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Analysis and Improvement of Seismic Design of Fire Fighting Facilities in Korea

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ABSTRACT

The purpose of this study is to analyze seismic design of firefighting facilities in Korea and to suggest improvement plan.

As a result of the analysis, the criteria for the fire-fighting facility's earthquake-resistant products were applied and the seismic design of the fire-fighting facilities was applied. The range of fire-fighting objects was retrospectively applied to the existing buildings as well as the existing buildings and the seismic design was applied. It has also been extended to include a liquefying facility, a connecting water pipe facility, a connecting water spraying facility, a ventilation facility, an elevator escapement, a large number of evacuation equipment, and a seismic design of a firefighting facility linked to fire insurance premiums.

Keywords: Firefighting, seismic design, fire insurance, earthquake, fire-fighting earthquake

1. INTRODUCTION

The largest earthquake ever occurred on the Korean peninsula after the 1978 earthquake began on September 12, 2016 with a 5.8-magnitude earthquake that occurred 8 km south-southwest of Gyeongju North Gyeongsangbuk-do. In the wake of the Gyeongju earthquake, the awareness that Korea is no longer an earthquake-safe zone has spread, and interest in disaster preparedness has increased. Disaster prevention experts also predict that such a large earthquake is likely to come back. As a preliminary observation, the study on the necessity of seismic design of firefighting facilities has been continuously carried out, and the seismic design standards of firefighting facilities have been implemented since January, 2016.

An earthquake can cause buildings to be destroyed by vibrations, causing people to die, and also destroy firefighting facilities in the building, making it impossible to respond even if a fire occurs. The main damage situation of firefighting facilities caused by earthquake is damage and damage of fire alarm equipment and fire extinguishing equipment, damage of building, breakage and damage of pressurized water supply equipment, loss of pressurized water due to breakage of water tank, Damage to the equipment due to water damage, separation of piping and connection parts of fire extinguishing facilities, and damage of sprinkler head and piping due to excessive rack movement in case of rack type warehouse**[1].**

These firefighting facilities may be damaged and the firefighting facilities can not perform their functions and they may not be able to respond to the fire immediately. Therefore, the purpose of this study is to analyze the seismic design of firefighting facilities in Korea and to find improvement plan at the present time when the seismic design criteria of firefighting facilities are applied.

2. MAIN FACILITIES SUBJECT TO SEISMIC DESIGN CRITERIA

Table 1 shows the major facilities to be set up in the seismic design criteria for buildings specified in Article 10 of the Enforcement Decree of the Korea Earthquake and Volcanic Ash Countermeasures Act.

Table 1.Application of Seismic Design Criteria

Target Facility	Applicable Law
Buildings that fall under any of the following categories: 1.Buildings with three or more floors (two floors in the area designated by the Building Ordinance, where the earth is weak and where building safety is required to be secured) 2. Buildings with a floor space	Article 32 (2) of the Enforcement Decree of the Korean Building Code

of 500 square meters or more 3. Buildings with a height of 13m or more 4. Buildings with an eave height of 9m or more 5. Buildings with a distance of 10m or more between the columns and pillars 6.Buildings in the earthquake zone designated by the Ministry of Land, Transport and Communications 7. Buildings worthy of preservation as a national cultural heritage, as prescribed by the Ministry of Land, Transport and Tourism 8. Buildings with one end fixed and the other end unsupported Buildings that protrude more than 3 meters from the center line of the outer wall 9. Buildings that require special design, construction, and construction methods and are designated by the Minister of Land, Article 32(2) of the Enforcement Decree of the Korean Building Code	
Airport Facilities	Article 2 (8) of the 「Korean Aviation Act」
Bridges, tunnels and history of railway facilities	Article 3 (2) of the 「Framework Act on the Development of the Korean Railroad Industry」 and Article 2 (6) of the 「Railway Construction Act」
Teachers, gymnasiums, dormitories, food facilities and auditoriums in school facilities	Article 2 (1) of the 「Korean School Facility Promotion Act」 and Article 1 (2) of the Enforcement Decree of the same Act
Organic Facilities and Organic Facilities	「Korea Tourism Promotion Act」 Article 3. (1) 6
General hospitals, hospitals and hospitals	「Korean Medical Law」 Article 3

3. COMPARISON OF SEISMIC DESIGN STANDARDS OF DOMESTIC AND FOREIGN FIREFIGHTING FACILITIES

3.1. Japan

The requirements for seismic design of fire-fighting facilities in Japan are based on the laws and regulations related to fire-fighting facilities. For detailed seismic design standards, refer to "Japan Building Equipment Earthquake Engineering Design and Construction Guidelines (2005)" have.

