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STEEL CONSTRUCTION TODAY & TOMORROW

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波

【 *n a m i* 】

“波 (*nami*)” in Japanese, or “wave” in English

Issue No. 41 is a special publication for the Japanese Society of Steel Construction (JSSC). It includes a special feature on measures devised to handle huge tsunamis (津波 *tsunami*, or tidal wave).

Photo: Kenichi Ishii




Published Jointly by

The Japan Iron and Steel Federation

JSSC Japanese Society of Steel Construction

Design and Construction of TOKYO SKYTREE

Prize winners: Nikken Sekkei Ltd., Obayashi Corporation, JFE Steel Corporation, Kobe Steel, Ltd., Nippon Steel & Sumitomo Metal Corporation, Komaihaltec Inc., Kawada Industries Inc., Tomoe Corporation and Nippon Steel & Sumikin Engineering Co., Ltd.

TOKYO SKYTREE® is a freestanding broadcast tower that was constructed in Sumida-ku, Tokyo, at the request of six Tokyo broadcasting companies. The tower rises 634 m into the sky and is the tallest structure of its kind in the world.

The structural concept upon which the tower is configured may be expressed with two words: the "warping" of Japanese swords (*katana*) and the "camper" found in the columns of traditional Japanese architecture. This concept is expressed three-dimensionally in the tower's complex design that begins as a regular triangle at the base and becomes circular at a height of 300 m.

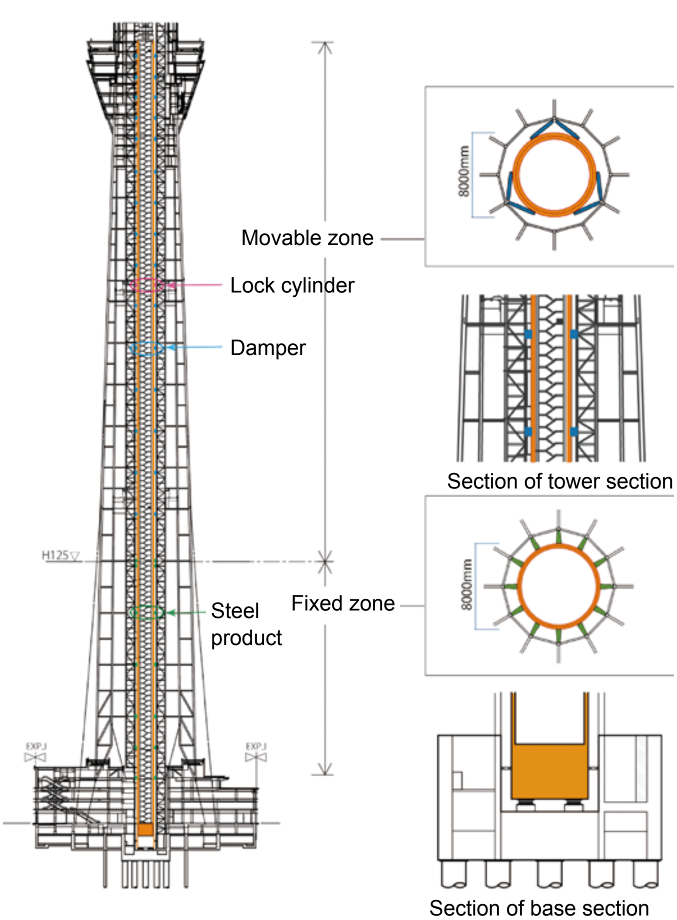
In terms of the structural plan, two observatories are installed at heights of 350 m and 450 m, respectively; while at heights of 500 m and higher, the tower supports the broadcasting antenna of the various broadcasting stations.

Because of the tower's extremely slender configuration (with a 9.3 width-to-height ratio imposed by the restrictions of the construction site), the foundation is worked upon by large press force and tensile force caused by earthquakes and high-velocity winds. To treat these forces and to ensure highly reliable and safe support for the tower, a continuous underground "knuckle wall" pile of steel and reinforced-concrete was adopted. In order to give the tower a neatly shaped appearance with no gusset plates, a steel pipe truss structure was adopted for the tower section that uses high-strength, large-section steel pipes joined by means of tubular joints.

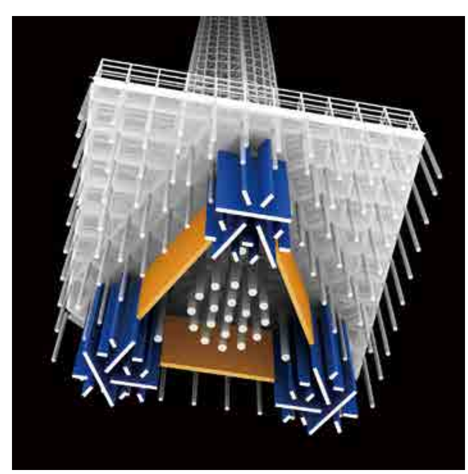
Outline of TOKYO SKYTREE®
Completion: February 2012 (Sumida-ku, Tokyo)
Project owner: Tobu Tower Skytree Co., Ltd. and Tobu Railway Co., Ltd.
Design: Nikken Sekkei Ltd.
Construction: Obayashi Corporation

Ample countermeasures have been employed to handle earthquake and wind. Based on field surveys, such as a wind velocity survey of upper-level winds using a GPS-mounted observation balloon and a micro-tremor survey of the construction site, simulated wave force waveforms and site waves were prepared to verify the tower's structural safety. To this end, the resulting structural safety is higher than that of other high-rise buildings commonly erected in Japan. As an additional measure to deal with earthquakes, the *shimbashira* vibration-control system (devised for the first time for this building) was developed and deployed to mitigate seismic forces. ■

Outline of *Shimbashira* Vibration-control System




World's tallest broadcast tower


Drawing of pile foundation (looking-up drawing)

—Performance Prize

Development of a Closed Demolition Method for High-rise Buildings

Prize winner: Taisei Corporation

High-rise buildings are mostly located in dense urban areas. In recent urban redevelopment, rebuilding of existing high-rise buildings greater than 100 m in height has increased, thereby making the proposed methods of high-rise building demolition an important element in the promotion of urban redevelopment projects.

Given this trend, Taisei Corporation developed a demolition method called the "TECOREP (Taisei Ecological Reproduction) System" that mitigates the adverse effects of demolition work on the surrounding environment, improves safety and reduces the negative environmental impact of the demolition work. This system has been successfully used already in the demolition of a high-rise office building with a height of 105 m and a high-rise hotel building with a height of 140 m.

The 140 m-high hotel building being demolished using the TECOREP system

A major feature of the TECOREP system is the capped enclosure that is built by effectively using the existing structure of the topmost floors and carrying out the demolition work within the enclosed space. Specifically, the building is demolished floor by floor downwards, starting from the top. The enclosure in which the target floor is demolished can be safely and quickly translocated to the lower floor using hydraulic jacks installed on temporary columns that support the capped structure. Further, the new system incorporates power generation capabilities in the vertical transport system that is used to lower the demolished materials etc. to the ground, thereby leading to energy savings and reduced CO2 emissions.

The practical applicability of the TECOREP system has been demonstrated by its use in the demolition of Japan's tallest hotel building with a height of 140 m. Demolition work conducted in a closed space mitigates neighborhood anxiety and ensures safety; it allows shortening of the demolition period through a reduction in the number of lost work days. The demolition system not only reduces noise levels (by 20 dB or more) but also prevents the dispersion of dust and soot (by 90% or more). Moreover, in terms of securing workplace safety, the implementation of demolition work in an enclosed space yields many other advantages, although they cannot be quantified numerically. ■

Inner view of the TECOREP system

Jacking-down procedure during demolition using the TECOREP system

—Performance Prize

Design and Construction of Shibuya Hikarie

Prize winners: A Joint Venture (JV) of Nikken Sekkei Ltd. and Tokyu Architects & Engineers Inc. and a JV of Tokyu Construction and Taisei Corporation

Shibuya Hikarie is positioned as one of the leading projects of the urban redevelopment program for the area surrounding Shibuya Station in Tokyo. It is a multipurpose high-rise building with a height of about 185 m. Its primary objective is to create new cultures and lifestyles by drawing together a multiplicity of dissimilar activities, such as commerce, recreation, culture and business.

A major task of the structural plan is that the building incorporates a theater with about 2,000 seats in the mid-story and that the design offer different configurations in the high- and low-rise sections.

In general, when different applications are accommodated in a multi-layered structure, columns do not pass vertically through the building structure. As a result, a widely adopted solution for resisting a building's vertical and horizontal loads is to form large trusses. In the current project, instead of a complex-structured building in which offices, a theater and commercial facilities are arranged in a multi-layered form, a simple and clear structural plan was adopted to avoid the structural issues associated with complex structures.

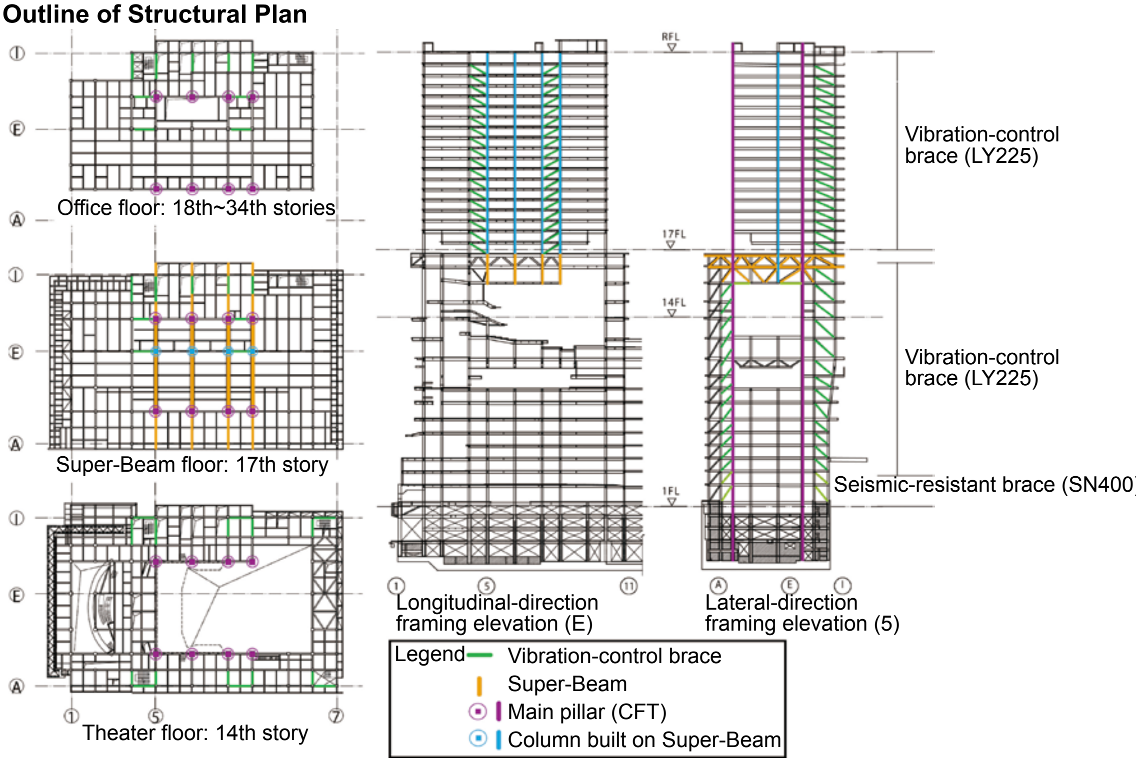
Among the major devices adopted to realize such a highly reliable structural plan are the following:

- Because a theater with a wide, column-free space is provided in the mid-story, the installation of columns that do not pass vertically through the building was held to a minimum (four columns).
- The adopted plan has four columns that rise from the upper theater section and are supported by "Super-Beam" having a truss height of two stories.
- On both sides of the theater, box-shaped concrete filled steel tubes (CFT) are arranged as the main pillars, rising upwards through the height of the building structure. Although the member sections of the Super-Beam become large, and as a result the bending stress working on the columns increases, the CFT main pillars having sufficiently high rigidity and strength tolerate these stresses.
- The adoption of CFTs for the interior columns reduces the shear force borne by the exterior columns that are subjected to additional large axial forces during an earthquake. ■

Outline of Shibuya Hikarie
Completion: 2012 (Shibuya-ku, Tokyo)
Arch./Eng.: Nikken Sekkei Ltd.

