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CHARACTERISTICS OF ACCIDENTS IN CONSTRUCTION PROJECT IN KOREA

Kyeong-Seok Chae[1] and Chan-Sik Lee[2]

[1] Graduate Student, Department of Architectural Engineering, University of Incheon, Incheon, Korea
[2] Professor, Department of Architectural Engineering, University of Incheon, Incheon, Korea
Correspond to 200921109@incheon.ac.kr

ABSTRACT: According to the labor related data from Korea Occupational Safety & Health Agency, accident victims of construction industry are increasing 6% annually since 2006. The major reason why the rate of accidents increases in Korea is that lots of labor working with another trades works simultaneously in various type of works. This study analyzes the current accident status in view of the type of building, type of works, and project size for the latest 3 years (2007~2009). As a result, 'single family & semi-detached houses' has the largest number of accidents among buildings. In addition, 'finishing work' shows the highest number in terms of work type. For the size, accidents occurred much for 'less than 300 million'. The results of this study can be used to focus on managing the highly hazardous area where the construction accidents mostly occur; therefore, it is anticipated to contribute to improve efficiency of safety management.

Keywords: Accident; Construction; Characteristic; Facility; Work type; Size

1. INTRODUCTION

According to the data from the Korea Occupational Safety & Health Agency, the number of construction victims has increased each year since 2006, and recorded 20,998 cases by 2009, accounting for 21.47% of the total number of victims (97,821). The number of death victims accounted for 27.79%, taking up 606 cases out of 2,181 deaths, recording the highest rate in the entire industry. Considering that the construction sector takes up 7.3%[1] of the total labor force, this figure is indeed very serious. Table 1 shows the industrial accident rates in Korea that occurred between 2007 and 2009.

Table 1. The Current Status of Industrial Accidents in Korea[2]

category		total	construction sector	rate (%)
2007	victims	90,147	19,050	21.13
	deaths	2,406	630	26.18
2008	victims	95,806	20,473	21.37
	deaths	2,422	669	27.62
2009	victims	97,821	20,998	21.47
	deaths	2,181	606	27.79

In order to reduce accidents at construction sites and increase the efficiency of the safety management system, we need to investigate the characteristics of construction accidents and obtain accurate statistical data. This study aims to explore the characteristics of construction accidents by collecting and analyzing the accident cases which occurred at construction sites within last three years (2007~2009).

2. METHODOLOGY

In order to analyze the characteristics of accidents that occurred between 2007 and 2009 in Korea's construction sector, application forms for treatment from the Korea Labor Welfare Corporation and investigation forms of industrial accidents from local labor authorities have been collected and analyzed, in order to calculate the number of victims. Before drawing out the characteristics of construction accidents, categorical items such as the Disaster Forecasting System from the Korea Occupational Safety & Health Agency, the Korea Standard Industrial Classification from the Statistics Korea, the Unified Construction Information Classification System of the Ministry of Land, Transport and Maritime Affairs, and the Information Classification System of the Construction Association of Korea have been analyzed to establish a new classification system for construction facilities. The classification system categorized by types of construction works is listed according to the Korean Construction Standard Specification, while the classification system categorized by size has been reestablished by categorizing the Korea Occupational Safety & Health Agency's classification system divided by the numbers of workers into several levels of construction costs. The classification system used in this study is presented in Table 2.

