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Nihonbashi Urban Redevelopment Project

Prize winners: NIHON SEKKEI, INC. and Obayashi Corporation

Redevelopment of Zone A

The Nihonbashi 2-chome Category-1 Urban Redevelopment Project is a development of a Special Redevelopment District consisting of four zones, centered on the Nihonbashi Takashimaya Shopping Center Main Building (one of the Important Cultural Properties) and the Category-1 urban redevelopment project.

Zone A is located on the east side of Takashimaya, and its above-ground floors comprise offices and retails as well as machine rooms including the certified DHC for the entire zones. Its basement floors comprise parking lots and machine rooms such as heat storage tanks. (See Photo 1)

Design and Construction of Zone A

Zone A structure involves the multi-layered buckling-restrained braces along with the hat trusses, belt trusses and oil dampers, appropriately arranged on the mega frames, of which the columns from the upper floor are bent outwards at the base of the upper structure. The seismic performance of Zone A is 1.5 times that of general high-rise buildings. (Fig. 1)

For the construction of the basement, the "Inverted Construction method" was adopted. The number of king posts was reduced as the columns along the perimeter of the building were bent outwards to connect to the retaining wall. The reduced number of king posts as well as adopting the "Mega Frame Inverted Construction method" greatly improved the workability of underground work and shortened the construction period by about 6 months. (Fig. 2)

The "Mega Frame Inverted Construction method" is a construction method in which temporary trusses are constructed between the 1FL beams and the B1FL beams to form mega frames, and the excavation is carried out while hanging the underground columns from the mega frames. (Fig. 3)

The pedestrian bridge between Zone A and Takashimaya was built with a cantilever structure supported from Zone A. In order to avoid the effect of inter-layer deformation at an event of an earthquake, the L-shaped frame was planned with a mechanism to restrain its vertical deformation by using liner sliders controlling the vibration induced at the end of the bridge. (Fig. 4) ■

Photo 1 Full view

Fig. 1 Above-ground Structure

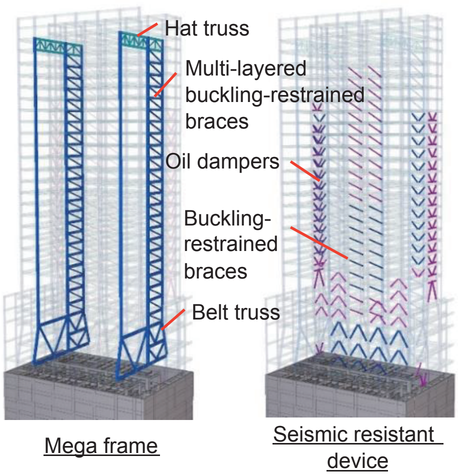


Fig. 2 Underground Structure

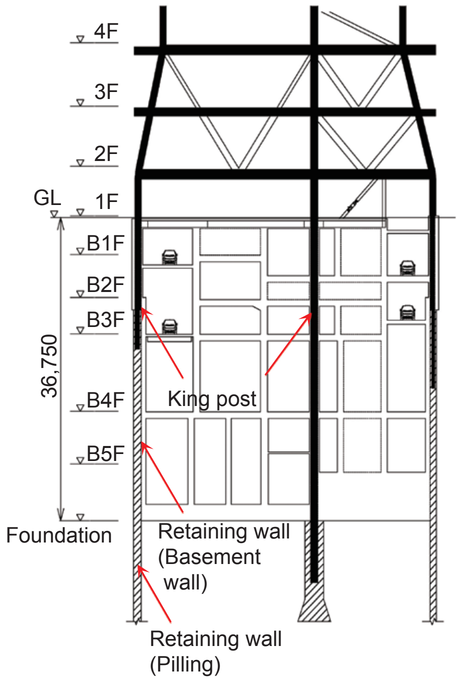


Fig. 3 Mega Frame

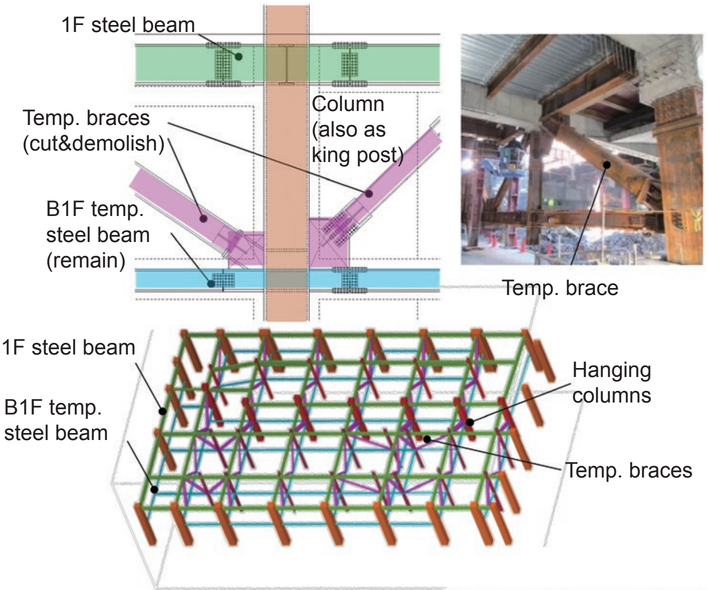
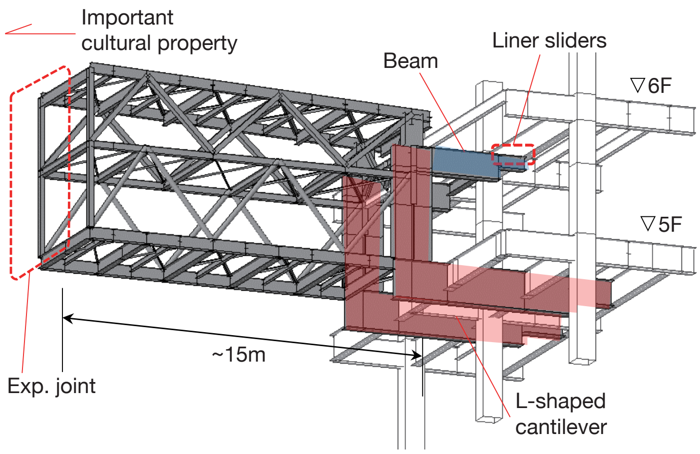


Fig. 4 Pedestrian Bridge (5F)



Nakanoshima Festival Tower West

Prize winners: Nikken Sekkei Ltd. and Takenaka Corporation

In Osaka, a twin tower project was promoted at the site sandwiching Yotsubashi-suji street, one of the major trunk roads in Osaka, and the Nakanoshima Festival Tower West is a high-rise building constructed as the second-phase project of this twin tower project. (See Photo 1)

The structural plan of the building constructed as the first-phase project featured a seismically-isolated intermediate layer and a giant truss structure. For the Nakanoshima Festival Tower West, seismic resistance similar to that of the first-phase project was required to be provided by the project owner. To meet such a requirement, a "low-rise floor-intensive response-control structure" was adopted for the Nakanoshima Festival Tower West as a structural plan that secures seismic resistance similar to that of the seismically-isolated intermediate layer.

Low-rise Floor-intensive Response-control Structure

A total of 48 units of 6,000-kN high-damping oil dampers were arranged for the large exterior wall of the low-rise section (first to fourth floors) of the building, which were covered with bricks. In addition, between the top of the self-standing wall from the first floor to the fourth-floor underfloor and the fourth-floor large beam on the building's east side, "BigWall framing" was structured in which 4 units of identical oil dampers were arranged. In this way, high-damping oil dampers whose high damping effects have already been confirmed were intensively arranged in the low-rise exterior brick-wall section on the four sides. (Refer to Fig. 1)

The adoption of the low-rise floor-intensive response-control structure has brought about two notable merits: securement of seismic resistance similar to that of seismically-isolated structure obtained by arranging high-damping dampers intensively at the low-rise floors routinely applied; and no need for providing the floors without building application purposes like the seismically-isolated floors.

Adoption of Eco-friendly and Advanced Steel-structure Technologies

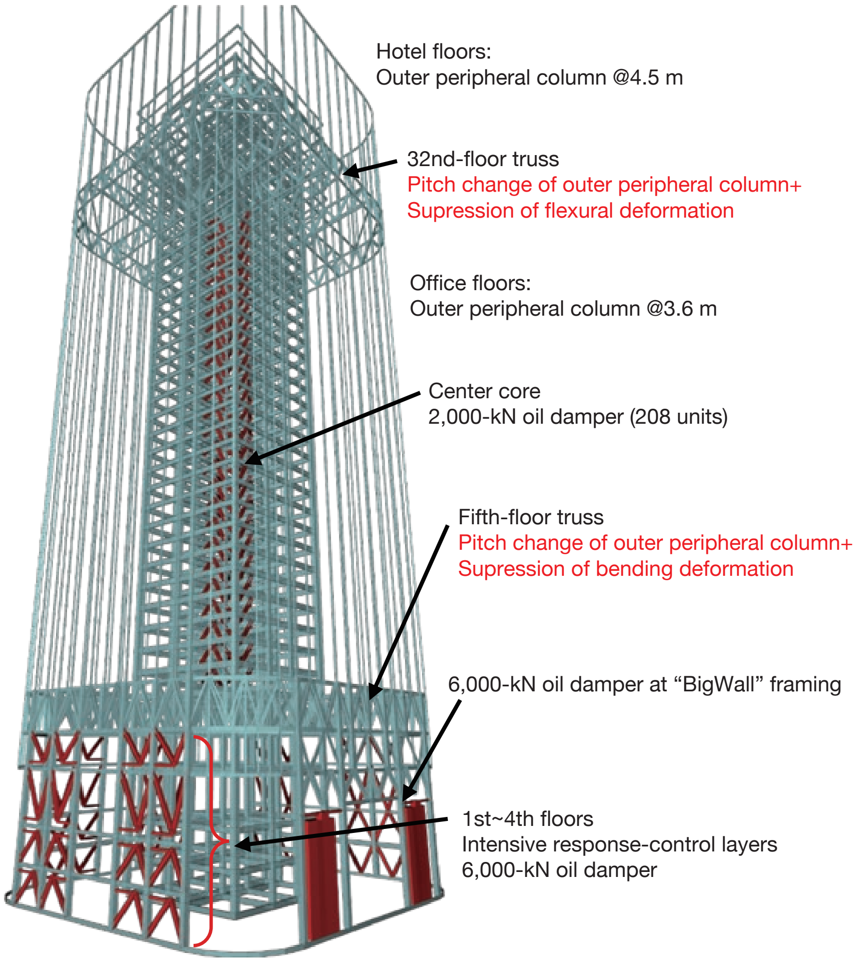
In the Nakanoshima Festival Tower West, diverse eco-friendly technologies have been applied, such as a regional air-conditioning system (for the two buildings in the twin tower project) using water from the rivers running on both sides of the project site and a double-wall glass "active skin" exterior wall attached to the columnar-state section of the office-floor exterior wall surface.

