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Long-span Pedestrian Suspension Bridge "Mishima SKYWALK"

Prize winners: Kawada Industries, Inc. and Chodai Co., Ltd.

Longest Pedestrian Suspension Bridge in Japan

The Hakone Seiroku Mishima Suspension Bridge is a pedestrian suspension bridge constructed in Mishima, Shizuoka Prefecture. Named "Mishima SKYWALK," it has a main span length of 400 m and is the longest pedestrian suspension bridge in Japan (Fig. 1).

Because the bridge is in a place of scenic beauty that commands a panoramic view of Mt. Fuji and Suruga Bay, plans for the bridge were worked out that cultivate various tourist attractions by capitalizing on this fine location, with Mishima SKYWALK as the main facility. Further, the bridge project was promoted with private funds, a rare case in the construction of large-scale structures. (Refer to Photo 1)

Fig. 1 General Drawing of Mishima SKYWALK

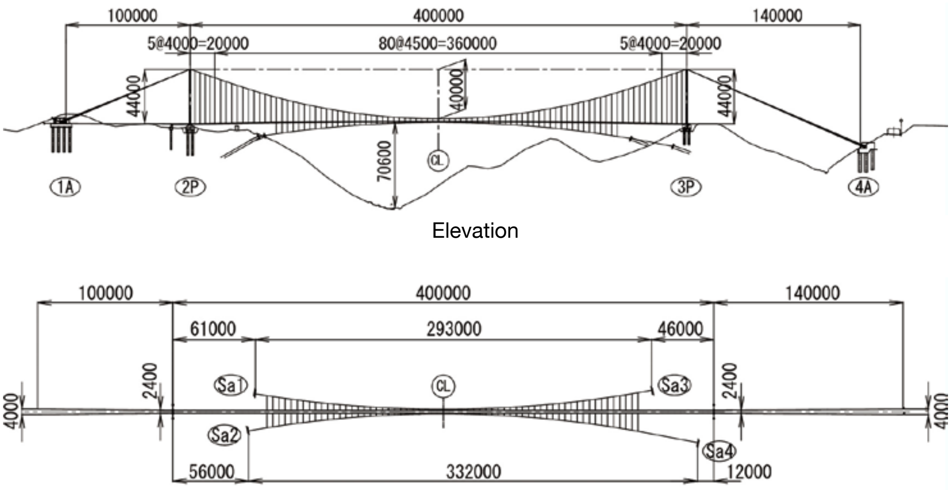


Photo 1 Full view of Mishima SKYWALK

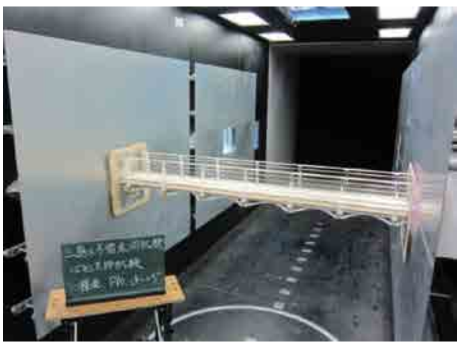
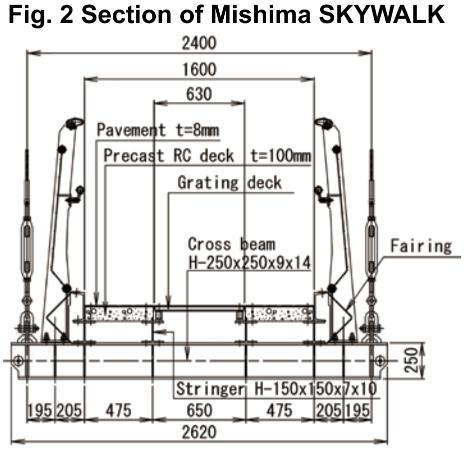


Photo 2 Wind tunnel tests

Fig. 2 Section of Mishima SKYWALK



Advanced Wind-resistant Design and Erection Method

To construct a bridge suitable for this beautiful scenery and to emphasize landscaping to create a new place of interest, minute care was paid at every stage of the design work using Mt. Fuji as a motif—from the configuration and color of the main towers to the configuration of the hand rails and the coloring of the thin pavement.

In examining the wind resistance of the bridge, the characteristics of wind conditions were found by means of on-site observation and by numerical fluid analysis using modeling of the peripheral topography at the bridge's erection site, the design wind velocity was then prescribed, and wind tunnel tests were conducted. (Photo 2)

As a result of these wind-tunnel tests, torsional flutter was found to occur in the standard section on which fairings with a tip angle of 90° were installed and 500 mm-wide gratings were provided at the center of the bridge width. To cope with this situation, the width of the gratings was expanded to 630 mm and 20 mm-wide slits were provided in the vicinity of the curbs, which successfully suppressed the flutter. (Refer to Fig. 2)

After installation of the main towers, stretching of the pilot rope, installation of the catwalks and erection of the cables, the bridge superstructure was erected by means of the cable crane method that was selected because of the topographical conditions of the valley at the bridge erection site.

While the bridge erection was carried out under the severe climatic conditions peculiar to mountain foothills, such as winds blowing up from Suruga Bay, dense fog and snowfall during the winter months, the bridge was safely put into service in December 2015. ■

Suita City Football Stadium—Seismic-isolation Structure for Roofing

Prize winner: Takenaka Corporation

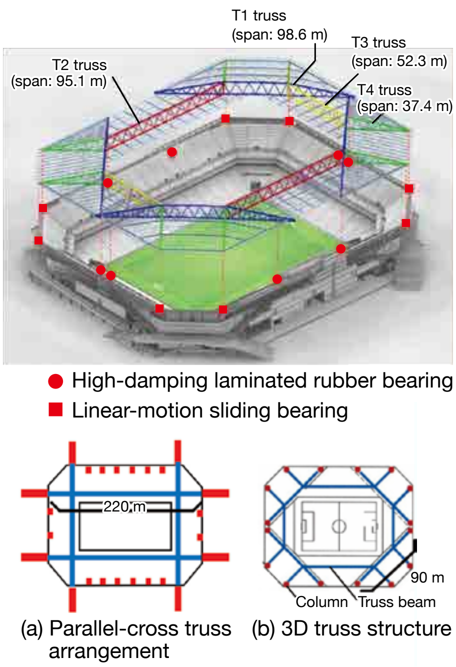
The Suita City Football Stadium is the home stadium of GAMBA OSAKA, a club team of the Japan Football Association (J-League). It is the first stadium in Japan constructed with donations from supporters and private enterprises.

At the design stage, a European-style stadium that would be simple and compact was chosen. Regarding the roof structure, a configuration was selected that images players standing shoulder-to-shoulder, and the frame was designed so that the design concept harmonizes well with the structural framing. (Refer to Photos 1 and 2)


Photo 1 Full view


Photo 2 Inner view

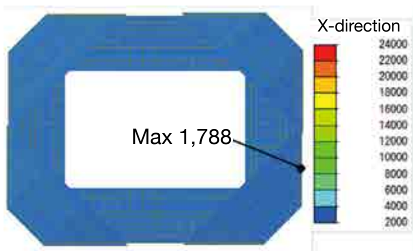
Fig. 1 Parallel-cross Truss Arrangement and 3D Truss Structure



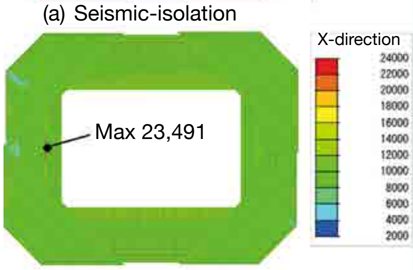
3D Truss and Seismic-isolation Roof Structures

A "3D truss structure" and a seismic-isolation roof structure were adopted for the roof structure of the stadium. The 3D truss structure is a framing system in which the truss is installed in three directions: long-side, short-side and 45° directions. In contrast to a framing system in which the trusses are arranged in parallel crosses, the 3D truss structure allows for shorter-span truss installation (Fig. 1), thereby greatly reducing the weight of the steel frames. For the seismic-isolation members, 8 high-damping laminated rubber bearings and 8 linear-motion sliding bearings were adopted.

Fig. 2 Profile of Maximum Response Acceleration (mm/s²)
(X-direction component at x-direction level 2 seismic motion)



(a) Seismic-isolation



(b) Non-seismic-isolation

Reduced Response Acceleration and Thrusting Force

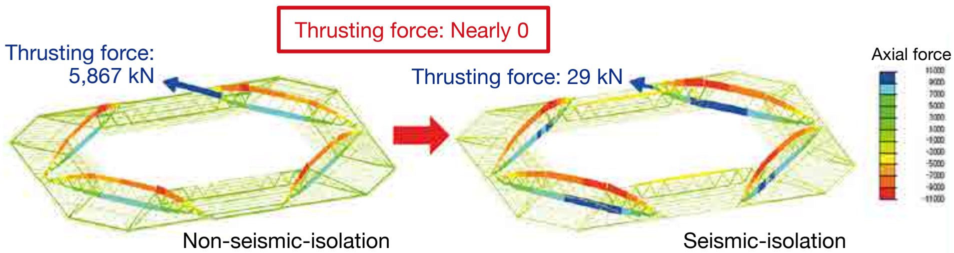
Fig. 2 shows a comparison of the maximum response acceleration of the x-direction components during a long-side direction (x direction) earthquake between a seismic-isolation structure and a non-seismic-isolation structure. As a result of this comparison, it became clear that the response acceleration of a seismic-isolation structure (a) can be reduced to about 10% that of a non-seismic isolation structure (b). Further it became clear that the response acceleration at the z-direction component cantilevered beam ends can also be reduced to about 10% and that the seismic-isolation structure offers a great improvement in the seismic safety of not only the framing but the catwalks and the lighting equipment.

Fig. 3 shows the axial force diagram obtained from the static analytical results (long period+temperature load (+30°C)). While a thrusting force of about 5,867 kN is generated in the non-seismic-isolation structure, the horizontal-direction support reaction force reaches nearly 0 in the seismic-isolation structure, which leads to a greater reduction of sections of truss-support columns in the lower framing structure from 1.5 m×6 m to 1.5 m×1.5 m.

◆

In the current project, a compact floor planning, rational structural planning and the latest in contemporary technology have extensively been incorporated to secure the highest level of structure quality, construction efficiency and cost performance. ■

Fig. 3 Static Analytical Results
(Axial force diagram: Long period+Temperature load (+30°C), kN)



Outer Frame CFH Method for the Framing of Steel-frame Multi-storied Housing

Prize winners: Takenaka Corporation and Nippon Steel & Sumitomo Metal Corporation

In the construction of conventional medium- and high-rise multi-storied housing, reinforced-concrete structures have commonly been adopted as the structural type because the required performance can easily be secured and economic merits can be obtained. However, this structural system does raise concerns about the measures to treat environmental issues and labor shortage. Consequently, we developed the "outer frame CFH®" method, a steel-structure framing system that eliminates these fears and creates new attractiveness. The outer frame CFH method has already been applied in practical housing projects.

Targets and Features of the Outer Frame CFH Method

Among the tasks targeted in the development of this new steel-frame housing method are: a shorter-term housing supply not governed by labor conditions, high seismic resistance during great earthquakes, application flexibility that can meet changes in life stages, expansion of effective indoor space, flatter finishing of indoor space and economic advantages similar to those of common RC-structure multi-storied housing. This has led to the development of the "outer frame CFH method" and the "outer/inner framing method" as the new housing construction technology that offers many advantages over RC-structure housing. This new technology assures indoor space with protrusion-free installation of columns and beams, and broad views.

A more notable feature of these two methods is not only the provision of high rigidity and high seismic resistance but enhanced freedom in floor planning and highly improved construction efficiency, all of which are attained by the adoption of concrete-filled H-shapes (CFH) for the outer frame and the separation of seismic-resistant elements into two orthogonal directions. These advantages allow greater reduction of the construction term over RC-structure housing, no protrusion of beams into the ceilings inside the rooms, and the provision of comfortable living spaces in which a wide opening section can be secured up to the full ceiling height. (Refer to Figs. 1 and 2)

Outline of Practical Projects and Achievements

The outer frame CFH method was applied in the reconstruction housing projects of the Kamaishi area that suffered damage in the Great East Japan Earthquake of 2011. Under the restricted labor conditions in disaster-stricken Kamaishi and other Tohoku areas, a housing project consisting of an 8-story and a 5-story medium-rise buildings (Photo 1) was completed in a construction term of only 1 year, about 2/3 the assumed term for RC-structure housing. In practical application, corrugated steel plate panel walls were installed in the short-side direction and the fittings of CFH beam-CFH column connections and other structural methods were newly devised to further improve seismic resistance and construction efficiency.

