

Causes of Fall of Person from Height Accidents on Building Maintenance and Repair Elevated Works in Hong Kong

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Abstract

Fall of Person from Height (FPH) is one of the main causes of accidents on construction sites and its accident rate is at the highest rank in Hong Kong. Therefore, this paper investigates into the causes of the FPH accidents and recommends possible solutions to tackle the deficiencies on the present safety management of building maintenance and repair elevated works. The information and data of the research project were collected through literature review and the questionnaire survey. The literature reviewed hazards and safety measures of maintenance and repair elevated works. A semi-structured questionnaire searched the opinions from 103 respondents for their views on safety measures of the building maintenance and repair elevated works. The results showed that the most important causes of accidents were the lack of sufficient knowledge of workers about safety, lack of safety training, improper communication, incompetent supervision, lack of work related training and not meeting the statutory requirements regarding the working platforms, safety management system and minor works control system.

Keywords

Construction Safety Management, Building Maintenance Works, Repair Elevated Works, Construction Accidents, Hong Kong

1. Introduction

Hong Kong's construction industry in the buildings sector has developed significantly since 1950s. There are now many buildings more than 50 years old in Hong Kong. The demand of maintenance and repair works of these old buildings has increased tremendously in recent years. This is true for both the high-rise and low-rise buildings in the public and private sectors. Many industrial accidents in recent years have occurred on these works. For building maintenance and repair elevated (BMRE) works, bamboo or metal scaffolds, tall ladders and gondolas are the common means for working at height in Hong Kong. Every year, considerable numbers of workers are subject to injuries and even death when using these means during such works. Fall of persons from height (FPH) is the one of the 23 different types of construction accidents in Hong Kong which has a high fatality rate. The data in Table 1 shows that over the 10-year period from 2007 to 2016 for which complete data is available, there is no real decrease in the accident and fatality rates on construction projects in Hong Kong. While the FPH accident rate is almost steady between 9 and 14% of total number of accidents, the fatality rate is much higher between 35 and 79%. This shows that the efforts in Hong Kong towards improving safety performance in the construction industry are not very effective. These efforts include promulgating health and safety in workplaces via training, promotion, legislation, etc. to improve the safety awareness and performance of workers and employers. In response to the above, the objective of this paper is to explore the situation regarding the safety management processes to understand the most important needs of safety requirements. It reviews the deficiency of current safety management system and seeks for

improvements in the existing safety circumstances of BMRE works to minimize or even eliminate any reoccurrence of accidents.

Table 1: Industrial Accidents in Construction Industry of Hong Kong (2007 – 2016)

Year	All accidents	FPH accidents	All fatalities	FPH fatalities	FPH accident percentage	FPH fatality percentage
2007	3042	360	19	9	12%	47%
2008	3033	388	20	8	13%	40%
2009	2755	397	19	15	14%	79%
2010	2884	406	9	6	14%	67%
2011	3112	390	23	10	13%	43%
2012	3160	423	24	12	13%	50%
2013	3232	431	22	15	13%	68%
2014	3467	372	20	7	11%	35%
2015	3723	376	19	9	10%	47%
2016	3720	349	10	7	9%	70%

Source: Data extracted from Labour Department of Hong Kong website:
<http://www.labour.gov.hk/eng/osh/content10.htm>

2. Literature Review

2.1 Means of FPH Accident Prevention

For the prevention of FPH accidents for BMRE works several means are used. Additional attention is required on the safety performance of building maintenance and repair elevated (BMRE) works. The tendency to hire relatively low-skilled workers on BMRE works is high. BMRE works are not subject to the same stringent statutory safety requirements as are for new construction (NC) works. FPH accidents are rather frequent in BMRE works. Despite using different techniques and safety measures, it has been observed that these measures are not effective to lower the fatality rate in BMRE works (Chan, et al. 2005). Several factors related to the technology of BMRE works contribute towards FPH accidents.

Truss-out bamboo scaffold is commonly adopted in BMRE works at external wall. FPH accidents usually are related to erecting, using and dismantling this kind of scaffold (Chan et al., 2008). Therefore, safety procedures for using bamboo truss-out scaffold were introduced in Hong Kong (Labour Dept., 2001a). To replace bamboo scaffolds, metal scaffolds can be adopted in BMRE works. To ensure the safe use of the scaffold, provision of proper design, selection of reputable contractor, employment of competent person and examiner for erection and dismantling, provision of site supervision and management shall be considered (Labour Dept., 2001b).

In Hong Kong, suspended working platform or gondola is also frequently used in building maintenance and repair elevated works, such as cleaning window and renovating external walls. They must be installed and dismantled by competent persons, supervisors and workers (Labour Dept. 2001c). Elevated working platforms are also widely adopted for works needed to be carried out at high level, for example, E&M installation, maintenance or repair works. For safe use of the platforms, their maximum elevated height and capacity for loading, the workplace restriction, provision of trained workers and adequate supervision, regularly checking of the platforms, etc. shall be carefully considered (Labour Department, 2008).