In addition, because a heavy-traffic expressway runs in the site and the site is next to a trunk road, special cares were required to pay to falling objects during construction. To cope with such site conditions, automated lifting-type external scaffolding, among others, was adopted to improve safety and productivity. Thus, the Nakanoshima Festival Tower West is assessed as a project that has greatly contributed towards the improvement of the construction technologies for high-rise steel-structure buildings. ■

Photo: Kiyohiko Higashide (Higashide Shashin Jimusho)

Photo 1 Full view and low-rise section

Fig. 1 Framing Elevation and Damper Arrangement



—Outstanding Achievement Awards

Osaki Garden Tower

Prize winners: Yuichi Koitabashi, Seiya Kimura, Kenichi Hirai, Yoshihide Takada, Toshihiro Hayasaka, and TAISEI CORPORATION

Osaki Garden Tower is an office building of the Urban Redevelopment Project by Sumitomo Realty & Development Co., Ltd., which is 114-meter-high, and the floor area is 178,000m^2 consisting of +24 floors and −2 floors (Photo 1).

Outline of the Building

In the design of the external appearance, the building was divided in order to reduce any oppressive feeling in the surrounding residential area. Also, the color of the glass was coordinated to show a uniform external appearance.

The standard floor provides open space with outstanding views, with a mega floor office of 5,500 m^2 per floor, the largest in Tokyo, with long spans of 10.8 m, ceiling height 3 m, and depth of 21 m without columns.

Earthquake-resistant Equipment Intensive Seismic Isolation System

The structural characteristic of the building is the column head seismic isolation on the basement B1 level coinciding with the building layout which adopts a center core with 10.8 m column spacing.

The main points of the structural plan are as follows.

- Steel columns are provided receiving the long span beams in the office space on both sides of the corridors in the center core, and columns are provided receiving seismic elements arranged so as to surround the EV bank.
- By bringing together both columns on the first floor into a transfer frame, the vertical loads collected on the columns receiving the long span beams act as a counterweight to balance the uplift forces concentrated in the seismic elements due to horizontal forces during an earthquake.

Photo 1 Exterior view

By arranging the EVs face-to-face within 10.8 m, it was possible to arrange the seismic resistant elements within the core on each of the grid lines with the EVs back-to-back.

By forming a rational seismic resistant structure concentrated in the core taking into consideration the office flow lines, in addition to adopting a seismically isolated structure, large office floors were achieved with a high degree of freedom of planning arrangement, while ensuring high seismic performance.

Construction Method for Underground Structure

The building has direct foundations, an RC structure below ground, and a steel structure above ground. Therefore the bottom-up construction method was adopted below ground, using SMW and earth anchors for the earth retaining work, so that construction of the earthworks and main frame could be carried out in an open state, 180,000 m^3 of soil was excavated, and the 50,000 m^3 underground structure was constructed in ten months.

The structural steel erection was carried out using four tower cranes and work proceeded with about 3,000 tons of structural steel in a cycle of two weeks. ■

Fig. 1 Floor Framing Plan

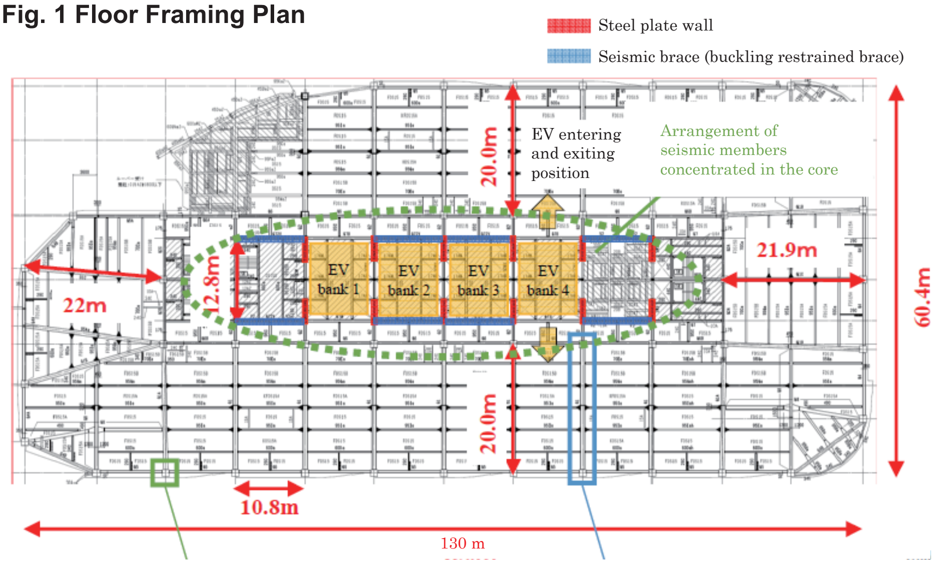
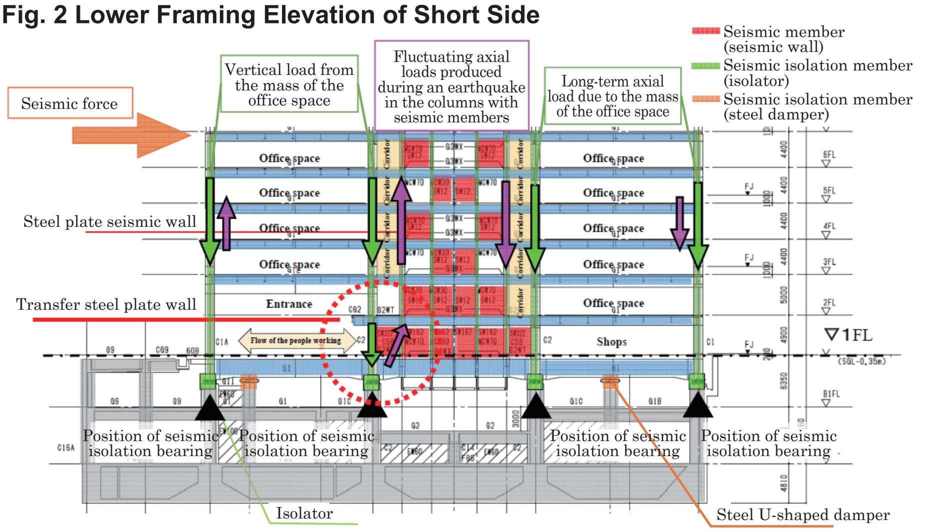


Fig. 2 Lower Framing Elevation of Short Side



Restraint Effect of Concrete Floor Slab on Lateral-Torsional Buckling Behavior of H-shaped Steel Beam

Prize winners: Yuji Koetaka, Haruna Iga, Jun Iyama and Takashi Hasegawa

Yuji Koetaka
1999: Graduated from Graduate of School Engineering, Osaka University
1999: Entered Taisei Corporation
2001: Assistant Professor, Kyoto University
2007: Lecturer, Osaka Institute of Technology
2011: Associate Professor, Graduate School of Engineering, Kyoto University

Preface

It is well known that in the composite beams produced by connecting H-shaped steel beams to reinforced-concrete floor slabs by the use of headed studs, lateral-torsional buckling is hard to occur because the out-of-plane displacement and torsion of the beam upper flange are restrained by the concrete floor slab. In order to examine the lateral-torsional buckling behavior of composite beams by means of numerical analysis while taking into account the restraint effect of concrete floor slabs on beam upper flanges, it is necessary to appropriately evaluate the stiffness and strength of the lateral and rotational springs shown in Fig. 1.

Fig. 1 Restraint Effect of Concrete Floor Slabs on Beam Upper Flange

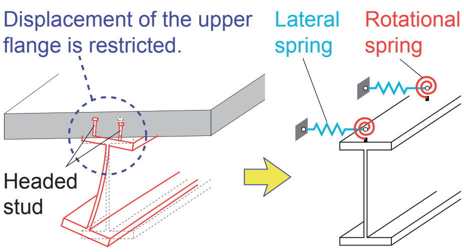
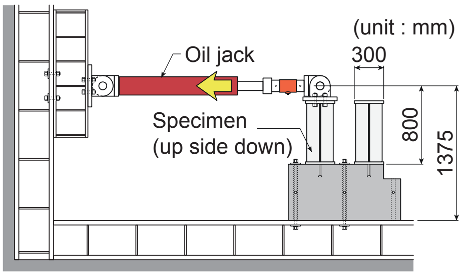


Fig. 2 Outline of Loading Test

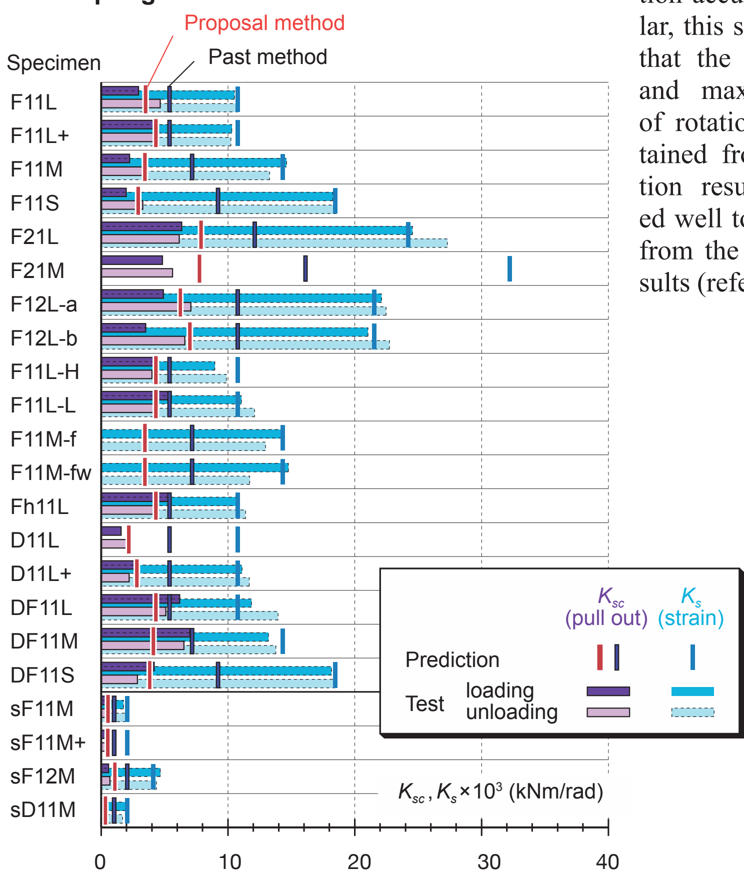


Outline of Loading Tests

In this study, targeting at a test specimen composed of a short-length H-shaped steel beam and a concrete floor slab (refer to Fig. 2), loading tests were conducted that simultaneously impart an out-of-plane horizontal force and torsion. Through the loading tests, the mechanical behavior, which corresponds to the force-deformation relationship, of lateral and rotational springs shown in Fig. 1 was confirmed.

