal construction joint, the independent experts agreed as follows –

> "All four experts agree that this is solely a workmanship issue.
>
> [Professor McQuillan, Dr Glover and Mr Southward] agree that nothing needs to be done but it would be prudent, from a public perspective, to remediate the two locations where poor workmanship has been identified.
>
> Dr Lau disagrees and considers the workmanship defects must be rectified by retro-installing vertical steel dowel bars."

The experts' final summary of their positions

406. In the supplemental memorandum of agreement dated 2 January 2020, the four independent experts summarised their conclusions as to whether, in their opinions, the station box structure was safe and / or fit for purpose. The short memorandum read as follows –

> "[Dr Glover, Mr Southward and Professor McQuillan] agree that the as-built [station box structure is] 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 [station box structure is] neither safe nor fit for purpose."

407. However, upon completion of the suitable measures, both Dr Lau and the Government agree that the station box structure will be safe and fit for purpose. As counsel for the Government expressed it in the course of final submissions to the Commission –

> "It is… common ground between the Government and MTRCL that one can safely conclude that upon the implementation of the 'suitable measures' the structures are 'safe' according to a set of objective standards as enshrined in the [Buildings Ordinance] and the [applicable codes]."

The Commission's determination in respect of whether the station box structure is safe and fit for purpose

408. In light of the findings of the Holistic Report, the Government determined that, unless the suitable measures were put into effect, the station box structure, as it stands, would fail to comply with the requirements of the Buildings Ordinance, the applicable codes and the established good practice of engineering design, those instruments and practices reflecting the standards required in Hong Kong for the purposes of ensuring safety and also fitness for purpose.

409. Dr Lau, the independent expert witness called by the Government, was of the same view. It was his evidence that, in determining the factor of safety, the requirements contained in those instruments reflected the community's expectations and a consensus reached among industry practitioners over many years that take into account circumstances particular to Hong Kong.

410. MTRCL, however, was of a different view. In its closing submissions to the Commission, MTRCL stated that –

> "…These actions are known as the Suitable Measures which are being implemented for the purpose of obtaining the ultimate approval of the works by the approval authorities so that the railway can be put into operation for use by the general public."

411. Three of the independent engineering experts – Professor McQuillan, Dr Glover and Mr Southward – were at all times of the firm view that, without the need for the application of suitable measures, the station box structure, as it stands, is safe and is also fit for purpose. All three, however, agreed that the

suitable measures would add to the robustness of the station box structure or, at least, would not result in the structure being in any way less safe[55].

412. That being the case, there was consensus among all the experts and the three involved parties (the Government, MTRCL and Leighton) that, whatever their conflicting views as to the need for remedial measures, with those measures in place, the station box structure will be safe and will also be fit for purpose.

413. In the view of the Commission, that consensus, reached after many months of investigation and debate, constitutes a compelling body of opinion. In light of that opinion, the Commission is fully satisfied that, with the suitable measures in place, the station box structure will be safe and also fit for purpose.

414. While the Commission has of course borne in mind the nature and extent of the suitable measures, it has never seen it as part of its mandate to conduct an in-depth, independent, forensic assessment of those measures. It suffices to observe that, notwithstanding the differences in approach as to the need for suitable measures, the gate has now been opened – very much in the public interest – to the commissioning of the Hung Hom Station Extension in the assurance that it will be used without concern as to its structural integrity.

415. In coming to this determination, however, the Commission recognises that in a number of respects, in the course of construction of the station box structure, there were unacceptable incidents of poor workmanship on site compounded by lax supervision and that in a number of respects also, management of the construction endeavour fell below the standards of reasonable competence.

[55] Professor McQuillan, however, warned that care must be taken in drilling for the dowel bars at the horizontal construction joint at the top of the east diaphragm wall.

Chapter 9

A monitoring programme to ensure ongoing structural integrity

416. The Extended Terms required the Commission to "make recommendations on suitable measures with a view to promoting public safety and assurance on quality of works."

417. Having regard to the extensive public disquiet that arose over the construction of the Hung Hom Station Extension, the Commission has at all times been of the view that it would be in the public interest, once the station is commissioned, to have in place some form of effective monitoring in order to provide reassurance to users of the station.

418. In the interim report, the Commission recommended that the east and west diaphragm walls together with the EWL and NSL slabs should be instrumented in order to detect movement during the operational phase of the station. It was recommended that the instrumentation should be by means of fibre optics or other approved measures. Movements should be monitored and reported to the Government.

419. However, in light of further evidence received from the independent engineering experts, the Commission has been persuaded that, should such instrumentation be installed, there is a real problem that – being highly sensitive, including a proclivity to be triggered by 'noise' factors – it may set off false alarms.

420. The Commission therefore recommends that regular visual inspections should take place in order to monitor those areas in the station with the highest assessed stress levels. The monitoring should take the form of a planned preventative inspection regime, a regime that should be in existence for an extended period, perhaps five years.

Chapter 10

The Extended Terms of Reference

The Commission's mandate

421. On 30 January 2019, the day after the Commission's hearings under the Original Terms had been completed, the Government held a press conference. At that press conference it was announced that further failings, potentially of a serious nature, had been discovered in respect of the construction works carried out on the Hung Hom Station Extension Project. On the basis that these failings also fell within Contract 1112, it was decided that the best way forward was to extend the Commission's Terms of Reference. On 19 February 2019, the Chief Executive in Council approved the Extended Terms.

422. As to the Commission's new geographical mandate, it was limited to the construction works at NAT, SAT and HHS. Where these structures are located within the geographical boundaries of Contract 1112 is shown in Diagram 3 (Chapter 1, page 31).

423. The structures have been described as follows –

a. NAT – (i) an open-trough structure resting on compacted soil for EWL; (ii) the shunt neck, which connects EWL to HHS; and (iii) an underground box-section tunnel partly constructed on soil and partly supported by socketed H-piles for NSL.

b. SAT – (i) an open-trough structure resting partly on socketed H-piles and partly on compacted soil for EWL; (ii) the launching and retrieval tracks, which connect EWL with HHS, resting partly on socketed H-piles and partly on compacted soil; and (iii) an underground box-section tunnel founded on diaphragm walls for NSL.

c. HHS – (i) at-grade open-trough structures accommodating 15 train tracks; (ii) two box-section underpasses beneath the tracks; (iii) at-grade open-trough structures at the North Fan Area resting on soil

and a noise barrier founded on piles; and (iv) eight single-storey accommodation blocks founded on piles.

424. In respect of these construction works, the Commission was required –

> "(i) to inquire into the facts and circumstances surrounding any problem relating to the steel reinforcement fixing or concreting works, including but not limited to any lack of proper inspection, supervision or documentation of such works undertaken, any lack of proper testing of the materials used for such works and of proper documentation of such testing, and any deviation of such works undertaken from the designs, plans or drawings accepted by the Highways Department or the Building Authority;
>
> (ii) to inquire into the facts and circumstances surrounding any works or matters which raise concerns about public safety or substantial works quality; and
>
> (iii) to ascertain whether the works and matters involved in [(i) and (ii)] above were executed in accordance with the Contract. If not, the reasons therefor and whether steps for rectification have been taken."

425. The Commission was also to conduct a review of the following –

> "(i) the adequacy of the relevant aspects of the 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;…"

426. Finally, following on from its inquiry, the Commission was required "to make recommendations on suitable measures with a view to promoting public safety and assurance on quality of works."

The issues that fell for consideration

427. In respect of the Commission's Extended Terms, a number of issues fell for consideration. Those issues may be listed as follows –

(1) missing RISC forms;

(2) defective construction of the three stitch joints and the shunt neck joint in NAT;

(3) unauthorised design changes: lapped bar connections into coupler connections;

(4) failure to ensure quality testing of all rebars; and

(5) the need for suitable measures (trough walls and shear links).

Looking first to the Verification Report

428. On 15 May 2019, three months after the Commission had been given its extended mandate, the Government accepted a proposal from MTRCL – the Verification Study – that was similar in nature to MTRCL's earlier Holistic Proposal.

429. The Verification Study was principally founded on the alarm caused by the very large number of RISC forms that could not be found, either because they had not been made out in the first place or because they had gone missing.

430. In substantial part, by reason of these missing records, the Verification Study sought to verify the as-constructed conditions of NAT, SAT and HHS and, on the basis of the data collected, to conduct a structural review. If, in terms of the structural review, 'suitable measures' were required, those measures would be identified. In addition, if required, a long-term monitoring system would be devised.

431. The meaning of the term 'suitable measures' was defined in the Verification Report (as it had been in the Holistic Report). The definition was said to include "structural modifications" and "remedial works". As to the

purpose of these measures, they were to address "the gaps and related workmanship / quality issues" discovered in the course of investigations so as to achieve the "safety level required in the then prevailing Code of Practice for Structural Use of Concrete [the 'Code'] for meeting the requirements of the Buildings Ordinance and the established good practice of engineering design". They were also geared to complying with MTRCL's NWDSM.

432. The Government accepted the Verification Study and investigation works were undertaken. To assist in these investigations, MTRCL engaged the following design consultants, namely, Atkins China Limited for the NAT and SAT structures and part of HHS, and AECOM Asia Company Limited ('AECOM') for the balance of the HHS structures. In addition, MTRCL engaged Siu Yin Wai & Associates Limited to conduct a verification study of available project information in relation to the NAT, SAT and HHS structures, and Ove Arup & Partners Hong Kong Limited to conduct an independent review of the structural integrity of the as-constructed works at the NAT, SAT and HHS structures with a view to ensuring "quality assurance" of the structures.

433. In the result, the Verification Report was issued on 18 July 2019.

434. As with the Holistic Report, the Verification Report identified a number of suitable measures that were required and it was confirmed that, upon satisfactory completion of these measures, the construction works in question would "achieve the safety level required in the Code for meeting the established good practice of engineering design". As the Commission has understood it, therefore, once the suitable measures have been satisfactorily completed, the construction works in question would then fully comply with the Buildings Ordinance and the Code and, as such, be both 'safe' and 'fit for purpose'.

435. As to the discrete areas of investigation undertaken for the purposes of the Verification Report, they are summarised below.

436. The Verification Report summarised the number of RISC forms that had been recovered in respect of the construction of the NAT, SAT and HHS structures, identifying to which hold point inspections they referred. The following table gives an analysis of the figures. It will be seen that, in respect

of some hold point inspections, the percentage of RISC forms available was well below 50%, the best figure being 61% while the worst was just 22%.

Table

Structures	Number of RISC forms required		Number and percentages of RISC forms available		Number and percentage of unavailable RISC forms to be addressed under the Verification Study	
NAT	Rebar	64	21	33%	43	67%
	Pre-pour	59	13	22%	46	78%
SAT	Rebar	42	23	55%	19	45%
	Pre-pour	44	27	61%	17	39%
HHS	Rebar	659	287	44%	372	56%
	Pre-pour	611	344	56%	267	44%

437. In the opinion of the Commission, the table is evidence that, in respect of the approach tunnels and the stabling sidings at least, the RISC scheme, as a primary quality assurance scheme, came close to redundancy.

438. The Verification Report, however, did acknowledge that there was *other* evidence – photographs, site diaries, WhatsApp messages and the like – to support the fact that construction works had been supervised and that important hold point inspections had taken place.

439. In seeking assurance of quality, the 'verification' investigations identified records as to the testing of construction materials. These records consisted of, first, concrete cube testing records, second, sand replacement testing records and, third, rebar testing records.

440. The concrete cube tests and the sand replacement tests were confirmed to have been carried out in accordance with contract requirements. The tests showed satisfactory results.

441. The available rebar testing records demonstrated that the rebars had been tested and had passed the test requirements. However, Leighton disclosed that approximately 7% of the rebars delivered to the construction site

had not been sampled for testing – as was required – by a Hong Kong Laboratory Accreditation Scheme ('HOKLAS') accredited laboratory. This is considered later under the sub-heading: 'Failure to ensure quality testing of all rebars'.

442. The Report further considered two areas of design change –

a. It appeared that there had been a change from coupler connections to drilled-in bars for the connection between the diaphragm wall and the NSL slab of SAT. However, no pull-out records for the drilled-in bars could be found, if indeed they had ever been carried out.

b. There had been a material design change in that couplers had been used at certain construction joints instead of the lapped bars that had been shown in the original design. This is considered later under the sub-heading: 'Unauthorised design changes: lapped bar connections into coupler connections.

443. Central to the investigations was, of course, the issue of structural integrity. For the purpose of the structural review, a comparison was made between deduced spare structural capacity and an assumed strength reduction factor to compensate for the lack of full records of the coupler connection works. In this regard, MTRCL decided to apply a strength reduction factor of 35% in areas where coupler connections had replaced lapped bars, doing so on the basis that the quality of workmanship was uncertain. The figure of 35% was comparable to the strength reduction factor applied in respect of the NSL slab in the station box structure. No allowance was made for the fact that (in the main) the steel reinforcement fixing required to build the trough walls was done in far better light and was a more open, simpler process, a process, in addition, more accessible for the purposes of inspection.

444. The strength of drilled-in bars between the diaphragm wall and the NSL slab at SAT was not taken into account because the required pull-out records were not available.

445. The task force responsible for the Verification Report determined that the following two sets of remedial measures were necessary –

a. In respect of the trough walls in the HHS, it was calculated that, in certain parts, the spare structural capacity was less than the strength reduction factor of 35%. Those parts were in the kickers of trough walls near movement joints of a total length about 150 m. Suitable measures were therefore required to strengthen those parts.

b. Apparent defects in shear link placements were first discovered, when shear links were exposed in the course of investigating honeycombing. Although the spare structural capacity at critical shear locations was greater than the strength reduction factors adopted to compensate for the 7% of rebars that had not been HOKLAS tested, suitable measures were proposed to enhance the shear strength at the NSL tunnel box because of concerns about possible missing or inadequate shear links in Area A of the NSL slab of the station box which adjoins SAT. The Commission notes that it is anticipated that the suitable measures will be completed by the end of June 2020.

446. The Commission notes that by the end of January 2020 the suitable measures to ensure the structural integrity of the trough walls had been substantially completed.

Issue (1): Missing RISC forms

447. As stated earlier, the set of proposals which led to the Verification Report was in large part founded on the alarm caused by the very large number of RISC forms that could not be found. These were documents which, on their face, were proof that formal inspections of construction work had taken place at moments of particular importance in the construction process. They were, therefore, evidence that the work had been completed to the required standard.

448. MTRCL was under a contractual obligation to the Government to have a quality assurance system in place, ensuring that the management of the construction works was of a standard not inferior to that required by the Buildings Ordinance and relevant regulations.

449. MTRCL's PIMS provided for the RISC form.

450. MTRCL's PIMS sets out the procedure for formal inspections and approvals of site works.[56] The contractor, in this case Leighton, is required to submit to MTRCL – a RISC form – in the format specified in PIMS. This is a notification from the contractor to MTRCL that the contractor wishes specified works to be inspected on a particular date and at a particular time.

451. The overall RISC form procedures require the contractor's development of Inspection and Test Plans ('ITP') for required elements of the works. The ITPs set out Quality Hold Points and Quality Control Points to be applied at key stages of construction. Leighton itself, in respect of its contractual obligations, set out the requirement for hold point inspections and the need in that process to employ RISC forms.

452. In summary, whether between the Government and MTRCL or MTRCL and Leighton, it was agreed, as a matter of contract, that hold point inspections would be carried out, those inspections being evidenced by the completion of RISC forms.

453. In the course of the inquiry, particular focus was placed on the hold point inspections that took place between completion of steel reinforcement fixing and the commencement of preparation for concreting; and the hold point inspections that took place between completion of preparation for concreting and the pouring of concrete: the so called 'pre-pour check'.

454. It is self-evident that, once concrete is poured, it presents particular difficulties in seeking to confirm the quality of work now buried by that concrete. Hold point inspections are therefore an essential element of quality control.

455. Typically, under Contract 1112, hold point inspections for steel reinforcement fixing would be conducted by Leighton and MTRCL engineers; while pre-pour checks would be conducted by Leighton supervisors and MTRCL inspectors of works.

[56] PIMS/PN/11-4/A6 "Monitoring of Site Works"

456. On completion of the inspection, the representatives of the contractor and MTRCL sign the RISC form to indicate satisfactory inspection. Provision is made on the form for relevant comments to be recorded.

457. While the hold points and RISC forms were matters of contract between the Government and MTRCL, and between MTRCL and Leighton, the RISC forms are not statutory or regulatory documents. Similarly, while Inspection Certificates are to be retained for 12 years after the completion of a project, RISC forms may be destroyed immediately after the completion. In the view of the Commission, this is a matter which should be subject to review and this will be considered later in this report[57].

458. In respect of the completion of RISC forms – being proof of quality of construction – the table on page 144 shows that a high percentage of the forms had either not been made out in the first place or had been lost.

459. It was submitted to the Commission that a failure to complete RISC forms did not impact on safety because there were other site records to prove that the work has taken place and to satisfy proof of standards of workmanship. In this regard, for example, audits had shown that nearly all of the essential hold point inspections for the construction works at NAT and SAT (but not for HHS) could be validated through available RISC forms and other information such as photographs, site diaries, WhatsApp exchanges and the like.

460. While these other records may perhaps present 'second best' evidence, leaving aside the protracted inconvenience of gathering that evidence, the Commission is of the firm opinion that completed RISC forms – which *are* an important contractual obligation – constitute primary certification of work correctly done in that they record the details of inspections carried out jointly by MTRCL and Leighton.

461. During the course of the hearings, the Commission heard evidence to the effect that the RISC process was cumbersome and caused delays. In this regard, for example, Lii Hing Yu, Jeff, a Leighton engineer who worked in the HHS area between February 2015 and May 2018 said the following –

[57] See Chapter 13

a. The RISC forms were not 'user friendly'; he would have to use a tri-colour photocopier to print the documentation using the INCITE system and, once entered, it was difficult to correct mistakes. The process was time consuming.

b. Both MTRCL and Leighton expected the hold point inspections to proceed without delay. In the result, inspections would often take place without the need to produce RISC forms, it being understood that they would be completed at a later stage.

c. However, he, along with other engineers, had other tasks to complete. Work piled up and the RISC forms would be left uncompleted.

462. While the Commission understands that the RISC process may have been 'cumbersome', it rejects the suggestion that the heavy workload on site did not provide sufficient time for the forms to be completed. The RISC process, as stated earlier, constituted a primary source of certification and was therefore of fundamental importance. It should have been the subject of full – and *contemporaneous* – compliance.

463. As it was, the evidence indicated that an 'informal system' had emerged with Leighton engineers informing their MTRCL counterparts by WhatsApp or by telephone that elements of the work in process would be ready for hold point inspections. In an apparent effort to be collaborative and not to delay the works, MTRCL personnel would then carry out inspections on the understanding that RISC forms would follow in due course. In many cases, as the evidence has shown, those RISC forms were never submitted.

464. In other cases, large batches of RISC forms would be submitted well after the events in question. This placed an unenviable burden on the MTRCL engineers and inspectors of works who were faced with the difficult task of completing the forms well after the event, having to rely on sketchy notes, photographs and other secondary evidence. Again, the Commission heard that MTRCL personnel were seeking to act in a collaborative fashion.

465. It was suggested by certain of the Leighton witnesses that MTRCL personnel appeared to be happy to proceed with the informal system. On the part of a number of MTRCL personnel that may have been the case: but

certainly not with all. And of course, the failure by one party to a contract (if it occurred) does not relieve the other party from its standing obligations.

466. The Commission is satisfied that, under the stress of work and the stress of maintaining progress of work, Leighton engineers came (over a period of time) to give the completion of RISC forms a low priority. Regrettably, MTRCL management did not insist on the correct procedures being followed. Nor does the matter appear to have been addressed at director level. In the result, the unsatisfactory situation was permitted to continue.

467. The Commission is further satisfied that the reason such a high percentage of RISC forms were never completed was that a form of contempt for the process was allowed to develop. The cause for that was poor management.

468. As the Commission understands it, recognising that the physical documentary process is cumbersome, MTRCL has already taken steps to improve the RISC form system by adopting a digital process through an online platform called 'iSuper'.

469. It was PYPUN's position that it was never under a duty to audit RISC forms: they did not fall under the headings of 'cost, programme and public safety'. The Government disagrees. It was the Government position that assessment of quality was integral to PYPUN's monitoring responsibilities.

470. It is not for the Commission to determine disputed contractual obligations. However, the Commission does observe that if there had been an audit of RISC forms that would have better ensured compliance with the RISC form procedures and may well have avoided the difficulties encountered in this inquiry.

Issue (2): Defective construction of the three stitch joints and the shunt neck joint in NAT

The nature and purpose of construction joints and stitch joints

471. For the purposes of this report, 'construction joint' and 'stitch joint' may be described as follows –

a. A joint itself is to be found where two bays of reinforced concrete come together.

b. Normally, when two successive bays of reinforced concrete are to be joined together, lapped bars or couplers may be employed and, once cast into concrete, create a continuous structure. A joint of this kind is called a 'construction joint'.

c. However, the two bays of reinforced concrete to be connected may be built on different foundations (for example, if one is founded on piles and the other at grade), or if one of them may be constructed well in advance of the other. In the result, the two bays of concrete may have different degrees of settlement or movement before they fully stabilise. Accordingly, if they are to be connected by way of a conventional construction joint (as described above) there is a risk that differential settlement or movement may create stress giving rise to cracking.

d. A stitch joint minimises this risk because the two bays of reinforced concrete are only 'stitched' together after their respective settlements have had time to stabilise.

Interface joints

472. The location of the three stitch joints and the shunt neck joint (the subject of Issue (1)) are to be found in **Diagrams 20 and 21**. Diagram 20 shows the lower NSL level. Two of the stitch joints are on this lower level. They are coloured orange and are shown on the right hand side of the diagram. Diagram 21 shows the upper EWL level with one stitch joint, again coloured in orange, and the shunt neck joint, coloured in dark blue, shown on the right hand side.

Diagram 20

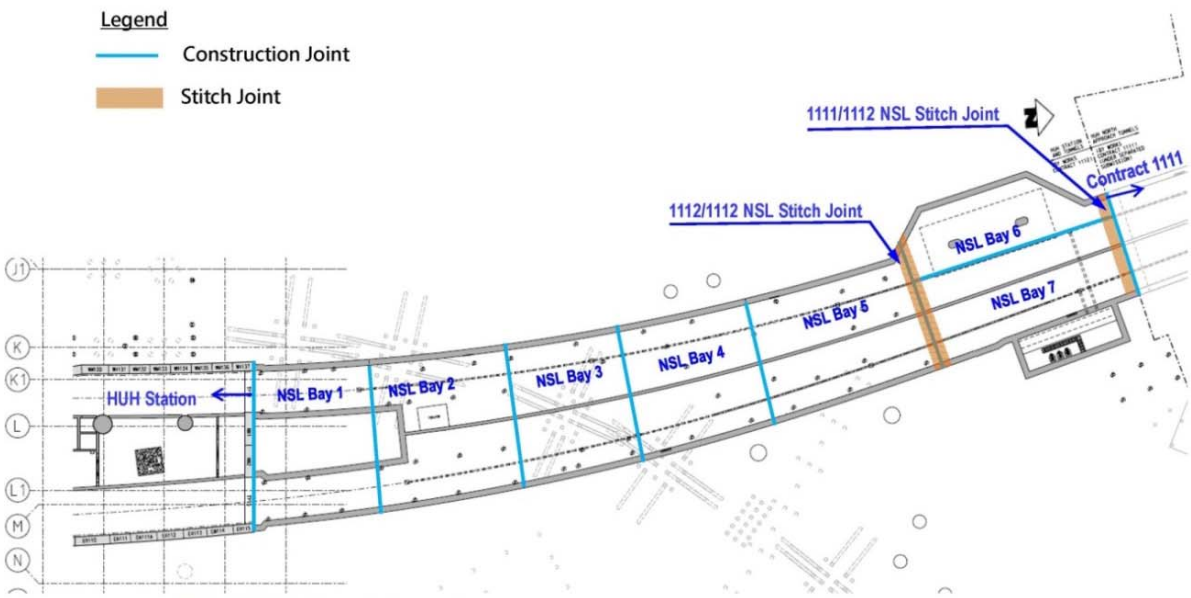
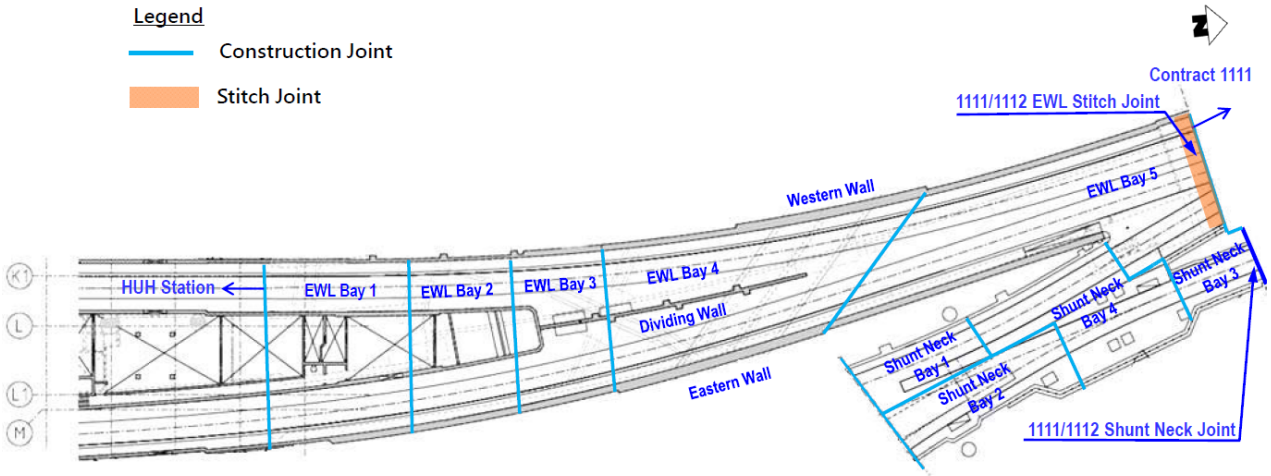
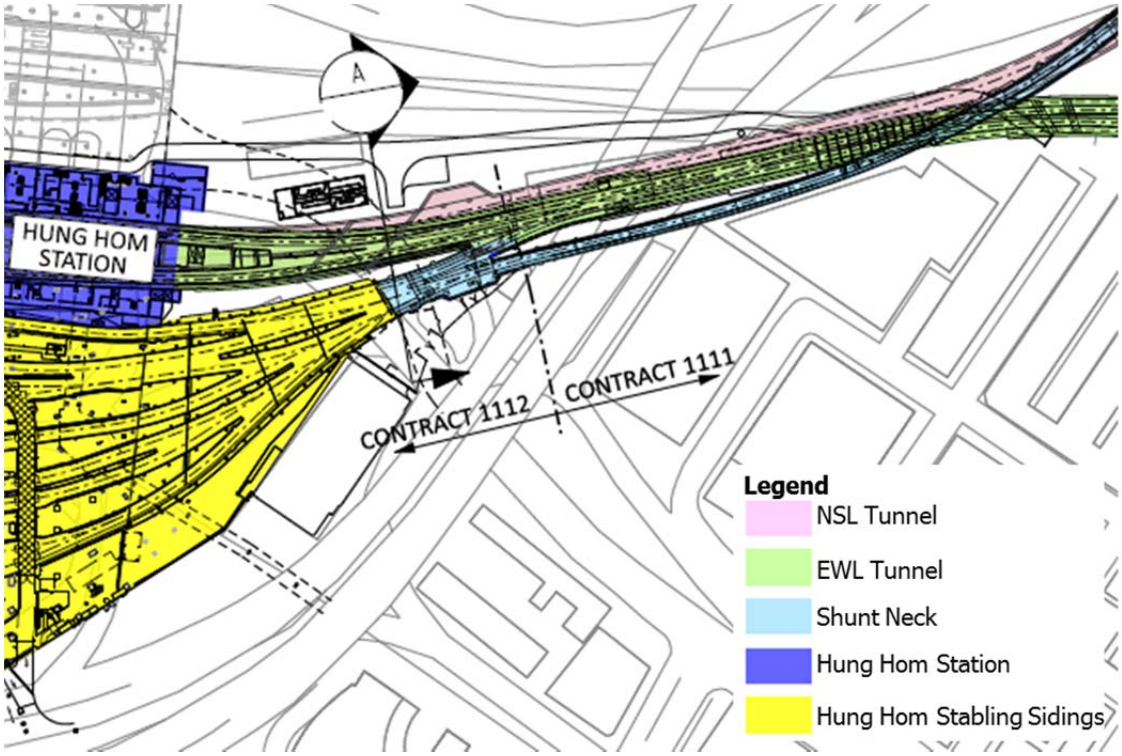


Diagram 21



473. A matter of importance in respect of these stitch joints is that two of them are 'interface' joints. Put simply, they are joints which mark the division (or interface) between two contracts. **Diagram 22** contains a black dotted line running east to west across the tunnels. This is the dividing line between Contract 1112 to the South, Leighton being the contractor, and Contract 1111 to the North, Gammon-Kaden SCL 1111 Joint Venture ('GKJV') being the contractor.

Diagram 22



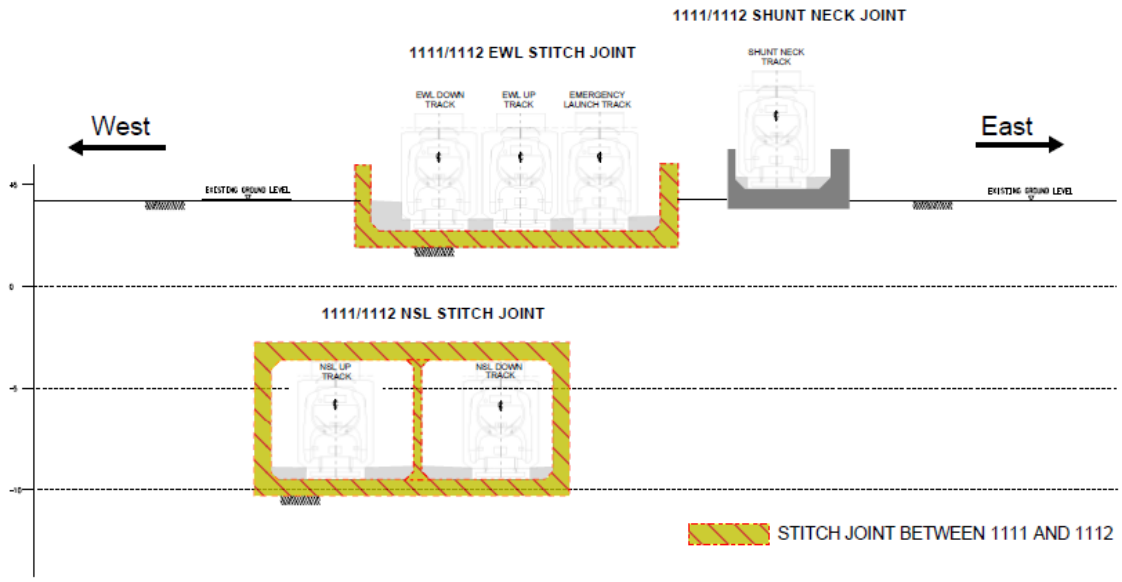
474. The three interface joints in the diagrams are designated with the two contract numbers: 1111 / 1112.

475. The purpose of the three stitch joints was to account for the fact that, in respect of one of them, the joining bays of concrete had been built on different foundations while, in respect of the other two stitch joints, one bay of concrete had been built well ahead of the other. The purpose, as stated earlier, was to minimise potential stress at the joints.

476. **Diagram 23** illustrates the nature of the construction of the interface joints. The stitch joint on the lower NSL level is a twin box underground tunnel structure; it is an enclosed reinforced concrete box. The stitch joint on the upper EWL level is built as an open trough tunnel.

Diagram 23

Section 1 - Simplified Sketch
at 1111/1112 Interface at North Approach Tunnel



NOTE:

1. THE SKETCH SHOULD ONLY BE USED FOR ILLUSTRATIVE PURPOSES.
2. THE SKETCH IS NOT DRAWN TO SCALE AND FULL DETAILS ARE NOT SHOWN.

477. On the upper EWL level, the shunt neck joint, an open trough structure and also an interface joint, is shown (in grey). It is shown in Diagram 21 as a thin blue line on the right hand side.

