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PHOTO: CENTRAL JAPAN PHOTO: SS

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Feature Articles: Japanese Steel Construction Technologies

The Pacific Structural Steel Conference (PSSC) is planned to be held in Tokyo in November 2019. With regard to the PSSC 2019 in Tokyo, the feature articles in Issue No. 56 highlight five notable steel-structure technology projects ongoing in Tokyo, among which are advanced facilities with distinctive features being prepared for the Olympic and Paralympic Games Tokyo 2020 in addition to a large-scale renewal project being promoted in the expressway network in Tokyo.

On the occasion of the PSSC 2019 and the Tokyo 2020 Games, we are hoping that many readers will visit Japan to make site visits to these latest facilities and to further seize for the opportunity to obtain new knowhow and to develop ideas involved in steel construction.

Feature Articles: Japanese Steel Construction Technologies (1) Renewal Project for Route 1 Haneda Line

by Shigeru Ihara, Metropolitan Expressway Company Limited

Background

In the Route 1 Haneda Line of the Metropolitan Expressway network in Tokyo, the section at the Higashi-Shinagawa pier area and its adjoining Samezu reclamation area (Fig. 1) commenced service in 1963, and about 55 years have passed since then. The daily average traffic volume of the Haneda Line is about 70,000 vehicles.

The total length of the renewal project currently being promoted in this section is 1.9 km. Of this total length, about 1.3 km section at the Higashi-Shinagawa pier area is located on the Keihin Canal and close to the sea surface (Photo 1), which thus poses difficulties in carrying out inspections. On the other hand, about 0.6 km section at the Samezu reclamation area is located on reclaimed land using steel sheet pile revetments (Photo 2), where the highway structure is subjected to salt damage, and as shown in Photo 3, significant peeling-off of concrete and corrosion of reinforcing steel bars have

Fig. 1 Section of Renewal Project for Route 1 Haneda Line



developed.

Given such environments, the project is being promoted as a large-scale renewal project that aims to ensure long-term durability and future maintenance management. On-site renewal work started in February 2016.

Structural Outline of Renewal Route

The Higashi-Shinagawa pier section



Photo 1 Higashi-Shinagawa pier area



Photo 2 Samezu reclamation area



Photo 3 Peeling-off of concrete and corrosion of reinforcing steel bars

is reconstructed to a viaduct as shown in Fig. 2. The superstructure is designed as a continuous steel plate girder bridge, and a scaffolding for permanent use is installed on the outer side of the bridge to secure maintenance performance.

The steel-structure pier is adopted for the bridge pier. Alloy spraying and heavy-duty coating are applied as corrosion-protection measures for the structural section located in the marine atmospheric zone, and a highly corrosion-resistant stainless steel lining is applied for the section located in the splash to underwater zones. The precast/prestressed concrete slab is adopted for the floor slab. For the foundation structure, the steel pipe sheet pile foundation is adopted that allows for a planar compact design.

In the Samezu reclamation area, in order to secure the road surface with a height greater than that of flood tides, a structural system is adopted in which the precast box that can secure inspection space on the solidly improved existing ground is connected with each of the box by the use of prestressed concrete cables.

Fig. 2 Renewal Image of Higashi-Shinagawa Pier Section



Renewal Steps

In order to avoid the long-term closure of the Route 1 Haneda Line, the renewal process is being promoted step by step while appropriately controlling traffic in service, as shown in Fig. 3.

In Step 1, in order to control inbound lane traffic on the Haneda Line, traffic is closed at Oi Junction, and a detour is constructed. In Step 2, the existing inbound lane of the Haneda Line is demolished, and a renewal inbound lane is constructed.

In the event of the Tokyo Olympics and Paralympics Games to be held in 2020, as shown in Step 3 in Fig. 3, the inbound lane of the Haneda Line is operated on a detour, and for the outbound lane of the Haneda Line, the renewal inbound lane will be operated temporarily as an outbound lane. In Step 4, the outbound lane temporarily in use for the renewal inbound lane will be switched to the renewal outbound lane, and the inbound lane that is temporarily operated as the detour will be switched to the renewal inbound lane. Finally, the detour will be removed.

