


Fire Safety Aspects of Scaffolding Across Public Access Staircases

W.K. Chow 

Department of Building Environment and Energy Engineering

The Hong Kong Polytechnic University, Hong Kong, China

Email: wan-ki.chow@polyu.edu.hk

Abstract

Scaffolding is important in building construction and refurbishment. However, it must not block the public access, particularly those which might be useful for emergency. An example of poor fire safety management with a scaffold erected along public access in a residential estate of Hong Kong was presented. Such erection would lead to possible violation of at least three local fire codes of practice. Blocking public access would lead to hazardous consequences. In addition to affecting evacuation strategy in fire, challenges from Means of Escape, Means of Access and Fire Service Installations Codes are possible. Fire safety management should be implemented to ensure proper housekeeping.

1. Introduction

Many fires occurred while having refurbishments in existing buildings, particularly with scaffolds erected [1]. As an example, a fire occurred in a 39-storey commercial complex on 15 December 2021 [2]. The fire originated from an electrical switch room and spread to the scaffolding. As the building was under major renovation on some floors, the fire alarm systems and sprinklers were shut down. Customers and staff in a restaurant inside the complex did not even know there was a fire. Occupants had great difficulties in escaping from the building due to smoke. More than 1200 people were evacuated from the building slowly. Some went to the rooftop of the building which functioned as a refuge floor. At least 13 were injured, with one in critical condition. The fire incident exposed a serious loophole in fire safety provisions that require a serious follow-up in regulations.

Scaffolding is important in building construction and refurbishment. There are many problems associated with scaffolding as reported [3-10]. Repeated accident scenarios with scaffolding were studied by Szostak et al. [3]. Based on the information contained in the Information Technology Database, the course of the accident sequence was analysed. Further, scaffolding must not block

the public access. Fire safety management should be implemented to ensure all fire safety provisions are maintained properly. Examples are replacing broken door closers for fire doors, maintaining fire detection and alarm system and ensuring adequate water supply. Another area is on assisting the fire brigade when they arrive on site, such as informing firefighters of the available fire protection systems and guiding them to the site.

An example of a scaffold erected along public access in a residential estate of Hong Kong is presented in this paper. Local fire safety codes have to be complied with [11-15]. Designing the fire safety management and other facility management schemes [16-25] is important. Evacuation strategy [26-36] has to be watched carefully. On top of fire, falling down under wind is another threat [37]. Good management on controlling the use of staircase would keep the means of access for firefighters free [11]. Smooth movement without any blocking would reduce the required safe egress time in case of fire.

2. An Example

A scaffold was erected along the public staircase to a car park one level below as in Fig. 1, blocking the passage. The staircase has a fire hydrant beside it, and so it is most likely functioning as a Means of Access (MoA) in fires under local fire codes, similar to opening of fire doors in a building during refurbishment [20]. This scaffolding arrangement is not acceptable. Disaster similar to a previous local big fire during building refurbishment might occur.

Such arrangement was very unsafe to reduce cost. This was not even handled immediately upon complaints. The estate management might be challenged in case of fire. Such procedure should not be allowed anymore again in other existing buildings. Passing this message clearly to those responsible for facility management is necessary. Fire safety management [16-25] should be implemented properly, not just appearing as a safety manual locked in the safe.



(a) Scaffolding



Hydrant

(b) Possible means of access



(c) Public access to car park



Erected
scaffold
reduced the
staircase
width

(d) Scaffold cutting along the staircase

Fig. 1: Scaffold erected

There is a guide on scaffolds issued [15] in 2006 by Buildings Department [15]. However, there is no mention of how to erect a scaffold in staircase, nor about not blocking any public staircase access, in particular the MoA [11] and the Means of Escape (MoE) [12]. General views from professionals appear to be quite confusing at the moment:

- General building regulations forbid blockage of staircases and MoA [11] by whatever structures or materials, including scaffolds.
- It is understood that the MoE [12] and MoA [11] should always be kept free, no blocking at any time as being cut along as in Fig. 1, without reporting to the government departments responsible for fire safety.
- There was even misinterpretation that the staircase can be blocked as in Fig. 1, if there is another staircase nearby.
- Water might not be delivered smoothly from the hydrant. There is possible violation against the Fire Service Installations (FSI) Code [13] and others [14].

For clear reference, perhaps this point might be considered in the next review [15], if any.

