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INCIDENT FREQUENCY AND SEVERITY FOR CONSTRUCTION FACILITIES

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ABSTRACT: Preventing incidents occurred in construction process is important for safe implementation of construction projects. Due to the complexity and magnitude of the project and moreover, poor safe planning and management, construction incidents in Korea have been increasing. Reducing construction incidents effectively, appropriate safety management program in consideration of the incident rate of each facility is to be adapted. This study analyzes incident frequency and severity rate of each facility based on the data of construction sites(about 1,560 thousand cases) recorded by Korea Occupational Safety & Health Agency for 3 years from 2007 to 2009, and the incident related data (about 40 thousand cases) of Korea Workers' Compensation & Welfare Service. The results of this study revealed that construction incident rates of 'cold refrigeration storage facilities' are the highest among building types, followed by traditional building religious building, arcade department store and shopping center. In case of other facilities, the incident rate and the rate of intensity of 'pipelining project' are the highest, followed by 'tunneling project'. These results would be used in providing safety programs beneficial for preventing construction incidents.

Keywords: Construction, Building/Facility, Incident, Frequency, Severity

1. INTRODUCTION

As construction business is set to go higher and large scale, risks of construction accidents continue to rise. If we have a look at the 「Status of Industrial Accidents 2009」 published by the Korea Occupational Safety ＆ Health Agency, the number of deaths caused by construction incidents accounts for 606 out of 2,181 deaths, taking up 27.79% of the total number of deaths. This is the highest in the entire industry.

In Korea, each year, the Korea Labor Welfare Corporation releases the data on approved applications for treatment, and local labor authorities announces the current status of industrial incidents reported in investigation forms of industrial incidents.

The Disaster Forecasting System used by the Korea Occupational Safety ＆ Health Agency investigates and announces victims of serious construction incidents by different types of facilities.

The objective of this study was to explore the frequency and severity of the incidents that occur in each type of facilities, by investigating and analyzing the current status of construction incidents, including incident-free construction sites.

2. METHODOLOGY

The incident frequency rates[1] and their severity[2] were calculated by categorizing the construction incidents that occurred between 2007 and 2009 in Korea and the number of workers who had experienced incidents at different types of facilities.

Based on the approved application forms for treatment from the Korea Labor Welfare Corporation and investigation forms of industrial incidents from local labor authorities, the number of victims and the lost workdays were calculated. After investigating the status of construction sites, the number of workers at each type of facilities was calculated by using the formula[3] for the number of full-time workers.

The methodology and procedures of this study is as follows:

1) The facility classification system used by the Korea Occupational Safety ＆ Health Agency was broken down to suit the purpose of this study.

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[1] The rate of victims per 100 workers was calculated by the number of victims/number of workers × 100

[2] It is the scale that shows seriousness of accidents, indicating the lost workdays per 1000 hours of labor due to accidents, calculated by "lost workdays/ working hours per year × 1,000(hours)."

[3] 'Article 3-2 of the Criteria and method for computing incidence rates of industrial accidents reported by construction companies and cases of industrial accident reporting violations'
(the annual domestic construction earnings X the labor cost rate) (the average monthly wage of a construction workerX12)

2) After analyzing the 60,521 cases of construction incidents that occurred between 2007 and 2009, the cases were divided into subcategories according to the facility classification system, and then the lost workdays were calculated.

3) The number of full-time workers were calculated by dividing the data obtained from construction sites with/without incidents within the past three years (07~09).

4) The incident frequency rates and the severity of incidents were calculated based on the number of full-time workers, the number of victims and the lost workdays.

3. BACKGROUND OF CASE STUDIES

Yang YoonSeon(2009) and etc. drew up the rank of multiple disaster jobs through analysis of the present situation of construction disasters from 2005 to 2007 using Analysis of disaster risk for the construction workers by job.

Lee Jungcheong(2008) and etc. pointed out the increase of middle and senior construction workers year by year using Disaster characteristics of middle and senior construction workers, and analyzed the death disaster characteristics of middle and senior construction workers over 50 years old from 2001 to 2005.

Park Kyeonghoon(2006) and etc. analyzed a great disaster case study found at the construction building place into types of both work and job in Analysis of great disaster occurrence characteristics at building construction.

In the 「Comparative Injury and Fatality Risk Analysis of Building Trades」, Selim Baradan and Mumtaz A. Usmen (2006) have estimated the risk levels of sixteen occupations, considering the frequency and the seriousness of incidents that occurred among the construction-related skilled workers, and argued that the occupations with higher risk levels require a more efficient safety management system.