Methodology of construction

478. As to the construction of the stitch joints, the method that appears to have been adopted may be illustrated by taking as an example the interface stitch joint: 1111 / 1112 NSL (shown in Diagram 20) –

a. GKJV first constructed its tunnel structures with a chosen brand of couplers – Lenton couplers – at the end of the structure. Then Leighton constructed its tunnel structures with its own chosen brand of couplers – BOSA couplers – fixed at the end of the structure. The

stitch joint would then be constructed by Leighton directing its sub-contractors, that being its contractual obligation, but only after the differential movements of the two connecting structures had stabilised.

b. To construct the stitch joint, Leighton's sub-contractor had to expose the Lenton couplers fixed at the end of the GKJV structure, installing starter bars (the '1111 rebars'), and then expose the BOSA couplers fixed at the end of the Leighton structure, fixing starter bars (the '1112 rebars').

c. Finally, the 1111 rebars would be lapped with the 1112 rebars. This would be done at the base slabs, roof slabs, external walls and dividing walls. Concrete would then be poured.

d. This construction sequence was essentially the same in respect of all three interfacing stitch joints except that the EWL open trough tunnels do not require roof slabs or dividing walls.

e. The building methodology was the same with respect to the 1112 / 1112 NSL stitch joint. The only difference was that, as both sides of the joint fell within the scope of Contract 1112, Leighton was responsible for all construction works.

Dates of original constructions

479. The original dates of construction were as follows –

a. The single EWL stitch joint (shown in Diagram 21) was originally constructed between January and March 2017.

b. The shunt neck joint (also shown in Diagram 21) was constructed between January and March 2017.

c. The NSL interface stitch joint (shown in Diagram 20) was originally constructed between July and August 2017. The NSL stitch joint within Contract 1112 (also shown in Diagram 20) was originally constructed between May and September 2017.

Missing RISC forms

480. In the judgement of the Commission, it is important to note that not a single RISC form appears to have been generated in respect of the original construction of the stitch joints and the shunt neck joint. Accordingly, as to the integrity of formal inspections by both Leighton and MTRCL, the Commission has had to rely upon the often vague oral evidence of witnesses to try to determine what in fact took place.

Problems

481. MTRCL observed water seepage in the NSL interface stitch joint during a routine inspection that took place within approximately two weeks of completion. Leighton was required to carry out grouting work to seal up the water seepage, a process that was repeated. It was not successful. In February 2018, Leighton was required to chip off the concrete at certain locations of all three stitch joints. It was found that in each stitch joint a number of the rebars had not been properly spliced to the couplers. As a result, MTRCL issued three NCRs to Leighton. It appears that Leighton, in its turn, served an NCR on its steel fixing sub-contractor, Wing & Kwong. The decision was made, however, that Wing & Kwong would not be carrying out the remedial works which would be completed by Leighton itself.

482. The remedial works were carried out by Leighton between about March and July 2018. The work was supervised by an independent quality control team and was subject to hold point inspections by MTRCL's inspectorate staff, the inspections being recorded in RISC forms.

483. In or about early 2019, further water seepage was observed. Further remedial measures were taken, that work being completed in or about mid April 2019. The Commission has been informed that the current position is that all water seepage has been treated and there is no further seepage.

A failure of liaison

484. The successful construction of the interfacing stitch joints required collaboration between the contractors: Leighton and GKJV. To this end, regular interface meetings were held over a period of some three years between

early 2014 and early 2017: over 20 meetings took place. Representatives from the two contractors and also from MTRCL regularly attended. Sub-contractors, however, such as the steel reinforcement fixers, did not attend.

485. The working drawings of the interface stitch joints did not indicate the type of couplers that would be used in either the Contract 1111 or Contract 1112 structures. The matter was, however, raised at the interface meetings. Whether the couplers were compatible was a matter of importance – Lenton couplers (used in Contract 1111) were taper-threaded while BOSA couplers (used in Contract 1112) were parallel-threaded. Leighton, it appears, agreed at a fairly early stage to check with its supplier, BOSA, as to the issue of compatibility. It failed to do so.

486. On behalf of Leighton, its counsel freely admitted that its staff, by their attendance at the various interface meetings, ought to have grappled with the issue of coupler compatibility. As one Leighton representative, who attended earlier meetings, put it: "at that point it wasn't on our radar". Later representatives were aware of the issue but, so it seems, either assumed the issue had already been dealt with or would be dealt with but by somebody other than themselves. Regrettably, although Leighton had an internal system – INCITE – which was meant to contain all project documents, it did not contain the minutes of interface meetings. In the result, the issue of compatibility was never resolved.

487. On behalf of Leighton, it was said that the company had learnt from the communication error and has since then taken active steps to put procedures in place which improve communication and distribution of key documents between its engineers.

The problem compounded: ordering the wrong materials

488. The problem, however, is that, when the time came to ordering materials for the stitch joint works to be done, Leighton failed to order the correct type of rebars for connection to the cast-in couplers for the Contract 1111 side of the two interface structures (*and* the shunt neck joint, it also being an interface joint), proceeding on the assumption that the cast-in couplers would be BOSA couplers. Accordingly, only rebars that fitted BOSA couplers were ordered.

489. Leighton's steel fixing sub-contractor, Wing & Kwong, was responsible for the provision of steel fixing labour only. It was not, for example, responsible for the work of chipping way the concrete to expose the couplers embedded into the interface structures.

490. While Wing & Kwong was required to specify quantities, it was not responsible for specifying the type of materials, for example, the brand of couplers. Its contractual relationship with Leighton required it simply to "complete reinforcement fixing works using an approved method" and to "follow the instructions of the [contractor's] site team in respect of speed, extent, timing, sequencing and staging".

491. Henry Lai, a member of Leighton's construction engineering team on the project – in terms of experience, a relatively junior engineer – was at the relevant time working in the area of NAT including the three stitch joints and the shunt neck joint. Henry Lai was responsible for ordering materials including the rebars. Regrettably, as it was put by Karl Speed, Leighton's General Manager –

> "It appears that certain members of Leighton's construction engineering team were aware that [GKJV] was using [Lenton] couplers… as a result of attending interface meetings with [GKJV representatives]. However, this information was not communicated to Mr Henry Lai."

492. Henry Lai himself said that the only couplers he worked with on site during the construction of NAT were BOSA couplers and he assumed that they were the only couplers (with their matching rebars) which were being used. He said that he did not attend any of the interface meetings and received no feedback as to what had been discussed during those meetings.

The problems facing Wing & Kwong

493. It was Wing & Kwong's position that, when it came on site to undertake its work, it faced two difficulties –

a. it had been given BOSA parallel-threaded rebars which would not properly engage into the Lenton couplers imbedded in the

Contract 1111 interface side, only two or three threads being capable of being engaged; and

b. there had been a failure by Leighton and / or GKJV to chip away the concrete covering some of the couplers, properly exposing them and thereby making it impossible to properly connect the rebars.

A conflict of evidence

494. Ng Man Chun, site supervisor of Loyal Ease (sub-contractor of Wing & Kwong), said that, when he went on site before the steel reinforcement fixing works were to begin, he saw both problems. They were, he said, visually very obvious. He therefore contacted Henry Lai, the Leighton engineer responsible for supervising the works to ask for instructions on how best to proceed.

495. Ng Man Chun said that Henry Lai expressly instructed him to do the best that he could in light of these difficulties; no time was to be wasted – no new rebars were to be ordered, neither Leighton nor GKJV were to be called in to complete the work of chipping the obstructing concrete away. Ng Man Chun said that there was a clear hierarchy: Leighton could dismiss Wing & Kwong from site without reason. He said that he and Henry Lai had been working together for over a year and he trusted him. He therefore followed instructions and did the best he could.

496. He did this, he admitted, despite knowing that the standard of workmanship that he and his colleagues would be capable of achieving would be below par and may therefore leave Wing & Kwong open to sanction. Ng Man Chun did not seek to protect himself and / or his company in any way; for example, by requiring Henry Lai to confirm his instructions in writing. Indeed, it appears that he did not inform anybody at Wing & Kwong itself until the poor workmanship had been revealed and he was contacted by one of his company's managers.

The findings in respect of Ng Man Chun

497. Even if Ng Man Chun's version of events is found to be credible, he has nevertheless, without evasion, accepted that the work he undertook in his role as site supervisor of Loyal Ease constituted work that was entirely

unacceptable. In an exchange with the Chairman, he accepted that he engaged rebars into couplers knowing that they would either not engage at all or would be engaged only to the extent of two or three threads. He further accepted that, if concrete had not been chipped away, he was prepared to leave matters as they were and not engage rebars into the unexposed couplers at all. The following exchange with the Chairman is clear –

> "Chairman: … So, as I understand it, these were two examples of very poor workmanship, correct, on your part?
>
> Ng: Yes, you can put it that way."

498. While the inability of Wing & Kwong to engage parallel-threaded BOSA rebars into Lenton couplers deeper than two or three threads is understood, what the Commission has difficulty understanding is why there was a material number of instances of a failure of connection on the Leighton side (a failure not obstructed by old concrete that had not been chipped away). The threaded rebar after all were designed for full engagement in Leighton's BOSA couplers. Yet William Holden, Leighton's Engineering Manager, who inspected the structures before demolition, reported that a number of rebars were not "lined up with couplers at all and were sitting adjacent to the couplers". In this regard, on a consideration of the evidence, the Commission agrees with the submission of counsel for the Government that the probable cause was poor workmanship on the part of Wing & Kwong and a lack of supervision by Leighton and MTRCL.

The findings in respect of Henry Lai

499. It was an integral part of Henry Lai's daily duties to conduct inspections. As he put it in one of his witness statements –

> "On a typical day, I spent most of my time (usually from around 9 am to 5 pm, especially around the period of the pouring of concrete) on site supervising various construction works, including conducting routine inspections.
>
> I would usually check once in the morning and once in the afternoon on the progress and manpower for the works. If there were any issues, I would raise them with the foremen of Wing & Kwong…"

500. In his evidence before the Commission, Henry Lai recalled that he had carried out formal inspections in respect of rebar fixing in the three stitch joints and the shunt neck joint, all being work completed by Wing & Kwong. Yet there is no evidence that he complained of the standard of work even though he would have been involved in general supervision as well as formal inspections.

The evidence of other inspectors

501. It was Henry Lai's evidence that, although he had no recollection of individual inspections, he was sure that he carried out rebar fixing hold point inspections for the three stitch joints and that he did so in the company of Chan Chun Wai, Chris ('Chris Chan'), an engineer with MTRCL. Chris Chan, however, denied that he had conducted any hold point inspections with Henry Lai. In his testimony he said that he was very clear on the point and that it had never happened.

502. In his turn, Chris Chan suggested that the formal inspections had been carried out by Ms Kang Pu, Kappa ('Kappa Kang'), an MTRCL engineer, and Tang Siu Hang, Tony ('Tony Tang'), an MTRCL inspector of works. Tony Tang, however, said that he was not involved in these inspections, suggesting that it was either Chris Chan or Kappa Kang.

503. For her part, Kappa Kang could not remember whether she had carried out hold point inspections at the three stitch joints or the shunt neck joint, saying that the areas where she had to inspect were very large.

The shunt neck joint

504. In addition to the three stitch joints, provision was originally made for a further stitch joint at the shunt neck interface between Contracts 1111 and 1112.

505. Although originally designed as a stitch joint, this was found to be unnecessary as the interfacing structures were all founded on piles and were not subject to any soil overburden. In the result, albeit in a somewhat round-about manner, MTRCL gave instructions that it should be built as a construction joint.

506. The shunt neck structure was completed in May 2017. At about the end of 2017, however, MTRCL observed minor cracks in the structure. In March 2018, instructions were given to Leighton to chip off the concrete at three locations. This revealed that – as with the three stitch joints – there had been a failure to screw rebars into the Lenton couplers fixed by GKJV on the Contract 1111 interface side. Some rebars were only slotted into the couplers.

507. On 30 October 2018, MTRCL submitted a detailed remedial proposal to the Government to make good the deficient works. Correspondence then ensued which resulted in MTRCL filing amended proposals. In May 2019, the Government accepted these amended proposals subject to certain conditions. Remedial works then proceeded.

Leighton: a failure of management

508. In submissions to the Commission by counsel for the Government, focus was centred on the breakdown in communication within MTRCL and Leighton in respect of the procurement of materials for the stitch joints and shunt neck joint. It was submitted that this breakdown revealed a more fundamental problem, one that revealed itself during the course of the inquiry, namely the absence of a mechanism within Leighton and MTRCL to ensure that important matters are communicated to relevant frontline staff in time. The Commission agrees with this submission.

509. In this regard, the Commission notes that staff often had to resort to their own private means of communication, for example, the use of WhatsApp.

510. Henry Lai, while effectively the 'hands-on' Leighton engineer responsible for the stitch joints and the shunt neck joint, was not invited to attend the interface meetings. Similarly, it is surprising that Kappa Kang and Tony Tang, the frontline staff responsible for the rebar and pre-pour hold point inspections, were not familiar with the details of the couplers to be employed on the Contract 1111 side of the interface.

The issue of the standards of the inspections

511. To the Commission's understanding, none of the formal hold point inspections that were apparently carried out in respect of the stitch joints and the

shunt neck joint resulted in any formal condemnation of the steel reinforcement fixing works.

512. In the opinion of the Commission, the formal hold point inspections of the steel reinforcement fixing works apparently carried out by Leighton and MTRCL in respect of the three stitch joints and the shunt neck joint must have been perfunctory. Regrettably, as earlier indicated, there is no record of any RISC forms being generated in respect of these inspections. What is known, however, is that the work to be inspected was well below standard – indeed, directly responsible for water seepage within a matter of weeks – and yet no record of any critical appraisal of the work exists. The Commission accepts that the areas to be inspected were congested and the lighting poor. That said, however, there would (or should) have been more than one formal inspection by more than one suitably qualified person. There were many areas on site that were congested and where the lighting was poor. Those who conducted the inspections, both Leighton and MTRCL personnel, were under an obligation to detect poor quality workmanship even in such conditions.

513. Leighton has accepted that there is clearly room for improvement in the processes to be followed by its supervision and inspection staff and has said that steps are now being taken to improve the quality of the management framework.

The structural integrity of the three stitch joints and the shunt neck joint

514. In the course of final submissions made to the Commission in July 2019, counsel for MTRCL confirmed that "a 'bespoke' quality assurance and control system for the remedial works" had been implemented to ensure the structural integrity of the three stitch joints. In addition, remedial proposals for the shunt neck joint had been accepted by the Government subject to certain qualifications. Accordingly, while the history of construction of these joints may have been less than happy there is now no concern as to their safety and fitness for purpose.

Issue (3): Unauthorised design changes: lapped bar connections into coupler connections

515. The Commission was informed that in the areas of NAT, SAT and HHS, a large number of reinforcement connections at construction joints between slabs and walls had been changed by Leighton from the specified lapped bar connections to mechanical coupler connections. This change was not notified by Leighton / MTRCL to the Government and permission for the change was not given by the Government. This was therefore an 'unauthorised change'.

516. It appears that the changes were made by the contractor to enable temporary vehicular access between parts of the construction site, which would otherwise have been prevented or obstructed by the presence of vertical 'starter' bars. The starter bars would subsequently be lapped with plain rebars to form lapped bar connections.

517. MTRCL's Construction Manager, Chan Kit Lam, Kit ('Kit Chan') explained to the Commission that a reason behind the change was to form an opening for the provision of temporary site access for a short period of time (for a few months). He went on to explain that this was very common practice in the construction and engineering industry for a large civil engineering project like the SCL Project.

518. While what is stated in the above paragraph is largely undisputed, the Commission notes that the Government has raised concerns regarding this change because –

a. MTRCL and / or Leighton failed to make a prior consultation submission to the Government regarding the change;

b. If such prior consultation had been made, the Government (that is, BD) would have imposed requirements in respect of the couplers not originally shown in the accepted drawings. These requirements likely would have included the submission of a Quality Supervision Plan ('QSP') or, in the event that a QSP was not deemed to have been required, the creation and preparation of an inspection checklist and an inspection log book in relation to the coupler installation;

c. MTRCL and Leighton consequently did not implement what the Government considers to be the appropriate supervision and inspection regime required for mechanical coupler installations.

519. The Commission notes however that both MTRCL and Leighton contend that the change from lapped bars to coupler connections was a 'minor change' and, according to Appendix 7 of the Project Management Plan submitted by MTRCL to the Government, no prior consultation was necessary.

520. The Commission finds that MTRCL's and Leighton's failure to make prior consultation regarding the change, in no way relieves them from complying with at least the minimum supervision and inspection requirements for coupler connections contemplated by the Government as had clearly been the requirement for all other coupler connections on this project.

521. Additionally, the Commission notes that no proper as-built records were prepared for the coupler connections which are the subject of this change. Leighton's records merely identify "indicative locations" only.

522. From the above, the Commission concludes that, with respect to this change, both MTRCL and Leighton failed to comply with the requirements of Contract 1112.

523. The Commission notes that the change from correctly lapped bars to properly installed mechanical couplers should have no structural implications. However, a difficulty arises should there be doubt regarding the proper installation of the couplers.

Issue (4): Failure to ensure quality testing of all rebars

524. It was a Government requirement that all rebars delivered to site should be subject to a quality test that was over and above the test performed in the ordinary course of events by the manufacturers. This test – the HOKLAS test – provided a secondary level of assurance that the reinforcement used in the works met the standards required by the Government.

525. On the evidence, however, approximately 7% (about 4 000 tonnes) of all the rebars delivered to the Hung Hom site under Contract 1112 (close to

58 000 tonnes) were not sampled and tested by a HOKLAS-accredited laboratory after delivery. Records indicate that most of the untested rebars were used in the NAT and HHS areas.

526. During the course of the hearing before the Commission, it was suggested that the system of colour-coding rebars by painting on defining colours in order to indicate their differing status may not have been consistently understood or adhered to by all of Leighton's frontline staff or its sub-contractors. It was pointed out, for example, that the paint was often knocked off or came away. In addition, untested rebars were often placed close to the relevant works areas, giving rise to the risk that they may be taken and used before HOKLAS testing could be carried out.

527. The root cause of the problem, however, appears to have been an admitted failure of communication between Leighton and MTRCL. As it was put during the course of evidence, it would be difficult for MTRCL's inspectorate team to know that certain batches of rebars required testing (or still remained untested) if there was not an efficient liaison with Leighton as to deliveries.

528. The Commission notes that MTRCL is looking to improve the system, for example, the storing of untested bars in a separate and clearly cordoned off location and, to enhance communication generally, the use of digitised platforms.

529. As to the issue of the integrity of the structures in which untested rebars were employed, it was essentially uncontested that, in this instance, there was no need for concern –

a. All rebars delivered to site were tested by the manufacturer, that fact being supported by mill test certificates. In this regard, it is to be emphasised the testing criteria carried out by the manufacturer was essentially the same as that carried out by the HOKLAS laboratory.

b. All rebars that were subjected to the HOKLAS test were found to be of suitable quality pursuant to that test: in short, a 100% pass rate.

c. The Verification Report – essentially a cautious document – concluded that 'suitable measures' were not required.

530. The three project management experts who assisted the Commission – Mr Steve Rowsell, Mr Steve Huyghe and Mr George Wall – prepared a joint statement (dated 2 October 2019) which is attached to this report as part of **Annexure G**. As to the issue of the quality of the steel that had not been subjected to the HOKLAS test they were confident this was not an issue. In this regard, they said the following –

> "A testing rate of 93% of the steel was used on the project, supported by the mill certificates and the successful testing of the steel samples, and this should provide a good degree of confidence in the quality of the steel."

531. The Commission agrees with this view.

Issue (5): The need for suitable measures (trough walls and shear links)

The issue of the trough walls in HHS

532. Due to the lack of full records of the coupler connection works – and thereby because of the concern as to the true quality of those works – the task force responsible for the Verification Report came to the decision that an overall strength reduction factor of 35% should apply in all the areas in NAT, SAT and HHS where coupler connections had replaced lapped bars.

533. As stated earlier in this report, the strength reduction factor of 35% had originally been determined by way of statistical analysis of the strength of the NSL slab in the station box structure. Although no physical opening-up exercises took place in the NAT, SAT and HHS areas, the decision was made to extrapolate that same percentage[58].

534. The strength of any drilled-in bars between the diaphragm wall and NSL slab at the SAT was not taken into account in the structural review process

[58] Although no opening up took place, Dr Lau (in his expert report) said that other types of investigation were carried out; for example, cover-meter scannings were conducted to check the thickness of concrete covers and the reinforcement spacing at various locations. In the course of that exercise, defects were found.

because, again, relevant records – the pull-out records – were not available. No value was therefore given to these structural changes.

535. In respect of the NAT and SAT structures, the spare structural capacity at critical coupler locations was found to be greater than the assumed strength reduction factor of 35%. Accordingly, no suitable measures in respect of coupler connections have been required in those areas.

536. For the HHS structures, using the strength reduction factor of 35%, it was found that all of the structures contained spare capacity – with the exception only of the trough walls. In respect of the trough walls, because it was assumed that there must be (or may well be) partially engaged coupler assemblies within the structure of the walls, the sections of the trough wall kickers adjacent to vertical movement joints were deemed to be structurally inadequate and therefore, by inference, unsafe. The decision was therefore made to apply suitable measures in these sections of the trough walls.

537. As the term implies, stabling sidings are used essentially to park and maintain trains not in use. The trains enter and leave at very low speed and there is no access to the platforms. Trough walls are provided to withstand a collision from rolling stock in the event of a derailment in the sidings. As pointed out by Professor McQuillan, the only safety-critical feature in HHS is that columns, supporting the main station podium structure above, are located between the trough walls. However, provided the walls can properly contain a derailed train without causing impact or damage to the columns, there is no issue of structural safety. In that event, the trough walls will have performed the role for which they were designed[59].

538. Dr Lau, the expert in structural engineering called by the Government, accepted this to be the case. There appeared to be no issue regarding the adequacy of the original design of the trough walls. Accordingly, if there was clear evidence that all the coupler connections at the kicker of the trough walls had been correctly connected as per the requirements of BOSA, the as-built trough walls would be considered safe and fit for purpose. However, in light

[59] In his report, Professor McQuillan said: "Provided the columns cannot be damaged by a train derailing and hitting a trough wall there is no structural safety issue. The columns could, for example, be surrounded by a compressible layer so that any lateral soil movement caused by impact to the trough wall has no effect on the column."

of the fact that there was doubt as to the adequacy of the workmanship in respect of the coupler connections, Dr Lau was firmly of the view that the suitable measures recommended by MTRCL's design consultants should still be put in place in order to guarantee structural integrity. In the absence of direct evidence of the adequacy of the coupler connection workmanship, Dr Lau was of the view that the adoption of the 35% strength reduction factor (taken from the analysis of the slabs in the station box structure) was not unreasonable.

539. As Dr Lau expressed it, there had to be a real doubt, in his opinion, as to whether some of the trough walls would be able to safely resist the horizontal impact load from a derailed train. In his report, Dr Lau said the following –

> "Suitable measures at some of the trough walls are meant to protect the columns that support the building above from possible damage caused by derailment of trains. It is important that these columns should not be affected in the event that a train accidentally hits and damages the trough walls in front of the columns. It is important that the trough walls do have adequate factors of safety against overstressing, local failure, excessive deflections or collapse of the wall when they are hit."

540. Dr Lau was therefore of the opinion that, in order to ensure structural integrity –

> "… suitable measures in the form of wall thickening and additional horizontal concrete struts are required for the trough walls near the movement joints where there is concern for defective coupler connection."

541. In coming to his expert opinion, Dr Lau adopted a structural analysis carried out by MTRCL's design consultant, AECOM.

542. In support of Dr Lau's opinion, counsel for the Government emphasised what had already been said in respect of the need for suitable measures in respect of the station box structures, namely, that the question of whether construction works are 'safe' can only meaningfully be answered by reference to some objective building standards. In the present instance the Buildings Ordinance and the Code reflect the level of structural safety expected. In the result, the Ordinance and the Code are intrinsically linked to structural safety.

543. Counsel for the Government continued by submitting that obviously Dr Lau's opinion in respect of the issues of safety and fitness for purpose needed to be assessed by looking at all relevant parameters and by adopting the levels of the safety factors stipulated in the applicable codes, these representing the "collective wisdom and consensus reached to suit the particular circumstances in Hong Kong" and to reflect the level of structural safety expected and required by the people of Hong Kong.

544. Counsel for the Government submitted that the Commission should not be concerned with the question of whether some part (or parts) of the suitable measures proposed by MTRCL were excessive and therefore unnecessary. The suitable measures proposed in the Verification Report, as with measures earlier proposed in the Holistic Report, will have to be carried out in any event as agreed between the Government and MTRCL for the purpose of ensuring that the requisite building standards are complied with and the requirements of NWDSM are met.

545. Counsel for MTRCL adopted a different approach. It was MTRCL's position, he said, that the suitable measures put into effect were required because of Leighton's breach of its obligations. The issue of suitable measures was not therefore relevant for the purposes of determining whether the structures are safe and fit for purpose. The suitable measures were adopted for the purposes of code, statutory and contractual compliance.

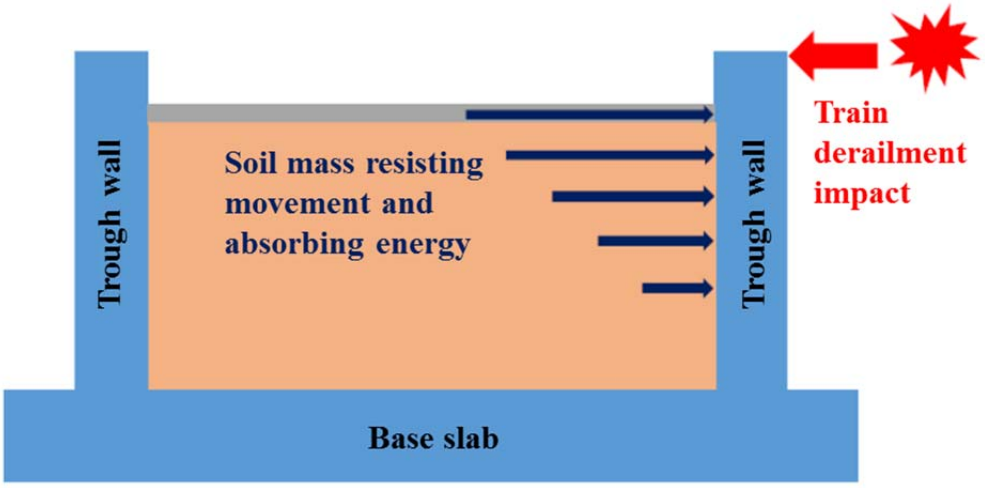
546. The three other engineering experts who gave evidence to the Commission in respect of its Extended Terms, namely, Professor McQuillan, Dr Glover and Mr Southward, were all of the opinion that, adopting a forensic approach, they were entirely satisfied that the trough walls were both safe and fit for purpose.

547. Dr Glover was of the opinion that the application of the strength reduction factor of 35% with regard to the trough walls in the Verification Report was decided upon entirely from a compliance perspective and was not derived from engineering considerations.

548. While Professor McQuillan, Dr Glover and Mr Southward recognised the need for column protection, they were satisfied that the existing trough walls adequately provide that protection.

549. Professor McQuillan pointed out that the space between the trough walls was filled with soil. As he put it, in the event of a train impacting a trough wall, the soil between the walls would absorb a significant amount of energy and restrict the deformation of the impacted wall section. **Diagram 24**, set out below, provides a general illustration of the point, showing a typical trough wall section in the HHS.

Diagram 24



550. Professor McQuillan, Dr Glover and Mr Southward approached the issue of structural safety from a number of different perspectives. Mr Southward, for example, adopted what is called a 'yield line analysis' to demonstrate that the trough walls have a large degree of spare capacity. Professor McQuillan was of the view that this analysis clearly demonstrated that the trough walls are safe and do have significant reserve capacity.

551. The contrasting determinations of the four engineering experts were set out in the second joint statement dated 20 December 2019 –

> "[Professor McQuillan, Dr Glover and Mr Southward] agree that Yield Line Analysis is valid in this Ultimate Limit State and is not linked to a shear assessment where

stirrups and ties would be required. There is no safety issue with the HHS trough walls.

[Dr Lau] disagrees with the other experts because the podium columns require to be protected against accidental impact. He adopts AECOM's analysis.

[Professor McQuillan, Dr Glover and Mr Southward] also recognise the need for column protection and are satisfied the existing trough walls provide the necessary protection."

The issue of shear links

552. Apparent defects in shear link placement were first discovered when the shear links at the EWL slab soffit were exposed during the course of investigations into honeycombing. Further investigations were conducted at other locations of the EWL slab and certain defects in respect of anchorage and / or spacing of shear links were discovered. These discoveries raised questions as to workmanship.

553. A strength reduction factor of 4% for rebars of diameter 16 mm or above and a strength reduction factor of 13% for rebars of diameter 12 mm and below were adopted for the untested rebars used in the NAT, SAT and HHS structures. The application of this strength reduction factor did not result in the need for suitable measures to be adopted for the NAT and HHS structures. However, for the SAT structures, in view of concerns as to the unsatisfactory shear link placement in Area A of the NSL slab adjoining SAT, it was determined that suitable measures to enhance the shear strength should be applied in the SAT NSL tunnel box.

554. Dr Lau accepted the measure to enhance the shear strength as being reasonable, there being a real concern that there may be no shear links present. As for the one area described as a 'hotspot', Dr Lau was concerned that there may be insufficient load redistribution ability.

555. The other three experts disagreed. In their professional opinion, the measures were not necessary. In this regard, among other factors, they made mention of the following –

a. in areas where nominal / minimum shear reinforcement is required, there is at least 25% over-provision in the shear links installed;

b. the shear links provided should not be disregarded in their entirety: to do so would give an artificial result;

c. the actual proven concrete cube strengths should be used in the structural shear assessment and, furthermore, strength gain with time is a legitimate consideration;

d. there are other beneficial factors which could be taken into consideration, for example, compressive action and arch action; and

e. in the one potential hotspot (that is, the NSL slab at SAT) failure cannot occur because of the load redistribution in the three-dimensional structure. In any event, the 'hotspot' is in an area where only nominal / minimal shear reinforcement is required.

A summary

556. The Commission has earlier observed that the Government's decision to proceed with 'suitable measures' in respect of the station box structure was, in all the circumstances, an understandably cautious approach. The Commission is of the same view in respect of the Government's decision to proceed with 'suitable measures' in respect of the NAT, SAT and HHS structures.

557. As stated earlier, the suitable measures discussed above have now been implemented and, if not completed, will be completed shortly. In his expert opinion, Dr Lau supported the need for the suitable measures to be implemented, especially on the basis that there had to be a real doubt as to the quality of workmanship in the building of the structures under consideration. As the Commission understands it, Dr Lau was of the view that issues of 'safety' and 'fitness for purpose' in Hong Kong cannot be disengaged from the requirements of the relevant codes.

558. Professor McQuillan, Dr Glover and Mr Southward were of the opinion that the issues of 'safety' and 'fitness for purpose' were in essence issues independent of compliance.

559. While the Commission was, in the discharge of its mandate, anxious to understand the recommendations of the Verification Report (as well as the Holistic Report before it) and the consequence of those recommendations, it has not seen it to be part of its mandate – outside of any concern as to safety – to determine whether the suitable measures should or should not be undertaken. The Commission has always understood that identifying suitable measures and managing their implementation – these being entirely matters of engineering design and management for MTRCL in consultation with the Government – has not been part of its mandate.

The Commission's determination in respect of whether the NAT, SAT and HHS structures are safe and fit for purpose

560. In coming to its determination under this heading, the Commission has taken the same logical pathway followed earlier in this report when deciding the issue of whether the station box structure is safe and also fit for purpose.

561. In light of the findings of the Verification Report, the Government determined that, without the implementation of suitable measures to structures in two discrete locations in the NAT, SAT and HHS areas, the structures in question would fail to comply with the requirements of the Buildings Ordinance, the applicable codes and the established good practice of building design, these requirements reflecting standards of safety demanded in Hong Kong. Dr Lau was of the same opinion.

562. MTRCL, however, was of a different view. In its closing submissions to the Commission, MTRCL stated that –

> "…These actions, referred to as the 'Suitable Measures', are being implemented for the purpose of obtaining the ultimate approval of the works by the approval authorities so that the railway can be put into operation for use by the general public."

563. As with the station box structure, three of the independent engineering experts – Professor McQuillan, Dr Glover and Mr Southward – were of the firm view that the suitable measures were not required in the two discrete locations and that the structures concerned were safe and were also fit for purpose as they stood. In short, that the measures were superfluous.

564. Again, however, all the experts were agreed (as were the Government, MTRCL and Leighton) that the works would add to the robustness of the structures or at least would not result in the structures being in any way less safe. That being the case, once all the suitable measures have been implemented in about two to three months from the date of this final report, there was consensus that, whatever their conflict of views as to the need for the remedial measures in the first place, the structures in question would then be safe and would also be fit for purpose.