[1] The Statistics Korea, 'Yearbook of Labors Statistics', 2009
[2] The Korea Occupational Safety & Health Agency, 'Status of Industrial Accidents', 2009

Table 2. The Classification System of construction accidents

facilities	types of work	size
single family & semi-detached houses	earthwork & substructure construction	less than 300 million
interior construction	structural framework	3~500million
apartment	finishing work	500 million~1billion
residential-commercial complex	others	1~2 billion
small neighborhood living facilities		2~5 billion
arcade, department store, shopping center		5 ~10 billion
government office, office building		10~12 billion
hotel, accommodation, inn		12~15 billion
education, research facilities		15~30 billion
hospitals		30~50 billion
traditional buildings, religious buildings		50 ~100 billion
show, assembly, electric facilities		over 100 billion
stadium, playground, comprehensive leisure & training complex		
plants, machine & equipment installation		
work station, terminal building		
cold & refrigeration storage		
storage, warehouse		
power plant, substation buildings		
other		

3. LITERATURE REVIEW

In the「Accident Characteristics of Construction Workers by Age」, Park Jong-Hyun et. al. (2009) analyzed deaths of construction workers reported between 2002 and 2007 by age, based on the 'status of industrial accidents' and the 'causes of industrial accidents' of the Korea Occupational Safety & Health Agency, analyzed the causes of accidents according to size and occupational types, and then presented the types of accidents and their characteristics by different age groups.

Moreover, in the「Accident Risk Analysis of Construction Workers by Occupation」, Yang Yun-Sun et. al (2009) calculated the risk scores of injuries and deaths by using the Risk Plan and an accident assessment method such as the IRR (index of relative risk for a given trade), and drew out the ranks of accident-prone occupations by giving more weight to IRR risk scores and thereby calculating risk scores of different occupations.

Furthermore, in the「Accident Analysis of Middle-aged & Advanced-aged Construction Workers」, Lee Jeong-Cheol and Lee Chan-Sik (2008) pointed out that accidents among middled-aged and advanced-aged construction workers do increase each year, and analyzed the types and characteristics of deaths and accidents that occurred between 2001 and 2005 among construction workers aged over 50.

In addition, in the「Characteristics of Unexpected Fetal Accidents in Construction Project」, Park Kyoung-Hun et. al. (2007) collected and analyzed the data of accident cases that occurred at construction sites according to different types of works and occupations, introduced factors that affect safety incidents and major considerations in construction management that are required for safety, and thereby provided basic information that can be used in establishing and managing safety plans to prevent accidents at construction sites.

Finally, in the「Development of the Safety Information Management System according to the Risk Index for the Building Construction Work」, Go Seong-Seok et. al. (2005) categorized accident cases into factors and detailed duties according to each type of construction work, analyzed the incidence rates and risks by different types of works, and developed a practical safety management system that can show risks of each category.

However, previous studies have usually focused on calculating the frequency of accidents (e.g., accident rates) based on statistical data, but not many of them presented multi-angle analysis that categorizes accidents according to facilities, types of work and size.

4. ANALYSIS OF CONSTRUCTION ACCIDENTS

「Accident Characteristics of Construction Workers by Age」, In this study, to analyze construction accidents, application forms for treatment from the Korea Labor Welfare Corporation and investigation forms of industrial accidents from local labor authorities have been collected for the period between 2007 and 2009. Out of 60,520 accident cases, 19,353 cases that were impossible to categorize due to unclear information have been excluded for analysis, and only 31,833 cases out of 41,167 cases which occurred at construction sites were analyzed. Table 3 shows the data of the construction accident cases to the total accidents cases used in this study.

Table 3. The number of victims

(Unit: case)

category	number of categorized accidents	number of construction accidents	rate of construction accidents to categorized accidents (%)
2007	12,354	9,539	77.21
2008	13,922	10,975	78.83
2009	14,891	11,319	76.01
Total	41,167	31,833	77.33

4.1 Characteristics of Accidents by Facilities

Figure 1 illustrates the number of construction accidents (31,833 cases) that occurred between 2007 and 2009 by different types of facilities. The results of the analysis show that accidents occurred most frequently in constructions of 'single family & semi-detached houses', followed by 'small neighborhood living facilities', and 'plants, machine & equipment installation', while occurred least frequently at 'work station and terminal buildings.'