Lee Jongbin(2006) and etc. evaluated the risk of work type of construction project considering a great disaster case study and job strength in Evaluation of building construction risk considering a great disaster case study and job strength.

However, other existing studies have merely analyzed the major incident cases and the characteristics of incidents that occur in specific types of construction works.

4. ANALYSIS OF THE PRESENT SITUATION OF CONSTRUCTION DISASTERS

4.1 The present situation of construction disasters

I analyzed the present situation of job type announced by Korea Occupational Safety & Health Agency to know the proportion and severity occupied by construction disasters among the total construction disasters, and Table 1 below shows the result.

Mining industry showed the highest rate per a thousand people and that of death per ten thousand people compared with other industries. Compared with manufacturing and construction, the rate of per a thousand people of manufacturing is higher(11.3) than that of construction(6.73). The rate of death per a thousand people of construction is higher(0.22) than that of manufacturing(0.2). This means that the disaster frequency of construction is lower than that of manufacturing, but disaster strength of construction is higher than that of manufacturing if a disaster occurs.

Table 1 Disaster labors of industrial

(Units: case)

Separation	Labor	Disaster	Disaster Rate Per A Thousand People (%)	Death People	Death Disaster Rate Per Ten Thousand People(%)
Mining Industry	76,784	8,166	106.35	2,159	28.12
Manufacturing Industry	15,467,794	174,845	11.30	3,029	0.20
Electricity, Gas And Waterwork	268,052	582	2.17	41	0.15
Construction Industry	14,017,878	94,394	6.73	3,146	0.22
Transportation , Telecommunications	3,455,500	23,596	6.83	820	0.24
Other Industry	29,365,779	157,514	5.36	2,762	0.09

4.2 The present situation of construction disasters

I analyzed “the present situation of construction disasters” announced by Korea Occupational Safety & Health Agency from 2004 to 2009 to know the present situation of construction disasters, and Table 2 shows the result. The rate of per a thousand people showing the number of people gotten disaster per a thousand workers was the highest (7.48) in 2005, and after that, it reduced to 7.05, 6.6 and 6.3 with time. The rate of death per a thousand people of construction showing the number of people gotten death disaster per a thousand workers was 0.29 in 2005, and after that, it reduced little by little to 0.29(2005), 0.25(2006), 0.22(2007), 0.21(2008) and 0.18(2009) with time.

Table 2 Annual disaster condition construction

(Units: case)

Separation	2005	2006	2007	2008	2009
Labor	2,127,454	2,547,754	2,887,634	3,248,508	3,206,526
Disaster	15,918	17,955	19,050	20,473	20,998
Disaster Rate Per A Thousand People(%)	7.48	7.05	6.6	6.3	6.5
Death People	609	631	630	669	606
Death Disaster Rate Per Ten Thousand People(%)	0.29	0.25	0.22	0.21	0.18

5. THE FACILITY CLASSIFICATION SYSTEM

In order to make use of the Disaster Forecasting System from the Korea Occupational Safety & Health Agency more effectively for safety guides and such measures, the system was divided into categories of construction, civil engineering, industrial facilities, and others. The construction field has nineteen facilities, civil engineering field has fifteen, industrial facilities and others field has eight. Table 3 represents the facility classification system.

Table 3 The facility classification system

Separation	Construction	Civil Engineering	Industrial Facilities and Others
1	Single Family And Semi-Detached Houses	General Roads	Waste Incineration . Recycling Facilities
2	Interior Construction	Expressway	Plants Project
3	Apartment	Bridges	Energy Storage Plants
4	Residential- Commercial Complex	Dam	Sewer And Wastewater Treatment Plants
5	Small Neighborhood Living Facilities	Reclamation, Port, Airport Project	Landscape Architecture
6	Arcade, Department Store, Shopping Center	Tunnel	Electric Works
7	Government Office, Office Building	General Railroads	Information And Communication Facilities Construction
8	Hotel, Accommodation, Inn	Rapid Transit Railway	Demolition Of Building And Structure
9	Education, Research Facilities	Subways	
10	Hospitals	Residential Land Development Project	
11	Traditional Buildings, Religious Buildings	Flood Control Afforestation, Canal	
12	Show, Assembly, Electric Facilities	Water Sewer System And Filtration Facilities	
13	Stadium, Playground, Comprehensive Leisure & Training Complex	Irrigation Ditch And Farmland Adjustment	
14	Plants, Machine & Equipment Installation	Pipelining Constructions	
15	Work Station, Terminal Building	Others	
16	Cold & Refrigeration Storage		
17	Storage, Warehouse		
18	Power Plant, Substation		

	Buildings		
19	Others		

6. ANALYSIS OF INCIDENT FREQUENCY AND SEVERITY

Based on the approved application forms for treatment collected from the Korea Labor Welfare Corporation and the data on the victims of industrial incidents reported in the investigation forms of industrial incidents obtained from local labor authorities between 2007 and 2009, the number of victims and the lost workdays were calculated. Table 4 demonstrates the incident victims that have been investigated and analyzed in this study.