A total of 25 test specimens were used, and among the parameters of these specimens were the length of headed studs, the arrangement of headed studs (one stud, two studs in a wide space or two studs in a narrow space), the sectional configuration of concrete floor slabs and the beam depth.

Fig. 3 Comparison of Elastic Stiffness of Rotational Springs



Verification of Elastic Stiffness and Maximum Strength

In this study, the test results for the elastic stiffness and maximum strength of beam upper flange-concrete slab connections were extracted from the force-deformation relationship. The results obtained from the relationship between the out-of-plane horizontal force and the displacement on the beam upper flange correspond to those of horizontal springs, and further the results obtained from the relationship between the torsional moment and the rotational angle around the beam upper flange correspond to those of rotational springs.

In addition, the existing calculation equations used to predict the elastic stiffness and maximum strength were verified, and new calculation equations were proposed to improve some of the existing equations low in prediction accuracy. In particular, this study made clear that the elastic stiffness and maximum strength of rotational springs obtained from the calculation results corresponded well to those obtained from the loading test results (refer to Fig. 3). ■

Estimation of Fracture Strength of Welded Joints with Weld Defects

Prize winners: Hiroumi Shimokawa, Takaaki Hiroshige, Tetsuya Fujita, Haruhito Okamoto, Yukihiro Harada and Tadao Nakagomi

Hiroumi Shimokawa
1993: Graduated from Graduate School of Engineering, Shinsyu University; Entered NKK Corporation
2003: Construction Engineering Services Dept., JFE Steel Corporation
2006: Kawagishi Bridge Works Co., Ltd
2008: Construction Materials Engineering Dept., JFE Steel Corporation

Preface

When weld-joining the beam ends, because it is very easy to attach the tab, cases are increasing in which the alternative tab is applied. With a welding method using alternative tabs, a weld defect is liable to occur at the beam end, and therefore a number of fracture tests have been conducted for weld joints having artificial defects since the occurrence of the Great Hanshin Earthquake.

Based on the existing test results and targeting at brittle fractures caused by weld defects occurring at the weld start/end section, we attempted to structure a fracture strength estimation equation by the use of linear fracture mechanics.

Structuring of Fracture Strength Estimation Equation

As the test data for use in structuring a fracture strength estimation equation, a total of 86 weld joint specimens with partial defects were selected from past references.

In structuring the estimation equation, it was considered that the fracture strength estimation equation for brittle fractures due to notching differs from that for ductile fractures at a section that takes into account sectional defects due to notching. As a result, the fracture strength estimation equation pertaining to brittle factures was structured by referring to the penetrated notch model (Fig. 1) used in linear fracture mechanics (refer to Equation (1)). In structuring the fracture strength estimation equation pertaining to ductile fractures, it was assumed that fractures occur when the sectional defect section reaches the range of tensile strength (refer to Equation (2)). As the estimated fracture strength value, Eqation (1) was compared to Equation (2), and the lower one of the estimated fracture strength values obtained in the comparison was to be determined as the fracture strength.

$$\frac{\sigma_{pr}}{\sigma_{uT}} = \frac{C}{\sigma_{uT}} \cdot \frac{\sqrt{E \cdot exp\left(C2 \cdot \left(T - {}_{v}T_{E}\right)\right) \cdot \xi' \cdot {}_{v}E_{br}}}{\gamma \cdot F(\xi) \cdot \sqrt{\pi \cdot Ak}} \quad (1)$$

(C=1.203, C2=-0.0057)

$$\frac{\sigma_{pr}}{\sigma_{uT}} = \alpha \cdot \frac{B - 2 \cdot Aeq}{B} \quad (2)$$

$$Aeq = a \cdot c / t_{cr} \quad (3)$$

E: Young's modulus (N/mm²), T: Test temperature (˚C), vTE: Energy transition temperature (˚C), ξ': B/(B-2•Aeq) or B/(B-Aeq), vEbr: Charpy absorbed energy (J), σuT: Tensile strength in fracture section at test temperature (N/mm²), γ: Structural stress concentration coefficient, F(ξ): Dimensionless coefficient determined by dimension ratio ξ of plate width B to penetrated notch length A, Ak: Equivalent penetrated notch length (mm), α: Improved strength ratio, *a*: Notch height (mm), *c*: Notch length (mm), t_{cr}: Fracture surface height (mm)

Assessment of Estimated Fracture Strength Value

Fig. 2 shows the relationship between the dimensionless fracture strength and the equivalent penetrated notch length as an example of results of comparison between the estimated value and the test result. The mark ● in the figure shows the test result, and the mark ○ the estimated fracture strength value. The curve in the figure shows the estimated curve for fracture strength. It can be seen from the figure that the estimated value agrees well with the test result.

It is considered that the fracture strength estimation equation proposed in the current study allows for grasping the permissible level of defect size required to secure the performance requirements for welded joints, and that the equation can be applied as an approach to judging the acceptance/rejection of defects in ultrasonic tests. ■

References:

1) Shimokawa, et al., Estimation of Fracture Strength Applying Linear Fracture Mechanics, Journal of Structural and Construction Engineering (Transactions of AIJ), No.585, pp169-175, November 2004
2) Ozawa, et al., Experimental Study of Butt Joints with Surface Defects at Welding End, Annual assembly of AIJ, C-1 Structure III, pp569-572, August 2004

Fig. 1 Penetrated Notch Model

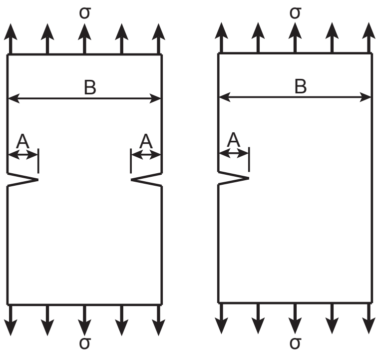
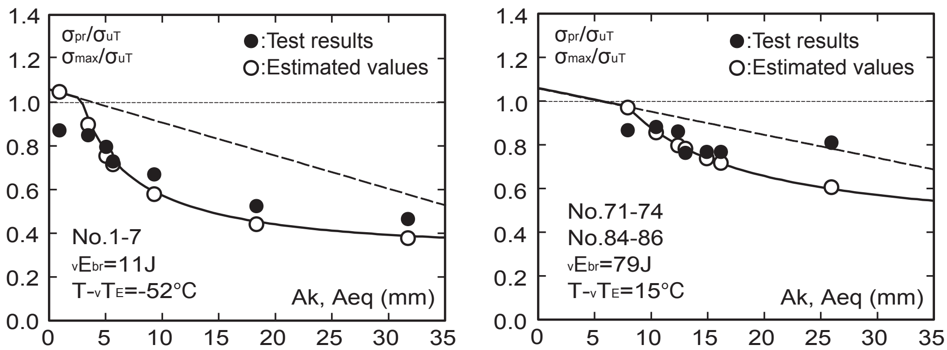


Fig. 2 Comparison between Estimated Values and Test Results



a) Plate test specimen[1)]　　b) Frame test specimen[2)]

—Thesis Awards

Low-cycle Fatigue Evaluation for Welded Joint of Shear Panel Damper in Multiple Steel Columns

Prize winners: Masaru Shimizu, Kazuo Tateishi, Takeshi Hanji, Hiroki Sugiyama, Yasumasa Soga, Riku Adachi and Hiroshi Noda

Masaru Shimizu
2010: Graduated from Kobe City College of Technology
2012: Finished the master course, Graduate School of Engineering, Kyoto University
2014: Finished the doctoral course, Graduate School of Engineering, Kyoto University
2014: Assistant Prof., Graduate School of Engineering, Nagoya University

Preface

Multiple steel columns are a highway bridge pier erected by joining four steel pipe columns by the use of shear panel dampers (Fig. 1). In the event of large earthquakes, shear panels manufactured using low-yield point steel absorb the seismic energy to secure the stability of an entire bridge structure. However, low-cycle fatigue-induced cracks may occur due to the repeated occurrence of large plastic strain at the welded joint of shear panels. In this study, an evaluation method of low-cycle fatigue in welded joint of shear panel damper was investigated.

Evaluation Method for Low-cycle Fatigue in Shear Panel Dampers

In this study, cyclic loading test on multiple steel columns was simulated by finite element analysis in which even weld toe configuration was reproduced. The analysis showed that the crack initiation and its growth can be estimated from the local strain range at the crack initiation point and the cyclic *J* integral (Fig. 2).

On the other hand, above-mentioned finite element analysis needs much labor and calculation times to obtain the local strain range. From the viewpoint of practical use, we constructed the relationship between the local strain range at the crack initiation point and the mean shear strain range of shear panels, which can be obtained using a comparatively simple structural calculation approach.