Full view of Shibuya Hikarie

Outline of Structural Plan



—Special Prize

Continuous Steel-Concrete Composite Girder Bridge Employing Compact Sections

Prize winner: East Nippon Expressway Company Limited

Expressway companies in Japan have developed innovative structural types in the construction of expressway bridges, such as minimum main girder structures that adopt PC slabs, and continuous composite structures that take into account the compound benefit of using PC slabs and steel girders. One successful result in this direction was the structurally very simple continuous steel-concrete composite two I-girder bridge. In order further to pursue rationalized bridge types, it will be necessary to introduce new design concepts.

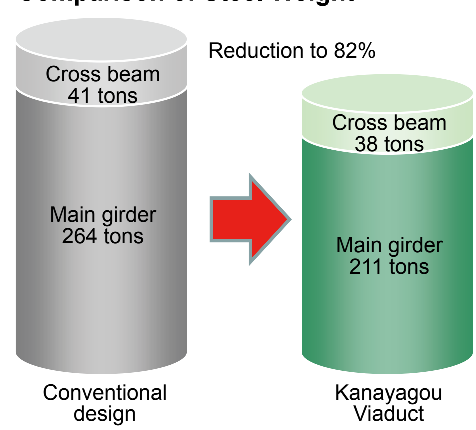
To meet this need, East Nippon Expressway Company Limited introduced compact section design to highway bridge construction—a first in Japan. The underlying idea of this design concept is to fully utilize the performance of various steel products to produce a more rational bridge structure. The Kanayagou Viaduct is an expressway bridge that was constructed using this new design concept.

In the center section of the bridge span where conventional continuous steel-concrete composite two I-girder bridges experience dominant positive bending, a neutral axis is located near the slab and the web bears most of the tension. At this stage, it was feared that an unstable phenomenon called buckling might occur in the compressed range that partially remains.

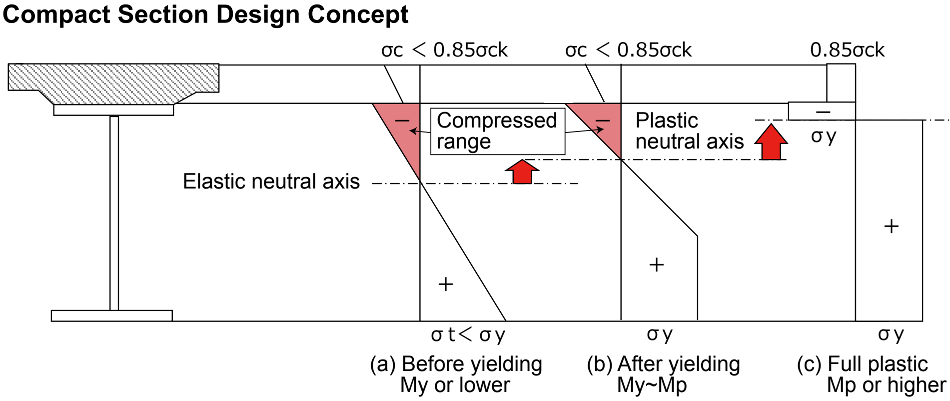
To remedy this situation, a new design concept was introduced. That is, if a section is structured so that it does not cause buckling in the web and reaches a fully plastic state, conditions are produced in which the compression is mostly borne by the slab and the tension is borne by the steel products. To this end, rationalized sections can be realized that take full advantage of the features of both steel and concrete structures to prevent rapid collapse. It is the compact section design concept that seeks to produce rationalized sections by maximizing the use of the performance characteristics of the structural members.

The adoption of compact section design for the Kanayagou Viaduct demonstrates many advantages: reduced steel weight, restricted girder height, and the realization of an economical and slender structure with girders of equal height without a loss of structural performance. ■

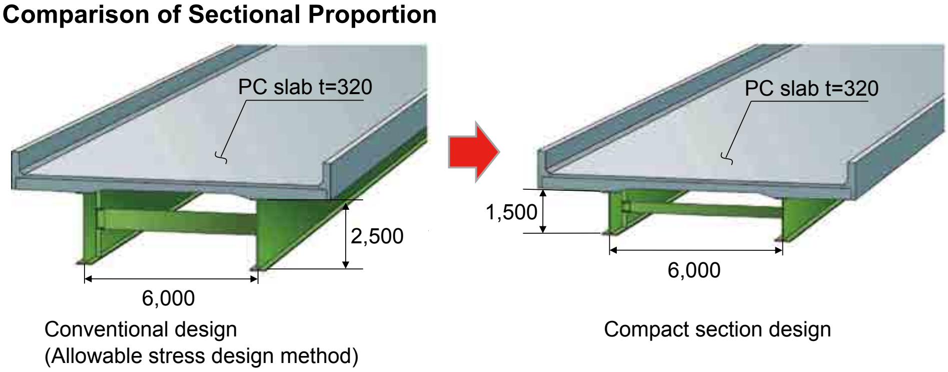
Comparison of Steel Weight



Compact Section Design Concept



Comparison of Sectional Proportion



Kanayagou Viaduct employing a new design concept based on compact section

—Thesis Prize

Effect of Deck Plate Thickness of Orthotropic Steel Deck on Fatigue Durability

Prize winners: Jun Murakoshi, Public Works Research Institute, Naoki Yanadori, Naoki Toyama, Honshu-Shikoku Bridge Expressway Co., Ltd. and Toshiki Ishizawa, Takumi Kosuge, Shin Nippon Giken Engineering Co., Ltd.

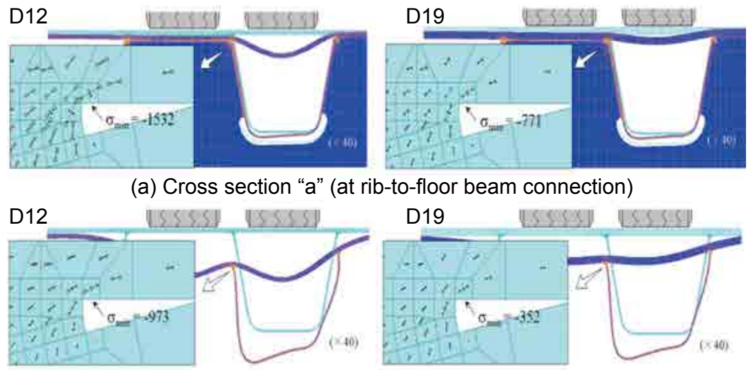
Jun Murakoshi
1987: Finished M.S., Civil Engineering, Tokyo Institute of Technology
1987: Entered Public Works Research Institute (PWRI), Ministry of Construction
2008: Chief Researcher, Bridge and Structural Technology Research Group, Center for Advanced Engineering Structural Assessment and Research, PWRI

The effect of thickness of deck plate on fatigue durability of orthotropic steel decks was discussed from experimental and analytical results to improve fatigue durability of the structural details for the deck plate cracks.

Photo 1 View of testing by wheel running test machine

Wheel running fatigue tests were performed for full-scale test specimen with combination of 16/19 mm thickness deck plates (D16/D19) and 6/8 mm thickness ribs (V6/V8) (Photo 1). Finite element analyses were also conducted in order to clarify the effect of thickness of deck plate on local stress at rib-to-deck welded joints (Fig. 1). ■

Fig. 1 Deformation and Principal Stress Vector Diagrams at Rib-to-Deck Welded Joints for D12U6 and D19U6



(a) Cross section “a” (at rib-to-floor beam connection)

(b) Cross section “A” (at span center of trough rib)

Research on Displacement Response Control Effect by Conventional Steel Braces

Prize winners: Hiroyuki Hayashida, JFE Civil Engineering & Construction Corp., Izumi Miyashita, Graduate School of Kumamoto University (formerly), Koji Ogawa, Graduate School of Kumamoto University

Hiroyuki Hayashida
2010: Graduated from Department of Architecture, Fukuoka University
2012: Graduated from Graduate School of Science and Technology, Kumamoto University
2012: Entered JFE Civil Engineering & Construction Corp.

The research examined the possibility that conventional steel braces could be utilized as seismic response-control members.

Fig. 1 compares the maximum inter-story drift angle in entire stories of steel frames with braces with that of pure rigid frames. These frames are equal in strength. In the range of small inter-story drift angles, as assumed in the seismic response control design, the deformation of the braced frames is smaller than that of the pure rigid frames.

Fig. 2 shows the relation between the strength-sharing ratio of the braces and the maximum value of the inter-story drift angle for the entire stories, with the strength of the frames fixed at a specified level. According to the figure, when the sharing ratio of braces is increased, the response steadily decreases, but when the sharing ratio is increased beyond a certain level, the response tends to rapidly increase.

