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# INTEP NEWSLETTER

INTERNATIONAL ENVIRONMENTAL PLANNING CENTER (INTEP)

-New Focal Point Established at the Department of Urban Engineering, the University of Tokyo-

## FROM THE EDITOR : SPECIAL EARTHQUAKE ISSUE
## May Japan's Sad Experience Contribute to the Preparedness for Water Supply and Sanitation Systems

"Disaster comes when the previous one is out of mind", uttered a famous Japanese scientist a century ago. Japanese people were reminded of the saying when the quake destroyed Kobe this January. However, even before the victims could assuage their grief, another killer earthquake took place in the northern part of Sakhalin, Russia on May 28 1995, which completely destroyed Neftegorsk and killed two thirds of the population. These earthquakes serve as a stern warning to all nations that such a disaster can take place anywhere and at any time.

As time passes, more detailed information about the damage has come to light. In earthquake-stricken areas, the damage caused by the quake was estimated to be more than 10 trillion yen (approximately ¥85=US$1), which is more than 2 % of the annual gross domestic product of Japan. As of April 5, damage to the water supply, sewage works and solid waste/nightsoil management systems in Hyogo Prefecture, in which Kobe City is located, were approximately 54.1, 59.6 and 4.4 billion yen, respectively.

The earthquake taught us many lessons; some were depressing but some were consoling. As large municipalities had made agreements with each other before the quake, unaffected municipalities could help the stricken areas by rapidly sending officials and aid equipment. The Self Defence Force, gas/electricity companies, NGOs, numerous volunteers etc. helped the area in various ways. The government is now considering how to improve the command system of emergency relief operations so that quick measures are taken even if communication systems are not working perfectly.

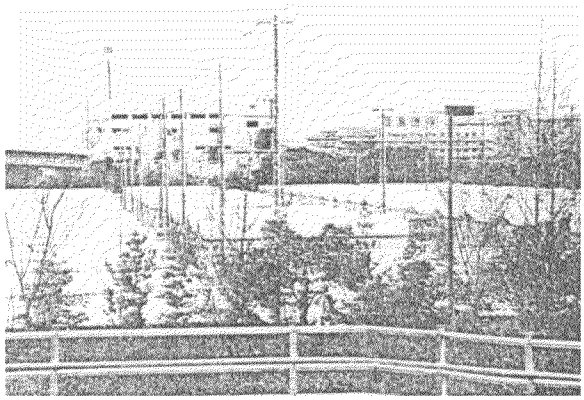
From the Department of Urban Engineering, including INTEP, a number of water supply and sanitation experts and student volunteers helped the stricken areas. Although a quick report on the quake was already made in the previous issue of the INTEP Newsletter, more detailed information is reported here from their experiences.

I think that Japan, as an earthquake prone nation, has the responsibility to disseminate information on this disaster to developing countries for the strengthening of preparedness, with which many lives will be saved. When we consider applying the experiences of this disaster to developing countries, we should take into account the similarities and dissimilarities between Japan and developing countries. For example, the availability of help such as equipment, or manpower from other municipalities, availability of advanced technology to check damage to sewage pipes etc.

At the same time, there are also many things Japan should learn from the world community. For example, measures taken at refugee camps may be applicable in such an emergency. When I heard of the initial measures that were taken, I was impressed that some were similar to what is happening in developing countries. For instance, public standpipes were used to secure water for as many people as possible at the earliest stage. Pit latrines were built as a temporary measure. In such cases, knowledge about public health in hot climates and in developing countries and know-how about appropriate technology for water supply and sanitation may help people survive emergencies.

The real challenges have just begun. A lot of difficulties are foreseen in the reconstruction process, which may last more than ten years; Modern water supply and sanitation systems, which had not anticipated damage on such a large scale, may suffer from unexpected aftereffects. Japan should keep other countries informed of the lessons learned from the quake and the reconstruction process. INTEP wishes to keep readers of the newsletter informed of the ongoing activities in Japan for preparedness against earthquakes.