Important Test for Future Highway Renewal Projects

Capitalizing on precast members and other rapid construction methods, the detour was put in service on September 14, 2017, about one and a half years after the start of the on-site renewal work. Photo 4 shows the condition in which corrosion-protection measures were applied to the steel bridge pier by means of highly corrosion-resistant stainless-steel lining. Currently, the construction of superstructures and bridge piers for the new inbound lane has reached its peak period (see Photos 5 and 6).

The renewal project for the Route 1 Haneda Line introduced above is the first case of its kind in Japan. The project is positioned as an important test for large-scale highway renewal projects to be promoted in the future. ■





Photo 4 Highly corrosion-resistant stainless steel lining



Photo 5 On-site condition (inbound for urban center of Tokyo)



Photo 6 On-site condition (left: renewal inbound lane under renewal)

Feature Articles: Japanese Steel Construction Technologies (2)

Ariake Arena -Seismically-isolated Large-space Roof Structure-

by Yuki Hamada, Takenaka Corporation

Outline of Building Plans

Ariake Arena is planned to be used as the indoor stadium for two games at the Olympic and Paralympic Games Tokyo 2020-the stadium for Olympic volleyball and Paralympic wheelchair basketball. It is an arena facility composed of a main arena that can accommodate about 15,000 spectators and a sub-arena that is located at the south side of the main arena. After the Olympic and Paralympic Games, plans call for the arena as a venue for not only sports events but also concerts and so on.

The main arena has a configuration in which the exterior wall upwardly opens

outwards and the roof inside the arena is structured in a downwardly convex form. Under the restricted site conditions, certain devices are incorporated so that the air volume inside the main arena is minimized while securing the spectator capacity. Table 1 shows an outline of the arena and Fig. 1 an illustration of the arena's appearance upon completion.

Construction is steadily ongoing with completion targeted around the end of 2019.

Fig. 1 Illustration of Completion of Ariake Arena

of the roof section during earthquakes, a steel-frame structure is adopted and

spectators.

Outline of Structural Planning

Directions in Structural Planning

The main structure of the stand section

is planned as a reinforced-concrete struc-

ture with high stiffness from the view-

point of preventing vibrations due to

excitation caused by a great number of

corners that carries the horizontal force

For the core framing structure at four



(As of October 2015, Tokyo Metropolitan Government)



Fig. 2 Structural Diagram of Main Arena and Sub-arena

planned to have sufficient redundancy in terms of both stiffness and strength.

For the roof structure, the steel-frame plane truss is adopted on the premise of erecting the large-space roof by the traveling construction method. Further, in order to mitigate the danger of falling ceiling and suspended equipments during great earthquakes, a seismically-isolated roof structure is adopted in which the isolation devices are arranged just beneath the roof.

Fig. 2 shows a structural diagram of overall arena structure.

• Plan for Stand Structure and Core Framing Structure

For the erection of the stand structure, it is planned to adopt precast structural members as much as possible from the perspective of enhanced labor-saving. Further, in the column section that supports the roof, the ribbed wall is arranged to secure the stiffness itself, and the roof supporting points are adjusted in order to cause no bending moments at the column bottom in the long-term loading.

For the core framing structure at the four corners, buckling-restrained braces are arranged to ensure high stiffness and strength. The structural members to be installed in the boundary between the core framing structure and the stand structure are reinforced to integrate these two structures.

• Plan for Roof Structure

The roof structure is composed of 22 main trusses and 7 connecting trusses as arranged orthogonally to the main truss. The main trusses are arranged at 6-m spacing, with a truss depth of about

 $6.4{\sim}9$ m, and a roof span of approx. 120 m.

