FINDINGS ON THE PARTIAL COLLAPSE OF THE MARRIED INSPECTORS QUARTERS AT THE CENTRAL POLICE STATION COMPOUND ON 29 MAY 2016

Independent Review Panel

31 October 2016

(If there are any discrepancies between the English and Chinese versions of this document, the English version shall prevail.)

1. The Hong Kong Jockey Club (**"HKJC"**) appointed an Independent Review Panel (**"Panel"**) to enquire into the partial collapse of the Married Inspectors' Quarters Building (**"MIQ Building"**) (or Block 4) at the Central Police Station Compound (**"CPS Compound"**) on 29 May 2016. The Panel's Terms of Reference are to: -

(a) undertake an enquiry into all the facts and circumstances that led to the partial collapse of the MIQ Building; and

(b) report to the Board of Stewards of HKJC on

  (i) the likely causes of the partial collapse; and

  (ii) whether any additional measures should reasonably or practically have been taken to prevent the incident.

2. The Panel conducted six meetings, visited the collapsed site six times and interviewed 17 persons who worked on the project. The Panel also conducted laboratory and field tests on the construction materials that were used at the MIQ Building and carried out structural analysis on the collapsed part of the MIQ Building. The Panel also reviewed construction drawings, calculation reports, method statements, monitoring records, site photographs and video footages,

inspection reports, a structural condition survey report of the MIQ Building and other relevant documents.

3. The Panel has reviewed various possible causes of the partial collapse and considered each of them using the technical data, construction records and information obtained from the interviews. The Panel's view is that, other than the three most likely causes identified below, the other possible causes are not considered to be direct causes of the incident.

4. The Panel's view is that the collapse most likely initiated at the north façade (**"North Wall"**, see Figure 1) under a "curtain fall" mode, as a result of the failure of one or more of the three brick columns at a point between the ground floor and the second floor, causing the entire section of the North Wall to collapse. This in turn pulled down the upper triangular section of the adjoining West Wall, as revealed in the photograph in Figure 2b below.