The cause of the rapid increase of the response is attributable to the concentration of deformation in a story. In this research an equation is proposed that calculates the upper limit of the strength-sharing ratio of braces so that deformation concentration could be avoided. In an example shown in Fig. 2, the upper limit ratio is shown using the line of alternating long and short dashes. ■

Fig. 1 Comparison of Inter-story Drift Angle between Steel Frames with Braces and Pure Rigid Frames

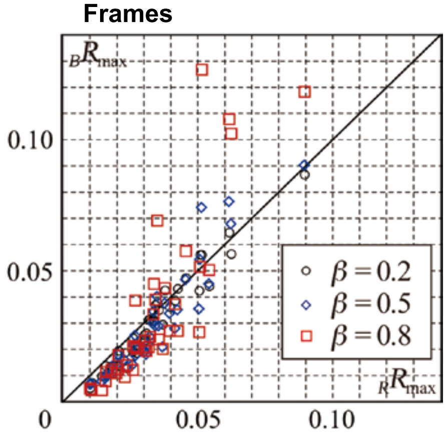
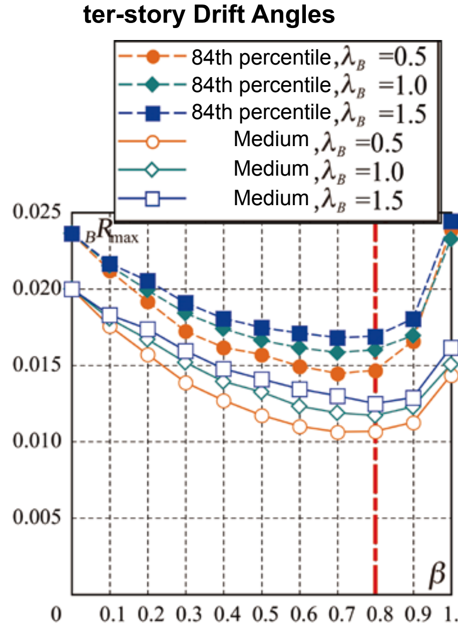


Fig.2 Maximum Value of Maximum Inter-story Drift Angles



Plastic Deformation Capacity of and Fracture Prevention Design Method for Welded Moment Connections Strengthened by Thick Flanges

Prize winners: Keiichiro Suita, Professor, Kyoto University and five other members

Keiichiro Suita

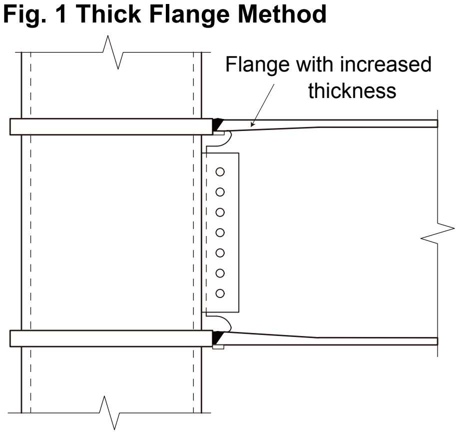
1988: Finished Ph.D. Course of Kyoto University
1988: Assistant Professor, Kyoto University
2001: Associate Professor, Kyoto University
2009: Professor, Kyoto University

With the aim of preventing the fracture of beam-end welded connections in steel moment structures and improving the plastic deformation capacity of welded connections, a new structural design approach was proposed in the current research. A key technology in this approach is to increase the flange thickness of the beam ends using as beam flanges steel products with varied thicknesses that are produced by a variable-roll rolling mill (Fig. 1).

In order to verify the high deformation capacity of beams with increased flange thickness, the material properties of steel products with varied thickness were confirmed using various testing methods; and, the performance of beams with increased flange thickness was compared to the performance of beams with equal sections and increased widths using full-scale specimens of T-shaped welded beam-to-column connections (Photo 1). Further, stress concentration at the toe of weld access hole was analyzed using the finite element method in order to propose a method to determine the most effective shape and dimensions for increased thickness flanges in order to prevent fracturing.

The proposed design approach is effective in improving the plastic deformation capacity of welded connections, particularly those made during on-site welding where quality control over welded connections is difficult to implement and where the mechanical conditions affecting welded connections are difficult to control. ■

Fig. 1 Thick Flange Method



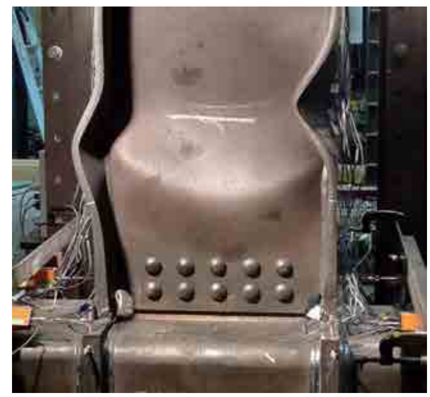


Photo 1 Specimen after testing

Proposal for a Method to Predict Volume Loss in Steel Members Using FSM Assisted by Static Electric Field Analysis

Prize winners: Mikihito Hirohata, Nagoya University, You-Chul Kim, Osaka University, and Chunfeng Jin, Osaka University

Mikihito Hirohata

2008: Finished Doctoral Course, Graduate School of Engineering, Osaka University
2008: Specially Appointed Assistant Professor, Joining and Welding Research Institute, Osaka University
2011: Assistant Professor, Graduate School of Engineering, Nagoya University

In the current research, a method was proposed that would predict corrosion-induced volume loss of steel products by means of FSM assisted by static electric field analysis.

In order to predict the volume loss of existing bridge members by means of FSM, it is necessary to understand the secular (age-related) change in the electric potential difference from the time of construction until the present. However, it is impossible to measure the secular change using the level existing, in sound condition, at the construction stage. To solve this problem, a parametric simulation that takes into account the various patterns of volume loss was conducted by means of electric field analysis to find the curve that accurately predicts volume loss.

An electrode and sensing pin to measure the electric potential difference were attached to the web of an H-section steel as shown in Fig. 1. The change in the electric potential difference thus measured was evaluated as a permillage of the initial electric potential difference (FC value). Volume loss was applied at random to the range encircled using the red line (250×40 mm) in Fig. 1. Meanwhile, prior to testing, an analysis was made using various volume loss patterns to find the curve that would predict the volume loss in the specimen. Fig. 2 shows the test and analytical results. The test results in the figure shown using the symbol are predicted with relatively high accuracy using the volume loss prediction curve found in the analysis. That is, the results thus obtained suggest the validity of the method for predicting volume loss, as proposed in the current research. ■

Fig.1 H-section Steel Specimen (300×300×10×15 mm, 650 mm in length)

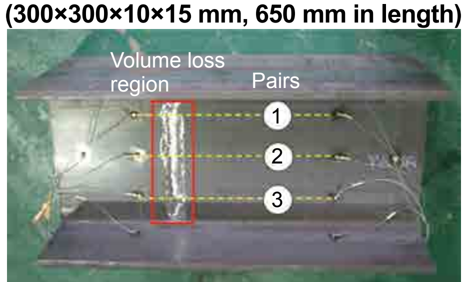
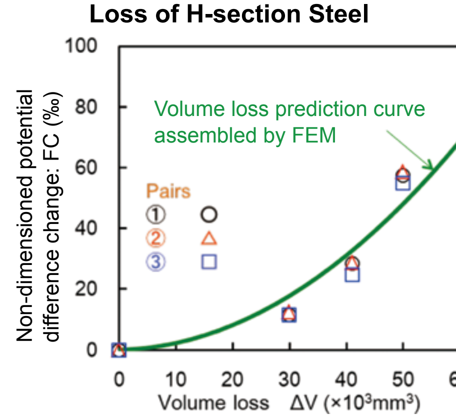


Fig. 2 Prediction Results of Volume Loss of H-section Steel



Three years have passed since the Great East Japan Earthquake occurred, and now reconstruction is expected to be further accelerated in the disaster-stricken area. Given such a situation, the pressing task for Japan is to structure society so that it is safety conscious and protected from disaster. This will be done by fully absorbing the lessons taught by the serious human and physical damages inflicted mainly by the tsunamis generated by the earthquake.

Triggered by this movement, Issue No. 41 features the latest attempts to prepare for the future, specifically measures to handle giant tsunamis employing steel structures.

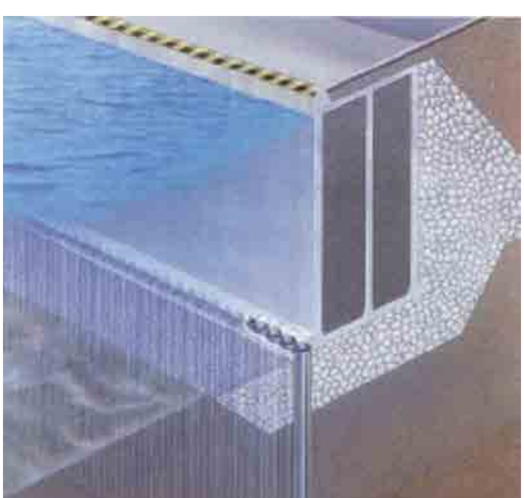
Steel-structure Technologies and Methods Used as Tsunami Countermeasures

by Takeshi Mochizuki, Chairman of the Committee on Civil Engineering, the Japan Iron and Steel Federation; Kazuyoshi Fujisawa, Chairman of the Committee on Building Construction, the Japan Iron and Steel Federation

Steel-structure Technologies and Methods Conducive to Preventing and Controlling Tsunami Damage

In response to the Great East Japan Earthquake of March 2011, the Japan Iron and Steel Federation prepared proposals designed to "make social infrastructure highly resistant to disaster" by maximizing the use of steel structures. The primary aim is to enable the quick recovery and reconstruction of disaster-stricken areas and to improve the disaster-prevention capacity of Japan. Among the many proposals are steel-structure technologies and methods that enhance the prevention and control of damage caused by tsunamis. These proposals are introduced below.

Fig. 1 Reinforcement Method for Existing Caisson Quay by Use of Steel Pipe Sheet Piles or Steel Pipe Piles



Reinforcement Method for Existing Caisson Quays (Revetments) Using Steel Pipe Sheet Piles or Steel Pipe Piles

Fig. 1 shows an image of a method to reinforce existing caisson quays (revetments) that not only improves seismic resistance but also prevents scouring of the caisson foundations. Caused by tsunami backwash, scouring can be prevented by installing embedded steel pipe sheet piles in front of the existing caisson quays (revetments). Also, steel pipe piles can be substituted as the reinforcing members in place of steel pipe sheet piles.

In addition, in cases where this method is expected to provide reinforcement mainly against the leading wave of a tsunami, another variation is feasible in which the steel products are aligned at the rear of the caissons.

Reinforcement Method for Revetments Using Steel Pipe Sheet Piles

Fig. 2 shows a revetment reinforcement method using steel pipe sheet piles. This method not only raises the crest height of the revetment but also imparts the structural tenacity against tsunamis to the revetment by installing to the rear of the revetment a new parapet that is supported by steel pipe sheet piles while at the same time utilizing the existing high-tide embankment.

Two features should be noted about the construction of new tsunami high-tide embankments. First, because there is no need for large-scale remodeling of the existing revetment, the reinforcement work can be completed more quickly. Second, the reinforcement work can be carried out even in narrow sites with limited workspace.

Fig. 2 Reinforcement Method for Revetment by Use of Steel Pipe Sheet Piles

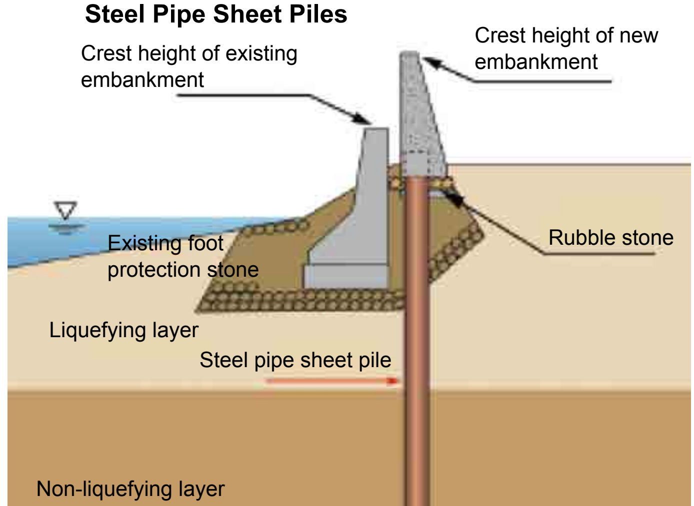
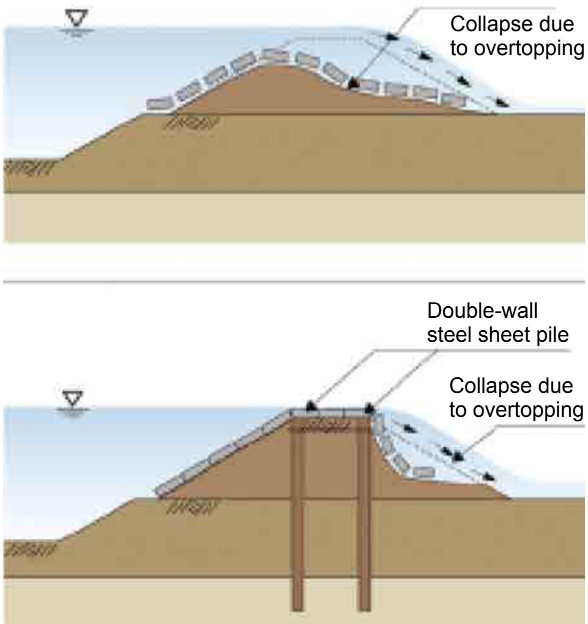


Fig. 3 Effect of Double-wall Steel Sheet Pile on Countermeasure against Overtopping



Countermeasure against Overtopping Using Double-wall Steel Sheet Piles

Fig. 3 shows the effects of reinforcement that uses double-wall steel sheet piles to prevent embankment collapse due to overtopping during the high water stage of tsunamis.