Table 4 Investigated Incident Victims

(Units: case)

Separation	Whole Victims Cases	Analysis Victims Cases	Analysis Rate (%)
2007	19,050	12,594	66.11
2008	20,473	14,144	69.09
2009	20,998	15,092	71.87
total	60,521	41,830	69.12

After obtaining the lists of construction sites with/without incidents for the period between 2007 and 2009 from the Korea Occupational Safety & Health Agency, the number of full-time workers was calculated. Table 5 illustrates the status of incidents at construction sites which have been investigated and analyzed in the study.

Table 5 Investigated construction site

(Units: case)

Separation	Whole Construction Site Cases	Analysis Construction Site Cases	Analysis Rate (%)
2007	551,718	464,369	84.17
2008	613,699	499,197	81.34
2009	804,290	724,808	90.12
total	1,969,707	1,688,373	85.72

6.1 Construction Facility

The facilities in the construction field that recorded the largest numbers of victims as well as lost workdays were single family and semi-detached houses, followed by apartment, small neighborhood living facilities, arcade．department store．shopping center, traditional and religious buildings, plants and machine & equipment installation, and cold．refrigeration storage.

The incident frequency rate and the severity of incidents that occurred in cold ． refrigeration storage facilities were the highest of all, followed by traditional building．religious building, arcade．department store．shopping center. The incident rates were high in the field of small neighborhood living facilities, followed by hospitals, interior constructions, and single family and semi-detached houses, while the incidents were most serious in the field of storage．warehouse, followed by hospitals, interior construction, and plants．machine and equipment installation.

The number of victims and the lost workdays were the highest among the fields of single family and semi-detached houses, apartment, small neighborhood living facilities, and plant and machine & equipment installation, but since the number of full-time workers was also big in those categories, the incident frequency rate was relatively low. Table 6 shows the incidence rates of incidents in the field of construction facilities.

6.2 Civil Engineering Facilities

In the field of civil engineering facilities, the number of victims and the lost workdays were most significant amongst the facilities such as general roads, followed by bridges, water．sewer system and filtration facilities, irrigation canal and farmland adjustment, and pipelining constructions.

The incident frequency rate was high in the category of pipelining construction, followed by tunnel, irrigation canal．farmland adjustment, water·sewer system and filtration facilities, bridge, and subways, while the incidents were most serious in the category of tunnel, followed by pipelining construction, general roads, bridge, subways, water·sewer system and filtration facilities.

Table 7 describes the incidence rates of incidents in the field of civil engineering facilities.

6.3 Industrial Facilities and Others

The number of victims and the lost workdays were the highest in the field of electric works, followed by information and communication facilities construction, and demolition of building and structure. The incident rates and the severity of incidents were more significant with sewer and wastewater treatment plants and facilities in the field of industrial facilities, and with demolition of building and structure in the category of others.

The incident frequency rate was the highest in followed by information and communication facilities construction, and electric works, while incidents were most serious with waste incineration ．recycling facilities, followed by information and communication facilities construction.

Table 8 shows the incidence rates in the fields of industrial facilities and others

Table 6 Construction Field Facility Incident Frequency and Severity

(Units: case)

Category	Full-Time Workers	Victims	Lost Workdays	Frequency (%)	Severity
Single Family And Semi-Detached Houses	169,908	4,290	890,614	2.52	2.18
Interior Construction	25,735	766	267,763	2.98	4.34
Apartment	295,964	3,223	1,649,324	1.09	2.32
Residential- Commercial Complex	124,379	1,632	1,031,830	1.31	3.46
Small Neighborhood Living Facilities	122,916	3,999	1,015,239	3.25	3.44
Arcade, Department Store, Shopping Center	45,355	1,747	605,726	3.85	5.56
Government Office, Office Building	124,766	1,843	700,883	1.48	2.34
Hotel, Accommodation, Inn	35,038	635	249,632	1.81	2.97
Education, Research Facilities	157,617	2,956	924,184	1.88	2.44
Hospitals	26,867	856	300,697	3.19	4.66
Traditional Buildings, Religious Buildings	19,167	1,244	445,994	6.49	9.70
Show, Assembly, Electric Facilities	30,342	434	166,937	1.43	2.29
Stadium, Playground, Comprehensive Leisure & Training Complex	48,429	598	194,470	1.23	1.67
Plants, Machine & Equipment Installation	199,354	3,906	1,963,358	1.96	4.10
Work Station, Terminal Building	7,420	87	55,464	1.17	3.11
Cold & Refrigeration Storage	1,541	139	313,667	9.02	84.81
Storage, Warehouse	28,077	552	367,612	1.97	5.46
Power Plant, Substation Buildings	99,629	233	209,773	0.23	0.88
Others	269,343	2,693	826,598	1.00	1.28

