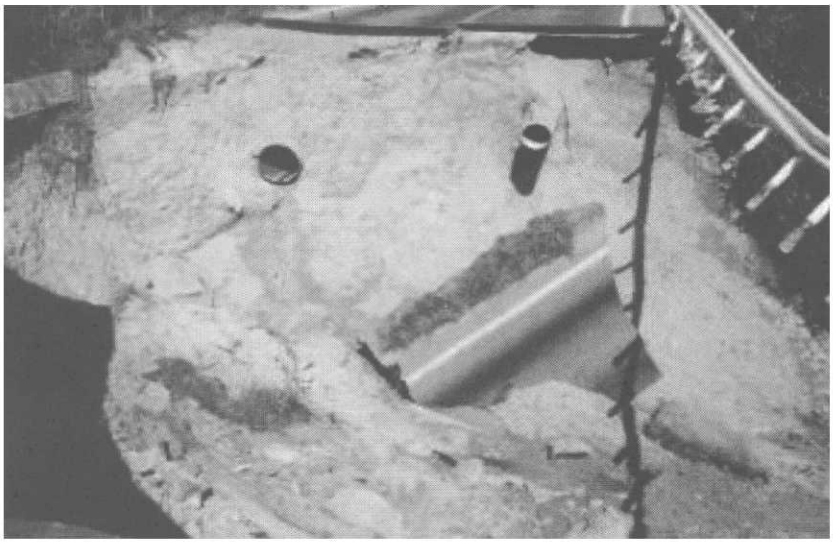
Collapsed Road and Damaged Pipes



- There were irrigation ponds on both side of this collapsed road.
- We didn't know whether the water main breaking caused the collapse of the road or the road collapse caused the damage to the water main. However, the fact is that some measures should be taken at such an unstable ground. For example, at both sides of the unstable ground division valve should be installed.

At the Attention Points of Pipeline Network it is required:

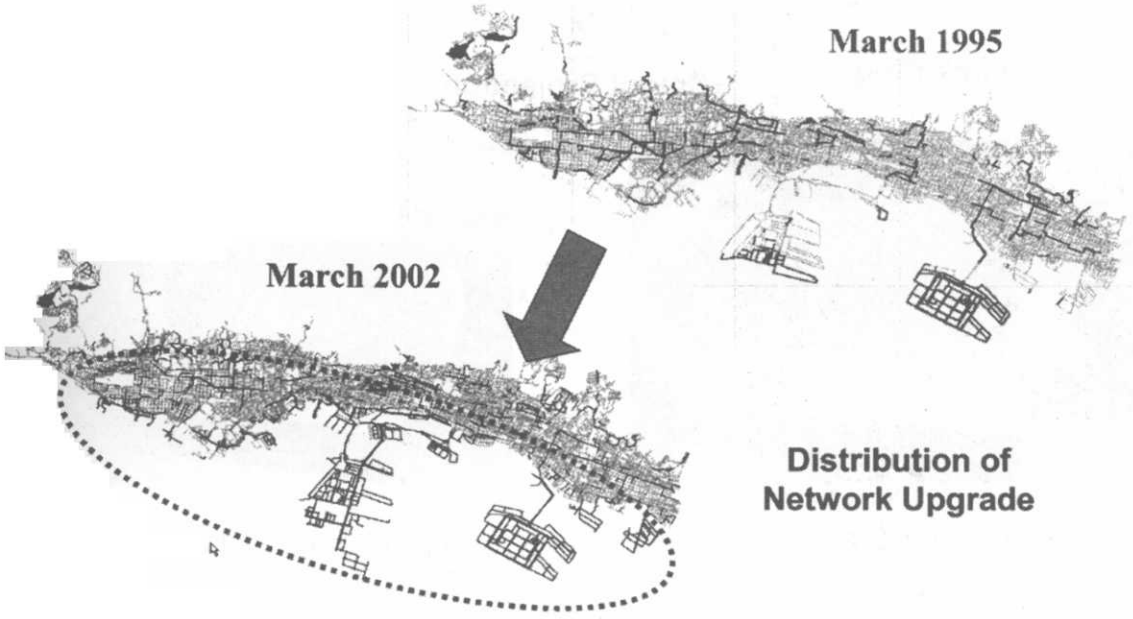
1. To install adequately spaced-division valves in the pipeline network.
2. Limit the depth of underground pipes to insure that they aren't buried too deeply, and properly locating manhole in the pipeline in order to make restoration work swift and easy.
3. If it was considered to occur a secondary disaster, such as in places where the pipe crosses over a railroad and the pipe is buried in the top of a steep slope., setting division valves both in back and in front of the pipeline was capable of preventing or reducing damage to important public and private facilities.
4. In addition, it's desirable to connect the main pipeline to the other water works pipelines in neighboring vicinities.