In this study, low-cycle fatigue crack generated from the boxing welded joints in a scallop of shear panel was focused on. The relationship between both strain ranges mentioned above depended mainly on the thickness of shear panel at the welded joint. Then, an equation to estimate the local strain range is proposed using the following equation.

$$\Delta\varepsilon_l = 1.4774\cdot\left(\Delta\bar{\gamma} - 2\bar{\gamma}_y\right)^{\beta} \qquad (1)$$

Where

$$\beta = -0.004490\cdot t_w + 0.6539 \qquad (2)$$

$$\bar{\gamma}_y = \frac{1}{G}\cdot\frac{\sigma_y}{\sqrt{3}} \qquad (3)$$

$\Delta\varepsilon_l$: Local strain range at the boxing weld toe in a scallop of shear panel
$\Delta\bar{\gamma}$: Mean shear strain range of shear panel
t_w : Plate thickness of shear panel
σ_y : Yield stress
G : Shear elastic modulus

By the use of above equation, the hysteresis of local strain range can be estimated from the hysteresis of mean shear strain range, which can be obtained from the seismic response analyses of frame structure model. As an example calculation, the low cycle fatigue life was also evaluated for several earthquakes using Equation (1) and the cumulative fatigue damage rule (Fig. 3). Low-cycle fatigue life calculated from Equation (1) evaluated its life on the same accuracy or safety side compared with the calculation using the finite element analysis. ■

Fig. 1 Multiple Steel Columns

Fig. 2 Comparison of Crack Initiation and Growth

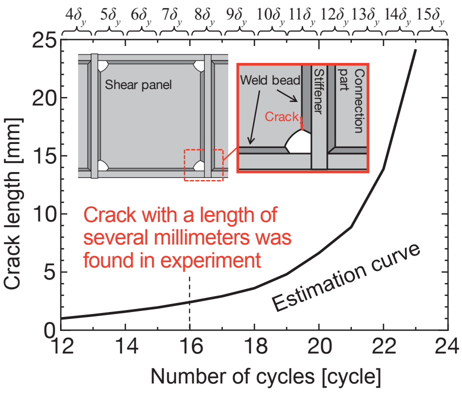
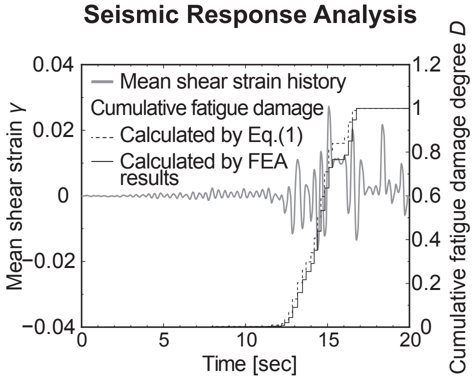


Fig. 3 Cumulative Fatigue Damage in Seismic Response Analysis



12th PSSC Held in Tokyo

The 12th Pacific Structural Steel Conference (PSSC'19) was held on November 9 to 10, 2019 at the Multi-Purpose Digital Hall of the Tokyo Institute of Technology in Japan.

The Pacific Structural Steel Conference is a major initiative bringing together expertise in structural steel research, education and construction from all around the Pacific Rim and beyond to promote cooperation among the structural steel associations and communication on development in the field of steel structures in Pacific countries. It was originated in 1986 in New Zealand, followed by Australia in 1989, Japan in 1992, Singapore in 1995, Korea in 1998, China in 2001, USA in 2004, New Zealand in 2007, China in 2010, Singapore in 2013 and China in 2016.

The current 12th PSSC was held in Japan for the first time in nearly a quarter of a century since the 3rd PSSC was held in Japan in 1992. At the last PSSC held in Shanghai, China in 2016, Japan took over the PSSC from China, and the Specialized Committee on PSSC'19 Arrangements was established within the Japanese Society of Steel Construction (JSSC) and chaired by JSSC President Yozo Fujino, which promoted preparations for PSSC'19. The major reason why the PSSC'19 was decided to be held in Japan owed to the 2020 Olympic and Paralympic Games is held in Tokyo and the PSSC-related technical tour could thus be organized to visit the latest facilities to be used for the Games.

Outline of PSSC'19 Programs

Date	Time	Event	Venue
Nov. 8	18:00-20:30	PCSSA meeting	Multi-Purpose Digital Hall
Nov. 9 (Sat.)	9:00- 9:30	Opening Ceremony	Multi-Purpose Digital Hall
	9:30-10:30	Keynote Lecture	Multi-Purpose Digital Hall
		• Professor Jerome F. Hajjar (Northeastern University, USA) • Professor Yaojun Ge (Tonji University, China)	
	11:00-17:00	Technical Session	(parallel session)
	18:30-20:30	Banquet	The Capitol Hotel Tokyu
Nov. 10 (Sun.)	9:00-10:30	Organized Session	Multi-Purpose Digital Hall
	11:00-12:00	Keynote Lecture	Multi-Purpose Digital Hall
		• Professor Chia-Ming Uang (UC, San Diego, USA) • President Mitsumasa Midorikawa (Building Research Institute, Japan)	
	9:00-17:00	Technical Session	(parallel session)
	17:00-17:15	Closing Ceremony	Multi-Purpose Digital Hall
Nov. 11 (Mon.)	8:15-14:00	Technical Tour	Tokyo Olympic facilities and Metropolitan highway renewal project

Major Programs of PSSC'19

At PSSC'19, the Keynote Lecture was delivered and the Technical Session to present research papers was held on November 9 and 10, 2019, and the Technical Tour was held on November 11, 2019.

A total of 21 countries participated in PSSC'19, and the total participants numbered 339 (201 from Japan, 90 from China and so on). In the Technical Session, 232 papers were reported. Consequently, PSSC'19 in Tokyo was a great success. (See Photos 1 and 2)

Photo 2 Main hall at PSSC'19 venue

At the Corporate Exhibition, 26 companies and organizations opened exhibition booths at the PSSC'19 venue, and many participants visited the booths. The Technical Tour

Photo 1 Group photo of participants

was made to visit Olympic and Paralympic athletic facilities that were newly completed or under construction (Ariake Arena, Ariake Gymnastics Centre and Olympic Aquatics Center) ahead of the 2020 Tokyo Olympic and Paralympic Games. The tour was also made to the site of the renewal project of the Metropolitan Expressway more than 50 years since its original construction. With many overseas participants, the tour was at full capacity.

The Organized Session with the theme “Toward 2020: State-of-the-art Steel Structure Technologies for the Future of Tokyo” was planned on the day before the Technical Tour. In advance of holding the tour, presentations were made at the session to introduce the technological issues involved in the design and construction of these latest facilities for use at the 2020 Tokyo Olympic and Paralympic Games.

Towards Resilient and Sustainable Steel Structures

At the opening ceremony held on the first day of PSSC’19, with Chairman Toru Takeuchi (Professor, Tokyo Institute of Technology) of the JSSC’s Organizing Committee on PSSC’19 as the chairperson, JSSC President Yozo Fujino gave an opening address representing the host organization (Photo 3). Then, addresses were delivered by two distinguished guests, President Izuru Takewaki of the Architectural Institute of Japan (Professor, Kyoto University) and Professor Zhou Xuhong (Honorary President of Chinese Steel Construction Society, Academician of the Chinese Academy of Engineering). An address by President Izuru Takewaki was read by the chairperson.

The general theme at PSSC’19 was “Steel Structures with Resilience and Sustainability.” In the recent circumstances in which natural disasters have frequently occurred and climate-related changes are becoming more apparent, active discussions were held with the aim of realizing resilient, sustainable and attractive steel structures. The significance and purpose of PSSC’19 mentioned above was stressed in the opening address by President Fujino, an excerpt of which is given below:

—“The general theme of this conference is ‘Steel Structures with Resilience and Sustainability.’ Because of recent experiences of natural disasters in Japan and all over the world, ‘resilience’ is becoming more and more important. The effects of climate change and limited growth are becoming evident, and ‘sustainability’ is also becoming very vital. I believe that various aspects of steel structures will be discussed today and tomorrow in this conference towards achieving ‘Steel Structures with Resilience and Sustainability’ and more attractive steel structures.”—


Photo 3 Greeting by JSSC President Yozo Fujino

Banquet and Ending Ceremony

On the first evening of PSSC’19, a banquet was held at the Capitol Hotel Tokyu. After a greeting by JSSC President Fujino, Emeritus Professor Yushi Fukumoto (Nagoya University and Osaka University), who has made great contributions to PSSC, proposed a toast, and a banquet was held that cultivated friendship among PSSC participants.

At the banquet, a performance was held of Japanese traditional folk songs accompanied with Japanese traditional musical instruments, *koto* and *shakuhachi*, and the participants, particularly those from overseas, listened attentively to the beautiful tones of these instruments.

Lastly, the PSSC flag was handed over from Japan to China, the host nation of the next PSSC planned to be held in 2022. In closing the banquet, the participants parted with a promise to meet again in China three years later in 2022. (See Photos 4~6)

◆◆◆

PSSC has traditionally been managed by the Pacific Council of Structural Steel Associations (PCSSA) composed of the membership of 11 nations, to which Indonesia (Indonesian Society of Steel Construction) and Thailand (Thailand Structural Steel Society) have joined as new members. On the day before PSSC’19, the PCSSA meeting was held, where the outline of PSSC’19 was reported and future operating plans were discussed. ■


Photo 4 Toast by Emeritus Professor Yushi Fukumoto


Photo 5 Performance of *koto* and *shakuhachi* at the banquet

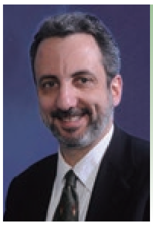
Photo 6 Handing over of PSSC flag from Japan to China, the host nation of next PSSC

Keynote Lecture

On the first and second days of PSSC'19, the Keynote Lecture was given at the Multi-Purpose Digital Hall of the Tokyo Institute of Technology, the main venue of PSSC'19. The lecture was delivered by four world-renowned experts in the fields of building construction and civil engineering from Pacific-rim nations including Japan.

In the delivery of the lecture, advanced and leading topics on the design and construction of steel-frame buildings and long-span steel bridges were reported, an outline of which is introduced below:

■ New Strategies for Sustainable Resilient and Structural Systems



Professor Jerome F. Hajjar
Department of Civil and Environmental Engineering, Northeastern University

In recent years, a new series of structural systems has been developed for designing sustainable and resilient steel and composite steel/concrete structural systems.

This paper summarizes research on systems developed to reduce the energy, pollution, and waste generated by construction and use of buildings, including systems that enable Design for Deconstruction and systems that break thermal bridges in steel structures.