FPH accidents are also related with the use of ladders. For the use of ladder, type of application, nature of ladder, need of safety precautionary measures and even the provision of training should be considered to ensure these can be used safely (Roughton and Mercurio, 2002). It is also a common kind of tool when carrying out BMRE works. Another means which is used in BMRE works are the safety belts and anchorage systems. Before choosing a suitable safety belt, risk assessment for the workplace should be done by proprietor and contractor. It is vital that if anchorage or fall arrest system is adopted, the system must provide continuous protection to the users throughout their operation. Many accidents for building maintenance and repair elevated works have occurred due to incorrect provision of the system.

2.2 Regulations for FPH Accident Prevention

Starting from 31 Dec 2010, the Buildings Department of Hong Kong Special Administration Region Government has fully implemented the Minor Works Control System (Buildings Department, 2011) which was launched to assist public to conduct minor works legally via simplified procedures to improve safety performance on such works (Buildings Department, 2010). Many of these works are related to external walls of buildings in which there are many threats for the occurrence of FPH accidents. A proper health and safety training and management is required to be enforced to conduct such works safely and to promote relationship between workers and project managers. Proper fall arrest system shall be also offered at the workplace to further reduce the safety risk for workers (MacCollum, 2007).

Under the Occupational Safety and Health (OSH) Ordinance (HKSARG, 1997), employers have liability on the health and safety of their employees. They must provide adequate supervision, instruction, information and training, and safe workplace, such as safe access and egress. Regarding the health and safety responsibility of employees at work, the OSH ordinance requires them to co-operate with their employer, who has reasonably set up health and safety requirements on them, and take care of others.

According to the HKSARG (2000), contractors or proprietors of certain industrial undertakings should fulfil the development, implementation and maintenance of safety management system that includes 14 specific elements, which are safety policy, organizational structure, safety training, in-house safety rules, inspection programme, hazard control programme, accident/incident investigation, emergency preparedness, evaluation, selection & control of sub-contractors, safety committees, job-hazard analysis, safety and health awareness, accident control & hazard elimination and occupational health assurance programme.

Employer also has liability to regularly repair and maintain those machines and equipment in workplace were in safe condition (Lee, 2011). The repair and maintenance works should be done by competent person, who had received sufficient training and experience. Health and safety promotion is other essential element in safety management. Lee (2011) suggested numerous posters promulgating health and safety should be displayed at prominent locations of workplace to enhance safety awareness of both employer and employees.

In Hong Kong, multi-layer subcontracting system is adopted in majority of construction projects. As result, Fang et al. (2006) stated that safety performance of subcontractors was the vital part to ensure health and safety in construction sites. The subcontractor workers should obey the health and safety requirements, which were reasonably set up by main contractor. Also, subcontractors should cooperate with each other to help main contractor on implementing on-site health and safety.

2.3 Summary of Literature Review

This brief literature review highlighted the current means and regulations of preventing FPH accidents of BMRE projects with emphasis on Hong Kong's conditions. The findings from this review are the basis of the design of the questionnaire survey the results and analysis of which is presented in the following sections.

3. Research Methodology

In this paper, the research methodology explored the underlying issues of descriptive research which were investigated using the literature review and the questionnaire survey. Literature review findings were used to develop the survey questionnaire and to provide background material for evaluating the survey results. Questionnaires were distributed to 140 respondents along with a letter of request via email or by direct delivery of the survey form. The target respondents were chosen from different levels of building maintenance and repair work field, which included workers, project supervisors, project managers from contractors and subcontractors as well as technical officers and property managers of property management companies. It took about three weeks to collect 103 responses. Responses to survey questions were analyzed on aggregate basis. No distinction of responses was made among responses from various types of responders. This provides support to the consensus-based answers to the survey questions.

The survey included 16 safety related questions divided into three main categories namely, (1) safety implementation from question 1 to 9, (2) safety improvement from question 10 to 13, and (3) safety promotion from question 14 to 16. The responses to the questions were measured on a five-point Likert scale including strongly agree, agree, neutral, disagree, and strongly disagree. The 17th question was the open-ended question for any comments and recommendations by the responders. To obtain objective outcomes, the responses were assigned with numbers from 5 to 1 corresponding to verbal scales from strongly agree to strongly disagree respectively. The weighted average of the responses was calculated based on these numerical scales and the frequency of each response. The main phrases of the questions are presented in Table 1 along with the analysis of responses.