1.6 Maintenance and Planned Improvements

- To undertake adequate inspection and maintenance.
- To conduct positive anti-seismic diagnosis inspections.
- To improve facilities with low anti- seismic ratings.
- Adequate inspection and maintenance of water supply facilities must be undertaken at a basis to insure their anti-seismic integrity.
- Facilities with low anti-seismic ratings must undergo retrofitting works through planning.

- First, in order to perform diagnosis, each facility must be categorized and listed in order of its importance.
- Second, initial diagnosis inspections must be conducted and the priority of work must be decided upon.
- Third, improvements or reinforcement must be proceeded with.

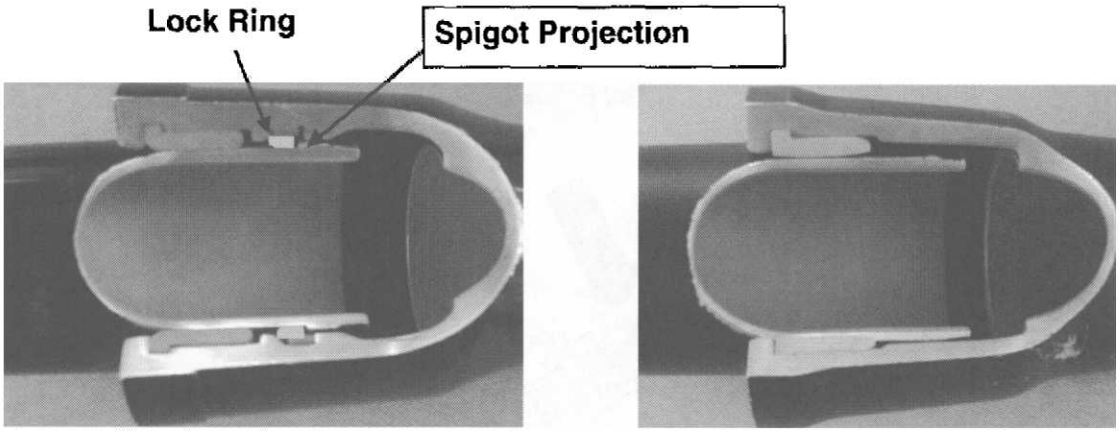
Seismic Pipe Replacement in the Coastal Area



Replacement of seismic proof distribution pipe is progressing in this way. The extension of seismic proof pipes by March 1995 is shown by red line, on the other hand, seismic proof pipe by March 2002 is increasing as shown in the lower figure. Especially, in coastal areas where there were so many damages, seismic proof pipe has been increasing, because we learned the consequence that pipelines in coastal area would be damaged if an earthquake occurs.

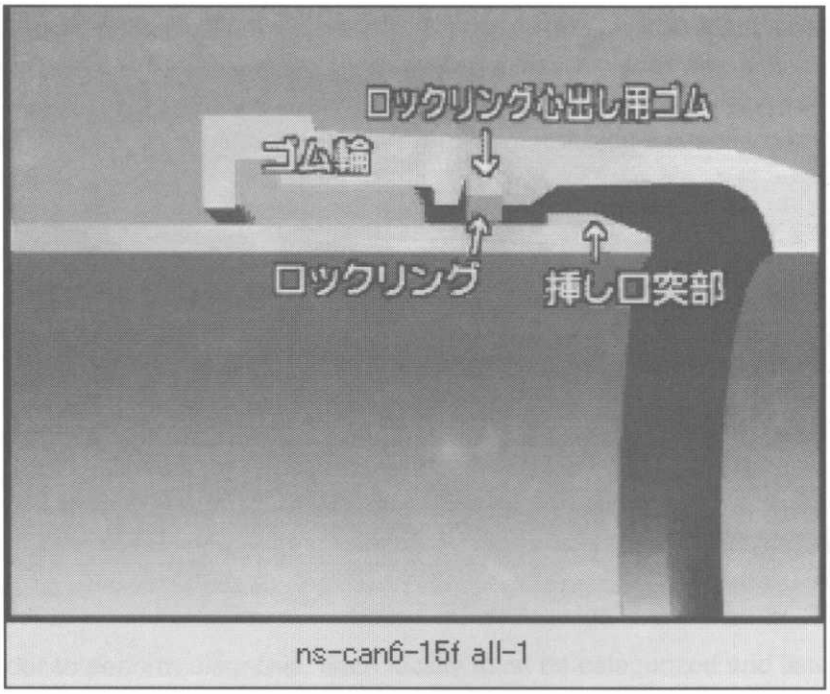
Good Performance of Seismic Proof Joints

Difference between Seismic Proof and Normal Joint



Seismic Joint (NS type) **Slip on Joint (T type)**

- Seismic joint is mechanical type and slip-on type to be flexible.
- In the assembled joint, lock ring is placed in the groove on the socket inside, so that joint can expand until spigot projection comes to contact with lock ring.
- Seismic joint allows a large amount of expansion, contraction and angular deflection, and also has a high restraint performance.
- Pipe lines with seismic joint are widely used in Japan, in places where earthquake is likely to occur and in unstable ground areas.