3. Fire Safety Management to Avoid Violating Fire Codes

That scaffold has challenges against at least three local codes:

- MoA code [11] for firefighters because car parks below had low ceiling height.
- MoE code [12] for occupants because they might be blocked in the escape route.
- FSI code [13] on making hydrants difficult to deliver water.

As reviewed by Malhotra in 1987 [16] and Lui and Chow [17], the main objectives of fire safety management are to ensure that in case of a fire:

- All the fire safety measures provided will be available.
- Occupants will be able to use the fire safety measures.
- Occupants will be assisted to escape to a safe place.

Therefore, fire safety management plays at least three roles:

- To ensure that the fire safety measures provided are kept in good order.
- To initiate actions in case of fire which would help occupants to reach a safe place.

- To review the adequacy of existing fire safety measures when there is a change of building, change of building use and new technology on fire services installation.

However, there are always problems while having refurbishment due to cost reduction, or some other reasons. Fire safety culture should be promoted [38-41] among occupants and even professionals.

To ensure fire safety provisions would function, appropriate fire safety management with a fire safety plan should be worked out by the management with reference to the building and the occupancy.

4. Fire Safety Plan

A fire safety plan should be prepared in fire safety management [16]. There should be at least three components:

- Maintenance plan for proper keeping of fire safety system.
- Staff training plan encompassing training schemes for staff.
- Fire action plan with well-defined actions to take in case of fire.

The maintenance plan should be implemented to avoid cases like Fig. 1 happening again. The following should be included to have good housekeeping:

- While repairing damages, make sure no blocking of passive systems, particularly MoE and MoA as in Fig. 1.
- Scaffold should not be erected to block the access, especially along the staircases.
- Ensuring active systems such as hose reels and fire hydrants to operate smoothly.
- The erected scaffolds should not interfere with smooth delivery of water from the fire hydrant as the firemen cannot operate the equipment smoothly. Fig. 1 shows a bad example.
- Information and drawings on layout, escape routes and information signs should be readily available to occupants.
- Routine checking by facility management staff is necessary.

5. Safety Culture

The proposal of introducing safety culture in handling public safety [38-41] on top of safety technology and safety management should be considered. These three elements should be operated as a tripod in Fig. 2. Tighter monitoring and punishment might be needed if there is any violation of codes [11-13].

The concept of safety culture in the Asia-Oceania regions might be different from other areas [42], but useful in monitoring implementation of fire safety management on controlling fire service installations. This is similar to the difficulties in controlling driving speed over the limit of 50 km/hr in downtown! Perhaps, recruiting an independent management group to control is a solution.

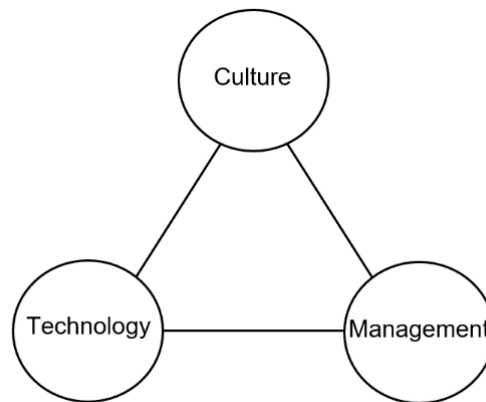


Fig. 2: Safety culture [Ivanov and Chow 2022]

6. Conclusions

A better working schedule for scaffolding safety for an existing building should be worked out. The Facility Management Office must designate a Building Safety Officer in the estate to advise and monitor refurbishment and repairing work. Something like Fig. 1 should not happen.

Facility management staff should be trained to handle fire safety. The management should at least increase the frequency of patrol for keeping proper discipline. Office staff, construction supervisors or even the Safety Officer should control the improper behavior of the workers.

The fire safety management schedule applicable must be passed to the facility management staff clearly. Higher responsibility should be dedicated to the facility management office, or the

Building Safety Officer. To ensure building safety, fire safety culture must be promoted to control both the software fire safety management and hardware fire safety provisions.

