

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

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

**OPENING ADDRESS  
BY COUNSEL FOR THE COMMISSION<sup>1</sup>**

**(in respect of the Substantive Hearing commencing on 23 September 2019  
for Statistical Expert Evidence )**

**A. Introduction**

1. On or about 18 July 2019, MTRCL, with the approval of the Government, produced the Final Report on Holistic Assessment Strategy for the Hung Hom Station Extension (the “**Holistic Report**”)<sup>2</sup> and the Final Verification Study Report on As-constructed Conditions of the North Approach Tunnels, South Approach Tunnels & Hung Hom Stabling Sidings (the “**Verification Report**”)<sup>3</sup>.
2. Having considered the Holistic Report and Verification Report, the Commission concluded that it would be appropriate to explore certain aspects of their content to better understand the conclusions reached and, in particular, the underlying justifications for the intention to carry out what are described as “suitable measures” to some of the structures. It

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<sup>1</sup> Unless otherwise stated, this Opening Address will adopt the same abbreviations used in the Closing Address for the Extended Inquiry by Counsel for the Commission dated 26 July 2019 [CA1/Tab 1].

<sup>2</sup>[OU5/3229+].

<sup>3</sup>[BB16/9952+].

became apparent to the Commission that the statistical analyses used were important, and would likely assist and inform the Structural Engineering Expert evidence.

3. Subsequently, pursuant to the directions of the Commission, in respect of the statistical analyses used in the Holistic Report and the Verification Report:-

(1) Leighton produced 2 expert reports of Mr Barrie Wells<sup>4</sup>;

(2) The Government produced 2 expert reports of Professor Yin Guosheng<sup>5</sup>; and

(3) MTRCL produced 2 anonymous “Reports on Statistical Analysis”<sup>6</sup>. MTRCL subsequently informed the Commission that those Reports were prepared by MTRCL’s project team, which includes Mr Neil Ng and Mr Nelson Yeung who would be able to speak to them at the hearing<sup>7</sup>.

4. In order to assist the Commission, the legal team of the Commission considers that it may be helpful to set out some of its preliminary observations in respect of the aforesaid reports and statements in this brief Opening Address. Needless to say, these observations are by no means intended to be exhaustive. It is however hoped that they will provide some focus to the hearing. The observations made are not intended to limit the scope of the cross-examination of the statistics witnesses.

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<sup>4</sup>COI 1/ER1/Tab 10; COI 2/ER1/Tab 2. Mr. Wells’ CV is at AA/241-242.

<sup>5</sup>COI 1/ER1/Tab 12; COI 2/ER1/Tab 4.

<sup>6</sup>COI 1/ER1/Tab 11; COI 2/ER1/Tab 3.

<sup>7</sup>[OU7/9964-9966][AA1/343-345].

## **B. Relevance of statistical analysis to the issue of safety/suitable measures**

5. By way of preliminary background and in simple terms:-

- (1) Coupler connections were tested by reference to set criteria;
- (2) Failure rates of the coupler connections were recorded and expressed as a percentage of those tested;
- (3) The failure rates were translated into strength reduction factors (also expressed as a percentage); and
- (4) The strength reduction factors were utilized to inform the extent of the proposed remedial works to parts of the structures.

6. As explained by MTRCL, statistical analysis adopting a binomial (pass/fail) methodology was carried out for:-

- (1) the general coupler connections at the EWL and NSL slabs resulting in defective rate/reduction factor of 36.6% and 33.2% respectively<sup>8</sup>; and
- (2) the capping beam coupler connections resulting in defective rate/reduction factor of 68%<sup>9</sup>.

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<sup>8</sup>See MTRCL's report for the Original Inquiry, at §§37-38 [COI 1/ER1/Tab 11/p.16].

<sup>9</sup>See MTRCL's report for the Original Inquiry, at §§39-43 [COI 1/ER1/Tab 11/pp.16-18].

7. The statistical analysis for the general coupler connections does not appear to raise any issue of safety or a requirement to carry out “suitable measures” at the EWL and NSL slabs. For the reasons set out in the Verification Report<sup>10</sup>, assuming the general coupler connections (in place of lapped bars) at NAT, SAT and HHS have a similar defective rate/reduction factor, however, there will be an issue of safety/suitable measures in respect thereof<sup>11</sup>.
8. Further, the statistical analysis for the capping beam coupler connections does raise an issue of safety/suitable measures at the EWL and NSL slabs in Area A (assuming the defective rate/reduction factor in respect of the capping beam coupler connections in Area A is the same as that in HKC)<sup>12</sup>.
9. In contrast, there has been no real statistical analysis carried out in respect of the untested rebar at NAT, SAT and HHS. In any event, they do not raise any issue of safety/suitable measures<sup>13</sup>.
10. In these circumstances, the focus of the hearing should be directed at the two statistical analyses referred to in §6 above.

### **C. Statistical analysis for the general coupler connections**

11. The position stated in the Holistic Report (and agreed by Professor Yin) appears to be as follows:-

(1) It is appropriate to use a binomial approach to analyse the data collected from the opening-up process<sup>14</sup>.

