

**INVESTIGATION REPORT
ON THE COLLAPSE OF THE CANOPY
OF A BUILDING
AT 3 Kin Kwan Street, Tuen Mun – T.M.T.L. 87
on 9 June 2011**



Buildings Department

July 2011

Introduction

1. On 9 June 2011 at about 6:00pm, the cantilevered slab canopy of a building at 3 Kin Kwan Street, Tuen Mun collapsed. The Buildings Department (BD) immediately mobilized its contractor to carry out emergency works to remove the damaged parts of the canopy and to support the remaining parts to ensure safety of the public.

2. The subject building is an industrial building of 13-storey high with occupation permit issued on 2 November 1979. The building has long frontages on Kin Kwan Street and Kin Wing Street. There was a 1.5 m span cantilevered slab reinforced concrete canopy at 1/F level of the building. The canopy ran continuously along the southern and eastern elevations (along Kin Kwan Street) and about 1/3 of the northern elevation (along Kin Wing Street) of the building. A portion of the canopy about 40 m long on the east elevation of the building collapsed onto the pavement on 9 June 2011 (see Annex).

Investigation

3. After the collapse of the canopy, the BD has conducted an investigation into the cause of the incident, through site inspection, analysis of samples collected on site, review of building records, and examination of information gathered from eyewitnesses.

4. From the evidence available, the following situations were revealed:

- (a) According to the BD's record, there was no submission for alteration and addition works related to the collapsed canopy of the building. Nevertheless, the approved 225 mm wide surface channel at the inner edge on the top of the canopy abutting on the external wall for draining of the surface water on the canopy was covered up with thickened screeding.
- (b) According to the witness statements, no building work was carried out on the canopy before the collapse but signs of water seepage were noted on the soffit of the canopy in recent years even not on rainy days. Also, blockage of the drainage outlets on the canopy was reported by one witness.

- (c) According to a witness who saw the actual collapse of the canopy, the portion of canopy on the eastern elevation of the building over the carpark entrance and the Shop No. B on the right started to fail first and then the whole section of the canopy on that elevation collapsed.

Structural Assessment – Cause of Collapse

5. Site investigation revealed that the reinforcement placement of the canopy was found to slightly deviate by 10% in bar spacing and 7% in vertical placement from the approved structural details but were consistent with the one revealed and recorded in an Authorized Person's investigation report submitted to BD in late 1997 and approved in early 1998¹. The extent and projection of the canopy were generally in accordance with the approved building/structural plans.

6. The measured thickness of the canopy slab was 130 mm throughout the span and the average assessed Structural Performance Factor for the canopy was about 1.3 which was greater than 1.1². Laboratory testing was carried out for the samples of concrete and steel reinforcement bars obtained from the collapsed canopy. The results of the testing are:

- (a) Crushing test of 10 core samples extracted from the collapsed canopy gave a mean concrete strength of 46 MPa which was more than the required characteristic compressive strength of concrete of 20 MPa.
- (b) 30 samples of steel reinforcement bars were taken for strength test. The average yield strength of the steel reinforcement bars evaluated was 410 MPa which met the required material yield strength for the design of the canopy.

¹ The AP's investigation report was submitted in response to an investigation order issued under section 26A(1) of the Buildings Ordinance by the BD to the owners in April 1997 requiring investigation of and report on the stability of the canopy. The AP's certification on completion of the remedial works was acknowledged by the BD in April 1999.

² The acceptable safety margin for cantilevered slab type structures.

7. Based on the on-site observation, it was found that the degree of corrosion of the steel reinforcement bars in the collapsed canopy, in particular at the portion located about 10 m to 22 m measured from the north-eastern corner of the building (the affected portion), was severe. Based on the on-site measurement and the results of the laboratory testing, structural evaluation of the canopy was carried out.

8. It was found that the severely corroded steel reinforcement bars in the affected portion were beyond their ultimate tensile strength. The affected portion of the canopy failed and collapsed when the steel reinforcement bars were stressed beyond their ultimate strength. As a result, the self weight of the affected portion that collapsed was redistributed from the edge beam to the adjoining portions of the canopy triggering its progressive collapse.

9. Rather extensive muddy deposits were observed near the root of the affected portion of the collapsed canopy which was right above the eastern entrance of the carpark and the two G/F shop units (Shop No. B and Shop No. B1) on the right. This is suggestive of prolonged water ponding at that location.

10. Judging from the condition of the steel reinforcement bars at various parts of the canopy, it is highly probable that the corrosion of steel reinforcement bars was the result of prolonged water infiltration at the root of the affected portion of the collapsed canopy. The collapse mode of the canopy was structural failure in bending of the steel reinforcement bars at the root of the cantilevered slab canopy when the bars were stressed to a magnitude beyond their ultimate tensile strength.

