

MEASURES TO REDUCE HUMAN ERRORS IN TOWER CRANE WORK THROUGH ACCIDENT CASE ANALYSIS

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Abstract

Recently, as the number of high-rise buildings continues to increase, the height of buildings is gradually increasing. According to this trend, the tower crane is playing a very important role in the building construction site. On the other hand, accidents that occur during tower crane work continue to occur. In order to reduce accidents occurring during tower crane work, studies have been conducted to analyze accident cases related to tower crane work, but few studies have analyzed them from the perspective of human error. Therefore, the purpose of this study is to analyze accident cases occurring during tower crane work from the perspective of human error and to suggest measures to reduce human errors occurring during tower crane work. This study will help reduce human errors occurring in tower crane work and ultimately reduce accidents.

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Peer-review under responsibility of the scientific committee of the Creative Construction Conference 2024.

Keywords: accidents case study, construction safety, human error, tower crane.

1. Introduction

1.1. Background and purpose

Recently, as the number of high-rise buildings continues to increase, the height of buildings is gradually increasing. According to this trend, the tower crane is playing a very important role in the building construction site. The report of the Ministry of Employment and Labor [1] shows, as of 2022 in Korea, the number of accident victims in the construction industry is the second highest after etc. industries, and the number of accident deaths accounts for about 46% ranking first.

In this situation, accidents in the construction industry are caused by various construction machines currently in use. Among them, there are many accidents related to tower cranes. According to a study of Lee [2], as a result of analyzing the number of accident deaths per 10,000 construction machines from 2014 to 2018, it was found that 153.4 persons in drills and hammers, 70.4 persons in mobile cranes, and 54.1 persons in tower cranes. It can be seen that tower cranes, which are used in construction, are associated with the third highest number of accidents among construction machines.

In order to reduce accidents related to tower crane work, research has been conducted to analyze cases of accident that occur during tower crane work. However, most of these studies were conducted in the form of analyzing accidents cases related to tower cranes by types and causes of occurrence. According to a recent study, the most important factor in construction site accidents is human [3], and human error by construction workers is one of the important causes of accidents [4,5]. Therefore, in order to reduce accidents related to tower cranes, research is needed to analyze tower crane accidents from the perspective of human error.

The purpose of this study is to analyze accident cases that occurred during tower crane work from the perspective of human error and to suggest measures to reduce human errors that occur during tower crane work. This study will help reduce human errors occurring in tower crane work and ultimately reduce accidents.

1.2. Study scope and method

The aim of this study is to analyze accident cases related to tower crane work from the perspectives of human error and suggest measures to reduce human errors in tower crane work. In order to collect accident cases, the author used the accident reports uploaded in the Construction Safety Management Integrated Information (CSI) [6] operated by the Korea Authority of Land & Infrastructure Safety (KALIS) at the request of the Ministry of Land, Infrastructure and Transport (MOLIT).

The author collected accident cases based on construction accident reports for the last 5 years (July 2019 to January 2024) related to construction tower cranes. In addition, human errors that because accidents were classified and analysed based on the frequency of accidents by process. Based on the analysed data, author propose a human error reduction measures that can reduce construction accidents related to tower crane work.

2. Literature review

2.1. Accidents related to tower cranes

A crane refers to a machine or mechanical device that uses power to suspend heavy objects and transport them up and down and left and right (meaning horizontally or turning). Cranes can generally be divided into tower cranes and mobile cranes, as shown in Figure 1. A tower crane refers to a crane that operates by installing a tower and then rotating a jib located at the top of the tower. A mobile crane refers to a crane that is attached to a vehicle so that it can travel on land. This study focuses on tower cranes used at high-rise building construction sites.

Reviewing researches related to tower crane accident, researches were mainly conducted to identify problems by analysing tower crane accident cases [7,8] and researches to identify risk factors of tower cranes using surveys [9]. It was found that research related to human error in tower crane accidents had not been conducted yet.