■ Dynamic and Aerodynamic Challenges of Long Span Steel Bridges

Professor Yaojun Ge
Department of Bridge Engineering, SLDRC, Tongji University

With the formidable increase of span length, dynamic and aerodynamic challenges of long span steel bridges have been presented in the aspects of dynamic characteristics of cable-stayed bridges, aerodynamic stability of suspension bridges and vortex-induced vibration mitigation of steel arch and girder bridges. Fundamental frequencies do not decrease rapidly with the increase of span length of cable-stayed bridges, and critical flutter speed is not so sensitive to span length, which may support to make further span length enlargement in the near future.

Long span suspension bridges have been identified with the most challenging problem of aerodynamic instability, and one of three kinds of control measures, including stabilizers, slot and the combination of slot and stabilizer, has to be adopted for the span length over 1,500 m. Long span arch bridges and girder bridges with steel box ribs or steel box girders may have vortex induced vibration problems due to bluff cross section of ribs or girders, but aerodynamic countermeasures and mechanical TMD can help to mitigate VIV performance.

■ Research on Seismic Design of Deep Wide-Flange Steel Columns in the U.S.

Professor Chia-Ming Uang
Department of Structural Engineering, University of California, San Diego

Designers in high seismic regions in the U.S. routinely use deep wide-flange columns for Steel Special Moment Frame design nowadays, a practice which deviates from that prior to the 1994 Northridge, California earthquake.

This paper presents history of deep column issues that first surfaced in testing of moment connections, results from a numerical simulation that led to a comprehensive NIST-sponsored research program involving cyclic testing of more than 45 large-size columns. Findings from this program including implications to AISC Seismic Provisions will be presented.

■ Inelastic Deformation Capacity of Steel Beam-end Connections and a Full-scale Three-story Steel Moment-resisting Frame under Cyclic Loading

Dr. Mitsumasa Midorikawa
President, National Research and Development Agency, Building Research Institute

When super-high-rise steel buildings suffer the long-period and long-duration (long-period/duration) earthquake ground motions, it is predicted that they will undergo numerous cyclic loadings than expected from the conventional seismic design. Since there was insufficient knowledge on the seismic performance and evaluation method of super-high-rise steel buildings under such many cyclic loadings, the joint research project in Japan was launched in 2010.

In this paper, presented are the tests on steel beam-end welded connections and the test on a full-scale three-story steel moment-resisting frame, which were performed in the project. The multilevel cyclic loading tests on the beam-end connections were carried out in order to establish the evaluation method of the cyclic deformation capacity of beam-end connections. The multilevel cyclic loading test on the full-scale steel moment frame was performed in order to verify the seismic performance of the steel frame and to confirm the validity of the fracture evaluation formulae. From the test results of the steel beam-end connections and the full-scale steel moment frame, the fracture evaluation formulae are proposed and verified in terms of the limit number of loading cycles until the beam-end fracture for the seismic design of super-high-rise steel buildings against the long-period/duration earthquake ground motions. ■

(Source of the texts: Reprinted from the abstract of respective papers delivered by four lecturers at the Keynote Lecture)

Technical Session

In the Technical Session of PSSC'19, a total of 228 papers were reported at 41 sessions. Table 1 shows the names of the sessions and the number of papers in each session.

Because of the regional peculiarity derived from the conference name— Pacific Structural Steel Conference (PSSC), many papers were reported that treated the earthquake, and thus the number of papers on earthquakes presented in the Session on Seismic Performance & Design was 45, the largest in the Technical Session. Following this session, many papers were reported in the Technical Session on Connections, Design Concept and Fatigue & Fracture.

Papers on Seismic Resistance

In the field of seismic design, papers targeting building structures accounted for a large share. Regarding research themes, a lot of research papers were reported that treated research on the response-control device, the seismic resistance of column-beam-brace structural systems, the behavior of beam-column joints during cyclic loading and the seismic design of gymnasium ceilings.

In particular, regarding research on response-control devices, the development of seismic-control devices with improved functions such as buckling-restrained braces, viscoelastic dampers and friction dampers was introduced, and seismic design methods employing these devices were also proposed. In this way, it was shown in the Technical Session that R&D on response-control devices is being actively promoted. (See Photo 1)

Session on Connections

In the Technical Session on Connections, 31 papers were presented, of which papers treating bolt joints accounted for a large share, but several papers on welding joints were also reported. The papers on bolt joints included friction coefficients, bearing strength and other basic properties of bolt joints; research on bolt joints employing new blind bolts and those functioning as a friction damper and produced by the use of belleville springs; a paper on beam-column joints; and the behavior of beam-column joints and column-base connections during cyclic loading. Regarding the report on welding joints, a paper investigated the residual stress of orthotropic steel decks for bridge.

In the Technical Session on Connections, a lot of research papers relating to behavior during cyclic loading were reported with the target placed on the application of research results into seismic design.

♦♦♦

Active Q&A on the report of research papers was held (Photo 2), and the two-day Technical Session on the whole ended successfully. ■

Table 1 Sessions and Number of Papers Reported at PSSC'19

Session	Number of papers
Seismic Performance & Design	45
Fatigue & Fracture	15
High Performance Steel & Special Materials	12
Spatial Structure	7
Connections	31
Design Concepts	16
Structural System	13
Wind Effect	5
Buckling & Stability	14
Bridge	10
Robustness, Redundancy & Resilience	3
Inspection & Monitoring	10
Construction	4
Applied & Computational Mechanics	6
Composite Materials & Elements	13
Dampers & Isolators	6
Corrosion	4
Welding	7
Fire Resistance	7
Total	**228**

Photo 1 Scene at Technical Session

Photo 2 Active Q&A held

Technical Tour

Construction is rapidly proceeding of various kinds of athletic stadiums and other similar facilities ahead of the 2020 Tokyo Olympic and Paralympic Games (Tokyo 2020). As one of the events involved in the PSSC (Pacific Structural Steel Conference) 2019 held in November 2019, the Japanese Society of Steel Construction (JSSC) planned a technical tour that visited not only these stadiums and facilities but also the site of the renewal project for the Metropolitan Expressway, a trunk expressway network running in metropolitan Tokyo and its neighboring areas.

In conjunction with the main theme of the Organized Session held on the final day of PSSC'19—"Toward 2020: State-of-the-Art Steel Structure Technologies for the Future of Tokyo," a technical tour was made to the site of advanced construction projects on Monday 11 November, the day after the session. The total participants numbered 54, of which about a half were overseas participants. On the tour day, while it looked like rain in the early morning, it stopped raining when the tour started and was warm in the daytime, thereby offering a really fine day for the tour.

Major Inspection Sites

The tour started from Shinagawa Station and reached the Ariake area where Tokyo 2020-related facilities was completed or are being constructed.

First, the participants inspected the Ariake Gymnastics Centre. Thanks to The Tokyo Organising Committee of the Olympic and Paralympic Games, an interior inspection was possible, and the participants were able to inspect the Centre in the situation in which preparations are being promoted for the first event there. For the Ariake Gymnastics Centre, design is made so that a beautiful large-span wooden roof framing is realized employing a composite beam strings structural system by the use of both beam strings structure and cantilever trusses. The interior inspection conducted was the best part for the participants. (See Photo 1)

Then, the participants visited the structural periphery of the Ariake Arena and the Olympic Aquatics Center while receiving explanations from the engineers involved in structural design and construction. While the seismically-isolated roof framing with a large span surpassing 100×100 meters has been adopted for both facilities, the framing plan and construction method differ from each other. Specifically, in the Ariake Arena, roof framing is composed of one-way steel trusses arranged with a spacing of 6 meters and each truss is supported by seismic-isolation devices at both ends. On the other hand, in the Olympic Aquatics Center, roof structure consists of two-directional steel trusses and is supported at four corners, where seismic isolators are installed between the roof and the core megastructure. The technical tour made by comparing these structural systems was very interesting for the participants.

Lastly, the participants made an on-site visit to the renewal project for Root 1 Haneda Line (Higashi Shinagawa Section etc.) of the Metropolitan Expressway. In the project, existing viaducts are being removed by providing temporary detour roads with new expressways erected in their place. The renewal step of the expressway in service seemed complicated in terms of time-series basis, but the on-site visit was instructive for the participants because they could understand the overall content of the renewal project by inspecting the renewal conditions while walking on the expressway. (See Photo 2)

Significant Technical Tour

Because the engineers involved in construction attended at each site, active Q&A were held and efficient site tours were accomplished in a shorter time. To that end, the current technical tour was assessed as a significant one.

JSSC expresses its deep gratitude to those who made on-site preparations to accept the tour and gave technical explanations in spite of their tight schedules. ■

Photo 1 Technical tour to Ariake Gymnastics Centre, one of major facilities for 2020 Tokyo Olympic and Paralympic Games

Photo 2 Technical tour to the renewal project for Route1 Haneda Line of Metropolitan Expressway

Feature Article: PSSC'19 (5)

Corporate Exhibition

Opening of Exhibition Booths

In order to introduce the latest steel construction technologies in Japan to overseas participants at PSSC'19, the Japanese Society of Steel Construction (JSSC) recommended to open exhibition booths at the PSSC'19 venue for structural design offices, general contractors, steelmakers, structural member makers, developers and infrastructure operating companies/organizations with proven records in their respective fields. At JSSC's request, a total of 25 corporations and 1 organization opened exhibition booths. The specific exhibiting corporations and organizations were as follows:

Exhibiting Corporations and Organizations

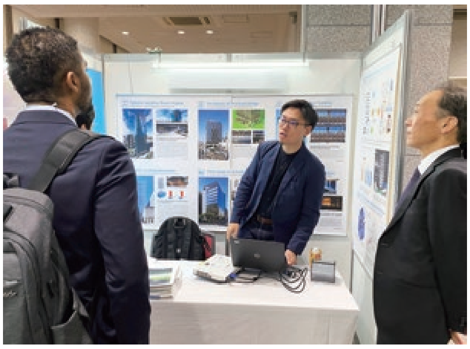
Nikken Sekkei Ltd., ARUP, Mitsubishi Jisho Sekkei Inc., Kozo Keikaku Engineering Inc., Obayashi Corporation, Kajima Corporation, Kumagai Gumi Co., Ltd., Shimizu Corporation, Taisei Corporation, Takenaka Corporation, JFE Steel Corporation, Nippon Steel Corporation, Nippon Steel Engineering Co., Ltd., Nippon Steel Metal Products Co., Ltd., Tomoe Corporation, Okabe Co., Ltd., Kyushu Daiichi Industry Co., Ltd., Hamanaka Nut Mfg. Co., Ltd., Progress Technologies Inc., IHI Infrastructure Systems Co., Ltd., East Japan Railway Company, Metropolitan Expressway Company Limited, East Nippon Expressway Company Limited, Central Nippon Expressway Company Limited, West Nippon Expressway Company Limited, SOF-Teck of Tokyo Institute of Technology

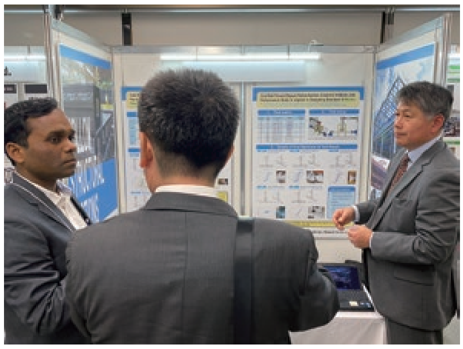
Successful Exhibitions

In the exhibition booths, steel construction technologies, steel structural materials and typical construction projects employing these technologies and materials were introduced, which were original to each respective exhibiting corporation and organization. Photos 1~3 show the exhibition booths and exchanges of views between PSSC participants.