Among the features of this method are high seismic resistance (ground liquefaction resistance) provided by the installation of double-wall steel sheet piles inside the embankment; and retention of the embankment height to prevent inundation even when the embankment slope might be broken due to overtopping.

A New Structural System for Building Construction

"New Structural System Buildings Employing Innovative Structural Materials" is a joint government-private sector R&D project. Specifically, buildings using this new structural system can withstand great earthquakes with a seismic intensity level of 7 and are constructed using both 780 N/mm^2-grade high-strength steel (H-SA700) and energy dissipative system.

Capitalizing on further conceptual enhancement of buildings using this new structural system, it will be feasible to construct raised street areas and multi-storied industrial facilities that can fend off the wave forces produced by tsunamis and floods, as seen in Fig. 4[1)].

Fig. 4 Examples of Buildings Constructed Using "New Structural System Buildings Employing Innovative Structural Materials"

Proto-type model of distribution center

Proto-type model of regional base

Proto-type model of dense urban area

Steel-structure Building for Use as a Disaster Emergency Base

Fig. 5 shows a steel-structure building that is used as a disaster emergency base. It has a pilotis structure that is highly resistant to earthquakes and tsunamis, is useful for multiple purposes, and can serve as a regional symbol.

The building employs a pilotis structure that has a height greater than the assumed tsunami height and uses high-strength, high-rigidity concrete filled steel tubes (CFT) that enhance the building's safety against tsunamis. It also adopts an energy dissipative system that uses buckling-restrained braces for the upper building section, thereby improving seismic resistance. In addition, the adoption of a large-span structure offers flexible space, which allows for multi-purpose use in an emergency.

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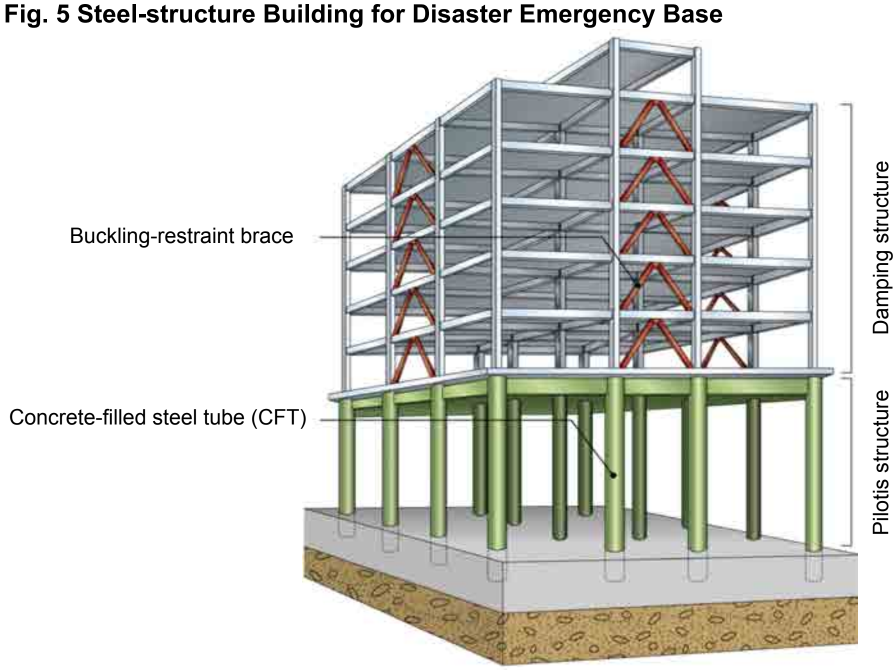
The technologies and methods that were developed in Japan and introduced above are expected to contribute to the security and safety of people living in Pacific-rim nations. ■

Fig. 5 Steel-structure Building for Disaster Emergency Base



Reference

1) New Structural System Buildings Employing Innovative Structural Materials—Proposal to Use These Buildings for Restoration and Reconstruction, Steel Construction Today & Tomorrow No.35 March 2013, pp.15-16.

Vertically Telescopic Breakwater—the World's First Prototype

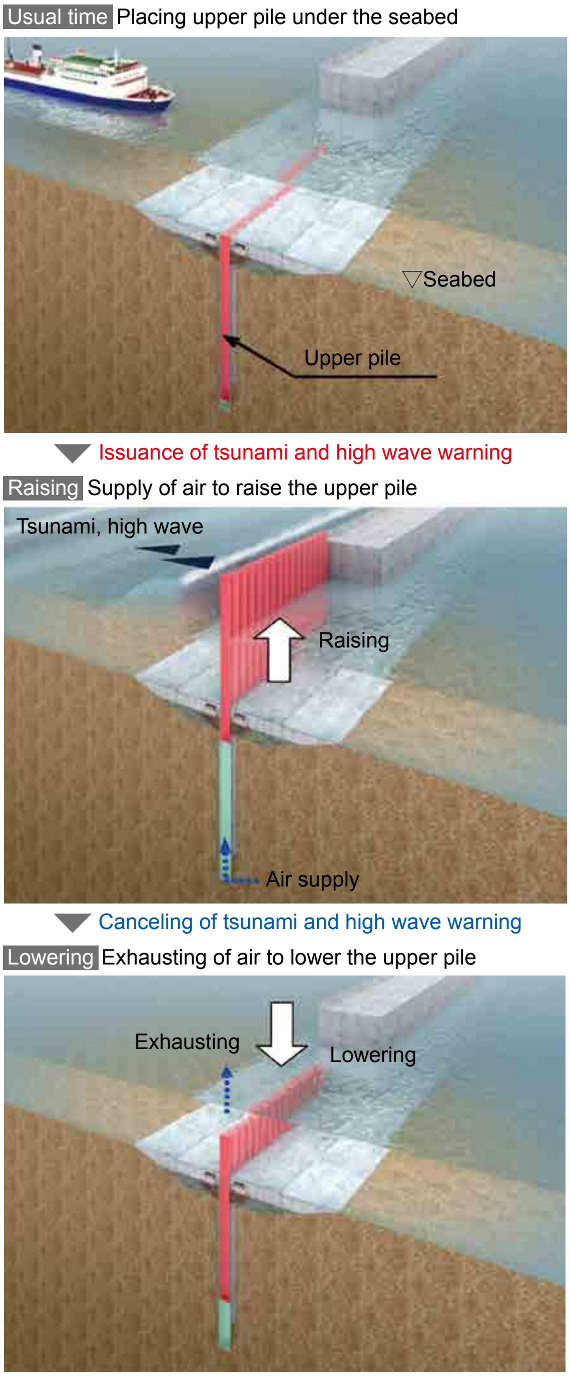
by Makoto Kobayashi, Obayashi Corporation; Taro Arikawa, Port and Airport Research Institute; Kazuyoshi Kihara, Mitsubishi Heavy Industries Bridge & Steel Structure Engineering Co., Ltd.; Hiroshi Inoue, Toa Corporation; and Hirotsugu Kasahara, Nippon Steel & Sumikin Engineering Co., Ltd.

The vertically telescopic breakwater (buoyancy-driven vertical piling breakwater; hereafter abbreviated as VTB) is a movable breakwater based on a new concept. It consists of upper and lower steel pipe piles arranged in multiple rows and is usually placed under the seafloor coinciding with ship navigation lanes. In times of emergency, such as for tsunamis and high waves, the upper piles are made to float in order to protect the various facilities located inside ports and harbors (Fig. 1).

It has been confirmed that in the Great East Japan Earthquake that occurred on March 11, 2011, conventional-type breakwaters contributed to the mitigation of tsunami damage. If the VTB is applied, not only this breakwater will pose no threat to ship navigation, it will also provide a means to prevent flowing-in of tsunamis through navigation routes.

The following introduces an outline of the VTB and the hydraulic model tests and field tests that were conducted to examine and verify key technological factors.

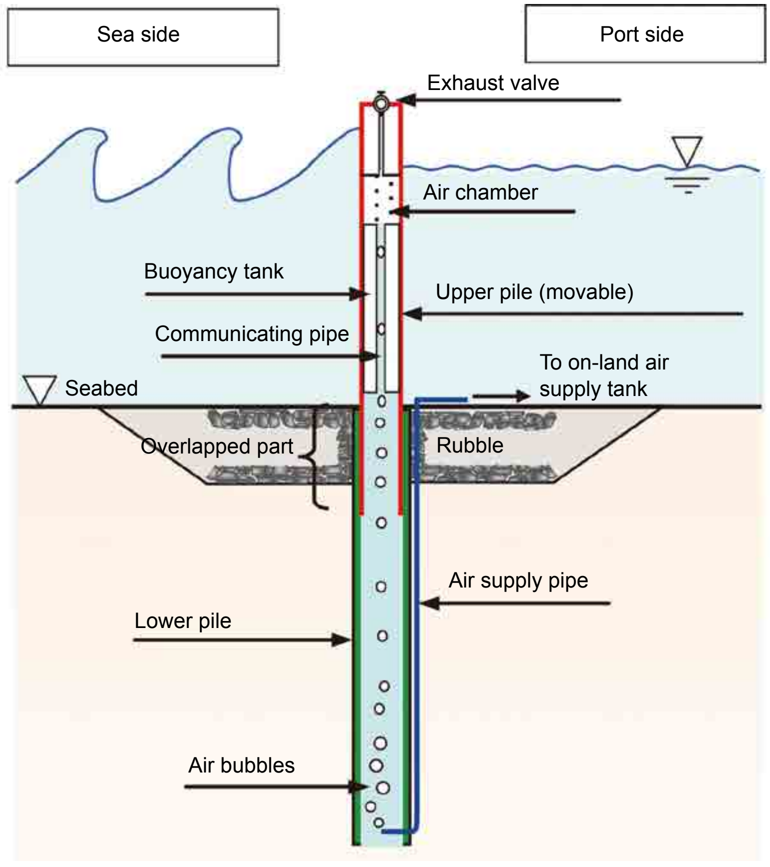
Fig. 1 Image Drawing of VTB



Structural Outline and Raising Mechanism

The new breakwater is composed of a sheathing structure in which the upper piles are inserted into the lower piles (Fig. 2). The upper piles are raised by filling them with compressed air and are lowered by releasing the air through exhaust valves. Both operations are executed by a remote control system. Transfer of horizontal forces (wave force, etc) takes place in the part where the upper and lower piles overlap.

