A Proposal for countermeasures against earthquakes, based on earthquake survey information, to improve water storage tank systems for the buildings

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1. Introduction

To maintain a stable water supply, public waterworks systems and water storage tank systems are necessary and both of them are operating in close relation. The public water suppliers have continuously been improving management standards for public waterworks and water storage tank systems in the event of disaster in order to supply water stably. Niigata Prefecture has been struck by two large-scale earthquakes, the Chuetsu Earthquake in 2004 and the Chuetsu Offshore Earthquake in 2007. After the two earthquakes, surveys of the extent of the damage to the water storage tank systems at the buildings were carried out. The differences in damage due to the types of the tanks and pipes were particularly important in this survey.

Through surveys, the importance of accessing water supply from the tanks in an emergency by the “draining method” was realized.

Here is the report about the risks which became clear in the surveys and the suggestions for measures to improve the water supply systems management and insure a stable water supply.

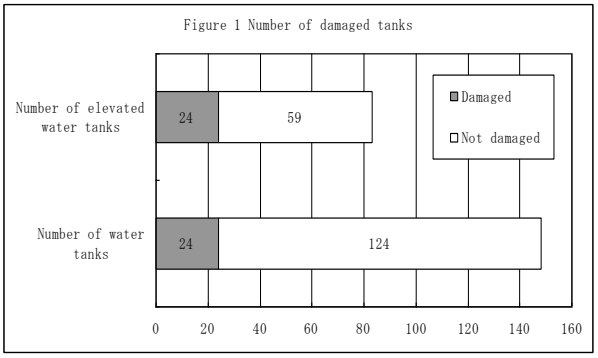
2. The details of surveys

The surveys of the damage to pipes of water tank systems and elevated tank systems were carried out at 151 small-scale water supply systems in the disaster-stricken area (22 hospitals, 16 public facilities used as shelters, 21 welfare facilities, 31 schools, 18 apartment houses, 21 factories, 22 hotels and inns)

There were 3 types of the tanks. (80 ground and elevated combination water tanks, 68 pressurized tanks, 3 elevated water tanks).

The surveys carried out to record damage to tank plumbing. (water supply pipes, connecting pipes, drains)

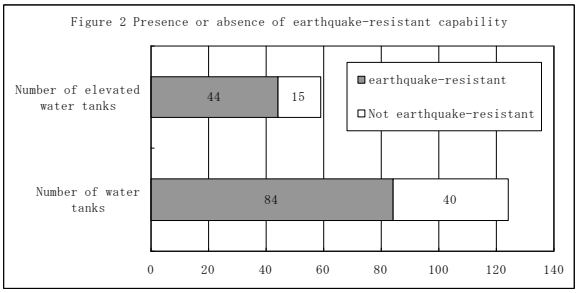
Figure 1 Number of damaged tanks



3. Damage to the tanks

The surveys of the damage to the tanks were carried out for both water tanks and elevated tanks respectively. 24 (16%) of 148 water tanks (80 ground and elevated combination water tanks and 68 water tanks of pressurized water supply method) were damaged. 24 (29%) of 83 elevated tanks (80 ground and elevated combination water tanks and 3 elevated tanks) were damaged. (Figure 1)

There was more damage to the elevated tanks than to the water tanks on the ground, mainly because flexible pipes of the elevated tanks for reducing distortion were fixed and failed to work.



4. Earthquake-resistant capability and number of damages

The survey was carried out for the water tanks and the elevated tanks which had no damage. 84(68%) of 124 water tanks had earthquake-resistant pipes. 44(75%) of 59 elevated tanks had earthquake-resistant pipes, too.

This result shows the effectiveness of earthquake-resistant pipes, although there were some cases with damage. The earthquake-resistant pipes are not 100% effective. (Figure 2)

5. Taking water from the water tanks with the “draining method”

On average, the suspension of water supply lasted 7 days, and the power failure lasted 2 days at the time of the earthquake. Water tanks were primary sources of water supply for 2 days. The “draining method” was important, because some of the water supply systems stopped instantly at the time of the power failure.

After the Great Hanshin Earthquake in 1995, there was a report that the room under the tanks was an important factor for convenient and effective work under the tanks. The “draining method” to make use of reservoir water in the tanks has been proved in the recent earthquakes in Japan since the Great Hanshin Earthquake.

The different “draining methods” are as follows.

1) To get water from a faucet fitted directly to the tank (HK method)
2) To get water from the manhole, using a siphon (SK method)
3) To get water from a faucet fitted to a pipe (KK method)
4) To get water from the overflow from the tank (DK method)
5) To get water from a underground tank, using a hand pump (PK method)

6. Summary

Based on the above surveys, there are two suggestions.

To make the plumbing earthquake-resistant, the pipes jointed to tanks must have the supports connected to the tanks or stands for the tanks, and must have flexible joints in order to prevent distortion. The supports of the pipes must be installed at proper parts of tanks so that flexible joints can absorb maximum distortion. (FRP earthquake-resistant design criteria of Japan in 1996) To prevent water leak and keep reservoir water as much as possible at the time of disasters, an installation of earthquake-resistant pipes (flexible pipes) are recommended.

To use reservoir water at the power failure, a facet for the “draining ” method is important. At an installation of a new water tank, a facet for an emergency must be placed at a proper place. As for a tank already installed, a facet must be placed at a proper place.

All these countermeasures can improve a stable water supply at the time of large-scale earthquakes.

References (in Japanese)

1) Countermeasures against the water cutoff at the Chuetsu Offshore Earthquake and the small-scale private water supply systems. Japan Waterworks Association : 2008(9-8)
2) Study on improvement of the water supply systems management standards by water safety plans. Health, Labor Sciences Research Grant 200733018A, provided by the Ministry of Health Labor and Welfare