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Analysis of the Earthquake Impact towards water-based fire extinguishing system

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Abstract. Recently, extinguishing system installed in the building when the earthquake occurred at a separate performance requirements. Before the building collapsed during the earthquake, as a function to maintain a fire extinguishing. In particular, the automatic sprinkler fire extinguishing equipment, such as after a massive earthquake without damage to piping also must maintain confidentiality. In this study, an experiment installed in the building during the earthquake, the water-based fire extinguishing saw grasp the impact of the pipe. Experimental structures for water-based fire extinguishing seismic construction step by step, and then applied to the seismic experiment, the building appears in the extinguishing of the earthquake response of the pipe was measured. Construction of acceleration caused by vibration being added to the size and the size of the displacement is measured and compared with the data response of the pipe from the table, thereby extinguishing water piping need to enhance the seismic analysis. Define the seismic design category (SDC) for the four groups in the building structure with seismic criteria (KBC2009) designed according to the importance of the group and earthquake seismic intensity. The event of a real earthquake seismic analysis of Category A and Category B for the seismic design of buildings, the current fire-fighting facilities could have also determined that the seismic performance. In the case of seismic design categories C and D are installed in buildings to preserve the function of extinguishing the required level of seismic retrofit design is determined.

1. Introduction

The definitions for the seismic design category (Seismic Design Categories, SDC) for the seismic design, in KBC2009. And thus to determine the importance of the group and earthquake seismic intensity Seismic Design category. The introduction to the standards based on the recently developed concept of seismic performance seismic design category. The higher the rating the seismic design category is enhanced using the building structure, limitations of the system, analysis methods, and design and the detailed regulations.

The seismic design criteria are established to ensure quality of facilities, including a public service essential to consider arbitrarily large personal accident prevention at the national level is necessary

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leading role. It can be said that the efforts to secure the necessary basis for such publicity for the analysis of earthquake effects on buildings fire safety facilities to be constructed in the study.

The firefighting facilities are mostly installed on the inside of the building. Conduct a seismic design and seismic performance of firefighting facilities classified according to the size of the vibration on the building during an earthquake. Most of the small mass inertia during earthquake size small or not fixed directly to the building fire protection facilities. Cannot be delivered at the time of the earthquake as the Firefighting Facility Construction acceleration and displacement. Therefore, it is reasonable to perform seismic risk for the seismic design category in the seismic design without the need for any seismic design category will be delivered some heavy earthquake loads.

Identify the effect of the fire-fighting water pipe saw the earthquake affected buildings during firefighting facilities in such a perspective. Seismic experiment was conducted by the installation of fire protection facilities of reinforced concrete specimens were determined categories designed for firefighting facilities are required to measure the size of the seismic acceleration and displacement passed the fire test facilities in each step.

When applied to a step-by-step construction of the aqueous digestion experiments seismic equipment and structures in seismic experiment, we measured the size and displacement of the acceleration due to vibration that was added to the building in fire-fighting water pipe water extinguishing system in the building. By analysing the data on the response of fire-fighting water pipe was investigated with respect to the required level of fire-fighting water pipe seismic reinforcement.

2. Seismic performance of water-based fire-fighting equipment (grade) Regulations

2.1. Seismic grade for firefighting facilities and seismic performance objectives

After the earthquake, can continue to operate by checking the equipment and piping, and to maintain the function of the equipment rather than with respect to vibrations transmitted to the earthquake damage occurs as a whole building construction equipment, vibration performance. In the event of falling of a large earthquake is fixed configuration of the installation device, but, it is possible to ensure the maintenance of such specific features. And ensure the safety of human life, is to prevent secondary disasters that accompany this goal. Seismic safety evacuation, etc., secured lifeline, ensuring safety is important after an earthquake, it is necessary to enhance the seismic grade is given.