We consider the outer frame CFH method to have attained many achievements in response to the calls of local governments and citizens for the immediate completion of reconstruction projects. We are striving to promote social contributions through further improvements of this new steel-frame housing method. ■

(Photo: Hiroyuki Oki, Blue Hours)

Photo 1 Appearance seen from courtyard

Fig. 1 Outline of Outer Frame CFH Method

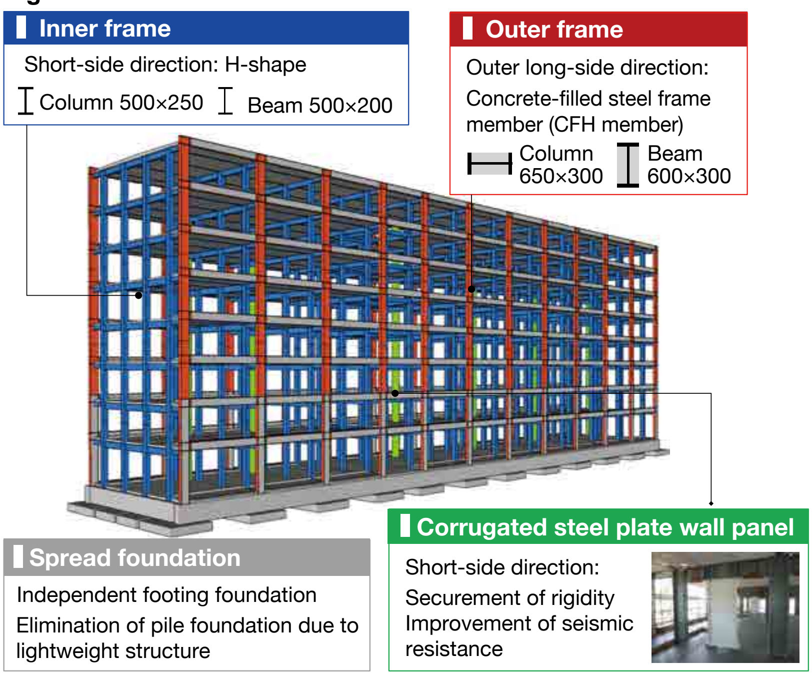
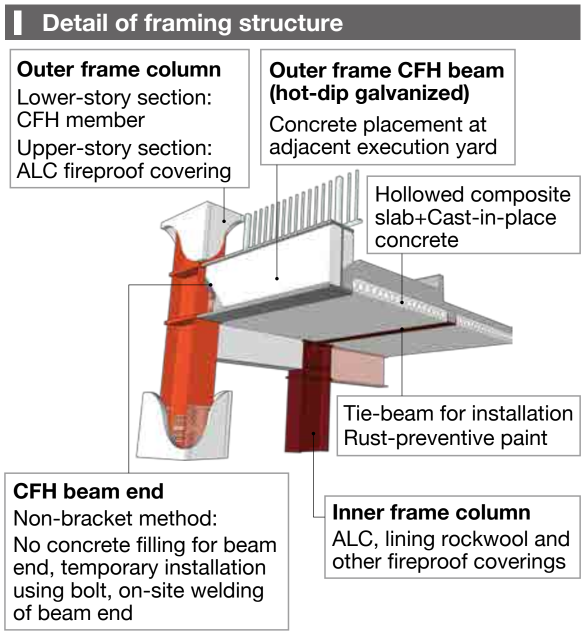


Fig. 2 Detail of Outer Frame CFH Method



Mechanism of Damage to Steel Finger Joints of Highway Bridges

Prize winners: Shuhei Sakai, Central Nippon Expressway Company Limited, Shuichi Ono, Japan Construction Method and Machinery Research Institute, and Kazuo Tateishi, Professor, Nagoya University

Shuhei Sakai
(representative author)
1996: Graduated from Graduate School of Gifu University
1996-2005: Engineer, Japan Highway Public Corporation
2005-2010: Chief Researcher, Nippon Expressway Research Institute Company Limited (seconded)
2010-: Subleader, Construction Department, Central Nippon Expressway Company Limited

The expansion joints installed on bridges frequently suffer damage, and there are rare cases in which this damage leads to serious traffic accidents.

Fig. 1 shows an example of damage to a steel finger joint that was installed in the 1950s and suffered damage after a lapse of 40 years. When implementing inspections, repairs and other maintenance operations on expansion joints, it is necessary to regulate road traffic. These maintenance operations bring about traffic congestion and there is some risk of minor collisions of maintenance workers with vehicles, always a headache for expressway administrators.

Damages Common to Many of Damaged Joints

We have conducted surveys of the appearance and fractured surfaces of numerous damaged steel finger joints and conducted their component analysis. As a result, we have found damages that are common to many of the damaged joints.

Steel finger joint members fracture in the following procedure due to wheel loading and corrosion:

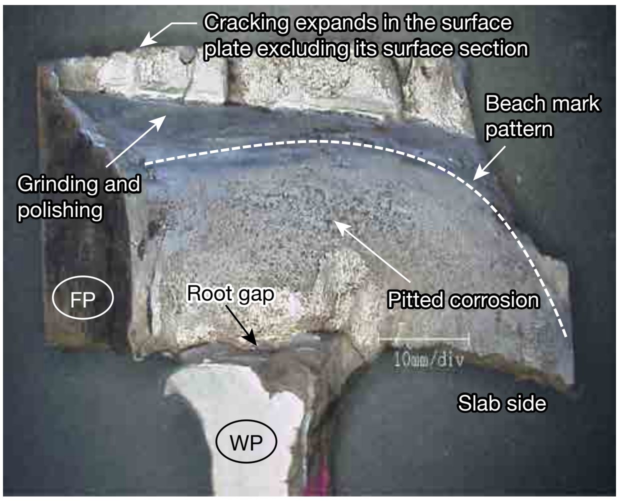
- Around the weld of plate-shaped anchors that are weld-joined to the face-plate and are embedded into the reinforced-concrete slab
- Around the weld of rib that are weld-joined to the face-plates and the web
- Around the weld of the face-plates of web
- In the face-plate around the cracking tips of the web

Further, the filled mortar under the face-plates were crushed and washed out due to wheel loading. Beach mark patterns were found in the fracture surfaces of face-plates as shown in Fig. 2, wherein fatigue crack occurred from the root of weld, piled up in the vicinity of the face-plate surface, spread in lateral directions, and finally led to the face-plate fracture. In addition, sectional loss was found in steel products in the neighborhood of respective fractured members.

It is clear from these survey results that the main causes of damage to steel finger joints are the corrosion caused by stagnant water that drained from the road surface between the damaged mortar and the face-plate and the fatigue of steel products caused by the face-plate deformation due to the wheel loading. And the steel members suffer from damage in the damaging processes mentioned above.

Fig. 1 Example of Damage to Steel Finger Joint

Fig. 2 Fracture Surface of Face-plate

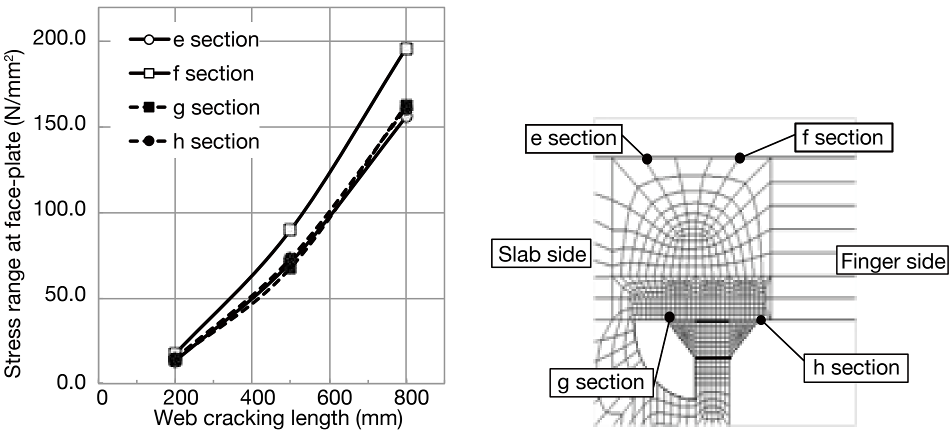


Verification of Damage Mechanism

Further, in the current survey, FEM analysis of damaged steel finger joints was conducted to grasp the range of vehicle traffic-induced stress in the damaged member sections so as to verify the damage mechanism.

Fig. 3 shows the relation between the stress range in the face-plate and the length of web cracking. It can be understood from the figure that, as web cracking expands, the possibility increases of face-plate fracture due to the fatigue. ■

Fig. 3 Web Cracking Length and Stress Range at Face-plate



Strength of Weld Joints of Framing Employing High-strength Built-up H-shapes Produced by Means of Undermatching Welding

Prize winners: Gento Yamamoto, Graduate School of Engineering, Kyoto University, and Keiichiro Suita, Professor, Graduate School of Engineering, Kyoto University

Gento Yamamoto
2014: Graduated from the master's course at the Graduate School of Engineering, Kyoto University
2014: Entered Tohata Architects & Engineers, Inc.

Application of H-SA700 High-strength Steel

The current study targets H-SA700, a high-strength steel grade developed for use in building structures. While H-SA700 has a tensile strength about twice that of conventional steel, its yield ratio is specified at 98% or lower and a key premise for its application is within an elastic range.

Because it is difficult to produce rolled H-shapes employing high-strength steel, there are cases in which H-shape members employing high-strength steel are to be produced by means of welded assembly. According to the guidelines for the welding of H-SA700 high-strength steel for building structures, it is specified that the welding material used to weld H-SA700 will have a tensile strength lower than that of the base metal, and therefore it is considered appropriate that built-up H-shapes employing H-SA700 be produced by means of fillet welding in which an undermatched weld joint is formed in order to apply these high-strength steel products in the building structural system.

Method to Verify Strength of Undermatched Weld Joints

In cases when seismic force works on a building structure for which built-up H-shapes produced by means of undermatching welding are used for the columns and beams, because the yield stress of the weld joint is lower than that of the H-SA700 base metal, panel connections are subjected to large shear force, and thus the peripheral side fillet welds are likely to fracture. Further, because large stress concentrates locally on the columns due to the tension force occurring from the beam flanges, the front fillet welds of built-up H-shape columns are also likely to fracture.

