Strategic Development of Pipeline Networks towards Olympic and Paralympic Games Tokyo 2020

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Threat of a major earthquake

Tokyo Waterworks maintains a massive distribution pipeline network that stretches for a total of approximately 27,000 kilometers, equivalent to two thirds of the circumference of the earth. In the past three years, this massive network has had on average 278.3 natural leaks per year. This record testifies to the fact that the network of water pipelines in Tokyo is properly maintained and managed. According to estimates by the Japanese Government, there is a 80% probability that an earthquake of magnitude 7 class will hit the nation's capital (including Tokyo) within the next 30 years. When the Great East Japan Earthquake struck in 2011, even with its epicenter approximately 400 kilometers away from Tokyo, leakage occurred to water pipes at waterworks facilities in Tokyo. In the event of a major earthquake striking Tokyo, it is easy to imagine that it will inflict untold damages to the waterworks facilities in Tokyo.

In Japan, one of the gravest threats among natural disasters is massive earthquakes. Since the Great East Japan Earthquake of 2011, 22 earthquakes with a magnitude of 7.0 or higher have occurred, including the 2016 Kumamoto Earthquake among others. These earthquakes inflicted severe damage, causing joints to come loose on water pipelines. Also, when there was long term water service suspension, long lines of people formed at water supply trucks dispatched to evacuation centers in disaster areas.

Damage from past earthquakes

Transmission pipes knocked loose by the Great East Japan Earthquake (Diameters: 2,4000 mm) (Miyagi Prefecture) (Source: Japan Water Works Association (JWWA), Ministry of Health, Labour and Welfare (MHLW)

Emergency water supply at evacuation sties

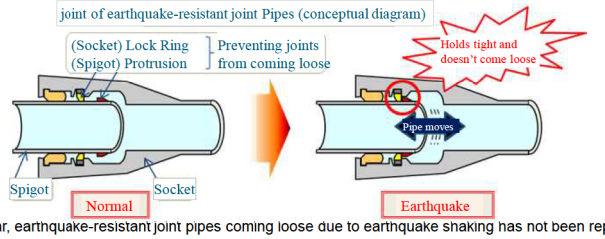
Tokyo Waterworks has been replacing water pipes with "earthquake-resistant joint pipes", which prevent joints from coming loose even when the ground is greatly shifted by an earthquake. Tokyo Waterworks has already achieved a leakage rate around 3%, and now gives priority to replacing pipes with earthquake-resistant joints on "supply routes". Furthermore, not only as an earthquake countermeasure, but as a strong and reliable measure to prevent leakage during the 2020 Tokyo Olympics Games, we are replacing pipes on event courses to build a strong pipe network.

Building strong pipelines

Using earthquake-resistant joint pipes, examining introduction and validity of the "supply routes" concept

(1) Full adoption of earthquake-resistant joints

99.8% of water pipes of Tokyo are ductile cast-iron pipes with high strength (as of 2016). However, Tokyo Waterworks learned a lesson from the Great Hanshin Earthquake in 1995. This earthquake hit Kobe, a big city with a population of approximately 1.42 million, which suffered severe damages to its waterworks service because the joints of water pipes came loose due to seismic shocks. Through the lessons learned from that earthquake, Tokyo Waterworks decided to replace all of its water pipes with ductile cast-iron pipes with joints that keep them from coming loose, in accordance with their respective renovations. The disengagement prevention force at the joints of earthquake-resistant joint pipes is equivalent to 3D kN (D: pipe nominal diameter), so it was a reliable and reasonable decision to use them.



So far, earthquake-resistant joint pipes coming loose due to earthquake shaking has not been reported in Japan.

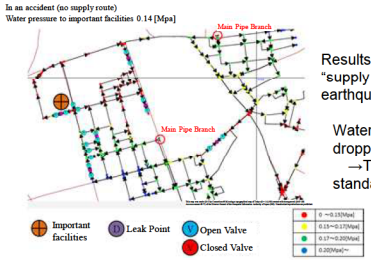
(2) Setting water "Supply Routes" and examining validity

The total length of Tokyo's water distribution pipes is approximately 27,000 km. It will take many years to replace all of them with earthquake-resistant joint pipes.

1) First, we designated "critical facilities", including government facilities necessary for maintaining functionality of the national government and the capital of Japan in the event of a major disaster, as well as emergency medical institutions that serve as bases for rescue activities during disasters, and examined how to continue supplying water as much as possible to these facilities even in the event of a major earthquake disaster.

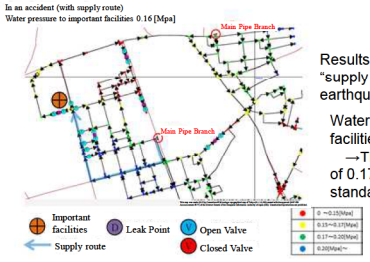
2) Next, because distribution pipes with a diameter of at least 400 mm, which serve as the backbone for water distribution, are buried at least 1.8 meters underground and the pipes themselves are of a certain weight, we expect that not many joints will come loose because of shaking in an earthquake.

3) Additionally, we conducted pipe network analysis, with the extraction points from water distribution pipes as starting points and service pipes of "critical facilities" as end points. The results of this analysis showed that because of the dense networking of distribution small pipes with a diameter of 350 mm or less, which are responsible for water distribution within a district, water supply can be secured despite pressure declining slightly.



Results of pipe network analysis when the "supply route" has not been retrofitted with earthquake-resistant joint pipes

Water pressure of target critical facilities dropped to 0.14 Mpa
→This is lower than Tokyo Waterworks standard of 0.17 Mpa



Results of pipe network analysis when the "supply route" has been retrofitted with earthquake-resistant joint pipes

Water pressure of 0.16 Mpa secured at target facilities
→This is below Tokyo Waterworks standard of 0.17 Mpa, but still exceeds that national standard of 0.15 Mpa

4) As a result, we defined "supply routes" as extending from the extraction points of distribution pipes to the service pipes of "critical facilities", and made it our policy to do priority, focused retrofitting to earthquake-resistant joint pipes on these routes.

Furthermore, we have a established a system to deploy our staff to facilities where we cannot secure the necessary supply water pressure of 0.17 Mpa during a disaster. These staff close the gate valve connecting the facility to the supply route and restore supply water pressure to critical facilities.

Supporting the 2020 Tokyo Olympics with strong pipes and "omotenashi" (hospitality)

(1) Completing earthquake-resistant joint pipe retrofitting of "supply routes"

Tokyo Waterworks has taken the decision to hold the 2020 Olympics in Tokyo as an opportunity to position event venues as a "critical facilities", and will finish retrofitting these "supply routes" with earthquake-resistant joint pipes by the end of 2019. In addition, we will retrofit water pipes of the marathon, race walk, and cycling courses with these pipes as much as possible. However, because of the congestion of buried objects in Tokyo, there are places where water pipes cannot be replaced so quickly. At these places, during the Olympics, our plan is to close gate valves and suspend water service, so as not to supply water through non earthquake-resistant joint pipes. Through these initiatives, we will make every effort to ensure safety from disasters and accidents during Tokyo Olympics.

(2) Providing "omotenashi"

Tokyo Waterworks has installed outdoor bottle dispenser drinking faucets, so that athletes and visitors can try "safe and delicious water" provided through our strong water pipelines.

We will promote these drinking faucets and temporary drinking fountains to be installed during the 2020 Tokyo Olympics as "Tokyo Drinking Stations".

Tokyo Waterworks promises to provide water through our strong drinking pipes with "omotenashi", in order to support the best games possible.