If you look at the details of the Japanese Building Equipment Earthquake Design and Construction Guidelines (2005), which is used as an earthquake proofing guide for firefighting facilities in Japan, it can be seen that earthquake damage has been corrected and supplemented with lessons learned. For buildings with a depth of 60 m or less, the safety of earthquake-resistant construction was established in 1978 as a lesson from the damage caused by the Miyagi Earthquake's construction equipment, and the "Japan Building Equipment Earthquake Design and Construction Guidelines (1982)". (1997) of the Japanese Building Equipment Earthquake Engineering Design and Construction Guidelines**[2]**, and revised a small fraction of the unit system, etc., and are currently used as the "Japan Building Equipment Seismic Design and Construction Guidelines (2005)"

3.2. United States of America

The criteria for the seismic design of domestic construction equipment in which the earthquake-reinforcement project for socially emphasized school facilities is started in earnest in 2009 is based on the Article 14 (9) of the "Regulations on the Structural Criteria, etc. of Buildings of the Ministry of

Construction and Transportation" 'Seismic design of non-structural members and building equipment'. However, no specific criteria are provided, and only simple measures are mentioned in seismic design. In addition, the seismic countermeasures of facilities were secured by the judgment of experts in the field concerned.

After the revision in May 2000, non - structural members and building fixtures installed on the frame of the buildings were provided with measures for earthquake loads and suggested seismic load and load calculation methods. In 2005, the Architectural Institute of Korea revised and supplemented KBC2000 to establish KBC 2005.

In this standard, the types of facilities are more subdivided than before. However, specific seismic criteria or guidelines for firefighting facilities

In other words, refer to building standards for earthquake load and structure related standards, and refer to fire standards for seismic design details of facilities.

Analysis of the application criteria for seismic analysis and design of firefighting facilities in the United States calculates seismic forces for the facility in accordance with the formula of SEAOC (1996), NEHRP (1997) and IBC (2006). In addition, as a design guideline for equipment, IBC (2006) specifies the seismic load calculation formula for piping facilities so that piping can be designed easily**[3]**.

The seismic criteria for sprinkler installations are specified in NFPA 13 for the criteria of coupling, separation, separation, and seismic braces in seismic design**[4-5]**

In the US, seismic standards are applied to firefighting facilities in all areas except the weakened areas. The degree of application of seismic standards is based on the magnitude of the seismic load introduced.

3.3. Korea

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In this standard, the types of facilities are more subdivided than before. However, there are no specific seismic safety standards or guidelines for firefighting facilities, and seismic design and construction guidelines for practical use are lacking**[6-8].**

KBC 2005 was established by re-establishing the IBC 2000 in the United States in accordance with the domestic situation. In the scope of application by building size, seismic analysis and design are mandatory for buildings of 3 stories or more and buildings of 1,000 m2 or more.

4. ANALYSIS AND IMPROVEMENT OF SEISMIC DESIGN OF FIRE FIGHTING FACILITIES IN KOREA

4.1. Establish standards for fire-fighting earthquake resistant products

In order to apply the seismic design standards of firefighting facilities in practice, firefighting earthquake resistant equipment is necessary. However, there is no standard for earthquake-resistant fire-fighting appliances so that it can be used temporarily without any additional confirmation procedure if it is certified as an international standard such as UL or FM. In case of domestic fire-fighting earthquake resistant products, I decided to admit it when I submitted the organization's performance verification documents.

However, there is no concrete standard for confirming the performance, so it is difficult to confirm that the seismic performance is actually achieved. It is necessary to establish the technical standards for fire-fighting earthquake-resistant articles and to prepare specific standards to apply the earthquake-resistant design standards of fire-fighting facilities to practical application.

4.2. Application of seismic design of fire-fighting facilities Retrofit

The application of the Korean firefighting facility seismic design standards is only applicable to fire-fighting objects, that is, new buildings, after the approval of construction permits or declaration of construction of fire-fighting facilities since January 2016.

If strengthened seismic standards are applied to existing buildings, some problems may arise in

implementation, but the existing buildings will be gradually expanded in accordance with the seismic rating.