Then, in order to prevent damage to these fillet welds from occurring, a 4-point bending test and local tension test were conducted to examine a method to verify the strength of the fillet welds. In addition, based on the results of these tests, a cruciform framing test specimen was prepared to conduct the experiments for column-beam connections under conditions close to those of practical column-beam connections, and a method to verify the strength of the weld joints was examined. (Refer to Figs. 1~3, and Photo 1) ■

Fig. 1 Loading Device Used for Cruciform Framing Test (unit: mm)

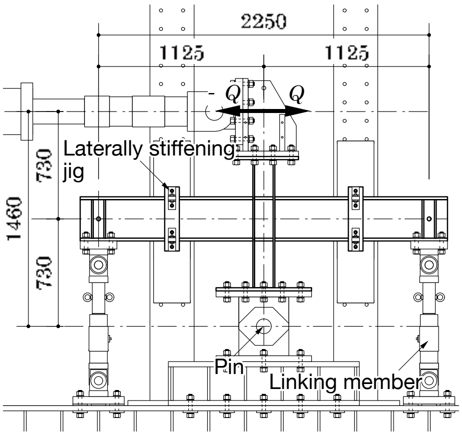


Fig. 2 Fracture Mechanism 1 Set Based on 4-point Bending Test Results (damage to peripheral side fillet weld)

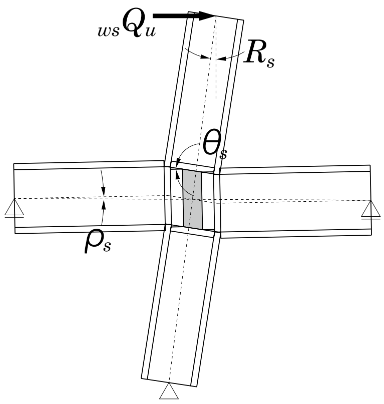


Fig. 3 Fracture Mechanism 2 Set Based on 4-point Bending Test Results (damage to front fillet weld)

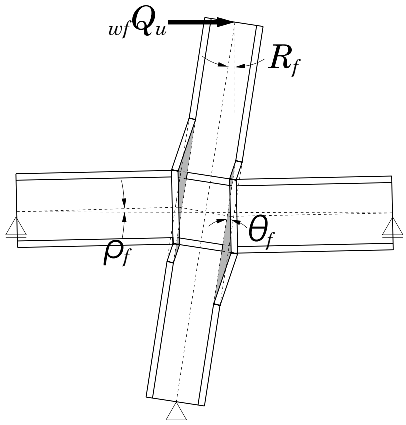


Photo 1 At the stage of maximum strength of peripheral fillet weld of cruciform framing test specimen (fracture of peripheral fillet weld)

Earthquake Damages and Transition in Seismic-resistant Standards in Japan

Revision of Building Standards

Japan is a prominent earthquake-prone country. Even when looking back upon the last half century, numerous earthquakes have occurred. Based on the examples of earthquake damage thus far suffered, seismic design methods and legal restrictions have been reinforced and revised (Table 1).

In the Tokachi-oki Earthquake that occurred in 1968, much damage occurred in reinforced-concrete (RC) structure buildings. In the quake, shear fractures of thick but short columns, so-called short columns, were found particularly in school buildings. Triggered by this damage, the Building Standard Law of Japan was revised in 1971 to make the spacing between column hoop reinforcements narrower to prevent the occurrence of shear fractures in columns.

Table 1 Major Earthquakes and Enforcement of Building Standards in Japan

1968	Tokachi-oki Earthquake (M7.9, serious damages to RC structures)
1971	Enforcement of the revised Building Standard Law (Severer restriction on column hoop reinforcement spacing)
1978	Miyagiken-oki Earthquake (M7.4)
1981	Enforcement of the revised Building Standard Law (New Seismic Design Code)
1995	Great Hanshin Earthquake (M7.3, serious damages to buildings constructed before 1981, enforcement of New Seismic Design Code)
	Enforcement of the Law for Promotion of Seismic Retrofit of Buildings
2000	Enforcement of the revised Building Standard Law (Implementation of performance-based design methods)
2003	Tokati-oki Earthquake (M8.0, oil tank damage by long-period earthquake motions)
2011-	Great East Japan Earthquake & Tsunami (M9.0, serious damages to buildings by tsunamis, building response by long-period earthquake motions)
	Amendment of the Law for Promotion of Seismic Retrofit of Buildings; Implementation of tsunami design; Study of long-period earthquake motions

New Seismic Design Code

Due to the development of analytical technologies, there was a growing tendency toward switching to a seismic design method that incorporates dynamic properties. Then, the “Development of a New Seismic Design Method,” a comprehensive technology development project of the Construction Ministry at that time, was promoted for five years starting from 1972. In this regard, the validity of this new design method was proven by the damage caused by the Miyagiken-oki Earthquake of 1978, based on which the Building Standard Law was radically revised in 1981 to establish the New Seismic Design Code.

The New Seismic Design Code presents technical standards based on the following two aims:

- That buildings suffer no damage in medium-scale earthquakes that are highly likely to encounter once or more during their service life.
- That buildings suffer neither destruction nor collapse in a rare mega-scale earthquake that might occur once during their service life.

Specifically, two-stage design methods are adopted in the New Seismic Design Code: for medium-scale earthquakes, an elastic stress design is adopted so that the framing will suffer no damage; and for mega-scale earthquakes, an ultimate stress design is adopted that considers the elasto-plastic performance of framing in order to protect human life. This Code has extensively been applied in the design of buildings in Japan.

Serious Damage in the Great Hanshin Earthquake

In 1995, the Great Hanshin Earthquake occurred, and many buildings suffered from destruction, collapse and other serious damage. In steel-frame structures, numerous fractures occurred in the brace joints and in the column-beam connections of buildings constructed before 1981, thus the importance of the connection design specified in the New Seismic Design Code was highly assessed. (Refer to Photo 1)

Fracture of brace joint

Fracture of column-beam connection

Photo 1 Damages of steel structural members in the Great Hanshin Earthquake

In RC structures, numerous instances of serious and destructive damage occurred in buildings constructed before 1971. While bending fractures of columns occurred in buildings constructed between 1972~1981, there were many cases in which the damage did not lead to the collapse of building structures. Most buildings constructed after 1981 experienced only slight damage. Photo 2 shows the earthquake-induced damage of RC-structure buildings over the developing course of seismic-resistant regulations, by which the distinctive features of damage depending on the construction period can be understood.

Fig. 1 shows an example of the level of damage to RC school buildings by construction period in the Great Hanshin Earthquake. In the figure, the construction period is divided into three terms: before 1971,

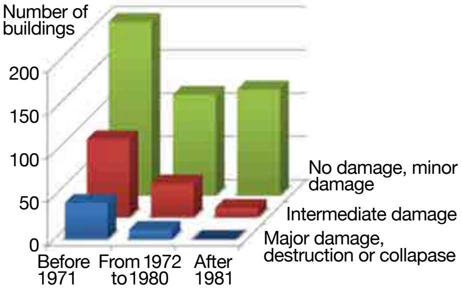
Former Building Standard Law	Former Building Standard Law (revised)	New Seismic Design Code
1971	1981	

Photo 2 Relation between earthquake damages and seismic-resistant standards

1972 to 1980 and after 1981, and the level of damage is also divided into three terms: no damage/minor damage, intermediate damage and major damage/destruction or collapse. Destruction or collapse occurred extensively in buildings constructed before 1971. On the other hand, almost no damage occurred in buildings constructed in 1981 and later, which clearly shows wide recognition of the effectiveness of the New Seismic Design Code enforced in 1981.

In those days, various moves arose such as recognition of the economic loss caused by various disasters, assessment of the value of building structures as a social asset and the steady diffusion of the BCP (business continuity planning during disasters) concept. Given this situation, the government enforced in 1995 a new law known as the "Law for Promotion of Seismic Retrofit of Buildings" for the sake of promoting the seismic retrofitting of existing buildings.

Fig. 1 Level of Damages to School Buildings by Construction Term



Source: Architectural Institute of Japan

Seismic Retrofitting of Existing Buildings

The aim of seismic retrofitting is to provide existing buildings with seismic resistance equal to that specified in the currently prevailing New Seismic Design Code to enhance the value of existing buildings. In most seismic retrofitting, the target buildings were constructed before 1981, and their seismic resistance is to be improved to a level similar to or higher than that specified in the New Seismic Design Code.

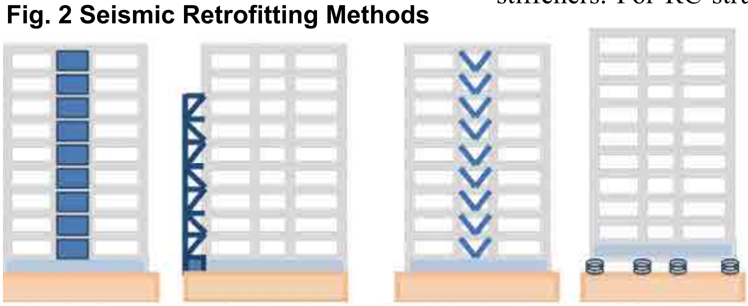
Seismic retrofitting methods are roughly divided into the following two classes:

- Methods to add strength—Shear walls, bracing or outer framing is added to an existing building (Fig. 2 (a) and (b)).
- Methods to mitigate the external force to be borne by the building—Two methods are applied: vibration control in which dampers are assembled in existing framing (Fig. 2 (c)), and base isolation in which seismic isolators are provided on the basement (Fig. 2 (d)).

Meanwhile, among the conventional methods to increase the strength and toughness of structural members of steel-structure buildings are the reinforcement of structural member sections using cover plates and shapes and the addition of stiffeners. For RC-structure buildings, a method is applied that retrofits the columns by wrapping of the columns with carbon fiber and steel plate.

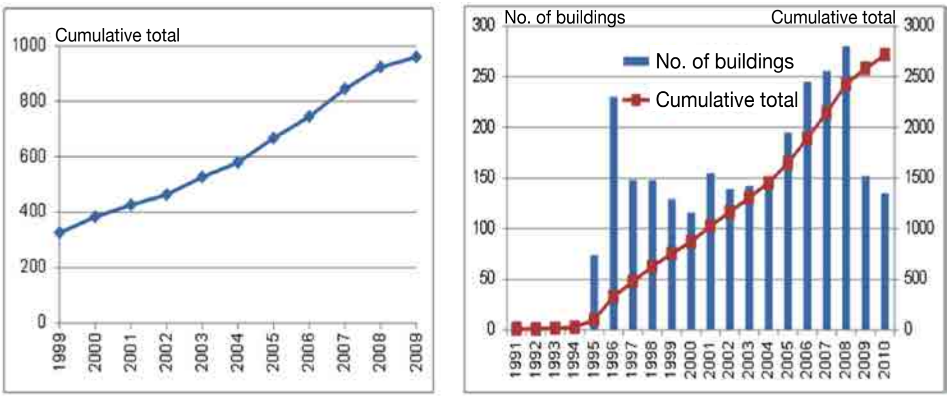
Fig. 3 shows the trend in the number of applications of vibration-control and base-isolation structures. Vibration-control structures have shown a rapid increase in application since the Great Hanshin Earthquake and have been adopted for nearly all high-rise buildings in Japan. The cumulative total of buildings employing vibration-control structures amounts to about 1,000. Base-isolation structures have been applied in wide-ranging fields from government buildings and office buildings to multi-storied housing since the Great Hanshin Earthquake, and the cumulative total of buildings employing base-isolation structures amounts to about 3,000.

Fig. 2 Seismic Retrofitting Methods



(a) Wall or bracing (b) Outer frame (c) Vibration control (d) Base isolation

Fig. 3 Increasing Adoption of Vibration-control and Base-isolation Buildings



Vibration-control buildings Base-isolation buildings

Source: The Japan Society of Seismic Isolation

Countermeasures against Tsunamis and Long-period Seismic Motions

In 2011, the Great East Japan Earthquake generated huge tsunamis that brought about serious damage to a wide area centered around the Tohoku and Kanto areas. Specifically, dead and missing persons totaled nearly 20,000 and more than 100,000 buildings were fully destroyed or washed away, causing us once again to recognize the terrible power of tsunamis.

In the wake of such huge disasters, local governments have planned the construction of tsunami evacuation buildings. To cope with such a situation, design standards for buildings that facilitate safe evacuation from tsunamis are being examined, and practical tsunami evacuation buildings are being proposed.

Another important task prompted by the disastrous effects of the Great East Japan Earthquake is how to treat "long-period seismic motion." In this earthquake, high-rise and base-isolation buildings with long natural periods experienced large-scale shaking over a long time due to the long-period, long-durable seismic motions that occur in the great earthquake of the subduction-zone type. It will be necessary in the future to promote further examinations of these "long-period seismic motions."

♦

To enhance the value of existing buildings, seismic retrofitting is being extensively promoted by capitalizing on advanced seismic designs and technologies. The latest retrofitting projects in the field of buildings and bridges are introduced on the following pages. ■

Seismic Retrofitting System Using Mega Response-control Frame and Two Buildings Connection

by Shigekazu Suzuki and Daijiro Ogata, Obayashi Corporation

There are about 25,000 multi-storied apartments or 18% of all the 133,000 apartments constructed in conformity with the former Seismic Design Code (enacted before 1981), which require seismic retrofitting, according to the actual situation surveys of multi-storied apartments made by the Tokyo Metropolitan Government in August 2011. However, the implementation of seismic retrofitting has been difficult because of its high costs and an impairment of openness and livability. Currently, there is strong demand to prolong the service life of buildings, to utilize housing stock effectively and to respond to issue of global environment.