Figure 1. Total number of construction accidents by different types of facilities

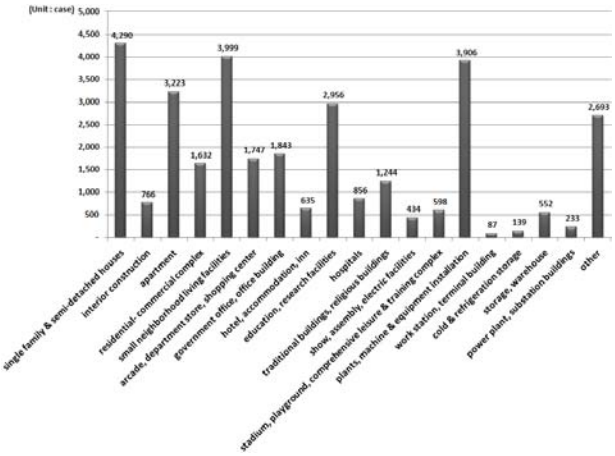
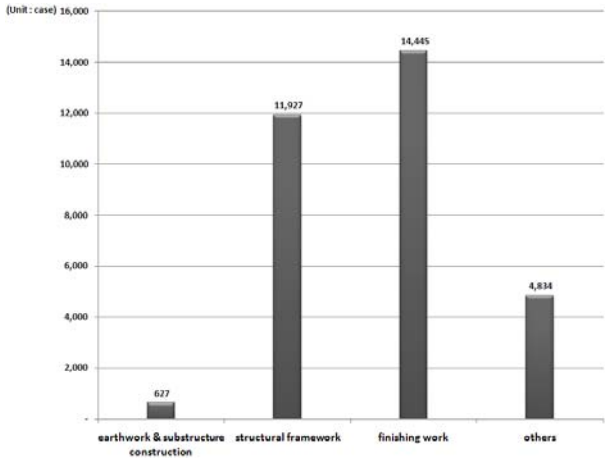


Table 4 demonstrates that although accidents at 'apartment' construction sites only accounted for 10.12% of the total number of accidents, the rate has gradually increased each year and in 2009, and accidents occurred most frequently at 'apartment' sites amongst other facilities. Likewise, accidents at 'education and research centers' do not take up more than 9.29% of the total accident rate, but showing a big increase over 40% each year. On the other hand, accidents at 'plants, machine and equipment installation' only take up 12.27% of the total number of accidents, and the number seems to decrease each year. Meanwhile, the number of accidents at 'work station, and terminal buildings' was recorded as the lowest among the entire facilities, three years in a row.

4.2 Characteristics of Accidents by Types of Work

The results of the analysis of the number of accidents by different types of works show that accidents occurred mostly frequently during 'finishing works,' and then during 'structural framework', 'others' and 'earthworks & substructure works' (Figure 2).

Figure 2. Total number of construction accidents by different types of works



If we have a look at the developments of construction accident cases by different types of works, the category of 'earthworks and substructure works' has the fewest accidents each year (Table 5). Moreover, it appears that the rate of change is not so great for the category 'finishing works,' but accident cases were reported most frequently in this category each year, and its rate to the total number of accident cases is also the highest.

Table 4. The number of construction accidents by different types of facilities

(Unit: case)

facilities	2007	2008	2009	total	rate
single family & semi-detached houses	1,140	1,805	1,345	4,290	13.48
interior construction	290	249	227	766	2.41
apartment	668	933	1,622	3,223	10.12
residential- commercial complex	747	550	335	1,632	5.13
small neighborhood living facilities	1,023	1,602	1,374	3,999	12.56
arcade, department store, shopping center	585	565	597	1,747	5.49
government office, office building	626	553	664	1,843	5.79
hotel, accommodation, inn	183	208	244	635	1.99
education, research facilities	625	960	1,371	2,956	9.29
hospitals	287	282	287	856	2.69
traditional buildings, religious buildings	366	473	405	1,244	3.91
show, assembly, electric facilities	85	156	193	434	1.36
stadium, playground, comprehensive leisure & training complex	209	221	168	598	1.88
plants, machine & equipment installation	1,454	1,303	1,149	3,906	12.27
work station, terminal building	17	35	35	87	0.27
cold & refrigeration storage	24	75	40	139	0.44
storage, warehouse	150	206	196	552	1.73
power plant, substation buildings	65	73	95	233	0.73
others	995	726	972	2,693	8.46

