Technical Investigation Report on Lift Incident at Waterside Plaza, Tsuen Wan, New Territories

新界荃灣海灣花園升降機事故技術調查報告

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English Version

英文版

機電工程署 EMSD

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Executive Summary

At about 4:37 pm on 8 April 2018, Lift No. 6 installed at Block 2, Waterside Plaza, Tsuen Wan, New Territories was carrying two passengers upwards from 7/F, but the lift doors did not open at the destination floor (15/F), and the lift continued to ascend until it collided with the ceiling of the lift shaft.

The technical investigation team of the Electrical and Mechanical Services Department (EMSD) found that the solenoid plunger of the brake system was jammed by metal debris from a damaged spacer ring, thereby obstructing the movement of the plunger and the application of the brake to stop the lift at the time of the incident.

Without an effective braking to hold the lift stationary, the lift car was pulled upwards by the heavier counterweight until it collided with the ceiling of the lift shaft.

The EMSD attaches great importance to lift safety. Following the incident, the EMSD required lift contractors to conduct special inspections on the brake systems of all lifts of the same brand to ensure their safe operation. The EMSD has also reminded all registered lift contractors to maintain the brake in accordance with the requirements in the Code of Practice for Lift Works and Escalator Works (CoP).

Following the completion of the technical investigation, The EMSD is conducting criminal investigation into the case, and will proceed with enforcement action if contravention to the Lifts and Escalators Ordinance or non-compliance with the relevant CoP is identified.

Technical Investigation Report on Lift Incident at Block 2, Waterside Plaza, Tsuen Wan, New Territories on 8 April 2018

1. Objectives

1.1 The purpose of the technical investigation is to identify the causes of the lift incident which occurred at Block 2, Waterside Plaza, Tsuen Wan, New Territories on 8 April 2018. This report presents the results of the technical investigation into the incident by the EMSD.

2. Background of the Incident

2.1 The lift incident occurred at Block 2, Waterside Plaza, Tsuen Wan at around 4:37 pm on 8 April 2018. At the time of the incident, Lift No. 6 was carrying three passengers upwards from G/F. One passenger left at 7/F while the other two continued to travel to their destination floor (15/F). When the lift reached 15/F, the doors did not open, instead the lift ascended to 46/F and finally collided with the ceiling of the lift shaft before it stopped. The two passengers were seriously injured.

3. Technical Information of the Lift Involved in the Incident

3.1 The lift was driven by a direct current (DC) variable voltage traction machine, with a rated speed of 2.5 metres per second and a rated load of 700 kilograms (or nine persons), serving all floors of the building from G/F to 46/F. The total travel of the lift was about 116 metres.

3.2 The lift was suspended by five suspension ropes, each with a nominal diameter of 12 millimetres. The lift machine room on the top of the lift shaft housed the traction machine of the lift.

3.3 The traction machine was equipped with a brake system (Figure 1) in which a single brake solenoid [a] was installed in a vertical orientation. The brake was made up of two braking arms [b] with a brake spring [c] and brake pad [d] for each arm. To release the brake, power had to be supplied to the brake solenoid coil [e] to generate a magnetic force to push the plunger [f] in the downward direction. The downward moving plunger [f] ① pushed the lever arms [g] downward via a circular block [h] attached to the bottom end of the plunger [f]② (see Figure 2), which in turn compressed the brake spring [c]③ and drove the braking arm [b] with the brake pads [d] away from

the brake drum [j]④. Once the brake pads [d] were driven away from the brake drum [j], the traction sheave attached to the brake drum [j] could then rotate. The lift car attached to the suspension ropes would be driven to ascend or descend by the traction sheave.