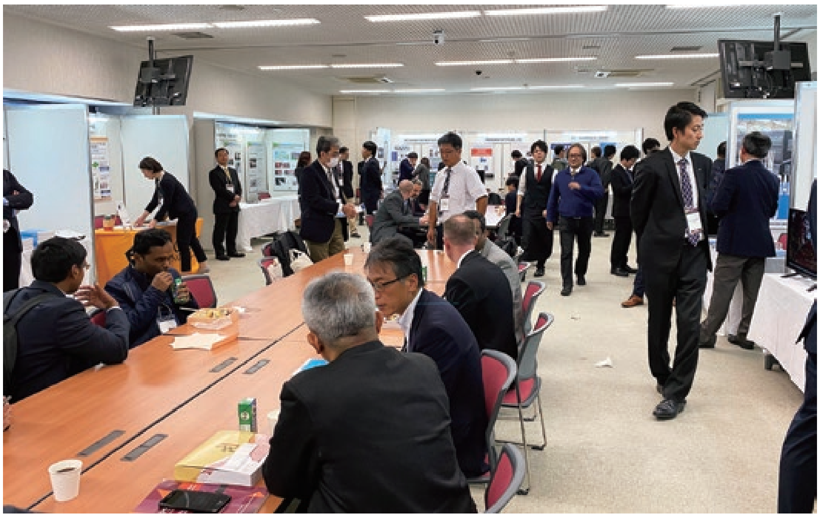
Twenty-five corporations and one organization opened exhibition booths separately in front of the PSSC's main venue and in the coffee-break room. A number of presenters visited the booths between presentations, and many participants dropped in at the booths on the way to make arrangements, which resulted in a brisk exhibition. (See Photos 4~5)

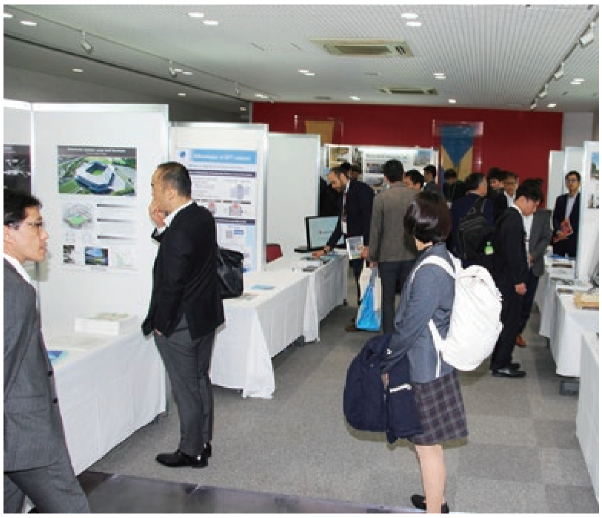
In addition, exchanges between neighboring booths were positively promoted, and further it appeared that exhibits were introduced between exhibiting companies and business cards were exchanged. Those who were in charge of explanations at the booths gave some comments on the exhibitions, such as: "At the two-day exhibition, we had the chance to deliberately talk with people whom it is normally difficult to meet even when visiting their companies." As stated above, it was generally accepted that the corporate exhibitions at PSSC'19 were successful. ■





Photos 1~3 Exhibition booths and exchanges of views between PSSC participants





Photos 4~5 Exhibition room and exhibitions

2019 China-Japan-Korea Tall Building Forum in Nara, Japan

by Dr. Masayoshi Nakai, Director of CTBUH Japan Structures Committee, International Committee of Japanese Society of Steel Construction; Engineering Fellow, Engineering Department, Takenaka Corporation

The 6th China-Japan-Korea Tall Building Forum was held on July 5th 2019 in an ancient city, Nara, Japan. This forum was organized by CTBUH Japan Structures Committee, International Committee of the Japanese Society of Steel Construction (JSSC) in collaborations with China International Exchange Committee for Tall Buildings and Korean Council on Tall Buildings and Urban Habitat.

The theme for this year's forum was "Visiting Old, Learn New." The opening addresses were given by Dr. Masayoshi Nakai as the director of CTBUH Japan Structures Committee, Prof. Guoqiang Li from Tongji University as the representative of China and Prof. Myungsik Lee from Dongkkuk University as the representative of Korea.

Following the opening addresses, nine presentations on the latest topics as summarized below were made from China, Korea and Japan. At the same time, this event fostered animated and meaningful discussions with more than 80 participants including 11 from China, 13 from Korea, 1 from US and 1 from Singapore.

Major Presentations in 2019 Forum

In the morning session, Prof. Xuhong Zhou from Chongqing University introduced the development of steel-tubed concrete structures, termed STRC and STSRC, and their applications to several high-rise buildings in China. Dr. Kwangryang Chung from Dongyang Structural Engineers Co., Ltd. provided analytical studies and structural designs of outer mega braced frame systems for two tall buildings currently projected in Seoul. To conclude the morning session, Mr. Yoji Ishibashi from Mitsubishi Jisho Sekkei Inc. presented a performance-based seismic design of a 212 m-high overhanging building tentatively named "Tokiwabashi Tower-A" in which the "Lower Stories Concentrated Vibration Control System" using oil dampers and viscous wall dampers was installed.

Photo 1 Forum venue, Todai-ji Cultural Center

Meanwhile, the venue of forum, the "Todai-ji Cultural Center," was located in the ground of Todai-ji Temple so that all participants visited Todai-ji Great Buddha Hall at lunch break. (Photo 1)

In the afternoon session, Mr. Lishan Xu from China Construction Third Engineering Bureau Group CO., LTD. introduced key construction technologies of "China Zun" in Beijing, such as integrated construction platform, the Jump-Lift Elevator, temporary-and-permanent fire protection system, BIM application and so on. Prof. Hong-Gun Park from Seoul National University provided analytical and experimental studies on corner steel-plate-reinforced RC core wall system for high-rise buildings. Lastly, Mr. Takumi Tsushi from Takenaka Corporation presented a structural design of a residential high-rise building tentatively named "Toranomon Hills Residential Tower" using the ultra-high strength 120-130 MPa concrete with steel fibers and more than 750 vibration control viscous and friction walls.

After the coffee break, Mr. Lianjin Bao from East China Architectural Design & Research Institute introduced two supertall connected buildings currently projected in China and mentioned their structural solutions and connecting effects. Prof. Jinkoo Kim from Sungkyunkwan University provided the building damages due to Pohang earthquake in 2017 and the following development of seismic retrofit devices such as corner rotational friction damper, steel slit damper, slit-friction hybrid damper and so on. The final presentation featured Mr. Takashi Kato from Kajima Corporation, who presented a structural design of a 192 m-high building named "Hibiya Mitsui Tower" using newly-developed high-performance oil dampers with the world's first energy recovery system, by which the energy absorption efficiency of the building can actually reach 4 times that by conventional dampers.

At the closing address, as the chairman of CTBUH Japan Structures Committee, Professor Emeritus Akira Wada at Tokyo Institute of Technology expressed deep gratitude to the gathering of many people and for a constructive meeting, and this year's forum being successfully completed.

(Refer to Photos 2~6)

Photo 2 Forum information signboard

Photo 3 More than 80 participants joined the forum

Photo 4 Lecture delivery from Prof. Zhou

Photo 5 Closing address from Prof. Akira Wada

Photo 6 Participants to the forum

“Visiting Old, Learn New”

On the next day after the forum, July 6th, approximately 40 delegates from China, Korea and Japan participated in a one-day tour to two ancient temples in Nara, following the theme of this forum “Visiting Old, Learn New.”

The first was the Horyu-ji Temple which was established in the 7th century and designated as World Heritage in 1993. The National Treasure, “Five-story Pagoda” in Horyu-ji Temple with a height of 32.5 m is the world oldest five-story timber pagoda in existence. (Refer to Photo 7)

The other was the Yakushi-ji Temple. The National Treasure, 34.1 m-high “East Pagoda” in Yakushi-ji Temple built in the early 8th century is the tallest three-story timber pagoda in designated cultural property, and currently under restoration work. Especially, participants were granted special access by Nara Prefecture and Yakushi-ji Temple to visit the restoration site of the “East Pagoda” and see the ancient pagoda really up close. It was a valuable and memorable experience for all delegates. (Refer to Photo 8)

The central column disconnected from wooden framework of pagoda becomes an important model for vibration control of recent high-rise structures such as the “Tokyo Sky Tree.”

In advance of this tour, Prof. Toshikazu Hanazato from Mie University made a lecture on the seismic and wind-resistant performances of five-story timber pagodas as one of his specialized researches. His kind support was greatly appreciated.

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In the end, we would like to express deep gratitude to the Obayashi Foundation for their grant, and to Nara Visitors Bureau for their great support and cooperation for this forum.