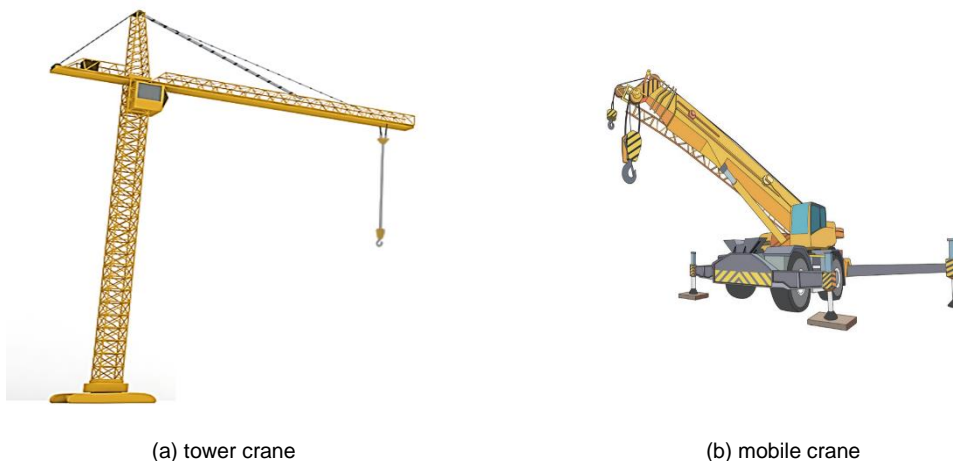


Fig. 1. Types of crane. (sources: <https://www.kosha.or.kr/kosha/data/mediaBankMain.do>)

2.2. Human error

Human error refers to the cognition, processing, decision and actions that occur when a human sensing, judging and acting with the intention of achieving a special goal, but fails to achieve the goal regardless

of the human will. In safety management areas, human error focuses on identifying unsafe human behavior and management targets to prevent accidents in the field [10].

Research on human error in the field of ergonomics has been ongoing for a long time. Many studies classify human errors from various perspectives. The most representative perspectives for classifying human errors include Reason's cognitive psychological perspective and Swain's behavioural psychological perspective [11]. Reason [12] classified human unintentional and intended behavior into slip, lapse, mistake, and violation based on a cognitive psychology.

And, Swain [10] classified human errors into errors that occur when an action required to perform a task is not done as an omission error, and an error that occurs when an action that is unnecessary to perform a task is performed as a commission error. Commission errors were more specifically divided into time errors, selection errors, sequential errors, and quantitative errors.

3. Human errors in tower crane work through accident cases analysis

3.1. hazard in Tower crane work through accident case analysis

As mentioned in Section 1.2, accident cases were analyzed based on construction accident reports contained in CSI. The analysis was conducted on 142 accident cases related to tower cranes from the last five years (July 2019 to January 2024). Accident cases related to tower cranes was largely divided into two tower crane works. It was divided into work related to tower crane installation work (assembling, telescoping, and disassembling) and tower crane lifting work using a tower crane (rigging, moving and unfastening).

Accident cases were classified into fatal accidents with fatalities, human accidents with human damage without fatalities, and material accidents with only material damage without human damage. Among the 142 accident cases, there were 18 fatal accidents, 113 human accidents with human damages, and 11 material accidents without human damages.

As shown in Table 1, accidents occurred similarly in tower crane installation work and tower crane lifting work. The sum number of accidents showed that moving work occurred the most among tower crane lifting work. When limited to fatal accidents, it was found that there were 11 cases of tower crane installation work, which is about twice as many as the 6 cases of tower crane lifting work. And, looking at the work process in detail, it was found that telescoping work among tower crane installation work and moving work among tower crane lifting work were the most common cause of fatal accidents, with 6 cases.

Table 1. Classifying the tower crane accident cases.

Type of work	Process	Fatal accidents	Human accidents	Material accidents	Sum
Installation work	Assembling	3	19	1	23
	Telescoping	6	10	0	16
	Disassembling	2	22	0	24
	Sub total	11	51	1	63
Lifting work	Rigging	0	11	0	11
	Moving	6	34	8	48
	Unfastening	0	11	0	11
	Sub total	6	56	8	70
Etc.		1	6	2	9
Total		18	113	11	142

3.2. Human Errors in tower Crane Work Accident

142 accident cases related to tower crane work were classified based on human error. In this study, it was classified into slip, lapse, mistake, and violation as suggested in Reason's research [18]. As shown in Table 2, it can be seen that accidents due to slips occur most frequently in tower crane work, followed by mistakes and violations.

Table 2. Tower crane accident cases according to types of human error.

Type of work	Process	Slip	Lapse	Mistake	Violation	Sum
Installation work	Assembling	14	0	5	4	23
	Telescoping	11	0	4	1	16
	Disassembling	17	1	5	1	24
	Sub total	42	1	14	6	63
Lifting work	Rigging	8	0	2	1	11
	Moving	17	1	23	7	48
	Unfastening	7	0	0	4	11
	Sub total	32	1	25	12	70
Etc.		6	1	2	0	9
Total		80	3	41	18	142

Table 3 classifies fatal accident cases based on human error. Unlike the classification of all accident cases (Table 1), the majority of fatal accidents were due to mistakes (61.1%). Next, slips were found to be 27.8%, violations were 11.1%, and there were no fatal accidents due to lapse.

Table 3. Tower crane fatal accident cases according to types of human error.