Fig. 2 Schematic Drawing of VTB



Hydraulic Model Test

The effect of the breakwater on stopping a tsunami was confirmed by means of a hydraulic model test. The test was conducted at a Large Hydro-Geo Flume (length 184 m, depth 12 m, width 3.5 m) at the Port and Airport Research Institute by installing a breakwater model on a scale of 1/5. Photo 1 shows the test conditions.

The test results show a transmission coefficient of 0.25~0.3, confirming that the breakwater offers sufficient effectiveness in stopping a tsunami.

Field Test

The field test was conducted at Numazu Port in Shizuoka Prefecture during the period from September 2006 to May 2009. The test specimen was a one-set specimen composed of an upper pile (1.422 m in diameter, 14.75 m in length) and a lower pile (1.600 m in diameter, 16.75 m in length). Two piles (1.422 m in diameter), which were fixed to the seafloor, were installed at both sides of the specimen (Photo 2). The major test items and results are introduced below:

• Raising and Lowering Tests

Testing of the raising and lowering mechanisms was conducted by introducing air from the supply tank and draining it through the exhaust valves. Raising was completed in 200 seconds after the supply of air began. While the raising and lowering operations were repeated 100 times, the raising and lowering conditions remained stable, thereby confirming the reliability of the air supply system.

• Wave Response Tests

These tests were conducted with the upper pile fully floated in order to clarify the breakwater's response to waves. The result confirmed that the breakwater's response could be forecasted by means of oscillation analysis using the upper pile as the floating structure.

• Surveying the Marine Growth and Steel Pile Corrosion

The upper pile was re-raised after 1 year installation. It was confirmed that the surface of the upper pile was free of any marine growth and free of any significant corrosion (Photo 3). This fact seems to attribute to an environment of extremely low light and negligible residual oxygen inside the lower pile in which the upper pile was encased.

Disaster-prevention Plan Employing the VTB

A structural outline of the VTB, its protection effect on waves, and verification of its raising and lowering systems was introduced above.

In Japan, two great earthquakes are forecasted to occur in the Nankai and Tonankai areas in the near future. In Wakayama-Shimotsu Port where great tsunami damage is predicted as a result from these earthquakes, a tsunami disaster-prevention plan is being promoted that applies a VTB. ■

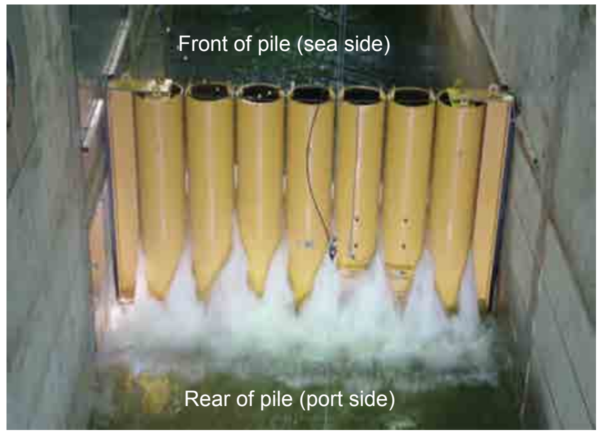
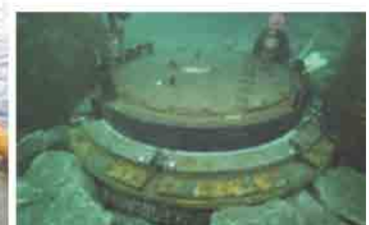


Photo 1 Hydraulic model test

Photo 2 Field test



Encasing of pile

Surface of upper pile after raising (thickness of marine growth: negligible)

Marine growth of neighboring fixed pile (thickness of marine growth: 10 cm)

Photo 3 Survey of marine growth

Flap Gate Tsunami Breakwater: Tsunami Disaster Prevention/Mitigation Facility

by Kyoichi Nakayasu, Hitachi Zosen Corporation

At 14:46 on March 11, 2011, Japan was rocked by the Great East Japan Earthquake with its epicenter located off the coast of Miyagi Prefecture. The great tsunamis caused by this earthquake wreaked serious devastation over a wide area along the Pacific coast, ranging from Hokkaido and Tohoku to Kanto. In spite of the fact that the quake occurred during the daytime and that there was a comparatively long time to escape before the first tsunami arrived, the initial delay in evacuation procedures due to confusion caused by the earthquake itself, normalcy bias, and poor communications resulted in an increase in the number of tsunami victims.

On the other hand, while recognizing the danger posed by tsunamis, many people still headed towards the sea in order to close the sluicegates and land locks. As a result, some of these people were engulfed by the tsunamis. A news release issued by the Cabinet Office on August 29, 2012, clearly states the nature of proper tsunami countermeasures: "Quick evacuation is the most important and effective countermeasure against tsunamis" and "Every tsunami countermeasure should be designed as a means of supporting quick evacuation." These two statements indicate the future direction of tsunami disaster prevention and disaster mitigation facility.

The flap gate tsunami breakwater (flap gate-type tsunami disaster prevention and disaster mitigation facility) not only reflects movement in the above-mentioned direction, but it also demonstrates reliable functionality in an emergency, poses less of an obstacle in daily life, and reduces maintenance efforts to a minimum. The following feature presentation introduces the expected application effects and the latest developments in the flap gate tsunami breakwaters.

Outline of the Flap Gate Tsunami Breakwater

The flap gate tsunami breakwater is a cutoff equipment that needs neither external power nor manual operation and represents a fusion of the raise-type gate, with many river installation records, and the flap gate. The conventional flap gate features a hinge that is installed in the upper section of the flap (Fig. 1), and the gate automatically opens and closes in response to differences in water level in front of and behind the flap gate. Meanwhile, the raise-type gate has a hinge installed in the lower section of the gate (Fig. 2) and controls the water flow by changing the angle of the gate by means of a driving device. In the flap gate tsunami breakwater, the center of rotation is located in the lower section of the gate as in the raise-type gate. And, as with the conventional flap gate in response to tsunamis, high tides and floods, the flap gate on the tsunami breakwater rises and falls down employing the difference in water level in front of and behind the gate.

Application of Tsunami Breakwaters

• Structural Outline

Fig. 3 shows an image of installed flap gate tsunami breakwater. It is composed of three main members: the gate leaf, the box structure that houses gate leaves, and the tension rods that transfer the load working on the upper section of the gate leaf to the box structure when the gate is rising.

The gate leaves are linearly arranged across the opening of a port and form a continuous breakwater; they rise, fall down and revolve around a rotating axis located in the bottom section of the structure.

The buoyancy required to lift the gate is

Fig. 1 Outline of Flap Gate

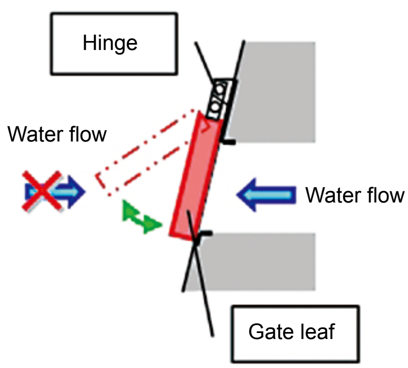


Fig. 2 Outline of Raise-type Gate

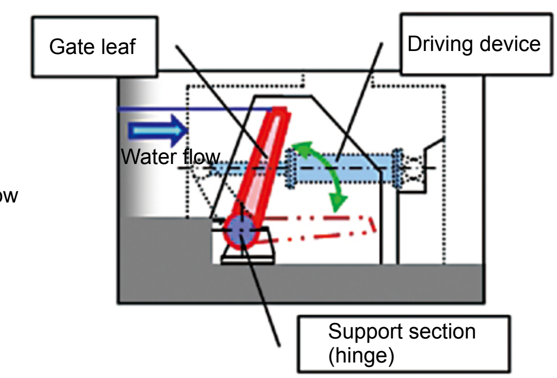
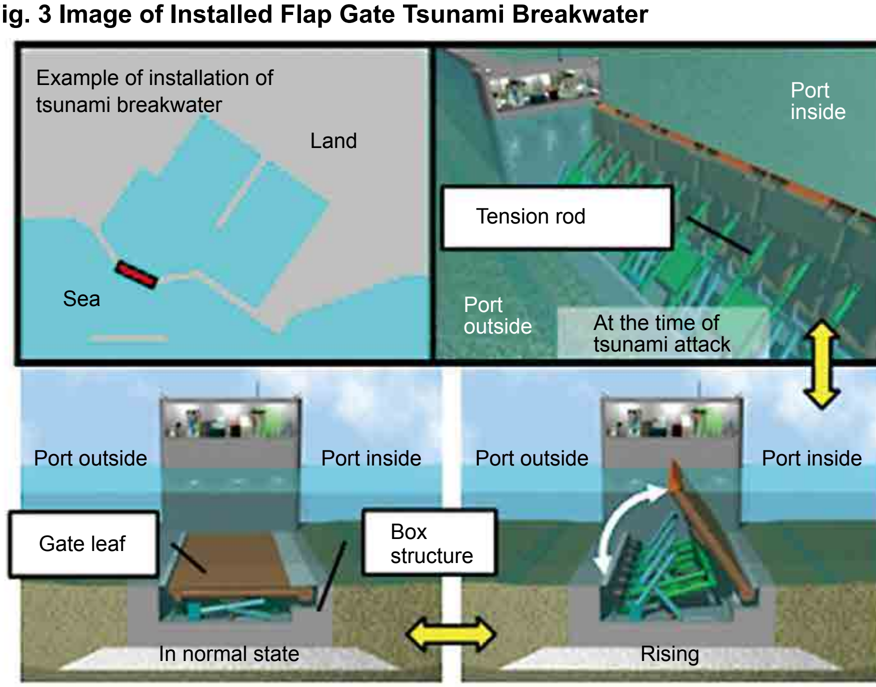


Fig. 3 Image of Installed Flap Gate Tsunami Breakwater



secured by a supply of air to the gate leaf's air chamber in normal time. Under normal conditions, the end of the gate leaf is moored using a hook installed on the box structure to prevent the gate from floating. When a tsunami is forecasted, the mooring hook is released and the gate leaves rise by means of its own buoyancy to the surface of the water. Then, as the tsunami arrives, the gate rises with no need for power and by the use of a difference in water level due to the rise of tidal level created by tsunamis until it reaches the specified angle.

The load working on the gate is transferred to the foundation of the box structure via tension rods and the rotating axis in the bottom section of the gate. This gives stability to the flap gate tsunami breakwater by establishing friction resistance between the box structure and the rubble mound.

• Features and Expected Application Effects

The flap gate tsunami breakwater exhibits these features: "The disaster protection area is wide because of its installation outside existing seawalls"; "The buoyancy required to rise the gate is supplied under normal conditions"; and "Tsunami wave force does not block the flap gate closing". To these ends, the following application effects can be expected:

♦ Even when attacked by the largest tsunamis, the time before inundation begins can be delayed, thereby extending the evacuation time.

♦ Because large-scale mechanical devices are not required, construction costs can be suppressed, and the maintenance burden is reduced.