In the erection of the roof structure, the traveling method is adopted in which each truss is assembled one by one on a temporary platform to be installed on the sub-arena and the trusses thus assembled are sent out in an orthogonal direction to the main truss. In order to secure the selfstanding stability of the roof under construction, the roof truss is designed as one-way truss for dealing with long-term loading, and as two-way truss for dealing with short-term loading due to wind and seismic loads. On the top surface of the roof, the horizontal brace is arranged to secure in-plane stiffness. On the bottom surface, the lower chord of connecting truss is arranged to secure in-plane stiffness. In addition, the steel beam that also serves as the catwalk bed arranged orthogonally to the main truss is planned to have a function as a lateral stiffening member for the main truss lower chord to which compressive force is partly applied during earthquakes.

In order to improve the sound insulation performance for neighboring areas and to realize various suspending arrangements during events, a structural feature is cited—the total weight of the roof structure of the main arena is heavier than that of common large space roof structures.

Plan for Seismic-isolation Layer

Because the roof supporting section of the stand structure has cantilever columns with comparatively small stiffness orthogonally to the exterior wall, lowfriction sliding supports with rubber-pad (SSR) are arranged so that the horizontal force occurring in the roof section is not transmitted to the stand structure during earthquakes.

In the core framing structure that can secure high stiffness in every direction, it is planned that lead rubber bearing (LRB), rubber bearing (RB) and oil damper (OD) are arranged so that the horizontal force occurring at the roof section is intensively transmitted to the core framing structure. On the top of the north and south exterior walls, two cross linear bearings (CLB) are arranged to control vertical deformation during wind and seismic loading. Fig. 3 shows a structural diagram of the roof structure and seismic-isolation layer.

Outline of Roof Steel Framing Erection and Traveling Construction

In the assembly of the roof steel frames, it is planned that the truss will be divided into five portions; the truss members are assembled on the ground, and then hoisted on the temporary platform about 20 m above ground; and the roof steel frames are assembled.

For the traveling construction, the common practice is to send out steelframe truss by a span. However, in the current traveling plan, it has become clear from the preliminary structural analysis in accordance with the roof erection procedure that deformation in an orthogonal direction to the main truss becomes larger because the depths of neighboring trusses differ and the roof finishing load is comparatively large. Therefore, a large block composed of as many as five trusses will first be assembled to secure stiffness in the orthogonal direction to the main truss. Fig. 4 shows an illustration of the traveling construction method.





Fig. 4 Illustration of Traveling Construction Method



Feature Articles: Japanese Steel Construction Technologies (3) **Ariake Gymnastics Centre** -Complex Structure Combined with Timber BSS and Cantilever Trusses-

by Yoshisato Esaka, Nikken Sekkei Ltd. and Takayuki Nishiya, Shimizu Corporation

Ariake Gymnastics Centre

The Ariake Gymnastics Centre is one of the major facilities being prepared for the Tokyo 2020 Olympic and Paralympic Games. For the events of the Olympic Games, it will be used as a stadium for gymnastics, rhythmic gymnastics and trampolines, and while for the Paralympic Games it will be used for boccia (precision ball sport). After the conclusion of the games, the stadium will be used as an exhibition hall.

"Extensive application of timber members in facility construction and sustainability," the two major schemes in facility construction stated in the Tokyo 2020 Candidate File, are positively embodied in the Ariake Gymnastics Centre design. The defining structural feature is the large indoor space, spanning approximately 90 m, which is realized by means of wooden construction employing large-section laminated lumbers.

An outline of the building is shown in Table 1.

Fig. 1 Bird's-eye Perspective View of Ariake Gymnastics Centre*



(*Courtesy of The Tokyo Organizing Committee of the Olympic and Paralympic Games, Completion image as of November 2017)

Timber

Fig. 3 Structural Outline



Table 1 Building Outline

Table i Ballallig Gatillo	
Planned location	Ariake 1, Koto-ku, Tokyo
Building area; Total floor area	About 21,200 m ² ; About 39,300 m ²
Fire-proof building	Root C (ministerial approval)
Height	About 30 m
No. of stories	3 stories above ground
Structure	Roof: Timber structure, partly steel structure Lower part: Steel structure (moment frame structure with braces) Foundation: Pile foundation (precast pile)
Structural calculation route	Route 3
Basic design, design development/detail design supervision, construction supervision	Nikken Sekkei Ltd.
Design development/detail design and construction	Shimizu Corporation
Technical guidance	Masao Saitoh

Architectural Design and Structural System Architectural Design

The current building has two major architectural features: firstly, an extremely flat arch configuration and lightweight, sharp appearance which is brought about by means of the deeply protruding eaves (Fig. 1); and secondly, a dome space structured by the use of wooden members (Fig. 2).

