

Statistical Analysis and Prevention Control of High-Altitude Fall Accidents in Building Construction

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Abstract

In order to reduce the occurrence of high-altitude fall accidents and improve the construction safety management level, a statistical analysis of 101 high-altitude fall accidents in my country from 2015 to 2019 was conducted. Using data tables and statistical charts, systematically analyze the release time of high-altitude fall accidents, the age of casualties and the direct causes of high-altitude fall accidents, so as to find out the general regularity and main causes of high-altitude fall accidents, and put forward preventive and control measures based on this.

Keywords

High-altitude fall accident; statistical analysis; general regularity; main causes; preventive and control measures.

1. INTRODUCTION

The construction industry is one of the most dangerous industries in the world [1]. In recent years, construction safety accidents in my country have been high. There are five major types of construction safety accidents in my country: high-altitude fall, object strike, mechanical injury, electric shock, collapse, and high-altitude fall is the highest accident rate [2]. In 2018, a total of 734 safety accidents occurred in housing municipal engineering in my country, killing 840 people, including 383 high-altitude fall accidents, accounting for 52.2% of the total [3]. Internationally, high-altitude fall accidents are also construction safety accidents with a relatively high incidence. Statistics of the United States Department of Labor from 1990 to 2001 show that high-altitude fall accidents accounted for 37% of the total construction industry accidents; the statistics of the number of deaths on construction sites in Ontario, Canada from 1997 to 2005 showed that the deaths caused by high-altitude fall accidents reached 41% [4]. It can be seen that the occurrence of construction safety accidents has not been effectively controlled, and the prevention of high-altitude fall accidents has become an important way to reduce construction safety accidents. Therefore, mastering the general regularity of high-altitude fall accidents and analyzing the causes of high-altitude fall accidents are helpful to put forward effective prevention and control measures, thereby reducing the occurrence of safety accidents.

2. THE REGULARITY OF HIGH-ALTITUDE FALL ACCIDENTS IN BUILDING CONSTRUCTION

2.1. Time Distribution of High-Altitude Fall Accidents

Count the 101 high-altitude fall accidents in my country in the past five years by time period, and plot the distribution of the number of high-altitude fall accidents in different time periods, as shown in Figure 1.

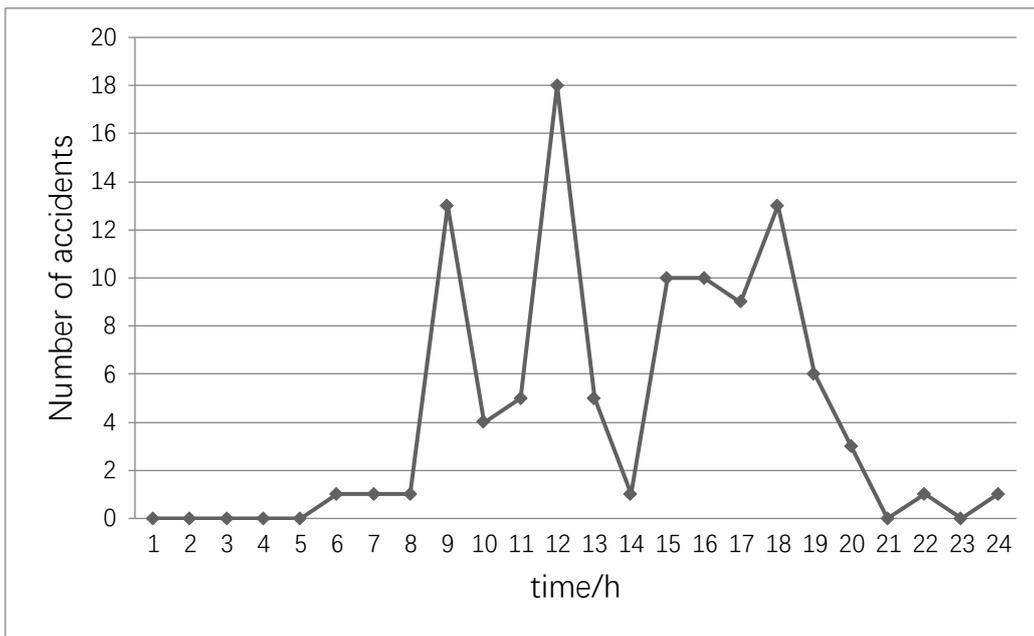


Figure 1. Distribution of the number of high-altitude fall accidents in different time periods