565. Again, having received an extensive body of forensic evidence in respect of the structures in question, that evidence being expertly tested and spoken to by counsel, the Commission is satisfied so that it is sure that the consensus reached is a correct one. Put simply, on the basis of the consensus reached, that consensus being considered in the light of all the evidence put before it, the Commission is satisfied that, once the suitable measures have been completed, the structures in question will then be safe and fit for purpose.

566. While the Commission has borne in mind the nature and extent of the suitable measures being employed, it has not found it necessary in this instance to determine independently whether they are necessary in order to ensure safety and fitness for purpose. The reasons are the same as those given earlier when determining the issue of the station box structure: see paragraph 414.

567. Finally, the Commission emphasises again that it has come to its determination in recognition of the fact that in a number of respects, in the course of construction of the relevant structures, there were unacceptable incidents of poor workmanship on site, lax supervision and that in a number of respects, especially in respect of the failure to comply with the RISC form process, management of the construction endeavour fell below the standards of reasonable competence.

Chapter 11

The need for construction records to be contemporaneous

568. In the previous chapter of this report – Chapter 10, the chapter examining the construction of NAT, SAT and HHS – the Commission has looked to the failure during those works of ensuring that RISC forms were completed contemporaneously. These forms, as explained, were of particular importance because they constituted primary evidence of works inspected (at hold point inspections) and certified as being correctly done.

569. The Commission has spoken of the fact that, because of difficulties presented by the RISC form process, an informal system emerged in its place with Leighton engineers informing their MTRCL counterparts by WhatsApp or by telephone that elements of work in process would be ready for hold point inspections and undertaking at a later stage to deliver the necessary RISC form. In this regard, the Commission has noted two problematic consequences. Either the RISC forms were never submitted or they were submitted well after the events in question, placing an unenviable burden on the MTRCL engineers and inspectors of works who had to complete them by relying on notes, photographs and other secondary evidence.

570. [redacted]

571. When conducting inquiries under its original mandate, that is, in respect of the station box structure, the Commission also came across evidence of a failure to maintain contemporaneous records and the very real difficulties occasioned by that failure: difficulties in this particular instance that arose out of the creation of retrospective records. In this regard, in the interim report the relevant events were described in some detail[60]. For the purposes of this final report, however, which looks to a far broader range of issues, the Commission is satisfied that the following summary suffices –

[60] See paragraph 302 onwards in Chapter 8 of the interim report

a. On 15 June 2018, in the wake of media reports concerning the cutting of threaded ends from rebars, MTRCL submitted a report to the Government: 'Report on SCL Contract 1112 – Review of the EWL Slab Construction' (the 'June Report'). The June Report was intended to allay concerns in respect of the manner of construction of the station box structure, more particularly in respect of the anchoring of the EWL slab to the diaphragm walls by way of coupler connections. Regrettably, rather than allaying fears, it compounded them.

b. The June report was compiled under considerable pressures of time. It dealt with matters that had occurred more than two years earlier. Regrettably, it contained a fundamental error.

c. It said that, in accordance with the design accepted by BD, the total number of couplers connecting the EWL slab to the east and west diaphragm walls numbered approximately 23 500. It was further said that relevant inspection records indicated that the works of splicing assemblies had been acceptable with no anomalies found.

d. However, those who contributed to the June Report – probably because they had no knowledge of it – had neglected to take into account the fact that there had been a design change. This change (the second design change dealt with in Chapter 4 of this report) had resulted in the trimming down of the top of the east diaphragm wall and a material reduction in the number of couplers. There were therefore materially *less* than 23 500 couplers.

e. This error was compounded by the fact that the relevant inspection forms showed that a large number of coupler connections – which in fact did not exist – had been correctly installed.

f. The error appears to have arisen because there was a lack of properly prepared contemporaneous records.

g. Because of that lack of contemporaneous records, an exercise was therefore undertaken to compile a spreadsheet based on site photographs and other secondary information. It was said to be intended for internal record purposes only but appears to have been

converted into a series of individual purported checklists made pursuant to the QSP[61]. The QSP had a checklist which sought confirmation that each and every coupler connection had been properly completed. In this regard, standard questions were asked, for example: 'has coupler been cleared of foreign material?' Each checklist also required confirmation that the coupler connection had been 'satisfactory or not satisfactory'.

h. Although at the foot of each checklist there was an endorsement saying that the forms served as retrospective records, regrettably in their compilation false assumptions had been made, namely that couplers had been correctly installed when no couplers had been installed at all.

i. The records were signed and backdated to February 2017, more than a year earlier.

572. When he testified before the Commission, the former Projects Director of MTRCL, Dr Wong Nai Keung, Philco, commented that these retrospective records "should not have been created. No one should ever do anything like that."

573. It is to be noted that, at about the same time, Leighton prepared similar records which contained the same false assumptions. The Leighton records did not bear any endorsement to the effect that they constituted retrospective records. The Leighton forms were not signed. The Leighton forms, however, appear to bear dates that relate directly to the appropriate RISC forms; indeed, each of the checklists was attached to a RISC form. The RISC forms with their attached checklists were produced to BD, Railway Development Office ('RDO') and PYPUN for inspection.

574. In the course of closing submissions, counsel for the Government spoke in blunt terms of the exercises described above. He said –

> "What MTRCL and Leighton ought to have done was to come clean at first opportunity about the lack of contemporaneous records, rather than engage in the

[61] QSP – Quality Supervision Plan – will be considered in the next chapter of this report, Chapter 12.

creation of misleading and confusing retrospective checklists. Such practice is wholly unacceptable and represents extremely poor project management."

Chapter 12

Uncertainties concerning the Quality Supervision Plan: the 'QSP'

The first uncertainty: was the QSP applicable?

575. In the letters sent by the Senior Structural Engineer for the Building Authority to MTRCL on 25 February 2013 and 25 June 2014, the direction was given that a Quality Supervision Plan – the QSP – was to be submitted prior to the commencement of mechanical coupler works. That QSP – effectively an enhanced supervisory regime – was to apply to "mechanical couplers for steel reinforcing bars for ductility requirement".

576. The QSP specified that MTRCL was to assign a quality control supervisor while Leighton was to assign a quality control co-ordinator "to supervise the manufacturing process of the connecting ends of the steel reinforcing bars, and the installation of steel reinforcing bars to the couplers". As to supervision of the works, the QSP directed that the frequency of quality supervision should be at least 20% of the splicing assemblies by the quality control supervisor of MTRCL and "full-time continuous supervision" by the quality control co-ordinator of Leighton.

577. The letters directed that an inspection log book should be kept giving relevant details of inspections and, importantly, there should be an independent checklist (the 'QSP checklist') which set out details of each and every installation, confirming, for example, whether the coupler had been cleared of foreign materials and whether the coupler had been fully screwed and fitted.

578. As it is, the independent engineering experts were unanimous in their view that ductility couplers were not required. They were used; in fact, all the couplers were ductility couplers. But, the uniform acquisition of ductility couplers was for convenience only.

579. In final submissions, it was submitted on behalf of Leighton that the couplers installed in the EWL and NSL slabs and the couplers at the intersections of the diaphragm walls and slabs were not subject to a ductility requirement. There was no requirement under BD's letters to have a QSP for couplers without a ductility requirement. It followed that the QSP did not

apply to the couplers used in the slabs or the horizontal couplers in the diaphragm walls. The only exception would be for those horizontal couplers at the intersection of the diaphragm wall and the NSL slab in Area A. Subject to that exception, the QSP was only relevant to the vertical couplers installed in the diaphragm walls.

580. It is not for this Commission, of course, to act as a court by interpreting contractual provisions. However, in the conduct of this inquiry, it *is* able to comment that, in the event of uncertainty as to such an important issue, managerial prudence would surely have dictated that the matter would have been discussed and an agreement reached as to what governing documents applied. However, that does not appear to have happened.

581. That said, as ductility couplers were in fact being used, it would appear that, both before relevant work began and during the course of that work, there was an assumption on the part of both MTRCL and Leighton that they were subject to the QSP.

582. By way of illustration, Carl Wu, the MTRCL Co-ordination Manager (and author of the MTRCL report referred to in Chapter 5 which examined EWL slab coupler installations) said that, when he was writing his report in February 2017, he was of the view that Leighton was subject to the QSP enhanced regime. Indeed, in the course of his evidence, Carl Wu referred to the fact that he had asked the construction team to seek confirmation that Leighton's records demonstrated that a requirement of the QSP enhanced regime had been met, namely, that supervisors of Grade T3 Technically Competent Person ('TCP') qualification (as stipulated in the Code of Practice for Site Supervision) had been employed.

583. The Commission further notes that the version of the QSP submitted by MTRCL to BD on 12 August 2013, which was essentially prepared by Leighton and bearing its logo, was not qualified or restricted in its application simply to the reinforced steel cages for the diaphragm walls. That submission confirms that it relates to the installation of 'Type II – Seisplice Standard Ductility Couplers' and confirms that quality control supervisors will be responsible for carrying out "full-time and continuous supervision" of the splicing assemblies on site.

584. It is Leighton's case that the QSP they prepared was meant to apply to the "diaphragm wall and barrettes" only. To the Commission, it is clearly another case of breakdown in communication.

The second uncertainty: questionable awareness of its applicability

585. On the evidence heard by the Commission, it is apparent that a significant number of Leighton staff, whose responsibilities included site supervision and inspection, were never informed of the existence of the QSP or of the obligations contained in it.

586. Kevin Harman, who at the time was Leighton's Quality and Environmental Manager, testified that he was not aware of the QSP –

> "Q. … So you mean at the time when you were quality manager of Leighton you did not have any knowledge as to whether there is a QSP with supervision and inspection requirements applicable to the coupling works at the EWL slab?
>
> A. I don't remember any."

587. Nor did Raymond Brewster, Leighton's Group Pre-Contracts Manager, have any recollection of the QSP. In an exchange with the Chairman, he made it clear that, in his view, Leighton's own quality control procedures were more than sufficient. The QSP was therefore, in practical terms, superfluous –

> "Q. … So in respect of couplers, you are saying effectively that anything that the QSP to which you have been referred, anything that was concerned there with couplers would have been already part and parcel of your standard quality control mechanisms and procedures?
>
> A. Yes, that's what I'm saying."

588. However, the enhanced regime of supervision set down in the QSP was not already part and parcel of Leighton's standard quality control mechanisms. The QSP required more.

589. Elsewhere, Raymond Brewster said that he would not have expected his Leighton engineers to have knowledge of the QSP –

> "… I wouldn't expect necessarily those field people, the site engineers, to actually be aware of the QSP, if we were working with our own quality management plan, and that plan … also provides facilities for checking reinforcements through RISC forms and also the pre-pour check."

590. Chan Chi Ip, a Leighton site supervisor, when asked what he knew of the QSP, said that he had never dealt with the document. Other site supervisors gave evidence to like effect.

591. Nor can it be said that, in practice, Leighton staff, whether they knew of the QSP or not, were *at all times* conducting supervision. Edward Mok, one of the Leighton engineers, gave evidence that, while on and off he would walk past the location where rebars were being installed into couplers, there was no one assigned or stationed at that location to watch every coupler being connected.

592. The Commission also notes that the Leighton engineers involved in the inspection process did not all hold a Grade T3 TCP qualification as required under the QSP.

593. In respect of the maintenance of detailed installation logs, the Commission notes that, while these detailed log records were kept in respect of coupler installations during the construction of the diaphragm walls, that practice fell away during construction of the EWL slab. In this regard, Wong Chi Chiu, Kobe ('Kobe Wong'), a senior inspector of works with MTRCL, was not even aware of his responsibility as a quality control supervisor (pursuant to the QSP) for the coupler installation works at the EWL slab, and was told by his superior that the responsibility fell on the construction engineering team instead and he should refrain from inspecting the couplers. However, he was assigned to inspect the couplers when the diaphragm walls were built. He considered at the time that the QSP did not apply to the construction of the EWL slab. No contemporaneous records were kept by MTRCL in respect of the supervision or inspection of coupler installation works at the EWL slab. Various kinds of summaries and records had been put together long after the event based on Kobe Wong's recollection and site photos.

594. In final submissions, counsel for the Government made the submission that MTRCL, as Project Manager, had to share responsibility for Leighton's

deficiencies under the QSP. In this regard, Mr Rowsell, the Commission's independent expert witness on matters of project management, made the following observation –

> "I would have expected that the MTRCL supervisory and inspection teams to have identified that the Contractor [Leighton] was working in ignorance of those key supervision documents [the Site Supervision Plan ('SSP') and QSP]. I would have expected the MTRCL teams to have checked that the levels of the Contractor's supervisory resources met the requirements in terms of numbers set out in the General Specification and also met the approved named resources and requirements for technical competence set out in the SSP and QSP."

The third uncertainty: the meaning of 'full time and continuous'

595. As indicated earlier, the QSP set specific requirements in respect of the frequency of enhanced supervision: MTRCL was to supervise at least 20% of the splicing assemblies while Leighton was to be responsible for "full-time continuous supervision" of the mechanical coupler works.

596. During the course of the inquiry, there was considerable debate as to the meaning and effect of the phrase" "full-time continuous supervision".

597. Stephen Lumb, Leighton's Head of Engineering, understood the phrase "full-time supervision" to mean simply that the person carrying out the supervision must be fully engaged on the project as opposed to working there part-time. He understood "continuous supervision" to mean no more than a normal daily supervision and inspection regime. In his opinion, it did not mean the need for what was described as "man-marking".

598. However, Mr Rowsell was of a different opinion. In his expert report, Mr Rowsell made the following observation –

> "In my opinion, I consider that where formal obligations are imposed on a project management or a contracting organisation then there needs to be precise definitions and consistency of terminology. For example, on this contract there is a requirement that the quality supervision should be full time and continuous supervision by the Contractor of the mechanical coupler works... It is likely that this

requirement was included because it was recognised that it would be a technically difficult process with a high risk of problems being encountered."

599. The Commission is also of the view that, in respect of the allocation of duties in a complex construction project, the need for clarity of definitions is critical. If a meaning cannot be made free of ambiguity in two or three words then it should be further qualified. Plain language, easily understood without the need for debate, must always be the requirement.

600. Mr Rowsell said that, in his opinion, the phrase "full-time and continuous supervision" meant that Leighton's supervisor –

> "… needs to be present at all times where mechanical coupler works are underway. The objective being to ensure that the work is done properly in accordance with the specifications and any problems are resolved without delay. It does not have to be the same supervisor for the whole of a working day but continuous supervision has to be provided for the full time that work is underway."

601. Mr Rowsell continued –

> "In my opinion, the obligation requires a supervisor to be present at the site of work activity rather than for example, being present elsewhere on site or in the site office carrying out other tasks. The General Specification requires that the Works shall be arranged so that the Works are supervised at a minimum ratio of 1 supervisor to no more than 10 workers... Therefore, if the number of workers involved in the coupler works is greater than 10 then there should be more than one supervisor in attendance."

602. That interpretation was not the interpretation given to the phrase by Leighton. Nor did Leighton seek clarification from BD as to the intended meaning of the phrase.

Were the enhanced standards nevertheless complied with 'in substance'?

603. When final submissions were made in respect of the Commission's Original Terms, that is, in respect of its inquiry into the station box structure only, it was submitted on behalf of MTRCL and Leighton that the well-tried process of hold point inspections evidenced by RISC forms constituted

sufficient evidence that coupler installation works had been fully supervised and inspected to the required standard. In this regard, in the course of his evidence, Aidan Rooney, at the material time MTRCL's General Manager, said that his company's engineers and inspectors checked 100% of the coupler connections at EWL slab and verified that through signing off of the RISC forms. While individuals may not have checked more than 40% or 50%, he was confident that the team as a whole would always manage a 100% check.

604. On the basis of all the evidence heard during the full inquiry – as set out elsewhere in this report in considerable detail – it is apparent to the Commission, indeed is accepted, that the system of hold point inspections verified by contemporaneous documentation, namely, completed and signed RISC forms, is not always made the subject of rigorous adherence. Indeed, the opposite was on occasions the case.

605. The Commission also has the following concerns –

a. The formal hold point inspections were only conducted after all the coupler installation works had been completed and were essentially visual inspections. In such circumstances, it was accepted that if, for example, the threads of a rebar had been cut and then inserted into a coupler, that would not be detected.

b. There was also the difficulty that these hold point inspections were not fully documented. Only the inspection of the top mat was recorded in the RISC form. There were no specific records indicating when or by whom the inspection of the bottom mat had been carried out.

c. The extent of inspection was also open to question. Kwan Pak Hei, Louis ('Louis Kwan'), a construction engineer with MTRCL whose primary role was to inspect the site works during the construction of the EWL slab, said that he did not specifically inspect the coupler installation works. It was put to him by the Chairman that, as he was responsible for checking the top and bottom mats of the EWL slab, did he not also check the coupler connections into the diaphragm walls. His answer was: "Formally, I was not assigned to check the coupler." The Chairman then asked, presuming another inspector inspected the couplers, did that inspector complete his own RISC form? Louis

Kwan replied: “From the records that we have got so far, I do not think so.”

d. During the course of final submissions, counsel for the Government submitted that the fact that, after May 2018, MTRCL and Leighton had both engaged in the compilation of retrospective record sheets for the coupler installations was itself an indication that they were or ought to have been aware of the need, at the time that the installation work was done, to compile full and accurate contemporaneous records. Clearly, that had not been done.

Chapter 13

Reviewing of MTRCL's and Government's management systems

606. The Commission's Extended Terms have required it, in light of its inquiry into the facts and circumstances surrounding the Contract 1112 construction works that have caused public concern, to conduct a review of the MTRCL's project management and supervision systems as well as the monitoring and control mechanisms of the Government. In this regard, the Extended Terms have directed the Commission to review –

> "(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…"

607. In the interim report, because at that time issues of safety were so pressing, the Commission placed particular emphasis on matters that might have had a direct bearing on the safety of the construction works in question. In this final report, however, the Commission has broadened its scope to address all matters which, in its opinion, in the light of its inquiries, have shown themselves to be materially relevant.

608. In reaching its determinations, the Commission has received valuable assistance from three independent experts in matters of project management. They are –

a. Mr Steve Rowsell, whose professional background has been summarised earlier in this report in Chapter 1, sub-paragraph 33(b).

b. Mr Steve Huyghe, who was engaged by MTRCL as an independent expert. Mr Huyghe is the Founder and Chairman of CORE

International Consulting, LLC, based in Atlanta, Georgia, USA. Before taking up the role of a consultant, Mr Huyghe held senior positions in the construction of major international projects including oil refineries, chemical and steel plants and large-scale infrastructure construction projects.

c. Mr George Wall, who was engaged by Leighton as an independent expert in the inquiry under the Extended Terms only. Mr Wall is the Managing Director of Asgard Project Solutions Limited, a company with offices in Hong Kong and Singapore. With over 20 years of experience in heavy infrastructure, oil and gas, mining and commercial building projects, he is a practising expert witness.

609. Of considerable assistance to the Commission is the fact that the three independent experts were able to meet, to discuss issues and to reach a large measure of consensus in respect of the principal matters that emerged during the Commission's inquiry.

610. Also of considerable assistance is the fact that Turner & Townsend ('T&T'), a leading management consultancy engaged by MTRCL in July 2018, has carried out an extensive review to assist MTRCL in updating and improving its management systems. The recommendations of the T&T review align substantially with the recommendations made by Mr Rowsell and Mr Huyghe. It is understood that MTRCL has established a special taskforce to oversee the implementation of T&T's recommendations and that task force has commenced its work.

Examining MTRCL's systems

Supervision and inspection of coupler splicing work

611. In Chapter 12 of this report, the Commission has spoken of the QSP, the enhanced supervision plan for ductility couplers. It has looked to the fact that there was uncertainty – certainly on the part of Leighton – as to whether it applied when ductility couplers were not an engineering requirement but were used for convenience and that there was further uncertainty as to the true meaning and extent of a provision in the QSP requiring "full time continuous supervision".

612. It is not for this Commission to determine matters of contractual interpretation but, in a public inquiry, in the public interest, it is able to express the view that, to avoid future confusion, emphasis must be placed on the clarity of definitions. As stated earlier, if the meaning cannot be made free of ambiguity in two or three words then it should be further qualified. Plain language, that is language that can have no ambiguity as to meaning and extent, must always be the requirement.

613. The nature and extent of supervision and inspection routines, and the identity of who will conduct them, must be agreed at the earliest possible stage.

614. In respect of the fundamentally important process of conducting hold point inspections, in the opinion of the Commission, it might be sensible in future contracts to introduce an earlier hold point inspection for the contractor and MTRCL to jointly confirm readiness to commence reinforcement installation. This would provide assurance that, among other matters, all couplers are in place and are properly exposed and that coupler threads are not damaged. Such an inspection, properly conducted, would ensure that there was no existing impediment to full and secure engagement of rebars into the couplers.

615. During the course of the inquiry, an issue of central importance was the efficient use of RISC forms, those forms being fundamental to MTRCL's systems of supervision, inspection and verification of work satisfactorily completed.

616. The RISC form process is set out in MTRCL's PIMS and, by virtue of the entrustment agreement, MTRCL is obliged to adhere to that process. By extension of that obligation, the RISC form process is a contractual obligation imposed on Leighton.

617. During the course of the Commission's inquiry, both MTRCL and Leighton recognised the need for the RISC form to be a primary – and therefore contemporaneous – document. However, during the course of the inquiry, it was demonstrated that a material number of these forms were not contemporaneous and, in the result, were questionable as to their accuracy. In the opinion of the Commission, the RISC form process proved itself, at least in

respect of construction works under Contract 1112, to be less than rigorously applied and therefore questionable as to its value.

618. As indicated earlier in this report, in the case of large parts of NAT, SAT and HHS, an unstructured approach to the use of RISC forms was allowed to come into being. Some Leighton site engineers, instead of initiating the RISC process, would instead notify MTRCL by telephone or by WhatsApp that particular works were ready for inspection and would accompany this notification with an undertaking to supply formal paperwork later. Evidence was put before the Commission that MTRCL personnel acquiesced in this modified arrangement, apparently in order to be co-operative and to avoid delaying the works. Regrettably, however, a material number of RISC forms were not subsequently submitted. The percentage of missing RISC forms was calculated in the Verification Report: the percentages are alarming.

619. As to how the RISC form process was allowed to become so unstructured, the Commission heard evidence that middle management within both MTRCL and Leighton were aware of the problem of the missing forms but seemingly did little to rectify the problem.

620. The former Construction Manager of MTRCL, Kit Chan, was aware of the outstanding RISC form problem as early as May 2015 and proposed that a register be maintained to keep track of missing forms. However, he accepted that at the time he did not consider the RISC form issue to be particularly serious. He did not, for example, insist on Leighton submitting the forms *before* inspections could be conducted. He told the Commission that "the contractor normally don't pay high attention to [the RISC form requirements]" and went on to say that, for minor pours, there was no need to comply strictly with the RISC form process. As to what constituted 'minor pours', Kit Chan confirmed that pours for the stitch joints would not be minor pours in his opinion. The Commission, however, was not aware of any evidence that Kit Chan clearly delineated, so that his staff understood, what constituted major pours and what constituted minor pours, leaving this, it appears, to his frontline engineers, a number of whom were clearly inexperienced.

621. [redacted]

[redacted] Leighton's Project Director, Jonathan Kitching, told the Commission that had MTRCL insisted that no inspections would be carried out unless RISC forms were duly submitted, Leighton would then have put more resources in place to ensure that these requirements were met. That, of course, is common sense. Kit Chan himself also believed that Leighton would have followed the system more rigorously had MTRCL insisted on it. [redacted]

622. The fact that the RISC form process became so unstructured introduced a real element of risk. By way of illustration, hold point inspections could be missed if, in the absence of a properly completed RISC form, one inspector was under the impression that another inspector had already carried out the inspection. It does not require particular imagination to appreciate that the system, in its unstructured form, was open to abuse. The Commission accepts that there was other secondary evidence; for example, diary entries showing the concrete had been poured on a particular date. But such entries cannot be taken as definitive evidence that the necessary hold point inspections themselves were carried out and, importantly, that the inspections had found the works to be satisfactory.

623. Finally, the Commission notes that there was contractual provision for procedures to be modified if both parties agree. In respect of the RISC form process, however, there was no such modification.

624. Looking forward, however, the Commission understands that, in recognition of the fact that the old paper system was cumbersome and outdated, RISC forms are being modified and placed on a digital platform.

Disparate documentation

625. One of the matters that caused the Commission concern, and which was identified by the independent expert witnesses, was that the obligations of the various parties operating on site appeared to be contained in a variety of disparate documents. In the result, engineers and others working on site were not always fully aware of the obligations that they must meet.

MTRCL's senior leadership of the SCL Project

626. The Commission notes that MTRCL appointed three General Managers to collectively oversee the SCL project with just one of the three having direct accountability within MTRCL for overall management of the project. The other two General Managers had reporting line relationships – marked as 'dotted line' relationships – with MTRCL's Projects Director. In the view of the Commission, these 'dotted line' relationships at senior level can lead to a blurring of accountabilities and should be avoided.

627. At material periods during the project, one of the General Managers was nominated as the 'Competent Person' under the Buildings Ordinance while another was responsible for supervising the works. The Ordinance, however, requires the Competent Person to be responsible for supervising the works. In the view of the Commission, split accountabilities of this kind at senior level may have contributed to some of MTRCL's project management issues that arose during the SCL Project.

628. Unsurprisingly, project staff members take their lead from their seniors. They take from their seniors what aspects of the work are considered to be important and what aspects are considered to be less important. By way of example, unless the senior and middle managers demonstrated that inspections and quality records were important, their subordinates would not give them a very high priority. The example cited above of Kit Chan's apparent approach to the RISC form process is a case in point.

629. MTRCL had two distinct roles on the SCL Project: one as the Engineer with defined powers under the contracts, and a separate role as the Project Manager. The Commission finds that it was not always clear which of these two roles MTRCL personnel were fulfilling at any given time. It is for senior leadership to provide that clarity, perhaps by allocating the distinct and separate roles to different designated individuals or teams.

Non-conformance reporting

630. The project management systems of both MTRCL and Leighton prescribe a system for reporting sub-standard works requiring the use of NCRs. The accepted practice is that it is unnecessary to issue an NCR if the defective

work that has been identified can be corrected and signed off on the same day. The project management experts agreed with this practice. However, they recommended that all site supervision and construction engineering teams should be made aware of the defective work so that they are put on notice to be watchful for repeat occurrences. In the event that similar defective work occurs again, an NCR should then be issued.

631. While this practice may be the pragmatic way forward, the Commission believes that, if used properly, NCRs can provide valuable learning points on construction sites and facilitate continuous improvement through the proper investigation and implementation of corrective measures. For example, of particular relevance to this report, the opportunity to learn from the first identified incidents of the cutting of threaded ends from rebars was lost because the matter was not reported: either by way of an NCR or by any other means.

632. NCRs may be used for two distinct purposes – to record non-conforming works and, quite separately, to record non-conforming processes. The Commission is of the view that it would be helpful to distinguish between these two types of NCR, perhaps labelling them differently.

633. In the view of the Commission, MTRCL's system of non-conformance reporting requires a full review which should include a review of the process of 'closing out' [redacted].

The role of Atkins

634. Atkins was responsible for preparation of the engineering designs for construction of the diaphragm walls and construction of both the EWL and NSL slabs plus interlocking ancillary works (such as the OTE slab).

635. As noted earlier in this report, Atkins was engaged by both MTRCL and Leighton. It was first engaged by MTRCL as a detailed design consultant in January 2010. Later, in April 2013, it was engaged by Leighton as a design consultant. In an attempt to address concerns as to any conflict of interest, Atkins set up two teams: Team A for MTRCL and Team B for Leighton.

636. During the course of the hearings, it was initially asserted that Atkins kept both teams independent of each other with no conflict of interest. However, both the project director and design team leader were the same persons for Team A and Team B. More than that, Justin Taylor, Leighton's Risk Manager / Revenue Recovery Manager, said that, as he saw it, the same people at Atkins were handling the work for MTRCL and Leighton and there was no practical difference in the teams. In the end, John Blackwood, Director of Transport of Atkins, accepted that "in retrospect, it probably would have been better to have totally separate people [in two teams]".

637. The Commission is satisfied that no actual conflict of interest was identified but the potential for such conflict was very real. As pointed out by Mr Rowsell, with Team A and Team B under the same leadership, there was the risk that Team A may be reluctant to identify faults in designs approved by Team B or may not review submissions from Team B as thoroughly as they might otherwise have done.

638. The Commission is of the view that it is not good practice for the same design firm to provide services both to the employer, in this case MTRCL, and the contractor, in this case Leighton. As illustrated, such an arrangement carries with it the immediate potential of both real and perceived conflict of interest.

639. The Commission further notes that Atkins was not required to have a presence on site under either of its arrangements. One of the risks associated with this absence from site is that the designer is given little opportunity to ensure that its design intent is properly implemented in the works. The Commission agrees with the project management experts that it is desirable, if not essential, for a designer to have a presence on site. The Commission believes that this should be considered for all future rail infrastructure projects.

640. During the course of the hearings, issues going to ambiguity of instructions arose. Whether such ambiguity existed or not, the Commission is strongly of the view that the presence of a designer on site will quickly resolve any lack of clarity in the designer's design intent.

'As-built' records

641. In all projects, MTRCL is obliged to submit 'as-built' records to the Government. 'As-built' records comprise a wide spectrum of documents. In addition to 'as-built' drawings, they include also submissions as to particular materials, test certificates and construction records (such as technical queries, requests for information, and photographs).

642. In accordance with its own PIMS, MTRCL's construction engineers and inspectors of works are required to ensure that 'as-built' records are prepared as a continuous operation as construction proceeds. This requires the contemporaneous recording of what has been built. This requirement is in addition to records confirming quality: contemporaneous records demonstrating that the works have been built correctly.

643. Although it was a suggestion made by some witnesses who testified before the Commission, it is not a sustainable argument to say that the keeping of contemporaneous records need not be a priority on a busy construction site. Indeed, in respect of a busy site, the Commission considers it to be all the more important to keep contemporaneous records.

644. The Commission is further of the view that quality records should be created and signed by the relevant parties at the time of the quality inspection or, if not possible, within a short period thereafter.

645. In the view of the Commission, the reason why records as to quality assurance must be produced contemporaneously with the inspection of the works is to demonstrate traceability and compliance; it must constitute verification by those who witnessed the works and / or carried out the inspections. This is a fundamental principle of quality assurance.

646. Moreover, site photographs, while no doubt they may have their uses, cannot in themselves constitute acceptable records going to quality assurance. They should only be used to support properly prepared quality records. Photographs may show that particular works were being carried out on a particular day but they cannot demonstrate that such works were properly inspected.

647. The Commission uncovered an ambiguity as to whether or not a completed RISC form constitutes a certificate, and as such whether it needs to be retained by MTRCL as a quality record and for what period it needs to be retained. The Commission considers that this matter should be clarified for future contracts.

648. The General Specification, forming part of Leighton's contract with MTRCL, requires that Leighton should produce 'as-built' records and 'as-built' drawings on a progressive basis, submitting them to MTRCL.

649. While the timing obligations of formal submissions may be in question, the Commission is in no doubt that Leighton had a clear obligation to provide them.

Adoption of technology

650. The Commission is aware of the fact that digital, hand-held devices are used extensively on construction sites around the world to capture the results of quality inspections and for tracking defects. It was surprising therefore to discover during the course of the hearings that MTRCL, together with its contractors and sub-contractors, did not appear to have made use of technology for systematic data capture on site, especially for producing contemporaneous records of quality inspections. The Commission heard from a number of witnesses that records of inspection were not immediately recorded on site but were recorded later on paper in the site office: on occasions, only being recorded much later, if at all. In respect of the use of technology on site, MTRCL appears to have 'fallen behind the curve'.

651. The Commission notes however that the use of technology on site has been addressed by MTRCL's consultant, T&T and steps are being taken to implement the recommendations that have been made by T&T.

Building Information Modelling

652. Building Information Modelling ('BIM') has not been used on the SCL Project. Indeed, it appears that BIM has hardly been used on any MTRCL projects. However, Mr Rowsell, the Commission's independent expert, recommended that MTRCL should develop and implement the use of BIM as a

collaboration tool. In addition, MTRCL's management consultant, T&T, has made reference to BIM in their review and the Commission has been informed that MTRCL is progressing the development of BIM for future projects.

653. What therefore is BIM and, in the view of the Commission, what benefits will it provide in future for Hong Kong infrastructure projects?

654. BIM is a process. A software model of the asset is developed and shared within a common data environment thereby increasing transparency between the parties. BIM provides clarity regarding the asset requirements at each phase of the project life cycle. Data from all parties are linked. The project is thereby kept on schedule and on budget. It may even be said that BIM is becoming part of the DNA of future construction.[62] Experience in the use of BIM demonstrates that significant savings of time and cost can be achieved, predominantly by reducing wasted or duplicated effort.