♦ It is also possible to automatically close waterways employing only the rising water level of tsunamis, and the breakwater clearly demonstrates its functionality during disasters that damage the communications infrastructure.

• Latest Developments

Development of the flap gate tsunami breakwater started in 2003. And then the breakwater's basic performance was examined and improved by means of various tests, with the laboratory tests required for practical application being nearly complete by 2009. From 2010 to 2012, the basic function and reliability of the breakwater were verified jointly by Hitachi Zosen, Toyo Construction and Penta Ocean Construction by means of practical sea area tests.

Photo 1 shows the practical sea area tests. The tests were conducted at the Yaizu Fishing Port, Shizuoka Prefecture, with the aim of confirming the reliability of the rising and falling-down operations, stability of the gate when fallen down, and the reliability of the maintenance and safety.

The device used for the tests was installed in February 2011, and for about 2 years up to March, 2013, tests were conducted that included 151 floatation/falling-down operations and 14 months of observation with the gate in the fallen-down position. The tests confirmed that there are no problems with the reliability of the breakwater's movement or its stability in the fallen-down state. In addition, during the test period, equipment conditions were constantly monitored to accumulate various operational data. At the same time, periodic observations and parts exchanges were conducted by divers to confirm the stability and safety of underwater operations. Meanwhile, the test results were publicly announced by the three companies in October 2013. For more details, please go to: http://www.hitachizosen.co.jp/products/products026.html

Photo 1 Installation of testing device at practical sea area

Application of the Land Lock

• Latest Developments

Photo 2 shows the condition to confirm the gate movement due to water flow when the flap gate tsunami breakwater is applied in the flap gate of land lock type. Development of the flap gate of land lock type started in 2009, and research efforts were directed toward the prevention of rapid rising and falling-down of the gate and the retention of gate strength and rigidity against passing vehicles.

In 2011, the durability of the gate was confirmed in practical field application using verification testing devices, and the operating conditions were confirmed using a water flow generation tank. In May 2013, the first practical flap gate of land lock type with an improved architectural design was installed.

Photo 2 Confirmation of flap gate movement due to water flow (applied as land lock)

• Expected Application Effects

The operating mechanism of the flap gate of land lock type is similar to that of the flap gate tsunami breakwater. Because the gate automatically rises with inundation, the following application effects can be expected:

♦ Because there is no need for gate operation, evacuation activities will not be inhibited.

♦ Even if a power supply infrastructure and a telecom infrastructure suffer serious damage, the flap gate of land lock type can surely demonstrate its function.

♦ Because the gate can be opened at any time, its effect on daily life is less, and in an emergency, the lock gate can be used as an evacuation route.

♦ Because of the gate's simple mechanical composition, trouble is not likely to occur; and because of the ease of maintenance, the maintenance burden is lessened.

Promising Application of Flap Gate

A notable feature of the flap gate tsunami breakwater (flap gate-type tsunami disaster prevention and mitigation facility) is that the breakwater can be operated using the natural forces, an outline of which was reported above. While tsunami disasters cannot completely be prevented using only the flap gate tsunami breakwater, we will be glad if this flap gate could provide even limited help in structuring a safe society. ■

Tsunami Evacuation Measures that Match Local Characteristics

by Mitsuo Seki, Takenaka Corporation

Initiatives to Build Tsunami Disaster-prevention Districts

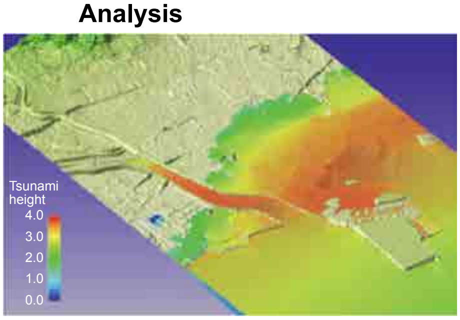
The huge tsunamis caused by the Great East Japan Earthquake were disastrous to coastal areas and claimed the lives of many people. Currently, initiatives are being called for that promote the creation of tsunami-prevention districts by means of multifaceted protection systems that combine the use of both software and hardware.

Capitalizing on high-precision simulation technology and rich experience in the construction of disaster-prevention facilities, Takenaka Corporation is undertaking the creation of a disaster-prevention district that accurately matches local characteristics.

Plan to Build a Tsunami Evacuation District

The characteristics of a tsunami are greatly affected by the local topography and local river/urban area conditions. Accordingly, when planning a tsunami evacuation district, it is important to properly assign the functions of the evacuation facility to the multiple levels by relying on a tsunami run-up analysis and an evacuation simulations, based on detailed topographical and other conditions of the urban area (Fig. 1).

Fig. 1 Example of Tsunami Run-up Analysis



Function and Arrangement of Tsunami Evacuation Facilities

The tsunami evacuation facilities can be organized into 3 levels and arranged as shown in Fig. 2.

• Level 1 Tsunami Evacuation Facility

Vulnerable pedestrians should be able to reach a Level 1 facility within 15~20 minutes after evacuation begins, and the facility should be able to provide minimum life support functions until relief arrives.

• Level 2 Tsunami Evacuation Facility

A Level 2 facility should be able to offer life support functions for a minimum of 3 days and, with relief support, be able to provide evacuees with safe living conditions for about 1 month.

• Level 3 Tsunami Evacuation Facility

A Level 3 facility would be responsible for covering a wider disaster-stricken area, would have its own power source, maintain communications functions, and offer emergency medical treatment capabilities. Further, it would serve as a branch office of the local administration.

Plans for a Tsunami Evacuation Facility

The general plans for a Level 2 tsunami evacuation facility are introduced below (Photo 1):

• High Resistance to Seismic and Tsunami Forces

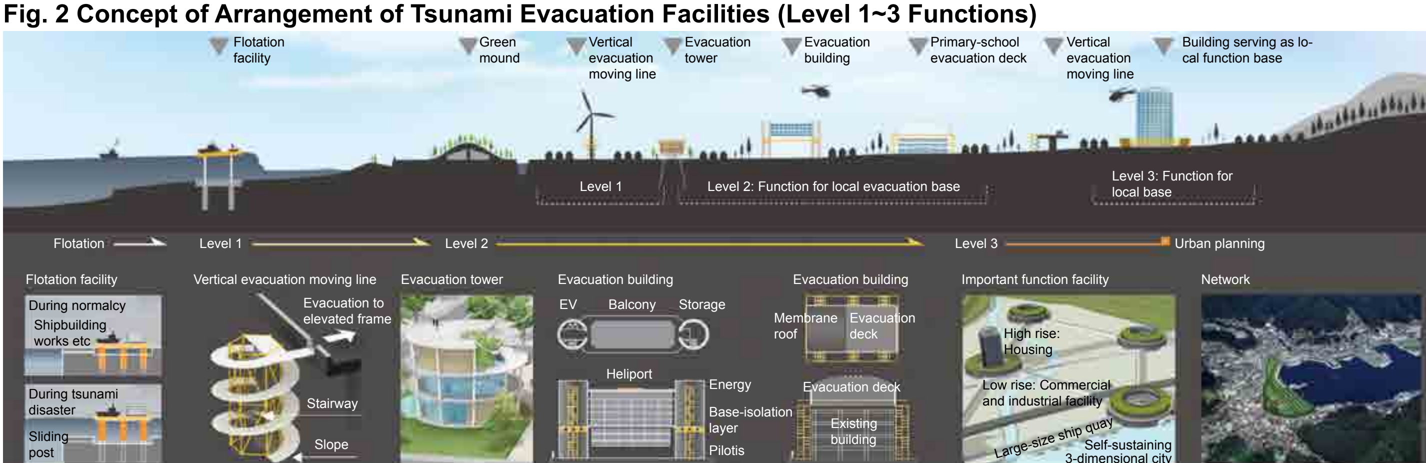
The facility would adopt an intermediate-story base-isolation structure with the base-isolation layer located at a height greater than that of the assumed tsunami height. Circular RC cores capable of fending off wave forces would be arranged on both sides of the facility. Further, the center section of the facility would be a suspension structure employing a high-strength steel frame.

• Local Disaster-prevention Base

The facility would be a self-sustaining structure during the period from normalcy through the disaster stage and then through reconstruction and would allow multiple uses. It would include a warehouse for disaster-protection equipment and goods, securely maintain energy supply and communications functions, and show the networks for evacuation routes. ■

Photo 1 Appearance of tsunami evacuation building

Fig. 2 Concept of Arrangement of Tsunami Evacuation Facilities (Level 1~3 Functions)



Measures for Handling Sliding post Tsunamis

Tsunami Evacuation Building: Arch Shelter

by Yasushi Watanabe, Shimizu Corporation

Media pictures clearly depict the destructive and unparalleled power of the tsunamis caused by the Great East Japan Earthquake of March 11, 2011. As a solution for handling the force of tsunamis, we introduce a tsunami evacuation building designed to withstand the external forces produced by a 20 m-high tsunami.

Building Outline

- No. of stories: B0-7F-P1
- Structure: Arch wall of RC construction; Inner building of steel construction (mid-story isolation structure)
- Building area: 1,450 m^2
- Total floor area: Arch wall 3,631 m^2; Inner building 6,019 m^2
- Building height: About 34 m

(Photo 1)

The building is expected to offer a solution for enterprises around the nation that have a plan of operation in coastal areas and for local governments in urban coastal areas where moving to high ground is difficult.

Photo 1 Perspective view of appearance of Arch Shelter

Structural Outline

The first-floor section of the building, excluding the core sections provided on both sides, is of the pilotis type. When a tsunami strikes the building, the seawater will pass through the pilotis section, thereby mitigating the tsunami's force (Figs. 1 and 2).

In order to effectively resist the external force applied by a tsunami, the building adopts a floor planning with oval-shaped peripheral arch wall as used for arch dams. Outside the building periphery, there is a curved RC wall structure with attached fin that serves as both a balcony and an evacuation passage. The inner building has the steel-structure with mid-story isolation layer between the first and second floors. The foundation structure employs both a mat slab and a pile foundation to resist buoyancy during a tsunami attack.

Fig. 1 Composition of Structure

Hybrid structure that resists tsunami wave and adopts mid-story isolation system

Arch Shelter is composed of a dual structure: The oval-shaped arch wall resistant to 20 m-high tsunami external force is provided in the outside of the building, and in the inside the inner building having mid-story isolation function is installed. It can simultaneously resist tsunami external force and seismic force.