**by Hidetoshi Kitawaki, Editor-in-Chief**



**The aftermath will torment relocated people for years**
**-Shelters for Evacuees**

# HYOGO NANBU EARTHQUAKE – DAMAGE TO WATERWORKS AND ITS RESTORATION

by Mr Masaki Itoh, Senior Researcher
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## 1. Introduction

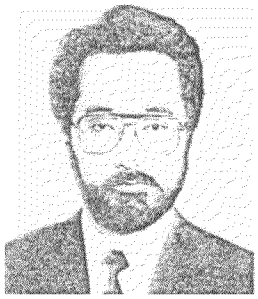
At 5:46 AM on Tuesday January 17 1995 a powerful earthquake struck the Hanshin and Awaji area that includes Kobe city west of Osaka. Its epicenter was the northern end of Awaji-shima or Awaji island and the magnitude was 7.2 on the Richter scale. More than 5,500 people perished and about 35,000 were injured. Some 320,000 survivors were left homeless and were forced to take shelter in school gymnasiums and other public facilities. The number of shelters reached nearly 1,250 at the peak. About 140,000 houses and buildings were destroyed or damaged and some 7,500 were burned down. The earthquake damaged many segments of the infrastructure including water supply facilities. In this article the damage and restoration of the water supply systems is reported.

## 2. Damage to Water Supply Facilities

Damage suffered from this earthquake was the most severe that waterworks have ever experienced in Japan. The damage ranges over 68 municipal water utilities and 3 bulk water supply authorities which cover 9 prefectures. The cost of restoring the water supply facilities is estimated to be about 60 billion yen (680 million US dollars). The number of houses which suffered from water supply cutoff reached 1,200,000 just after the earthquake. The trend of water supply recovery is shown in Fig. 1. In Kobe city 595,000 houses out of 650,000 (92%) had their water supply cut off immediately after the earthquake and there were still 41,000 houses which could not get water through their taps at the end of February.

### 2.1 Damage to Water Purification Plants

There are twenty water purification plants in the heavily damaged areas of Kobe, Nishinomiya and Ashiya cities. Five plants out of the twenty have filtration capacity of more than 100,000 $m^3/d$. Of those five, three plants of the Hanshin Water Supply Authority, which is the bulk water supply authority for the area, are the biggest facilities. Many open-top basins like sedimentation basins had damage especially the opening of expansion joints causing leakage. There was also differential displacement at many expansion joints and cracks were observed at the bottom of some basins. Leakage caused secondary damage. Pumps and mechanical or electric installations placed in galleries were submerged and damaged. Inclined tubes or plates in settling basins fell, were destroyed or displaced by sloshing and many inlet-outlet channels were also damaged. Damaged expansion joints were temporarily mended and pumps and other installations were repaired. Those purification plants supplied water again about a week after the earthquake.



Mr M. Itoh

The reasons for damage were considered to be classified into problems with the structures themselves, earthquake-induced forces and earth displacement. The latter includes sliding at faults, collapse of slopes or landslides, earth slides, liquefaction, ground settlement and others. Structures were designed by using different design criteria depending on the age. It is believed that there was usually more than one reason for the destruction, however, more detailed analysis will be needed.

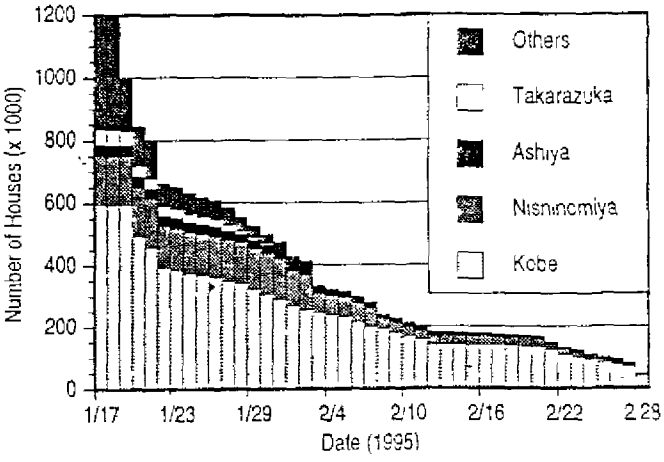



**Fig. 1 Number of Houses Which Suffered Water Supply Cutoff**

### 2.2 Damage to Pipelines and Distribution System

The most damaged parts of the water supply system were the pipelines. A great deal of leakage occurred in transmission lines and distribution networks.