Fig. 1 Arrangement of Kawaramachi Housing

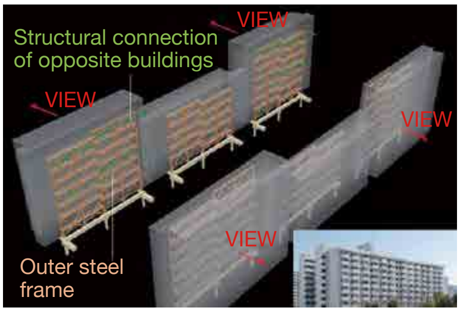


Photo 1 Kawaramachi housing after seismic retrofitting

Photo 2 "Skip arrangement" of mega response-control frame

Connection of Two Apartment Buildings

Our ambition for a retrofitting project of the Kawaramachi municipal multi-storied housing in Kawasaki is "harmonizing the retrofitting device with the original design concept of Otani Associates" and also "making the space attractive."

Two buildings that require seismic reinforcement stand close to and parallel with each other. In order to make full use of this arrangement, response-control braces for longitudinal direction and horizontal connections of the two buildings for lateral direction were installed in the courtyard. (Refer to Photo 1 and Fig. 1)

As the response-control braces were installed only outside the corridor, lighting and ventilating conditions were maintained and there was no influence on the appearance and residence space. In addition, "skip arrangement" of the mega response-control frame, where a two-floor frame was prepared as one unit, reduced the number of structural members and the joints with the existing buildings (Photo 2). And even while retrofitting work was going on, this retrofitting method minimized the influence on circulation of residents and allowed residents to stay in their apartments.

New Attractive Common Space

The courtyard between those two buildings had served as a children's playground and as a place of rest and relaxation. Although the courtyard became a space surrounded by steel frames in the current retrofitting, the residents who pass the corridor can be seen through the frame as before. The steel frame dynamically overlaps with the original concrete corridor handrail, which composes a near-future space in a sense (Photo 3). ■

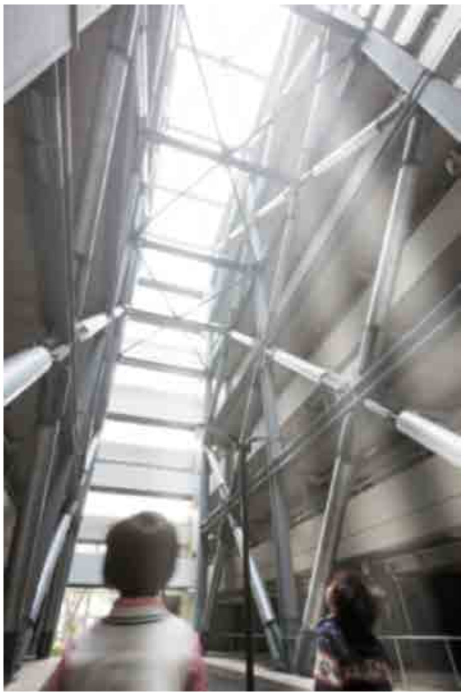


Photo 3 A kind of near-future space created between two housing buildings

Parallel Structural Method Using PC Steel Members

by Tomofumi Sekiguchi and Motoaki Hiruma, Kajima Corporation

Outline of East School Building
No. of stories: 3 stories aboveground and 1 penthouse
Total floor area: 957.88 m²
Structural type: Reinforced-concrete structure
Completion: 1958

How the Parallel Structural Method Works?

The parallel structural method is a seismic retrofitting method to improve the seismic resistance of existing buildings. Specifically, foundations and precast columns are newly installed outside the existing buildings, PC steel members are then arranged to which tension is applied, and finally the existing buildings are joined with these foundations and columns (joining of the foundation is with hole-in anchors, pressure joining of the aboveground structures is with PC steel members). In the parallel structural method, the principle of cable-stayed bridges is utilized for seismic retrofitting.

The prescribed prestressing is introduced in advance into the PC steel members on both the left and right sides of the precast column. When an earthquake occurs, the tension force of the PC steel member on one side is increased and that on another side is released due to the horizontal deformation of the buildings so that the PC steel members on both sides resist the seismic force. (Refer to Fig. 1)

Seismic Retrofitting Plan for the East School Building of Yakumo Gakuen

In addition to the parallel structural method (seismic retrofitting on the long-side of the rectangular building), seismic retrofitting by means of the new installation of an RC reinforcing wall, the additional concrete placement for existing walls and the closing of openings in existing walls (in both the long-side and short-side directions) was carried out to satisfy the seismic resistance required of the school facilities.

In particular, as a symbol in the current seismic retrofitting of Yakumo Gakuen, an application condition for the parallel structural method on the west side of the East School Building was presented to feature a "lightweight-image retrofitting design in spite of the use of steel reinforcing members" (Fig. 2 and Photo 1). Further, the effect of retrofitting on the classroom layout was kept to a minimum level to realize an open and bright school building that secures fine views from the classrooms, and good ventilation and lighting in the classrooms as well.

On top of this, a retrofitting plan was worked out that suppressed the effect of the plan on school life to a minimum by reducing on-site work that would be accompanied by noise and vibration. As a result, the retrofitting work was completed during the summer vacation period (48 days) of Yakumo Gakuen. ■

Fig. 1 Principle of Seismic Retrofitting by Means of Parallel Structural Method

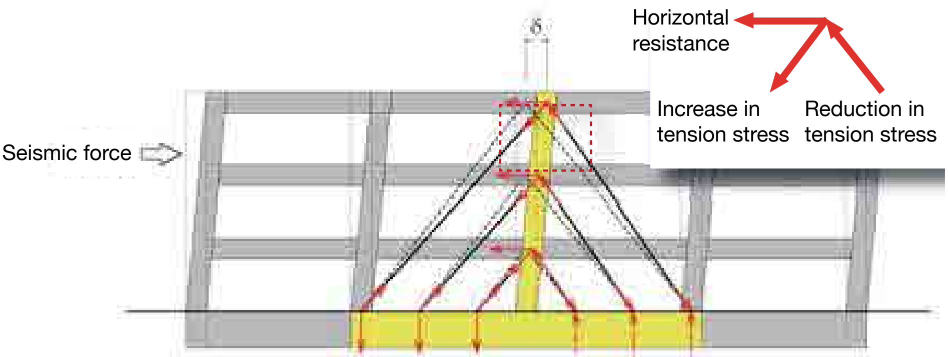
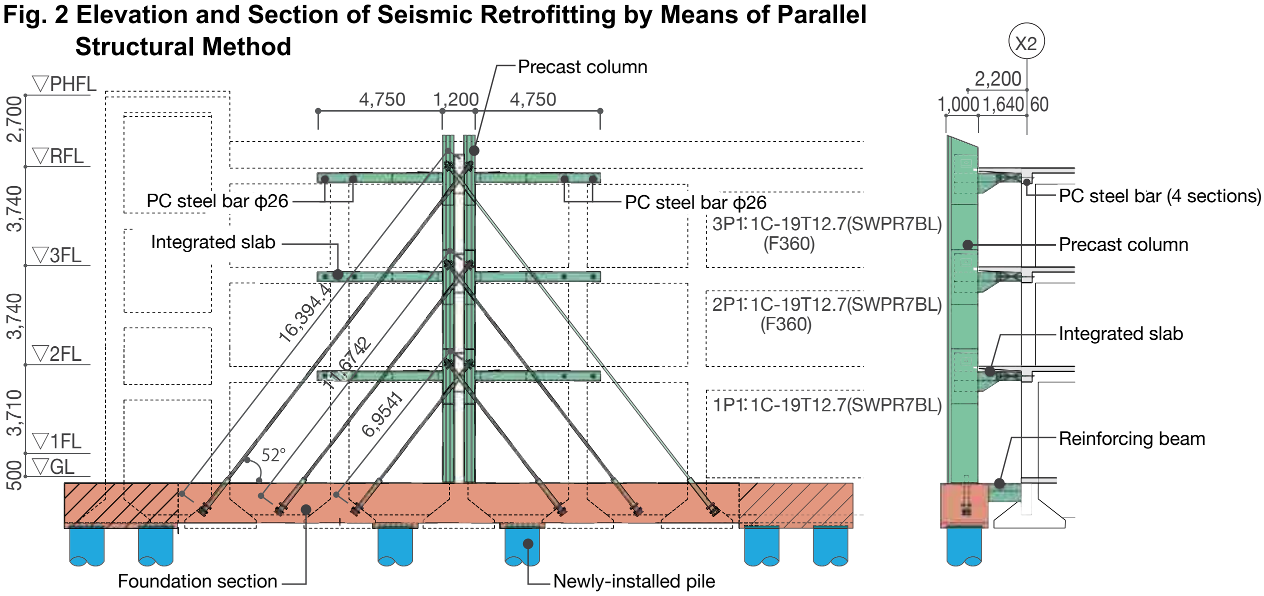


Photo 1 Appearance of East School Building after seismic retrofitting by means of Parallel Structural Method

Fig. 2 Elevation and Section of Seismic Retrofitting by Means of Parallel Structural Method



Seismic Retrofitting Harmonized with Function and Façade Design

by Hideharu Ushiba, Shimizu Corporation

Restoration of a Town Symbol

The Tobu Asakusa Station Building was designed by Misao Kuno, then the first construction chief of the Japanese Ministry of Railways, and was built by Shimizu Gumi (currently Shimizu Corporation) in 1931. A department store was established on all floors other than the second one, which serves as the platform floor of the Tobu Railway's Asakusa Station. The building opened as the first full-scale railway terminal building in the Kanto area.

Along with the opening of the world-class broadcasting tower TOKYO SKYTREE® in May 2012, retrofitting of the terminal building was planned. However, in light of its application as a station building that would be difficult to reconstruct, a full-scale restoration plan was promoted that involved not only prolongation of the building's service life due to seismic retrofitting but also remodeling of the building's façade. To that end, the old station building was restored as a new commercial facility named EKIMISE (station square). (Refer to Photo 1)

Photo 1 EKIMISE (station square) after restoration and seismic retrofitting

Outline of Seismic Retrofitting

In order not to suspend operations of both the station and the department store, it was necessary to implement safe and secure retrofitting work. The work on the platform was carried out on a detailed minute-by-minute schedule. All steel frames were prepared in a unit member to keep on-site assembly work to a minimum. The major retrofitting work is outlined below:

• Wheel-type Arch Braces

The wheel-type arch braces were manufactured so as to respect the design of the original station building (Photo 2). These braces not only improve the building's seismic resistance but also revive, by the use of contemporary technology, the role that has been played by the building in Asakusa, a prominent traditional downtown area of Tokyo.

• Steel Plate Shear Walls

The steel plate shear walls were sandwiched between the existing building and the newly-installed exterior members by reducing the thickness of wall system, so its application is invisible in terms of both inner and outer appearance (Photo 2).

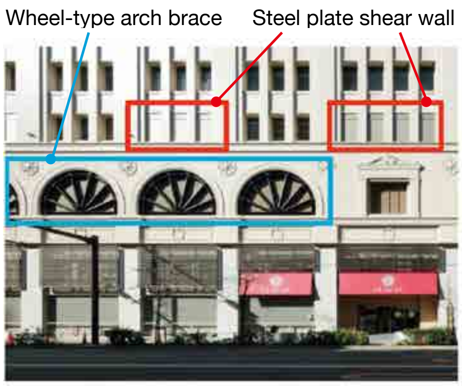


Photo 2 Wheel-type arch brace and steel plate shear wall

• Carbon Fiber Wrapping of Columns

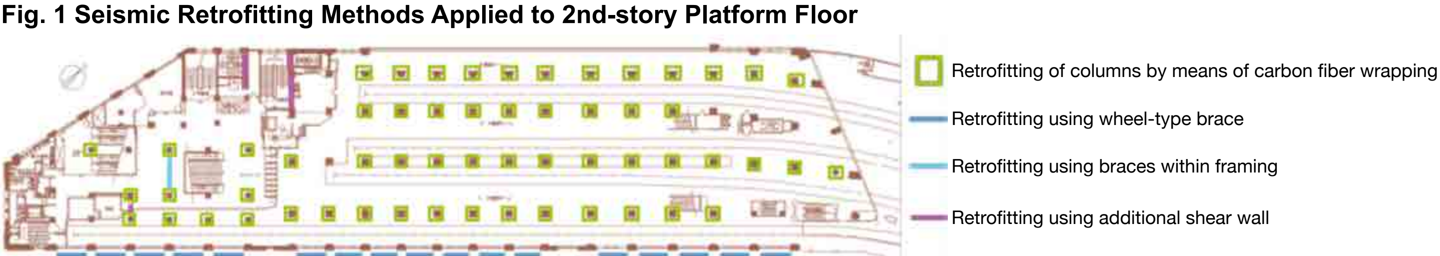
Shear walls and braces could not be installed for the platform area because of the need to maintain passenger route, so it was necessary to retrofit internal columns using retrofitting members with thicknesses as thin as possible. To meet this need, the major part of seismic resistance was secured by other frames and the platform columns were retrofitted by means of carbon fiber wrapping. (Refer to Photo 3 and Fig. 1).