2.1.1. Wet-piping fire extinguishing facilities

Water based firefighting system is consist of hydrant, sprinkler, pump, pipe, water for fire fighting
The digestion tank plumbing and fire-fighting equipment and fire-fighting water facility such as the main target of seismic design is to be considered a priority. Because they reduce the damage of life and property caused by fire in the building during an earthquake. In addition, it is effective to require seismic design is to be the most robust in the building of other facilities, including evacuation facilities, fire protection facilities, the seismic design of buildings, or include it in the review if necessary. It is reasonable to classify the facility affected by the behaviour of building structures in order to evaluate the seismic performance of water-based fire extinguishing facilities.

2.1.2. Seismic Design Criteria

Seismic design criteria for water-based fire extinguishing equipment facilities (draft), I was prepared to conform to the facility of a water-based fire extinguishing equipment refer to the (KBC2009) Architectural design criteria (II) and the study of seismic design criteria of Construction and Transportation has enacted .

- **Seismic performance objectives**

Set the seismic performance targets by taking into account the importance of the building of the seismic design time, it is determined to understand the intent of the main building and use of the building in the option.

That is, it can be classified to the loss of three forms of the effects of seismic buildings.

① the safety of human life : Injury or death of activists and residents of the neighbourhood and the users of the building
② property damage : Cost for replacing or maintenance of the building or its contents
③ function infeasible : Financial loss due to the fact that it is not possible where the facility to perform the functions of the normal after the earthquake

With regard to the biggest earthquake, for the earthquake to ensure the safety of human life, usually occurring frequently, performance goals of the building, for the purpose of execution of the functions of the building roughly.

2.2. Seismic performance secure firefighting facilities

Enhancing the seismic performance of the facility another is fundamental measures which can minimize the damage of earthquake.

In facilities that are related to lifeline fire extinguishing equipment, power equipment, gas equipment, water and sewage facilities, such as communication facilities, you will need strong earthquake, to be able to allow for quick recovery also earthquake damage, especially after. If the pipe attached to the building, by changing the material with excellent earthquake resistance, it is necessary to consider the structural. You also need to be checked on a regular basis, based on the technical standards for the facility and to ensure a water-based fire extinguishing equipment which operates stably even earthquake disaster.

3. Analytical methods of the impact of the piping of the earthquake

In this section we discuss how to format the title, authors and affiliations. Please follow these instructions as carefully as possible so all articles within a conference have the same style to the title page. This paragraph follows a section title so it should not be indented.

In this study, it is in the grasp of the vibration level that can be to satisfy the seismic performance above a certain level reliability and maintenance of water-based fire extinguishing equipment through the shaking table test.

3.1. Earthquake vibration generator (shaking table test device)

Pusan National University (distributed shared research infrastructure construction projects, Korea Construction Engineering Development Program) KOCED public use Table B to earthquake vibration test centres in three groups was shown in Table1 the following specifications. Figure 1 is Shaking table in Pusan National University Earthquake test Center

Table 1. Shaking Table Specification

Table	**Specifications**	**dimension**
Table B	Degrees of freedom	3DOF (5m×5m, Movable)
	Maximum load weight	60 tonf
	The maximum acceleration	3g
	The maximum speed	100cm/sec
	The maximum displacement	±30.0cm (±20.0cm)*

Figure 1. Earthquake test Center (Pusan National University, korea)

3.2. Seismic experiment body production

Was produced experimental body of reinforced concrete structure of the two-story in order to perform a seismic experiment (Figure2). Installation to aqueous digestion facilities shown in Figure3, in order to determine the effect on the piping of a water-based fire extinguishing system in the earthquake, as shown in Figure4, was placed the measuring sensors.