Table 5. The number of construction accidents by types of work

(Unit: case)

types of work	2007	2008	2009	rate
earthwork & substructure construction	191	226	210	1.97
structural framework	3,701	4,167	4,059	37.47
finishing work	4,154	5,079	5,212	45.38
others	1,493	1,503	1,838	15.19
total	9,539	10,975	11,319	100.00

4.3 Analysis of Accident Rate by Types of Work

In this study, the accident rate has been analyzed, limited to the facilities such as 'apartment' and 'plants, machine and equipment installation' based on the characteristics of accidents by facilities. Accidents at 'apartment' construction sites have increased each year, and reached the highest among other facilities in 2009, while accidents at 'plants, machine and equipment installation' sites is rather decreasing, although over 1000 accidents still occur at these sits each year, and ranks high on the total number of accidents. Table 6 shows the detailed categorization of types of works, which was created to analyze the characteristics of accidents of these two types of facilities.

Table 6. Detailed Classification System for types of construction works

types	Detailed types
earthworks, substructure construction	earthworks
	substructure works
structural framework	reinforced concrete construction
	steel construction
	carpenter's work
finishing work	masonry work
	plaster work
	stone work
	tile work
	waterproofing & damp proofing work
	roof & gutter work
	metal & miscellaneous steel work
	interior & exterior wall finishing work
	heating system & floor work
	fitting & glass work
	coating work
	interior finishing work
	heat insulation & fire proof work
	equipment work
others	landscape work
	pre-accessory civil work
	demolition & recycling work
	temporary electric work
	temporary safety installation
	lifting equipment
	maintenance, defect repair works
	management & cleaning

The accident rate indicates the number of injuries occurring per 100 workers, using the formula (1) as follows.

$$\text{The accident rate (\%)} = \text{the number of victims/the number of full-time workers} \times 100 \quad (1)$$

The number of full-time workers was calculated with the following formula (2).

$$\text{The number of full time workers} = \text{the annual domestic construction earnings / the average monthly wage of a construction worker} \times 12 \quad (2)$$

In formula (2), the labor cost rate and the average monthly wage of a construction worker were adopted from the notifications by the Minister of Labor in compliance with the 'Act on the collection, etc., of premiums for employment insurance and industrial accident compensation insurance'. The annual domestic construction earnings were based on the statistics yearbook of construction industry published by the Construction Association of Korea. Since each statistics yearbook of construction industry shows the earnings from construction works completed in a year by each type of facilities, in order to calculate the number of full-time workers according to detailed types of works, estimates were made for the distribution ratio of the expenses regarding each detailed type of works for the two facilities based on the actual cost data, as shown in Table 7.