It can be seen from the analysis of Figure 1 that the high-altitude fall accidents are prone to occur from 7:00 to 8:00, 10:00 to 11:00 and 13:00 to 17:00. Among them, 10:00 ~ 11:00 is the peak period of the accident, because the workers have consumed a lot of physical energy during this period, and are close to lunch and lunch breaks, which will make the workers easily distracted at work, thereby making some unsafe behaviors. The time period from 7:00 to 8:00 is the period when the workers have just started to work. The danger of the workers to the surrounding environment is still unclear, so their vigilance is weak. They often don't wear safety protective equipment correctly according to regulations, and do not check whether the safety protective equipment is defective, etc. From 13:00 to 17:00, due to the short rest period, workers are prone to fatigue, the body is slowly tired, and the spirit is easily loosened. During this period of time, the emergency response capacity of workers will be reduced. When they encounter dangers and difficulties, it is difficult to respond quickly. Therefore, the incidence of falling accidents at high places during this period is also particularly high. In addition, it can be seen from the figure that there are also a few high-altitude accidents from 5:00 to 6:00 and 22:00 to 23:00, because the light environment of the work site is poor in these two time periods, which will cause the line of sight of workers to be blocked, and the ability to identify potential safety hazards will decline, so it is inevitable that a high-altitude accidents will occur.

2.2. Age Distribution of Casualties in High-Altitude Fall Accidents

The 101 high-altitude fall accidents occurred in my country in the past five years are counted according to the age of casualties, and the distribution of the high-altitude fall accidents at different ages is plotted, as shown in Figure 2.

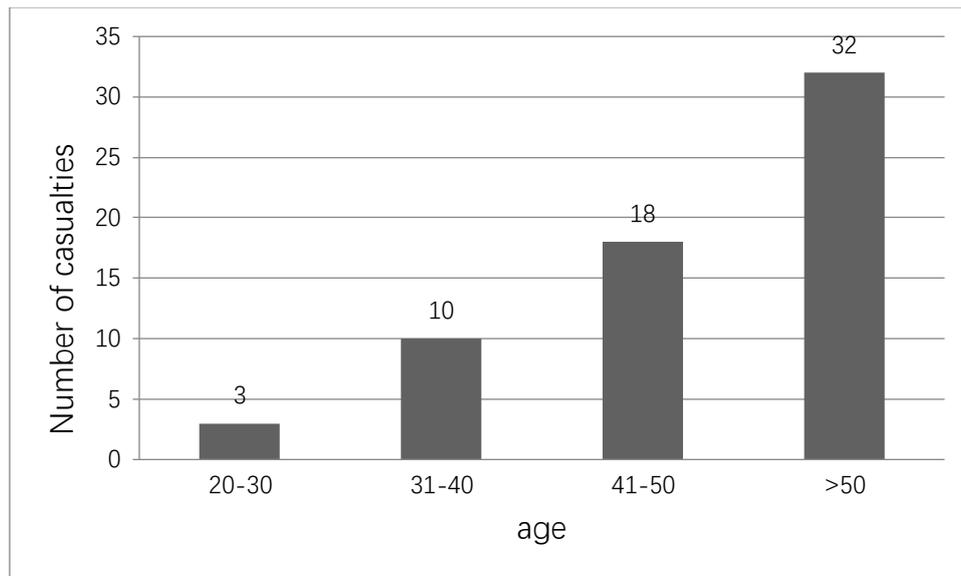


Figure 2. Distribution of the number of high-altitude fall accidents at different ages

It can be seen from Figure 2 that as the age of workers increases, the probability of high-altitude fall accidents also increases. Because with the growth of age, people's memory, emergency response ability and physical coordination ability will decline. And most of the older workers were born in the 1960s and 1970s, their educational level is generally not high. They have not received systematic and comprehensive learning of safety knowledge and skills, and can only rely on previous work experience to identify risks and eliminate potential safety hazards. In addition, some older workers have low safety awareness. They think they have good skills so that they don't have to follow safe operating rules. Therefore, they often do not obey the instructions of the safety management personnel and blindly take risks and work in violation of regulations.

3. ANALYSIS OF THE DIRECT CAUSE OF THE HIGH-ALTITUDE FALL ACCIDENTS

The current research on the causes of high-altitude fall accidents mainly focuses on qualitative analysis. ZHU Renping showed through case analysis that the causes of high-altitude accidents include unsafe behaviors of people, unsafe conditions of things and management reasons [5]. REN Chuanjun analyzed five years of high-altitude falls and pointed out that the causes of high-altitude fall accidents include no protection or defective protective facilities, the safety of construction equipment does not meet the requirements, the safety management system is not perfect, training and education are not in place, workers work in violation of regulations, etc [6]. ZHENG Xiazhong based on HFACS analyzed the human error that caused the high-altitude fall accident [7]. Some scholars also used Fault tree analysis (FTA) method or Decision tree analysis method to analyze the cause of the high-altitude fall accident [8 -9]. However, these studies failed to clearly point out the main causes of high-altitude fall accidents in buildings, which are not particularly significant for improving site safety management and formulating safety precautions.