Fig. 2 Inner View Perspective View of **Ariake Gymnastics Centre***

Timber



Structural System

In order to harmonize this architectural design with structural mechanics and to ensure construction rationality, we proposed the structural system that is comprised of a Complex Structure combined with Cantilever Trusses and Beam Strings Structure (BSS).

A large space with a span of approximately 90 m is provided by the combined use of the cantilever trusses (9.6 m) arranged at both ends (composed of steel frames and laminated lumber) and the BSS (69.6 m, @7.2 m) arranged in the center section (composed of laminated lumber, cables and struts). This is illustrated in Fig. 3.

BSS is a self-balanced structure that is comprised of three main elements: by the upper chord timber beam which acts as a flexural and compression member, the steel cable (string) which acts as a tension member, and finally the axial compressive struts to connect them. In order to make use of the self-balanced feature of BSS, a lift-up erection method is proposed (Fig. 4). As a result, a structural system is realized in which the thrusting force resulting from the dead weight of the roof does not occur and in which the arch structural resistance to the load of BSS is demonstrated after the erection. Further, taking into account the occurrence of diverse kinds of loads, sub-cables (sub-strings) are proposed so that the stiffness and strength of the roof are improved. In the long-side direction of the roof, identical framings composed of 15 planes of structures are continuously arranged, and further structural plywood having a thickness of 28 mm is arranged horizontally on the entire surface of the roof.



Outline of Roof Structural Design Design Loads and Design Outline

Two erection procedures (tension introduction and lifting-up) were considered when examining the sustained load.

Two main variations of snow loading are considered for the roof—a uniform snow load of 750 N/mm², determined by taking into account an increment coefficient α =1.21 (in consideration of rainfall after snowfall), and unbalanced loading (one-side eccentric and center eccentric) that is unfavorable for the arch structure.

The wind load is calculated based on wind tunnel test results, as well as code-based calculations in compliance with the Building Standard Law of Japan and the Architectural Institute of Japan's (AIJ) *Recommendations for Loads on Buildings (2015)*. Additionally, it has been confirmed that the tension forces in the main cables do not disappear when there is uplift of the roof due to wind loading.

For the roof seismic loading, a combination of static loads, a lateral seismic coefficient of 1.35G and a vertical seismic coefficient of ± 1 G, are adopted. Further, the stress in the structural members occurring in the anti-symmetric-mode during horizontal seismic motion is confirmed using time-history response analysis.

Detail of Joints

Fig. 5 shows the position of respective joints. Because BSS system spans approximately 70 m, it is composed of curved beams divided into 5 separate sections.

Fig. 6 Joints for Lifting-up



Therefore, it is necessary to provide 4 joints. In connecting the timber members at the end of each section, GIR (glued-in rods) joints using adhesives and steel re-inforcing bars are adopted. These benefit from high strength and stiffness, and are concealed so that they do not hinder the architectural design.

For the joining of the cantilever trusses and BSS, the high-strength bolt friction joining method is adopted (Fig. 6 and Photo 1). The end of the cantilever truss sections experiences vertical deformations by about 40 mm and horizontal deformation by about 20 mm during lifting. As such, a slotted hole design is adopted (torque-shear type S14T and M24 bolts, minor axis 30 mm, major axis 60 mm, aluminum-sprayed friction surface, acquisition of ministerial approval). A wooden cover is then attached to the joint section, to which some final finishing is applied so that the timber arch appears continuous.