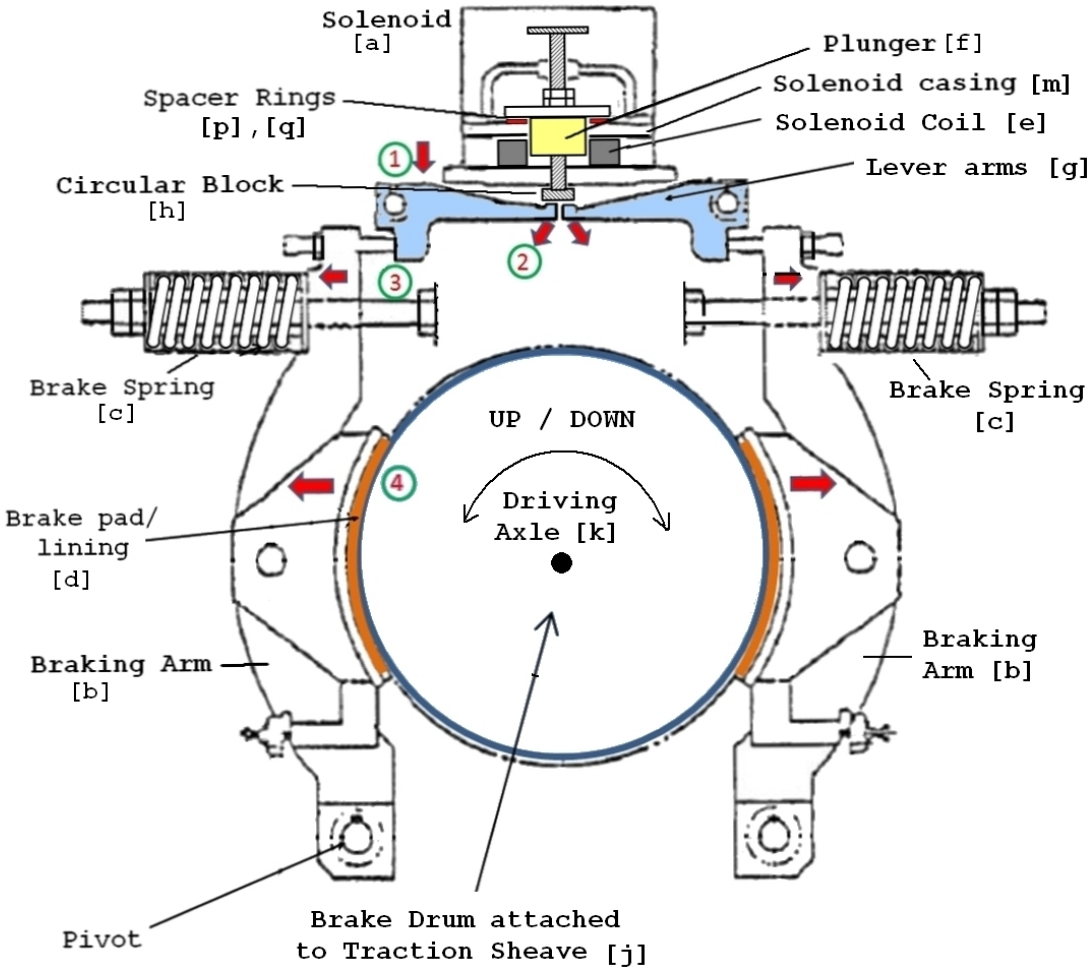

Figure 1 - Arrangement of lift brake system (released)

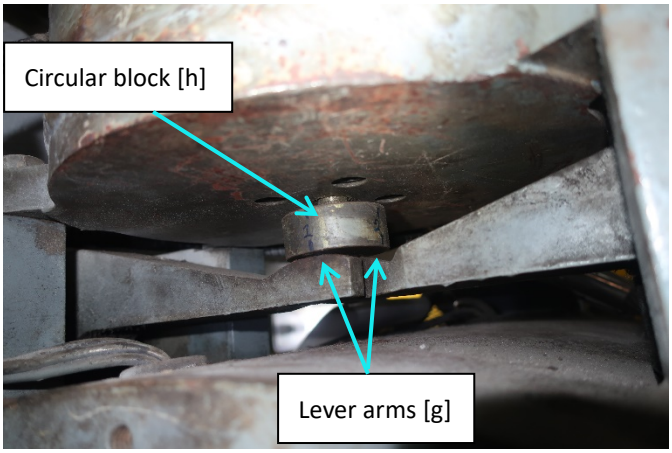

Figure 2 – Brake plunger

3.4 To apply the brake, power supply to the brake solenoid coil [e] (see Figure 3) was disconnected and the magnetic force generated by the solenoid coil for pushing down the plunger[f] was removed. The compressed brake springs [c] ③ would press the braking arms [b] and the brake pads [d] onto the brake drum [j] ④ in order to stop the movement of the lift car. The lever arm [g] ② and the plunger [f] ① would also be pushed upwards by the brake spring [c]. Eventually plunger [f] would fall under its own weight and the attached circular block [h] would rest in contact with the lever arms [g]. The plunger [f] should also be capable of being rotated smoothly within the solenoid casing [m].