In 1936, Heinrich proposed the causal chain theory (domino theory), which pointed out that the direct cause of accidents is the unsafe behavior of people and the unsafe state of things, and more than 80% of accidents are caused by unsafe behavior of people [10]. Chinese scholar Fu Gui has conducted in-depth research on the causes of safety accidents for 10 years, and finally put forward a theoretical model of accident causes-behavioral safety "2-4" model, which also

shows that the direct cause of accidents is unsafe Action and unsafe state [11-12]. In view of this, this paper analyzes the investigation reports of 101 high-altitude fall accidents in the past 5 years, summarizes the direct causes of high-altitude fall accidents, and finds the main influencing factors of high-altitude fall accidents. This provides a theoretical basis for preventing the occurrence of high-altitude fall accidents in building construction, and is conducive to formulating protective measures to prevent and controlling high-altitude fall accidents.

China's security accident report is analyzed by experts in the security field and issued by government departments, so the cause of the security accident in the accident report is credible. This article analyzes 101 reports of high-altitude fall accidents in the five years from 2015 to 2019, and summarizes the direct causes of high-altitude fall accidents. As shown in Table 1, according to the above theory, the direct causes of high-altitude fall accidents are divided into unsafe behaviors of people and unsafe states of objects, and statistical analysis is performed to find out the main influencing factors that lead to high-altitude fall accidents. As shown in Table 1, according to the above theory, the direct causes of high-altitude fall accidents are divided into unsafe behaviors of people and unsafe states of things.

Table 1. Your table here and center

Influencing factors		Frequency	Proportion	Total proportion
Unsafe behavior of people	Failure to (correctly) use safety protective equipment	56	36.60%	77.12%
	Work in violation of safe operating procedures	46	30.06%	
	Unauthorized ventures into dangerous areas	10	6.54%	
	Work without a special operation certificate	5	3.27%	
	Violation of regulations to direct workers to work	1	0.65%	
The unsafe state of things	Security measures are not done well	27	17.65%	22.88%
	Structural damage or mechanical failure	5	3.27%	
	Poor external environment	3	1.96%	

It can be seen from Table 1 that, by summarizing the direct causes in 101 high-altitude fall accident reports from 2015 to 2019, the direct influencing factors leading to high-altitude fall accidents can be divided into 9 categories. Including people's unsafe behaviors: failure to (correctly) use safety protective equipment, work in violation of safe operating procedures, unauthorized ventures into dangerous areas, work without a special operation certificate, violation of regulations to direct workers to work, and the unsafe state of things: security measures are not done well, structural damage or mechanical failure, poor external environment. Moreover, these 9 types of influencing factors do not necessarily appear alone, and it is often the combination of multiple factors that causes construction workers to high-altitude fall accidents. It can be seen from the table that the proportion of unsafe behaviors of people has reached 77.12%, which is the main cause of falling accidents. This also confirms Heinrich's view that most safety accidents are caused by unsafe behaviors of people. Among the unsafe behaviors of people, failure to (correctly) use safety protective equipment has the highest frequency, accounting for 36.60%, followed by work in violation of safe operating

procedures, accounting for 30.06%. My country's construction industry employs labor differently from foreign countries. My country implements labor subcontracting, most construction workers are migrant workers. Their educational level is generally not high, and their safety knowledge and awareness are not strong. In addition, many construction companies in our country have formalized safety education and training for construction workers. Therefore, in the process of working at heights, there are often construction workers who do not use safety protective equipment to carry out dangerous work, which eventually leads to safety accidents. In the unsafe state of things, the frequency of Security measures are not done well is the highest, accounting for 17.65%. Building construction has the characteristics of fluidity, long construction period, complexity, etc. Therefore, safety management is a dynamic process, which needs to be unified with production and take into account the construction speed and benefits. However, many construction companies in my country have insufficient capital investment in safety production, there is a serious shortage of safety professionals, and the salaries of safety management personnel are low, so safety management has been at a low level. Therefore, many construction companies do not have enough knowledge about the hazards, the safety hazards are poorly checked, and the safety protection measures are not in place, which cannot guarantee that construction workers can safely carry out construction and production activities.

4. PREVENTION AND CONTROL OF HIGH-ALTITUDE FALL ACCIDENTS

Through the statistical analysis of 101 reports of high-altitude fall accidents in construction in the past five years, we have a certain understanding of the regularity and main influencing factors of high-altitude fall accidents in construction. we can formulate control measures and countermeasures to prevent the occurrence of high-altitude fall accidents in construction based on the above analysis, which is conducive to reducing the occurrence of high-altitude fall accidents in construction and further improves the severe security situation in construction.