4. Results and Discussions

4.1 Purposes of Survey Questions

For the questions number 1 to 9, the purpose is to find out the present status of safety management system (SMS) that workers implement for BMRE works. Questions number 10 to 13 aim to acquire comments on control scheme which is being used to make improvement on the safety management system of BMRE works. The last three questions from 14 to 16, aim to get opinions on the safety promotion, which should be able to reduce number of accidents in the BMRE works.

4.2 Responses to Survey Questions

The weighted average column in Table 2 shows the relative importance of the factors towards safety of BMRE workers with an emphasis of FPH accidents in Hong Kong. The Rank column further clarifies the importance of the factors. Going by these numbers, the most important six factors are (1) the need for safety promotion by government for BMRE works, (2) having award and penalty scheme to improve safety, (3) workers not knowing well about safe working platform use, (4) consensus that the FPH is the main type of fatal accident in BMRE works, (5) lack of knowledge by public to employ qualified BMRE contractors (factor 14), and (6) the importance of communication among work team member for arresting the occurrence of FPH accidents. While these were the six most important factors. The next three factors were also important as their scores were at least 3.92 which is just above average score of all factors. These factors are (1) not implementing well

the safety management system, (2) below average quality supervision of workers and (3) insufficiently trained workers.

Table 2: Analysis of Factors affecting the Safety in BMRE Works

No.	Factors	Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)	Weighted Average	Rank
1	FPH is the main type of fatal accidents	36	58	7	2	0	4.24	4
2	Workers do not have sufficient safety training	27	49	21	4	2	3.92	9
3	Workers not know well about PPE use	9	53	23	11	7	3.45	14
4	Lack of fall protection equipment	5	39	28	21	10	3.08	16
5	Workers not implement well safety management system	34	55	8	4	2	4.12	7
6	Workers not know well about safe working platform use	47	43	6	4	2	4.26	2
7	Workers are not notified well about work place hazards	22	48	19	9	5	3.71	10
8	Workers lack awareness of safety measures	20	37	23	15	8	3.45	14
9	Reduce FPH accident risks by improving communication	40	43	18	2	0	4.17	6
10	Lack of workers' supervision	34	42	19	11	0	3.93	8
11	Need monitoring system for BMRE workers	30	36	20	10	7	3.70	11
12	Need control system for BMRE contractors	27	33	22	16	5	3.59	12
13	FPH accidents could be reduced by MWCS	29	30	19	16	9	3.52	13
14	Less realization of liability for employing BMRE contractors	33	63	5	2	0	4.23	5
15	More safety promotion by government for BMRE works	60	40	3	0	0	4.55	1
16	Having award and penalty scheme to improve safety	41	50	8	3	0	4.26	2

The minimum score of these factors is 3.08 which is more towards agreement to the factors asked in the questions. This shows that the factors are holistically important, and their ranks are just relative to each other. For example, the three least important factors (in relative terms) are (1) the lack of fall protection equipment, (2) workers not knowing well about PPE use, and (3) workers lack awareness of safety measures. All these three relatively least important factors are important as shown by their weighted scores. Figure 1 graphically shows

the range of weighted scores of all the 16 factors considered. The variation of the weighted scores is quite small with standard deviation of 0.4 and co-efficient of variation of 10%. The mean value is about 3.9. Together, these statistics confirm that all factors considered are important and their importance ranks are only relative.

The responses from the 17th question was open ended. The responders commented on the enforcement of compulsory specialised safety training to contractors’ employees who work at height. This training should be provided in both large and small-scale contractors and be refreshed once every three years. Only those contractors should be employed which provide safety training to their workers and can provide such records for confirmation. The current safety management system proposed by the government for general construction projects should also be enforced on BMRE works. Appropriate safety training should also be for the supervisory staff and management personnel. Award and penalty scheme shall be provided not only for workers and contractors but also for the property management company.