In the cable joining section, the sliding force is usually transferred by means of the friction that occurs due to the bolt fastening force of the steel clamp. However, the large sliding force requires a correspondingly larger steel clamp. To overcome this, a transfer mechanism by means of bearing pressure is proposed and adopted in the roof erection (Photos 2 and 3). The adoption of the approach mentioned above allows for the reduction of the steel clamp size to about half compared to the case of transfer by means of friction. To that end, it becomes possible to adopt a smaller-size lower steel clamp that is not very eye-catching.



Photo 1 Joints for lifting-up

• Erection and Roof Lifting-up

The stress and shape (span) of the roof are controlled by the use of cable tension force on the erection platform installed on the ground.

In the lift-up plan, three planes of structures are set as a unit (69.6 m in length, 14.4 m in width and about 2,000 kN in weight), which is lifted up toward the cantilever trusses installed at a height of 19 m and at a lifting speed of about 5 m/hour (Photo 4). A total of five lifting operations are carried out at a pace of one operation every two months. ■



Photo 2 Model of steel clamp



Photo 3 Steel clamp



Photo 4 2nd lifting-up

Feature Articles: Japanese Steel Construction Technologies (4) **Olympic Aquatics Center** —Structural Features and Construction—

by Yasuhiko Asaoka and Kazuaki Abe, Obayashi Corporation; Tatsuya Kataoka, Yamashita Sekkei Inc.; and Ikuhide Shibata, Ove Arup and Partners Japan Ltd.

Outline of the Project

Olympic Aquatics Center is swimming competition venue for Tokyo Olympic and Paralympic Games 2020. The footprint is approximately 200 m in southnorth (longitudinal) direction and 130 m in east-west (transverse) direction. The building is 34 m high, and 4 stories above ground and 1 story underground, consisting of main arena and sub-arena. The main arena has main pool of 50 m long and diving pool of 5 m deep, and the sub-arena has another pool of 50 m for preparation at the time of Olympic and Paralympic Games.

The structural feature is represented by the roof covering the main arena, the sub-arena roof and the perimeter columns around the main arena. These elements are characterized both in structure and construction way and the following chapters explain each element. (Figs. 1, 2)

Design Approach

The perimeter column supporting grandstand is slender steel column covered with prestressed concrete to prevent from buckling and satisfy with fire and rust resistance, inspiring traditional Japanese style. The column is precast at fabricator and is erected at site as if it were steel column. This can be possible because at the end of column, the steel column is exposed while the other part is covered with concrete, and only steel is connected by welding at site without the rebar of concrete being free from joint. The upper part of perimeter column is designed as prestressed composite column, aiming not to cause crack. Once crack happens, the restriction of steel buckling by concrete becomes slack and the buckling resistance goes down. And any crack reduces durability and aesthetic sense as well. (Fig. 2)

The sub-arena roof is total of 43.2 m span beam consisting of the prestressed precast concrete beam of 36 m long and steel truss of 7.2 m long, adding aesthetic sense to the sub-arena. The concrete beam gives enough stiffness to the roof as entrance approach. The beam is designed to be in compression against dead and imposed load. This means cracks are not likely to happen, giving durability in wet condition. The concrete beam dived into units are precast at fabricator, assembled at construction site and tied by prestressed cables. (Fig. 2)

The main arena is covered with the steel truss roof spanning 130 m in longitudinal and 80 m in transverse direction, giving column-free space to main arena. The roof soffit is concaved by 1.5 m at center, giving comfortable atmosphere. The roof truss is supported by rubber bearings at each corner cores. The bearing rubber works as isolator to swap seismic input and to separate the behavior of the roof from that of the superstructure, and also as buffer to absorb thermal extension and shrink. (Figs. 2, 3)

Lift-up Construction and Structural Design

The main arena roof truss is erected at lower level for easy, safe and quick construction, and lifted up from four corner cores to the designed level. Each corner core has eight oil jacks with the center of them coinciding with the center of rubber bearing. The structural design requires that two rubber bearings take equal loading from the roof. In order to make this happen, these jacks are controlled so that they carry same load, resulting in the roof deforming as if it is supported equally by two rubber bearings at each corner core. And the two rubber bearings can take the same load if the roof is rest on the rubber bearing with keeping its deformation when it is hung from these jacks, otherwise inside