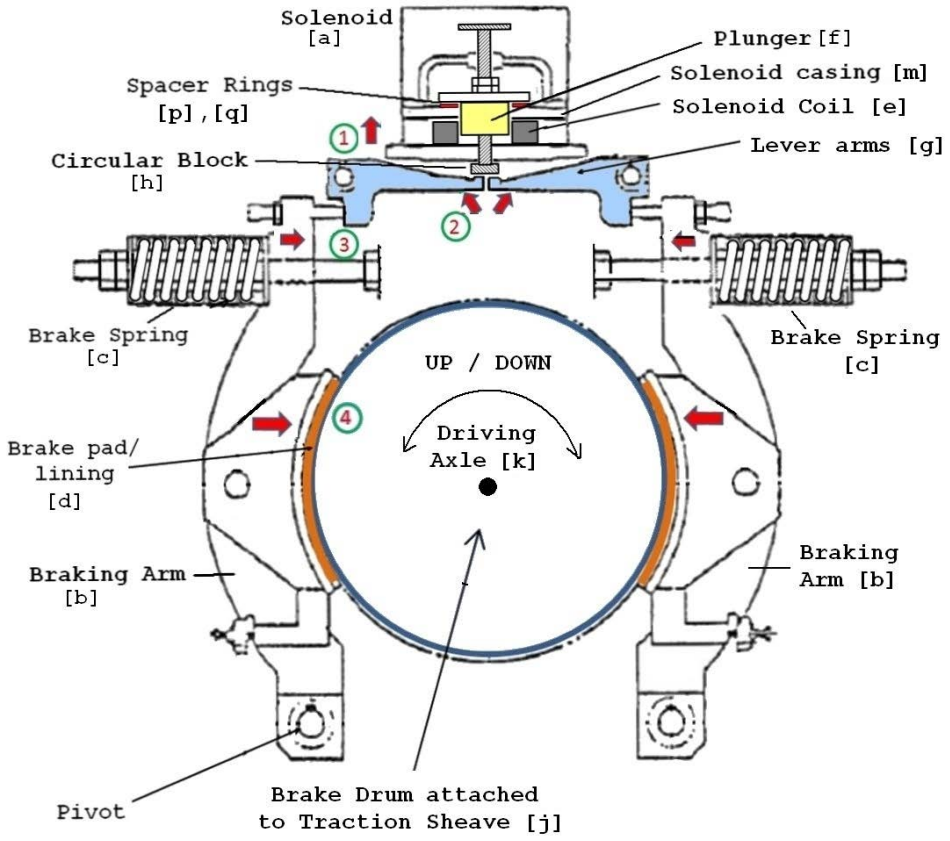

Figure 3 - Arrangement of lift brake system (engaged)

3.5 Basic particulars of the lift are as follows:

Make	Dong Yang
Drive Control	DC variable voltage electric motor
Rated Speed	2.5 m/s
Rated Load	700 kilograms
Rope Ratio	2 to 1

Floor Served	G/F, 2, 5-12, 15-23, 25-33, 35-43, 45-46/F
Year of Installation	1991
Date of Last Examination with Load by Registered Lift Engineer	25 January 2018
Date of Last Routine Maintenance by Registered Lift Worker	26 March 2018

3.6 Appendix I illustrates the basic structure of a lift.

4. Approach of Investigation

4.1 The approach of the investigation is outlined below:

(i) review and analyse the CCTV footage to assess the movement of the lift during the course of the incident;

(ii) inspect and test the brake system, traction sheaves and suspension ropes, with the assistance of an independent expert;

(iii) retrieve and analyse the status log from the lift controller;

(iv) interview the maintenance personnel and those involved in the incident, including fire services officers, responsible person concerned, registered lift contractor, registered lift engineer, registered lift workers, general workers and passengers involved in the incident; and

(v) collect and examine relevant records, including logbook, maintenance instructions and records, test and examination reports.