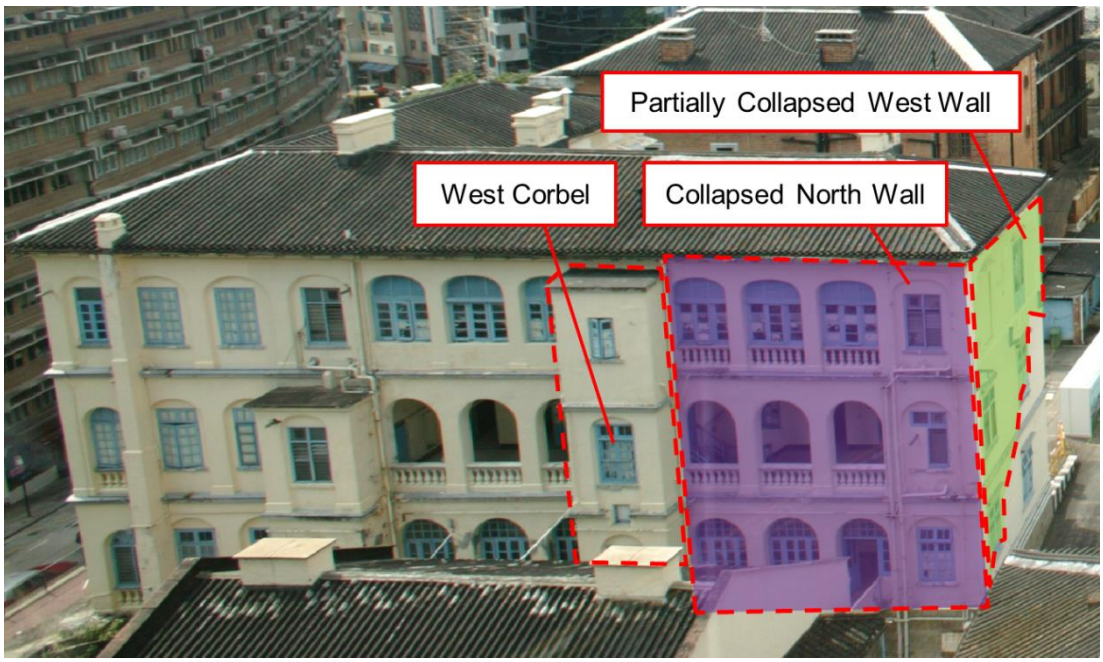

Figure 1: View of MIQ Building from the north

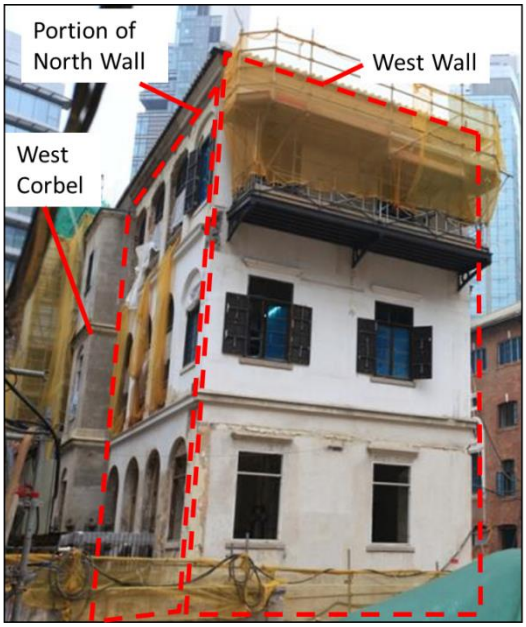

Figure 2a: Before the incident (March 2016)

Figure 2b: After the incident (31 May 2016)

Figures 2a and 2b: Views of MIQ Building from the northwest before and after the incident

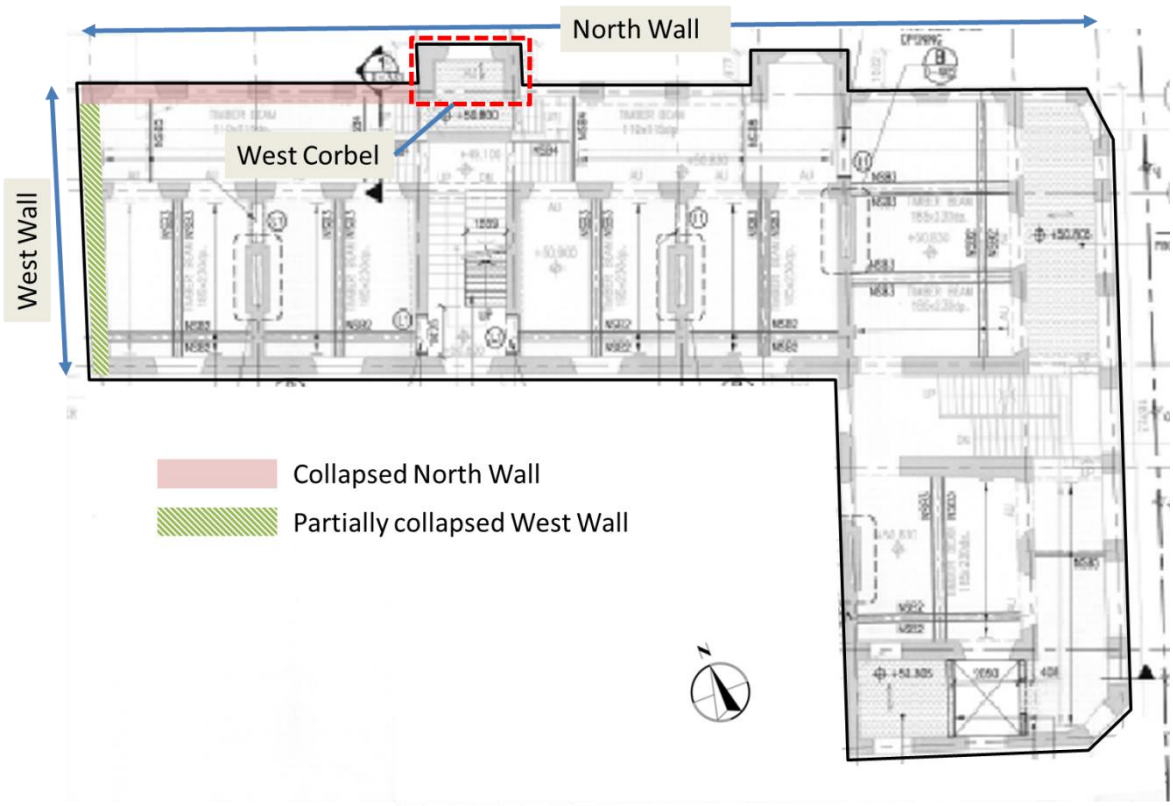

Figure 3: Layout Plan of MIQ Building

5. The Panel's view is that the three likely causes of the partial collapse are:

(a) In March 2016, the West Corbel was temporarily supported by steel support while excavation was carried out at its base for the purpose of installing permanent reinforcement as part of the strengthening works on the west bay window on the North Wall. The temporary steel support would have deflected as a result of carrying the weight of the West Corbel, causing settlement of the West Corbel, which in turn would have caused stress to increase in the adjacent brick columns C4 and C3 of the North Wall (see Figure 4a). Whilst the increase in the stresses in those brick

columns in March 2016 was not large enough to cause failure, it might have reduced the ability of those columns to take any additional load in subsequent stages of the construction works and made the columns C3 and C4 more vulnerable to collapse in the future.