There is a need to avoid confusion. Rather, firefighting facilities in existing buildings may be relatively vulnerable to earthquakes, so seismic design for existing buildings is essential.

The seismic risk can be estimated by referring to the seismic area map, the type of the ground, and the seismic risk of the specific fire - fighting object.

4.3. Realization of application range of seismic design of firefighting facilities

As stated in Article 9-2 (Seismic Design Criteria for Fire Fighting Facilities) of the "Fire Prevention, Fire Prevention, Installation and Maintenance of Fire Fighting Facilities and Safety Management Act", the scope of the object to be subjected to earthquake-Specific fire fighting objects ". The fire-fighting facilities prescribed by the Presidential Decree shall be limited to fire-fighting equipment such as indoor fire hydrant equipment, sprinkler equipment, and water spray according to Article 15-2 (Seismic Design of Fire-fighting Facilities) of the Enforcement Decree of the Fire Prevention, Fire Service Facilities Installation and Maintenance and Safety Management Act .

In the case of firefighting facilities, except for outdoor fire hydrant facilities, most of the firefighting facilities that are installed inside the buildings and fixed directly to the buildings are subject to impacts due to the vibration of the buildings in case of earthquakes**[9].** Therefore, not only fire extinguishing facilities such as indoor fire hydrant facilities, sprinkler facilities, and water spray are among the existing fire extinguishing facilities, but also fire extinguishing facilities, connection water pipe facilities, connection water spraying facilities, ventilation facilities, It is necessary to include a large number of evacuation equipment in the scope of the seismic design of firefighting facilities.

4.4. Preparing a plan to reduce seismic design cost of firefighting facilities linked to fire insurance premiums

The application of the seismic design of firefighting facilities to specific fire protection objects requires

The implementation of the duty of seismic design of firefighting facilities causes an increase in costs in the design and construction of firefighting facilities. In the end, it may lead to poor construction in order to reduce construction cost.

If the earthquake-resistant design of firefighting facilities is classified according to the specific fire-fighting object, the initial cost due to the earthquake-proof design will increase partly. However, if a fire due to earthquake is encountered, the earthquake- The total cost will eventually be reduced.

In addition, it is necessary to increase the participation of seismic design by reducing the fire insurance premium in conjunction with the fire insurance premium because it can reduce the risk due to the fire due to the optimized design of the fire protection facilities against the earthquake.

The analysis of the seismic design of firefighting facilities in Korea is summarized as Table 2.

Table 2. Summary of Analysis and Improvement Plan of Seismic Design of Fire Fighting Facilities in Korea

Analysis	Improvement
No standards for fire-fighting earthquake resistant products	Establish standards for fire-fighting earthquake resistant products
Application of fire-fighting facilities earthquake-resistant design The scope of application of specific fire-fighting objects is restricted to new buildings only	Application of seismic design of firefighting facilities Retrospective application of specific fire protection object range
Application of seismic design Fire extinguishing facilities are restricted to indoor fire hydrant facilities, sprinkler facilities, fire extinguishers, etc.	Application of seismic design Expansion of fire fighting facilities to ventilation equipment, connection water pipe facility, connection water spraying equipment, ventilation equipment, lift escape equipment,
Increase construction and design cost of firefighting facilities by seismic design of firefighting facilities	Reduced fire insurance premiums on the basis of optimized design of firefighting facilities for earthquakes, reducing seismic design cost of firefighting facilities

5. CONCLUSION

Since January 25, 2016, the seismic design standards for firefighting facilities have been established and implemented in Korea, but many problems are still being exposed. The fire protection facilities are not equipped with the standards for fire-fighting earthquake-resistant products due to the problems of

fire-fighting facilities earthquake-proofing design, the application of fire-fighting equipment earthquake-resistant design is applied only to new buildings, It is pointed out that the construction and design costs of firefighting facilities are increased due to the earthquake-resistant design of firefighting facilities. In addition, Design application Apply retrofit of specific fire protection object range, apply to existing buildings as well as existing buildings, apply seismic design Fire extinguishing facilities that are impacted by earthquake, connecting water pipe facility, connection water spray facility, ventilation facility, lift escapement , Expanded to a large number of evacuation equipment, seismic design of firefighting facilities linked to fire insurance premiums It was presented.

6. ACKNOWLEDGMENTS

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