References

1. W.K. Chow and C.L. Chow, “Fire and explosion hazards to watch in developing big dense areas such as the Guangdong-Hong Kong-Macao Greater Bay Area”, *Journal of Changzhou University (Natural Science Edition)*, Vol. 32, No. 2, p. 1-12 (2020).
2. South China Morning Post, “Fire alarm on some floors shut down due to renovation, authorities reveal after blaze grips Hong Kong’s World Trade Centre, trapping hundreds on rooftop”, 16 December 2021. <https://www.scmp.com/news/hong-kong/society/article/3159776/major-fire-breaks-out-hong-kongs-world-trade-centre-trapping>
3. M. Szostak, B. Hoła and P. Bogusławski, “Identification of accident scenarios involving scaffolding”, *Automation in Construction*, Vol. 126, 103690 (2021).
4. R. Collins, S. Zhang, K. Kim and J. Teizer, “Integration of safety risk factors in BIM for scaffolding construction”, 2014 International Conference on Computing in Civil and Building Engineering, American Society of Civil Engineers, Reston, pp. 307–314 (2014). <https://doi.org/10.1061/9780784413616.039>
5. K. Ohdo, “The effect of fall prevention methods for construction scaffolds in accident prevention”, *International Conference on Applied Human Factors and Ergonomics AHFE 2018: Advances in Safety Management and Human Factors*, pp. 306–314 (2018).
6. T. Lipiecki, P. Jamińska-Gadomska, J. Bęc and E. Błazik-Borowa, “Façade scaffolding behaviour under wind action”, *Archives of Civil and Mechanical Engineering*, Vol. 20, 27 (2020).
7. K.M. Halperin and M. McCann, “An evaluation of scaffold safety at construction sites”, *Journal of Safety Research*, Vol. 35, pp. 141–150 (2004).
8. M. Sawicki and M. Szóstak, “Assessment of the safety of working on scaffolding based on post-accident protocols”, *Acta Scientiarum Polonorum Architectura*, Vol. 18, No. 2, pp. 51–59 (2019).
9. U. Kjellen and T.J. Larsson, “Investigating accidents and reducing risks - A dynamic approach”, *Journal of Occupational Accidents*, Vol. 3, No. 2, pp. 129–140 (1981).
10. B. Hoła and M. Szóstak, “Modeling of the accidentality phenomenon in the construction industry”, *Applied Sciences*, Vol. 9, No. 9, 1878 (2019).
11. Buildings Department, *Code of Practice for the Provision of Means of Access for Firefighting and Rescue*, Hong Kong Special Administrative Region (2004).

12. Buildings Department, Code of Practice for the Provision of Means of Escape in Case of Fire, Hong Kong Special Administrative Region (1996).
13. Fire Services Department, Codes of Practice for Minimum Fire Service Installations and Equipment and Inspection, Testing and Maintenance of Installations and Equipment, Hong Kong Special Administrative Region (2012).
14. Buildings Department, Code of Practice for Fire Safety in Buildings 2011 (October 2015 version), Hong Kong Special Administrative Region.
15. Guidelines on the Design and Construction of Bamboo Scaffolds, Buildings Department, Hong Kong (2006).
16. H.L. Malhotra, Fire safety in buildings, Building Research Establishment Report, Department of the Environment, Building Research Establishment, Fire Research Station, Borehamwood, Herts, WD6 2BL, UK (1987).
17. Gigi C.H. Lui and W.K. Chow, "A demonstration on working out fire safety management schemes for existing karaoke establishments in Hong Kong", International Journal on Engineering Performance-Based Fire Codes, Vol. 2, No. 3, p. 104-123 (2000). Also available at: <https://www.academia.edu/71578505/>
18. W.K. Chow, "Review on fire safety management and application to Hong Kong", International Journal on Engineering Performance-Based Fire Codes, Vol. 3, No. 1, p. 52-58 (2001). Also available at: <https://www.academia.edu/71836841/>
19. H.H. Wu and W.K. Chow, "Fire safety management in hotel", A paper presented at the International Conference on Sustainable Development in Building and Environment, SET2 (Sustainable Energy Technology), 24-27 October 2003, Chongqing, China; Also appeared in Journal of Chongqing University (English Edition), p. 236-241 (2003).
20. W.K. Chow, "Fire safety management: Replacement procedure of fire doors for an existing building", Architectural Science Review, Vol. 46, No. 1, p. 13-17 (2003).
21. S.C. Tsui and W.K. Chow, "Legislation aspects of fire safety management in Hong Kong", Facilities, Vol. 22, No. 5/6, p. 149-164 (2004).
22. S.C. Tsui and W.K. Chow, "A holistic approach to fire safety management for high-rise multiple occupancy building", Proceedings of the 5th International Conference on Performance-Based Codes and Fire Safety Design Methods, 6-8 October 2004, European Commission Facilities, Luxembourg, p. 421-433 (2004).
23. Gigi C.H. Lui and W.K. Chow, "Fire safety management for small and medium enterprise offices in old industrial buildings", Proceedings of the 6th International Conference on Indoor Air Quality, Ventilation and Energy Conservation in Buildings 2007 (IAQVEC2007), Sendai, Japan, Vol. 1, 28-31 October 2007, p. 929-936 (2007).