Table 7. Ratio of the expenses regarding each detailed types for two facilities

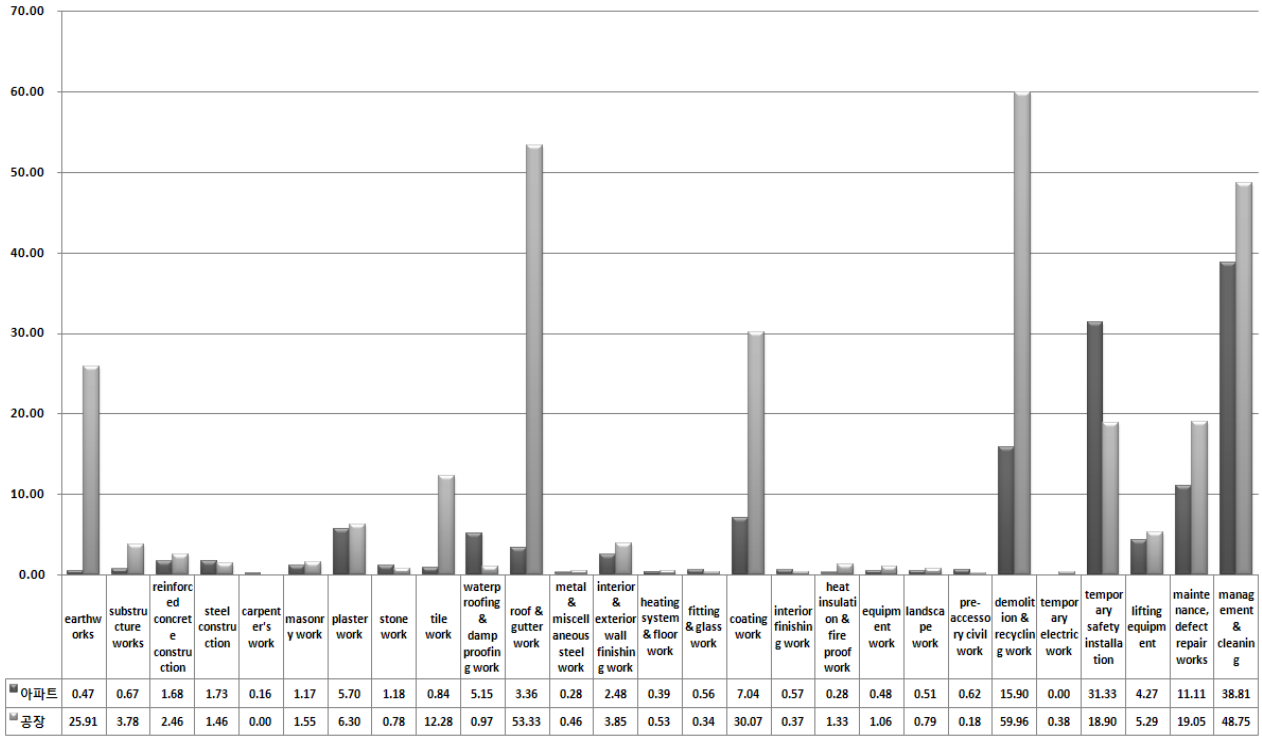
types	detailed types	Ratio of the expenses	
		apartment	plants, machine & equipment installation
earthworks, substructure construction	earthworks	3.98	0.07
	substructure works	1.48	0.40
structural framework	reinforced concrete construction	26.44	11.37
	steel construction	0.35	12.60
	carpenter's work	0.65	0.00
Finishing work	masonry work	2.25	1.17
	plaster work	0.95	0.63
	stone work	3.17	0.97
	tile work	1.95	0.04
	waterproofing & damp proofing work	0.65	1.13
	roof & gutter work	0.36	0.09
	metal & miscellaneous steel work	2.42	3.97
	interior & exterior wall finishing work	1.32	2.50
	heating system & floor work	1.47	0.50
	fitting & glass work	5.84	6.68
	coating work	0.85	0.24
	interior finishing work	8.22	12.08

Table 7. Ratio of the expenses regarding each detailed types for two facilities (continuous)

types	detailed types	Ratio of the expenses	
		apartment	plants, machine & equipment installation
Finishing work	heat insulation & fire proof work	2.70	0.57
	equipment work	28.12	32.50
others	landscape work	2.93	1.44
	pre-accessory civil work	3.00	10.15
	demolition & recycling work	0.15	0.15
	temporary electric work	0.20	0.20
	temporary safety installation	0.10	0.10
	lifting equipment	0.10	0.10
	maintenance, defect repair works	0.25	0.25
	management & cleaning	0.10	0.10

Figure 3 represents the total accident rate for 'apartment' and 'plants, machine and equipment installation'. The accident rate for 'apartment' sites is higher in 'demolition and recycling works,' 'temporary safety installation', 'maintenance and defect repair works' in the category of others, compared to the other detailed types of works. The category of 'plants, machine and equipment installation' shows higher accident rates in the majority of detailed types of works, compared to 'apartment', followed by 'roof and gutter works', 'demolition and recycling works' and 'management and cleaning'.