655. BIM has been widely adopted in the UK, Europe and North America. In 2012, the Government of the UK mandated that BIM be used on all publicly procured projects from April 2016. Many private sector clients in the UK have followed suit and BIM is progressively becoming the norm for designing, implementing and maintaining building and infrastructure assets across the UK and parts of Europe. The Commission notes that similar government mandates have been introduced in Finland (2007), Norway (2008), USA (2008), Singapore (2014) and France (2017). Germany will follow in 2020.

656. The Hong Kong construction community is already aware of the benefits of BIM. In the Chief Executive's 2018 Policy Address it was stated that the Government has established a "HK$1 billion Construction Innovation and Technology Fund to encourage wider adoption of innovative technologies and stimulate the provision of cutting-edge solutions".[63] Further, the Government's 2018-19 Budget stated that starting from 2018, the Government will adopt BIM technology in the design and construction of major government capital works projects.[64]

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[62] AIM Group, Hong Kong

[63] See paragraph 145 of the 2018 Policy Address

[64] See paragraph 113 of the 2018-19 Budget

657. The Commission also notes that the Secretary for Development issued Technical Circular (Works) number 7/2017 in December 2017 setting out the requirement to use BIM technology in all capital works projects with estimated costs greater than HK$30 million, effective 1 January 2018.

658. The Commission is not therefore recommending a technological process that is unknown in Hong Kong or of no interest to the construction industry here. In the context of this report, however, and looking forward, it is a development to be encouraged.

659. The Commission heard expert evidence that it may be preferable to first introduce BIM at a basic, 'collaborative' level so as to gain experience before building up to more sophisticated, multi-dimensional versions.

Communication

660. As mentioned earlier in this report, in respect of the second design change – 'the second change' – to a portion of the top of the east diaphragm wall, the modifications went ahead on the basis of a fundamental misunderstanding between MTRCL's design management and construction management teams. Having considered the dynamics of the incident, Mr Rowsell commented as follows in his report –

> "The opinion I have formed is that the contractual procedures had at this stage broken down and the position reached could be described as build and design (rather than design and build). I do understand the pressures that can develop on site during construction and the need to maintain programme but there always comes a stage where either the Contractor or the Engineer (or jointly, particularly in a partnering environment) should halt construction activity to ensure that approved designs are clear, procedures have been followed and are being implemented in practice."

661. The Commission agrees with these observations. It notes, however, that the misunderstanding may have been aggravated by the absence of the designer from site, a matter emphasised above.

662. The Commission recognises that there can be breakdowns in communication in the best managed organisations. The independent expert

witnesses have, however, suggested that one way of materially improving communications, including communications within a single organisation, is by the adoption and use of BIM.

Site entry / exit systems and procedures

663. Under Contract 1112, Leighton was responsible for maintaining site security and in that regard implementing a secure entry and exit system. The Commission understands that its purpose was to provide a record of who was on site at any given time and also to provide a record for the payment of workers.

664. During the course of the inquiry, however, it became very apparent to the Commission that the system could not be relied upon. People – including casual visitors – came and went without the security system making any record.

665. As Mr Rowsell pointed out, an accurate record of site attendances is essential in order to support payments to the contractor under the 'target cost' contract model employed on the SCL Project.

Examining the Government's systems

666. The Government performed multiple roles in the SCL Project, including overseer of MTRCL in its management of the project as part of administering the entrustment agreements, public sector funder of the project, statutory approving authority under various Ordinances, and ultimate approver and accepter of the completed works. The Commission notes that these were not passive roles, but rather demanded the active involvement of the Government in the performance of the project. Timely action was required of the Government including, when necessary, instructions to MTRCL to take corrective actions. Given the failings and deficiencies that have been identified in this final report, the Commission is of the view that the Government has to bear a measure of responsibility. It was not a passive bystander, it was an active participant.

Government's sponsorship of rail enhancement projects

667. During the course of the hearings, the Commission could not fail to take note of the very large number of Government bureaux, departments, offices,

committees and other sundry bodies involved in rail enhancement projects. In respect of the SCL Project, the various bureaux and departments with a role to play have included the following: THB, HyD, BD and DEVB. In addition, MTRCL has been required to consult with numerous other Government bodies including Geotechnical Engineering Office, Civil Engineering and Development Department, Drainage Services Department, Water Supplies Department, Architectural Services Department, Antiquities and Monuments Office, Leisure and Cultural Services Department and Housing Department. Even this extended list may not be complete.

668. Mr Rowsell suggested that, in respect of a project which the Government is funding, it could ensure greater efficiency, greater cost effectiveness and savings in time if there was a single point of responsibility within the Government for administering the Government's agreement with MTRCL, more especially to oversee and manage internal Government consultations. The Commission believes there is much strength in Mr Rowsell's recommendation.

669. In the course of final submissions, counsel for the Government said that it was RDO within HyD that served as the single point of contact for overall administrative co-ordination. However, counsel went on to say that, if considered necessary, the Government was prepared to instil further clarity into its lines of communication and reporting. The Commission believes this should be done.

670. The Commission notes that in her 2019 Policy Address Supplement, the Chief Executive has committed to examining the feasibility of establishing a new government department specifically tasked to handle and supervise railway planning and delivery matters.[65] The Commission welcomes this new initiative.

671. Indeed, the Commission goes further. It believes that the Government should critically address the way in which it executes its multiple roles in relation to railway enhancement projects and that active consideration should be

[65] See page 107 of the Chief Executive's 2019 Policy Address Supplement

given to creating an overall 'sponsor' role[66] for all individual projects. The sponsor must command authority and take responsibility for the project on behalf of the Government. Mr Rowsell also recommended that the Government should address its project sponsorship arrangements. In the view of the Commission, this is not a small change requiring minor adjustments to the Government's current arrangements for monitoring and controlling projects. Rather, the Commission is of the view that the Government should carry out a comprehensive review of the way in which it monitors and controls major projects, making fundamental changes where appropriate.

672. In this regard, the Commission respectfully suggests that the Government might wish to look to the experience of its counterparts elsewhere in the world, for example, in the UK where a number of major rail infrastructure projects have been funded (wholly or partly) and sponsored by the central Government.

673. Finally, it is to be emphasised that, in the view of the Commission, the skill sets required for effective sponsorship of projects are not the same as that required for effective project management.

PYPUN: the work of monitoring and verification

674. As mentioned in Chapter 1, in order to ensure due compliance by MTRCL of its obligations under its entrustment agreements, the Government adopted what has become known as the 'check the checker' approach in terms of which various bureaux and departments of the Government, operating through a hierarchy of committees and oversight gatherings, have monitored construction progress. In this respect, the Government has been assisted by PYPUN in its role as an M&V consultant.

[66] Sponsorship of a project, programme or portfolio is an important senior management role. The project sponsor is the individual (often a manager, executive or senior officer) with overall accountability for the project. The project sponsor is accountable for ensuring that the work is governed effectively and delivers the objectives that meet the identified needs. The project sponsor is primarily concerned with ensuring that the project delivers the agreed benefits. It is normal on a large, complex project for the project sponsor to be supported by a sponsorship team. See *Body of Knowledge* by the Association for Project Management

675. During the Commission's inquiry, the exact nature and extent of PYPUN's monitoring role was subject to questioning. For example, why it was that PYPUN had apparently played no role whatsoever in monitoring adherence to the RISC form process or other processes related to quality assurance.

676. Mak Yu Man, Project Manager of PYPUN, explained that his company's role was, in terms of its contractual obligations, focused on "cost, programme and public safety of the Project". This, he suggested, did not include the monitoring of the quality or integrity of the works being constructed.

677. Counsel for PYPUN, in the course of closing submissions, said that a general obligation to monitor, verify and assess *all* issues arising out of the construction process and matters relevant to it was never understood to be part of PYPUN's contractual remit. There was simply nothing in the M&V agreement, he said, to suggest that PYPUN had to undertake an investigative role in respect of issues related to quality and whether or not they would impact on the construction programme or cost. Such a role would have to be stated in the agreement to give rise to an obligation.

678. The Commission has always understood that PYPUN has had to act within the constraints of its mandate. It further accepts that there were almost daily exchanges with HyD and other Government teams to discuss and agree the nature of the work that it was to undertake. The evidence shows that over an extended period of years PYPUN received performance reports of the highest calibre from the Government.

679. In its interim report, the Commission commented that PYPUN exhibited a degree of passivity which was disappointing. It spoke, for example, of PYPUN's 'surprise checks' on site being anything but a surprise. Again, however, PYPUN was able to point to the constraints of its contractual obligations, for example, in respect of access to the construction sites, that access was subject to the giving of reasonable advance notice and would only be allowed with the prior agreement of MTRCL.

680. The Commission cannot say, and does not say, that PYPUN failed to meet its contractual obligations. It is concerned, however, by the constraints

of the contract itself. In his first report, Mr Rowsell made a number of recommendations as to the role of the M&V consultant. The Commission is pleased to note that the Government is taking these recommendations forward. Mr Rowsell has made further recommendations in this regard in his second report.

Looking to a more collaborative culture

681. Finally, and more fundamentally, the Commission is of the view that there is in Hong Kong considerable scope for creating a more collaborative culture between the Government, MTRCL and contractors with the object of achieving more successful project outcomes. The Government should take a leading role if such a change is to take place.

682. By way of example, the Commission believes that there would be great value in BD working much more closely and more collaboratively with MTRCL and its designers and contractors in order to facilitate dialogue on all engineering matters.

683. In the view of the Commission, BD is considered currently to be a relatively remote authority whose approval is required to be sought and obtained. BD is, quite properly, the ultimate 'gatekeeper' of acceptability of building standards. Consideration should be given as to whether it might be more beneficial for BD to act more as a proactive project participant, offering its advice and expertise. The Commission believes that this shift can be achieved without BD diluting its ultimate gatekeeper role.

684. The Commission has taken note of the progress that is being made across the world in changing the internal culture of the construction industry from one that has been essentially adversarial (with low levels of trust between the parties) to one that is becoming more collaborative (with higher levels of trust and mutual respect). This change is recognised as progressively resulting in the reduction of project delay and budget overruns.

685. Key enablers of this change have been the introduction of new contract forms such as NEC3 and NEC4[67] and the introduction also of collaborative initiatives such as partnering and alliancing. The introduction of BIM has also made a significant contribution to improving trust and performance on project delivery.

686. Mr Rowsell advocated the establishment of a Senior Leadership Forum, comprising the Government, MTRCL and its contractors in order to "monitor working relationships and cultural aspects of service delivery and to agree ways of developing collaborative working". He went on to suggest that it should include leaders of the major sub-contractors. The Commission supports this suggestion.

687. In summary, the Commission can do no better than employ the words of Dr Glover, the independent expert on structural engineering engaged by MTRCL, who has headed a great many major infrastructure projects. He stressed the importance of all parties working together to achieve a successful project outcome.

688. Finally, the Commission is of the view that the Hong Kong construction industry has much progress to make in becoming more collaborative. The Commission is further of the view that the Government can and should take a leading role to make this beneficial change happen, through its effective sponsorship of major infrastructure projects. In this regard, the Commission notes and welcomes the publication of 'Construction 2.0'[68].

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[67] The New Engineering Contract ('NEC') is a suite of contracts created by the Institution of Civil Engineers. NEC3 is a family of contracts unique in offering a complete end-to-end project management solution for the entire project life-cycle; from planning, defining legal relationships and procuring of works, all the way through to project completion, management and beyond. NEC4 builds on NEC3, providing improved flexibility, clarity and ease of use, thereby enabling the delivery of projects on time, on budget and to the highest standards.

[68] 'Construction 2.0 – Time to Change' by DEVB, with the assistance of KPMG, published in 2018

Chapter 14

Recommendations

689. The Commission is required to make recommendations on suitable measures with a view to, first, promoting public safety and second, promoting assurance on quality of works.

Promoting public safety

Monitoring of the station structure

690. With regard to the first part, namely promoting public safety, the Commission recommends ongoing monitoring of the station structure during operation of the station, so as to provide reassurance to the public. Such monitoring should take the form of an enhanced 'Planned Preventative Inspection' regime, perhaps for a period of up to five years. However, the Commission notes the expert advice it has received that any movement of the station structure will be extremely low, if indeed any movement occurs at all.

691. The Commission further notes the expert advice that such low level of movement will have no impact on the safe operation of the railway.

Promoting assurance on quality of works

692. With regard to the second part, namely promoting assurance on quality of works, the Commission sets out it recommendations below.

693. 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 the Government, system and processes for communication internally and with various stakeholders, and other related systems, processes and practices, and the implementation thereof, have been addressed in Chapter 13 above.

694. Additionally, the extent and adequacy of the monitoring and control mechanisms of the Government, and the implementation thereof, have also been addressed in Chapter 13.

695. The Commission adopts without reservation all the recommendations set out in Part 3 of the two expert reports of Mr Rowsell, the independent project management expert appointed by the Commission. Mr Rowsell's recommendations are set out in paragraphs 150 to 200 of his first expert report and in paragraphs 130 to 169 of his second expert report. These include matters to be addressed by both MTRCL and the Government.

696. There is a degree of overlap between the recommendations in Mr Rowsell's two expert reports, which are provided in **Annexure H** of this report.

697. The Commission sets out its own recommendations below, based in part on those in Mr Rowsell's expert reports.

Leadership and culture

698. The Commission recommends the closer involvement of senior leaders of all parties – the Government, MTRCL and contractors – working collaboratively to achieve a quality outcome. This would involve senior leaders being more visible to the workforce and taking a lead role in communicating key messages throughout their respective organisations.

699. In this regard, the Commission welcomes the new leadership focus on a 'quality culture' within MTRCL and the enhanced scope of MTRCL's Board level Capital Works Committee to oversee also the quality of the works within its capital programme.

MTRCL's roles and responsibilities

700. The Commission recommends that MTRCL reviews and clarifies its roles and responsibilities in relation to its construction contracts, perhaps by allocating and distinguishing its roles as the 'Engineer' (and his representatives) from its separate roles as the Project Manager.

PIMS

701. The Commission observes that MTRCL places a high reliance on its PIMS, which MTRCL claims has served it well over more than two decades.

However, a record of past success cannot be a guarantee of future performance. The Commission is of the opinion that substantial change to PIMS is warranted. In particular, the Commission recommends that MTRCL reviews its requirements for site record keeping, supported where appropriate by technology solutions. The Commission welcomes MTRCL's commitment to adopt in full the recommendations of its consultant, T&T, and observes that notable progress is being made in implementing those recommendations.

RISC form and inspection procedures

702. The Commission recommends that MTRCL reviews the provision of 'hold points' in its contract specifications. In addition to the current hold points, the Commission observes that it may be sensible to introduce a further hold point for the contractor and MTRCL to jointly confirm readiness to commence reinforcement installation. This would provide assurance that, *inter alia*, all couplers are present and properly exposed and that coupler threads are not damaged.

703. The Commission recommends that MTRCL provides clarity in its contract specifications as to the status of RISC forms (in paper and / or digital form), and as to their retention and storage requirements.

Mechanical couplers

704. The Commission makes one specific recommendation regarding the use of BOSA mechanical couplers. To facilitate the proper and safe use of this type of coupler on future construction projects, the Commission recommends that the manufacturer devises and prescribes a clearer and more foolproof means of positively indicating that the coupler assembly has been correctly installed in a manner that will achieve its specified structural properties. In the view of the Commission, this should not be dependent on merely counting the number of exposed threads.

Interface management

705. The Commission recommends that MTRCL reviews its interface management requirements, considering defining a joint interface inspection as a hold point.

Non-conformance reporting

706. The Commission recommends that MTRCL distinguishes in its contract specifications the procedures to be used for reporting non-conforming works, separately from those to be used for reporting non-conforming processes.

Competence and training

707. The Commission recommends that both MTRCL and the Government should review the 'Competence'[69] requirements for personnel engaged in project management and project sponsorship roles in their respective organisations. The Commission recognises that even when competent people are employed, errors may still occur. Effective measures must therefore be in place to reduce the risk of failure, be it by mistake, incompetence or malicious act. The Commission recommends that MTRCL and the Government respectively should review their checks and procedures to ensure the ongoing competence of their project-related staff.

708. The Commission recommends that MTRCL reviews its induction training for project staff, considering culture and values, together with training in PIMS and in appropriate behaviours for working in a project partnering environment.

BIM

709. The Commission recommends that MTRCL expedites its adoption of BIM for new capital projects within its portfolio.

On site presence of designer

710. The Commission recommends that for future rail infrastructure projects, the designer should have a site presence so as to assist in ensuring that the design intent is implemented in the works.

[69] 'Competence' can be defined as the combination of training, skills, experience and knowledge that a person has and their ability to apply them in performing a task effectively. Factors such as attitude and physical ability can also affect someone's competence. See 'In Plain Sight: Assuring the Whole-life Safety of Infrastructure' by the Institution of Civil Engineers, published in 2018

Monitoring and verification

711. The Commission recommends that the Government considers extending the role of the M&V consultant to provide a wider 'eyes and ears' role to help protect the Government's interests in the delivery of projects. This role might include monitoring of the operation of the project quality assurance systems on top of the current role of monitoring cost, programme and public safety issues. The M&V consultant's role could be developed into a Government's 'Project Representative' role that works more closely with MTRCL to monitor performance and to identify emerging issues.

Governance / sponsorship

712. The Commission recommends that the Government should critically address the way in which it executes its multiple roles in relation to the delivery of railway projects. Of particular concern is the Government's role as 'client' or 'sponsor' of railway projects. The sponsor organisation must both command authority and take responsibility for the project.

713. The Commission recommends that for future railway projects, a Project Board should be established to provide strategic direction. The Project Board might comprise appropriate Government officials as board members, supported by external non-executive members from specialist backgrounds who could bring experience of best practice from the wider industry so as to provide strategic advice. The Sponsor should attend the Project Board meetings and report to the Project Board.

714. The Commission recommends that consideration be given as to whether it is appropriate for railway projects to remain within the portfolio of the Director of Highways, or whether a new distinct Director of Rail Development role should be established to handle and supervise railway planning and delivery matters. In this regard, the Commission is pleased to note that the Chief Executive has announced in her 2019 Policy Address Supplement that the Government will examine the feasibility of establishing a new department specifically tasked to handle and supervise railway planning and delivery matters.

715. The Commission recommends that consideration should be given as to the appropriateness of the 'Concession' model for future projects entrusted by the Government to be project managed by MTRCL, or whether the Government should revert to the previously used 'Ownership' model. Alternatively, consideration might be given to the creation of a Special Purpose Vehicle ('SPV') approach, with a dedicated Board and delivery organisation, as has been employed on major rail infrastructure projects in the UK.[70]

Liaison and communications with BD

716. The Commission recommends that the Government reviews the way that liaison and communications is carried out between HyD / RDO, MTRCL and BD. The Commission suggests that it might be more beneficial for BD to act more as a proactive project participant, offering its advice and expertise.

Follow-up

717. The Commission was made aware of the follow-up progress that has already been made by MTRCL and the Government on the Commission's recommendations in its interim report. This is set out in **Annexure I** of this report.

718. The Commission recommends that a follow-up audit be conducted 12 months following the date of this final report, to provide assurance to the Chief Executive that the recommended measures herein have been properly implemented and / or satisfactory progress towards their implementation is being made. It should be noted that the Commission recommended something similar in its interim report in February 2019, but is unaware that action has been taken on this. The Commission feels strongly that such action should be taken in relation to its recommendations in this final report. Given that the recommendations are for action by both MTRCL and the Government, this follow-up audit should be carried out independently of the Government.

[70] Crossrail Limited and HS2 Limited

Instruments of appointment (10 July 2018)

Mr Michael John Hartmann, GBS

Dear Mr Hartmann,

Commissions of Inquiry Ordinance (Chapter 86)

The Chief Executive in Council has appointed you as Commissioner and Chairman of a Commission of Inquiry under section 2 of the Commissions of Inquiry Ordinance (Chapter 86) to inquire into the matters set out in the Terms of Reference below, being matters which are of public importance.

The Terms of Reference of the Commission shall be as follows –

"In respect of the diaphragm wall and platform slab construction works at the Hung Hom Station Extension under the MTR Corporation Limited ("MTRCL")'s Contract No. 1112 ("Contract") of the Shatin to Central Link Project,

(a) (i) to inquire into the facts and circumstances surrounding the steel reinforcement fixing works, including but not limited to those works at locations that have given rise to extensive public concern about their safety since May 2018;

(ii) to inquire into the facts and circumstances surrounding any other works which raise concerns about public safety; and

(iii) to ascertain whether the works in (i) and (ii) above were executed in accordance with the Contract. If not, the reasons therefor and whether steps for rectification have been taken;

(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."

The Commission shall report to the Chief Executive within six months from the date of this appointment or such time as the Chief Executive in Council may allow.

The Chief Executive in Council has –

(a) conferred on you as Chairman a second or casting vote for use where the Commission shall, in any case, be equally divided on any question arising during the proceedings;

(b) directed that when hearing evidence the two Commissioners shall sit together but as Chairman, you may sit alone to consider procedural matters and to give directions for the efficient conduct of the inquiry;

(c) directed that the Commission may appoint experts to provide reports or other forms of assistance on any matters covered by the inquiry;

(d) directed that the Commission shall have and exercise the powers conferred by section 9 of the Commissions of Inquiry Ordinance to punish all or any of the contempts specified in section 8; and

(e) directed that the determination of any criminal or civil liability of any party (whether individual or legal entity) shall be outside the Terms of Reference of the Commission.

The Commission may submit interim reports on any aspects of the inquiry as it may see fit.

Mr Patrick Chan has been appointed as Secretary to the Commission to provide you with the necessary administrative support for

the inquiry. The Commission will also be provided with other support staff.

The Chief Executive in Council has appointed Professor Peter George Hansford as the other Commissioner of the Commission.

I am most grateful to you for your agreement to take on this important task.

Yours sincerely,

(Mrs Carrie Lam)
Chief Executive

Professor Peter George Hansford, FREng, FICE, FAPM, FRSA

Dear Professor Hansford,

Commissions of Inquiry Ordinance (Chapter 86)

The Chief Executive in Council has appointed you as Commissioner of a Commission of Inquiry under section 2 of the Commissions of Inquiry Ordinance (Chapter 86) to inquire into the matters set out in the Terms of Reference below, being matters which are of public importance.

The Terms of Reference of the Commission shall be as follows –

"In respect of the diaphragm wall and platform slab construction works at the Hung Hom Station Extension under the MTR Corporation Limited ("MTRCL")'s Contract No. 1112 ("Contract") of the Shatin to Central Link Project,

(a) (i) to inquire into the facts and circumstances surrounding the steel reinforcement fixing works, including but not limited to those works at locations that have given rise to extensive public concern about their safety since May 2018;

(ii) to inquire into the facts and circumstances surrounding any other works which raise concerns about public safety; and

(iii) to ascertain whether the works in (i) and (ii) above were executed in accordance with the Contract. If not, the reasons therefor and whether steps for rectification have been taken;

(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."

The Commission shall report to the Chief Executive within six months from the date of this appointment or such time as the Chief Executive in Council may allow.

The Chief Executive in Council has –

(a) conferred on the Chairman a second or casting vote for use where the Commission shall, in any case, be equally divided on any question arising during the proceedings;

(b) directed that when hearing evidence the two Commissioners shall sit together; but the Chairman may sit alone to consider procedural matters and to give such directions for the efficient conduct of the inquiry;

(c) directed that the Commission may appoint experts to provide reports or other forms of assistance on any matters covered by the inquiry;

(d) directed that the Commission shall have and exercise the powers conferred by section 9 of the Commissions of Inquiry Ordinance to punish all or any of the contempts specified in section 8; and

(e) directed that the determination of any criminal or civil liability of any party (whether individual or legal entity) shall be outside the Terms of Reference of the Commission.

The Commission may submit interim reports on any aspects of the inquiry as it may see fit.

Mr Patrick Chan has been appointed as Secretary to the Commission to provide you with the necessary administrative support for the inquiry. The Commission will also be provided with other support staff.

The Chief Executive in Council has appointed Mr Michael John Hartmann as the Chairman of the Commission.

I am most grateful to you for your agreement to take on this important task.

Yours sincerely,

(Mrs Carrie Lam)
Chief Executive

Annexure B

Rules of procedure and practice (24 September 2018)

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

Rules of Procedure and Practice

(made at the Preliminary Hearing on 24 September 2018)

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1. The Commission's proceedings will address the matters set out in its Terms of Reference stipulated in the Gazette Notice No. 5166 dated 13 July 2018.

2. Parties permitted to participate and/or be legally represented at the Inquiry will be referred to hereinafter as "the involved parties" or "involved party".

I. General

Public hearings

3. Unless otherwise directed, the hearings of the Inquiry will be open to the public.

Prohibition on photograph, audio/video recordings without the authorisation of the Commission

4. Without the authorisation of the Commission, no photographs may be taken or audio/video recordings made in the Hearing Room, the hearing transmission gallery, hall area or any other areas in the former Tsuen Wan Law Courts Building ("the Building") used for the purposes of this Inquiry.

Language

5. The proceedings will be conducted in English, although witnesses may give their evidence in any language or dialect of their own choice. Testimony given in a language other than English will be translated into English. The Commission will provide simultaneous interpretation services when appropriate.

Access to documents

6. The Secretariat of the Commission has compiled, and will update regularly, an index of documents and materials provided to the Commission for the purposes of the Inquiry. Any involved party who wishes to gain access to such documents or materials may apply in writing to the Secretariat of the Commission. At its discretion, the Commission shall determine whether or not, when and to what extent access may be permitted, and what conditions, if any, should be imposed upon the grant of such access. Given that access may be restricted and conditions may be imposed, documents and materials

provided to an involved party shall not be disclosed or disseminated to other involved parties or unrelated persons without the consent in writing of the Commission.

7. If access is permitted to any involved party, only soft copies of the documents and materials to which access has been permitted by the Commission will be provided. The cost of obtaining such copies shall be borne by the party obtaining such copies.

Use of materials provided by the Commission

8. All materials supplied by the Commission to any of the involved parties shall be used only for the purposes of the Inquiry. Public dissemination of any of such materials shall not be allowed until and unless they have been adduced as evidence and expressly referred to in the Inquiry.

II. Standing

Written witness statements

9. Insofar as not already provided, the involved parties and other parties or individuals who have been directed by the Commission to provide written statements shall provide such statements by the date specified by the Commission, subject to applications for extension of time as approved by the Commission.

10. Any involved party who wishes to provide responsive written statement(s) to a statement provided by another involved party, other party or individuals, shall apply in writing to the Commission within 14 days from the date when soft copies of the documents and materials are provided under paragraph 7 above, and a draft of its proposed responsive written statement(s) shall be provided to the Commission with the application. Unless directed by the Commission, any further written statement(s) which is not responsive in nature will not be permitted.

11. Any involved party who wishes to adduce expert evidence on any issue relevant to the Inquiry must make an application to do so on reasonable notice to the Commission, and any such application shall be made to the Commission through its solicitors and accompanied by the provision of 3 copies of the written report signed by the expert concerned together with a soft copy. If the Commission grants any such application, it will give directions as to when the expert is required to be called to give evidence at the Substantive Hearing. The Commission will not grant any such application if it is not satisfied that the evidence to be tendered is independent expert evidence.

The participation and legal representation of other parties

12. Any party (apart from the involved parties), who wishes to (1) participate in the Inquiry (if leave to participate has not yet been granted by the Commission); (2) call any witnesses; and/or (3) adduce any witness statements and/or materials for the purposes of the Inquiry,

shall apply in writing to the Commission within 7 days from today (ie. by Tuesday, 2 October 2018).

13. If the Commission decides that an application referred to in paragraph 10 above be granted, the party in question shall (unless otherwise directed by the Commission) provide the witness statement(s) of the witness(es) to be called and/or material(s) to the Commission within such period as the Commission may consider appropriate.

III. The hearing procedure

Opening addresses

14. Counsel for the Commission may make a written and oral opening address. Counsel for the involved parties may make their own opening addresses provided an application to do so (enclosing a written opening address which should not be longer than **20** pages and provided in font size 14 with single spacing and no footnotes other than for document references) has been made within 21 days from today (ie. by Monday, 15 October 2018). If the Commission accedes to such application, the oral addresses will be made immediately after the address of Counsel for the Commission. The Commission may determine the sequence and length of such oral addresses.

Evidence

15. The Commission notes that section 4(1) of the Commissions of Inquiry Ordinance, Cap. 86 provides that in conducting the Inquiry, it may:

> "*(a) receive and consider any material whether by way of oral evidence, written statements, documents or otherwise, notwithstanding that such material would not be admissible as evidence in civil or criminal proceedings.*"

The examination of witnesses

16. Oral evidence will be given under oath or affirmation.

17. The procedure by which the Commission will receive oral evidence is as follows:

    (1) The Commission shall determine the sequence in which oral evidence be given in the Inquiry.

    (2) Counsel for the Commission will lead the evidence of witnesses called by the Commission; Counsel for any involved party may apply to the Commission for leave to question a particular witness and the Commission will determine the sequence of cross examination by those Counsel whose application for cross examination has been granted; Counsel for the Commission may re-examine the witness.

    (3) Unless otherwise directed by the Commission, Counsel for an involved party may lead the evidence of witnesses who testify on behalf of such a party, after which Counsel for the Commission may question such witness. Thereafter, Counsel for other involved parties may apply to the Commission for leave to question such witness and the Commission will determine the sequence of cross examination by those Counsel

whose application for cross examination has been granted. Finally, Counsel for the involved party leading the evidence of the witness may re-examine such witness.

(4) Unless otherwise directed by the Commission, insofar as any witness wishes to adopt his or her witness statement as his or her evidence (with or without modification or elaboration), the contents of his or her witness statement are to be read out either by the witness or by his or her counsel.

(5) At any stage of the Inquiry the Commission may ask questions of any witness.

(6) The Commission may give directions to each party limiting the length of examination of witnesses and submissions.

(7) The Commission shall inform all involved parties as and when the witness statements and/or expert reports of the witnesses to be called by the Commission become available.

(8) The Commission may recall any person who has given oral evidence to answer further questions.

"Witnesses" referred to above shall include factual and expert witnesses.

Closing addresses

18. Counsel for the Commission and Counsel for the involved parties may make written and oral closing addresses. The Commission may

determine the sequence and length (both written and oral) of such addresses.

The Substantive Hearing

19. The Substantive Hearing of the Inquiry shall commence on 22 October 2018 at 10 am in the Building.

20. The Substantive Hearing shall, subject to any adjournments that the Commission may consider necessary from time to time, continue until 16 November 2018 and shall resume from 26 November 2018 until 21 December 2018 (on a provisional basis).

21. Unless otherwise directed, the Substantive Hearing will be held from 10 am to 1 pm and from 2.30 pm to 5 pm every weekday. The Commission may consider the Substantive Hearing being held on Saturday mornings during the periods mentioned in paragraphs 19 and 20 above.

22. There will be a Real-time Transcript Streaming ("Transcend") of the Substantive Hearing. Any applications for subscriptions to Transcend should be made in writing to the Secretariat of the Commission within 14 days of today (ie. by Monday, 8 October 2018), stating how many subscriptions are required and undertaking to pay the costs thereof. To view the real-time transcript during the Substantive Hearing, subscribers will need to use their own laptops or notebook computers and make arrangement with the service provider directly.

23. An electronic bundle has been and continues to be prepared for use at the Substantive Hearing. This will be managed by the Secretariat. All involved parties should be able to read pages in the electronic bundle during the course of the Substantive Hearing on monitors provided by the Secretariat.

24. Seating arrangements in the Hearing Room during the course of the Substantive Hearing will be determined by the Secretariat on a day to day basis. Seating for Counsel and Solicitors for the Commission will be fixed throughout the Substantive Hearing but the representatives of the involved parties will be allocated seats depending upon the witness giving evidence, those parties who have been granted leave to cross-examine the witness and any other factors that the Secretariat deems relevant. The Commission expects the parties' representatives to fully co-operate with each other in respect of the seating arrangements in the Hearing Room. Within 7 days of today (ie. by Tuesday, 2 October 2018), each involved party should nominate a single contact person and send his/her name, post title, name of firm, telephone number and email address to the Secretariat. The Secretariat will compile a contact list and use the list for disseminating messages in relation to seating and other hearing arrangements during the course of the Substantive Hearing.

25. At the discretion and determination of the Commission, each involved party may, subject to availability, be allocated a lockable room within the Building for its use for the duration of the Substantive Hearing.