Main arena

Fig. 3 Roof Plan



Sub-arena

rubber takes most of the load, resulting in onerous tension at outside rubber due to wind. (Fig. 3)

The interface between roof and corner core is also designed so that the roof can rest on the bearing rubber with keeping its deformation shape. The interface between the roof and the bearing rubber is spherical bearing to fit the rotation of the truss, and the bearing rubber rests on concrete stub base poured in situ, so that its level can be easily adjusted to the truss deformation. The anchor bolt is slotted into concrete filled tube incorporating into support beam from corner core. (Fig. 6)

Outline of the Roof Steel Work

The roof truss assembling at construction site begins with the main truss in longitudinal direction at first. And sub-truss between the main trusses comes next and cantilever in east-west direction follows it. The main truss in transverse direction and the cantilever from it are erected at last. The temporal supports are removed except under the main truss before liftup.

The main truss in south-north direction is cambered by about 500 mm at middle so that it becomes flat after lifted up. On the other hand, the main truss in east-west direction and the sub-truss are flat in order to avoid making steel fabrication complicate. However, the cantilever truss in south side is cambered to make flat edge as front façade.



Photo 1 Overall view before lift-up



Photo 2 Monitoring system view

Outline of Lift-up

Lift-up is carried out by the following three steps before lifting down to the bearing rubber. The deformation of the roof is monitored throughout every step with monitoring system developed for this project. (Photos 1, 2)

At Lift-up 1, the roof floats off from temporary support by 1.7 m. Most of roof deflection takes place at this stage and finish work hereafter becomes free from excessive deflection. And this roof level allows access to ceiling work by high deck vehicle.

At Lift-up 2, the roof is pulled up by another 5 m so that central main monitor can be hung from the roof.

At Lift-up 3, the roof reaches at the 500 mm above designed level. At this stage, the roof support cantilever beams under the bottom chord of the main truss are welded to the corner core column.

The bearing rubbers are set on the cantilever beam so that its position fits to the roof deformation, which makes the rubber bearings take equal loadings.

At the last step, the roof lifts down and all the tension force in the strand cable transfers to the compression force in the rubber bearing. (Figs. 4, 5, 6)

Conclusions

These elements feature Olympic Aquatics Center as Olympic and Paralympic venue and offer appropriate quality of space for the event with proper technics. ■



Fig. 6 Interface of Main Roof Truss and Rubber Bearing



Feature Articles: Japanese Steel Construction Technologies (5)

by Osamu Hosozawa, Taro Mizutani and Shinichiro Kawamoto, Taisei Corporation

The New National Stadium is a facility that is also used as the venue for the Tokyo Olympic Games and Paralympic Games in 2020. This stadium is hoped to become a place where all athletes can show their best performance, and to be loved and used frequently by people of future generations. Based on the concept of "Stadium in Forest," the new stadium is open to everyone. Becoming a part of the forest of Meiji Jingu Shrine, it will form a green network spreading from the Inner Garden of Meiji Jingu Shrine to the Imperial Palace, and become a "new center of sports cluster" where everyone can enjoy taking walks and various types of sports. (Refer to Fig. 1)

Building and Structural Outlines

The maximum building height is 50 m or less, and the low slope roof consists of a cantilever truss structure of about 60 m in length (Fig. 2). The sense of oppression to the neighborhood is reduced through building setback from the street, with the inclined outer columns. The main structure of the stadium is a steel structure above ground. A steel-reinforced concrete structure using precast and prefabricated products is adopted for the oblique beams (i.e. the raker beam), which supports spectator seats, and for the outer columns, which support the roof truss. Furthermore, the response controlled structure by Soft-First-Story

Fig. 1 Image of Aerial View from Southeast

The renderings are intended to show conceptual image at completion and may subject to change. Vegetation shows an image about 10 years after completion of the stadium.

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system provides a high seismic performance to this stadium.