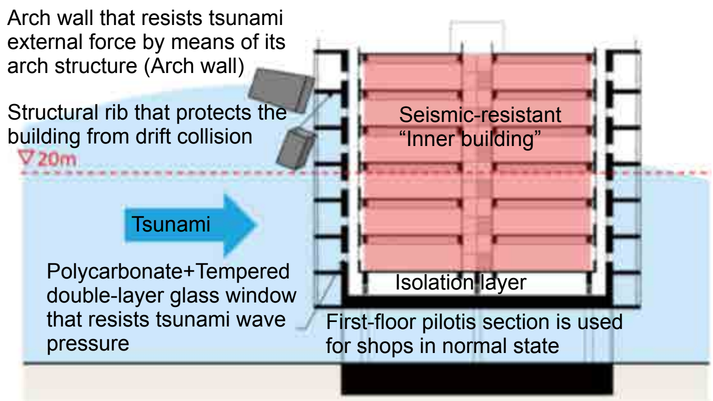
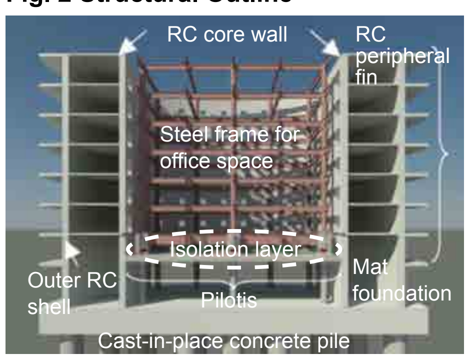


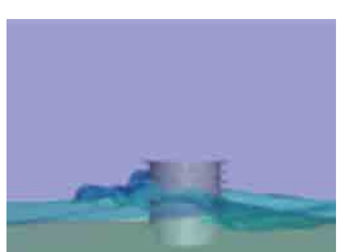
Fig. 2 Structural Outline



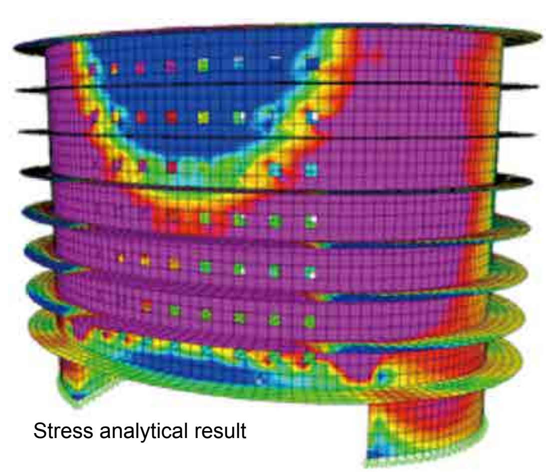
Structural Examination

With an assumed tsunami height of 20 m, the hydraulic pressure and the buoyancy working on the building were calculated using a hydraulic test and a volume of fluid (VOF) analysis. The results of these calculations were applied in the structural examination of the tsunami evacuation building (Photo 2). Both the upper structure and the foundation were designed so that the strength of the members would exceed the working stress. ■

Hydraulic test



VOF analytical result



Stress analytical result

Photo 2 Tests and analytical results

Building for Use as a Tsunami Countermeasure: T-Buffer

by Masaaki Watanabe, Taisei Corporation

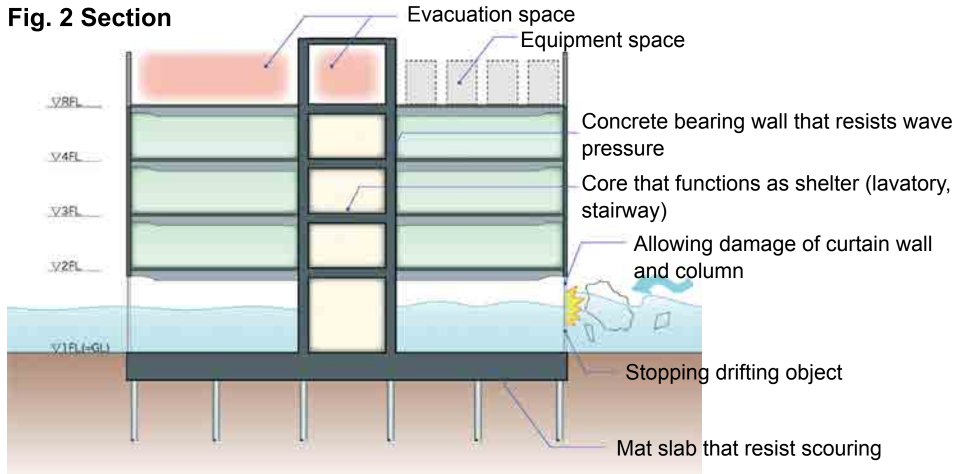
The "T-Buffer" is a new type of building used as a tsunami countermeasure. Although it is expected to serve as an ordinary office building during normal times, it always retains its functionality as an evacuation center during a tsunami emergency. A major feature of the building plan is the built-in structural redundancy against collisions with drifting objects, in addition to the wave pressure caused by tsunamis, by allowing partial damage to the columns. (See Photo 1)

Photo 1 Perspective view of appearance

Structural Outline

The main structural feature of a T-Buffer building is that the core bearing wall located at the center of the building bears the vertical load and the seismic/tsunami loads, and that the peripheral columns of the first floor support only the building's exterior members but do not bear the vertical load of the building itself.

Fig. 2 Section



The peripheral columns serve as buffers that resist the wave pressure of tsunamis and the collision force of drifting objects. This prevents fatal damage to the bearing wall and as a result allows for the quick recovery of building functions after a tsunami attack. Even if the first-floor peripheral columns are by any chance damaged by wave pressure or collisions with drifting objects, the building is constructed so that the vertical load is borne by both the belt trusses that are located in the peripheral sections of the upper floors and the suspension members that are located in the top-most floor to support the entire building structure.

A piling foundation is adopted for the foundation, in conjunction with a mat slab in order to resist scouring.(Refer to Figs. 1~3)

Protection of Human Life and Buildings from Tsunamis

The first-story height is determined so that it surpasses the design inundation height. However, even in cases when the tsunami height surpasses the height of the first story, the design approach used for first story is also adopted for the second and higher stories, thereby allowing the building to cope with tsunamis of any height. Furthermore, in a T-Buffer building, waterproof doors are adopted for the wall openings in order to offer evacuation passageways to the upper floors and to allow the building to serve as an evacuation shelter. These design approaches create a suitable "building for use as a tsunami countermeasure" that can protect both human life and building functionality from tsunamis. ■

Fig. 1 Structural Model

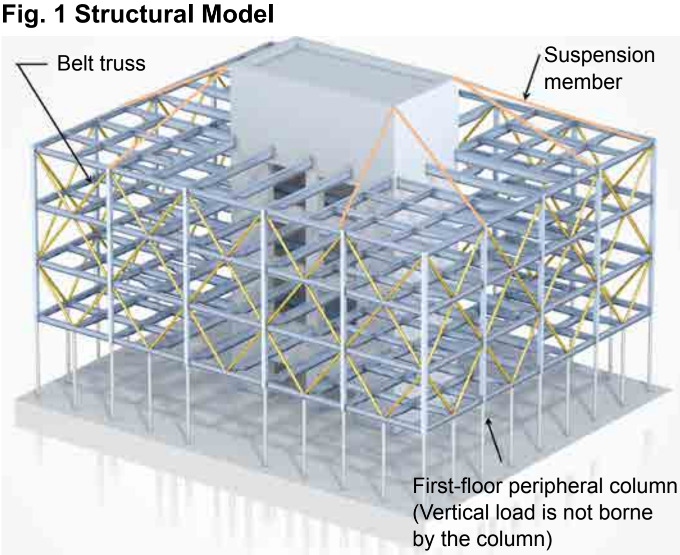
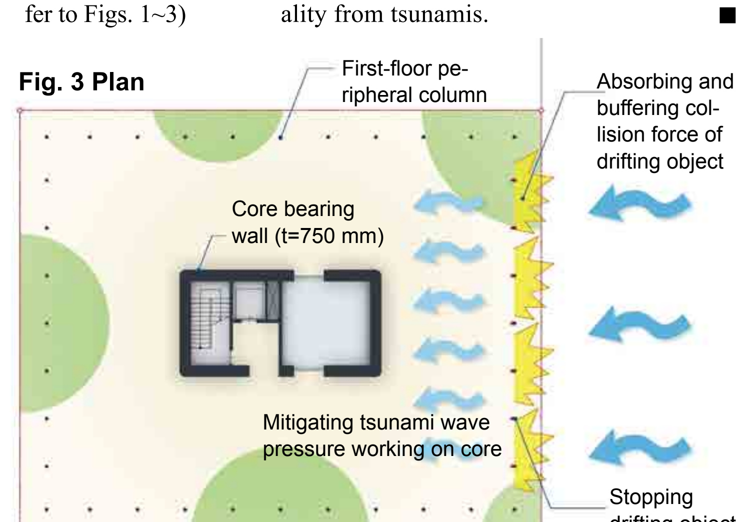


Fig. 3 Plan



Measures for Handling Giant Tsunamis

Structural Design Method for Tsunami Evacuation Buildings

by Tomokazu Tateno, Kajima Corporation

The disastrous Great East Japan Earthquake that occurred on March 11, 2011 caused serious damage in the Tohoku to Kanto areas. The dead and missing numbered more than 20,000, and more than 100,000 buildings collapsed or were washed away. Most of the damage was caused by tsunamis.

There is a growing call for tsunami evacuation buildings to be specified as emergency evacuation sites in areas where it is difficult for residents to move to high ground before a tsunami arrives. For that purpose, it is necessary to confirm the structural safety of such tsunami evacuation buildings.

In the building standards improvement project promoted by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) for 2011, specific proposals concerning design tsunami load were made based on the results of damage surveys conducted in the disaster-stricken areas of the Great East Japan Earthquake[1]. The results of these surveys are reflected in the temporary guidelines (MLIT, Nov. 17, 2011) concerning the structural requirements for tsunami evacuation and other buildings.

In the following, an outline of the structural design method for tsunami evacuation buildings shown in the temporary guidelines is introduced.

Structural Design Method for Tsunami Evacuation Buildings

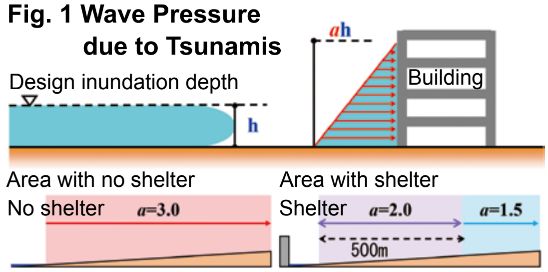
• Confirmation of Application Ranges

The primary condition for a tsunami evacuation building is that its seismic resistance be in conformance with the Building Standard Law for newly built buildings and that it be adaptable to the Seismic Resistance Diagnosis Standards for existing buildings.

• Calculation of Tsunami Wave Force

Next, the tsunami wave force is calculated. Fig. 1 shows the tsunami wave pressure shown in the temporary guidelines. The wave pressure when a tsunami with a design inundation depth h collides with a building is equivalent to the hydrostatic pressure a times the design inundation depth h. While this equation is set in reference to the hydraulic model test results by Asakura et.al[2], it is also known, as a result of disaster surveys of the Great East Japan Earthquake, that the disaster level differs depending on local conditions.

Fig. 1 Wave Pressure due to Tsunamis



The wave pressure explained above is incorporated as the water depth coefficient a in the temporary guidelines. Fig. 1 shows the coefficient depending on local conditions.

• Calculation of Buoyancy

Photo 1 shows a hotel building, located in Onagawacho where an inundation depth of 15 m was observed, that was turned over at a point about 70 m from its original site. It is believed that the building was washed away and overturned by buoyancy that was caused by the horizontal force and rapid rise in water level caused by the tsunamis and, further, by ground liquefaction. In order to prevent this type of damage, it is necessary to conduct structural design with an appropriate reckoning of buoyancy.

• Design of Structural Frames and Examination of Sliding and Overturning

In the design of structural frames, it must be confirmed that the horizontal strength of a building is greater than the tsunami load. The horizontal strength is found by analyzing the load increments attributable to the wave pressure distribution of the tsunami load; and the buoyancy is taken into account in the analysis.