Conclusion

11. The effectiveness of draining the surface water on the canopy had been adversely affected by the covering up of the surface channel with screeding and caused the accumulation of water on the canopy especially at the affected portion. The accumulated water then penetrated through the inner edge of the canopy and caused serious corrosion of the steel reinforcement bars inside. Over time, the strength of the reinforcement bars at the affected portion was reduced to an extent that they could not support the self weight of the canopy and started to fail. The self weight of the canopy further fractured the corroded reinforcement bars at both sides of the affected portion of the

canopy and caused the sudden collapse of the whole section of the canopy on that elevation.

12. According to the witness statements, no building work was carried out on the canopy before the collapse. Also, the canopy was designed and constructed with the subject building in accordance with the approved plans of the building and no significant unauthorized building work was involved.

13. In view of the above findings, it can be concluded that the cause of collapse was mainly due to lack of proper and periodic maintenance of the canopy, in particular the drainage system and waterproofing thereof.

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ANNEX

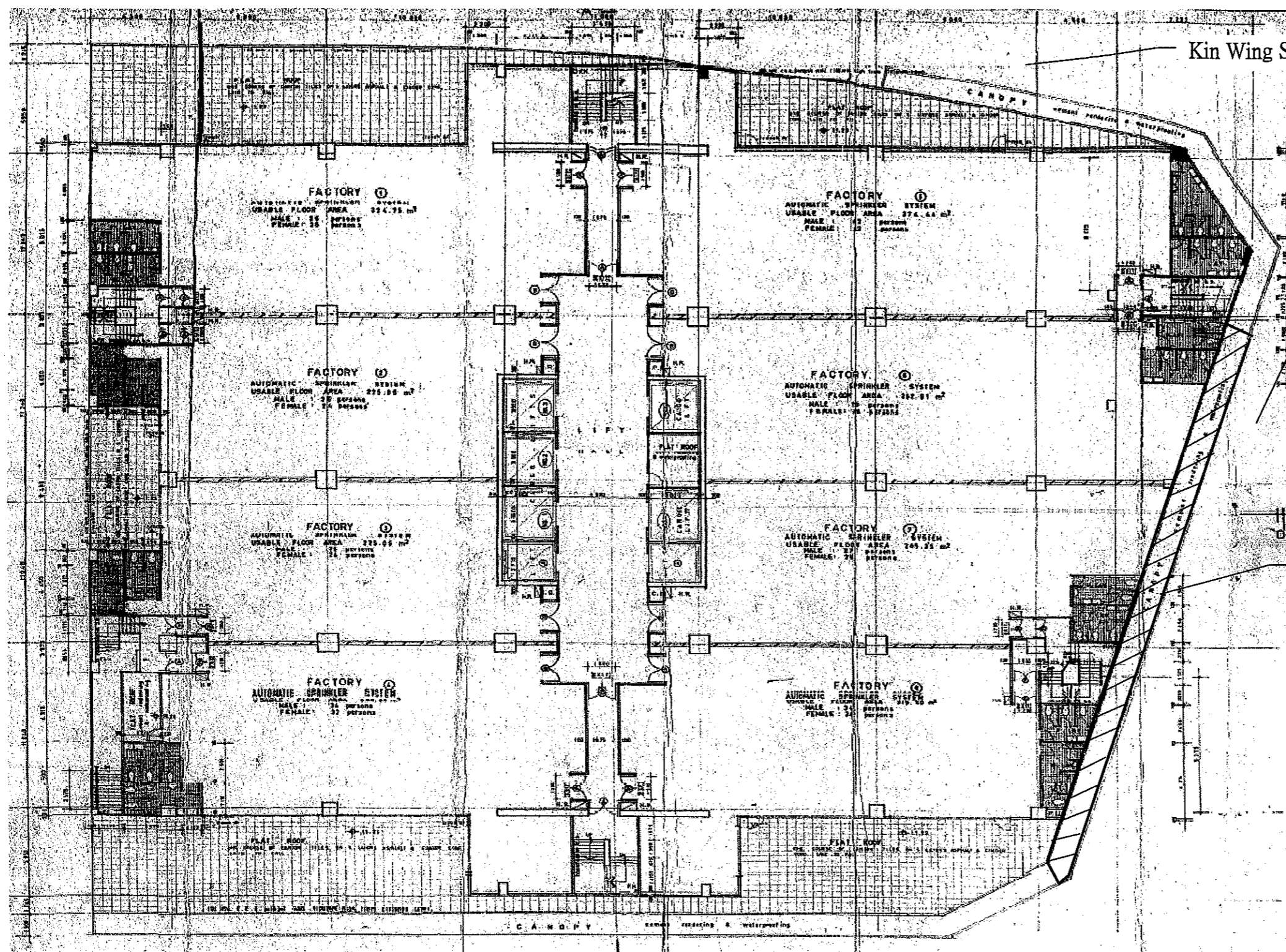


Kin Wing Street

Kin Kwan Street

Collapsed Portion

Kin Kwan Street



Title: Approved 1st Floor Building Plan

Location: No. 3 Kin Kwan Street, Tuen Mun