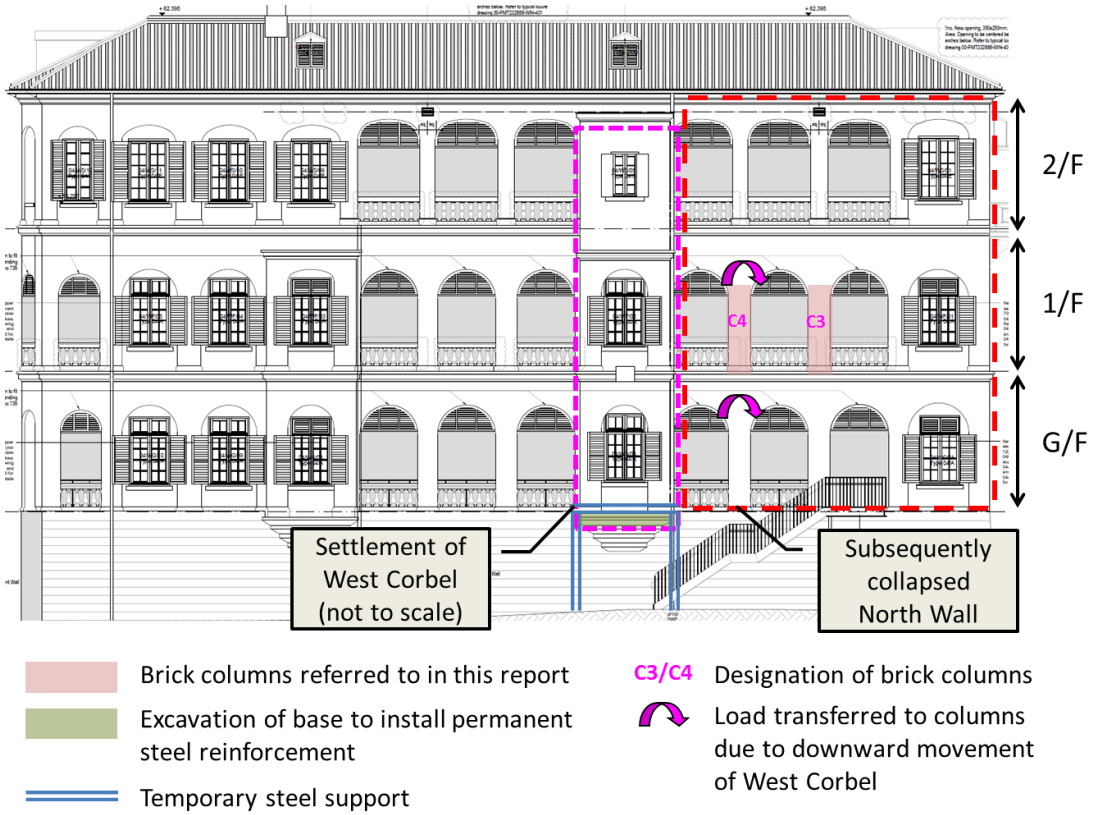

Figure 4: North elevation illustrating West Corbel strengthening works

(b) Since the commencement of the project, the only construction works that have been performed on the collapsed North Wall was carried out between 20 May 2016 and 28 May 2016. Such works were part of the first floor timber floor strengthening and fire resistance works and involve the

excavation of 18 holes on the North Wall to pocket certain steel square box sections into the North Wall. Generally speaking, workers would backfill the holes with bricks bonded with lime mortar and cement grout the remaining gaps on the day of the excavation or on the next day after the excavation. The dimensions of the holes were approximately 350mm wide, approximately 200mm high and 200mm to 300mm deep, and were beneath the first floor level. Eight of such holes had been backfilled by 27 May 2016. On 27 May 2016 and 28 May 2016, four further holes were excavated, including two holes that were close to the bases of brick columns C3 and C4. A worker reported that those four holes were backfilled with bricks and grouted late in the afternoon of 28 May 2016. Further, there was another hole at the base of brick column C4 near the first level floor which had remained open since 20 May 2016. Some of the holes were located beneath and were very close to the base of columns C1 to C4, which support the North Wall from the second floor to the roof above. These brick columns collapsed on 29 May 2016. The excavation of the holes in the North Wall before the collapse is most likely to have been the immediate cause of the collapse.