The 7th China-Japan-Korea Tall Building Forum will be held in Nanjing in September 2020. ■

Photo 7 “Five-story Pagoda” in Horyu-ji Temple

Photo 8 The restoration site of “East Pagoda” in Yakushi-ji Temple

The 2nd IABSE Young Engineers Colloquium in East Asia, Tokyo 2019

by Shunichi Nakamura, Tokai University, Vice President of IABSE

The IABSE Young Engineers Colloquium (YEC) in East Asia is jointly organized by the Japanese, Chinese, Korean and Hong Kong Groups of IABSE. Following the 1st YEC held in October 2018 in Shanghai, the 2nd YEC was held on November 7-8, 2019 at Tokyo Institute of Technology, Tokyo. Prof. Yozo Fujino (Chair of the Organizing Committee) made a welcome speech at the opening ceremony. The Japanese Society of Steel Construction (JSSC) serves as a secretariat of the Japanese Group of IABSE (International Association for Bridge and Structural Engineering).

IABSE activities provide useful and educational opportunities for young engineers. YEC in East Asia was initiated so that young engineers can participate in these activities more conveniently with much lower cost both in travel expenses and registration fees (about 1/10 of the conventional symposium). Furthermore, this event encourages young engineers to be more actively involved in IABSE activities. At this YEC Tokyo there were 99 participants from not only East Asia but also Europe and Southeast Asia (Photo.1).

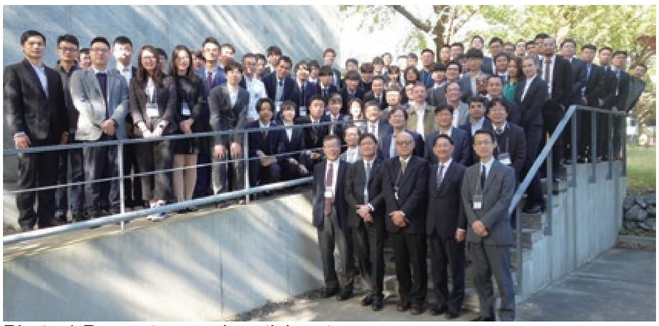


Photo 1 Presenters and participants

Programs of 2nd IABSE Young Engineers Colloquium

The program included the keynote lecture, the technical sessions and the design competition sessions. The keynote lecture, titled “Innovations for sustainable bridge construction,” was given by Dr. Akio Kasuga (Photo.2), an executive vice president and CTO of Sumitomo

Photo 2 Keynote lecture by Dr. Akio Kasuga

Mitsui Construction. He has designed more than 200 bridges and is currently deputy president of fib (Fédération internationale du béton). The lecture shows a way to sustainable bridge construction with non-metallic and long-life bridges. It was useful and educational for young engineers.

The design competition was held for footbridges which was assumed to cross over the Sumida River with a river width of 160 m. Various types of bridges were proposed such as suspension bridges, arch bridges, truss bridges, floating bridges with different construction materials such as steel, concrete and timber. The first place of the Design Award was conferred to a stress-ribbon bridge stiffened with arch ribs (Photo 3) designed by the Tongji University Team, Zhanhang Liu, Ao Wang and Lanxin Luo, China (Photo 4). The two runners-ups were the floating timber bridge designed by the Seoul National University student, Rudolf T. Starossek, Korea, and the suspension bridge with PC girders designed by the Sumitomo Mitsui Construction Team, Hoang Trong Khuyen, Rankoth Kumara Chamila and Enrique Corres Sojo, Japan (Photo 4).

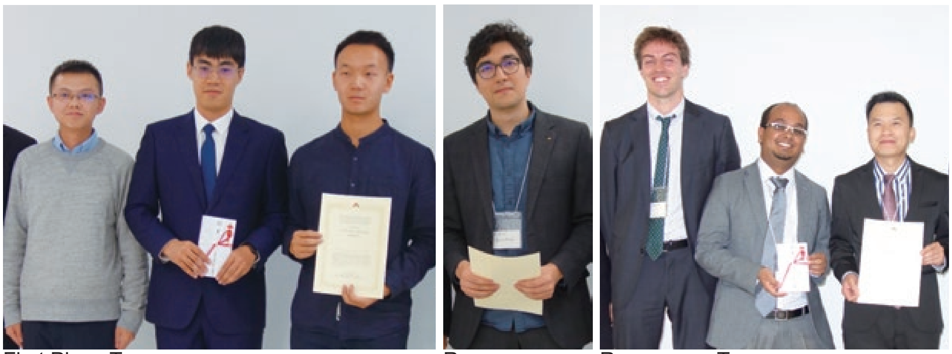
At the technical sessions, a total of 42 young engineers (15 from Japan, 21 from China, and 1 from Korea, 2 from Hong Kong, 1 from Thailand, 1 from Viet Nam and 1 from Germany) presented interesting research papers and technical reports of construction projects. The topics covered wide aspects of structures: design and construction of bridges, buildings and tunnels, health monitoring, structural materials, design against winds and earthquakes, fatigue and durability, and so on. After presentations were finished in a session, all of the presenters were back on stage and Q&A and discussions were carried out between presenters and audience, which was very active (Photo.5). The Outstanding Presentation Awards were conferred to three presenters (Photo 6): Ms. Dorina Siebert (Technical University of Munich, Germany), Ms. Sanako Kato (Gifu University, Japan) and Mr. Biao Tan (Tongji University, China).

The technical boat tour was carried out to see bridges over the Sumida River in the afternoon on the second day (Photo 7).

3rd IABSE Young Engineers Colloquium

The 3rd IABSE Young Engineers Colloquium in East Asia will be held at Seoul National University, Korea, on 11 and 12 November 2020. ■

Photo 3 The First Place Footbridge of Design Competition



First Place Team Runners-up Runners-up Team

Photo 4 Winners of design competition

Photo 6 Awarded Three Outstanding Presenters

Photo 5 Discussion with presenters and audience

Photo 7 Bridge boat tour on the Sumida River

268 Orchard Road

—Stainless Steel Glass Box Façade—

by Tomomi Kanemitsu, Hidemi Nakashima and Masaki Yamada, Shimizu Corporation

Introduction

Building façades are important aspect from the design standpoint. Glasses are often used for expressing transparency of the façades. In Singapore, a commercial building with a large glass box façade was completed in 2015 (Photo 1). The façade consists of three boxes with glass roofs and glass walls. The frames supporting the glasses are made of stainless steel. They are formed of slender members and neat joints and fabricated by digital technology. The façade design concept of transparency is realized by the glasses and special frames with its material, structural system and digital fabrication.

Photo 1 Exterior and interior views

Structural Design

The building has twelve stories with 72 m height and one basement. The building consists of a three-stepped main structure, façades and a front entrance with a canopy. The glass box is formed of plate glasses supported on the stainless steel lattice frame (Fig. 1).

The roof structure is formed by the lattice frame, the struts and the net structure. The cross sections of the lattice frame, the struts and the tension net are the v-shaped section, the pipe section and the circular section (rod) respectively (Fig. 2). In the design of the tension net, only tensile force is considered, therefore, the members of the tension net can be slender.

The wall structure is formed by the columns, the horizontal beams, the struts, the bow strings and the wall support rings (Fig. 3). In the design of the strings and the rings, only tensile force is considered, therefore, the members can be slender.

The material of the members of the glass boxes is stainless steel. Selection of material is based on the design

Fig. 1 Outline of Front Façade

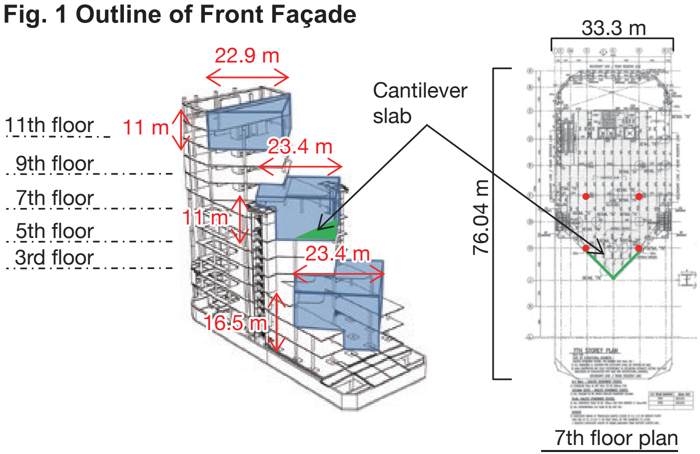


Fig. 2 Vertical Load Resistant Mechanism

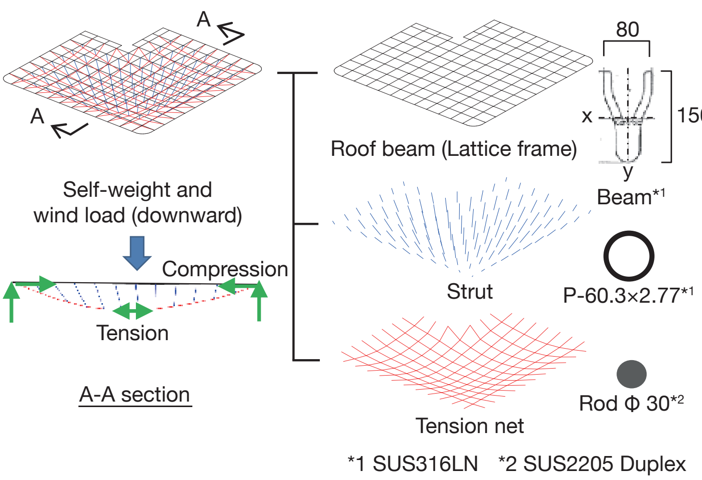
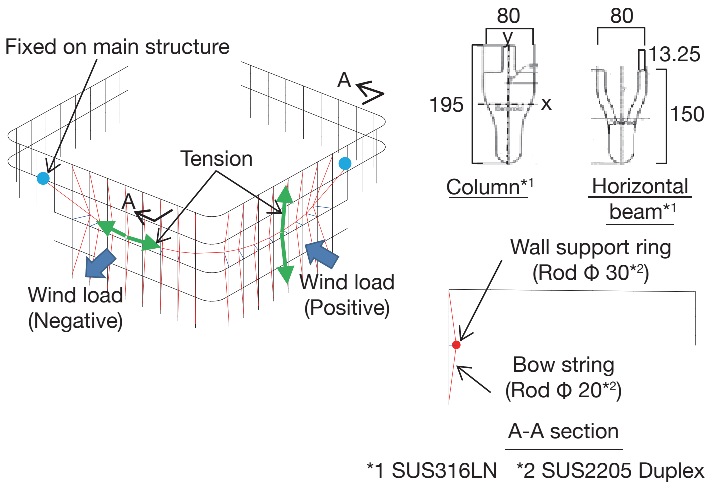


Fig. 3 Horizontal Load Resistant Mechanism



concept of structural safety, corrosion resistance and construction performance. The materials with both high strength and high corrosion resistance are used in the main structural members considering reduction of the sizes of the cross sections and sustainability.