Annexure C

List of witnesses

Original Terms

Factual witnesses giving evidence before the Commission at the substantive hearing

	Date of attendance	Factual witness	Position held in organisation at the material time
1.	23-24 October 2018	Mr Jean-Christophe Jacques-Olivier Gillard	Director of Intrafor Hong Kong Limited
2.	24 October 2018	Mr Wong Yiu Mo	Steel bar fixer of Hung Choi Engineering Company Limited ('Hung Choi')
3.	24-25 October 2018	Mr But Ho Yin, Ian	Assistant Foreman of China Technology Corporation Limited ('China Technology')
4.	25 October 2018	Mr Ngai Lai Chi, Thomas	Superintendent of China Technology
5.	25-26 October 2018	Mr Li Run Chao	Assistant Foreman of China Technology
6.	29 October 2018	Mr Chu Ka Kam	Foreman of China Technology
7.	29 October 2018- 2 November 2018 5 November 2018	Mr Poon Chuk Hung, Jason	Managing Director of China Technology
8.	5 November 2018	Mr Chui Tim Choi	Director of Hung Choi
9.	6-7 November 2018	Mr Pun Wai Shan	Sole Proprietor of Fang Sheung Construction Company ('Fang Sheung')
10.	7-9 November 2018 12 November 2018	Mr Cheung Chiu Fung, Joe	Site Foreman of Fang Sheung

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	Date of attendance	Factual witness	Position held in organisation at the material time
11.	8 November 2018	Mr Malcolm Plummer	Project Director of Leighton Contractors (Asia) Limited ('Leighton')
12.	9 November 2018	Mr Khyle Anthony Rodgers	Superintendent of Leighton
13.	12 November 2018	Mr Karl Robert Speed	General Manager of Leighton
14.	13 November 2018	Mr Law Chi Keung	Construction Worker of Rankine Engineering Company Limited ('Rankine')
15.	13 November 2018	Mr Ho Hiu Tung	Construction Worker of Rankine
16.	13 November 2018	Ms Emily Cho	Site Clerk of Leighton
17.	13 November 2018	Mr Ngai Chun Kit	Quality Surveyor Manager of China Technology
18.	13-14 November 2018	Mr Anthony Peter Zervaas	Project Director of Leighton
19.	14 November 2018	Mr Ian Noel Rawsthorne	Project Manager of Leighton
20.	14-15 November 2018	Mr So Yiu Wah, Gabriel	Superintendent / General Superintendent of Leighton
21.	15 November 2018	Mr Chan Chi Ip	Site Supervisor of Leighton
22.	15 November 2018	Mr Tam Chi Ming, Joe	Construction Manager of Leighton
23.	15 November 2018	Mr Chow Ming Yin, Gary	Construction Manager of Leighton
24.	16 November 2018	Mr Leung Kwok Cheong, Joe	Site Agent of Leighton
25.	16 November 2018	Mr Ip Wai Ming, Andy	Sub Agent of Leighton
26.	26 November 2018	Mr Edward Mok	Graduate Engineer of Leighton
27.	27 November 2018	Mr Man Sze Ho	Assistant Engineer of Leighton
28.	27-28 November 2018	Mr Raymond David Brewster	Group Pre-Contracts Manager of Leighton

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	Date of attendance	Factual witness	Position held in organisation at the material time
29.	28-29 November 2018	Mr Brett Charles Buckland	Senior Site Agent of Leighton
30.	29 November 2018	Mr Justin Paul Taylor	Risk Manager / Revenue Recovery Manager of Leighton
31.	29-30 November 2018	Mr Stephen John Lumb	Head of Engineering of Leighton
32.	30 November 2018	Mr Ngai Yum Keung, Clement	Chief Design Manager – SCL / Head of Project Engineering of MTR Corporation Limited ('MTRCL')
33.	30 November 2018 3 December 2018	Mr Leung Fok Veng, Andy	Design Manager – SCL of MTRCL
34.	3 December 2018	Mr Chan Kit Lam, Kit	Construction Manager – SCL Civil of MTRCL
35.	3-4 December 2018	Mr Ho Ho Pong, James	Senior Construction Engineer – Civil of MTRCL
36.	4 December 2018	Mr Ma Ming Ching, Derek	Construction Engineer I – Civil of MTRCL
37.	5 December 2018	Mr Aidan Gerald Rooney	General Manager – SCL Civil – NSL / General Manager – SCL Civil – EWL / Acting General Manager – SCL Civil – EWL of MTRCL
38.	5-6 December 2018	Mr Kwan Pak Hei, Louis	Construction Engineer II – Civil of MTRCL
39.	6-7 December 2018	Mr Wong Chi Chiu, Kobe	Senior Inspector of Works II (Civil) / Inspector of Works (Civil) of MTRCL
40.	7 December 2018	Mr Wong Kai Wing, Andy	Assistant Inspector of Works – Civil of MTRCL
41.	10 December 2018	Mr Fu Yin Chit, Michael	Construction Manager – SCL Civil of MTRCL
42.	10 December 2018	Mr Wu Ka Wah, Carl	Co-ordination Manager – SCL of MTRCL

Annexure C

	Date of attendance	Factual witness	Position held in organisation at the material time
43.	10 December 2018	Mr Yeung Chi Kin	Senior Quality Assurance Engineer of MTRCL
44.	10 December 2018	Mr Wong Chi Chung, Jason	General Manager – SCL Civil EWL / General Manager – SCL Civil – EWL & PMO of MTRCL
45.	10-11 December 2018	Mr Lee Tze Man	General Manager – SCL / Head of E&M Construction of MTRCL
46.	11 December 2018	Mr Au Koon Shan, Raymond	Principal Contracts Administration Manager – SCL of MTRCL
47.	11 December 2018	Dr Wong Nai Keung, Philco	Projects Director of MTRCL
48.	11 December 2018	Mr Leong Kwok Kuen, Lincoln	Chief Executive Officer of MTRCL
49.	12 December 2018	Professor Ma Si Hang, Frederick	Non-Executive Chairman of MTRCL
50.	12 December 2018	Mr John Blackwood	Director of Transport of Atkins China Limited ('Atkins')
51.	12 December 2018	Mr Sung Chi Man, Wilson	Technical Director (Structure) of Atkins
52.	13 December 2018	Mr Lee Wan Cheung	Structural Team Leader (Team A) of Atkins
53.	13 December 2018	Mr Mak Yu Man	Project Manager of PYPUN-KD & Associates Limited ('PYPUN')
54.	14 December 2018	Mr Yueng Wai Hung, Ron	Director and Leader – Building Submission Review & Compliance Team of PYPUN
55.	14 December 2018	Mr Chung Kum Wah, Daniel	Director of Highways, Highways Department ('HyD')

Annexure C

	Date of attendance	Factual witness	Position held in organisation at the material time
56.	17 December 2018	Mr Chan Fan, Frank	Secretary for Transport and Housing, Transport and Housing Bureau ('THB')
57.	17 December 2018	Mr Li Tsz Wai, Ralph	Chief Engineer of Railway Development Office ('RDO'), HyD / Assistant Secretary (Transport) 7A of THB
58.	17 December 2018	Mr Leung Man Ho, Jonathan	Government Engineer / Chief Engineer of RDO, HyD
59.	17 December 2018	Mr Paulino Lim	Sale Marketing Manager of BOSA Technology (Hong Kong) Limited
60.	17 December 2018	Dr Robert William McCrae	Design Team Leader (Team A) / Project Manager (Team B) of Atkins
61.	18 December 2018	Mr Kevin Wayne Harman	Quality and Environmental Manager of Leighton
62.	18 December 2018	Mr Ho Hon Kit, Humphrey	Assistant Director / New Buildings 2 of Buildings Department ('BD')
63.	18 December 2018	Mr Chau Siu Hei, Francis	Deputy Secretary for Development (Works) 3 of Development Bureau ('DEVB')
64.	18 December 2018	Dr Cheung Tin Cheung	Director of Buildings, BD
65.	19 December 2018	Mr Lok Pui Fai, Andrew	Senior Structural Engineer of BD

Annexure C

Project management expert witnesses giving evidence before the Commission at the substantive hearing

	Date of attendance	Expert witness	Position
66.	10 January 2019	Mr Steve Huyghe	Independent project management expert engaged by MTRCL / Chairman & Founder of CORE International Consulting, LLC
67.	10 January 2019	Mr Steve Rowsell	Independent project management expert engaged by the Commission / Director of Rowsell Wright Limited

Structural engineering expert witnesses giving evidence before the Commission at the substantive hearing

	Date of attendance	Expert witness	Position
68.	14-15 January 2019	Professor Francis T K Au	Independent structural engineering expert engaged by the Government / Professor and Head, Department of Civil Engineering of the University of Hong Kong
69.	15-16 January 2019	Dr Albert T Yeung	Independent structural engineering expert engaged by China Technology / Associate Professor, Department of Civil Engineering of the University of Hong Kong
70.	16-17 January 2019	Mr Nick Southward	Independent structural engineering expert engaged by Leighton / Executive Director of Tony Gee and Partners LLP and Managing Director of Tony Gee (Asia) Limited

Annexure C

	Date of attendance	Expert witness	Position
71.	17-18 January 2019	Dr Mike Glover	Independent structural engineering expert engaged by MTRCL / Arup Fellow
72.	18 January 2019	Professor Don McQuillan	Independent structural engineering expert engaged by the Commission / Director of RPS Consulting Engineers

Factual witnesses who did not give evidence before the Commission but their witness statements have been admitted into evidence

	Factual witness	Position held in organisation at the material time
73.	Mr Chan Yuk Hung	Works Supervisor (Resident Site Staff) of MTRCL
74.	Ms So Pui Yin	Assistant Clerical Officer of Secretary for Transport and Housing's Office (2), THB
75.	Mr Leung Sai Ho	Assistant Secretary (Transport) 7B of THB
76.	Mr Chu Tun Hon, Vincent	Senior Engineer / Shatin to Central Link (7) of HyD
77.	Ms Lai Wai Yin, Vanessa	Executive Officer of Secretary for Transport and Housing's Office, THB
78.	Mr Giang Tsz Sheung, Keith	Administrative Assistant to Secretary for Transport and Housing of Secretary for Transport and Housing's Office, THB
79.	Mr Cheng Nim Tai, Raymond	Principal Assistant Secretary for Transport and Housing (Transport) 7 of THB
80.	Ms Wong Ying, Christie	Engineer of HyD
81.	Ms Pun Ting Ting, Rebecca	Deputy Secretary for Transport and Housing (Transport) 1 of THB

	Factual witness	Position held in organisation at the material time
82.	Mr Loo Kam Wah, Maurice	Deputy Secretary for Development (Planning and Lands) 2 of DEVB
83.	Mr Chan Chi Kong	Divisional Director of Structure Division, Atkins
84.	Mr Fung Lim Cheung, James	Project Co-ordinator (2) of Railway Development Division 1-1 of RDO, HyD
85.	Mr Fan Tak Pun, Patrick	Structural Engineer of BD (seconded to Railway Development 2 of RDO, HyD)
86.	Mr Wong Wing Wah, Edward	Structural Engineer of BD (seconded to Railway Development 1 of RDO, HyD)

COWI UK Limited is a consulting firm engaged by Leighton to undertake an independent structural analysis and assessment of EWL[71] slab to diaphragm wall connection at the Hung Hom Station Extension for the purpose of this inquiry. It did not appear before the Commission at the substantive hearing to give evidence.

[71] East West Corridor / East West Line

Annexure C

Extended Terms

Factual witnesses giving evidence before the Commission at the substantive hearing

	Date of attendance	Factual witness	Position held in organisation at the material time
1.	28 May 2019	Mr Pun Wai Shan	Sole Proprietor of Fang Sheung
2.	29-30 May 2019	Mr Ng Man Chun	Site Supervisor of Loyal Ease Engineering Limited
3.	30 May 2019	Mr Leung Chi Wah	Steel reinforcement worker of Loyal Ease Engineering Limited
4.	30-31 May 2019	Mr Henry Lai	Engineer / Senior Engineer of Leighton
5.	3 June 2019	Mr Cheung Yick Ming, Ben	Quantity Surveyor Manager of Wing & Kwong Steel Engineering Company Limited
6.	3 June 2019	Mr Jonathan Charles Kitching	Project Director of Leighton
7.	4 June 2019	Mr Lii Hing Yu, Jeff	Engineer / Senior Engineer of Leighton
8.	4 June 2019	Mr Leung Yik Wang, Johnny	Site Agent of Leighton
9.	4 June 2019	Ms Wong Hin Wai, Regina	Sub-Agent / Site Agent of Leighton
10.	5 June 2019	Mr Karl Robert Speed	General Manager of Leighton
11.	5 June 2019	Mr William Holden	Engineering Manager of Leighton
12.	5-6 June 2019	Mr Tam Chi Ming, Joe	Construction Manager of Leighton
13.	6 June 2019	Mr Wong Yuen Shing, Sean	Engineer / Senior Engineer of Leighton

Annexure C

	Date of attendance	Factual witness	Position held in organisation at the material time
14.	6 June 2019	Mr Chan Kwok Sing, Saky	Assistant Engineer / Engineer of Leighton
15.	6 June 2019	Mr Kong Sai Kit, Sebastian	Graduate Engineer of MTRCL
16.	6 June 2019	Mr Wong Fui Yu, Jim	Senior Site Agent / Construction Manager of Leighton
17.	10 June 2019	Mr Leung Chi Yung, Ronald	Site Agent of Leighton
18.	10 June 2019	Mr Yeung Ka Lun, Alan	Senior Engineer of Leighton
19.	10 June 2019	Mr Tsoi Ka Chun, Raymond	Graduate Engineer of Leighton
20.	10-11 June 2019	Mr Fu Yin Chit, Michael	Construction Manager – SCL Civil of MTRCL
21.	11 June 2019	Mr Chan Chun Wai, Chris	Construction Engineer II / Construction Engineer I of MTRCL
22.	12 June 2019	Ms Kang Pu, Kappa	Construction Engineer II – Civil of MTRCL
23.	12 June 2019	Mr Tang Siu Hang, Tony	Inspector of Works – Civil of MTRCL
24.	13 June 2019	Mr Tung Hiu Yeung, Victor	Inspector of Works / Senior Inspector of Works II of MTRCL
25.	13 June 2019	Mr Lee Chiu Yee, Jacky	Senior Construction Engineer – Civil of MTRCL
26.	13 June 2019	Mr Ngai Kwok Hung, Cano	Senior Construction Engineer of MTRCL
27.	13-14 June 2019	Mr Chan Kit Lam, Kit	Construction Manager – SCL Civil of MTRCL
28.	14 June 2019	Dr Peter Ewen	Engineering Director of MTRCL

Annexure C

	Date of attendance	Factual witness	Position held in organisation at the material time
29.	17 June 2019	Mr Yueng Wai Hung, Ron	Director and Leader – Building Submission Review & Compliance Team of PYPUN
30.	17 June 2019	Mr Chiu Chung Lai	Director and Deputy Project Manager – Programme Monitoring (Civil), Monitoring & Verification Team of PYPUN
31.	17 June 2019	Mr Li Tsz Wai, Ralph	Chief Engineer of RDO, HyD
32.	17 June 2019	Mr Leung Man Ho, Jonathan	Government Engineer / Chief Engineer of RDO, HyD
33.	17 June 2019	Mr Lok Pui Fai, Andrew	Senior Structural Engineer of BD
34.	24 September 2019	Mr Ng Wai Hang, Neil	Lead Project Manager – SCL Civil – NSL of MTRCL
35.	24 September 2019	Mr Yeung Kin Wa	Project Manager – SCL Civil – HUH of MTRCL
36.	4 October 2019	Mr Dean Cowley	General Manager (Safety, Health, Environment, Quality and Sustainability) of Leighton
37.	2 January 2020	Mr Chow Kai Fat	Site Supervisor of Leighton

Annexure C

Statistical expert witnesses giving evidence before the Commission at the substantive hearing

	Date of attendance	Expert witness	Position
38.	25-26 September 2019	Dr Barrie Wells	Independent statistical expert engaged by Leighton / Senior Consultant and Co-founder of Conwy Valley Systems Limited
39.	27 September 2019	Professor Guosheng Yin	Independent statistical expert engaged by the Government / Professor and Head, Department of Statistics & Actuarial Science of the University of Hong Kong

Project management expert witnesses giving evidence before the Commission at the substantive hearing

	Date of attendance	Expert witness	Position
40.	4 October 2019	Mr Steve Huyghe	Independent project management expert engaged by MTRCL / Chairman & Founder of CORE International Consulting, LLC
41.	8 October 2019	Mr George Wall	Independent project management expert engaged by Leighton / Managing Director of Asgard Project Solutions Limited
42.	10 October 2019	Mr Steve Rowsell	Independent project management expert engaged by the Commission / Director of Rowsell Wright Limited

Annexure C

Structural engineering expert witnesses giving evidence before the Commission at the substantive hearing

	Date of attendance	Expert witness	Position
43.	2-3 January 2020	Mr Nick Southward	Independent structural engineering expert engaged by Leighton / Executive Director of Tony Gee and Partners LLP and Managing Director of Tony Gee (Asia) Limited
44.	3 January 2020 6-7 January 2020	Dr James Lau	Independent structural engineering expert engaged by the Government / Managing Director and Chairman of James Lau & Associates Limited
45.	7-8 January 2020	Dr Mike Glover	Independent structural engineering expert engaged by MTRCL / Arup Fellow
46.	8-9 January 2020	Professor Don McQuillan	Independent structural engineering expert engaged by the Commission / Director of RPS Consulting Engineers

Factual witnesses who did not give evidence before the Commission but their witness statements have been admitted into evidence

	Factual witness	Position held in organisation at the material time
47.	Mr Daniel Teoh	Sub-Agent of Leighton
48.	Mr Cheung Chi Wai	Senior Site Agent of Leighton
49.	Mr Man Sze Ho	Engineer of Leighton

Rules of procedure and practice (6 May 2019)

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

(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)

Rules of Procedure and Practice for the Extended Inquiry

[made at the Preliminary Hearing on 6 May 2019 ("the Preliminary Hearing")]

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1. The Commission's proceedings will address the matters set out in its Expanded Terms of Reference stipulated in the Gazette Notice No. 1539 dated 22 February 2019. These proceedings are referred to herein as the "Extended Inquiry". The part of the Inquiry covered by the original Terms of Reference in respect of which an Interim Report was submitted by the Commission to the Chief Executive on 25 February 2019 shall be referred to as the "Original Inquiry".

2. Parties permitted to participate and/or be legally represented at the Original Inquiry will be referred to hereinafter as the "original involved parties" or "original involved party." Parties permitted to

participate and/or be legally represented at the Extended Inquiry will be referred to hereinafter as "the involved parties" or "involved party". As at the date of the Preliminary Hearing, the involved parties are those named in the "Opening Address for the Preliminary Hearing" by Counsel for the Commission in the Extended Inquiry.

I. General

Public hearings

3. Unless otherwise directed, the hearings of the Extended Inquiry will be open to the public.

Prohibition on photography, audio/video recordings without the authorisation of the Commission

4. Without the authorisation of the Commission, no photographs may be taken or audio/video recordings made in the Hearing Room, the hearing transmission gallery, hall area or any other areas in the former Tsuen Wan Law Courts Building ("the Building") used for the purposes of this Extended Inquiry.

Language

5. The proceedings will be conducted in English, although witnesses may give their evidence in any language or dialect of their own choice. Testimony given in a language other than English will be translated into English. The Commission will provide simultaneous interpretation services when appropriate.

Access to documents

6. The Secretariat of the Commission has compiled, and will update regularly, an index of documents and materials provided to the Commission for the purposes of the Extended Inquiry. Any involved party who wishes to gain access to such documents or materials may apply in writing to the Secretariat of the Commission. At its discretion, the Commission shall determine whether or not, when and to what extent access may be permitted, and what conditions, if any, should be imposed upon the grant of such access. Given that access may be restricted and conditions may be imposed, documents and materials provided to an involved party shall not be disclosed or disseminated to other involved parties or unrelated persons without the consent in writing of the Commission.

7. If access is permitted to any involved party, only soft copies of the documents and materials to which access has been permitted by the Commission will be provided. The cost of obtaining such copies shall be borne by the party obtaining such copies.

Use of materials provided by the Commission

8. All materials supplied by the Commission to any of the involved parties shall be used only for the purposes of the Extended Inquiry. Public dissemination of any of such materials and the information therein shall not be allowed until and unless they have been adduced as evidence and expressly referred to in the Extended Inquiry.

9. The Extended Inquiry is deemed a judicial proceeding. Any unauthorised disclosure of materials and information in breach of paragraph 8 above constitutes a contempt of court. For the avoidance of doubt, the direction under paragraph 8 above applies to the involved parties, including their witnesses, experts, staff and other related persons. In respect of the materials and information supplied by the Commission, the involved parties shall ensure that their witnesses, experts, staff and other related persons (if they have access to such materials and information and any parts thereof) are fully aware of and strictly comply with the direction under the foregoing paragraph.

II. Standing

Written witness statements

10. Insofar as not already provided, the involved parties and other parties or individuals who have been directed by the Commission to provide written statements for the purposes of the Extended Inquiry shall provide such statements by the date specified by the Commission, subject to applications for extension of time as approved by the Commission.

11. No further responsive statement(s) shall be filed by any involved party unless leave is given by the Commission. The Commission will not consider any application for leave to adduce a further responsive statement unless such written application is made in good time and accompanied by the proposed responsive written statement(s). Any

written statement(s) which are not responsive in nature will not be allowed.

12. Any involved party who wishes to adduce expert evidence on any issue relevant to the Extended Inquiry must make an application to do so on reasonable notice to the Commission, and any such application shall be made to the Commission through its solicitors and accompanied by the provision of 3 copies of the written report signed by the expert concerned together with a soft copy. If the Commission grants any such application, it will give directions as to when the expert is required to be called to give evidence at the Substantive Hearing. The Commission will not grant any such application if it is not satisfied that the evidence to be tendered is independent expert evidence.

The participation and legal representation of other parties

13. Any party (apart from the involved parties currently named in the Extended Inquiry) who wishes to (1) participate in the Extended Inquiry (if leave to participate has not yet been granted by the Commission); (2) call any witnesses; and/or (3) adduce any witness statements and/or materials for the purposes of the Extended Inquiry, shall apply in writing to the Commission by **Tuesday, 14 May 2019**.

14. If the Commission decides that an application referred to in paragraph 13 above be granted, the party in question shall (unless otherwise directed by the Commission) provide the witness statement(s) of the witness(es) to be called and/or material(s) to the Commission within such period as the Commission may consider appropriate.

III. The hearing procedure

Opening addresses

15. Counsel for the Commission may make a written and oral opening address. Counsel for the involved parties may make their own opening addresses provided an application to do so (enclosing a written opening address which should not be longer than **25** pages and provided in font size 14 with single spacing and no footnotes other than for document references) has been made by **Wednesday, 22 May 2019**. If the Commission accedes to such application, the oral addresses will be made immediately after the address of Counsel for the Commission. The Commission may determine the sequence and length of such oral addresses.

Evidence

16. The Commission notes that section 4(1) of the Commissions of Inquiry Ordinance, Cap. 86 provides that in conducting the Extended Inquiry, it may:

> "*(a) receive and consider any material whether by way of oral evidence, written statements, documents or otherwise, notwithstanding that such material would not be admissible as evidence in civil or criminal proceedings.*"

The examination of witnesses

17. Oral evidence will be given under oath or affirmation.

18. The procedure by which the Commission will receive oral evidence is as follows:

(1) The Commission shall determine the sequence in which oral evidence be given in the Extended Inquiry.

(2) Counsel for the Commission will lead the evidence of witnesses called by the Commission; Counsel for any involved party may apply to the Commission for leave to question a particular witness and the Commission will determine the sequence of cross examination by those Counsel whose application for cross examination has been granted; Counsel for the Commission may re-examine the witness.

(3) Unless otherwise directed by the Commission, Counsel for an involved party may lead the evidence of witnesses who testify on behalf of such a party, after which Counsel for the Commission may question such witness. Thereafter, Counsel for other involved parties may apply to the Commission for leave to question such witness and the Commission will determine the sequence of cross examination by those Counsel whose application for cross examination has been granted. Finally, Counsel for the involved party leading the evidence of the witness may re-examine such witness.

(4) Unless otherwise directed by the Commission, insofar as any witness wishes to adopt his or her witness statement as his or her evidence (with or without modification or elaboration), the contents of his or her witness statement will not be read out.

Witness statements adduced as evidence at the hearing will be uploaded (without exhibits) to the Commission's website.

(5) At any stage of the Extended Inquiry the Commission may ask questions of any witness.

(6) The Commission may give directions to each party limiting the length of examination of witnesses and submissions.

(7) The Commission shall inform all involved parties as and when the witness statements and/or expert reports of the witnesses to be called by the Commission become available.

(8) The Commission may recall any person who has given oral evidence to answer further questions.

"Witnesses" referred to above shall include factual and expert witnesses.

Closing addresses

19. Counsel for the Commission and Counsel for the involved parties may make written and, if the Commission so directs, oral closing addresses. The Commission may determine the sequence and length (both written and oral) of such addresses.

The Substantive Hearing

20. The Substantive Hearing of the Extended Inquiry shall commence on **27 May 2019 at 10 am** in the Building and shall, subject to any

adjournments that the Commission may consider necessary from time to time, continue until 19 June 2019.

21. During the period 27 May 2019 to 19 June 2019, the Substantive Hearing will only deal with the factual evidence in relation to paragraph (a)(2) of the Expanded Terms of Reference in respect of the construction works at the North Approach Tunnels, the South Approach Tunnels and the Hung Hom Stabling Sidings.

22. The Commission will make further directions in due course in relation to the other necessary areas of the Expanded Terms of Reference, including any further necessary evidence and/or hearing.

23. The Commission will also make further directions as necessary in relation to matters pertaining to the Original Inquiry, and the original involved parties shall be notified in writing accordingly in due course.

24. Unless otherwise directed, the Substantive Hearing for the Extended Inquiry will be held from 10 am to 1 pm and from 2.30 pm to 5 pm every weekday. The Commission may consider the Substantive Hearing being held on Saturdays during the period mentioned in paragraphs 20 and 21 above.

25. There will be a Real-time Transcript Streaming ("Transcend") of the Substantive Hearing. Any applications for subscriptions to Transcend should be made in writing to the Secretariat of the Commission within 14 days of today (ie. by **Monday, 20 May 2019**), stating how many subscriptions are required and undertaking to pay the costs thereof. To

view the real-time transcript during the Substantive Hearing, subscribers will need to use their own laptops or notebook computers and make arrangement with the service provider directly.

26. An electronic bundle has been and continues to be prepared for use at the Substantive Hearing. This will be managed by the Secretariat. All involved parties should be able to read pages in the electronic bundle during the course of the Substantive Hearing on monitors provided by the Secretariat.

27. Seating arrangements in the Hearing Room during the course of the Substantive Hearing will be determined by the Secretariat on a day to day basis. Seating for Counsel and Solicitors for the Commission will be fixed throughout the Substantive Hearing but the representatives of the involved parties will be allocated seats depending upon the witness giving evidence, those parties who have been granted leave to cross-examine the witness and any other factors that the Secretariat deems relevant. The Commission expects the parties' representatives to fully co-operate with each other in respect of the seating arrangements in the Hearing Room. By **Tuesday, 14 May 2019**, each involved party should nominate a single contact person and send his/her name, post title, name of firm, telephone number and email address to the Secretariat. The Secretariat will compile a contact list and use the list for disseminating messages in relation to seating and other hearing arrangements during the course of the Substantive Hearing.

28. At the discretion and determination of the Commission, each involved party may, subject to availability, be allocated a lockable room within the Building for its use for the duration of the Substantive Hearing.

Annexure E

Structural engineering and other technical reports

This annexure, prepared with reference to the final submissions by counsel for the Commission, provides a list of the independent engineering experts' reports and other technical reports and analyses that were made available to the Commission during the inquiry.

Independent engineering experts' reports

1.	**Professor Don McQuillan**	
	President of the Institution of Structural Engineers Director of RPS Consulting Engineers	
	Original Terms	
	a. Expert Report	6 January 2019
	b. Supplemental Expert Report	6 December 2019
	Extended Terms	
	Expert Report	6 December 2019
2.	**Professor Francis T K Au**	
	Professor and Head, Department of Civil Engineering of the University of Hong Kong	
	Original Terms	
	a. Expert Report	7 January 2019
	b. Opinion and Structural Checks based on Design Information provided by Atkins by Letters dated 20 and 22 February 2019	1 March 2019
3.	**Dr James Lau**	
	Managing Director and Chairman of James Lau & Associates Limited	
	Original Terms	
	Structural Engineering Expert Report	10 December 2019
	Extended Terms	
	Structural Engineering Expert Report	12 December 2019

4.	**Dr Mike Glover**	
	Arup Fellow (Ove Arup)	
	Original Terms	
	a. Expert Report	7 January 2019
	b. Structural Engineering Expert Report	6 December 2019
	Extended Terms	
	Structural Engineering Expert Report	6 December 2019
5.	**Mr Nick Southward**	
	Executive Director of Tony Gee and Partners LLP Managing Director of Tony Gee (Asia) Limited	
	Original Terms	
	a. Change of Details at Eastern Diaphragm Walls and Slabs	7 January 2019
	b. Structural Engineering Expert Report	11 October 2019
	Extended Terms	
	Structural Engineering Expert Report	18 October 2019
6.	**Dr Albert T Yeung**	
	Associate Professor, Department of Civil Engineering of the University of Hong Kong	
	Original Terms	
	Engineering Expert Report	7 January 2019

Other structural engineering reports / assessments

1.	**COWI UK Limited ('COWI')**	
	Original Terms	
	COWI was engaged by Leighton Contractors (Asia) Limited ('Leighton') to undertake an independent structural analysis and assessment of section utilisation of the East West Corridor / East West Line ('EWL') slab to diaphragm wall connection at the Hung Hom Station ('HUH') Extension. The scope, basis and findings of the structural analysis and assessment of section utilisation are detailed in the 'Findings Report' (referred to in item (a) below), and the 'Assessment Report (Volumes 1 to 4)' (referred to in items (b) to (e) below) is supplemental to the 'Findings Report' and provides additional details of the Assessment methodology, input and output of the structural analysis and the findings of the structural assessment of different locations –	
	a. Findings of its Independent Structural Assessment of the EWL Slab to Diaphragm Wall Connection	21 December 2018
	b. Assessment Report (Volume 1)	21 December 2018
	c. Assessment Report (Volume 2)	21 December 2018
	d. Assessment Report (Volume 3)	21 December 2018
	e. Assessment Report (Volume 4)	21 December 2018
2.	**Atkins China Limited ('Atkins')**	
	Original Terms	
	Under MTR Corporation Limited ('MTRCL')'s instruction, Atkins produced the following reports on structural capacity checks for the EWL slab / diaphragm wall joint –	
	a. EWL Slab / Diaphragm Wall Joint Assessment Report	15 August 2019
	b. Stage 3 Assessment Report (Rev A)(6 Volumes) presenting the findings from the Stage 3 Structural Assessment of the Holistic Report –	August 2019
	i. Volume 1	
	ii. Volume 2	
	iii. Volume 3	

	iv. Volume 4	
	v. Volume 5	
	vi. Volume 6	
	Extended Terms	
	On 19 July 2019, Atkins prepared a report setting out its findings upon review of the previous design submissions (the 'Base Case') for the North Approach Tunnels ('NAT') and the South Approach Tunnels ('SAT'), the reinforced concrete structures for EWL, North South Corridor / North South Line ('NSL') and also the shunt neck for access to the stabling sidings (referred to in (a) below) (the 'Atkins Study Report'). This report also examines rebar utilisations as set out in previous submissions to the 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. On 27 September 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 (b) below).	
	a. Atkins Detailed Design for HUH and Associates Tunnels NAT and SAT Revised Structural Assessment	19 July 2019
	b. Atkins BD Consultation Document HUH-1 – HUH Primary Structure and Excavation & Lateral Support Part 1 to 4: SAT, Area A and HK Coliseum (Rev AN) (Volume 1)	27 September 2019
3.	**AECOM Asia Company Limited ('AECOM')**	
	Original Terms	
	AECOM was engaged by MTRCL to provide an independent design review and structural assessment of the as-constructed Shatin to Central Link ('SCL') HUH underground structures, i.e. EWL and NSL slabs and diaphragm walls. The following two reports were produced –	
	a. AECOM Final Independent Structural Assessment Report (for Area A, Hong Kong Coliseum ('HKC'), Area B and Area C)	20 August 2019
	b. AECOM's Sensitivity Study Report in respect of its Final Independent Structural Assessment	20 August 2019