Figure 5a: Illustration of holes formation on the collapsed North Wall

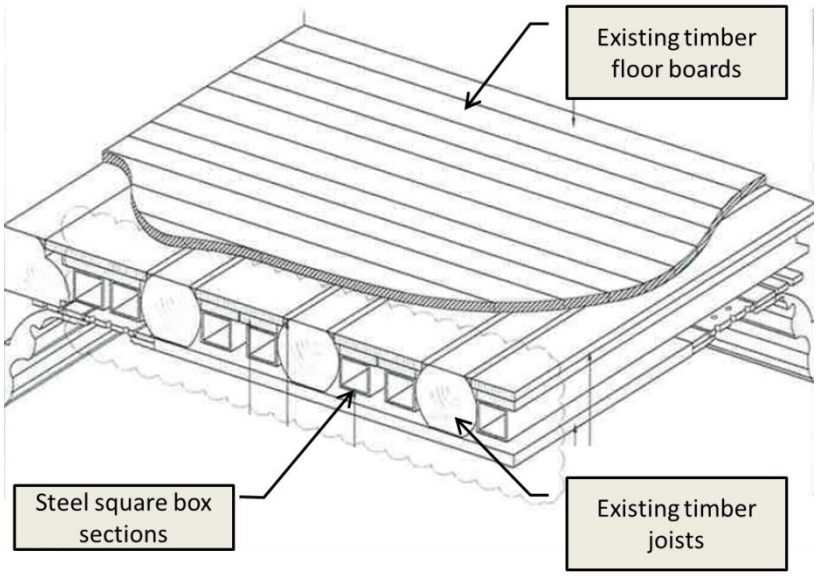

Figure 5b: Illustration of the timber floor strengthening and fire resistance works

Figure 5c: Photo taken after the incident showing holes excavated in the North Wall

(c) The final likely contributory cause of the collapse is the combined effect of localised weak masonry and the cutting of holes at the brick columns. Visual inspection of the North Wall columns prior to the hole excavation might have led to a conclusion that the brick columns could have remained stable during the period of the temporary cutting of holes. In reality, the brick columns might have had unnoticed vertical cracks or weak bonding at the first floor near the holes that allowed cracks to propagate during or shortly after the hole excavation and led to the eventual collapse. Fortunately, the cutting of many holes in the masonry walls only occurred in MIQ Building and not in the other buildings at the CPS Compound.

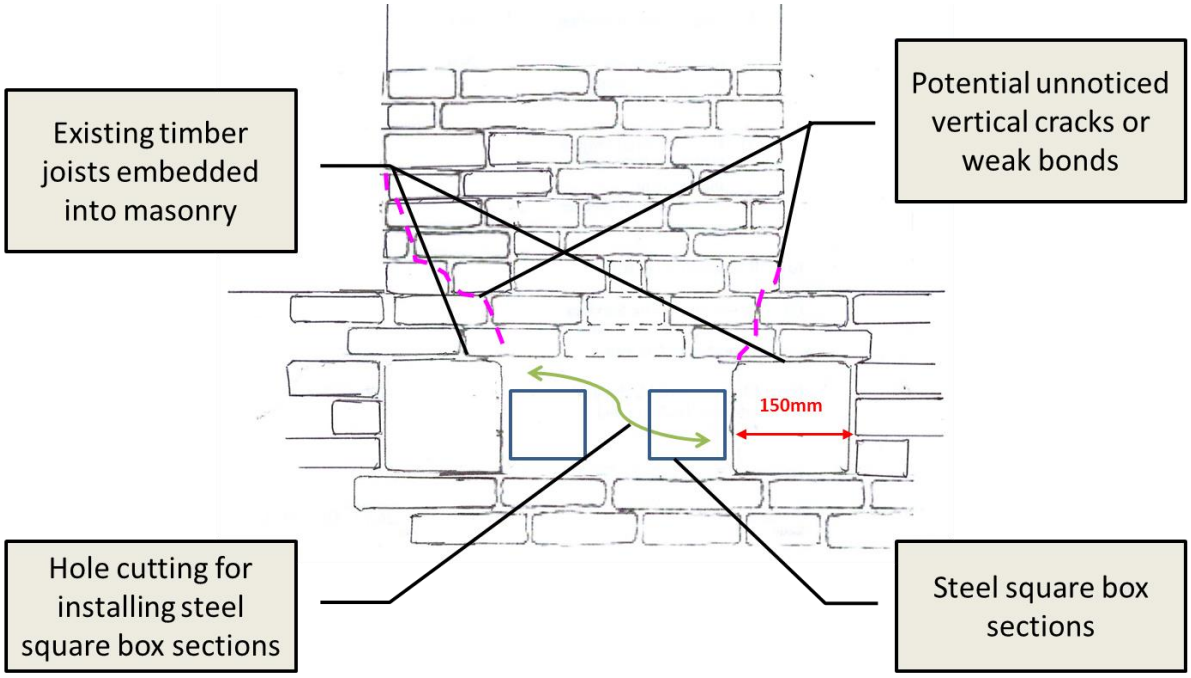

Figure 6a: Combined effect of localised weak masonry and holes formation

Figure 6b: Example of vertical cracks revealed after removal of rendering at a column in the east wing of the MIQ Building

6. With regard to any additional measures that should reasonably or practically have been taken to prevent the incident: -

(a) The Panel, through its investigation, has identified that, in planning for the timber floor strengthening and fire resistance works, any holes for pocketing the square steel box sections which were located within the brick columns base width should have been avoided and an alternative reinforcement detail, which did not involve cutting into the zone immediately below the brick columns, should have been adopted.