Photos 2 and 3 are examples of the frame joints. In the design of the joints, the followings are considered:

- The structures of the glass boxes are stable in strength and in stiffness;
- Jointing works in the construction field are easy;
- The appearances of the joints meet the design concept of transparency

The flexible stiffnesses of the joints are designed through buckling analysis.

Construction

The strength and the stiffness of the glass box structures depend on pre-tension values installed into the members of the tension structures. The frames supporting the glasses deform by pre-tensioning. Therefore, the glasses are installed after pre-tensioning. The self-weight of the glasses deflects the roof frames downward. The downward deflection needs to be managed for providing drainage slope of the roof surface. The dimensional accuracy of the members and the joints affects the erection accuracy. From the above, the management of pre-tensioning and the dimensional accuracy is critical in the construction process.

Processes in the shop fabrication are mainly machining and assembling by welding. Shop drawings are produced using 3-dimensional CAD. Digital data of the shop drawings are transmitted directly to machining facilities (Fig. 4).

Critical control points of welding are as follows:

- Select appropriate welding methods including selection of welding material;
- Select certified skilled welders;
- Conduct appropriate inspections in the welding process

Especially for site welding, many welding tests simulating the actual conditions of the construction site are performed (Fig. 5). ■

(a) Upward view

(b) Downward view

Photo 2 Joint of roof beam

Photo 3 Joint of tension rod

Fig. 4 Digital Fabrication

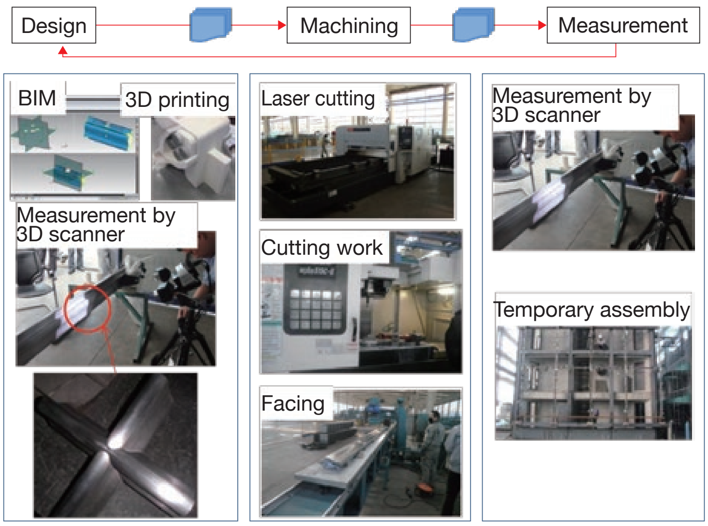


Fig. 5 Welding Management

(a) Shop welding test

(b) Ultrasonic test

(c) Field welding test

*Finishing is done after welding.

Kamihirai Flood Gate

—Retrofitting by the Use of Alloy-saving Duplex Stainless Steel—

by Yuji Shuto, IHI Infrastructure Systems Co., Ltd.

The Kamihirai flood gate, located at the juncture of the Nakagawa River and the Ayase River in the suburbs of Tokyo, was completed in 1970 to prevent the running-up of high tides. In the current retrofitting project, the flood gate is entirely renewed and seismically retrofitted so that the gate can retain its function as a flood gate and prevent inundation due to tsunamis even in cases when the possible maximum-scale earthquake will occur. (See Photo 1)

The flood gate adopts a pipe Vierendeel-type structure, the only such example in Japan, and in its retrofitting project, an identical type is adopted.

Outline of Gate Structures

Alloy-saving duplex stainless steel (JIS SUS323L) was adopted as the structural member for the gate structure in the current retrofitting project. Because the flood gate is located in a brackish water zone, it is required for the structural member for use for flood gate to possess pitting corrosion resistance. Alloy-saving duplex stainless steel offers high performance—the steel has pitting corrosion resistance higher than that of SUS316L and a strength about twice that of SUS316, and in addition its cost is lower than SUS316.

Another advantage brought about by the use of alloy-saving duplex stainless steel is no need for coating in practical applications. It is known from comparison study results that, when a 50-year life cycle is taken into account, the life-cycle cost of this stainless steel is better than that of ordinary carbon steel (SS400 steel for general structure+coating) having the lowest initial cost.

Outline of Renewal Project
Project owner: Tokyo Metropolitan Government
Project name: Seismic retrofitting of Kamihirai flood gate
Scope of work: Gate structure, gate stop, opening/closing device, operation control equipment, operation bridge
Location: Katsushika-ku, Tokyo
Total weight: 2,150 tons

Outline of Flood Gate
Type: Pipe Vierendeel-structure steel roller gate
No. of gate: 4
Span length: 30.000 m
Gate height: 11.100 m
Lift: 8.900 m during operation, 9.700 m during maintenance/inspection
Water seal system: Both-side three edges rubber seal
Opening/closing system:
1-motor, 2-drum wire rope winch system (attached with self-weight closing function by means of hydraulic control)
Opening/closing speed:
1.0 m/min
3.3 m/min (high speed) and 1.0 m/min (low speed) during self-weight closing

Manufacture of Gate Structures

The temporary assembly of the gate structure is commonly undertaken setting the skin plate to the upper side. Because a special structural system called the pipe Vierendeel structure (arch girder for the girder side) is adopted, temporary assembly is undertaken setting the skin plate to the lower side and the arch girder to the upper side (Photo 2).

(Continued overleaf)

Photo 1 Full view of the flood gate before retrofitting (from upper stream side)

Fig. 1 Three-dimensional Model of Gate Structure

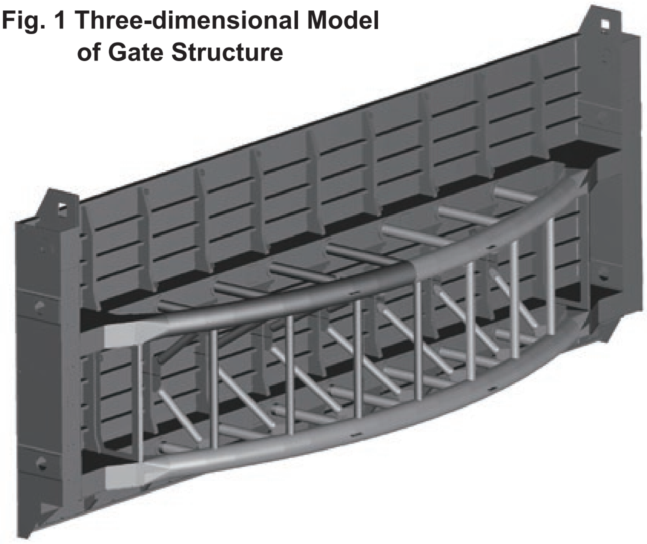


Photo 2 Temporary assembly at fabrication plant

On-site Installation

The retrofitting project is proceeding in accordance with the following installation plan. Specifically, each one of a total of 4 gates is installed throughout the year in a dried environment using steel temporary cofferdams while making possible the operation of 3 gates in flood season and 2 gates in the non-flood season.

• Removal of Operation Bridges

In the removal of operation bridges, the entire operation bridge structure is hung out by means of a co-hoisting method using two 200-ton hoisting crane barges and without dividing the operating bridge structure (Photo 3).

• Installation of Gate Structures

The gate structure is carried on to the site by dividing the total structure to 10 blocks on skin plate side, 3 blocks of arch girders and arch supporting members depending on the transport condition. Photo 4 shows the present renewal conditions. ■

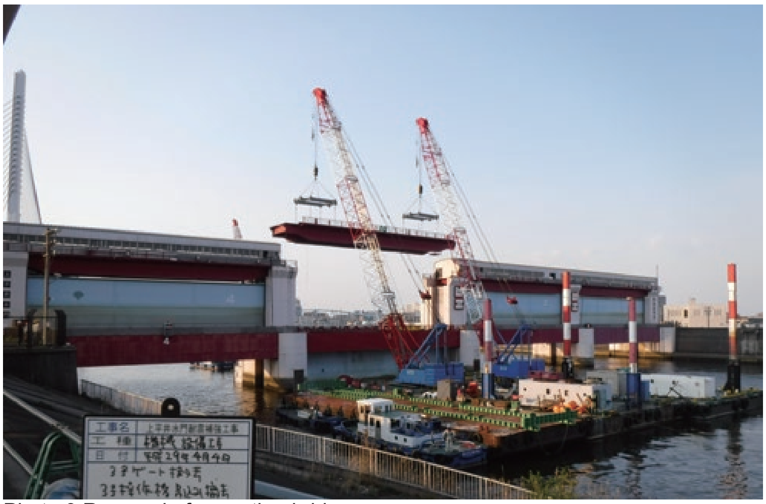


Photo 3 Removal of operation bridge

Photo 4 Current on-site condition

JSSC International Committee

Message from Chairman

by Hiroshi Katsuchi, Chairman, International Committee (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 overseas organizations. 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. 59 issue.

No. 59 issue introduces 2019 JSSC commendations for outstanding achievement in steel construction and thesis. In addition, this issue features reports of the 12th Pacific Structural Steel Conference (PSSC) held on November 9 to 11 in Tokyo. It followed the last PSSC in 2016 in China and this time was organized by JSSC. As reported inside, it was very successful with more than 300 participants from 21 countries. JSSC also organized two other international activities in 2019. Those are the Tall Building Forum of the Council on Tall Building and Urban Habitat held in Nara, Japan in July, and the 2nd IABSE Young Engineers Colloquium in East Asia held in Tokyo in November. In particular, the Young Engineers Colloquium organized not only technical presentations but also bridge design competition for the first time. Construction reports of a new commercial complex “268 Orchard Road” in Singapore and flood gate seismic reinforcement using duplex stainless steel are also included.

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

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