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<sup>10</sup>**BB16/9976 (§4.2.6)**

<sup>11</sup>See MTRCL’s report for the Extended Inquiry, at §§6-9 [COI 2/ER1/Tab 3/pp.2-3].

<sup>12</sup>See MTRCL’s report for the Original Inquiry, at §44 [COI 1/ER1/Tab 11/pp.18-19].

<sup>13</sup>See MTRCL’s report for the Extended Inquiry, at §10 [COI 2/ER1/Tab 3/pp.3-4].

- (2) The acceptance/rejection criteria are<sup>15</sup>:-
- (a) There shall be a maximum of 2 full threads exposed; and
  - (b) The engagement length of the threaded steel rebar inside the coupler should be at least 37mm.
- (3) Adopting the binomial approach and applying the aforesaid criteria, the defective rate/reduction factor with a 95% confidence level for the general coupler connections at the EWL and NSL slabs is 36.6% and 33.2% respectively<sup>16</sup>.

12. Mr. Wells makes several criticisms of the above approach.

13. First, by adopting such an approach, a rebar coupling connection with 37mm engagement length is assumed to be fully functioning, but a rebar coupling with 34.8mm engagement length (which is the mean for the EWL slab and only 5.8% less than the engagement length criterion) is assumed to bear no load and be completely ineffective<sup>17</sup>.

14. In contrast, Mr. Wells' primary approach is to assume that a small reduction in engagement results in a corresponding reduction in contribution to strength. Consequently, he arrives at a reduction factor of

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<sup>14</sup>See Professor Yin's report for the Extended Inquiry, at Section 1.3 [COI 2/ER1/Tab 4/pp.6-7].

<sup>15</sup>[OU5/3252/§3.3.13].

<sup>16</sup>[OU5/3255-56/Tables 1 and 2].

<sup>17</sup>See Mr. Wells' report for the Original Inquiry, at §4.24 [COI 1/ER1/Tab 10/p.8].

9.1% for the EWL slab and 3% for the NSL slab, with an overall reduction factor of 6.6%<sup>18</sup>.

15. Second, Mr. Wells considers that in relation to the discarded items, a Missing Value approach (i.e. instead of discarding those items, treating them as missing and replacing them with a representative or expected value) should be adopted<sup>19</sup>.
16. Third, Mr. Wells explains that assuming there is zero contribution of load bearing capacity from the defective items, if one changes the engagement length passing criterion from 37mm to 28mm, together with the application of the Missing Value approach, the defective rate/reduction factor will be substantially reduced to 14.5% for the EWL slab, 6.5% for the NSL slab and 9.4% for overall<sup>20</sup>.
17. It is perhaps noteworthy that certain cyclic tension and compression tests were carried out by MTRCL after the conclusion of the Original Inquiry hearing<sup>21</sup>. By reference to the results of such tests and according to Arup, MTRCL's consultant:-
  - (1) Although 37mm is the compliance acceptance criterion, 32mm (or 7 threads) engagement "*can constitute a full strength connection*" and "*it would be unreasonable not to accept at least 7 thread engagement as an acceptance criterium for a full strength connection*"<sup>22</sup>.

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<sup>18</sup>See Mr. Wells' report for the Original Inquiry, at §4.25, Note 6 [COI 1/ER1/Tab 10/pp. 8 & 21].

<sup>19</sup>See Mr. Wells' report for the Original Inquiry, at §4.10 – 4.13[COI 1/ER1/Tab 10/p. 5].

<sup>20</sup>See Mr. Wells' report for the Original Inquiry, at §§4.27 – 4.32[COI 1/ER1/Tab 10/pp.8-9].

<sup>21</sup>[OU2/907.46 – 907.61].

<sup>22</sup>[OU6/8634].

(2) On this basis the “fit for purpose” acceptance criterion has been taken as 7 threads or 32mm of engagement<sup>23</sup>.

(3) Consequently, the defective rate/reduction factor should be 12%<sup>24</sup>.

18. MTRCL however has not referred to Arup’s report in its 2 reports.

**D. Statistical analysis for the capping beam coupler connections**

19. The position of the Government and Professor Yin is that the defective rate/reduction factor is 68.3%<sup>25</sup>.

20. Mr. Wells’ position is that the defective rate/reduction factor should be at most 46.7%<sup>26</sup>. The difference appears to arise from the different statistics methods adopted (i.e. the Delta Method vs the Monte-Carlo Method).

21. It is also noteworthy that Arup’s position is 23% (based on 32mm engagement length)<sup>27</sup>.

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<sup>23</sup>[OU6/8620].

<sup>24</sup>[OU6/8621, 8637].

<sup>25</sup>See Professor Yin’s report for the Extended Inquiry, at Section 4 [COI 2/ER1/Tab 4/pp.19-21].

<sup>26</sup>See Mr. Wells’ report for the Original Inquiry, at §§3.5 and 4.42 [COI 1/ER1/Tab 10/pp.3 and 12].

<sup>27</sup>[OU6/8621].