4.1. Strengthen Safety Supervision During Accident Prone Periods

The project manager should formulate a work plan and arrange the working hours and rest time of construction workers reasonably. From the above analysis, it can be seen that construction workers are prone to inattentiveness and some unsafe behaviors during the time period from 7:00 to 8:00, 10:00 to 11:00 and 13:00 to 17:00. Therefore, during these prone periods of high-altitude fall accidents, safety inspections and safety supervision should be strengthened to find and eliminate hidden safety hazards in a timely manner. In the process of safety supervision, as long as the workers do wrong, they should be punished in accordance with the corresponding rules and regulations. When a problem occurs during the construction process, the work should be stopped immediately, and the problem should be solved before proceeding to the next process. In this way, the safety management of the construction site can be strictly controlled, so as to reduce the occurrence of high-altitude fall accidents during construction.

4.2. Arrange Work Tasks Reasonably According to the Age of Workers

According to the above analysis, the older the construction worker is, the easier it is to high-altitude fall accidents. In my country, there is no maximum age limit for workers on construction sites, so most construction sites have many older construction workers. Therefore, when assigning work tasks, managers try to avoid arranging construction workers over the age of 50 to work in high places. And divide those more difficult work and the work on the key working surface to workers with flexible limbs, strong emergency response ability, quick absorption of safety knowledge, and skilled work. Such targeted division of work tasks can prevent the occurrence of high-altitude fall accidents to a certain extent.

4.3. Controlling the Unsafe State of Things

The project safety manager should fully implement the safety rules and regulations, formulate corresponding safety production measures and emergency measures, and organize construction activities in strict accordance with the corresponding safety rules and regulations. Construction enterprises should appropriately increase safety production investment and introduce safety management talents, provide construction workers with sufficient and reliable safety protection equipment, strengthen the investigation of hidden dangers, do a good job of safety protection measures for dangerous areas such as edge and openings, and set up eye-catching safety in dangerous areas Warning signs and warning lights prevent workers from entering the danger zone by mistake. At the same time, the relevant managers of the enterprise should regularly carry out strict inspection and maintenance on some construction machines and building structures to prevent their function failure due to aging, wear and damage, so as to avoid the formation of hidden safety hazards. The materials on the construction site should also be neatly stacked according to the construction requirements, and the construction work should be carried out safely and civilized, so as to provide a good construction operation environment for the construction workers and ensure the safe production of the construction workers. In addition, construction workers should be resolutely prevented from working in bad weather, which can reduce the interference of the harsh environment on the workers and ensure the personal safety of the workers.

4.4. Controlling People's Unsafe Behavior

The construction workers in China are generally migrant workers. Before engaging in construction work, they did not have the corresponding safety technical training. They all rely on the construction team leader or the older construction workers in the team to impart corresponding work experience, and then use their existing safety knowledge reserves to carry out construction operations. As a result, the safety awareness of construction workers in our country is generally weak, and the safety skills are not systematically comprehensive. Therefore, in order to improve the safety awareness and safety skills of construction workers, construction enterprises should implement the safety education and training of construction workers to ensure that construction workers have the necessary safety production knowledge and follow the safety operation regulations. Only when they attach importance to production safety can they consciously regulate production behavior in their work. At the same time, the cost of violation should be increased, and the "three violations" (illegal command, illegal operation, violation of labor discipline) operation on the construction site should be severely punished, so as to reduce the unsafe behavior of construction workers and reduce the incidence of high-altitude fall accidents.

5. SUMMARY

In summary, this article analyzes the reports of 101 high-altitude fall accidents in my country from 2015 to 2019, explores the regularity of high-altitude fall accidents, and analyzes the direct causes of high-altitude fall accidents. The results show that the time from 7:00 to 8:00, 10:00 to 11:00 and 13:00 to 17:00 are the most prone to high-altitude fall accidents, and the older workers are more prone to high altitudes Fall accident. The direct cause of falling accidents in high places can be divided into unsafe behaviors of people and unsafe state of things, in which construction workers fail to (correctly) use safety protective equipment as the main influencing factors. Therefore, combining the above regularity, from the aspects of time, age, human behavior and the state of things, the prevention and control measures of high-altitude fall accidents are proposed, which are of great significance to reduce the occurrence of high-altitude fall accidents. However, since the report of the high-altitude fall accident did not publish the working years of the casualties, the impact of the construction worker's working years on the

relationship between age and high-altitude fall accidents was not taken into account, so there are some deficiencies.

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