(b) Shoring and propping of the arches and floors should have been installed prior to the cutting of any holes into critical load bearing areas, including the brick columns, in substitution of the function of the brick columns. The Panel notices that these have now been carried out in the remaining parts of the MIQ Building after the incident.

~End~

有關二零一六年五月二十九日晚上
舊中區警署建築群已婚督察宿舍大樓
部分倒塌事故
檢討結果

獨立檢討小組

二零一六年十月三十一日

（如中/英文版本有異，以英文版本為準）

一. 香港賽馬會（「馬會」）委任獨立檢討小組（「檢討小組」）調查二零一六年五月二十九日晚上發生的舊中區警署建築群已婚督察宿舍大樓部分倒塌事故。檢討小組的職權範圍包括：

（甲） 就導致已婚督察宿舍大樓部分倒塌的所有事實及情況進行調查；及

（乙） 向馬會董事局就以下事項作出匯報：－

（i） 造成大樓部分倒塌的可能原因；及

（ii） 是否有合理或可行的措施可以採取以避免事件發生。

二. 檢討小組進行了六次會議，在倒塌現場進行了六次實地研究，並會見了十七位有份參與該項目的人員。檢討小組亦對已婚督察宿舍使用的建築物料進行了實驗室及現場測試，並對大樓倒塌的部份進行了結構分析。檢討小組亦檢閱了與已婚督察宿舍大樓有關的施工圖、計算報告、施工方案、監察紀錄、

地盤相片及錄像、視察報告、結構狀況勘測報告及其他相關文件。

三. 檢討小組檢視過多個導致大樓部分倒塌的可能原因，亦根據技術數據、建築紀綠及會面所得的資料考慮了每個原因。檢討小組認為，除以下三項最可能的起因外，其他的都不是導致事故發生的直接原因。

四. 檢討小組認為大樓的部分倒塌，是始於向北的牆(見圖 1「北面牆」)當中三條磚柱其中一條或多條於地下和二樓之間受到損毀，導致整幅牆發生「幕落模式」倒塌。如下圖 2b 所見，北面牆倒塌亦把相連的西邊牆高處的倒三角部份拉下。