	Report (for Area A, HKC, Area B and Area C)	
	Extended Terms	
	AECOM was engaged by MTRCL to conduct a structural review for utilisation of the following structural elements of the Hung Hom Stabling Sidings ('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 (a) below) (the 'Draft AECOM Review Report'). 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 (b) below).	
	a. Draft AECOM Review Report for the Utilisation of the HHS Structures Rev 0	28 June 2019
	b. 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 August 2019
4.	**Ove Arup & Partners Hong Kong Limited ('Ove Arup')**	
	Original Terms	
	Ove Arup was engaged by MTRCL in late September 2018 as the independent expert consultant for 'A Holistic Proposal for Verification & Assurance of As-constructed Conditions and Workmanship Quality of the Hung Hom Station Extension (EWL Platform Slab, NSL Platform Slab and the Connecting Diaphragm Walls)' ('Holistic Proposal') intended to verify the structural integrity of the as-constructed condition of HUH Extension and produced the following report –	
	a. Stage 3 Assessment Report (Rev F)	23 August 2019
	i. Volume 1 – Design Basis Report	
	ii. Volume 2 – Assessment Report – Area C	
	iii. Volume 3 – Assessment Report – Hong	

		Kong Coliseum	
	iv.	Volume 4 – Assessment Report – Area B	
	v.	Volume 5 – Assessment Report – Area A	
	vi.	Volume 6 – Integrity and Ductility of Slab / Diaphragm Wall Connections in Areas B and C	
	vii.	Volume 7 – Shear Strength Investigation of Slabs and Structural Safety Checks	
	viii.	Volume 8 – Analysis Summaries	
	Extended Terms		
	Ove Arup was engaged by MTRCL in April 2019 to conduct an independent assessment and review under Stage 2 of 'Verification Proposal of As-constructed Conditions of NAT, SAT and HHS' ('Verification Study'), 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 Ove Arup accordingly –		
	a.	Arup Report – Holistic Study to Verify As-constructed Condition of NAT, SAT & HHS (Volume 1 – Final Independent Report on Findings)(Rev B)	8 July 2019
	b.	Arup Report – Holistic Study to Verify As-constructed Condition of NAT, SAT & HHS (Volume 2 – Drawings)(Rev A)	8 July 2019
5.	**EIC Activities PTY Ltd ('EIC')**		
	EIC was engaged by Leighton to produce the following reports –		
	Original Terms		
	a.	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 Holistic Proposal	23 August 2019
	b.	EIC Memorandum on 'EIC Response to MTR	29 August 2019

		Holistic Assessment – Couplers' dated 29 August 2019 setting out EIC's review of the 'suitable measures' proposed for coupler connections in EWL in Area A and HHS.	
	c.	EIC's 'Response to MTRC Recommended Suitable Measures – Shear' setting out EIC's findings for the shear requirement in the EWL, Mezzanine and NSL slabs	30 August 2019
	d.	EIC's Review of the Stage 3 Assessment Reports produced by Atkins, Ove Arup and AECOM	23 September 2019
	e.	Supplemental Report on 'Shear Analysis'	16 October 2019
	Extended Terms		
	a.	EIC Memorandum entitled 'HUH – EIC Response to MTR Final Verification Study Report for NAT, SAT and HHS'	23 August 2019
	b.	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 Study	23 August 2019
	c.	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.	29 August 2019
	d.	EIC's 'Response to MTRC Recommended Suitable Measures – Shear'	30 August 2019
	e.	EIC's Review of the Stage 3 Assessment Reports conducted by Atkins, Arup and AECOM	23 September 2019
	f.	EIC Memorandum entitled 'HUH – EIC Response to MTR Proposed Suitable Measures Shear – SAT Area'	11 October 2019
	g.	EIC Memorandum entitled 'HUH – EIC Review of Suitable Measures Proposed for SAT'	24 October 2019

6.	**Professor Stephen Foster**	
	Original Terms and Extended Terms	
	Professor Stephen Foster, Professor and Head, School of Civil and Environmental Engineering of the University of New South Wales, Sydney, Australia, was engaged by EIC on behalf of Leighton to produce the following report –	
	Report on 'Mechanisms relating to shear strength of reinforced concrete thick one-way slabs in relation to HUH, and the influence of reduced anchorage of shear reinforcement' produced as Appendix D to EIC's 'Response to MTRC Recommended Suitable Measures – Shear'	2 September 2019
7.	**CEEK Limited ('CEEK')**	
	Original Terms	
	CEEK was engaged by Leighton / EIC to carry out comprehensive independent testing of partially engaged coupler assemblies and produced the following reports –	
	a. Technical Review of Coupler Testing of EWL Slab Reinforcement Couplers at HUH and Stabling Sidings produced as Appendix A to EIC Memorandum on 'Design Principles' dated 23 August 2019	14 June 2019
	b. Area A Slabs Design Review Report – Shear Capacity Review on EWL Slab	23 September 2019
	c. Area A Slabs Design Review Report – Shear Capacity Review on Mezzanine Floor	19 September 2019
	d. Area A Slabs Design Review Report – Shear Capacity Review on NSL Slab	23 September 2019
	e. Area A Slabs Design Review Report – Bending Moment Capacity (Coupler) review on EWL Slab	9 October 2019
8.	**Siu Yin Wai & Associates Ltd ('SYW')**	
	Extended Terms	
	SYW was engaged 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 at NAT,	

	SAT and HHS, focusing on the identification and scrutiny of four main aspects, i.e. (a) site supervision records, (b) material testing records, (c) design changes, and (d) 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 (a) below). SYW was also engaged by MTRCL to carry out the following tasks: (a) checking of the design calculations for the NAT and SAT structures and (b) 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 (b) below).	
	a. Part 1 Study Report – Verification of As-constructed SCL, HUH Station NAT, SAT and HHS Structures	24 May 2019
	i. Appendix A: Summary of Information Boxes for NAT, SAT & HHS	
	ii. Appendix B: Summary of Review Findings on Material Testing Records for NAT, SAT & HHS	
	iii. Appendix C: Location of Couplers used against accepted plans for NAT, SAT & HHS	
	iv. Appendix D1: Summary of Findings for Verification of As-Constructed Conditions of NAT	
	v. Appendix D2: Summary of Findings for Verification of As-Constructed Conditions of SAT	
	vi. Appendix D3: Summary of Findings for Verification of As-Constructed Conditions of HHS (Accommodation Blocks)	
	vii. Appendix D4: Summary of Findings for Verification of As-Constructed Conditions of HHS (Trackslabs, Troughwalls and Underpasses)	

		viii. Appendix D5: Summary of Findings for Verification of As-Constructed Conditions of HHS (North Fan Area)	
	b.	Part 2A Study Report - Verification of As-constructed SCL, HUH Station NAT, SAT and HHS Structures	14 June 2019

Agreed memorandum of independent engineering experts (18 December 2018)

APPENDIX XI

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

App. XI - Agreed Expert Memorandum signed on 18 December 2018

Transcript

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

Meeting of Experts Tuesday 18 December 2018

At Tsuen Wan Court 11:00

Present:

For C.O.I.	Don McQuillan instructed by Lo & Lo	
MTRCL	Mike Glover Colin Wade	instructed by Mayer Brown
LCAL	Nick Southward instructed by O'Melveny	
Chinat	Albert Yeung instructed by Lim & Lok	
Government	Francis Au instructed by D.O.J.	

Purpose: To discuss "without prejudice" relevant issues and, if possible, to list for the benefit of the Commission, items of agreement and disagreement.

1. General Code requirements

- All agreed there was no requirement for ductility couplers.
- All agreed that an amount equivalent to 50% of the top tensile steel was required in the bottom of the EWL slab to be carried through in the D-wall. i.e. less than 50% of the bottom steel at the interface was required for Code compliance.

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2. All agreed that irrespective of the code requirement the EWL slab does not, in theory, rely on steel at the interface, at the bottom, for flexure and shear capacity.

3. The cutting-down of a D-wall is a normal part of the construction process with the methodology governed by the specification and is analogous to the construction of a shear key.

   All agreed that the change from couplers to through bars in the top of the cast D-wall was a better detail and provided more steel across the interface (subject to a review of the internal stresses at the top-of-wall construction joint relating to the "first change" and its rebar detailing). Notwithstanding, all agreed the outcome would not show the construction joint to be problematic.

4. All agreed except Nick Southward (not part of his brief) that miscellaneous workmanship issues eg spalling, voiding, gaps etc. were all repairable.

   The main discussion related to mis-aligned shear links. All agreed this was of no structural significance in the context of the slab rebar.

5. All agreed that a load test was unnecessary because it would yield no meaningful result and long-term monitoring would be a better approach to allay public safety concerns.

6. In terms of the current opening-up regime all agreed, based on the "redundancy" of the couplers in the bottom of the EWL slab, that further opening-up was unnecessary. Focus should be directed to the top of the east D-wall to verify the as-built drawings and the details which are of structural significance.

Moreover, it was noted during the site inspection that the EWL soffit slab openings were creating safety hazards for the staff on-site.

Also the decision to expose the third and fourth layers of rebar is impractical and will cause major disruption to the slabs.

All agreed that the GPR NDT was inaccurate, time consuming and inappropriate when opening-up has to be carried out anyway.

All agreed that invasive investigation of the D-walls and NSL slab should also be reviewed.

Mike Glover [signed]

Colin Wade [signed]

Nick Southward [signed]

Albert T Yeung [signed]

Francis T.K. Au [signed]

Don McQuillan [signed]

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

Meeting of Experts — Tuesday 18 December 2018

At Tsuen Wan Court — 11:30

Present:

SOT C.O.I	Dan McQuinlan instructed by Lo & Lo
MTRCL	Mike Glover, Colin Wade instructed by Mayer Brown
LCAL	Nick Southward instructed by O'Melveny
China Government	Albert Yeung instructed by Linklaters
	Francis Au instructed by D.O.J.

Purpose: to discuss "without prejudice" relevant issues and, if possible, to list for the benefit of the Commission, items of agreement and disagreement.

1. General Code requirements.

- All agreed there was no requirement for ductility couplers.
- Au agreed that an amount of 50% of the top fill steel required to be carried across the joint into the support is equivalent to Au agreed that an amount of 50% of the top tensile steel was required in the bottom of

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the Ehll slabs to be carried through in the D-wall. i.e. less than 50% of the bottom steel at the interface was required for Code compliance

All agreed that

2. irrespective of the code requirement the Ehll slabs does not, in theory, rely on ~~the~~ steel at the interface, at the bottom, for flexure and shear capacity.

3. The cutting-down of a D-wall is a normal part of the construction process with the methodology governed by the specification and is analogous to the construction of a shear key.

All agreed that the change from couplers to through bars in the top of the east D-wall was a better detail and provided more steel across the interface (subject to a review of the internal stresses at the top-of-wall construction joint relating to the "first change" and its rebar detailing). Notwithstanding, all agreed the outcome would not show the construction joint to be problematic.

except Nick Southward (not part of his brief)

4. All agreed that miscellaneous workmanship issues eg, spalling, voiding, gaps etc were all repairable.

The main discussion related to mis-aligned shear links. All agreed this was of no structural significance in the context of the slab rebar.

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because it would yield no meaningful results

5. All agreed that a Load Test was unnecessary and long-term monitoring would be a better approach to allay public safety concerns.

6. In terms of the current opening-up regime all agreed, based on the "redundancy" of the concrete in the bottom of the EWL slab, that further opening-up was unnecessary. Focus should be directed to the top of the east D-wall to verify the as-built drawings and the details which are of structural significance.

Moreover, it was noted during the site inspection that the EWL split-slab openings were creating safety hazards for the staff on-site.

Also the decision to expose the third and fourth layers of ~~rebar~~ rebar is impractical and will cause major disruption to the slabs.

All agreed that the GPR NDT was inaccurate, time consuming and inappropriate when opening-up had to be carried out anyway.

All agreed ~~that~~ that invasive investigation of the D-walls and NSL slabs should also be terminated.

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Mike Glover M Glover

COLIN WADE

NICK SAUNDERS

Albert T Yeung

FRANCIS T.K. AU

SEAN McQUILLAN

Annexure F

Agreed memorandum of independent engineering experts (20 December 2019)

Commission of Inquiry into the Construction Works at and near the Hung Hom Station Extension under the Shatin to Central Link Project (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)

Meeting of Experts No. 2 on Friday 20 December 2019 at 08:30 UK time (16:30 HK time) by V.C.

Present:

a) at HKETC, London
- for COI Don McQuillan instructed by Lo and Lo (DM)
- for MTRCL Mike Glover instructed by Mayer Brown (MG)

b) at the offices of Lo & Lo, HK
- for Government James Lau instructed by D.O.J. (JL)
- for LCAL Nick Southward instructed by O'Melveny (NS)

Purpose:

To discuss "without prejudice" relevant issues and, if possible, to produce a jointly-signed memorandum for the benefit of the Commission listing items of agreement and disagreement

COI 1

1. Coupler connections/engagement

MG, NS and DM agree that, on the basis of all the testing carried out to-date, a partially-engaged coupler assembly with a minimum of 7 threads (32mm) satisfies the strength criteria.

MG, NS, and DM agree that the permanent elongation tests carried out in the laboratories to-date are more indicative of the "bedding-in" of the threads of a partially-engaged coupler assembly at low tensile load, rather than a measure of permanent elongation i.e. "stretch".

MG, NS and DM agree that there is an incompatibility with BOSA's inspection protocols and their intent to achieve a full butt-to-butt connection. Anything less than a full butt-to-butt will not pass the permanent elongation test e.g. 2 threads exposed will not pass the test.

MG, NS and DM agree that HyD's acceptance criteria, based on BOSA's criteria, therefore unwittingly sanction the use of partially engaged coupler assemblies because anything less than locked, full butt-to-butt coupler assemblies will fail the permanent elongation test.

JL disagrees with the above points i.e. only full engaged couplers i.e. full butt-to-butt and locked should be used in the structural assessment

2 Shear link reinforcement and utilisation

MG, NS and DM agree that in the areas where nominal/minimum shear reinforcement is required, there is some 25% overprovision, or more, in the shear links installed.

MG, NS and DM agree that the shear links provided should not be disregarded in their entirety.

MG, NS and DM agree that the actual proven concrete cube strengths should be used in the structural shear assessment and furthermore strength gain with time is a legitimate consideration.

MG, NS and DM agree there are other beneficial factors which could be considered, eg. compressive action and arch action.

MG, NS and DM agree that codes allow, when retro-analysing (forensically) a structure, the safety factors to be reviewed e.g. to use actual loads and actual material properties.

JL does not agree with the other experts generally. He is concerned that there may not be any shear links in areas where shear reinforcement is required.

3. The horizontal construction joints (CJ)

All four experts agree that this is solely a workmanship issue

MG, NS and DM agree that nothing needs to be done but it would be prudent, from a public perspective, to remediate the two locations where poor workmanship has been identified.

JL disagrees and considers the workmanship defects must be rectified by retro-installing vertical steel dowel bars.

COI 2

4. HHS trough walls - coupler connections/engagement

MG, NS and DM agree that Yield Line Analysis is valid in this Ultimate Limit State and is not linked to a shear assessment where stirrups and ties would be required. There is no safety issue with the HHS trough walls.

JL disagrees with the other experts because the podium columns require to be protected against accidental impact. He adopts AECOM's analysis.

MG, NS and DM also recognise the need for column protection and are satisfied the existing trough walls provide the necessary protection.

5. SAT NSL Shear Capacity

MG, NS and DM agree, as per "2" above, 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 needed.

JL 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.

Don McQuillan (signature)

Mike Glover (signature)

Nick Southward (signature)

James Lau (signature)

Annexure F

Agreed supplemental memorandum of independent engineering experts (2 January 2020)

Commission of Inquiry into the Construction Works at and near the Hung Hom Station Extension under the Shatin to Central Link Project (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)

Supplemental Memorandum of Agreement arising from Meeting of Experts No. 2 on Friday 20 December 2019 in respect of the as-built structures pertaining to COI 1 and COI 2.

Experts:

- for COI — Don McQuillan instructed by Lo and Lo (DM)
- for MTRCL — Mike Glover instructed by Mayer Brown (MG)
- for Government — James Lau instructed by D.O.J. (JL)
- for LCAL — Nick Southward instructed by O'Melveny (NS)

Purpose:

To produce a jointly-signed supplemental memorandum for the benefit of the Commission stating whether or not the as-built structures, which are the subject of COI 1 and COI 2, are safe and fit for purpose.

Summary statement

MG, NS and DM agree that the as-built COI 1 and COI 2 structures are safe and fit for purpose.

JL disagrees with the above and is of the opinion that without the implementation of suitable measures the as-built COI 1 and COI 2 structures are neither safe nor fit for purpose.

Don McQuillan

Mike Glover

Nick Southward

James Lau (signature)

2 January 2020

Joint statement of independent project management experts (9 January 2019)

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

Joint Statement of Project Management Experts

Without Prejudice

Prepared by

Steve Rowsell
Project Management Expert
for the Commission

Steve Huyghe
Project Management Expert
for MTR Corporation Limited

9 January 2019

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Joint Statement of Project Management Experts

1. This Joint Statement has been prepared by Mr. Steve Rowsell (Project Management Expert for the Commission) and Mr. Steve Huyghe (Project Management Expert for MTRCL). We have met and discussed on a without prejudice basis all of the relevant project management topics[1] as set out in our respective Expert Report.

2. We have reached agreement on nearly all the major project management issues and, in addition, have set out in this Joint Statement our suggestions on ways to improve the project management systems. Our independent expert reports set out the full list of recommendations we have each identified.

A. MTRCL'S OVERALL PROJECT MANAGEMENT OBLIGATIONS

3. We agree that MTRCL is a very experienced organization with extensive experience and capability in the planning, delivery and operation of railway networks and systems in Hong Kong [2].

4. We acknowledge that MTRCL has a proven track record in delivering many major railway projects [3].

5. We agree that it is common that some mistakes or oversights will inevitably be made in the performance of the works of such scale and complexity. However, procedures should be in place to mitigate errors and enable the works to be executed in a professional manner [4].

6. We agree that MTRCL's overall project management obligations are defined and set forth in the Entrustment Agreement (EA3), MTRCL's PMP, PIMS, BD's Instrument of Exemption, BD's Code of Practice for Site Supervision 2009, the contract documents between MTRCL and Leighton and the Quality Supervision Plan for coupler installation as per BD's Acceptance Letters.

7. We agree that MTRCL has a thorough knowledge and understanding of its responsibilities and duties associated with delivering the Entrustment Activities[5] for a project of this magnitude and complexity.

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[1] Huyghe Report does not address the issues pertaining procurement, forms of contracts such as the use of Target Cost Contract, and the Government's monitoring and control mechanism.
[2] Rowsell Report, §8a; Huyghe Report, §84.
[3] Huyghe Report, §120. These major railway projects include the Airport Express Line, the Tseung Kwan O Line, the Disneyland Resort Line, the West Island Line, the Kwun Tong Line Extension, the South Island Line, and the Express Rail Link, which was most recently opened in 2018 and constructed sing the concession approach.
[4] Rowsell Report, §3, 8g; Huyghe Report, §36, §53, §63
[5] MTRCL's project management obligations are set out in the EA3 Clause 4.6(C).

B. MTRCL'S PROJECT MANAGEMENT PLAN (PMP) AND PROJECT INTEGRATED MANAGEMENT SYSTEM (PIMS)

8. We agree that the PIMS is defined in the PMP and includes manuals, procedures and practice notes and provides a robust basis for the development and implementation of project specific plans [6].

9. We agree that the PIMS is accredited with ISO 9001 [7] and the PIMS undergoes periodic internal review and external audits to ensure it stays up to date to serve its purpose in the management of railway projects [8].

10. We suggest that certain improvements can be made to the PIMS as follows:

    a. Review the PIMS manuals and identify any broad language that can be converted into project specific information.
    b. Review and refresh the older documents in the PIMS system.
    c. Consider opportunities to rationalise or combine documents to reduce the overall numbers to which practitioners have to refer.
    d. It would be desirable to be more specific about which PIMS manuals are applicable to a project and job roles rather than just including a long list of all PIMS documents.

11. Whilst we are not fully agreed about the adequacy of the Project Management Plan, we do agree there is room for improvement, and additional modifications can and should be made. Our suggestions for improvement include:
    a. Consideration should be given to preparing a cross-referencing system between the PMP and the PIMs to help identify the roles and responsibilities of the various staff members, including contractual roles and responsibilities.
    b. Review and improve the detailed content of the PMP, to make them more comprehensive and relevant to the project by translating generic guidance into project specific requirements.
    c. Consider the inclusion in the PMP of proposals for any project partnering arrangements and initiatives.

C. CHANGE IN CONNECTION DETAIL AT THE TOP OF DIAPHRAGM WALL

12. We agree that, even though interactions had occurred, there was a lack of meaningful communications between MTRCL's DM and CM teams, Leighton, and Atkins.

13. We agree that the modification works at the top of the Diaphragm Walls should not have proceeded without approved working drawings.

14. Suggestions on how the communications between MTRCL's CM and DM teams can be improved include:

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[6] Rowsell Report, §19; Huyghe Report, §75.
[7] Rowsell Report, §26.
[8] Rowsell Report, §26, §28; Huyghe Report, §77, §84.

a. Review the liaison arrangements between the Contractor's design team, the DA and MTRCL's design and construction management teams to ensure that there a common understanding of submission requirements and that all parties are aware of design issues and the forward programme submissions.
b. Develop and implement the use of BIM as a collaboration tool.

D. ATKINS' DUAL ROLES IN SUPPORTING MTRCL AND LEIGHTON

15. We agree that it is not a good practice for the same design firm (i.e. Atkins [10]) to provide services to the Employer and to also represent the Contractor in making design revisions or modifications, because it poses a real or perceived conflict of interest [11].

16. We agree that MTRCL should develop a conflict of interest policy and procedure for a conflict of interest check on all design related services.

E. REBAR/COUPLER INSPECTION AT THE EWL SLAB

17. We agree that if the bottom layers of the rebar are obscured by the subsequent top layers, then an individual inspection by layer (or by mat [12]) should have been performed [13]. Separate inspection forms (i.e. one for top mat and one for bottom mat) should have been prepared for signing off the rebar inspections.

18. We agree that MTRCL and Leighton should have followed the QSP requirements regarding the logging, execution and filing of the Record Sheets for coupler inspection [14].

19. We agree that the factual testimony as we have read states that the defective rebar/coupler installations were identified during the course of construction and corrected on the same day, albeit for three rebar/coupler installations that were encased in concrete.

F. PROCESS OF NON-CONFORMANCE REPORTING

20. We agree that the PIMS [16] provides the definition of Works NCR, which also provides guidelines regarding *"Minor defects reported in routine inspections"*. The PMP and the CoP however, state that if any non-conformity arises it should be the subject of a NCR. We agree that this inconsistency between the documents should be clarified.

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[10] Atkins' Team A was appointed by MTRCL as its Detailed Design Consultant under MTRCL's Consultancy Agreement 1116; Atkins' Team B was appointed by Leighton as its Temporary Works Designer.
[11] Rowsell Report, §53; Huyghe Report, §144.
[12] There are top mats and bottom mats of rebar at the 3 metre thick EWL slab. Each mat comprises no more than three layers of rebars connecting into the Diaphragm Walls.
[13] Rowsell Report, §83; Huyghe Report, §198-200.
[14] Rowsell Report, §73; Huyghe Report, §64.
[16] PIMS Practice Note, PIMS/PN/11-4/A4 Monitoring of Site Works, Exhibit 7.9 Guidelines for Raising Contract-level Works NCR.

21. We agree that all NCRs received should be entered into a single NCR database and they should be logged and tracked, and should not be taken lightly and require proper investigation and implementation of corrective measures [17].

22. We agree that an NCR need not be issued if the defective work is identified, corrected and immediately signed off on the same day. However, all site supervision and construction engineering teams [18] should be made aware of this defective work and put on notice. If such defective work occurs again, an NCR should be issued.

G. PRODUCTION OF AS-BUILT DRAWINGS

23. We agree that it is Leighton's scope of work to produce the as-built drawings and submit the same to MTRCL. The General Specification to the contract sets out that the as-built records and drawings shall be produced on a progressive basis. The as-built records comprise a wide spectrum of records including material submissions, test certificates, construction records (such as TQs, RFIs, photographs) and as-built drawings [19].

24. We agree that MTRCL is obliged to submit as-built records and drawings to the Government.

25. We agree that the documentation setting as-built records requirements should be reviewed for consistency and clarity of responsibilities. The arrangements should ensure that records and submitted progressively and promptly.

H. FULL-TIME AND CONTINUOUS SUPERVISION

26. We agree that *"full-time and continuous supervision"* does not mean *"man-marking"*. The requirements for supervision by the Contractor are set out in the General Specification and require a minimum ratio of 1 supervisor to no more than 10 workers.

27. We are agreed that the obligation on MTRCL was to supervise at least 20% of the splicing assemblies. We are agreed that MTRCL had in place a supervision team comprising engineers and inspectors who had a continuous presence on site to undertake the supervision duties. We are also agreed however, that there was a lack of clarity for the designated responsibility of formal inspections and for maintaining records.

28. Suggestions we have for how the specification of supervision duties could be improved in the future include:

    a. Develop a clear definition of supervision for the purposes of contractual obligations and adopt consistent approach to terminology throughout the documentation. The requirements need to be specific about the information that needs to be recorded and certified.

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[17] Rowsell Report, §98; Huyghe Report, §212.
[18] These include MTRCL's Construction Engineers and Site Inspectorate Team; Leighton's Construction Engineering Team and Site Supervision Team.
[19] Huyghe Report, §127.

b. Review the current documents containing requirements in relation to supervision duties and aim to produce an all-inclusive supervision manual accessible to all involved in supervision duties and produced in multi-languages as required.
c. Review options for the use of technology to support efficiency and effectiveness in undertaking site supervision and record-keeping duties.

Signed

S. G. Rowsell

Steve Rowsell
Commission's Project Management Expert

Steve Huyghe
MTRCL's Project Management Expert

Dated the 9th day of January 2019

Joint statement of independent project management experts (2 October 2019)

The Extended Commission of Inquiry
into the Hung Hom Station Extension
under the Shatin to Central Link Project

Joint Statement of Project Management Experts

Without Prejudice

Prepared by

Steve Rowsell	**Steve Huyghe**	**George Wall**
Project Management Expert for the Commission	Project Management Expert for MTR Corporation Limited	Project Management Expert for Leighton

2nd October 2019

Joint Statement of Project Management Experts

1. This Joint Statement has been prepared by Mr. Steve Rowsell (Project Management Expert for the Commission), Mr. Steve Huyghe (Project Management Expert for MTRCL) and Mr. George Wall (Project Management Expert for Leighton). The Expert Reports produced by Mr. Huyghe and Mr. Wall were required by the Commission to be responsive to the project management issues identified in Mr. Rowsell's Expert Report. We met on 3rd September 2019 in London and held subsequent telephone conferences and discussed on a without prejudice basis all of the relevant project management topics[1] as set out in Mr. Rowsell's Expert Report.

2. In relation to project management, Mr. Rowsell was instructed to review and report on the adequacy of the relevant aspects of the MTRCL's project management systems etc., in the light of the matters set out in paragraph (a) of the Commission's Expanded terms of Reference.

3. Mr. Huyghe was further instructed by Messrs. Mayer Brown to prepare a Supplemental Expert Report ("**Huyghe Report 2**"), based upon the Directions given by the Commission on 24 September 2019 to provides further opinions regarding Leighton's project management procedures. and performance and how they may have caused or contributed to the work which is the subject-matter of the Extended Inquiry.

4. Mr. Rowsell has reviewed Mr. Huyghe's Report 2 and has taken it into consideration with regards to Joint Statement.

5. Mr. Wall disagrees that Mr. Huyghe's Report should be considered.

6. This Joint Statement follows on from a similar statement produced by Mr. Rowsell and Mr. Huyghe covering project management issues discussed during the Original Inquiry. In the Joint Statement covering the Original Inquiry suggestions were put forward on how MTRCL could improve aspects of its project management systems and procedures. The further suggestions set out in this Joint Statement should be read in conjunction with the Joint Statement for the Original Inquiry.

7. We have reached agreement on the many of the major project management issues as set out in this Joint Statement. Our independent expert reports set out the full list of conclusions and recommendations we have each identified. Mr. Wall has identified some disagreements where Mr. Roswell and Mr. Huyghe have reached agreement and they are listed in Paragraph 47.

[1] Mr. Huyghe's Report and Mr. Wall's Report do not address the issues pertaining to the Government's monitoring and control mechanism.

A. MTRCL'S OVERALL PROJECT MANAGEMENT OBLIGATIONS

8. In the Joint Statement for the Original Inquiry it was agreed that MTRCL is a very experienced organization with extensive experience and capability in the planning, delivery and operation of railway networks and systems in Hong Kong[2]. It was also agreed that Leighton is a well-recognized construction company with an extensive history in providing construction services in both Hong Kong and internationally. However, with even the most experienced companies, we are agreed that it is normal that some mistakes or oversights will inevitably be made in the performance of works of such scale and complexity. However, procedures should be in place to mitigate errors and enable the works to be executed in a professional manner.

9. MTRCL's overall project management obligations were covered fully in the Joint Statement for the Original Inquiry. We agree that the obligations are defined and set forth in the Entrustment Agreement (EA3), MTRCL's PMP, PIMS, BD's Instrument of Exemption, BD's Code of Practice for Site Supervision 2009, and the contract 1112 documents between MTRCL and Leighton.

B. MTRCL'S PROJECT MANAGEMENT PLAN (PMP) AND PROJECT INTEGRATED MANAGEMENT SYSTEM (PIMS)

10. We agree that MTRCL has put considerable effort over the years into developing its Project Integrated Management System (PIMS) which has achieved ISO 9001 accreditation for the project management of new railways. We agree that PIMS provides a robust basis for the development and implementation of project specific plans and procedures, but we have identified some aspects that we consider should be reviewed and updated.

11. Leighton has indicated in the evidence given by its employees that it is continually improving its systems to further enhance their effectiveness (as described in the witness statement of Mr Dean Cowley). We welcome and encourage these efforts by Leighton.

12. Suggestions were set out in the Joint Statement for the Original Inquiry for potential improvements to be made to PIMS. We are aware that MTRCL are in the process of reviewing and improving their procedures based the findings of the Turner & Townsend Report and also on the findings of the Original Inquiry. We welcome and support that work which was described in the evidence provided by Dr Peter Ewen, MTRCL Engineering Director[3]. In relation to the specific project management issues examined by the Extended Inquiry, we recognise that improvements that MTRCL have been developing and implementing will help to prevent recurrences of these issues. In our opinion we consider that the following aspects of MTRCL's review of its project management procedures are the most significant in addressing the issues examined in the Extended Inquiry:

[2] Original Inquiry Joint Statement §3.
[3] See Appendix A – Dr Peter Ewen – List of Improvements

a. Strengthen the procedures setting out the roles of MTRCL's leaders in establishing and embedding appropriate culture, values and behaviours throughout the organisation.
b. Review arrangements for training staff in the use of PIMS and consider the development of training modules focused on the requirements of specific roles, including the introduction of updates and revisions to PIMS procedures.
c. Review processes for planning resource levels and identify potential resource pressures which could improve quality management.
d. Review the current advice and procedures in relation to the issue and monitoring of non-conformance reports.
e. Develop clearer and more comprehensive guidance for site record keeping, including the use of photographs, supported where possible by technology solutions and devices.
f. Consider the development of a PIMS procedure for the development of project communication strategies and systems.
g. We understand that a wide range of improvement measures are being implemented by MTRCL regarding leadership, the independent Quality team, which is being set up, the review of the PIMS, training and competence mapping, and use of technology for supervision/inspection, record-keeping and communication.

13. Suggestions were also set out in the Joint Statement for the Original Inquiry for potential improvements to be made to the content of the Project Management Plan (PMP). We agree that the PMP is intended to be a strategic document which covers the project management of the overall Shatin to Central Link (SCL) project. Based on the evidence examined by the Extended Inquiry we consider that it would be desirable for the standard content of PMPs for similar future projects to cover additional aspects of project management at a strategic level as follows:

a. The inclusion of a section on resource planning and monitoring.
b. Training and development arrangements for project specific purposes.
c. The development of project communication strategies.
d. Coverage of interface risk planning and management.
e. A stronger focus on the role of senior leaders in establishing appropriate culture and behaviours.

14. We consider that the above additions to the PMP should be covered at a strategic level and not in the detail required for contract specific management plans. We also understand that the PMP and PIMS documents are under review and may be revised to address some of these considerations. The inclusion of the above additions in the PMP should help to ensure that they are recognized as key aspects of successful project delivery planning and provide the Government with greater confidence that successful project outcomes will be achieved.

C. RISC FORM AND INSPECTION PROCEDURES

RISC Form Procedures

15. We agree that the requirements for inspection planning, notification and execution, including the application of RISC Form procedures, are set out in a range of documents including the 1112 contract, the general specification, the particular specification, various PIMS procedural documents and the PMP.

