A DEVELOPMENT OF MODEL FOR FIRE HAZARD ASSESSMENTS IN THE BUILDINGS

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ABSTRACT

The hazard assessment in which the potential hazard factors in the buildings are investigated and the scale of the hazard is analyzed should be performed first in order to prevent personal and material damages due to building fire. In this study, the building fire hazard are assessed using 822-item checklist, for the qualitative evaluation of which the main factors are classified into 10 items, yielding 100 scale points with some weighting. It is shown that present model is applicable for the assessment of all general buildings through the examination of the suitability of assessment model by actual assessment of existing building. Also, the checklist is prepared in itemized questionnaire form for easy assessment of building fire hazard.

Therefore, the present model will be helpful for those working in fire prevention, who are suffering from the lack of manifest evaluation model for the fire prevention assessment so far in Korea.

1. INTRODUCTION

1.1 Background and Purpose of Study

In order to minimize the human and material damages caused by building fire, it is essential to identify the potential hazardous factors inherent in their facilities and equipments and assess how hazardous they are.

In the same context, in order to keep safe a building against fire, it is necessary to design the building to be a systematic anti-fire structure at the initial design stage for a new building, while for the existing buildings, the fire-fighting facilities should be thoroughly maintained and serviced.

With such a basic conception in mind, this study was aimed at systematically assessing the potential fire hazards of buildings to prevent fires and help maintain and service the fight-fighting facilities.

1.2 Preceding Studies

The current PSM or SMS systems which were conceived through preceding studies are now being implemented in the "Industrial Safety & Health Code" and "Urban Gas Business Code" for chemical plants and gas facilities, respectively. Namely, for such facilities the methods of assessing potential fire hazards may well have been standardized.

In particular, the assessment models for chemical plants allowing the fire-fighting personnels to determine, classify and put priorities on the hazardous factors are being developed by various research institutes and private companies independently. The major assessment models available are "Measuring Performance and Effectiveness of Process Safety Management" developed by CCPS (Center of Chemical Process Safety) under the Society of US Chemical Industries and "QSA" (Quality Safety Audit) developed and distributed by the German Hoechst Inc. The latter system consists of a total 770 checkpoints which can be categorized into 5 areas of safety management. On the other hand, "ISRS" (International Safety Rating System) developed by DNV Inc., is designed to classify the safety management points by each of 20 categories to rate them, so that the total scores can be 12,000, when 652 checkpoints are all rated as "10".

In Korea, However, any model assessing the potential fire hazards for buildings has yet to be developed.

2. MAIN DISCUSSIONS

2.1 Analysis and Assessment of Potential Fire Hazards

The general concepts for the assessment of potential fire hazards may well vary much. The popular approaches to the assessment of potential fire hazards are quantitative and qualitative ones.

The assessment of potential fire hazards means the following 4 procedures in general :

(1) Identification of potential fire hazards

(2) Rating of the hazards

(3) Priorities on the hazards for their control

(4) Selection of proper fire-fighting measures

2.2 Theoretical Reviews of the Potential Fire Hazard Assessment Methods

"Hazard" may be interpreted as source of danger. While "risk" is a qualitative concept expressed as risky probability multiplying the size of accident, "hazard" may be a qualitative concept.

In case of identifying the potential fire hazards inherent in the buildings to assess its fire-fighting performance, it will be very difficult to assess the performance in a quantitative way due to various qualitative elements of potential fire hazards.

For a fire-fighting plan, the basic concepts of fire-fighting safety and the necessary fire-fighting level should first be defined, and thereupon, a systematic and logical method to assess the fire-fighting performance should be presented.

The methods to assess the potential fire hazards which have been introduced to Korea so far may be grouped into "M. Gretener" approach of a Swiss Insurance Company aimed at assessing the qualitative fire-fighting tools and "Fire Safety Concepts Tree" of N.F.P.A pursuing a qualitative goal with an aid of theoretical basis.

2.3 Analysis of the Factors for Assessing Potential Fire Hazards for Building

In order to select the important factors and weight them for assessment of potential fire hazards for buildings, local fire statistics and results of safety checks for special buildings were analyzed.

For 5 years from 1991 to 1995, 20,101 fires broke out; Among them, independent and apartment houses accounted for 28.3%. Meanwhile, 1,181 people died due to these fires. Independent and apartment house fires accounted for 45.9% (862 people) of the casualties. These findings suggest that the ratio of casualties is higher in independent or apartment house fires.

On the other hand, in view of the causes of these fires for the last 5 years ('91-'95), the electric fires accounted for 37.4% (37,661) of the total significant 100,806 fires, followed by cigarette (11%), arson (8.6%), children's fire-playing (8.6%), oil, gas, stove, etc. All in all, the electricity must have been the main culprit of local fires.