Table 7 Civil Engineering Field Facility Incident Frequency and Severity

(Units: case)

Category	Full-Time Workers	Victims	Lost Workdays	Frequency (%)	Severity
general roads	149,003	1,558	626,138	1.05	1.75
Expressway	82,225	96	116,445	0.12	0.59
bridges	21,013	378	307,498	1.8	6.1
dam	9,775	134	25,768	1.37	1.1
reclamation, port, airport project	18,400	160	112,032	0.87	2.54
Tunnel	2,443	105	100,882	4.3	17.21
general railroads	9,361	156	160,992	1.67	7.17
rapid transit railway	22,066	8	1,665	0.04	0.03
subways	11,064	180	121,121	1.63	4.56
residential land development project	26,990	245	77,742	0.91	1.2
flood control afforestation, canal	65,584	378	77,985	0.58	0.5
water.sewer system and filtration facilities	50,901	1,065	522,142	2.09	4.27
irrigation ditch and farmland adjustment	12,243	260	87,111	2.12	2.96
pipelining constructions	6,982	347	218,313	4.97	13.03
others	14,820	338	108,691	2.28	3.06

Table 8 Industrial Facilities and Others Field Facility Incident Frequency and Severity

(Units: case)

Category	Full-Time Workers	Victims	Lost Workdays	Frequency (%)	Severity
waste incineration . recycling facilities	11,478	71	68,088	0.62	2.47
Plants project	7,768	181	93,737	2.33	5.03
Energy Storage plants	10,237	50	9,969	0.49	0.41
sewer and wastewater treatment plants	9,302	226	139,240	2.43	6.24
landscape architecture	103,272	714	226,397	0.69	0.91
electric works	185,484	1,328	661,095	0.72	1.49
information and communication facilities construction	62,234	738	238,693	1.19	1.60
demolition of building and structure	6,086	533	284,545	8.76	19.48

7. CONCLUSIONS

As construction business is set to go higher and large scale, risks of construction incidents continue to rise. The number of deaths caused by construction incidents accounts for 27.79% of the total number of industrial deaths in 2009 in Korea, the highest in the entire industry. In order to reduce the incidents practically, it is necessary to investigate the incidence rates of incidents that occur at every single construction site in Korea and apply the results to the safety management system at construction sites.

The existing classification system has been reestablished in this study, to make it more suitable to manage construction incidents. After analyzing the number of sites with incidents (approx. 1,680,000 cases) and the cases of victims of construction incidents (approx. 40,000 cases) recorded between 2007 and 2009 in Korea, the frequency of incidents and their severity were calculated according to the types of construction works and scales.

The construction incident frequency rate and the severity of incidents that occurred in cold . refrigeration storage facilities were the highest of all, followed by traditional building . religious building, arcade . department store . shopping center.

The Civil Engineering incident frequency rate was high in the category of pipelining construction, followed by tunnel, irrigation canal . farmland adjustment, water · sewer system and filtration facilities, bridge, and subways, while the incidents were most serious in the category of tunnel, followed by pipelining construction, general roads, bridge, subways, water · sewer system and filtration facilities.

The Industrial Facilities And Others incident frequency rate was the highest in followed by information and communication facilities construction, and electric works, while incidents were most serious with waste incineration . recycling facilities, followed by information and communication facilities construction.

If we apply the characteristics of construction incidents in Korea presented in this study to safety policies and development of such policies, as well as safety guides at construction sites and supervision procedures, we may expect reductions in construction incidents, and be able to control the timing, frequency and levels of technical supports and management . supervision according to different facilities . scales. Furthermore, it may become possible to focus on managing dangerous facilities and maximize the efficiency of construction safety management systems.

In this study, the 'application forms for treatment' collected from the Korea Labor Welfare Corporation and the ‘lists of construction sites’ obtained from the Korea Occupational Safety ＆ Health Agency were used as the baseline data. It is expected that by further categorizing and analyzing the excluded data, we may be able to find out more precise characteristics of construction incidents and thereby assist in establishing a more effective safety measures.

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