♦

In spite of a short construction term of only 15.5 months and the high work difficulty within the railway terminal building, restoration and seismic retrofitting of the building were successfully completed by fully implementing advanced technologies. Wishes submitted by both the engineers at the initial construction stage and the project owner for restoration have successfully been realized and the restored building again serves as a symbol of downtown Asakusa. ■

Photo 3 Seismic retrofitting of platform columns by means of carbon fiber wrapping

Fig. 1 Seismic Retrofitting Methods Applied to 2nd-story Platform Floor



"T-Grid" Method for Attractive Seismic Design of Façade

by Takenobu Koga, Taisei Corporation

The headquarters building of the Shikoku Bank, Ltd. is an office building constructed facing the Harimaya-bashi crossing in the center of Kochi City (Photo 1). The current seismic retrofitting has been implemented as a link in a number of countermeasures provided in anticipation of the Nankai Earthquake that is forecasted to occur in the future. The main goal of the retrofitting is to protect client and employee lives and to secure continuous bank operations during the outbreak of Nankai Earthquake. The specific measures involve seismic retrofitting of three sections: building structure, exterior curtain wall and the ceiling of the banking business space.

In addition to securing the enhanced safety of these structural sections, another important task was to suggest to the local citizenry the refined presence of the Shikoku Bank Headquarters.

Directions in Seismic Retrofitting

The headquarters building constructed in 1963 is a steel-reinforced concrete structure of lattice construction. The first floor facing the street is the banking business space with an atrium structure up to the ceiling of the second floor, and the third to sixth floors are for office space. The seismic-resistant elements are arranged as shown in Fig. 1.

It is a typical structurally eccentric building in which seismic-resistant elements are eccentrically arranged in the core side. Thus, it is believed that damage due to significant twisting will occur in the section that faces the street during a great earthquake. To that end, seismic retrofitting has been required that not only controls structural eccentricity but also offers an attractive design in harmony with the street while retaining the openness necessary for first-floor banking operations (Photo 2).

Photo 1 Appearance of the building (after retrofitting)

Attractive Façade Design

Because of the formation of the surrounding streets that feature Japanese-style architecture, a retrofitting method using a vertical-grid steel plate shear wall (T-Grid) was developed with a "vertical grid" theme that is frequently adopted in Japanese traditional architecture. In order to suppress twisting of the building structure, in five structural planes of the first-floor corner sections, T-Grid members with an opening ratio of 50% were arranged that apply 25 mm-thick flat bars as the grid members and 16 mm-thick flat bars as the panel members.

Steel products were applied for the vertical and lateral grids. A rectangular grid was adopted with dimensions of 400×600 mm, the same ratio as that of the existing openings, and the depth of the vertical members was set at 200 mm, and that of the lateral members at 175 mm. This led to a structural design with a striking vertical line. The glass curtain wall was arranged shifting from the T-Grid to stress the transection of the simple and strong steel-frame grid. How to obtain finely finished and safe weld joints was a primary concern at every stage from design to manufacture and installation. (Refer to Photo 3)

Highly Effective Seismic Retrofitting

The seismic resistance diagnosis was carried out based on the rigidity and strength of the T-Grid that was obtained from an incremental analysis of FEM models. The result showed that seismic retrofitting, by improving the strength and the eccentricity ratio of the building, was successfully carried out to secure an Is value of 0.6 or more. ■

Photo 2 Interior view of banking business space (after retrofitting)

Fig. 1 Arrangement of Seismic-resistant Elements

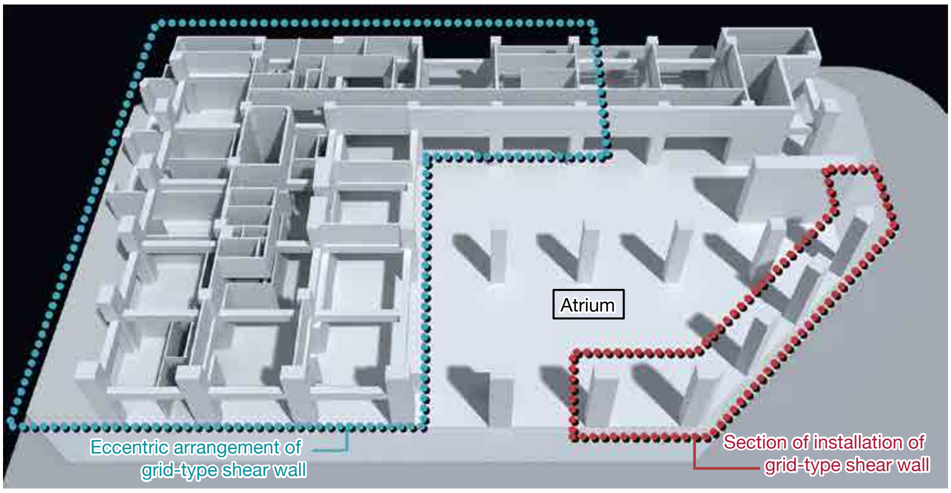


Photo 3 Details of façade

Seismic Retrofitting of Buildings: Shinjuku Nomura Building

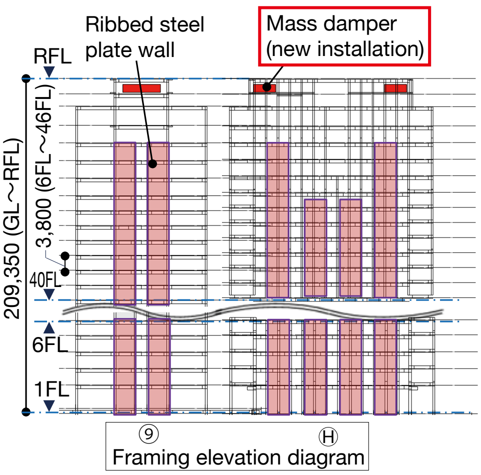
"Dual TMD-NT" Devices as a Measure against Long-period Seismic Motion

by Hiroki Nakayama and Kei Mutou, Takenaka Corporation

The Shinjuku Nomura Building is a high-rise steel structure constructed in 1978. It has a height of about 210 m and a plane configuration of about 51×33 m.

In the current seismic retrofitting of the building, as a countermeasure against long-period seismic motion, two units of a new-type of TMD (tuned mass damper) were installed within the machine room on the topmost 53rd story with the aim of having no effect on tenants or building appearance (Figs. 1 and 2, Photo 1).

Fig. 1 Framing Elevation and Installation Location of Tune Mass Dampers



Steel Weight Response-control Device of Japanese Development: "Dual TMD-NT"

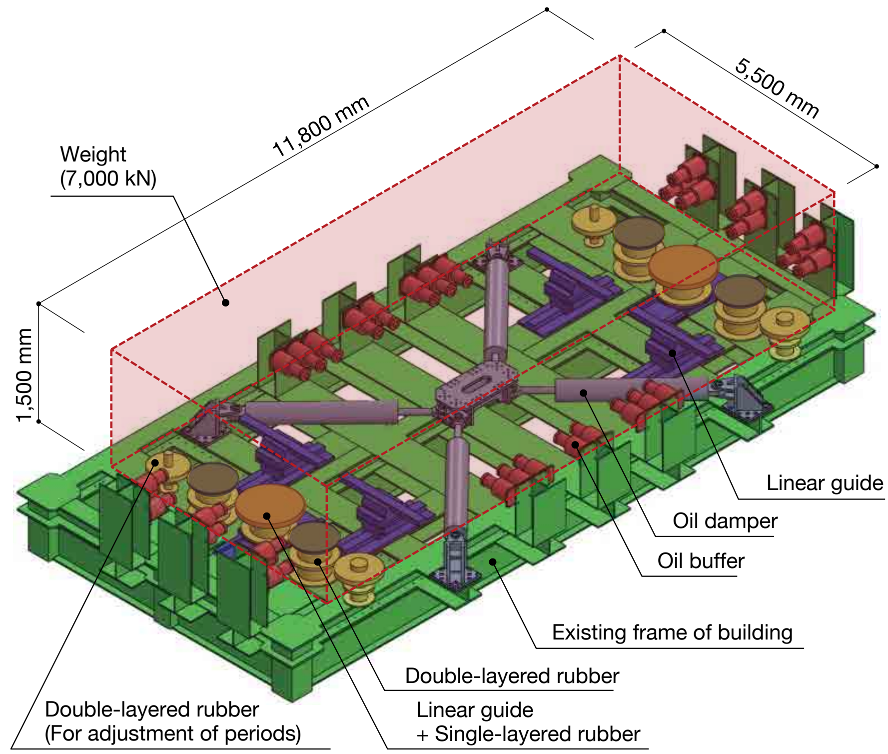
A feature of the Dual TMD-NT is the structuring of a compact system for installing steel weight response-control devices within a machine room with limited space. Specifically, the stroke was suppressed by setting the damping ratio by TMD to be particularly high and the height of the device was suppressed by adopting a slider system that supports the steel weight using a linear guide and double-layered rubber. (Refer to Fig. 2)

Photo 1 Appearance of "Dual TMD-NT"

The mass of the TMD is made from steel (composed of steel plate to facilitate easy transport), and its total weight is about 7,000 kN. The ratio of the mass weight (covering 2 units) to the building's aboveground weight is about 2.4%, and the mass weight is supported by a two-step response-control mechanism composed of 4 units of double-layered rubber and 4 units of bi-direction movable linear guides.

The rigidity of the TMD is to depend on the double-layered rubber and damping is to depend on a velocity dependent-type oil damper. A feature of the two-step response-control mechanism is that the steel weight is supported using the double-layered rubber in the case of small deformations, for example, caused by wind-induced shaking, and that the steel weight is supported using the linear guide in the case of large deformation during earthquakes (Fig. 3). These supporting systems allow for the mechanism to stably make compatibility with the large mass deformation not only without being affected by the friction of the linear guide during strong winds but also during earthquakes.

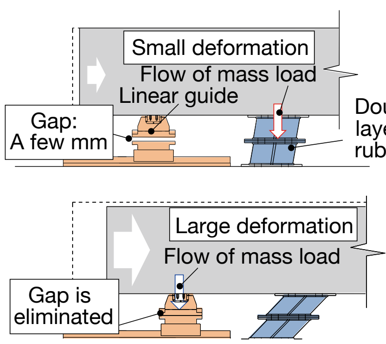
Fig. 2 Outline of New-type Response-control Device "Dual TMD-NT"



Reduction of Shaking Width and Time

It is now possible by the installation of Dual TMD-NTs to reduce not only earthquake-induced building response by about 20~30% but wind-induced shaking response by about 40%. ■

Fig. 3 Two-step Response-control Mechanism by the Use of Double-layered Rubber and Linear Guide



Introduction of Base-isolation and Response-control Structures in a Truss Bridge

by Syuji Kashimoto, Hitachi Zosen Corporation

The Katashinagawa Bridge is a long truss bridge composed of a series of three 3-span continuous trusses, which is located on the Kanetsu Expressway that opened in 1985. It has a total extension of 1,034 m, and its maximum span length is about 169 m. Its distinctive feature is its main trusses spaced 16 m apart because of the up and down lane integrated structure, a high structural height of main trusses with heights of 14~25 m, and the continuous arrangement of high bridge piers with heights of 50~70 m, excluding the P1 pier. (Refer to Photo 1)

Seismic Retrofitting of a Long Truss Bridge

Seismic retrofitting was implemented for the superstructure of this long truss bridge based on the latest seismic-resistant standard. The commonly-applied seismic retrofitting method was basically adopted. Specifically, the seismic response was reduced by adopting a base-isolation structure for the bearings (replacement with base-isolation bearings), and then the structural members were seismically reinforced.