When fires broke out actually, the overall activation ratio of fire-fighting facilities was around 75%; To break down, 75% of the fire extinguishers, 80% of the convenient extinguishers, 71% of indoor hydraunt and 49% of outdoor hydraunt were activated. In contrast, the portable fire extinguishers or the powder fire extinguishers were all activated, while only 11.8% of sprinklers were enabled.

2.4 Results of a Questionnaire Survey

A questionnaire survey was conducted for the fire-fighting managers educated by Korea Fire Safety Association in an effort to determine the weighted effects of 10 large factors for building fire hazard assessment. Out of 117 respondents, 91 ones were chosen to be subject to analysis, excluding 26 improper ones. The results of analysis almost agree to the weighted values of factors rated through a preliminary study. Any way, the results of survey were reflected in determining the weighted values of the factors for assessment of building fire hazards.

2.5 Assessment Model for Potential Fire Hazards of Buildings

Table 1 is presented the assessment factors for potential fire hazards of buildings which has been based on the results from theoretical reviews of potential fire hazard assesment. And the checklists have been referred analysis of local fire accidents, foreign companies' program analysis, etc., and in reference to local paper codes including "Fire-Fighting Code", "Construction Code" and "High Pressure Gas Code". The general table for detail factors of potential fire assessment is shown in Table 2.

Table 1. An Assessment Factors for Potential Fire Hazards

Factors (in large classifications)	Medium classification	Small classification	Items of assessment	Total ratings	Weighted percentage
1. Prevention activities	1	3	27	236	14%
2. Source of ignition	1	4	100	919	10%
3. Flammables	1	3	108	999	9%
4. Emergency alarm	2	5	145	1,378	11%
5. Manual suppression	1	2	66	644	13%
6. Automatic suppression	1	4	195	1,872	15%
7. Full-scale fire-fighting facilities	2	3	55	520	5%
8. Flame propagation control	1	1	12	120	5%
9. compartmentation	2	8	60	594	10%
10. Management of exposures	3	5	64	540	8%
Total	15	38	822	7,822	100%

2.5.1 Checkpoints for Auditing Model

2.5.2 Rating of the Factors for Assessment of Potential Fire Hazards for Buildings

1) Weighted Values of the Factors Classified in Large

The factors classified in large are prevention activities, source of ignition, flammable, emergency alarm, manual suppression, automatic suppression, full-scale fire-fighting facilities, flame propagation control compartmentation and management of exposures. In order to select the primary factors for assessment of potential fire hazards for buildings and thereby, give weight to them, local fire statistics and results of safety checks for special buildings were analyzed and thereupon, those personnels (91) educated for fire-fighting were surveyed through a questionnaire. The results of survey were processed for appropriate weighted scores with the assistance from a field fire-fighting manager.

2) Weighted Rating of Assessment Points

Except for special cases, the weights were given to the checkpoints by classifying each of them into 3 classes and using differential weights for each class.

- "Important" : When a factor is important in terms of function or maintenance (10 points)
- "Necessary" : When a factor is not much important, but necessary (7 points)
- "Ordinary" : When a factor is an object of general management (4 points)

Table 2. Overall factors for Assessment of Potential Fire Hazards for Building

Classification			No. of items	Total of rating	Percentage	
Large classification	Medium classification	Small classification			small classfi.	large classfi.
1. Prevention activities	1) Fire-fighting management	(1) Organizational system	6	60	40	14
		(2) Fire-fighting plan	9	90	30	
		(3) Fire-fighting activities	12	86	30	
2. Source of Ignition	1) Management of ignition source	(1) Management of fire-fighting tools	11	89	20	10
		(2) Management of smoking	9	75	15	
		(3) Welding work	10	97	15	
		(4) Electric spark	70	658	50	
3. Flammable	1) Management of flammable	(1) Oil facilities	18	150	20	9
		(2) Gas facilities	74	689	30	
		(3) Ordinary flammable	16	160	50	
4. Emergency alarm	1) Automatic fire detection facilities	(1) Automatic fire detection facilities	44	422	50	11
	2) Emergency alarm & broadcasting facilities	(1) Emergency alarm	14	140	15	
		(2) Emergency broadcasting	17	158	15	
		(3) Electric leakage alarm	44	410	10	
		(4) Auto fire news facilities	26	248	10	
5. Manual Suppression	1) Manual fire-fighting facility	(1) Fire extinguisher	10	94	40	13
		(2) Indoor/outdoor fireplug	56	550	60	
6. Automatic Suppression	1) Auto fire-fighting facility	(1) Sprinkler	66	648	40	15
		(2) Water sprayer	34	310	20	
		(3) Foam sprayer	34	325	20	
		(4) Special tool	61	589	20	