Figure 2. Make a seismic experiment Structure (Shaking Table)

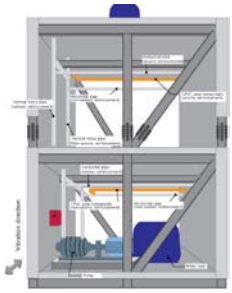

Figure 3. Water-based extinguishing system installation on the shaking. table

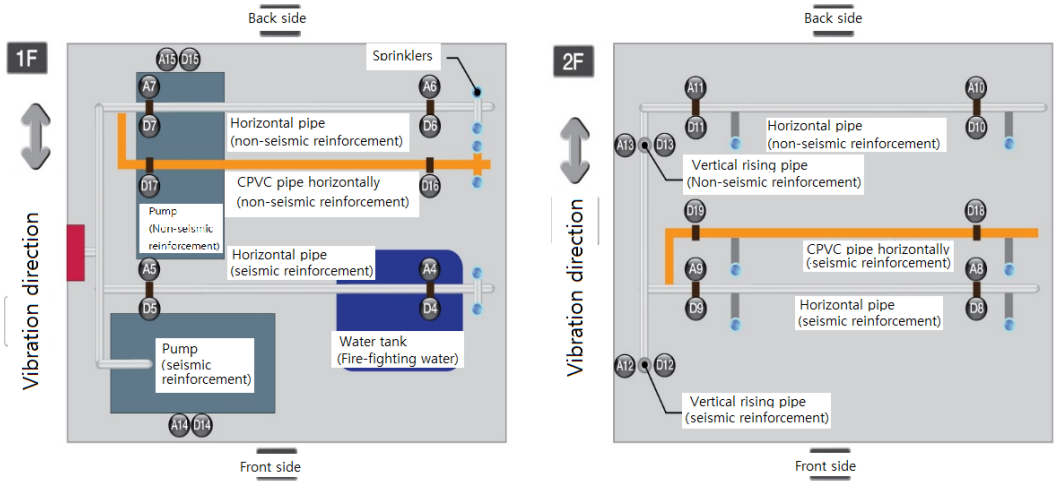

Figure 4. Installing the sensor for measuring the amount of change of the fire extinguishing system

3.3. production Determination of experimental seismic wave

Seismic wave that has been used to study this time, using artificial seismic waves and El Centro wave. The seismic wave was made on the basis of "Test Method for Seismic telecommunications equipment" announcement No. 2009-3 issue of radio laboratory.(Figure 5,6).

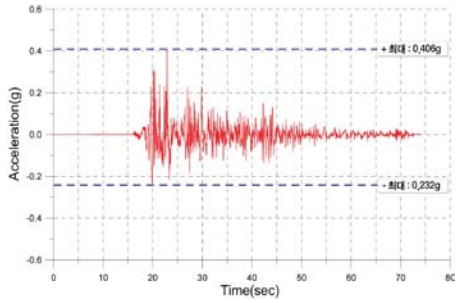

Figure 5. El Centro seismic acceleration input wave for test

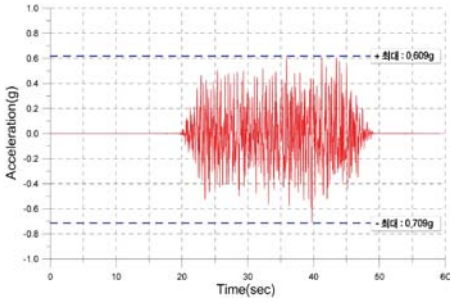

Figure 6. Artificial seismic acceleration input wave for test

3.4. Seismic experimental methods

We assume the acceleration of the acceleration of the bottom surface of the specimens.

Therefore, the user can view the value of the acceleration in accordance with the SDS bottom KBC2009. We have a maximum acceleration level of the bottom to reproduce the acceleration corresponding to the seismic design category in the present study.

- 0.18g corresponding to Seismic Design Category A
- 0.21g corresponding to Seismic Design Category B
- 0.36g corresponding to Seismic Design Category C
- 0.50g corresponding to the seismic design category D.

4. Analysis of the experimental results

4.1. Analysis of experiments results for seismic design categories A and B

In this study, an experiment was carried out (digester, such as pressurized water pumping equipment) for connected devices and piping corresponding to the digestion of water-based facility. The Figure8 and Figure7,8, is the experimental results of the piping and B Seismic Design Category A

Looking at the experimental results, the maximum displacement of the vibration table was attached with about 30mm occurs, but the maximum displacement of the firefighting equipment occurred in less than 1mm. It is determined that the acceleration in the case of acceleration does not occur almost response acceleration and 0.18g, affected by the vibration of the earthquake is very small.