Type of work	Process	Slip	Lapse	Mistake	Violation	Sum
Installation work	Assembling	2 (11.1%)	-	1 (5.6%)	-	3 (16.7%)
	Telescoping	1 (5.6%)	-	4 (22.2%)	1 (5.6%)	6 (33.3%)
	Disassembling	-	-	2 (11.1%)	-	2 (11.1%)
	Sub total	3 (16.7%)	-	7 (38.9%)	1 (5.6%)	11 (61.1%)
Lifting work	Rigging	-	-	-	-	-
	Moving	1 (5.6%)	-	4 (22.2%)	1 (5.6%)	6 (33.3%)
	Unfastening	-	-	-	-	-
	Sub total	1 (5.6%)	-	4 (22.2%)	1 (5.6%)	6 (33.3%)
Etc.		1 (5.6%)	-	-	-	1 (5.6%)
Total		5 (27.8%)	-	11 (61.1%)	2 (11.1%)	18 (100.0%)

4. Measures to reduce human errors in tower crane works

In order to understand the causes of human errors, human errors in fatal accidents were classified based on 4M as shown in Table 4. 4M refers to Man, Machine, Media, and Management, and is used to identify the causes of human errors and find ways to improve them [16,17]. As shown in Table 4, all slip cases are due to man, and the specific cause is all due to worker's carelessness. Of the 11 mistakes, 7 are related to machine and 4 are related to management. If we look at the specific causes related to the

machine, most of them are caused by insufficient equipment inspection. Management was found to be all caused by failure to properly manage tasks. Violation was found to be caused by the use of substandard equipment and failure to take protective methods.

Table 4. Human error in tower crane fatal accidents according to 4M

Human error	Man	Machine	Media	Management	Sum
Slip	5 (27.8%)	-	-	-	5 (27.8%)
Lapse	-	-	-	-	-
Mistake	-	7 (38.9%)	-	4 (22.2%)	11 (61.1%)
Violation	-	2 (11.1%)	-	-	2 (11.1%)
Total	5 (27.8%)	9 (50.0%)	-	4 (22.2%)	18 (100.0%)

Although it was not summarized in a table, it was found that most of the material accidents occurred due to insufficient equipment inspection (Machine), and some accidents were also caused by the weather (Media). If looking at the details of the material accident in detail, it was an accident that could have occurred due to a human accident, but fortunately, there were no workers nearby, so it was only a material accident without a human damage. These accidents do not just result in injury, but can lead to death, so we must thoroughly seek reducing measures.

To summarize, three major measures are needed to reduce human errors that cause accidents in tower crane work. The first is a plan to reduce slip of workers. Since this is mostly caused by the worker's carelessness, workers must be sufficiently educated and informed of the risks and precautions of the work before starting work. Second, mistakes that occur when inspecting equipment and machines must be reduced. To this end, the manuals and checklists used to inspect equipment and machines must be reviewed and supplemented. In addition, there is a need to improve inspection methods so that anyone can perform safe work without mistakes if they inspect according to the manual and checklist. Third, work management must be implemented systematically. At construction sites, managers have responsibilities and obligations to supervise and manage workers, so they must do so faithfully. To this end, it is necessary to strengthen training for managers.

5. Conclusion

Accident cases were analysed based on the report of construction accidents related to tower crane work from the last five years. Accidents related to tower crane work occurred similarly in tower crane installation work and tower crane lifting work. It was found that fatal accidents occurred twice as often in tower crane. In detail, telescoping work among tower crane installation work and moving work among tower crane lifting work were the most common cause of fatal accidents.

In addition, accident cases related to tower crane work were classified based on human error. Accidents due to slips occur most frequently in tower crane work, followed by mistakes and violations. Unlike the classification of all accident cases, the majority of fatal accidents were due to mistakes. After that, slips were the second most common.

In order to understand the causes of human errors, human errors in fatal accidents were classified based on 4M. And, the results of those classification showed that three major measures are needed to reduce human errors that cause accidents in tower crane work. The first is to reduce slip of workers such as sufficiently educated and informed of the risks and precautions of the work before starting work. Second, mistakes that occur when inspecting equipment and machines must be reduced through reviewing and supplementing the manuals and checklists used to inspect equipment and machines. Third, work management must be implemented systematically. At the construction sites, managers must faithfully perform their responsibilities and duties. Therefore, it is necessary to strengthen training for managers.

In this study, author identified human errors that causes accidents related to tower crane work and suggested reduction measures. However, machines other than tower cranes are widely used in construction sites. Therefore, in the future, research is needed to identify human errors and suggest reduction measures to reduce accidents related to construction equipment other than tower cranes.

Acknowledgements

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT). (NRF-2022R1A2C1004565)

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