Earthquake Preparedness

Harumi Island Triton Square
Toward a **Town** for Safe and Secure Working, Relaxation and Living

**Earthquake Preparedness at Harumi Triton Square**
- Creating a Community Resistant to Earthquake Damage -

When the Great Hanshin-Awaji Earthquake occurred (January 17, 1995), the urban development of Harumi Triton Square was under the basic design stage. We learned a lesson from this devastating earthquake and wanted to make the most of what we learned in the design of our town. So we adopted a highly stable and strong earthquake resistant design that includes an integrated underground structure covering all three high-rise buildings and putting the basement structure directly on the firm load-bearing ground and a damage level control design that mitigates the damage to the major structural elements, i.e., columns and beams, and quickly and accurately monitors the building damage level upon occurrence of a major earthquake for early recovery.

The basis of the block layout is clear and simple, which is clear zoning, clear building design, and clear office planning. This is also a design strategy with business continuity planning (BCP) taken into account. As the integrated manager of the block, we continue to maintain deep ties with the people of the block and local stakeholders around the block and reinforce the power of the block and community so as to make the town more resistant to earthquake and other disasters.

**Takashi Yamazaki**
Representative Director, President and CEO
Integrated Manager of the Harumi Island Triton Square
Harumi Corporation

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Building Foundation - It’s All in the Groundwork.

Like Mori Motonari’s famous historical anecdote “Three Arrows,” linking the ground parts of three high-rise buildings with a massive, stable foundation set the center of gravity of the buildings to a lower position and provided excellent structural balance and stability to the entire block.

The high-rise buildings are firmly supported by the underground structure that provides structural integrity to the buildings.

Foundation structure of about 30 m in thickness

Firm supporting ground

Since the firm supporting ground lies at a depth of about 30 m from ground level at the Triton Square site, the former method was adopted, which is the safer choice. As an interesting side effect, a large heat storage tank was introduced, which further enhances energy saving. The Harumi area was born as reclaimed land with the final landfilling completed in 1931. Generally speaking, when a high-rise building is constructed, the spread foundation is built on the firm ground on which the building stands, or piles are driven into the ground to support the building.
The Buildings are Supported by Solid Ground.

Tokyo gravel layer: A relatively stable stratum formed 1 million to 10,000 years ago

Kazusa Group: Solid stratum formed 2 million to 1 million years ago

Considering Harumi's vicinity to the sea, it may be a commonly thought that the ground under Harumi is soft. On the contrary, Harumi Triton Square is supported by the Kazusa Group, a solid stratum located at a depth of about 30 m with sufficient load-bearing capacity. This ground condition is almost equal to that of other areas at the Metropolitan center, such as Marunouchi or Shiodome.
Energy-absorbing members are braces composed of soft steels wrapped in mortar which are then covered by steel pipes. Since these members are small enough to fit in an elevator, they can easily be sent to the place where damaged members are located for quick replacement in the event of a major earthquake. Quickly replacing major structural members can help us restore the building only after a short shutdown period.

Displacement of the energy-absorbing members can be monitored at any time to allow quick identification of damage.
Quick and Efficient Remediation of Damage

Conventional Flexible Earthquake-resistant Structure
A conventional flexible earthquake-resistant structure is designed to allow some major structural members (columns and beams) to be damaged by a major earthquake for the purpose of seismic energy absorption to prevent the entire building from being destroyed, thereby protecting the people in the building. But because of its mechanism, time and efficiency of building restoration is expected to be a major post-earthquake problem.

Damage Level Control Structure
The damage level control structure absorbs seismic energy by allowing energy-absorbing members to be damaged, protecting major structural members. The energy-absorbing members also serve as dampers to mitigate seismic force acting on people as well as facilities, furnishings and furniture.
Electricity-oriented Energy Structure Enhances Reliability

The Recovery Time of the Lifeline is the Major Issue.

Use of a power system centering on electric power with a DHC source, will lead to quick recovery from earthquake damage.

According to the review of the Tokyo Metropolitan Disaster Prevention Council, it is demonstrated that among major energy sources, the recovery of electric power is relatively quicker than gas. When past major earthquakes occurred such as the Miyagiken-oki Earthquake or Great Hanshin Awaji-Earthquake, lifelines including power, gas and water supplies were damaged. Of these utilities, electricity was restored more quickly than other utilities in past cases. At Harumi Triton Square, the heat for heating and other utilities is created by electricity. Therefore, the risk of a long functional shutdown is expected to be small.