24. K.W. Lau and W.K. Chow, "Fire safety management system in modern high-rise buildings - Hong Kong perspective", International Symposium CIB-W096 2009 Taiwan - Future Trends in Architectural Management, 2-3 November 2009, Tainan, Taiwan (2009).
25. Y. Huo, C.H. Cheng, T.K. Yue and W.K. Chow, "Fire safety management on staircase allocations for evacuation in a tall building", CONFAB 2017, 10-12 Sep 2017, Brunel University, London, UK (2017).
26. J. Li and W.K. Chow, "Numerical studies on atrium evacuation with and without fires", Journal of Applied Fire Science, Vol. 9, No. 4, p. 347-359 (2000).
27. W.K. Chow and Gigi C.H. Lui, "Numerical studies on evacuation design in a karaoke", Building and Environment, Vol. 37, No. 3, p. 285-294 (2002).
28. W.K. Chow and C.L. Chow, "Evacuation with smoke control for atria in green and sustainable buildings", Building and Environment, Vol. 40, No. 2, p. 195-200 (2005).
29. Candy M.Y. Ng and W.K. Chow, "A brief review on the time line concept in evacuation", International Journal on Architectural Science, Vol. 7, No. 1, p. 1-13 (2006).
<https://www.academia.edu/75710578/>
30. J. Li and W.K. Chow, "Review on emergency evacuation time estimation for performance-based fire safety design", Journal of Applied Fire Science, Vol. 15, No. 2, p. 147-163 (2006).
31. W.K. Chow and J. Li, "Evacuation of atria under different uses", ASCE - Journal of Architectural Engineering, Vol. 13, No. 2, p. 78-83 (2007).
32. W.K. Chow, "'Waiting time' for evacuation in crowded areas", Building and Environment, Vol. 42, No. 10, p. 3757-3761 (2007).
33. W.K. Chow and Candy M.Y. Ng, "Waiting time in emergency evacuation of crowded public transport terminals", Safety Science, Vol. 46, No. 5, p. 844-857 (2008).
34. J. Li and W.K. Chow, "Key equations for studying emergency evacuation in performance-based design", 3rd International Symposium on the 21st Century Center of Excellence Program: Tokyo University of Science, 10-11 March 2008, Tokyo, Japan (2008).
35. Edgar C.L. Pang, W.K. Chow and S.S. Han, "Evacuation strategy for supertall buildings", The First International Conference on Building Energy and Environment (COBEE), 13-16 July 2008, Dalian, China, Vol. 1-3, p. 2094-2100 – Poster presentation (2008).
36. N. Cai and W.K. Chow, "Fire safety requirements on lift system for evacuation in supertall buildings", International Journal on Engineering Performance-Based Fire Codes, Vol. 10, No. 2, p. 17-23 (2011). <https://www.academia.edu/79729451/>
37. The Standard, "One dead as scaffolding collapses on Broadwood Road", 8 October 2021. <https://www.thestandard.com.hk/breaking-news/section/4/181299/One-dead-as-scaffolding-collapses-on-Broadwood-Road>

38. W.C. Fan, “Some thinking behind public safety science”, 2019 International Conference on Urban Public Safety and Emergency Rescue, Invited talk, Changzhou, China, 24-26 May 2019.
39. M. Ivanov, W.K. Chow, T.K. Yue, H.L. Tsang and W. Peng, “Upgrading of fire safety requirement for tall buildings in Bulgaria and proposal of implementing fire safety management under facility management”, *Facilities*, Vol. 40, No. 5/6, p. 380-393 (2022).
40. W.K. Chow, “Scientific aspects of fire and smoke hazards associated with lithium batteries”, Invited talk, Chinese Enterprises SHE Forum, Capital University of Economics and Business, Beijing, China, 17 October 2021.
41. M.L. Ivanov and W.K. Chow, “Importance of Safety Management and Safety Culture for Storage with Explosion Risk: Lesson Learnt from the Beirut Disaster”, *engrXiv*, Posted 25 May 2022. <https://engrxiv.org/preprint/view/2229>
42. G. Vierendeels, G., Reniers, K. van Nunen and K. Ponnet, “An integrative conceptual framework for safety culture: The Egg Aggregated Model (TEAM) of safety culture”, *Safety Science*, Vol. 103, pp. 323-339 (2018).

engrxiv_FSMScaf22-2b