Further, the foundation is to be designed so that the building does not slide and overturn due to the tsunami load; and, depending on the situation, piles are to be used in the foundation. In addition, due consideration must be paid in the design to the inclination (Photo 2) and to drifting objects.

Promotion of Joint Research

An outline of the structural design method for tsunami evacuation buildings has been introduced above. An instruction manual and design examples are available at the website of the Japan Building Disaster Prevention Association[3].

At Kajima Corporation, joint research is underway between Kajima and the Institute of Industrial Science of the University of Tokyo, in support of improving the building standards. The specific programs being promoted using hydraulic model tests and simulation are: to confirm the mitigating effect that providing openings has on tsunami wave force; and to examine the buoyancy generation mechanism, both of which aim at pinning down the design tsunami wave load. ■

Photo 1 Overturned and washed away building

Photo 2 Inclined building

References

1)Institute of Industrial Science, the University of Tokyo: Building Standard Improvement Promotion Project for 2011 (40. Examination Conducive to Improving Building Standards in Tsunami Dangerous Areas, March 2011

2)Asakura et al: Experimental Research on Wave Force of Tsunami Overtopping the Revetment, Journal of Coastal Engineering, Vol. 47 (2000)

3)The Japan Building Disaster Prevention Association, http://www.kenchiku-bosai.or.jp/seismic/tsunami_text.html

10th Pacific Structural Steel Conference (PSSC 2013)

The Pacific Structural Steel Conference (PSSC) is an international conference sponsored by the steel construction-related organizations of 10 nations (the United States, Australia, Canada, China, Chile, Japan, Korea, Mexico, New Zealand and Singapore). Since the first session in 1983 in New Zealand, the participating nations have alternated in holding the conference every three years. The Tenth Pacific Structural Steel Conference was held for three days from October 9 to 11 in Sentosa, Singapore.

Opening ceremony at PSSC 2013

A scene of PSSC venue

At the tenth conference, about 300 individuals participated from all around the world—the European nations, India, South Africa and elsewhere—in addition to the usual 10 nations.

On the first day of the conference, 13 keynote lectures were delivered (Table 1), including an address by Prof. Masayoshi Nakashima of the Disaster Prevention Research Institute, Kyoto University, who represented Japan. Among the major themes of the keynote speeches were progressive collapse, Eurocodes, and the latest examples of construction in various nations.

On the second and third days, the sessions were divided into four groups, in which 270 theses were presented with active Q&A. A total of 48 theses were delivered from Japan, followed by 60 theses from China. These two nations accounted for about half of all the presentations (Fig. 1). When classified by field of specialization, 40 theses referred to seismic resistance, or 20% of the proceedings. Other prominent fields included structural design, new construction technologies, and joints (Fig. 2).

The next PSSC is scheduled to be held in 2016, with China as the host nation. China hosted a previous session in 2010. In total, China will have held three PSSC sessions, which strongly indicates the robust activities of that nation's construction industry, including steel construction. ■

Table 1 List of Keynote Lectures

1.How to Improve Resistance to Progressive Collapse When Designing Steel and Composite Buildings
Professor David A. Nethercot
2.Progressive Collapse Analysis of Buildings: The Middle-Way Approach
Professor Chan Ghee Koh
3.Needs of Physical Evidences for Advancement of Steel Research
Professor Masayoshi Nakashima
4.Main Issues on Seismic Resistance of Steel Frames Coupled with Concrete Core for Tall Buildings
Professor Guo-Qiang Li
5.Current Developments for International Steel Design Codes
Professor Reidar Bjorhovde
6.Second-Order Plastic Analysis of Steel Frames by a Single Element Per Member Allowing for Arbitrarily Located Plastic Hinge
Professor Siu-Lai Chan
7.Structural Design of Steel High-Rise Buildings in Korea
Jong-Ho Kim
8.Advancements and Achievements in Structural Steel in Australia
Professor Brian Uy
9.Deformation Characteristics of Shear Connections with Different Configurations Under Complex Loadings
Professor Kwok-Fai Chung
10.Impact of Structural Eurocodes on Steel and Composite Structures
Associate Professor Sing-Ping Chiew
11.Flower Dome and Cloud Forest Conservatories @ Gardens by the Bay
Allan Teo
12.Design of the Singapore National Stadium Roof and an Assessment of the Potential Benefits of High Strength Niobium Steels
Mike King

Fig. 1 Proceedings at PSSC 2013 by Country (Total Number: 194)

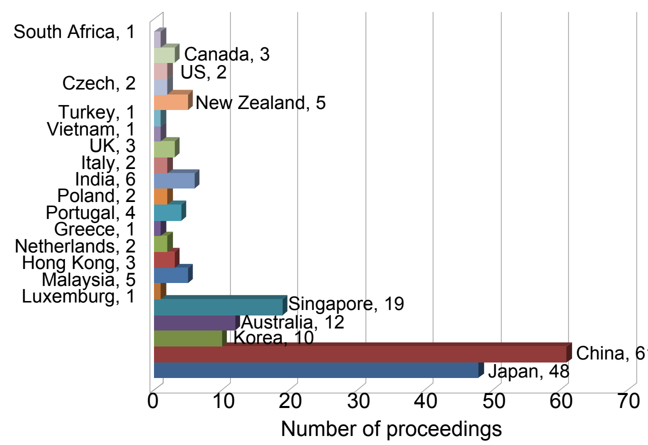
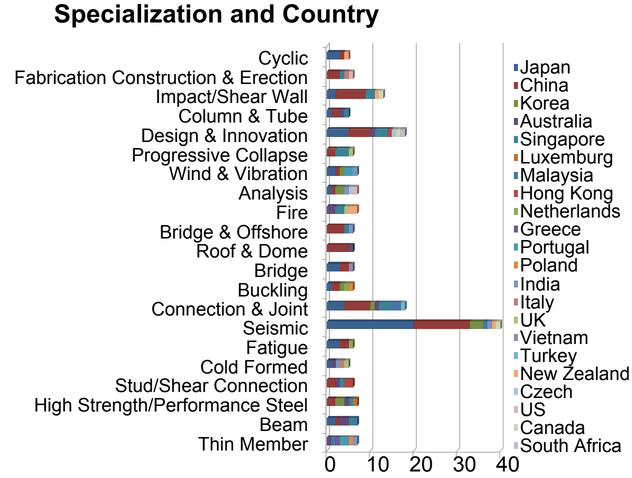


Fig. 2 Proceedings at PSSC 2013 by Field of Specialization and Country



JSSC Symposium 2013 on Structural Steel Construction

The Japanese Society of Steel Construction (JSSC) has annually held its Symposium on Structural Steel Construction since 2004. The major aim of this symposium is to comprehensively and functionally link the operating results of JSSC's various committees and working groups and to provide a venue for exchange between JSSC members and others working in the field of steel construction. The 2013 symposium was held November 14 to 15 in Tokyo.

The 2013 symposium offered the wide range of programs shown in the table below. Also, the works that received one of JSSC's commendation prizes for outstanding achievement were introduced in a panel exhibition. (See pages 1-6 for the prize-winning works).

Insofar more than 800 people participated in the two days of sessions, the symposium was clearly found to be a useful venue for exchanges between researchers and engineers working in steel construction and for collecting the latest information on steel construction. ■


Academy session on steel construction technologies


Session on international operations


Social gathering


Prize winners in JSSC's commendations for outstanding achievements

Programs and Sessions at the Symposium 2013

Novbember14, 2013

	General program		Academy session		
AM	Stainless Steel Session (Stainless Steel Technology and Standard Committee)			Load-bearing Capacity and Joints (Civil engineering)	Members (1) (Building construction)
PM	Engineering Session (Technology and Standard Committee)	Commendations for Outstanding Achievements Commendation ceremony Lecture by prize winners Special Lecture (Lecture by JSSC Prize winner)	Structural Analysis and Design (Building construction)	Corrosion/Corrosion Protection and Repair/Reinforcement (Civil engineering)	Members (2) (Building construction)
			Structural Analysis and Others (Civil engineering)	Measurement/Inspection/ Monitoring (Civil engineering and building construction)	Members (3) (Building construction)
	Social gathering				

November 15, 2013

AM		Materials (Building construction)	Vibration/Vibration Control/Seismic Resistance (Civil engineering)	Fatigue/Fracture (Civil engineering)
PM	Session on International Operations (Joint session: IABSE and JSSC)	Vibration/ Seismic Resistance (1) (Building construction)	Connections (1) (Building construction)	Maintenance/ Management (1) (Civil engineering)
		Vibration/ Seismic Resistance (2) (Building construction)	Connections (2) (Building construction)	Maintenance/ Management (2) (Civil engineering)

To Our Readers

Greeting from the Chairman of JSSC's International Committee

by Toshiyuki Sugiyama
Chairman, International Committee,
Japanese Society of Steel Construction
(Professor, Graduate School of Yamanashi University)

Starting with issue No. 26 of *Steel Construction Today & Tomorrow* published in 2009, our International Committee has been responsible for the editorial planning of one of the three issues published annually. Since its inauguration, the Japanese Society of Steel Construction (JSSC) has conducted wide-ranging activities in the form of surveys, research and technological development aimed at promoting the spread of steel construction and at improving associated technologies and, further, to extend cooperation to related organizations overseas.

Following the merger of JSSC with the Stainless Steel Building Association of Japan in 2010, JSSC's field of operation expanded to include not only carbon steel but also highly corrosion-resistant stainless steel. Consequently, we intend to actively transmit information throughout the world that is related to a wider range of steel construction areas.

As was true in issue No. 38, the previous special issue on the JSSC for which the International Committee was responsible, our current issue, No. 41, introduces the excellent works and theses that received the prize in JSSC's commendation for outstanding achievement in 2013. In addition, this issue also reports on two JSSC events in 2013: the Pacific Structural Steel Conference (PSSC) in which the steel construction-related organizations of 10 nations participated, and the 2013 JSSC Symposium on Structural Steel Construction.

A special feature of this issue is a piece on tsunami countermeasures based on articles published in JSSC No. 13, a steel construction magazine published by JSSC for domestic use. The Great East Japan Earthquake that occurred on March 11, 2011 caused severe earthquake and tsunami damages. In order to make the most of the lessons learned from these disasters, various types of the latest tsunami countermeasures are introduced under the theme "Measures for Handling Giant Tsunamis" that will be of help in structuring a society safe from tsunami disasters.

The International Committee, while working on multi-faceted responses to the internationalization of steel construction specifications and standards, promotes exchanges of technical information and personnel between Japan and overseas organizations. As one aspect of these operations, we are attempting with this issue to inform our readers of JSSC operations, trends in steel construction, and the technologies and technological developments relevant to the planning, design, and building of steel structures in Japan.

If you wish to obtain more detailed information about the various articles contained in this issue or to receive related technical information, please do not hesitate to contact info-jssc@jssc.or.jp.

Prize-winning works in JSSC's commendations for outstanding achievements

Assembly of the tower section of TOKYO SKYTREE, the world's tallest broadcasting tower

Shibuya Hikarie building, marked by different configurations in its high- and low-rise sections

Closed demolition of 140 m-high hotel building, mainly featuring the mitigation of neighborhood anxiety

Kanayagou Viaduct, an expressway bridge constructed using a new design concept based on compact sections

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