4.2 Owing to the damage to the supporting structures at the ceiling of the lift shaft, structural stabilisation works including addition of fixings and supports were needed. The investigation could only proceed upon completion of such works.

5. Observations and Findings

5.1 The CCTV footage revealed that the lift carried three passengers upwards

from G/F. One passenger left at 7/F and the doors were closed, and then the lift carried the other two passengers to 15/F. However, the lift doors did not open at 15/F and the lift continued to ascend until it hit the ceiling of the lift shaft. The status log recorded by the lift controller indicated that a series of fault signals had been generated since reaching 15/F, indicating failure to stop the lift machine and engage the brake in order to stop the movement of the lift, and the lift car travelling upwards beyond the final limit switch above the topmost floor to eventually hit the lift shaft ceiling.

Findings by Materials Expert

5.2 Two spacer rings [p and q] (See Figures 4 - 6) between the plunger's top flange [n] and the brake solenoid casing [m] were found broken and heavily deformed.

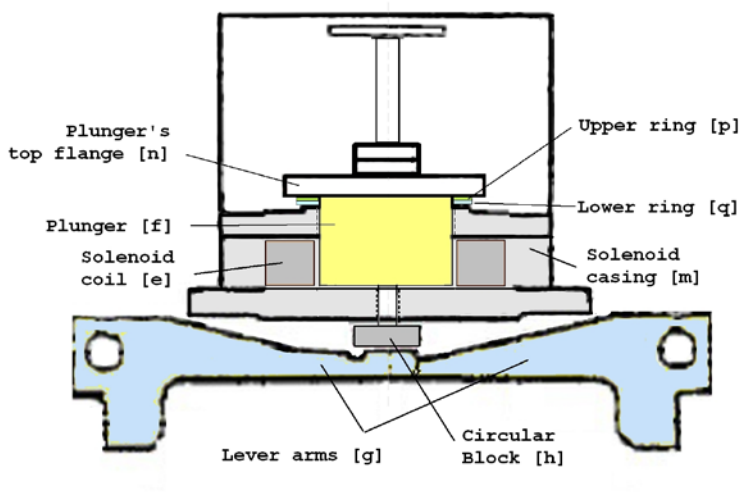

Figure 4 – Detailed view of Brake Solenoid [a]