On the other hand, in the P4 and P5 piers of the center-span intermediate support section, where the span length is greatest, the vertical reaction of the bearings is extremely high (35,000 kN/pier/bearing), and therefore a technical study was made of how to secure the space necessary for installing the jacks, how to retrofit the main trusses and the possibility of expanding the pier width in order to adopt a base-isolation structure.

As a result of the study, it became clear that the safe retrofitting of the P4 and P5 piers employing a base-isolation structure would be difficult. Then, in place of the base-isolation structure method, another method was adopted in which the seismic energy is absorbed by assembling seismic-response dampers into the bearing sections and their peripheral areas.

Adoption of Friction Dampers

In adopting seismic-response dampers, priority was placed on ease of maintenance and sure damping performance. As a result, friction dampers (damping capacity: 2,600~9,800 kN) were selected that facilitate not only easier inspection but easier confirmation of whether or not deformation occurs during an earthquake than the buckling-restraint braces thus far commonly applied. (Refer to Fig. 1)

Major features of friction dampers are as shown below:

- Friction dampers have a structure in which stainless steel plates and friction plates slide over each other as shown

Photo 1 Katashinagawa Bridge, a long truss bridge, on the Kanetsu Expressway

Fig. 1 Installation of Friction Dampers (P3~P6)

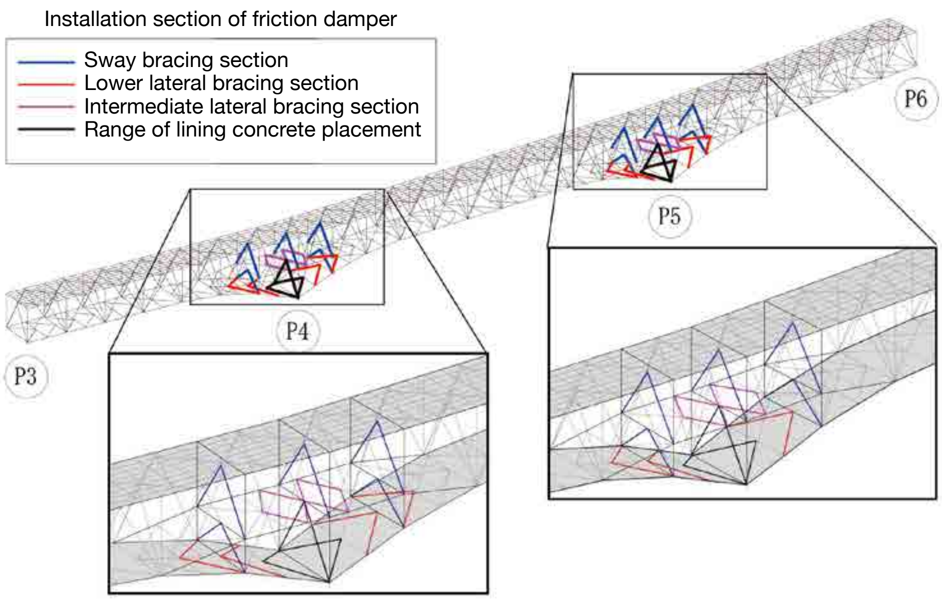
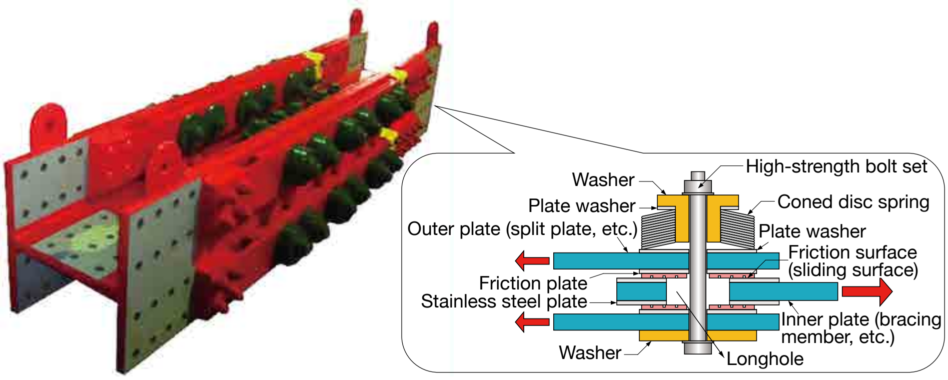


Fig. 2 Friction Damper and Its Basic Components (double-surface friction)



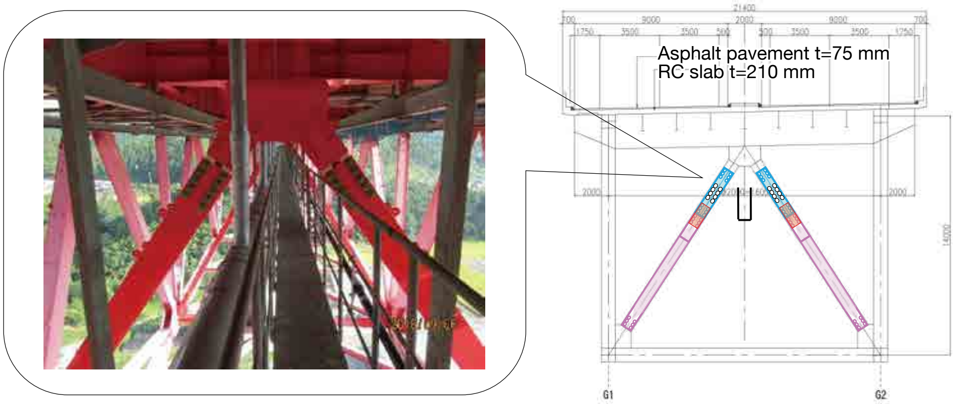


Photo 2 Installation of friction damper in sway bracing gusset section

Table 1 Performance Requirements for Friction Dampers

	Allowable deformation	Response velocity
Friction damper for Katashinagawa Bridge	±120 mm	120 cm/s
(Reference) Friction damper for buildings	±45 mm	40 cm/s

in Fig. 2, and allow easy confirmation of whether deformation occurs during an earthquake.

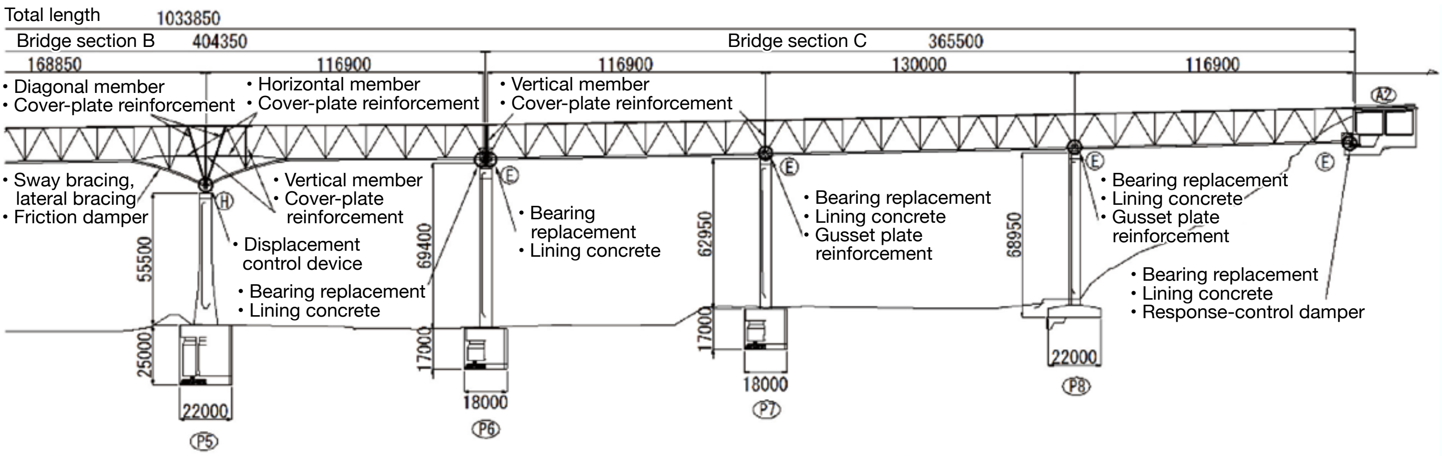
- Because these dampers are compact in size and only 3 m in length, they can be inspected from the inspection path by installing them in the vicinity of the upper gusset sections of the sway bracing and thus maintenance can easily be carried out (Photo 2).

Friction dampers have conventionally been applied as response-control devices mainly in building construction, and there has been no record of their application in long bridges. Thus, after clearly determining the performance required for the dampers (allowable deformation and response velocity) by means of a time-history dynamic response analysis of the entire Katashinagawa Bridge system, these dampers were adopted that were developed to satisfy the required performance (Table 1), and further improvements were added that could secure the corrosion resistance needed for outdoor applications peculiar to a civil engineering structure. These endeavors have allowed application of the friction dampers into the Katashinagawa Bridge.

♦

As stated above, in addition to the adoption of base-isolation structures for bearing, response-control dampers were applied that facilitate easy maintenance, which has led to the successful seismic retrofitting of the long truss Katashinagawa Bridge that satisfies the latest seismic-resistant standard. (Refer to Fig. 3) ■

Fig. 3 General Drawing of Katashinagawa Bridge



Retrofitting Design of Steel Deck-type Langer Bridge with Seismic Dampers

by Shuhei Yasumoto, West Nippon Expressway Company Limited, and Tomoaki Nakamura, Yokogawa Bridge Corp.

Nishiike Bridge on the Hanwa Expressway, which is managed by the West Nippon Expressway Company Limited, is a steel deck-type Langer bridge and it has been in service for over 40 years. The bridge site is located within 200 km of the Nankai Trough where magnitude 8 scale earthquake occurs repeatedly every 100 to 150 years.

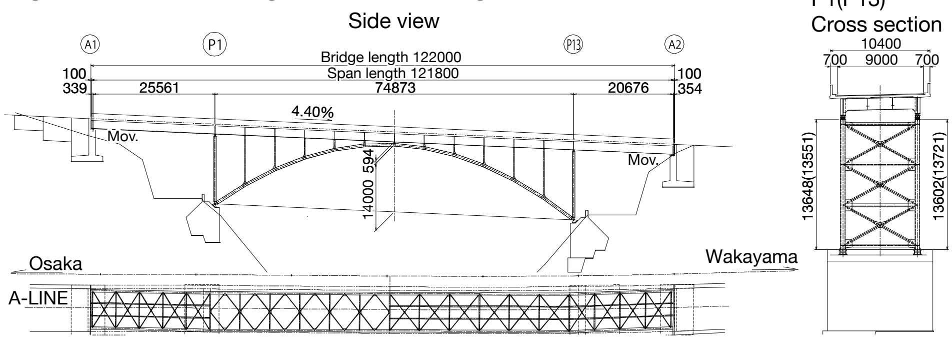
Nishiike Bridge was designed according to the steel highway bridge design specification in 1964, which did not assume a large-scale earthquake.

With the aim of not dynamically exceeding the elastic range during large earthquake, various seismic dampers were adopted and nonlinear time history analysis was applied in the seismic retrofit design of Nishiike bridge, an outline of which is reported in this article.

Outline of Nishiike Bridge

Nishiike Bridge was constructed in 1974. The arch span is 75 m and the arch rise is 14 m. It stands on the Type 1 ground (Bedrock). Fig. 1 shows the general drawing of the bridge.