16. Mr. Rowsell and Mr. Huyghe agree that MTRCL did establish a RISC administrative system. However, with regards to the NAT, SAT and HHS areas, Leighton did not submit RISC Forms for all formal inspections and MTRCL continually requested that the RISC forms be provided but did continue to carry out inspections in the absence of all RISC Forms. A series of NCR's were later issued by MTRCL on 16 April 20184 and 6 July 20185

17. Mr. Rowsell and Mr. Huyghe agree that due to not receiving all the RISC forms from Leightons, MTRCL should have eventually conducted joint meetings to come up with a formalized alternative process. It is apparent that this was not done by those involved as both parties were focused on not affecting the progress of the work.

18. We suggest that training with regards to providing a more user-friendly RISC process procedure is strengthened to address the responsibilities of both the Contractor and MTRCL. It is important that RISC form procedures are followed by the Contractor and insisted upon by the Engineer to the contract in case situations arise which lead to the quality of the works being called into question. If the RISC form procedure is not being followed, that there are specific contractual remedies available to the Engineer to take the appropriate actions

19. We cannot be certain from the evidence we have seen what led to the use of alternative procedures to the RISC Forms being introduced but we agree that it is likely linked to the Leighton's staff stating they were too busy and apparently did not take into consideration that the time necessary to conduct the standard RISC process. We acknowledge that the RISC process was cumbersome, time-consuming.

20. We believe that both MTRCL and Leighton's engineers felt that the proper hold point inspections were being conducted and both were conscious of not delaying the Project.

21. We 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 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 on it. We are agreed that this notice period was not critical for MTRCL and Leighton's site team to conduct the necessary inspections because these staff were present on site and carrying out ongoing supervision of the works during construction. In practice, in most cases it would have been sufficient if Leighton's site team had submitted RISC Forms at any point prior to the inspections. 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 forms

22. We agree that the use of WhatsApp to arrange and record inspections did not provide an adequate or structured approach which met the requirements of an effective quality management system. We agree that WhatsApp or similar social media systems could be used as a useful communication tool, but it would require central coordination to form part of a quality management system.

23. We are agreed that for each of the NAT, SAT and HHS areas there are varying numbers of outstanding RISC Forms. The specific details are set out in the WSP report, which was prepared by MTRCL's consultants following an independent audit of the available records. The WSP report generally validated that the required hold-point inspections had been carried out in the NAT, SAT and HHS areas.

24. We agree that the current RISC Form procedures are time consuming and inefficient. We consider that they should be improved by making better use of technology solutions of the kind which Dr. Peter Ewen has explained in his evidence regarding MTRCL's current steps to improve these procedures.

Inspection Procedures

25. Notwithstanding the shortage of RISC forms, we agree that sufficient evidence has been provided (including wider documentary evidence and witness testimony) which indicates that inspections were carried out but not recorded in a structured way.

26. Despite inspections apparently having been carried out, we agree that the procedures were not effective in identifying Leighton's steel reinforcement installation problems subsequently discovered at the stitch joints in the NAT. We consider that likely contributory causes for the defects in the steel reinforcement fixing included:

    a. In practice, the reinforcement was inspected by Leighton's engineers and MTRCL's inspection staff during routine and informal inspections. We agree that this is a contractual requirement under the provisions of Clause 60.1, of Leighton's Contract 1112 Examination of Work before Covering Up. We recognise that there may have been some difficulty for the Inspectors in visually examining steel reinforcement due to the constrained nature of the site and the complexity of the reinforcement work.

    b. Inspections may have been signed-off despite the difficulty in carrying out effective visual surveys of the work.

    c. Whilst the use of Lenton couplers was identified at an early stage at the interface stitch joints in the NAT area, it does not appear that the associated requirement for tapered reinforcement bars was communicated to Leighton's site teams Mr. Rowsell and Mr. Huyghe agree that annotated drawings would have helped to identify the Lenton couplers used on Contract 1111. A Method Statement should have been prepared by Leighton's for the couplers used in locations for site access.

d. We agree that each PM expert has his views on how this type of problem can be addressed in the future that is set out in their respective reports.

27. In relation to RISC Form and inspection procedures, we recognise that MTRCL has been considering and developing improved procedures. We consider that the most important aspects of the procedures which require improvement to address the project management issues considered by the Extended Inquiry are:

a. 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.
b. Review its training strategies and plans to ensure that staff are provided with the necessary training required to perform their roles effectively. Training systems should be used to verify that individuals have the required skills, competences and experience to perform allocated roles and duties.
c. Review responsibilities for ensuring that procedural non-compliances by the Contractor 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.
d. 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.
e. Review the preparation of ITPs to ensure that inspection proposals can be carried out effectively. Ensure that ITPs are reviewed and assured by people with adequate site experience.
f. 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.

D. NON-CONFORMANCE REPORTS

28. We are agreed that MTRCL should have considered alternative ways regarding to address the issue of Leighton not following RISC Form procedures in the NAT, SAT and HHS areas, including meetings to discuss alternative procedures and possibly issuing non-conformance reports (NCR) as they eventually did after the identification of the defects at the stitch joints in the NAT area. We are of the view that NCRs are a very valuable performance management tool and that there should not be a reluctance to use them when there are significant defects or non-conformances. We consider that the Contractor is more likely to take action to resolve problems when NCR procedures are used.

29. We suggest that MTRCL give consideration to enhancing the NCR procedures to increase their effectiveness as an early warning mechanism and to encourage their use to help ensure that problems are resolved promptly. This could be achieved by having different grades of NCR covering minor, medium and major non-conformances requiring different responses as appropriate. As an alternative, more robust use could be made of MTRCL's existing audit procedures.

E. INTERFACE RISK MANAGEMENT AND PLANNING

30. We agree that interfaces between contracts generally represent high risk areas for both MTRCL and Leighton who should include key risks in project risk registers and which should receive a close management focus.

31. We agree that the PIMS procedure documents identify interface coordination as a key process requiring a proactive approach to coordination and interface management. The procedure places a requirement on MTRCL to liaise with all contractors, however with regards to the differing coupler issue between Contract 1111 and Contract 1112, it was Leighton's responsibility to coordinate and comply with the requirements regarding to the interfaces between the Contracts and MTRCL responsibility to liaise with all contractors.

32. We agree that contractual responsibilities in relation to the contract interfaces between Contracts 1111 and 1112 were clearly set out in the Particular Specification at Appendix Z2 including obligations on both Leighton's and MTRCL's involvement in planning, inspection and in the exchange of information.

33. We agree that the planning of the interface work would have been helped by holding an early workshop, involving the relevant site people, to ensure that all issues had been addressed and that they understood the requirements and the Plan.

34. We agree that in relation to the 1112 contract requirements for interface risk management, Leighton acknowledges that its staff by their attendance at the interface meetings ought to have known that GKJV's couplers were of the Lenton type but unfortunately omitted to pass this information to the engineer responsible for supervising the rebar fixing works at the NAT Stitch Joints and the Shunt Neck Joint. Leighton has also acknowledged that there was miscommunication between the Leighton staff who attended the interface meetings (as set out in Leighton's closing submission). We also agree that not all members of Leighton and MTRCL's inspection team received technical training in the installation requirements of the different types of couplers used at the interface joints.

35. 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 difficulties.

36. We agree that contractual responsibilities in relation to the contract interfaces between Contracts 1111 and 1112 were clearly set out in the Particular Specification at Appendix Z2 including obligations on both Leighton's and MTRCL's part in terms of planning, inspection and in the exchange of information.

37. In relation to the working drawing which set out a note constraining the timing of the execution of the stitch joint works, we consider that it should have included engineering criteria setting out how it would be established that it was safe for the construction work to be carried out. This would then have allowed the criteria to be monitored and discussed at the regular interface meetings. We accept however, that there is no suggestion that the timing of the interface work was not carried out as required. We note that the drawing

included in the evidence before the Extended Inquiry is marked up as being produced for BD submission purposes. We agree that this provided BD with the opportunity to comment on the potential inadequacies of the note setting out the constraint on the timing of the work but that it appears that no comment was made.

F. TESTING OF REINFORCEMENT STEEL

38. On the basis of evidence provided by Leighton, we understand that approximately 7% of the rebar used on the project was not tested by a HOKLAS accredited laboratory.

39. We understand that all steel delivered to site was accompanied by an appropriate mill certificate and that all of the steel that was tested successfully passed the specified tests.

40. We agree that the standards for the testing of steel reinforcement on the contract are set out in Construction Standard CS2:1995. We understand that CS2 has been subsequently revised and republished as CS2:2012. The revised standard includes a new definition of a "batch" which was not applied to the contract and which may have reduced the overall numbers of tests required.

41. A testing rate of 93% of the steel was used on the project, supported by the mill certificates and the successful testing of the steel samples, and this should provide a good degree of confidence in the quality of the steel.

42. We suggest that MTRCL, in relation to its role in overseeing the implementation of steel testing by the Contractor, consider the following:

    a. Use audit arrangements to provide assurance that MTRCL is confident that all material delivered to site is tested by the Contractor before being incorporated into the works.
    b. 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.

G. RECOMMENDATIONS IN MR. ROWSELL'S EXPERT REPORT

43. We agree with the recommendations for improving procedures as set out in Part 3 of Mr. Rowsell's Expert Report, noting that Mr. Huyghe and Mr. Wall were not instructed to consider issues relating to Government's monitoring and control mechanisms.

44. We are aware of, and we support the work being done by MTRCL to review and improve its procedures based on the findings of the Turner & Townsend Report. We also observe that MTRCL has already taken proactive measures as set out in Dr. Ewen's statement. These measures include:

    a. Digitalization of the site inspection process and the adoption of BIM;
    b. Enhanced training of frontline staff for better implementation of PIMS;
    c. Enhancements to the quality assurance system; and

d. Fundamental revision of PIMS.

45. We recognise therefore, that MTRCL is already looking at aspects of its project management procedures on which we have also made suggestions for improvement. However, we are not in a position, to confirm the details of that work or the progress achieved.

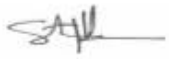
46. We consider that the matters discussed in our individual Expert Reports and in this Joint Statement should be used to help inform the review of project management procedures being taken forward by MTRCL.

47. Disagreements: Mr. Wall does not agree with paragraphs:

a. Paragraph 4
b. Paragraph 16
c. Paragraph 17
d. Paragraph 26c

Signed

Steve Rowsell
Commission's Project Management Expert



Steve Huyghe
MTRCL's Project Management Expert

George Wall
Leighton's Project Management Expert

Dated the 2nd day of October 2019

Recommendations of Mr Steve Rowsell on strengthening systems for supervision, monitoring, control and management

Original Terms

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

REPORT PART 3: OPINION ON HOW SYSTEMS FOR SUPERVISION, MONITORING, CONTROL and MANAGEMENT MAY BE STRENGTHENED

150. Based on my opinions set out in Parts 1 and 2 of this report, I consider that the actions set out in this Part should be considered to help strengthen the existing systems for supervision, monitoring, control and management. I have classified them into categories for ease of presentation.

Leadership

151. Strengthen the involvement of senior leaders in all parties in establishing appropriate behaviours across the organisations to support a collaborative approach in the delivery of the project. Leadership roles should be developed in line with the principles set out in ISO9001:2015 and would involve senior leaders being more visible to the workforce and in them taking a lead role in communicating key messages throughout the organisations.

152. To support collaborative working on projects, establish a cross-party Senior Leadership Forum to monitor working relationships and cultural aspects of service delivery and to agree ways of developing collaborative working.

MTRCL Organisation

153. Consider ways of improving closer working between different groups within the project organisation to avoid the risk of silo-working in which information and knowledge is not shared. Consider the effectiveness of existing communication arrangements between the teams and throughout the organisation. Review information databases and systems to ensure that there is a single source of the true position which is accessible as appropriate to all people.

154. Review and clarify MTRCL roles and responsibilities in relation to the provisions and requirements of the Conditions of Contract. In particular ensure that the position of Engineer to the Contract is understood and that roles and responsibilities respect the need for the Engineer to act impartially in the administration of the contract. The role of the Engineer needs to be integrated and compatible with the roles of others in MTRCL who have responsibilities for delivering obligations under EAs.

155. Review arrangements for managing relationships with stakeholders to ensure that there is clarity on responsibilities and clear lines of communications particularly with Government Departments. Arrangements should be set out in a Stakeholder Management Plan which is accessible by all involved in the project delivery.

Government related enhancements

156. Review how Government organises itself for the management of its interests in the railway project. The structure needs to take account of the requirement for MTRCL to consult ten or more different Government Departments as part of its responsibilities for delivering the project. Whilst the Agreement with MTRCL is signed by the Secretary for Transport and Housing on behalf of the Hong Kong SAR Government, there would appear to be scope for improving the Government's project sponsorship arrangements to provide greater clarity in communication and reporting lines and more efficient project controls.

157. In relation to BO and consultation, the current structure of documents setting out requirements is quite complex and not easy to follow. I consider that for a specific project it would be helpful for Government to pull together the provisions into a clearer and more precise description of the requirements and responsibilities.

158. Consider extending the role of the MVC to provide a wider "eyes and ears" role to help protect Government's interests in the delivery of the project. The role should also provide high level monitoring of the operation of the project quality assurance systems as well as the current role in monitoring cost and programme issues. The MVC role could be developed into a Government's Project Representative role who works more closely within the MTRCL organisation to monitor performance and to identify emerging issues.

159. Consider options for working arrangement in which Government staff would be integrated within MTRCL teams on a regular basis, say one day a fortnight, to help ensure a common understanding of requirements, improve communications, undertake joint forward planning and to resolve issues more efficiently.

160. Review the attendance at the PSC to ensure that it is operating as intended, as a high-level committee focusing on strategic issues and performance. Ensure that the reporting arrangements to PSC are providing the Committee with reliable performance data which

will allow substantive issues relating to time, cost and quality to be identified and acted upon.

161. Review the BD's CoP to give clarity on the definition of supervision, record keeping requirements and non-conformance reporting. Terminology such as "continuous and full time supervision" requires further explanation. It would also be desirable for the BD's CoP to set out requirements of the communication of the supervision plan and associated obligations. The overall supervisory arrangements should provide an adequate role for the designer to give assurance that the intent of the design is delivered in the construction of the Works.

162. Develop a conflicts of interest policy appropriate and applicable to projects of this nature. Allocate responsibility for administering the policy to the PCM or other committee as appropriate.

163. Review the lump sum contractual arrangement used to employ the MVC and consider options which may provide a more effective incentive to be proactive in the execution of its duties.

164. Clarify in MVC briefs clearer requirements in relations to site audits and surprise checks.

165. Ensure that companies appointed to MVC roles have access to the necessary levels of resource if the level of monitoring by the MVC has to be increased due to concerns about poor performance.

166. Consider the option of recovering MVC audit costs if poor performance by the contracting parties results in additional audits being required above that normally required.

Design Submissions, BD Consultation Procedures and Changes

167. Review the wording of the Particular Specification in relation alternative works design proposals to ensure that the process and terminology is aligned with the contract conditions.

168. Ensure that construction method statements are in place based on the latest approved designs before construction commences.

169. Review the liaison arrangements between the Contractor's design team, the BA and MTRCL's design and construction management teams to ensure that there is common understanding of submission requirements and that all parties are aware of design issues and the forward programme of potential submissions.

Supervision requirements

170. Review the significant number of various documents which set out supervision requirements and guidance with the aim of rationalising the documents to a more manageable and readable number. Ideally, it would be better to have all supervision requirements and responsibilities pulled together into a single Supervision Manual made accessible to all involved in the supervision and inspection procedures and such Supervision Manual should be translated into the Chinese language which workers are familiar with. There is evidence before the Commission that there might not be any Chinese version of the SSP and the provisions of the SSP were not explained to site supervisors[54].

171. Develop a clear definition of supervision for the purposes of contractual obligations and adopt a consistent approach to terminology throughout the documentation. The requirements need to be specific about the information that needs to be recorded and certified.

172. To deliver best value for money and to make best use of resources, the frequency of supervision and inspections should be flexible and reactive to the compliance and performance of work with requirements. Demonstration of consistently high-quality work should allow supervision requirements to be reduced with confidence being maintained by less frequent supervision supported by self-certification and audits.

173. Review the requirements for formally defined hold-points in relation to the contract provisions for not covering-up work without inspection. Clarify whether inspection certificates apply to both hold-points and pre-covering up inspections. In the evidence given before the Commission, there seems to be confusion and misunderstanding over the requirements to keep contemporaneous inspection records and RISC forms. Mr Aidan Rooney, General Manager of MTRCL, took the view that RISC forms alone were more than

[54] Chan Chi Ip **[Day 19/pp.26:29:9; 66:17-68:8]**

enough evidence to show that the rebar and couplers were properly completed and connected[55]. Mr Louis Kwan, Construction Engineer of MTRCL responsible for the inspection of bar-fixing works, however, gave evidence which suggested that the RISC forms which he signed did not, in fact, signify that couplers had been inspected. As far as he was concerned, he was never even assigned to inspect the couplers, hence he did not inspect the couplers on formal inspection, and the RISC forms which he signed did not cover couplers[56]. Mr Kobe Wong as a Senior Inspector of Works of MTRCL, on the other hand, gave evidence that he was expressly told by his superior that inspection of couplers for the EWL slab was the responsibility of the Construction Engineer team (which included Mr Louis Kwan) and that he should refrain from inspecting the couplers. This is notwithstanding that he was assigned to inspect the couplers when the diaphragm walls were built[57].

174. Review options for the use of the latest technological applications and tools, such as tablets or smartphones, to support the efficient effective recording of site records.

175. Ensure that there are procedures in place to record who are undertaking supervision duties on a daily basis and that supervisors have the required level of competence.

176. Ensure that records are kept to support the possible application of the contractual disallowable cost provisions.

Site entry / exit systems and records

177. Review the adequacy of existing entry / exit site staff recording system in relation to:
    - knowing who is on site;
    - supporting the payment of people under the commercial model;
    - knowing who undertook work inspections and who certified work;
    - helping to confirm that the required level of supervision and the numbers supervisors to workers is provided.

Non-Conformance Reporting

[55] Aidan Rooney **[Day 28/p.53:16-24]**
[56] Louis Kwan **[Day 29/pp.16:7-29:20]**
[57] Kobe Wong **[Day 30/pp.4:17-12:25]**

178. Review current guidance on NCRs to ensure that there is clarity and consistency on when non-conformance reports should be issued.

179. Encourage a culture that treats non-conformance reporting in a similar way to "near-miss" reporting on health and safety so that lessons learnt drives continuous improvement.

180. Maintain a single NCR database across all parties which is accessible to all supervisors and inspectors to allow recurrent issues to be readily identified.

181. Review and enhance the NCR close-out procedures including effective monitoring arrangements.

Project Management Plans

182. Review and improve the detailed content of Project Management Plans, as set out in paragraphs 22 and 23 of this report, to make them more comprehensive and relevant to the project by translating generic guidance into project specific requirements. The Plan should minimise the need to cross refer to other documents for details of project specific requirements.

183. Consider including an introductory section in PMPs setting out MTRCL's corporate policies and the project strategic objectives to help steer the development of the project.

184. It would be desirable to be more specific about which PIMS manuals are applicable to a project and job roles rather than just including a long list of all PIMS documents.

185. Consider including in the PMP, proposals for:

- partnering arrangements and initiatives;
- checklists for sub-contract approval procedures, including revisions to sub-contract terms and arrangements; and
- commercial management procedures including the settlement of sub-contract final accounts.

PIMS Manuals

186. Review PIMS procedures, and update as necessary, to ensure alignment of project management guidance and procedures with contractual procedures. As part of this, highlight in the manuals the aspects of the guidance which need to be assessed for the specific circumstances of a project and translated into project-specific guidance in the PMP.

187. Review and refresh the older PIMS manuals which date back as far as 2008.

188. Review training on PIMS and contract procedures, including ongoing refresher training and the coverage of any updates to the procedures. Where appropriate, consider integrated training sessions with the Contractor to ensure a common understanding of requirements.

189. Highlight the aspects of PIMS manuals which need to be converted from generic advice into project specific proposals.

As-built Drawings

190. Review the current documents setting out requirements for as-built drawings to ensure that there is consistency and clarity on roles, responsibilities and procedures. Pull together responsibilities and procedures associated with as-built drawings in the PMP.

191. Clarify and maintain site records to support the delivery of the contractual requirements for the prompt recording of as-built dimensions and details.

192. Rigorous monitoring of as-built drawing production to be introduced and progress reported as part of the monthly progress to PSC.

Partnering / Collaborative working

193. Review and clarify the procedures for the submission and acceptance of working method statements.

194. Introduce the standard use of an industry standard collaborative form of contract such as NEC4.

195. Reiew options for more integrated and co-located working between the parties to achieve greater transparency of issues, better forward planning and joint risk management.

196. Develop and implement the use of BIM as a collaboration tool.

Commercial issues

197. Review the procedures for the approval of sub-contracts and any subsequent revisions which change the conditions and / or prices.

198. Review the arrangements for the commercial settlements of sub-contracts to include a stage for MTRCL to verify and accept that proposed settlements are in line with the approved sub-contract terms and conditions.

199. Review and rationalise the provisions for disallowable cost and consider incorporating works not undertaken in accordance with approved plans and procedures as a disallowable cost. This would be achieved by the use of the NEC contract.

Turner Townsend Review of MTRCL procedures

200. I have seen the report of the review carried out by Turner & Townsend into MTRCL's Processes and Procedures **[B17/24421+]**. I consider that there is good alignment between the recommendations of that report and the findings of my report. I understand that MTRCL has already established an implementation group to take forward the TT recommendations and I consider that to be a positive indication of MTRCL's desire to learn lessons and achieve continuous improvement.

Recommendations of Mr Steve Rowsell on strengthening systems for supervision, monitoring, control and management

Extended Terms

REPORT PART 3: OPINION ON HOW SYSTEMS FOR SUPERVISION, MONITORING, CONTROL AND MANAGEMENT MAY BE STRENGTHENED

130. Based on my opinions set out in Parts 1 and 2 of this report, I set out below my recommendations for actions that I consider would help strengthen existing supervision, monitoring, control and management systems. These actions should be read in conjunction with the actions I identified in my Original Report which I have not repeated below but there may be a degree of overlap. I have classified the actions into various categories for ease of presentation.

Leadership and Culture

131. MTRCL should review and reflect on the priorities that it has identified for their top management particularly in relation to culture and the application of corporate procedures. MTRCL should review how effectively the leadership priorities set out in PIMS/MAN/003/A6 at paragraph 3.1 **[B3/1080-1081]** are being achieved. MTRCL should develop an improvement action plan to maintain progress in the implementation of the leadership priorities.

132. MTRCL should consider how successful the leadership has been in embedding throughout the organisation, the culture and behaviours which flow from the leadership priorities set out in PIMS/MAN/003/A6. It would be desirable to establish a method for monitoring and measuring company culture on an ongoing basis.

133. Senior leaders should develop a coordinated programme of office and site visits to support the communication of corporate values, behaviours and priorities directly to MTRCL staff throughout the organisation.

134. MTRCL should review its processes for monitoring resource levels throughout the organisation and identifying potential pressure points. It should ensure that:

a. line managers at all levels are applying systems to measure the performance of individuals in relation to the application of required quality procedures and are reporting the findings to top management;

b. individuals are encouraged to report resource pressures which may put the implementation of quality procedures at risk; and

c. line managers should consult with senior managers about priorities in the event that resource pressures are identified.

RISC Form and Inspection Procedures

135. MTRCL should investigate and introduce new technology-based RISC form procedures which can be implemented by site staff using portable devices such as tablets. MTRCL should ensure that roles and responsibilities in relation to the RISC procedures and the recording of results are clear and communicated to all those involved in the procedures on a project specific basis.

136. Requirements relating to RISC form procedures and inspections are set out in a number of different documents. MTRCL should consider whether it would be beneficial to pull the information together into a single source covering requirements on individual projects.

137. MTRCL should review and clarify procedures in relation to inspections which are not formal hold-points. Ideally procedures for informal and formal procedures would be administered and recorded using the same technology and systems.

138. MTRCL should review its arrangements for ensuring that its site staff have access to the latest working drawings to support more reliable surveillance and inspections of the works. It is likely that this would be best facilitated through the use of technology solutions and mobile devices.

139. MTRCL should consider ways of improving the forward planning of formal inspections. Forward programmes should be informed by the notice periods provided by the submission of Inspection and Test Plans. The plans should be used to support MTRCL's resource planning and to monitor when inspections are expected and ensure that they are being requested and completed.

140. MTRCL should review responsibilities and procedures for ensuring that non-compliances with procedures by the Contractor are addressed promptly and that action is taken to remedy non-compliances. MTRCL should ensure that

responsibility is clearly seen to lie with the Engineer and that appropriate action is taken in accordance with the provisions of the contract.

Training and Development of Staff

141. MTRCL should review its training strategies and plans to ensure that staff are being provided with the necessary training required to perform their roles effectively. Individual training and development plans should be maintained and regularly updated to ensure that they develop the necessary skills and competences for the tasks they are performing.

142. Training modules on PIMS procedures should be developed which align with the requirements of individual roles. Training for different roles should focus on specific PIMS procedures which are of particular relevance to the role.

143. MTRCL should maintain a readily accessible system which records training undertaken and qualifications achieved by individuals. A system that links required skills, competences and qualifications to individual roles and duties within project teams would be highly desirable. The system should be used to confirm that individuals allocated to key tasks have completed necessary training schemes including the use of technical components specific to the project.

144. Induction training for new staff should be reviewed to ensure that it is effectively covering corporate culture, values and behaviours. The importance of working within MTRCL's quality management system should also be covered. Induction training should be mandatory and opportunities found to refresh the messages at regular intervals.

145. As part of the development of project staff, line managers should implement mentoring arrangements for team members which would include them being accompanied on occasions by experienced staff whilst they become familiar with their roles and the tasks they are performing. This should be used to identify any weaknesses in their technical or procedural knowledge and to identify requirements for training and development.

146. MTRCL should assess the understanding throughout project organisations of the understanding of non-contractual project partnering where it is applied to projects. Where necessary, further direction and training should be provided on the behaviours expected of staff working in a partnering environment. It should be emphasised that partnering arrangements are not an excuse for failing to implement specified procedures.

PIMS Procedures and Documentation

147. MTRCL should review its arrangements for training staff in the use of PIMS and seek to ensure that training modules are focused as closely as possible on the roles of individuals. Training should cover the procedures to be followed and also provide an understanding of the importance of applying quality procedures.

148. MTRCL should review its arrangements for communicating updates and revisions to staff and should develop procedures for targeting relevant staff who are mainly responsible for implementing new guidance and procedures.

149. PIMS procedural document PIMS/PN/11-4/A6 Monitoring of Site Works includes requirements for the issue of Non-conformance Reports. MTRCL should review this guidance to ensure that it is consistent with BD's Code of Practice for Site Supervision.

150. MTRCL should review its requirements for site record keeping and develop clearer and more comprehensive guidance which is communicated effectively to site staff. This should be supported by technology solutions and devices which make the procedures as simple and as efficient as possible.

151. MTRCL should review and update PIMS guidance on the use of photographs as a record of works inspections. This should ensure that photographic records are controlled and stored in a structured system.

152. MTRCL should consider the development of a PIMS manual on the development of project communication strategies setting out roles, responsibilities, systems and reporting requirements.

Project Management Plans

153. MTRCL, in liaison with the Government, should review the content and use of Project Management Plans and ensure that they are effectively performing the role expected of them. Consideration should be given to including sections in PMPs on the following:

a. resource planning;
b. training and development plans for project purposes;
c. project communication strategies;
d. interface risk management; and
e. leadership roles in establishing appropriate culture and behaviours.

MTRCL Organisational Roles

154. MTRCL should consider and clarify roles and responsibilities in relation to their obligations as Project Manager in delivering Entrustment Activities and also as Engineer to the Contract. In particular, clarification and guidance should be given to project team members in relation to reporting and communication requirements both internally within the MTRCL organisation and externally with the Contractor and stakeholders.

155. MTRCL should review its systems and procedures for escalating problems and disputes up through the organisation to senior management. Senior management should encourage the reporting of issues where there may be doubt about whether to elevate them, so that senior management can consider their significance and decide whether to get involved.

Interface Risk Management

156. MTRCL should ensure that interface risks are generally treated as potential key risks in its procedural documents, risk management and reporting procedures.

157. Interface management meetings should ensure that actions are clearly allocated and communicated to the responsible individuals. Meeting notes containing relevant information about interface issues should be communicated to all

members of site teams who may be involved in the execution and supervision of the interface works.

158. Consideration should be given, where appropriate, to holding interface workshops attended by relevant site team members, to ensure that the works are adequately planned and risks are identified and mitigated.

159. MTRCL should ensure that method statements are required from contractors for the execution of works at interfaces.

160. MTRCL should consider the appointment of a project interface manager in the Engineer's team who has responsibility for ensuring that interface planning and communications are delivered as required.

Steel Testing

161. MTRCL should develop procedures for ensuring that the Engineer's team is notified by the Contractor that a delivery requiring testing has arrived on site.

162. MTRCL should ensure that requirements are included in contracts to achieve effective segregation on site of tested and untested steel to avoid the risk of untested steel being used in the works.

Investigating Failures

163. MTRCL should review its procedures for reviewing problems that have occurred and learning lessons to avoid them being repeated. In the case of the need for major remedial works there should be an automatic requirement for an investigation to the causes of the problems.

Government Related Enhancements

164. The Government should review and confirm its requirements for as-built records particularly in relation to the need for hard copies of RISC forms. The review should take account of the development of the increasing use of technology to

create drawings and records and should ensure that requirements can be met as efficiently as possible.

165. The Government should review its Consultation procedures in relation to design revisions and clarify arrangements for fast-tracking the Consultation process for minor design changes.

166. The Government should review its requirements in relation to Project Management Plans and should ensure that they cover all of the key aspects that need to be in place to achieve successful outcomes. Consideration should be given to inclusion of the additional contents suggested in the section above on PMPs.

167. The Government should review the way that liaison and communications have worked between RDO, BD and MTRCL. Consideration should be given as to whether the aim of a partnering approach to facilitate close communication on technical and project management issues as set out in the PMP has been achieved. Ways of improving communications and working relationships should be explored, such as more frequent site visits at a working level by members of RDO and BD.

168. The Government should review its requirements for the testing of steel that has been delivered to sites from quality accredited sources in line with the long-term objectives set out in CS2:1995.

169. In relation to the role of the Monitoring and Verification consultant, the Government should consider the following:

a. The M&V role should include construction quality and checks on construction records as failures in these areas can impact adversely on cost, programme and safety.

b. The Government should review its procedures for satisfying itself that the M&V consultant has sufficient resource capacity and flexibility of resource to deliver required services.

c. The Government should review its commercial arrangements for M&V contracts to ensure that they do not act as a disincentive to the delivery of comprehensive services. The Government should ensure that contracts provide a fair return for a good service.

d. The Government should consider on major complex contracts whether there could be benefit in appointing more than one M&V consultant to provide more flexibility and resilience of resource in delivering requirements.

e. The Government should ensure that M&V consultants treat interface risks as potential key risks as part of their risk-based approach to the identification of review priorities.

f. The Government should consider ways of ensuring that M&V consultants are advised promptly of construction problems and defective work which may require remedial works and could have significant cost and programme implications. This could include the possibility of the M&V consultant having an entitlement to sit in on Project progress meetings not normally attended by the Government.

Follow-up by the Government and MTRCL on the Commission's recommendations in its interim report

Table A

Commission of Inquiry into the Construction Works at and near the Hung Hom Station Extension under the Shatin to Central Link Project

Progress Report Regarding the Commission's Specific Recommendations for the Government Set Out in the Interim Report

Item	Reference (Interim Report §)	Recommendation	Actions taken / to be taken
(1)	442, 444	Government sponsorship of rail enhancement projects – there should be the establishment of a single point of responsibility within the Government. To critically address the way in which the Government executes its multiple roles in relation to railway enhancement projects, active consideration should be given to creating an overall Government "sponsor" role for all individual projects to take responsibility on behalf of the Government.	- To be implemented subject to findings of a consultancy which looks into the Government's monitoring and control regime, as well as delivery approach in implementing future railway projects ("**the Consultancy**"). - The Consultancy will be commissioned in January 2020 and is expected to complete in a year. - The Government would take the consultant's findings into account when considering the structure and composition of any new department specifically tasked to handle and supervise railway planning and delivery matters.
(2)	451	Foster collaboration – there should be created a more collaborative (as opposed to adversarial) culture between the Government, MTRCL and contractors, with a leading role taken by the Government.	- Implemented. - HyD and MTRCL established a high-level Steering Group on Communications ("**SGC**") in May 2019, aiming to enhance the effectiveness of communication between the Government and MTRCL and ensure that the reporting of the Shatin-to-Central Link ("**SCL**") Project matters from MTRCL to the Government is timely, with

			appropriate context and pitched at the right level. It also focuses on promoting collaborative working relationships and culture in delivering the SCL project to achieve a quality outcome. - HyD directorate officers have started meeting with senior representatives from the MTRCL construction team, the Monitoring and Verification ("**M&V**") consultant, contractors, sub-contractors and suppliers of construction materials during their regular visits to sites at key construction stages.
(3)	452	The Buildings Department may work much more closely with MTRCL and its designers and contractors in order to facilitate dialogue on all engineering matters.	- Implementation underway. - BD is working with MTRCL on the introduction of a fast track consultation process so that certain types of "minor changes" could be processed within a shorter period of time (e.g. within 7 days) through an enhanced communication system and working arrangement with MTRCL and its design consultants/contractors.
(4)	454	There should be the introduction of new contract forms such as NEC3 and NEC4 and the introduction of collaborative initiatives such as partnering and alliancing.	- Implemented. - The adoption of collaborative approach (by NEC form) in the procurement and management of public works projects has been an established Government policy. Up to 2019, more than 180 NEC works contracts have been awarded.