1.7 Assumption of Earthquake Damage

1 Assumption of damages and countermeasures.

a) Based on assumptions on the type and magnitude of damage to the water supply systems as a result of an earthquake, plans for emergency water service and repair works must be established.
b) To facilitate such works, information networks, emergency manpower mobilization plans, and mutual cooperation system must be established.
c) And comprehensive preparation must be made for stockpiling materials and equipments required for restoration works, preparation of complete sets of facilities drawings and decentralization of their management.

2. Water supply systems existing on good or bad foundations, must be built wherever people carry on their activities. Some damages cannot be avoided since some part of a facility's structure always possesses a seismic weakness.

3. Therefore, predictions of disaster damage and emergency service restoration based on such predictions must be established and used by an emergency restoration agency and to prepare before the disaster occurs. In addition, emergency exercises should be regularly practiced on workdays.

1.8 Order of Restoration Works

- To start with up-stream preparations.
- To be sufficiently considered on relationship between emergency restoration works and subsequent permanent restoration works.

1. As a general rule, restoration work after the disaster should start with raw water intake facilities, followed by, in sequence, water treatment facilities, and distribution facilities, and finally water service connections. After completion of restoration work, leak survey work must be conducted.

2. When disaster damaged facilities are to be repaired through emergency restoration work, including the use of temporary water supply piping methods, it's necessary to work in conjunction with other related agencies.

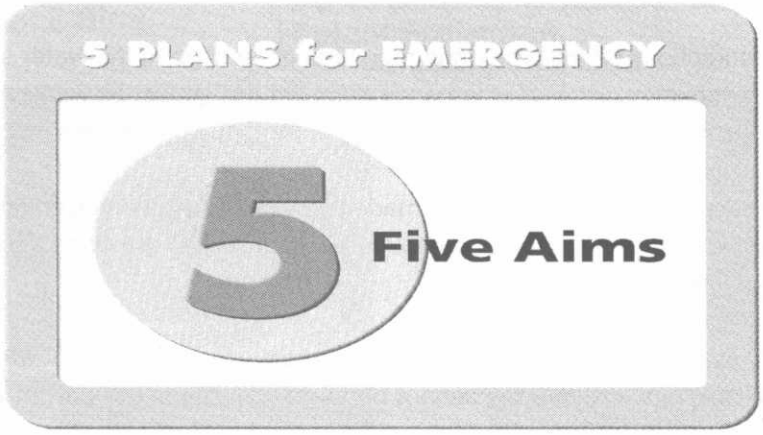
3. Work must proceed according to a restoration plan which is prepared before a disaster and which involves sewage agencies, traffic control managers, and group maintenance managers.

4. Depending on the scale and degree of the disaster, relief work may require help from other water works utilities.

5. It's so desirable to have details, such as the standardization of valve-caps, which are necessary to operate cut-off valves or hydrants, prepared before a disaster to smoothly carry out widespread relief activities.

(To realize early resumption of water service, sufficient consideration should be made on relationship between emergency restoration works and subsequent permanent restoration works.)

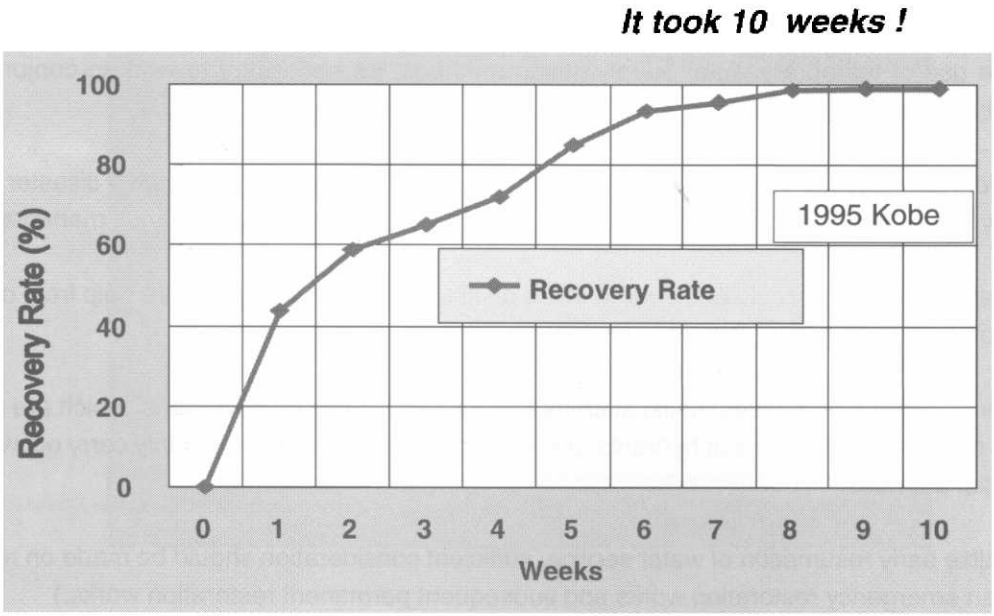
Kobe's Guidelines and Basic Plan for Anti-Seismic Water Supply