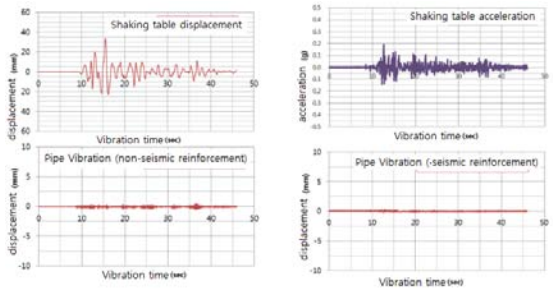

Figure 7. experiments results of fire extinguishing system (Earthquake Wave intensity 0.18g)

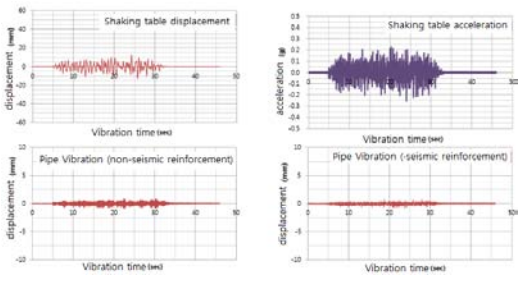

Figure 8. experiments results of fire extinguishing system (Earthquake Wave intensity 0.21g)

4.2. analysis of experiments results for seismic design categories C and D

In Figure9, it is the result of an experiment conducted using 0.50g the base acceleration of the vibration table. Level of 0.50g is the acceleration level is corresponding to the maximum acceleration of the category C of seismic design, corresponding to the seismic design category D. The maximum displacement of the shaking table for about 30mm occur, wall fixing device showed no specificity.

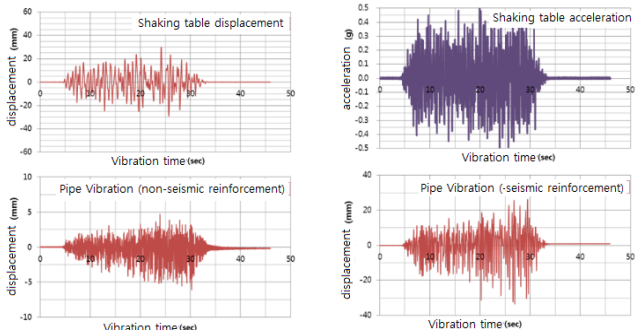

Figure 9. experiments results of fire extinguishing system
(Earthquake Wave intensity 0.50g)

5. Conclusion

If the value of the SDS of Category A of seismic design is less than 0.17g. Corresponding to a level of about 0.07g in case 0.19g / 2.5 = 0.068g in terms of the value of this ground acceleration. This is the level at the level corresponding to the collapse prevention level of about 2 grade of seismic design criteria for other facilities, for the ground motion of 0.07g normal level below, has not been carried out seismic design. It is possible to know that for the 0.07g level, damage does not occur at all vibration table test results of this study. Therefore, if applicable to the seismic design category A, it is determined that sufficient even without the seismic design of firefighting facilities.

If the value of the SDS of seismic design category B corresponds to 0.17g~0.33g. As shown in shaking table test results of this study, in the case of a normal type firefighting equipment that are out of seismic design, major damage has not occurred. However, sometimes it causes damage spring anti-vibration of the pump, and the digester, in the inertial force due to the weight of the earthquake, such as water tank. Therefore, when the water tank pressurized pumping water systems, the digester, however, when the firefighting equipment other, it is determined that there is no need to perform seismic designed to be performed the seismic design case of seismic design category B.

If seismic design category C and category D seismic survey was that most of the damage in the fire at the facility during the earthquake spectral acceleration of 0.33g or higher earthquake ground acceleration acting on the occurrence and size of buildings. Therefore, seismic design categories C and Seismic Design Category D is needed for the seismic design of fire protection facilities.

6. References

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