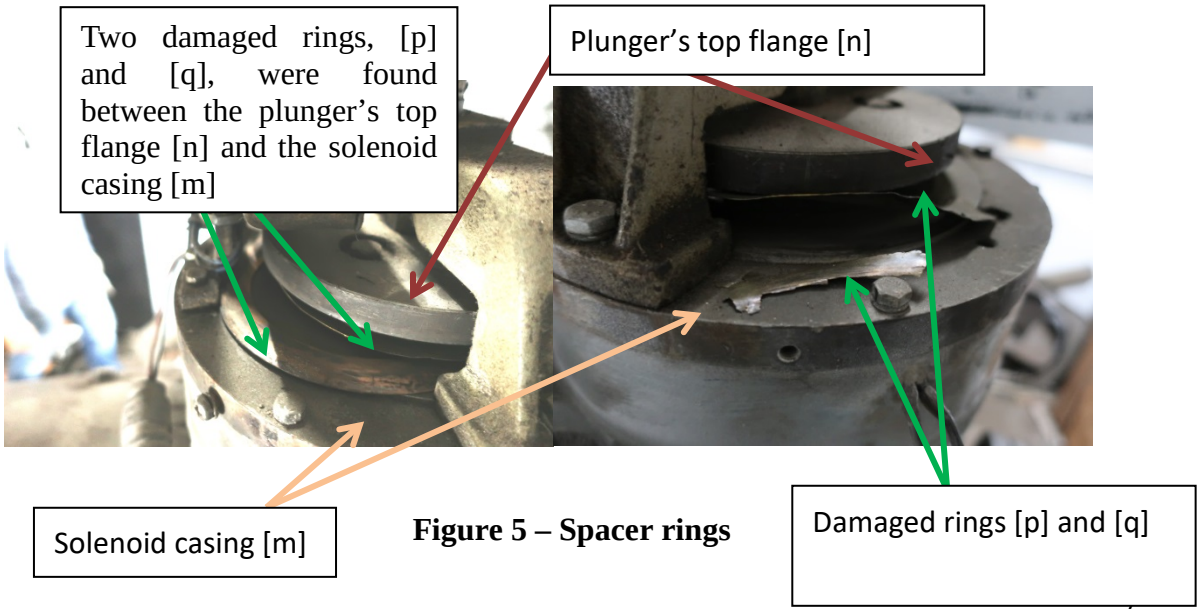

Figure 5 – Spacer rings

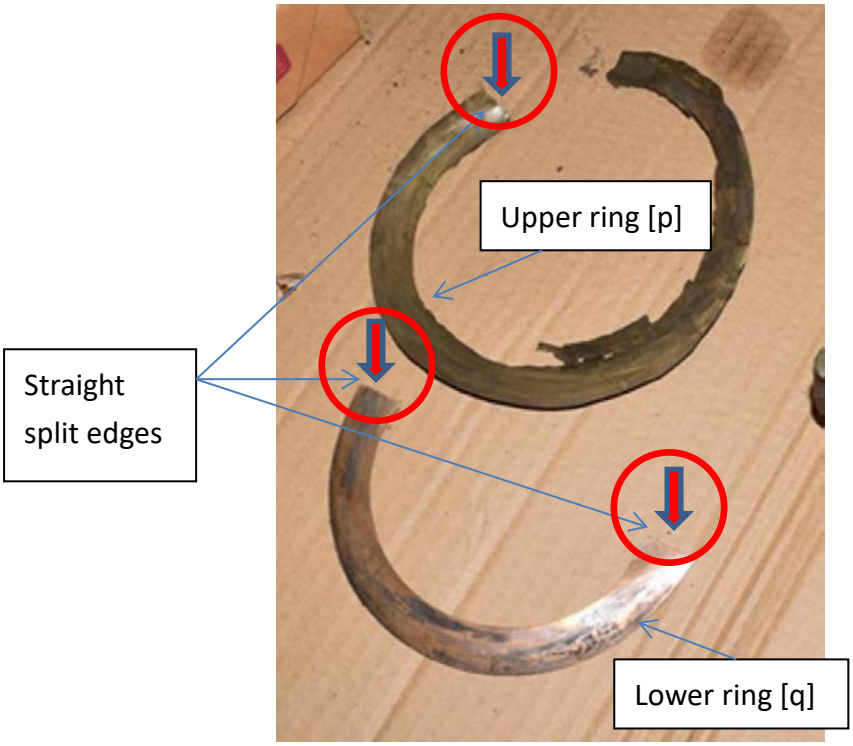

Figure 6 - Spacer rings

5.3 In the test carried out after the incident, the brake plunger [f] started operating jerkily upon energisation of the solenoid coil [e] before slamming downwards forcefully. When the power supply to the solenoid coil [e] was cut, the plunger [f] was pushed back upwards forcefully by the brake spring [c]. The circular block [h] at the end of the plunger [f] did not rest down on the lever arms [g] as it would have normally done if the plunger [f] was free to fall back down by gravity inside the solenoid casing [m], indicating that the plunger [f] was jammed.

5.4 The plunger [f] could not rotate as smoothly as other plungers in lifts of similar make and model, again indicating that the plunger concerned was jammed.

5.5 The spacer rings [p and q] between the plunger [f] and the solenoid casing [m] were found damaged. In the laboratory analysis, the upper ring [p], which sustained more severe hammering/stamping damage due to the plunger's top flange [n] hitting the ring [p] and the plunger [f] dragging the edges, suffered thinning and some of its edges were cut into strips. The ring was also split open at one position.

5.6 The lower ring [q] was split open and only half was found remaining between the plunger [f] and the solenoid casing [m]. This ring sustained less severe stamping damage.