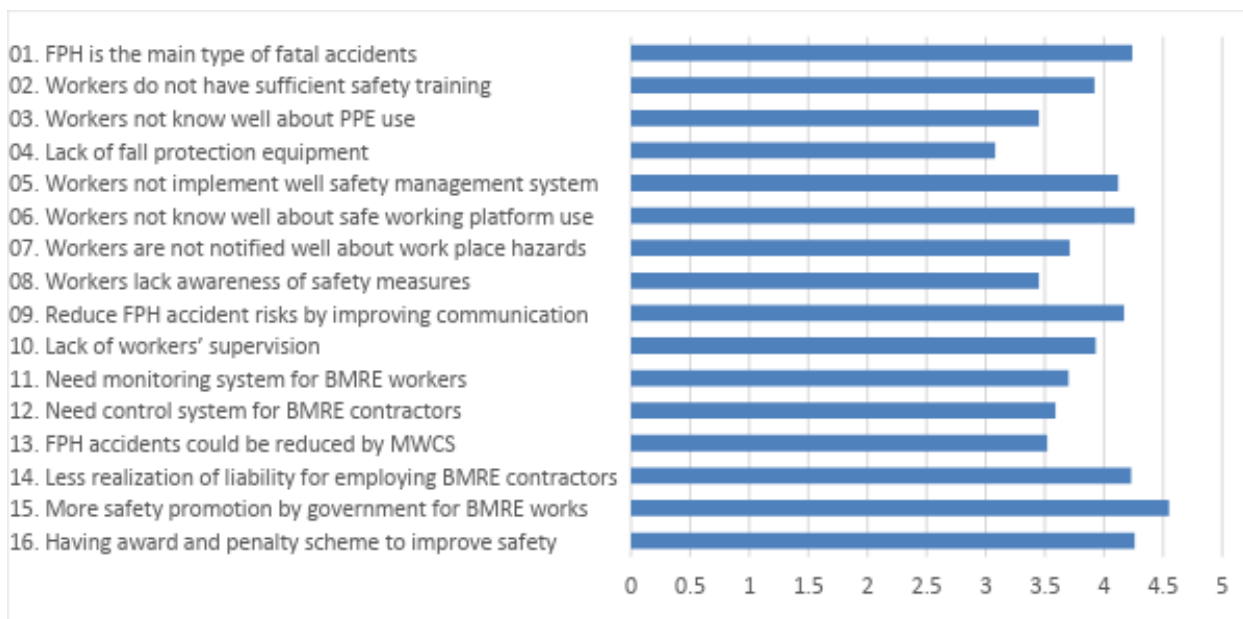


Figure 1: Weighted Average of Factors affecting the Safety in BMRE Works

4.3 Discussion of Research Results

The factors affecting the safety performance on BMRE works with respect to FPH accidents are logical and have an intuitive appeal towards their suitability. Other researchers have also investigated such factors and invariably there are similarities and differences in the results of this study and other studies. Chan et al. (2008) identified a proper safety management system, suitable working platform, regular safety training, suitable fall arresting system and maintaining a safe work place as the five most important factors. All these factors have been considered in this study as important factors. Nadhim et al. (2016) identified several factors which include the risky activities, individual characteristics, site conditions, organization/management, means/tools, weather, and environmental conditions to affect such accidents. Many of these related factors have been considered in this paper. Hu et al. (2011) identified twenty factors from a broad review of literature. The five most important factors were the working surfaces and platforms, worker’s safe behaviour and attitudes, construction structure and facilities, contractors’ level safety intervention and worker’s age.

From the results of this paper, more safety promotion by the government and the award/ penalty scheme was highly emphasized by the responders of questionnaire survey. By such actions, safety performance can be improved as the workers would consider safety aspects as integral part of their tasks and would have incentive to adopt safe practices and tendency to deter unsafe practices. This in turn will help workers understand well about the safe use of the working platform. The building clients will understand well the importance of employing competent contractors for BMRE works. One can expect competent work teams having good intra-team communications which is one of the important element identified for safe work practices in BMRE works.

The importance of implementing the safety management system cannot be underemphasized of which proper monitoring, supervision of workers, and their training are important components. Once a proper work supervision mechanism is set up, the workers can get right instructions for the safe performance of hazardous BMRE works. In addition, a separate but more importantly the specific control system in the form of minor works control system (MWCS) provides a much-needed support framework for such kinds of works being distinguished from regular large-scale construction projects. Last but not the least, the role personal protection equipment, the fall prevention gears and other common safety measures is generally not well understood. That's why many accidents happen not because those measures were not provided to workers but because workers either did not apply these measures in correct ways or workers did not have complete knowledge about how to correctly use those measures.

5. Conclusions

According to the review and analysis on the past accident data of the construction industry in Hong Kong "Fall of Person from Height" is one of accident causes with highest fatal accident rate. Even though the figures do not indicate they referred to BMRE works, it can be concluded that workers need to face very high risk when they work at height. According to the research findings, the vital factors which cause FPH accidents are as follows:

1. Workers do not have sufficient knowledge about the utility of safe working platform.
2. Workers, who are required to work at height, did not receive adequate safety training and are not particular to wear safety harness with fall arrester.
3. Communication was inadequate in the work teams.
4. Workers lack enough supervision by a competent person.

Nevertheless, feasible policy and strategy can be identified and executed to further improve the present safety management on BMRE works. Such policy may include:

1. Proper scheme, such as minor works registration contractor scheme, for all scales of building maintenance and repair contractors can be mandatory to enhance the control under the government.
2. Government can put more efforts and resources to enhance the safety promotion on the importance of working at height safely.
3. An incentive system or attractive award system can be established to encourage contractors and workers to improve their safety performances.

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