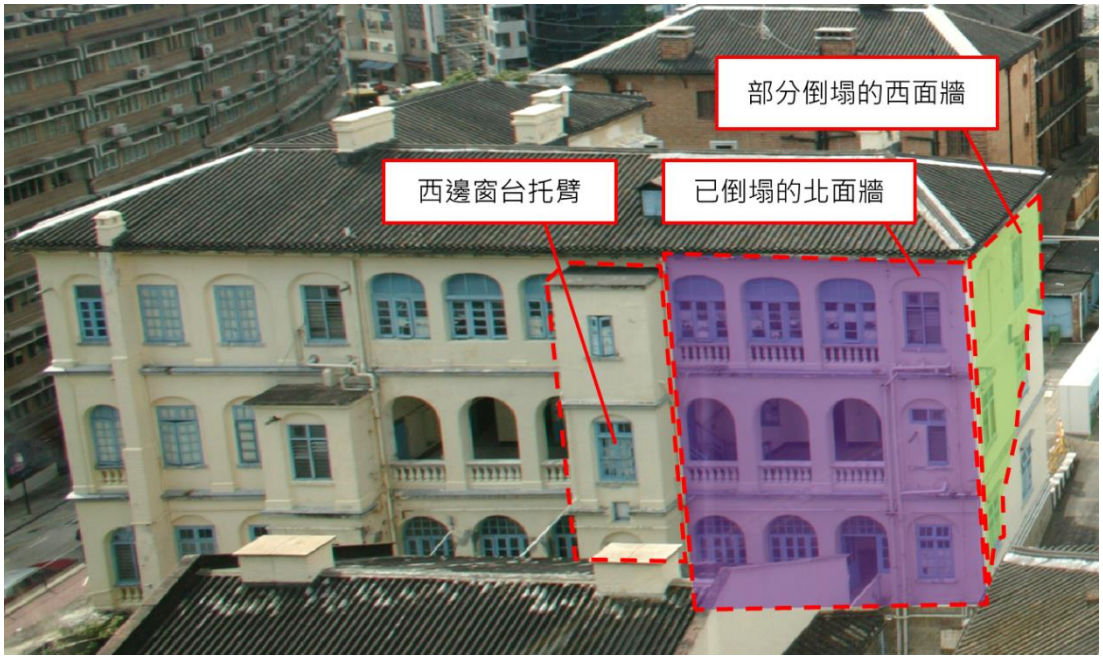

圖 1: 已婚督察宿舍大樓（北視圖）

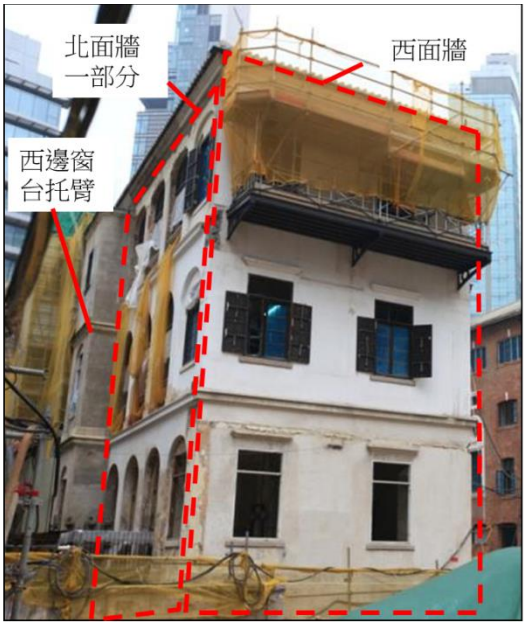

圖 2a: 事件發生前 (二零一六年三月)

圖2b: 事件發生後 (二零一六年五月三十一日)

圖 2a 及 2b: 已婚督察宿舍大樓（西北視圖）（事件發生前後對比）

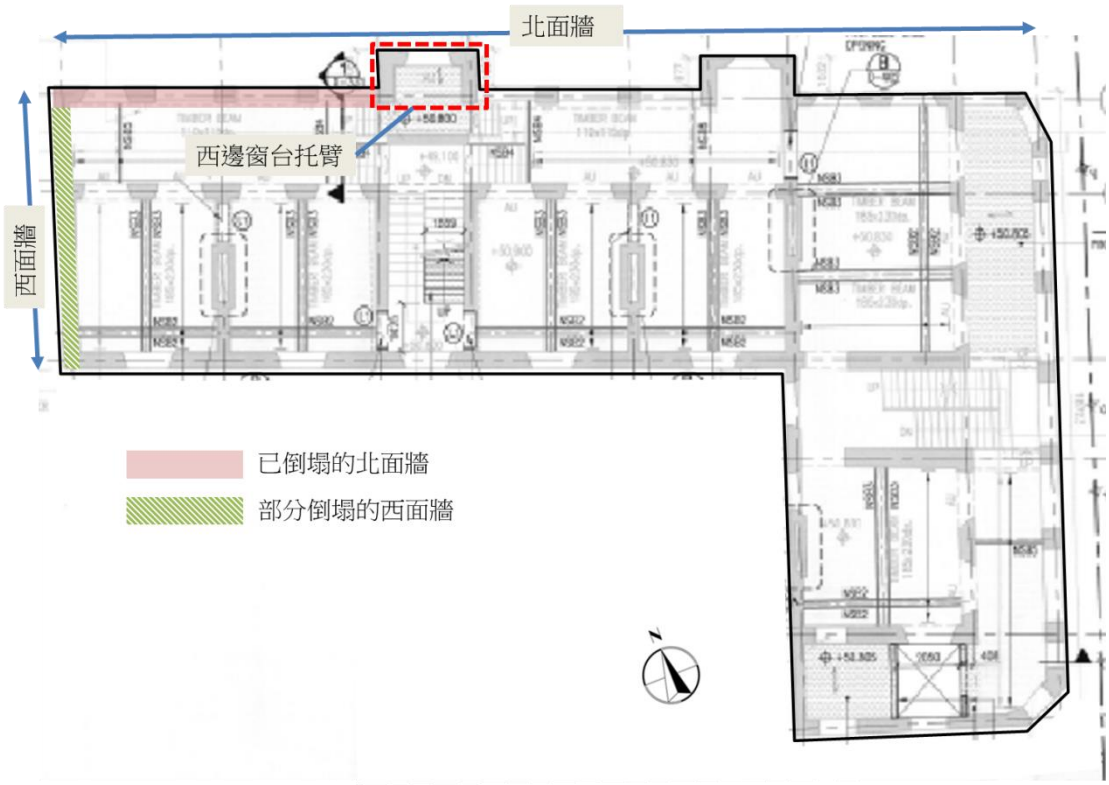

圖 3: 已婚督察宿舍大樓的平面圖

五. 檢討小組認為以下的三件事項是引致大樓部分倒塌的可能原因：-

(一)在二零一六年三月，北面牆的西邊窗台進行鞏固工程。施工過程中，在西邊窗台托臂下安裝鋼框架作為臨時支撐，以便進行托臂底部的挖掘及安裝永久支撐工序。鋼框架因承托窗台的重量而壓縮，導致托臂及窗台出現輕微沉降。沉降導致鄰近的磚柱 C4 及 C3（見圖 4a）的負荷增加。增加負荷並未足以導