5.7 Upon removal of the plunger [f], metal debris was found trapped inside the solenoid casing [m] (Figure 7). The debris was of similar composition as the upper spacer ring [p].

Figure 7 - Metal debris

5.8 Damage and scratches were found on the plunger [f] surface (Figures 8 and 9). There were also scratches on the plunger's [f] axle rod (Figure 10) and the bush was worn down unevenly (Figure 11). The damages and wearing are believed to be caused by the metal debris being jammed in the solenoid casing [m] along the travel of the plunger [f].

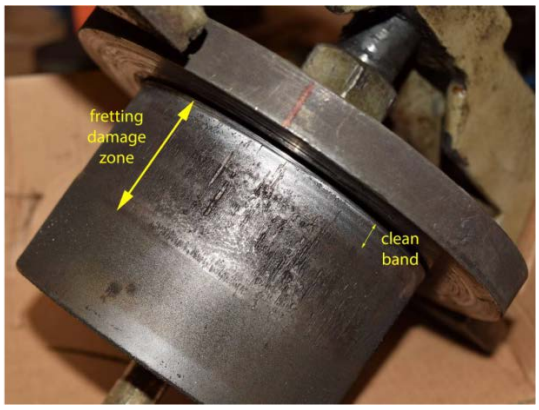

Figure 8 - Plunger surface

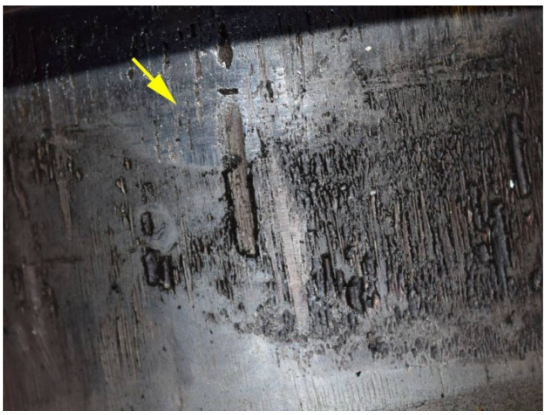

Figure 9 - Plunger surface

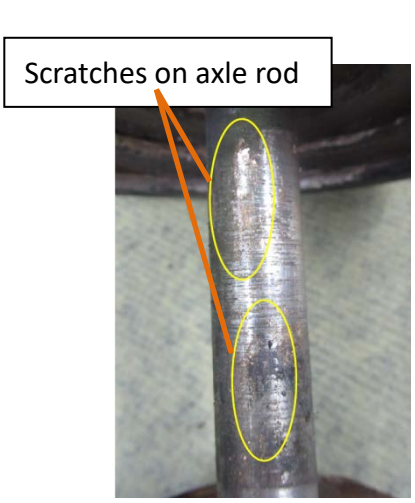

Figure 10 - Plunger rod

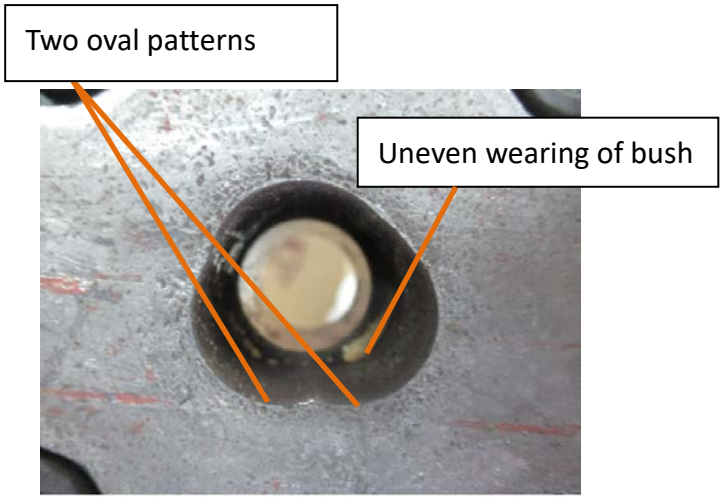

Figure 11 - Bush at the bottom end of the solenoid casing [m]