Figure 3. Total accident rate for two facilities



4.4 Characteristics of Accidents by Size

This study explored the characteristics of accidents according to different construction size (construction costs). Figure 4 illustrates that accidents occurred most frequently during constructions that cost less than '300 million' won, and indicates that the number tends to decreases as the size increases.

Figure 4. Total number of construction accidents by size

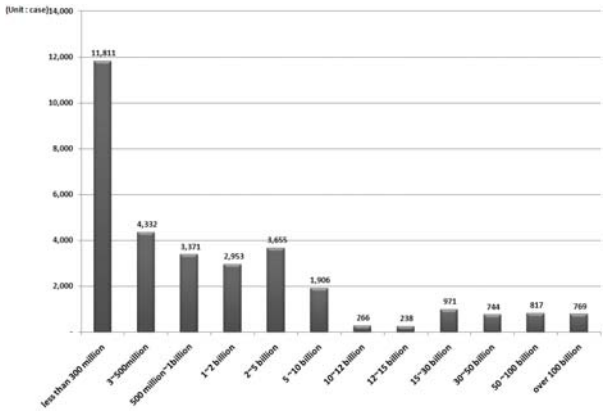


Table 8 represents the developments of accidents according to different construction size. Constructions cost less than '300 million' won accounted for 38.31% of the total number of accidents, which is the highest in the category, and the number of accidents keeps rising each year. On the other hand, constructions that cost between '10 and 12 billion' won and over '12 to 15 billion' won recorded the lowest number of accident cases in three years, taking up 0.86% and 0.77% of the total number of accidents, respectively.

Table 8. The number of construction accidents by size

(Unit: case)

size	2007	2008	2009	total	rate
less than 300 million	3,571	3,847	4,393	11,811	38.31
3~500million	1,905	1,167	1,260	4,332	10.81
500 million~1billion	1,013	1,207	1,151	3,371	10.93
1~2 billion	932	1,020	1,001	2,953	9.58
2~5 billion	1,191	1,279	1,185	3,655	11.85
5 ~10 billion	626	666	614	1,906	6.18
10~12 billion	93	78	95	266	0.86
12~15 billion	62	108	68	238	0.77
15~30 billion	290	360	321	971	3.15
30~50 billion	212	277	255	744	2.41
50 ~100 billion	187	322	308	817	2.65
over 100 billion	212	255	302	769	2.49

5. CONCLUSION

As construction projects are becoming more complex and diversified, the risks of accidents continue to grow, demanding an appropriate safety management system customized for different types of facilities or size. The objective of this study was to promote a strict safety management system at construction sites via distinguishing the characteristics of accidents that occur during different types of construction works that account for the highest number of construction accidents. Application forms for treatment from the Korea Labor Welfare Corporation and investigation forms of industrial accidents from local labor authorities have been collected for the period between 2007 and 2009, and analyzed to calculate the number of victims. Moreover, the characteristics of construction accidents were analyzed according to the classification criteria for construction works. The results show that amongst the facilities, accidents occurred most frequently at 'single family and semi-detached houses' sites, while amongst types of works, 'finishing work' category ranked the highest in terms of the number of accidents. By construction size, construction that cost less than '300 million' won showed the largest number of accidents. The significance of this study lies in the fact that it provided the basic information that can promote a strict safety management system as it distinguished the risk factors at different construction sites. However, it is necessary to establish safety measures in the future, in order to eliminate the risk factors at construction sites, by analyzing the characteristics of accidents that occur at construction sites as well as the ones occur within the entire industry.

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