In Kobe city there were 1,962 leakage points in the distribution network and 62,651 leakage points at service pipes as of the end of March. Leakage occurred at pipe breaks, joints or couplings, valves, air valves, fire hydrants and so on. Breakage such as pull-out or crushing at pipe joints was dominant, reaching nearly 50% of the total breakage in the distribution network. Breakage outbreak per unit pipe length is calculated ranging from 0.45 to 1.42 breakage/km in Kobe, Nishinomiya, Ashiya cities and the Hanshin Water Supply Authority. Although these figures do not represent a

final analysis of pipeline damage, they show higher leakage levels compared to past earthquakes in Japan.

Lead-caulked bell-and-spigot connections and mechanical couplings without stops to limit lateral movement caused pull-out breakage but mechanical couplings with stops with seismic-resistant joints had little damage. Although older concrete or cast iron pipes suffered damage to the pipes themselves and joints, there was no leakage from ductile iron pipes with earthquake-proof connections laid in reclaimed land or supported under bridges. Generally, damage to pipes was concentrated in the geological or topographical conditions of alluvium, artificial islands, reclaimed land, near a fault and an unstable foundation like on fill or near the toe or shoulder of a slope.

## 3. Emergency Water Supply and Restoration

Because the water supply was cut off for almost all of Kobe city and its neighbors, provision of an emergency water supply using tank trucks and the restoration or rehabilitation of the water supply system, mainly distribution networks, was executed with the aid of other municipalities or organizations.

### 3.1 Emergency Water Supply

In order to supply necessary drinking water to residents, many supply utilities and personnel were sent from all over Japan. An emergency water supply system was organized in cooperation with the Ministry of Public Health and the Japan Water Works Association. 1,027 tank trucks were used from 587 water supply utilities from 44 prefectures including the stricken cities and Self Defense Forces (Photo 1). For the immediate supply of water, more than 300,000 twenty liter plastic containers, 500,000 one to two liter bottles of water and 210,000 polyvinyl bags were distributed. The Marine Self Defense Force and the Maritime Safety Agency offered water tank boats for emergency water supply besides tank trucks. The number of people who supported the emergency water supply during the two months after the earthquake are shown in Fig. 2.

### 3.2 Emergency Restoration of Water Supply System

Emergency restoration was executed with nation wide cooperation through the Japan Water Works Association and other related organizations similar to those involved with the emergency water supply. 40 municipalities in 42 prefectures sent 6,208 personnel including engineers, technicians and workers with trucks and spare parts and tools. The distribution network has been repaired and installation of temporary water taps for damaged houses is finished but complete restoration of service pipes will need more time because there are still many damaged houses left as they are.

## 4. Strategy for Long-Term Restoration Planning

The Ministry of Health and Welfare organized a study team and committee, and surveyed waterworks in the stricken area. After the survey the committee proposed some items which should be considered during long-term restoration planning. Those are summarized as follows. 1) Because the water supply is a lifeline for citizens, a minimum amount of water should be secured at appropriate sites. 2) Since the water supply is an important function for urban activity, an earthquake-proof water supply system should be reconsidered according to the city restoration program. 3) Telemetering and a remote control system are effective when traffic is congested or information is unavailable. Information transmission, the remote control system, and the power supply system for plant operation should function even during an earthquake. 4) Restoration planning should not only include reconstruction to the original form but the improvement of earthquake resistance e.g. installing flexible joint, anti-pull-out joints or reinforcement of concrete structures to make them water-proof.

**Photo 1** Tank Truck at Water Loading Base for Emergency Water Supply

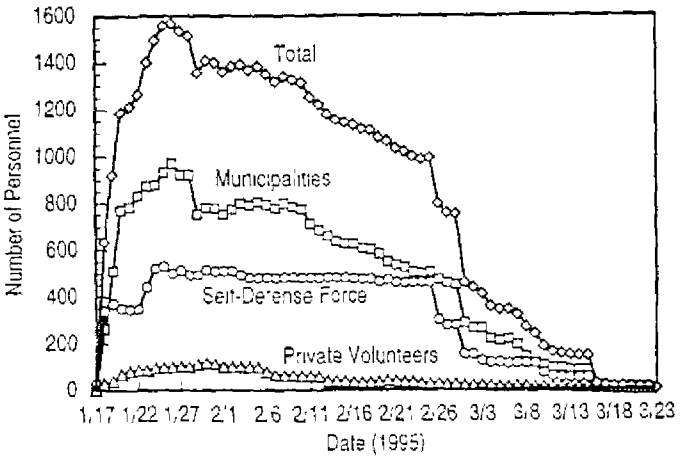



**Fig. 2** Number of Personnel Who Supported Emergency Water Supply