			- As regards rail projects, while the project manager should determine the most appropriate contract form and contract package, HyD organised an experience-sharing session with MTRCL on the implementation of NEC contracts in public works projects under HyD's management on 13 December 2019.
(5)	454	Building Information Modelling ("**BIM**") should also be utilised to improving trust and performance on performance delivery.	- Implemented. - The Government set out in end 2017 the requirement to use BIM technology in major capital works projects (exceeding $30M) to enhance project management. It is also exploring wider use of BIM through trial projects to facilitate off-site prefabrication, site supervision, asset management and integration with geospatial data for smart city planning. - Insofar as public works projects are concerned, as at end December 2019, 224 consultancy agreements/works tenders with BIM adoption have been invited and 162 consultancy agreements/works tenders have been awarded. - For future railway projects, HyD will impose the use of BIM as a standard requirement. Additionally, HyD organised an experience sharing session with MTRCL on the implementation of BIM in projects under HyD's management on 6 December 2019.

(6)	455, 471	There may also be established a Senior Leadership Forum, comprising the Government, MTRCL, its contractors and leaders of major sub-contractors in order to monitor working relationships and cultural aspects of service delivery and to agree ways of developing collaborative working.	- Implemented. - A Senior Leadership Round-table, with participation of senior representatives from the Government, MTRCL, contractors and major subcontractors, was held on 10 January 2020. Senior leaders discussed the challenges in project delivery and exchanged views in such areas as cross-party collaboration, trust and reward to staff. - A bi-monthly survey on partnering behavioural changes will be carried out from March to December 2020.
(7)	460	Ongoing monitoring of station structure – the east and west diaphragm walls and EWL and NSL platform slabs should be instrumented to detect movement during the operational phase of the station, by way of fibre optics or other approved measures.	- Implementation underway. - To allay public concerns, we remain supportive of the Commission's recommendation in its Interim Report in relation to long-term monitoring. In fact, Preliminary Recommendation No. 2.6 in the EAT's Interim Report No. 1 is consistent with the Commission's recommendation, namely that "*MTRCL should consider supplementing the automatic deformation monitoring system with other monitoring devices, such as those that could record small structural strains and deformation, to measure and monitor the structural health of the platform slabs and diaphragm walls in the Hung Hom Station Extension.*" The same idea of long-term monitoring was also proposed by MTRCL in the Final Holistic Report and Verification Report - It is incumbent on MTRCL to propose the suitable form and details of the monitoring system, taking into account the latest expert evidence. The proposed system should minimise disturbance to the railway operation while providing reliable

			information and an alert system on any signs of abnormal structural behaviours. As regards the potential false alarm due to high sensitivity, it could be minimised by calibration. - In addition, in view of the concern on poor workmanship, the Government has asked MTRCL to provide additional quality assurance and/or undertakings in respect of the structures.
(8)	473-474	Ensure competence of personnel – the Government should review the "competence" requirements for personnel engaged in project management/sponsorship roles and should review checks and procedures to ensure ongoing competence of project-related staff. Effective measures should also be in place to reduce the risk of failure.	- Implementation underway. - The Railway Development Office ("**RDO**") of HyD is reviewing the competence requirements for its project-related staff. Subject to the results of the review, a framework for the required qualification, working experience and training requirements will be promulgated for RDO professionals. HyD is also preparing new operation procedures and/or work instruction to regularise (i) staff competence review and (ii) training for RDO professional staff, so as to ensure their ongoing competence. - HyD has been holding quarterly experience-sharing sessions for its project management staff. The experience in relation to Hung Hom Station Extension incident will be included in future experience-sharing session(s) upon the conclusion of the present inquiry. HyD will also ensure that Government site and non-site supervisory staff will receive integrity training regularly.

(9)	475	The Government should address the way in which it executes multiple roles in relation to railway enhancement projects, in particular its role as "client" and its role as "sponsor".	See Item (1) above in relation to the Consultancy.
(10)	476	A Project Board should be established for future railway enhancement projects to provide strategic direction, comprising appropriate Government officials as board members, supported by external non-executive members from specialist backgrounds.	See Item (1) above in relation to the Consultancy.
(11)	477	Consideration should be given as to whether rail projects should remain within the portfolio of the Director of Highways, or whether a new distinct Director of Rail Development role should be established.	See Item (1) above in relation to the Consultancy.
(12)	478	Consideration should also be given as to the appropriate model to be fused for future projects, i.e. whether there should be used the "Concession" model, "Ownership" model, or the creation of a "Special Purpose Vehicle" approach with a dedicated Board and delivery organization.	See Item (1) above in relation to the Consultancy.

Table B

Commission of Inquiry into the Construction Works
at and near the Hung Hom Station Extension under the Shatin to Central Link Project
Progress Report Regarding Mr Steve Rowsell's COI-1 Recommendations for the Government Set Out in Appendix F to the Interim Report

Item	Reference (Appendix F §)	Recommendation	Actions taken / to be taken
(1)	6	Review communication channels and reporting lines – the Government should review how it manages its interests in railway projects, with an aim to provide greater clarity in communication and reporting lines and more efficient project controls.	See Items (1)-(3) in Table A.
(2)	7	Clear summary of relevant requirements – the relevant requirements in relation to the Buildings Ordinance and the consultation process could be pulled together into a clearer and more precise description.	- Implementation underway. - BD is preparing a new practice note to consolidate various requirements relating to specific tasks and testing of materials (e.g. quality supervision plan for installation of ductility coupler splicing assemblies, on-site sampling for testing, etc.) imposed under the Buildings Ordinance when granting approval (or specified in the acceptance letter under the Instrument of Exemption) with a view to providing clearer and more precise description of the requirements and responsibilities. - BD plans to consult the industry via the Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers Committee

			("**APSEC**") and the Building Sub-Committee ("**BSC**") of the Land and Development Advisory Committee in the next joint APSEC and BSC meeting scheduled for February 2020. - Also see Item (3) in Table A.
(3)	8	Extend role of M&V consultant – the role of the M&V consultant should be extended to provide a wider "eyes and ears" role to help protect Government's interests, and should provide high level monitoring of the operation of the project quality assurance systems, and also cost and programme issues. The M&V role could be developed into a Government's Project Representative role that works more closely within the MTRCL organisation.	- To be implemented subject to findings of the Consultancy (as mentioned in Item 1 in Table A). - The Consultancy will review the pros and cons of the "check the checker" mechanism under the concession approach and the monitoring mechanism under the ownership approach. The Government will then consider how the existing duties of the M&V consultant can be extended to help protect the Government's interests during project delivery. - For the SCL Project, owing to contractual limitations, HyD has since July 2019 deployed in-house inspectorate staff on various sites serving as the Government's "eyes and ears" to carry out site inspections and audits, including those surprise (unscheduled) checks. The Government has also encouraged more proactive involvement of the M&V consultant since mid-2018, such as inviting the M&V consultant to join all of the three-tier project supervision meetings and increasing the number of site visits and on-site record checks.

(4)	9	Develop working arrangements with MTRCL – working arrangements should be made such that Government staff would be integrated within MTRCL teams on a regular basis to help ensure common understanding of requirements, improve communications, undertake joint forward planning and to resolve issues more efficiently.	- Implemented. - For the SCL Project, HyD has since July 2019 deployed in-house inspectorate staff to station at MTRCL's site offices. Similar arrangements have been extended to HyD's engineers, who commenced working together with MTRCL staff at a site office initially for half a day at monthly interval since December 2019.
(5)	10	Review Project Supervision Committee ("**PSC**") – the Government should ensure that PSC operates as intended, as a high level committee focusing on strategic issues and performance, and that the reporting arrangements provide PSC with reliable performance data.	- Implemented. - For the SCL Project, starting from September 2019: (i) PSC meetings has been divided into two parts, with Part II, attended by a smaller number of more senior members, dealing with more strategic and sensitive issues; and (ii) the escalation of issues from Project Progress Meeting to Project Co-ordination Meeting ("**PCM**") and from PCM to PSC has been formalised. - On HyD's request, MTRCL has been submitting performance data on site supervision and communication, and other issues relevant to works quality, project cost and progress for review and monitoring at the PSC meetings.
(6)	11	Review Building Department's Code of Practice ("**CoP**") – the CoP should be reviewed to give clarity on the definition of supervision, record keeping requirements and non-conformance reporting. It should also set out requirements of the communication of the supervision plan and associated obligations. The overall	- Implementation underway. - BD will make amendments to the CoP with a view to further enhancing its clarity on the definition of supervision, record keeping requirements and non-conformance reporting, strengthening the requirements on obligations of the site supervisory personnel and the communication among the site

		supervisory arrangements should provide an adequate role for the designer to give assurance that the intent of the design is delivered in the construction process.	supervisory personnel to ensure delivery of design intent in the construction. - BD plans to consult the industry on the proposed amendments to the CoP in the next joint APSEC and BSC meeting scheduled for February 2020.
(7)	12	Develop a conflicts of interest policy.	- To be implemented in future contracts. - There is established policy on conflict of interest for civil servants. - HyD has requested and MTRCL has agreed to review their policy on conflict of interest. Subject to legal advice and negotiation with MTRCL, this requirement will be added to the relevant entrustment agreement or project agreement of future railway projects.
(8)	13	Review the lump sum contractual arrangement used to employ the M&V consultant – the Government should consider options which would provide a more effective incentive to the M&V consultant to be proactive in the execution of its duties.	- To be implemented subject to findings of the Consultancy (as mentioned in Item 1 in Table A). - For future railway projects, taking into account the findings in relation to the role of the M&V consultant under the Consultancy, the procurement approach and remuneration arrangement of the M&V consultant will be reviewed. - For the SCL Project, additional services would be ordered from the M&V consultant if such services are necessary and justified under the M&V agreement. -
(9)	14	Clarify requirements in M&V consultants' brief – clearer requirements should be stipulated in relation to site audits and surprise checks.	- To be implemented subject to findings of the Consultancy (as mentioned in Item 1 in Table A). - For future railway projects, taking into account the findings in relation to the role of the M&V consultant

			under the Consultancy, HyD will ensure that the requirements related to site inspections, audits and/or surprise checks are clearly set out in the M&V consultants' briefs. - For the SCL Project, HyD will continue discussing with the M&V consultant at their monthly meetings the requirements and details of site inspections and audits, such as the frequency, location and scope.
(10)	15	Ensure sufficiency of resources of M&V consultants – the Government should ensure that companies appointed to M&V roles have access to the necessary levels of resource if the level of monitoring by the M&V consultant has to be increased due to concerns about poor performance.	- Implemented. - HyD would continue monitoring the level of resources of the M&V consultant to ensure it has sufficient resources to deliver its tasks. A standing item for reviewing the level of resources of M&V consultant has been included in the monthly progress meeting since October 2019.
(11)	16	Consider options of recovering M&V audit costs – consideration should be given to recovering M&V audit costs from the defaulting party if poor performance by the contracting parties resulted in additional audits being required.	See Item (8) above in relation to the Consultancy.

Progress Update for CoI Recommendations Implementation by MTRCL
[Status as at January 2020]

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
1. Promoting Public Safety			
1.1	**On-going monitoring of station structure**		460
	- Instrumentation, by means of fibre optics or other approved measures, at the east and west diaphragm walls and the East West Line and North South Line platform slabs to detect movement during operational phase of the station, and movements should be monitored and reported to the Government.	Evidence concerning alternative proposals involving visual monitoring has been placed before the Commission in CoI Stage 2 and awaits the Commission's consideration.	(391)
2. Leadership, Competence and Governance			
2.1	**Leadership**		-
2.1.1	- Closer involvement of senior leaders of all parties - Government, MTRCL and contractors - working collaboratively to achieve a quality outcome, involving senior leaders being more visible to the workforce and taking a lead role in communicating key messages throughout their respective organisations.	• SCL Steering Group on communications involving Executive and Senior Management of MTRCL and Government has been set up • A first Senior Leadership forum between MTRCL / Government / contractors has been held with the following objectives - Developing and aligning consistent and disciplined	471 F-1

[1] Paragraph reference in the redacted Interim Report; F-X denotes paragraph reference in Annexure F.

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
		communication strategies - Fostering a collaborative working relationship at all levels - Building a working culture that supports constructive challenges • PSC Meeting Agenda has been reviewed and enhanced to encourage greater transparency between all stakeholders and early reporting of issues to Government	
2.1.2	- Leadership roles should be developed in line with the principles set out in ISO9001:2015.	• As the overarching document of the ISO9001 compliant PIMS (Projects Integrated Management System), the PIMS Policy has been updated, signed by the current CEO of MTRCL and published since May 2019. The new Policy defines better project management principles and articulates expected behaviours of staff involved in managing railway projects. • The word "quality" is now adopted and prominently used in the latest updated PIMS Policy, further reinforcing MTRCL's focused attention to "quality", in addition to "safety" and the "environment". • An External Consultant has been appointed to carry out a full review and update of the PIMS documents with the emphasis on clarifying roles and responsibilities (including Leadership), such that these are consistently and clearly defined and embedded across all documents, with the use of a standard 'RACI' (Responsibility, Accountability, Consulted, Informed) model being implemented.	F-1

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
2.1.3	- Establish a cross-party Senior Leadership Forum comprising the Government, MTRCL, contractors and major sub-contractors to monitor working relationships and cultural aspects of service delivery and to agree ways of developing collaborative working.	See item 2.1.1 bullet 2	F-2 (455)
2.2	**Competence**		-
2.2.1	- Review the "Competence" requirements for personnel engaged in project management/sponsorship roles and review checks and procedures to ensure ongoing competence of project-related staff.	• MTRCL have established a Transformation Board to carry out a comprehensive review and update of current management procedures and processes to be adopted in Project Delivery. Six Working Groups have been formed to drive improvements, one of which is dedicated to the development of Competency Management Processes. • A Competency Management Procedure is currently under development by the Working Group to develop a framework of requirements for all key roles across supervisory staff for all principles	473
2.2.2	- Put in place effective measures to reduce the risk of failure by mistake, incompetence or malicious act.	• Quality Department has introduced a Quality Site Alert System to identify developing problems on site and notify other Contracts to be on the lookout for similar issues • A 'Second Line of Defence' has been introduced on site to provide independent monitoring and verification of the works	474
3. Looking to a More Collaborative Culture			

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
3.1	**Fostering integrated working arrangement**		-
3.1.1	- Consider options for working arrangement in which Government staff could be integrated within MTRCL teams on a regular basis to help ensure a common understanding of requirements, improve communications, undertake joint forward planning and to resolve issues more efficiently.	To promote communication and collaborative working, RDO engineers and inspectors have been co-located at MTRCL NSL site offices since Q3/2019. Monthly site visits by RDO engineers are also held which are followed-up with office discussions with the MTRCL project team on areas of concern and priority issues.	F-9
	- Review options for more integrated and co-located working between the parties to achieve greater transparency of issues, better forward planning and joint risk management.	Ditto	F-45
3.1.2	- Create more collaborative culture between the Government, MTRCL and contractors with the objective of achieving more successful project outcomes, e.g. Closer working relationship between BD and MTRCL and its designers and contractors to facilitate dialogue in all engineering matters.	• See item 3.1.1 • MTRCL/BD meeting format has been amended to promote more collaborative working with respect to BD Submissions	451- 452
3.2.	**Introducing New Engineering Contract ("NEC")**		F-44
	- Introduce standard use of an industry standard collaborative form of contract such as NEC4.	• NEC4 will be adopted in the next two major contracts to be awarded: - Ma Chai Hang Recreation Ground Detailed Design	(454)

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
		- Tung Chung Line Extension Preliminary Design • Further use of NEC Contracting is also being actively considered	
3.3	**Adopting Building Information Modelling ("BIM") as a collaboration tool** - Develop, implement and promote the use of BIM as a collaboration tool.	• MTRCL has now set up a Common Data Environment to facilitate the future design and data management on site using BIM. Training on how to use this Common Data Environment has commenced • All designs/construction/approval/certification data as well as method statements and ITPs will be linked to the BIM model to ensure that there is one single source of truth • Executive has endorsed the decision that all future Projects will be fully designed and managed from the Preliminary Design Stage onwards using BIM. The required documentation to enforce is being prepared • The next 2 design consultancies to be awarded by MTRCL in Q2 2020 have been prepared with contract documents that mandate the use of BIM	469 F-46 (428-434) (437) (454)
3.4	**MTRCL's internal organisation**		-
3.4.1	- Consider ways of inducing closer working between different groups within the project organisation to avoid the risk of silo-working in which information and knowledge is not shared. Consider the effectiveness of existing	• iShare has developed as a web-based knowledge and information management portal for managing documents, information and other functions for internal knowledge sharing and collaboration purposes. It is accessible to all MTRCL staff across contracts and contractors.	F-3

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
	communication arrangements between the teams and throughout the organisation. Review information databases and systems to ensure a single accessible source of true position accessible as appropriate to all people.	• PIMS are being updated as referenced in item 2.1.2 • Dashboard reporting has been introduced to keep all parties better informed on developing issues • RISC Sheet format has been redeveloped to be inclusive of all relevant parties for review and sign off digitally • RISC, RFI, Site Discussions and Quality Observations are all now digitised for ease of access to relevant parties	
3.4.2	- Review and clarify MTRCL roles and responsibilities in relation to the provisions and requirements of the Conditions of Contract. In particular, ensure that the position of Engineer to the Contract is understood and that roles and responsibilities respect the need for the Engineer to act impartially in the administration of the contract. The role of the Engineer needs to be integrated and compatible with the roles of others in MTRCL who have responsibilities for delivering obligations under the Entrustment Agreements ("EAs").	• As part of the Transformation Initiative mentioned in item 2.2.1, a Working Group on Commercial & Contract Procedure has been set up and MTRCL's Projects Division is looking at the various forms of contract to be adopted by MTRCL in the future • The role of the Engineer in future Projects will be transferred to the Engineering Division to give a greater degree of independence	F-4
3.4.3	- Review arrangements for managing relationships with stakeholders to ensure that there is clarity on responsibilities and clear lines of communications particularly with Government Departments, and set out	• See item 2.1.1 • As part of the review of PIMS referred to above, a framework is being developed for a Stakeholder Management Plan which will be introduced in future Projects	F-5

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
	such arrangement in a Stakeholder Management Plan which is accessible by all involved in the project delivery.		
4. Commercial Issues			
4.1	**Devising and developing a conflict of interest policy**		F-12
	- Developing a conflict of interest policy appropriate and applicable to projects of this nature, the administration of which may be assigned to the Project Coordination Meeting or other committees as appropriate.	• Recommendation under review • Procedure introduced for SCL Project to better manage firewalls where the same Design Consultants are currently employed by Contractors and MTRCL on Contract 1123	
4.2	**Commercial settlements**		F-48
	- Including subcontracts within the provisions for commercial settlements set out in the EA to provide the Government with greater transparency of commercial settlements which have a significant impact on the settlement of the final contract value and greater control on the settlement of the contract final account.	This recommendation will be addressed by the Working Group on Commercial & Contract issues referred to above	Para 143 of Rowsell Expert Report
4.3	**Subcontracting arrangements and commercial settlements**		-
4.3.1	- Review the procedures for the approval of sub-contracts and any subsequent revisions which change the conditions and / or prices.	See item 4.2	F-47

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
4.3.2	- Review the arrangements for the commercial settlements of sub-contracts to include a stage for MTRCL to verify and accept that proposed settlements are in line with the approved sub-contract terms and conditions.	See item 4.2	F-48
4.3.3	- Review and rationalise the provisions for disallowable costs and consider incorporating works not undertaken in accordance with approved plans and procedures as a disallowable costs.	See item 4.2	F-49
5. Rules and Requirements			
5.2	**Clarifying design submission and consultation procedures**		-
5.2.1	- Review the wording of the Particular Specification in relation to alternative works design proposals to ensure that the process and terminology is aligned with the contract conditions.	See item 4.2	F-17
5.2.2	- Ensure that the construction method statements are in place based on the latest approved designs before construction commences.	• PIMS Practice Note on "Monitoring of Site Works" which includes the use and review of methods of construction is currently being updated to reflect the RACI of MTRCL in site inspection • All ITPs within current contracts have been reviewed against best practice since the SCL issues came to light • The PIMS Consultancy referred to above will also address this issue	F-18

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
		for future Projects	
5.2.3	- Review the liaison arrangements between the Contractor's design team, the Building Authority and MTRCL's design and construction management teams to ensure common understanding of submission requirements and awareness of design issues and the forward programme of potential submissions.	• The revised PIMS currently being prepared will address enhanced measures for stakeholder engagement and statutory submission processes. These PIMS will be RACI based • At site level, regular meetings are now being held between all parties and BD to identify submission requirements and the status of submissions made, together with the prioritisation of submissions against the programmed works on site	F-19
5.3	**Rationalising and clarifying supervision requirements**		-
5.3.1	- For future infrastructure projects, require site presence of the designer to assist in ensuring implementation of design intent in the works.	• The role of the DLR on site is now being more strictly enforced in all existing Contracts to ensure that design related issues are dealt with efficiently • The presence of Design Staff on site in future projects is being addressed in the Commercial & Contract Working Group referred to above	470 (416)
5.3.2	- Review documents which set out supervision requirements and guidance to rationalise the documents to a more manageable and readable number, ideally with a view to producing an all-inclusive and bilingual "Supervision Manual" accessible to all involved in supervision and inspection procedures.	• A new SCL Quality Management Plan (QMP) with a quick reference guide for staff on PIMS documentation has been prepared and issued to all project staff and is readily accessible on iShare • The PIMS review being carried out by the External Consultants referred to above will also see a shift to flowchart based sub-process documents supporting clear RACI definitions, and clearer definition of minimum mandatory requirements (with mandatory documents vs recommended 'good practice' guidelines being separated into	F-20 (419)

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
		different document types for clearer reference and use). • This will mean shorter and easier to comprehend documents. The documents will be grouped together online into relevant disciplines (e.g. Construction Management) and sub-disciplines (e.g. Site Monitoring / Supervision), and will also be accessible online by relevant Job Title, but it should be noted they will not be published in the form of a 'Supervision Manual'.	
5.3.3	- Develop a clear definition of supervision for the purpose of contractual obligations and adopt a consistent approach to terminology throughout the documentation, with requirements being specific about the information that needs to be recorded and certified.	• See item 4.2 • The PIMS being prepared by the External Consultant will include the details of the roles and responsibilities of the staff under the Contract with respect to their obligations. This Consultancy will be completed towards the end of 2020 and the revised suite of documents produced will be used to manage future projects	F-21 (422)
5.3.4	- Make the frequency of supervision and inspections flexible and reactive to the compliance and performance of work with requirements, with less frequent supervision supported by self-certification and audits upon demonstration of consistently high-quality work.	• See item 4.2 • A new Independent Quality Assurance Team in Engineering Division, titled AM&V, for Second Line Defence has been set up to monitor performance of teams on site. PIMS training for all front line Project Staff has been enhanced to improve the site team's understanding of their supervision role. PIMS classroom training has been introduced and an online Training Module to be completed by all Projects staff are planned. This will be supplemented by discipline specific training. • Specific training on quality management has been delivered to	F-22 (416)

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
		project teams as has the retraining of staff nominated as self-auditors	
5.3.5	- Review the requirements for formally defined hold-points in relation to the contract provisions for not covering-up work without inspection and clarify whether inspection certificates apply to both hold-points and pre-covering up inspections.	The new iSuper digital system introduced on site will more efficient in terms of managing hold points and allows for easy identification of any hold points which have been passed without authorisation. The system is fully archivable for tracking of certification documents	F-23 (419)
5.3.6	- Review options for the use of the latest technological applications and tools to support the efficient effective recording of site records.	• See item 5.3.5 • New digital management tools for site records (iSuper and iComm) have been introduced. These include systems for managing the key activities of RISC Sheets and NCRs. Trials on a system for digitising Site Diaries are under way. In addition, a secure site communication system to record discussions/requests/actions between MTRCL and the Contractors, which allows for archiving of the communications records, has been introduced • The above systems have provided a quick short term solution. MTRCL is also looking to develop a more robust long term digital system for future Project Management. MTRCL's Projects Division has received endorsement from the Executive that all future Projects will be delivered using BIM technology from the Preliminary Design through to the hand-over of the Project to the Client. A Common Data Environment has already been developed in-house to facilitate this and will be used in the Ma Chai Hang Recreation Ground Contract to be awarded Q2 2020 and the Tung Chung Line Extension which	F-24 (426-427)

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
		will also be awarded in Q2 2020. Enhanced site project management systems will be developed to be compatible with BIM and rolled out in future Construction Contracts	
5.3.7	- Ensure there are procedures in place to record who are undertaking supervision duties on a daily basis and that supervisors have the required level of competence.	• See item 2.2.1 for reference to the Working Group on Competency • Re-Training on CoP for Site Supervision 2009 to SIOW / IOW / ConE / SConE on appropriate Contracts has been carried out. This training now forms part of the training requirements for staff on new Projects as they come on line	F-25 (422)
5.3.8	- Ensure that records are kept to support the possible application of the contractual disallowable cost provisions.	The iSuper system discussed in item 5.3.5 and 5.3.6 provide archived records on approvals for work to proceed which can be used to evaluate potential disallowed cost activities	F-26
5.4	**Reviewing site entry/exit systems and records**		F-27
	- Review the existing entry/ exit site staff recording system in relation to: • knowing who is on site; • supporting the payment of people under the commercial model; • knowing who undertook work inspections and who certified work; and	This recommendation is currently under consideration	

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
	• helping to confirm that the required level of supervision and the ratio of supervisors to workers.		
5.5	**Reviewing non-conformance reporting**		-
5.5.1	- Review current guidance on non-conformance reports ("NCRs") to ensure clarity and consistency on when NCRs should be issued.	• The NCR process has been substantially revised to allow more detailed categorisation of NCRs, enhanced communication on issues with all stakeholders and increased visibility on close out rates. The system is now digitised for ease of recording and tracking NCRs • PIMS have been updated to reflect the new system and staff trained in its use	F-28 (408)
5.5.2	- Encourage "near-miss" non-conformance reporting to drive continuous improvement.	A pilot run of a module called "Quality Observation" under iSuper has been implemented on Contract 1123 and Contract 1128 since Sep 2019 for the MTRCL inspectorate to capture "quality issues" found prior to Hold Point inspections. The "quality issues" are logged and communicated to the relevant contractor(s) for action, and the due closure of which is monitored	F-29 (410)
5.5.3	- Maintain a single NCR database across all parties which is accessible to all supervisors and inspectors to allow recurrent issues to be readily identified.	• A database on iShare capturing NCRs and issued by MTRCL and NCR Registers provided by contractors are being maintained for access by both parties covering all SCL Contracts • For future projects MTRCL's Projects Division will move towards one system using a digital platform	F-30 (409)
5.5.4	- Review and enhance the NCR close-out procedures including effective monitoring arrangements.	See item 5.5.2	F-31 (409)

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
5.6	**Reviewing Project Management Plans ("PMPs")**		-
5.6.1	- Make PMPs more comprehensive and relevant to the project by translating generic guidance into project specific requirements while minimising cross-reference to other documents.	• The current PMP for the SCL Project has been amended to update information within the PMP which has been superseded • As a long term objective, MTRCL will be revisiting the PMP format and contents to address the recommendations for future Projects. MTRCL has tasked the Projects Quality Working Group (PQWG) under the Projects Transformation Programme Board to address the recommendations prior to the commencement of the next major Project	F-32
5.6.2	- Consider including an introductory section in PMPs setting out MTRCL's corporate policies and the project strategic objectives to help steer the development of the project.	See item 5.6.1	F-33
5.6.3	- Include specific details about which PIMS manuals are applicable to a project and job roles.	• A new SCL Quality Management Plan (QMP) with a quick reference guide for staff on PIMS documentation has been issued in May 2019. All project staff are notified of the issue of this PIMS document and it is readily accessible on iShare. Project staff training on specific PIMs relevant to their work task has also been implemented for existing SCL site staff since the SCL incidents occurred and will in the long term be expanded to train future Projects Staff across all roles and responsibilities on new Projects as they are progressed	F-34

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
		• MTRCL has commissioned a consultant (who has been engaged since October 2019) to review and revamp the PIMS. Recommendations relating to PIMS documentation will be addressed in the new PIMS accordingly. This review will also address relevant training requirements for staff in the revamped PIMS	
5.6.4	- Consider including in the PMP (i) proposals for partnering arrangements and initiatives; (ii) checklists for sub-contract approval procedures; and (iii) commercial management procedures.	See item 5.6.1 bullet 2	F-35
5.7	**Reviewing Project Integrated Management System ("PIMS")**		-
5.7.1	- Review and update PIMS procedures and manuals, to ensure alignment of project management guidance and procedures with contractual procedures.	• As referred to above, an External Consultant has been appointed to review, reformat and re-write all PIMS based on RACI principles, a whole project lifecycle approach and a workflow based format. • This Consultancy is being managed by a PIMS Working Group and will be completed in Q4 2020. • As an intermediate solution, MTRCL has also formed an internal PIMS review group which is progressively updating the PIMS in their current format to address concerns	F-36 F-37 (467)
5.7.2	- Highlight in the manuals the aspects of the guidance which need to be assessed for the specific	See item 5.7.1	F-36 F-39

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
	circumstances of a project and translated into project-specific guidance in the PMP, and the aspects of PIMS manuals which need to be converted from generic advice into project specific proposals.		
5.7.3	- Review training (with the contractor where appropriate) on PIMS and contract procedures, including ongoing refresher training and the coverage of any updates to the procedures.	• Since Q3/2018 a more structured training on PIMS and contract procedures (such as SCL PMP and SSP) has been provided to project staff and the contractor's staff. Training of this nature will be on-going. An annual training plan on the subject is in place, which is subject to continuing review and updating under the auspices of the PIMS Working Group. This training will be sufficient to address staff needs for the remainder of the SCL Project • As part of the PIMS Review Consultancy looking at future Projects, further recommendations on training in PIMS specific to the roles of different staff will be further developed. As part of the PIMS Review project, an introductory Online Training Module is being developed which will become mandatory for all personnel involved in Projects delivery. This will be supplemented by additional training of staff on the specific PIMS procedures and process requirements that staff are required to adopt when performing their duties. • All PIMS documents will be related to Project Stage, Discipline / Sub Discipline, as well as to specific Job Titles, to enable a clearer definition as to which procedures relate to which relevant role	F-38
5.8	**As-built drawings requirements and production**		-

	Recommendation	Follow-up Actions Being Taken	CoI Ref[1]
5.8.1	- Review the current documents setting out requirements for as-built drawings to ensure consistency and clarity on roles, responsibilities and procedures, and pull them together in the PMP	The Project Transformation Board referred to above has set up a Project Quality Working Group who will be responsible, in collaboration which the External PIMS Consultant, for reviewing and updating all aspects of as-built documentation	F-40
5.8.2	- Clarify and maintain site records to support the delivery of the contractual requirements for the prompt recording of as-built dimensions and details	• See item 5.8.1 • The adoption of BIM in future Projects will improve the accuracy of as-built data by developing it in 'real time' as the works progress on site	F-41
5.8.3	- Introduce rigorous monitoring of as-built drawing production and report the monthly progress to PSC	• See item 5.8.2 • The SCL Monthly Co-ordination Meeting with RDO/BD/GEO has been enhanced to investigate in depth submission matters, including as-built records. The status of submissions, including as-built records has been reported to PSC since Q4 2018	F-42
5.9	**Clarifying method statement procedures**		F-43
	- Review and clarify the procedures for the submission and acceptance of working method statements	• PIMS Practice Note on "Monitoring of Site Works" has been updated in August 2019 to reflect, amongst other enhancements the RACI of MTRCL in site inspection • All ITPs within current contracts have recently been reviewed to ensure their continuing applicability to the works to be inspected	