7. Full-scale fire-fighting facilities	1) Auxiliary fire-fighting facilities	(1) Tap-water linkage	16	151	50	5
		(2) Water pipe	26	248	40	
	2) Emergency power source	(1) Emergency plug	13	121	20	
8. Flame Propagation	1) Fire-fighting compartment	(1) Arrest of fire spread	12	120	100	5
9. Compartment	1) Fire-fighting compartment	(1) General compartment	7	70	35	10
		(2) Fire-fighting door	6	60	15	
		(3) Fire-fighting shutter	6	90	15	
		(4) Fire-fighting damper	4	40	15	
	2) Office, etc.	(1) Prevention of ignition	12	114	5	
		(2) Detection/ notification/ initial fighting	6	60	5	
		(3) Arrest of fire spread	7	70	5	
		(4) Escape	9	90	5	
10. Management of exposure	1) Escape facilities and equipment	(1) Guide light, emergency lamp	14	140	20	8
		(2) Emergency exit or route	9	90	30	
		(3) Escape tool & equipment	13	130	10	
	2) Assessment of Escape	(1) Escaping time	4	40	10	
	3) Smoke control	(1) Smoke control facilities	14	140	30	
Total			822	7,822	-	100

3) Rating of the Classifications of Factors Based on Field Checking

Factors were grouped into the following 5 classes;

- A (Excellent) : 100%
- B (Good) : A slight defect (70%)
- C (Middle) : An ordinary defect (50%)
- D (Poor) : A serious defect (10%)
- E (None) : A legal requirement has not been installed. (0%)

4) Calculation of Scores for Each Factors

The scores (10, 7, 4) were calculated by following equation

points × class weight = **score for the factor.**

2.5.3 Summing-up of Assessed Scores according to Overall Factors

The scores were summed up according to factors of checklist(table 2) as follows;

1) Calculation of Scores by Small Classification

Scores by Medium/Small Classification = (Σ scores of the factors checked/Σ weight of the factors checked) × percentage of the small classification

2) Calculation of Scores by Large Classification

Scores by Large Classification= (Σ score by small classification/Σ Total Score by small classification) × percentage of the large classification

3) Calculation of Total Scores

Total Scores (scores by large classification) = (Σ score by large classification

Here, the scores or weights of the checkpoints which were not checked were excluded.

2.6 Results of Actual Assessment

According to the Assessment checklist, 4 buildings were selected to assess levels of the fire safety. The buildings were a hotel, an officetel, an investment and trust bank building and a general hospital. The results are as shown in Fig.1 and Tab. 3.

Table 3 Results of Rating the Buildings

Building	Hotel	Officetel	Investment & Trust Bank	General Hospital
Score	84.64	83.14	82.96	81.2

Fig 1. Results of Rating the Buildings

The percentage scores to be obtain by assessment

As a result of assessing the buildings, it was found that factors of activities and fire-fighting compartment were scored lowest. During assessment, the weak points could be reinforced separately according to the checklist.

When preventive activities, source of ignition and compartmentation were improved the problems of fire protection, it was found that the score increased from 84.64 to 88.06, which suggests that a mid- or longer-term improvement of weak factors could obtain a higher scores. If the procedure should be repeated for a quantitative management, the potential fire hazards will be reduced.

3. CONCLUSION

In this study, buildings were assessed for their potential fire hazards, and then checklist for building fire hazards was developed. The checklist consists of a total 882 checkpoints which would be rated to be weighted by 10 large classified factors to be converted into 100 percentage scores. As a result of testing this assessment model, it was found that it can be applied to other ordinary buildings to assess their potential fire hazards.

On the other hand, as a result of assessing the actual fire hazards, it was conceived that the weak points could be improved to be rated better or controlled in a quantitative way. The model developed through this study to assess the potential fire hazards of buildings according to a checklist is expected to have the following effects;

1. The checklist can be used to assess the potential fire hazards carefully and quantitatively as well as easily.
2. The model can be used by a fire-fighting manager to self-check the fire protection facilities and learn about the fire prevention knowledge in a systematic way.
3. When diagnosing a building for its fire safety, necessary and systematic fire protection knowledge and diagnostic points can be integrated into a checklist for more effective fire protection diagnosis.
4. The model can be applied to a comprehensive fire-fighting design for a building by supplying the necessary data for the design.
5. The model can provide the fire-fighting manager with the basic data which are produced by systematically assessing the potential fire hazards, and then it can be used to have the fire insurance premium discounted.

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