致倒塌，但可能令致 C4 及 C3 磚柱在往後的施工過程中，可以承受的額外負荷減少，因而增加倒塌風險。

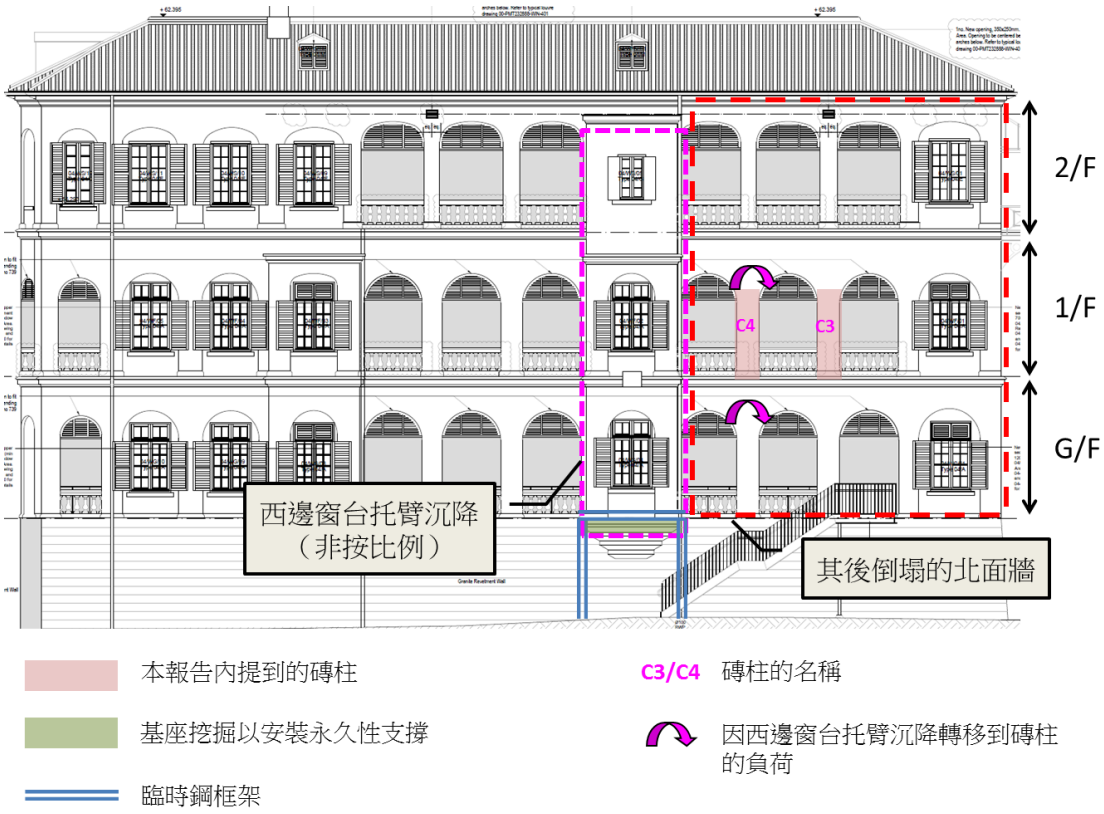

圖 4: 西邊窗台托臂鞏固工程（北視圖）

(二)自舊中區警署項目開展後，唯一在北面牆倒塌部分進行過的工程，乃於二零一六年五月二十日至五月二十八日期間進行。是項工程屬於一樓木地板鞏固及防火工程的其中一部份，計劃是在北面牆挖掘十八個小孔，把方形鋼管安放進北面牆。工人一般會於施工當天或翌日以石灰砂漿黏合的磚頭填回小

孔，剩餘的空隙則灌入英泥漿。小孔約 350 毫米闊、200 毫米高、及 200 至 300 毫米深，位於一樓樓面下面。當中八個小孔在五月二十七日前完成回填。另外四個小孔則是在五月二十七日及五月二十八日開挖的，其中兩個小孔接近 C3 和 C4 磚柱底部。據悉工人在二十八日下午較後的時間已用磚頭填回該四個小孔及灌漿。此外， C4 磚柱一樓柱底部另有一個小孔在五月二十日挖掘後一直留空。部份小孔位於北面牆支撐二樓及屋頂的 C1 至 C4 柱的底部，非常接近 C1 至 C4 柱底的範圍內。這些磚柱在二零一六年五月二十九日晚上倒塌。在事故發生前於北面牆挖掘的小孔，是最有可能導致大樓部份倒塌的即時原因。