Damage estimate in Chuo-ku in the event of a major earthquake

<table>
<thead>
<tr>
<th>Damage estimate in Chuo-ku in the event of a major earthquake</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Maximum water level by tsunami: A.P. + 3.0 m</td>
</tr>
<tr>
<td>2. Road bridge damage ratio (ratio of road bridges rendered useless): 2.3%</td>
</tr>
<tr>
<td>3. Lifeline damage</td>
</tr>
<tr>
<td>Water and sewage system malfunction ratio: 3.8%</td>
</tr>
<tr>
<td>City gas: 100%</td>
</tr>
<tr>
<td>Electricity: 17.6%</td>
</tr>
<tr>
<td>Telephone: 5.6%</td>
</tr>
<tr>
<td>Water and sewage system: 7.4%</td>
</tr>
<tr>
<td>Approximate recovery time (days):</td>
</tr>
<tr>
<td>Water and sewage system malfunction: 17 days</td>
</tr>
<tr>
<td>City gas: 17 days</td>
</tr>
<tr>
<td>Electricity: 6 days</td>
</tr>
<tr>
<td>Telephone: 17 days</td>
</tr>
<tr>
<td>Water and sewage system: 60 days</td>
</tr>
</tbody>
</table>

Source: Study on Earthquake Damage Estimates in Tokyo Metropolitan Area, Tokyo Metropolitan Disaster Prevention Council (September, 1991)
Community Tank Stores Important Water

The Multiple Functions of Harumi DHC’s Heat Storage Tank (about 20,000 m³ in volume)
Harumi Triton Square has a large heat storage tank that stores cold water even during short-time power outages. In the event of a major disaster, it serves as a large fire water tank or provides miscellaneous service water (such as for temporary toilets) for emergency situations. For fire water, the tank can provide 30 fire engines with water enough for over 10 hours of firefighting. For water used in daily life, it provides water to about 20,000 people for one month.

Schematic illustration of the community tank

Harumi Fully Resistant to High Water
(Designated as a Wide-area Evacuation Site in Case of Disaster)

The Harumi area is protected by earthquake-resistant embankments to make it resistant to high water by tsunami or typhoons (AP + 6.5 to 6.3 m).

Based on the lesson learned from the Great Hanshin Awaji Earthquake, marine transport is proven to be effective when traffic on roads or public transport is blocked.

Harumi Triton Square faces the Asashio Canal flanked by embankments and water gates and it can use the water route for transportation in case of an emergency situation.

Embarkment layout in the Harumi area
Source: Internal data of the Bureau of Port and Harbor, Tokyo Metropolis (from the Tokyo Port Disaster Prevention Plan Diagram)
Trinity of “Hardware,” “Software,” and “Heartware” Ensures Safe Town.

Clear Facility Zoning (Hardware)

Two- and three-dimensional zoning of the business, commercial and residential zones restricts the area accessible to the unspecified majority to commercial facilities to ensure both security and safe evacuation. The 54 m x 54 m rectangular floor planning of the office floors creates flexibility for ease of restoration in the event of a disaster.

Integrated Management System by the Integrated Disaster Prevention Center (Software)

Each building has its own sub disaster prevention center and those sub centers are managed by the Integrated Disaster Prevention Center. The buildings are organically coordinated by optimized operation of individual management and central management.

Quick Prediction and Diagnosis of Building Damage by Earthquake

● The system was established based on the advice of a general consulting firm that specializes in all kinds of damage risks from earthquake and other disasters.

● Each building mutually uses and deploys personnel so that an emergency situation can be responded to by the entire block.

● Monitor cameras installed on the rooftops check the damage in the surrounding area.

● The VERN System, which allows real-time acquisition of Meteorological Agency information, is introduced for information sharing and disaster prediction.

VERN: Virtual Emergency Response Network
In order to maintain a safe and secure town, it is important for all the people connected to the town to share a sense of oneness and togetherness and a high awareness of disaster prevention. As the integrated manager of the block, we annually hold the Disaster Prevention Exhibition on National Disaster Prevention Day and the Extended Joint Fire Prevention Management Council and the General Disaster Prevention Drill in autumn for all relevant people (mainly office workers and employees) in order to deepen further ties of trust among people of the block and local stakeholders. No matter how excellent the disaster prevention equipment or how well the disaster prevention system has been organized, they alone do not make up sufficient risk management. Actual danger can only be eliminated by a group, all of whose members share a strong disaster preparedness mindset.

We continue to actively provide knowledge on disaster prevention in order to enhance people’s disaster preparedness mindset.
Harumi Island Triton Square is a redevelopment project that was the first in the Harumi Island to aim at creating a “corridor of water, greenery and wind” that connects the sea and the Metropolitan center.
Only 3 km away from Tokyo Station, Triton Square enjoys marine access, which provides a highly excellent location in the event of a major earthquake and other disasters.