Fig. 1 General Drawing of Nishiike Bridge

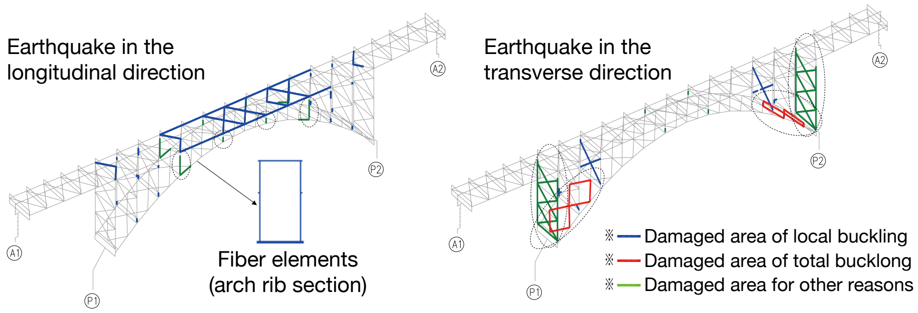


Present State Analysis

Fig. 2 shows the result of the present state analysis.

It shows that the strains in the stiffening girder and columns exceeded their yield strain (maximum 19 εy in the compressed side) in the longitudinal direction. In the transverse direction, the strains in the arch lateral bracing and column sway bracing exceeded their yield strain (maximum 72 εy in the compressed side). And at the arch support, the huge lifting force of maximum 2,300 kN was generated.

Fig. 2 The Result of the Present State Analysis



Selection of Seismic Dampers

The present state analysis reveals the seismic performance of this bridge. Two cases for decreasing seismic response are given in Table 1.

Table 1 Case of Seismic Retrofit

	Direction of countermeasure	
	Longitudinal direction	Transverse direction
CASE1 (Model of placement of order)	Filled-spandrel of arch crown + Unbuckling brace	Shear damper
CASE2 (Model added viscous damper)	CASE1 + Viscous damper	

For the longitudinal direction, in CASE1, "filled-spandrel of arch crown" and "unbuckling brace" are adopted to increase in-plane stiffness of arch. In addition, "viscous damper" is installed at the end-abutment in CASE2.

For the transverse direction, "shear damper" is installed at gusseted connection of end-column and lower-lateral (Fig. 3). Fig. 4 shows the placement of those devices.

Functional Overview of "Shear Damper"

This section describes about shear damper, which is one of the devices adopted at this retrofitting.

Shear damper is a damping damper using low-yielding steel at its shear panel. It exerts a damping effect against the transverse directional seismic wave by setting it at gusseted connection.

Fig. 3 Image of Shear Damper

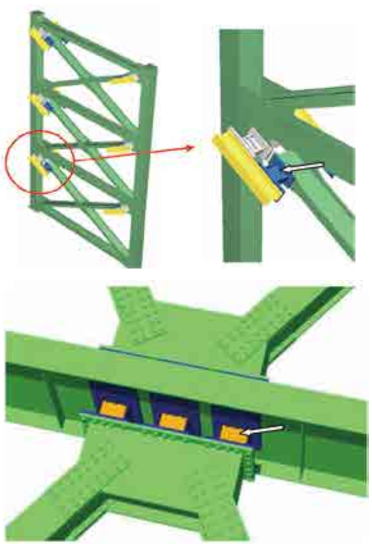
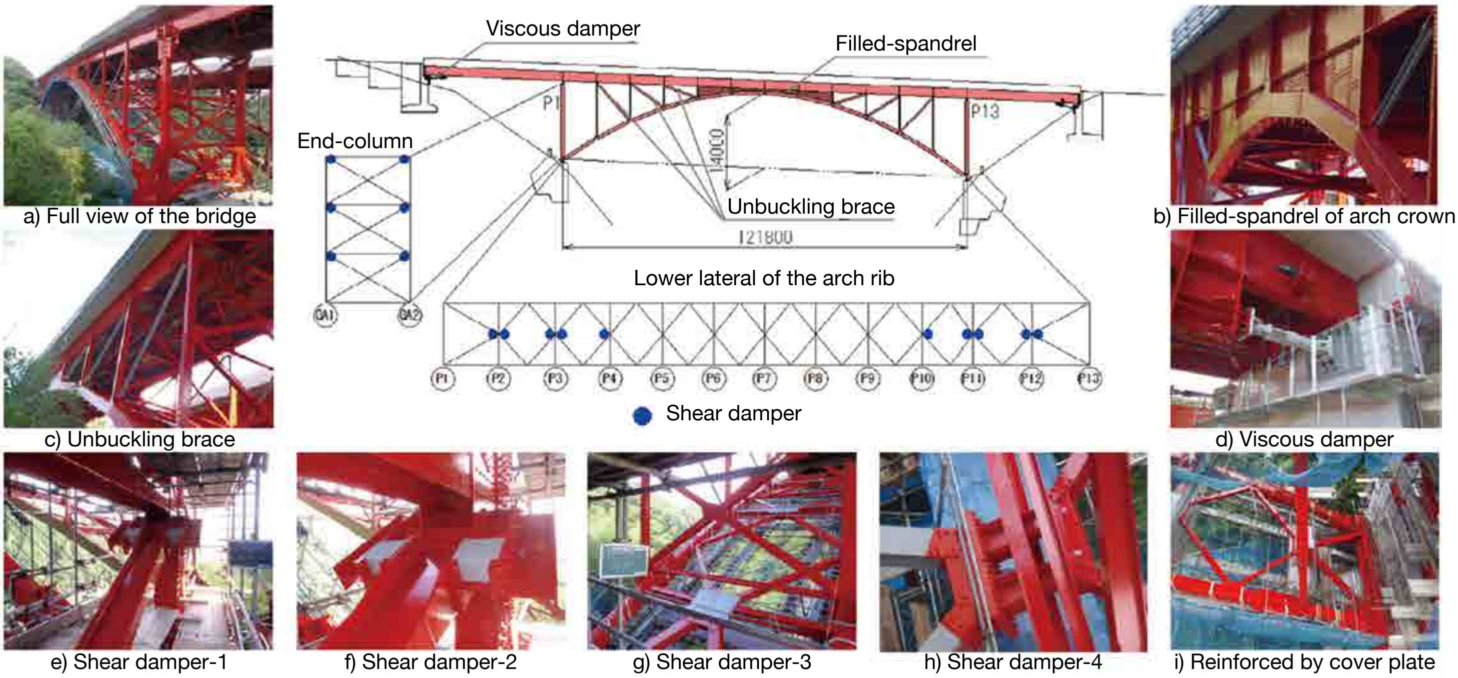


Fig. 4 Summary of Retrofit Measures on Nishiike Bridge



It takes a fixing behavior in the elastic range until the occurrence of Level 1 Earthquake (with high probability of occurrence). During the Level 2 Earthquake (with less probability of occurrence but strong enough to cause critical damage), it absorbs seismic energy by yielding its shear panel. (Refer to Figs. 5 and 6)

Additionally, shear damper can be replaced independently after a quake because of the isolation structure with bolted joint.

Fig. 5 Actuation Mechanism of Shear Damper

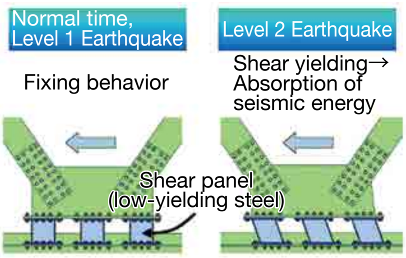


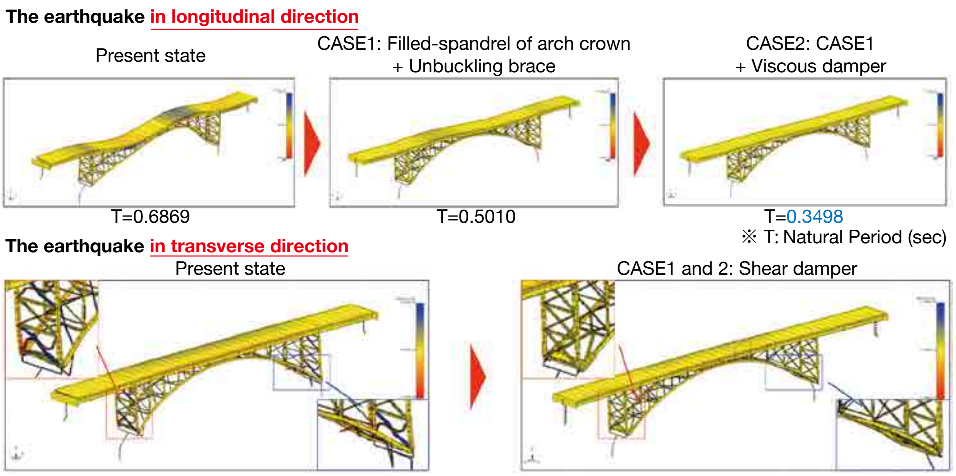
Fig. 6 Situation of Frame Model Experimentation for Shear Damper

Seismic Retrofit State Analysis

Fig. 7 shows the comparison of contour figure which illustrates the response in CASE1 and 2.

In CASE1, there were still a large amount of reaction forces remaining at arch rib base and end-column. Therefore, the thickness of reinforcing plate was also increased. The more the reinforcement, the more intensify the reaction force. In CASE2, a viscous damper was added, which reduced the axial displacement of bridge. As a result, the stress of the members of the bridge did not exceed the elastic limit ($\sigma_{max}/\sigma_y<1.0$) and the reinforcement was suppressed to a realistic amount.

Fig. 7 Comparison of Contour Figure



Conclusion

In recent years, due to the technological advances of seismic damper, various products have been put into practical use. In this case, the response of the entire bridge could be reduced within the elastic limit by using dampers. However, the total weight of reinforcement is still not a small amount.

It is expected that more economical seismic retrofitting will be able to lead through a design for plasticity with close consideration of the seismic behavior. ■

Development of High-strength Welding Materials for SUS304A

by Working Group on Welding, Stainless Steel Technology Standardization Committee, Japanese Society of Steel Construction

Large Plastic Deformation Capacity to Resist Earthquakes

The framing of steel-frame structures in the field of building construction is composed of column and beam members, and the type of column-beam connection shown in Fig. 1 is commonly applied. Column-beam connections are prepared by means of full-penetration welding, and thus they are formed with structures in which fully-penetrated welds are concentrated.

In earthquake-prone Japan, the frequency of large-scale earthquakes is high. When a building is subjected to great seismic forces, large tension force works on the weld joints. To cope with such a situation, in the construction of steel structures in Japan, plastic design is adopted that premises the plasticization of beam ends in order to treat the external forces of large-scale earthquakes.

Fig. 1 Type of Column-Beam Connections Widely Applied

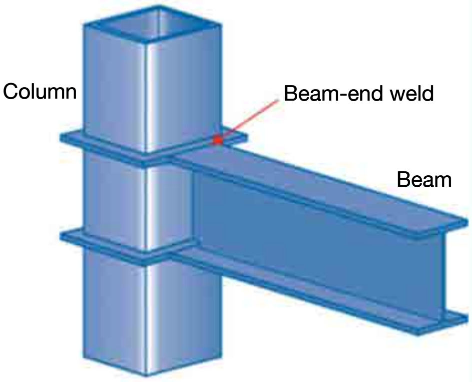


Photo 1 Examples of stainless steel structures

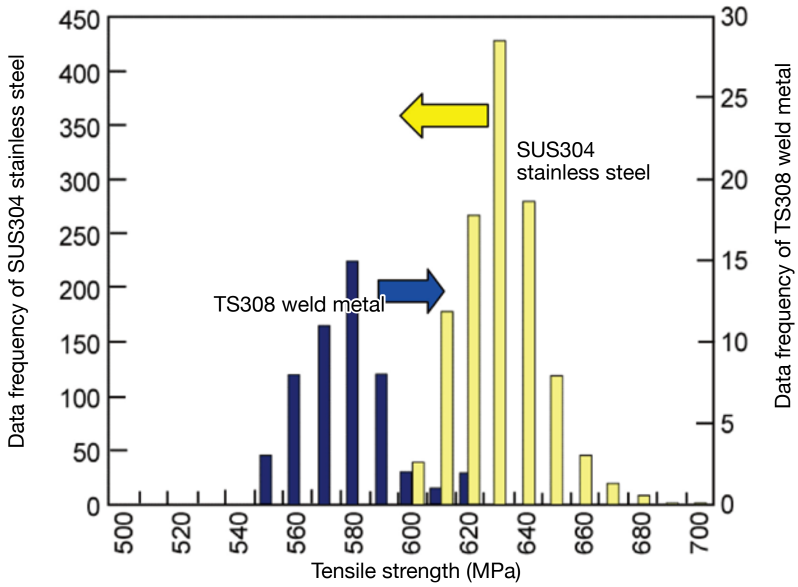
More specifically, during large-scale earthquakes, building collapse is avoided by the maximum use of the plastic deformation capacity (seismic energy absorption capacity) of steel products.