The Kobe's Basic Plan for earthquake proof Systems reflects the lessons learned from the experience of the earthquake disaster restoration project. We established a committee for waterworks restoration planning and studies in March 1995 and formulated seismic reinforcement guidelines in waterworks. Based on the guidelines, basic seismic improvement plan for waterworks facilities was drawn up in July, and includes very specific measures. The guidelines designate the direction of Kobe's waterworks facility development, that is, to realize disaster resistant and easily restorable facility development. The fundamental idea of the guidelines is to take action in accordance with the customer's point of view, so as to enable the people who experienced the Kobe earthquake to use the water service with confidence, and also by reflecting Kobe's characteristics.

There are five aims as objective in this Guidelines. It utilized the lessons which were gotten from the earthquake disaster and it settled on the Basic Plan in the water supply Systems Guideline.

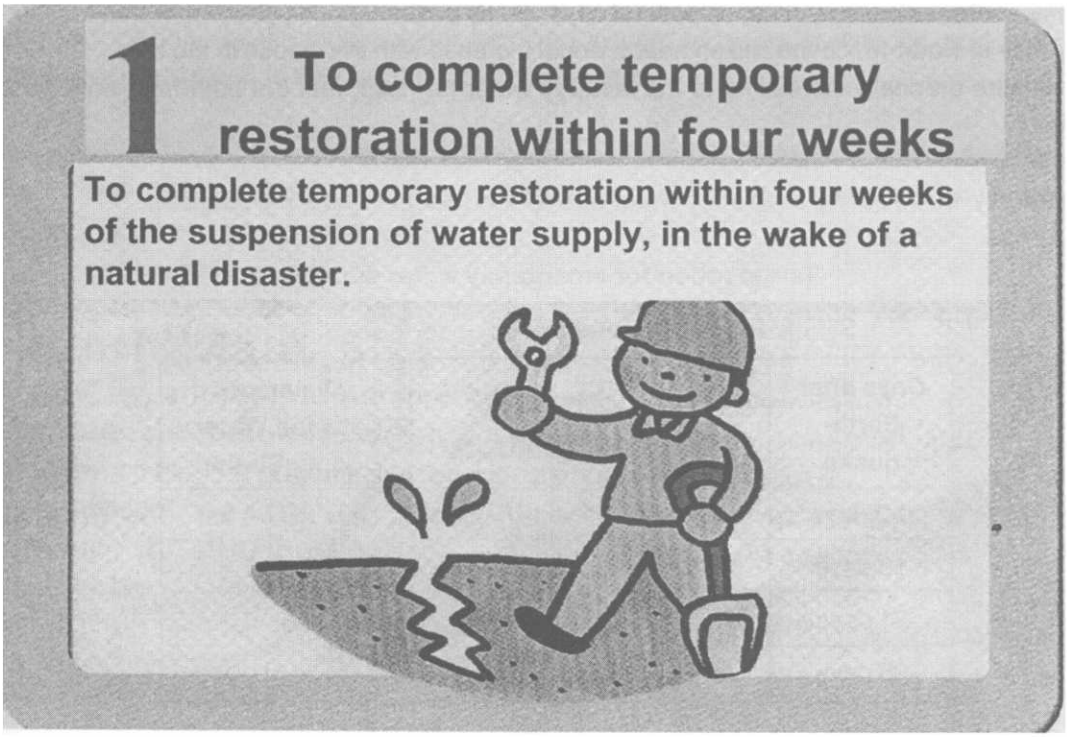
Long period of Service Recovery



Inquires and Requests from Citizens after the Kobe Great Earthquake

First, the lesson which was gotten from the earthquake disaster is the fact to have taken the long period of 10 weeks until the whole water supply area began supplying.

This figure shows the inquiries and complaints from the customers in the earthquake disaster.
It was found that the citizen's mind changed from **"Impatient"** to **"Frustrated"** to **"Angry"** while the time goes on from the earthquake occurrence.



As for the emergency restoration, the following was set as the goal based on the customer's Voices.

- We aim to complete temporary restoration within four weeks of the suspension of water supply, in the wake of a natural disaster.