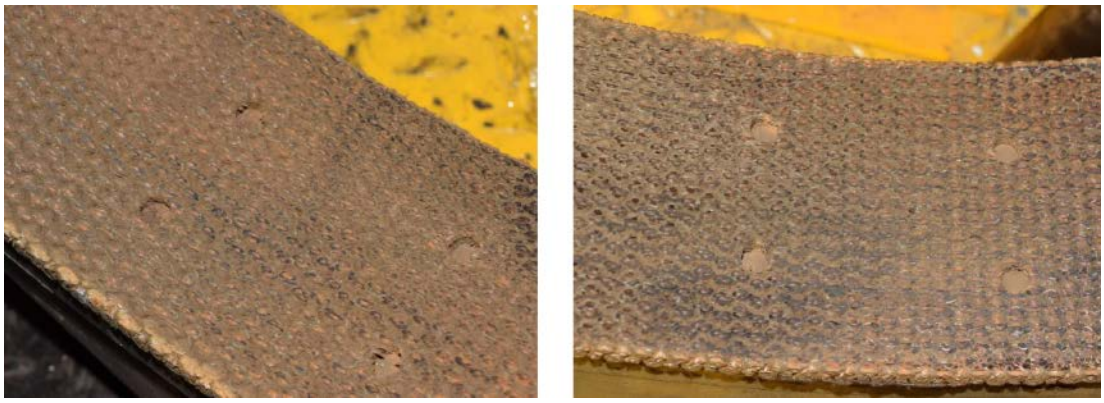

Figure 12 – Lining surface of the brake pads

5.9 The brake pads [d] were in good condition and had no signs of overheating. No obvious scratch marks or abnormal wear patterns were found on the lining surfaces (Figure 12).

5.10 A static load test was conducted to measure the braking force of the engaged brake system. The result showed that the engaged brake system of the lift could provide sufficient braking force to the lift system.

5.11 The profiles of individual grooves on the traction sheaves were checked and found to be satisfactory for normal operation. There should be sufficient traction, and there were no signs of rope slippage.

5.12 No abnormality was found regarding the condition of the five suspension ropes of the lift concerned.

6. Conclusions

6.1 From the available evidence, the lift motor was believed to have stopped when the lift reached the destination floor (15/F), but the lift car could not be held thereat due to jamming of the brake plunger [f] and so malfunctioning of the brake system. Without any braking force and with the lift car carrying only 2 passengers and so less heavy than the counterweight, the lift car was pulled upwards by the counterweight and eventually hit the lift shaft ceiling.

6.2 The cause of malfunction of the brake system was the trapping of metal debris from the damaged upper spacer ring [p] that eventually jammed the movement of the plunger[f], preventing the mechanical brake from engaging at the time of the incident.

6.3 The upper spacer ring [p] was damaged by repeated hammering/stamping, which generated metal strips and debris that jammed the brake plunger[f] at the time of the incident.

7. Measures Taken after the Incident

7.1 Subsequent to the lift incident, the EMSD took immediate action to inspect other lifts of Dong Yang brand installed at Waterside Plaza. They were checked to be in safe working order.

7.2 As a prudent measure, the EMSD also requested all registered lift contractors who were responsible for the maintenance of the same brand of lift to complete special inspections within two weeks, covering the traction systems, suspension ropes and braking systems. The special inspections covered 384 lifts of the same brand installed in Hong Kong, and sampling checks were conducted by the EMSD. Except for the lift involved in the incident at Waterside Plaza and ten others for which special inspections were not yet conducted due to modernisation works in progress, special inspections for the remaining 373 lifts had been completed with their associated equipment (traction systems, suspension ropes and braking systems) confirmed to be in safe working order.

7.3 According to the Code of Practice for Lift Works and Escalator Works, registered lift contractors are required to carry out brake maintenance and overhaul works as recommended by the lift manufacturer to ensure safe operation of lifts. The EMSD has issued circular letters to all registered lift contractors to remind them to maintain the brake system properly according to this requirement.

7.4 The EMSD is conducting criminal investigation on the case, and will proceed with prosecution and/or disciplinary action if contravention to the Lifts and Escalators Ordinance or non-compliance with the relevant code of practice is identified.

Appendix I

Basic Structure of a Lift