Overmatched Weld Joints Are Required to Demonstrate Deformation Capacity

In order to make steel structural members fully demonstrate their plastic deformation capacity, it is required to take into account the relative strength of the base metal and the weld metal and as a result to adopt so-called overmatched weld joints (tensile strength of the base metal<tensile strength of the weld metal).

In the construction of stainless steel-structures (Photo 1), SUS304A stainless steel (equivalent to ANSI Type 304) is most commonly used for building structural members and E308T flux-cored wire, the most popular welding material in building construction, is used. However, when comparing the respective strengths of SUS304A and E308T, the tensile strength of SUS304A surpasses that of E308T by about 50 MPa (Fig. 2) and, as a result, when such undermatched weld joints are used, the weld joints would be fractured in the weld metal. Therefore, weld joints using E308T cannot be applied as weld joints specified in a seismic design that is established to cope with large-scale earthquakes.

Fig. 2 Comparison of Tensile Strength between SUS304 Base Metal and TS308C Weld Metal in Practical Use



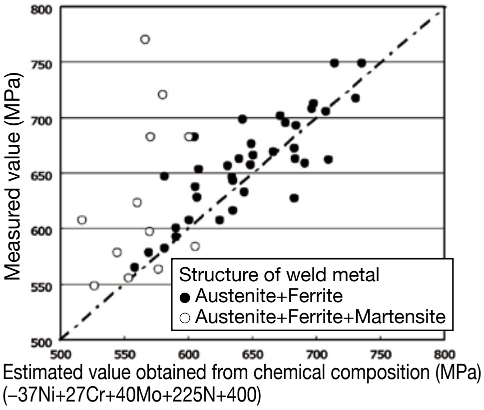
Development of Overmatched TS308MoJ Flux-cored Wire

As a measure to cope with this situation, the Japanese Society of Steel Construction (JSSC) conducted diverse surveys on the effects of the main chemical compositions of weld metal on tensile strength (Fig. 3). The main aim was to develop high-strength flux-cored wire in which fractures occur in the base metal of SUS304A weld joints.

As a result of these surveys, it became clear that in cases when an acicular-state ferrite structure (Fig. 4) is utilized that is obtained from F-mode solidification (solidified primary crystal: ferrite phase), weld metal with stabilized strength and no considerable reduction of elongation can be obtained (Fig. 5). Thereafter, JSSC registered in the Japanese Industrial Standards the newly-developed TS308MoJ flux-cored wire for which the composition range of AWS E308MoT is slightly modified to the high-ferrite composition side.

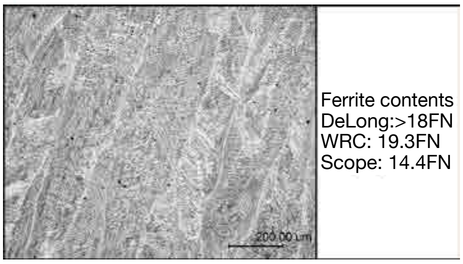
Further, it became clear that the composition system of TS308MoJ offers a feature in which its sensitivity to embrittlement that occurs due to σ-phase precipitation at high temperatures is far lower than that of high-alloy, high-ferrite content weld metals such as TS309Mo and TS2209.

Fig. 3 Analytical Results for Tensile Strength Obtained from Chemical Composition Regression Equation



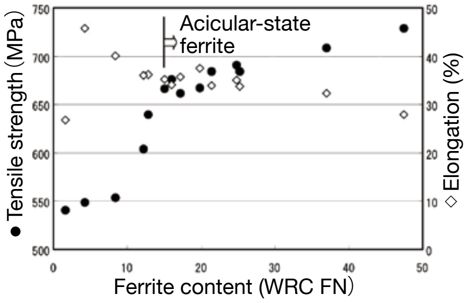
In order to confirm the strength of SUS304A weld joints employing TS-308MoJ, a joint tensile test was conducted. This test made clear that, although the strength solely of the weld metal surpassed that of the base metal, a phenomenon was observed in which weld joint fractures occurred in the weld metal. As a result of an analysis of this phenomenon by means of numerical simulation, it became clear that, when there arises a great difference in uniform elongation between the base metal and the weld metal in a tension test, such a phenomenon occurs under certain conditions. Further, it became clear that the occurrence of the phenomenon is largely affected by the size of the test specimens and the difference in strengths becomes dominant as a factor to decide fracture position in practical weld joints having a large width to thickness ratio.

Fig. 4 Microstructure of Acicular-state Ferrite



To this end, it can be assessed that SUS304A weld joints employing TS-308MoJ appropriately function as overmatched weld joints in the preparation of weld joints practically applied. ■

Fig. 5 Weld Metal with Stabilized Strength and No Considerable Reduction of Elongation



JSSC Operations

2016 China-Japan-Korea Tall Building Forum

The 2016 China-Japan-Korea Tall Building Forum was held on July 8, 2016 at the Tokyo Institute of Technology in Japan. It was organized jointly by the CTBUH Japan Structures Working Group, the International Committee of the Japanese Society of Steel Construction and the Laboratory for Materials and Structures, Institute of Innovative Research of the Tokyo Institute of Technology. The Forum is an international conference that is held as a link in the Asian operations of the Council on Tall Buildings and Urban Habitat (CTBUH) and intended mainly for structural engineers and learned persons in China, Korea and Japan. The current 2016 Forum is the third session in a series that follows the 2014 Forum in Shanghai and the 2015 Forum in Seoul.

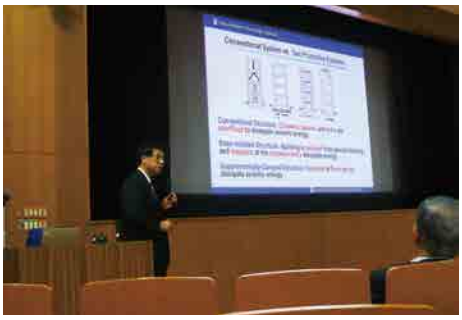
At the 2016 Forum in Tokyo, Professor Kazuhiko Kasai of the Tokyo Institute of Technology delivered a keynote address titled “Performance of Seismic Protective Systems for Super-Tall Buildings and Their Contents,” which was then followed by nine presentations given by the representatives of the three participating nations.

The presentations from China covered the structural design of the 500 m-class high-rise China Zun Tower, the seismic engineering of ultra-tall mega framing and the structural shear wall system reinforced with steel members. Two presentations for the 555 m-high Lotte World Tower and another one for 400 m-high supertall RC building constructed in Pusan were given by Korea. Two examples of the seismic retrofitting of existing buildings and the design of the GINZA KABUKIZA (*kabuki* theater) were presented by Japan.

More than 150 engineers, researchers and students participated in the Forum, where positive discussions continued throughout the day. At the closing of the Forum, Professor Emeritus Akira Wada of the Tokyo Institute of Technology (Chairman, CTBUH Japan) made an address of gratitude, and it was announced that the next Forum will be held in Beijing, China in September 2017. The 2016 Forum came to an end with many successful results.

On July 7, the day before the Forum, a technical tour was organized mainly for CTBUH members to inspect two high-rise construction sites in Tokyo. In the tour, high evaluations were given to Japanese advanced seismic-resistant technologies, such as the tuned mass dampers installed across three consecutive stories and the isolation system at the intermediate 25th story of the 40-floor building.

(by Hideo Oka, Takenaka Corporation)



Keynote address by Professor Kazuhiko Kasai of Tokyo Institute of Technology

Technical tour at the day before the Forum

11th Pacific Structural Steel Conference

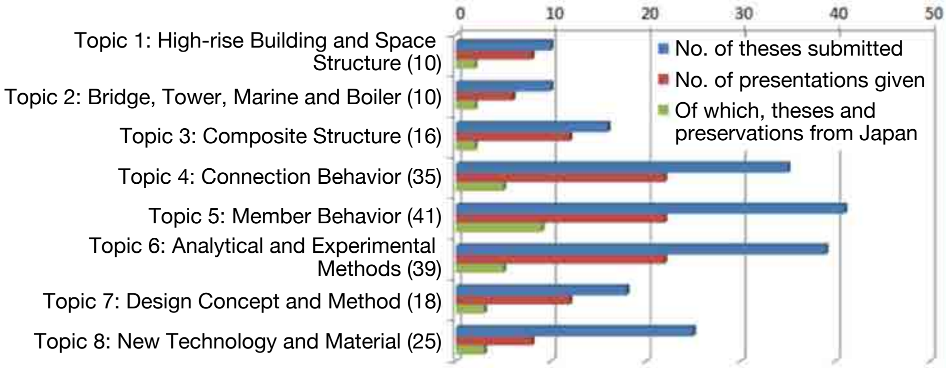
The 11th Pacific Structural Steel Conference (PSSC) was held for 2 days starting from October 30, 2016 at the Crowne Plaza, Shanghai, China under the sponsorship of the Chinese Society of Steel Construction. Many countries participated in the conference—11 member countries of the Pacific Council of Structural Steel Association (PCSSA) and 18 countries from Europe. A total of 209 theses, keynote lectures and others were submitted, and a total of 123 individuals presented their theses in Topics 1~8. Presentations from Japan totaled more than 30.

The proceedings by topic at the 11th PSSC are shown in the figure below. As seen in the figure, many theses were presented in the fields of connection and member behaviors. At the conference, 11 keynote lectures were delivered by the representatives of the 11 PCSSA member countries, and representing Japan, a lecture titled "2016.4 Kumamoto Earthquake in Japan and Its Damage on Structures" was delivered by Yozo Fujino, President of the Japanese Society of Steel Construction.

Since the first PSSC in 1986 in New Zealand, the participating countries have alternated in holding the conference every three years. The next conference is to be held in 2019 in Japan. This, the 12th conference in the series, will be the first one held in Japan since the third one 27 years ago in 1992. Because it is to be held in the year prior to the 2020 Tokyo Olympic Games, it will be possible to observe the construction of the new athletic facilities. To this end, the positive participation and cooperation by our younger generations are expected in the preparation work for the 12th PSSC to be held in 2019 in Japan.

Delivery ceremony for PSSC flag from China to Japan

Proceedings at 11th Pacific Structural Steel Conference by Topic
(Total number of theses submitted: 194)



Message from Chairman of International Committee

Hiroshi Katsuchi, Chairman, International Committee of JSSC (Professor, Yokohama National University)

JSSC has conducted a wide range of activities in the form of survey, research and technological development aimed at promoting the spread of steel construction and at improving associated technologies, and at the same time it has extended cooperation to related organizations overseas. Aimed at spreading steel construction technologies of Japan and developing overseas markets, the International Committee of the Japanese Society of Steel Construction (JSSC) was responsible for the edition of No. 50 issue.

No. 50 issue introduces 2016 JSSC awards of outstanding achievement in steel construction and excellent thesis. In addition, this issue features seismic retrofit of steel structures. Following the overview of earthquake damages in Japan, revisions of seismic design codes, the law on promotion of renovation for earthquake-resistant structures, spread of seismic base isolation and control, and classification of seismic retrofit methods, examples of seismic retrofitting of buildings and bridges are introduced, which are not only structural reinforcement but also a wide range of seismic control/base isolation devices. In addition, recent research results of welding materials for stainless steel are introduced.

International activities in 2016 that are the Tall Building Forum of the Council on Tall Buildings and Urban Habitat held at Tokyo Institute of Technology in July organized by JSSC and the 11th Pacific Structural Steel Conference (PSSC) in Shanghai, China in October are reported. The next 12th PSSC was decided to be hosted by JSSC in Japan in 2019. JSSC would like to invite many participants to the 12th PSSC in Tokyo where the Tokyo Olympic Games is waited one year later in 2020.

Finally, we would like you to continuously understand for activities of JSSC and we would also like to hear your opinions at any time.

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