圖 5a：在已倒塌的北面牆小孔形成的情況

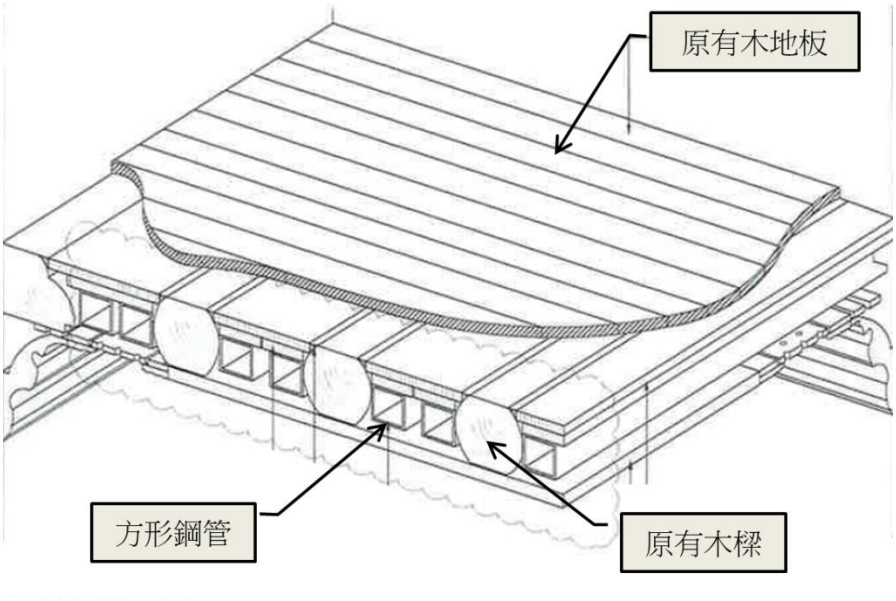

圖 5b：木地板的鞏固及防火工程

圖 5c: 在北面牆已挖掘的小孔（事件發生後攝）

(三)最後一個可能引致倒塌的原因，是大樓內局部較弱的磚石結構與在磚柱開挖小孔的綜合效應。即使在開挖小孔事前目測北面牆磚柱，相信磚柱結構狀況，能夠在短暫的小孔挖掘時段保持穩定。但事實上，磚柱可能在小孔附近內藏未能被察覺的垂直裂縫或較弱的粘結砌體，在開挖期間或稍後，誘發裂縫擴散，最終導致磚柱倒塌。可幸得悉在磚牆挖掘多個小孔的情況，只發生於已婚督察宿舍大樓，而不涉及中區警署建築群的其他樓宇。

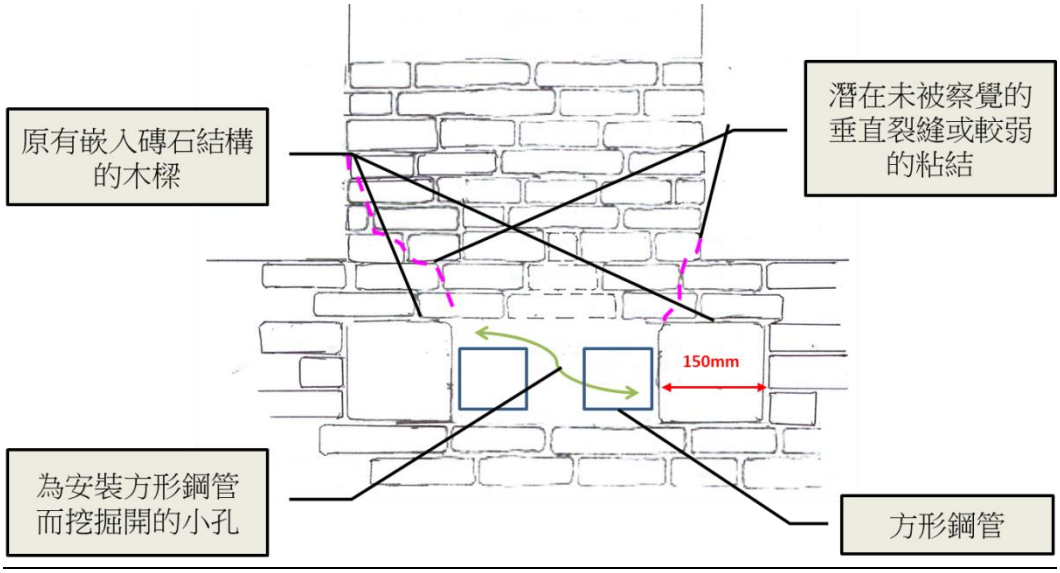

圖 6a：局部較弱的磚石結構與挖掘小孔所造成的綜合效應

圖 6b：已婚督察宿舍大樓東翼其中一條磚柱在移除批盪後發現的垂直裂縫

就是否有合理或可行的措施可以採取以避免事件發生:

(甲)檢討小組經調查後認為規劃木地板鞏固及防火工程，應該避免在磚柱底部下挖掘安放方型鋼管的小孔，而改為採用不涉及於磚柱底部開孔的替代加固工程方案。

(乙)在主要的結構件，包括磚柱進行挖掘工程之前，應該先在鄰近拱門及地板安裝好足夠的裝頂，代替磚柱的功能。檢討小組注意到，在事件發生後，這些措施已經在已婚督察宿舍的其他部分實施。

~完~