The hybrid structure composed of the wood and steel materials for the lower chords (Japanese larch) and the lattice members (Japanese cedar), arranged in the three dimensions of roof trusses, creates a space where Japanese features can be felt sufficiently. The wood is used as the member that controls the deflection of trusses caused by earthquakes and strong winds.

Simple Stand Structure in Consideration of High Constructability

By employing the same frame composition repeatedly in the circumferential direction for both roof and stand frame systems, productivity, transportability, efficiency of drawings production, and constructability are improved, which results in the thorough reduction of construction period and cost (Photo 1).

Further, considering the manpower shortage at current construction sites and the efficiency of construction site work by unitization, promotion of factory prefabrication is planned. In particular, the unitization of the roof trusses, the precastization of the foundation and the outer SRC column, and the proactive use of prefabrication products are planned.



Cantilever Roof Frame That Can Be Built Efficiently

The roof truss is unitized to achieve efficient construction, and reduce the construction period. By creating a one-frame free-standing structure of cantilevering truss, simultaneous construction of the stand, the field, and the roof portion can be achieved (Fig. 3).

The roof frame adopts a frame system that has cantilever space trusses with triangular cross sections continuously arranged in the circumference direction. Two upper chords and one lower chord are connected using lattice members in three dimensions. Lattice members contribute to avoid buckling of the upper chords and the lower chord and behave as horizontal braces in the roof surface. The roof is united by joining the web of the upper chords of each unit by the use of high-tension bolts. Upper chord adopts channel steel (Photo 2).

Response Controlled Structure by "Soft-First-Story" System with High Seismic Performance

In consideration of the unspecified number of people using the stadium, we decided to give higher seismic performance than that of general buildings.

Generally, the oblique beams of the stand (i.e. the raker beam) that support spectators' seats, behave as brace members, achieving a high seismic resistance. However, its high stiffness leads to a short natural period. Therefore, when time history response analysis is carried out to confirm the structural integrity, the results of response are generally so large that it isn't possible to design the building within its structural criteria. To deal with this, it is necessary to add responsecontrol devices that absorb earthquake energy, or to make the natural period of the building longer. However, even if additional damp-

At this stadium, the natural period of the lower part frame is prolonged as in a base isolation structure (soft story), and the response-control devices (oil damp-

longed.

base isolation structure (soft story), and the response-control devices (oil dampers) are arranged there concentrically. This creates the response controlled structure by the Soft-First-Story system with high seismic performance. A less stiff story compared to the other layers is achieved by adopting a moment resisting frame of three stories, from the second floor in the basement, to the first floor above ground. By providing a soft story to the three stories, the stadium achieves high redundancy (Fig. 4).

ing is added to a building with high stiff-

ness, like a stadium, this measure doesn't

have an effect so large as to reduce the

response of a building. Then, the natu-

ral period of the building should be pro-



Photo 1 Simple structure plan Copyright © Japan Sport Council, "Regular Briefing for the New National Stadium," Made by 29th handout (October 12, 2018)



Photo 2 Roof truss section

Copyright © Japan Sport Council, "Regular Briefing for the New National Stadium," Made by 17th handout (July 28, 2017)

Fig. 3 Image of Roof Construction







Special Article: Stainless Steel **TOKYO MIDTOWN HIBIYA** —Application of Stainless Steel in Façade Design—

by Akira Kubota, Kajima Corporation

Outline of TOKYO MIDTOWN HIBIYA TOKYO MIDTOWN HIBIYA was planned as an urban redevelopment project covering the reconstruction of two noted buildings, Hibiya Mitsui Building and Sanshin Building, and the lot substitution with a street operated by Chiyoda City and sandwiched between the sites for these two buildings. The redevelopment area was designated as a National Strategic Special Zone, the first of its kind in the Tokyo metropolitan area, and the project involved the provision of industry support facilities extending to 2,000 m² in area and a business continuity plan (BCP) function including the support of those who will have difficulties in returning home for 72 hours in the event of a natural disaster. To that end, TOKYO MIDTOWN HIBIYA was planned as a new symbolic tower in the Hibiya area of downtown Tokyo.

TOKYO MIDTOWN HIBIYA is a high-rise building with 35 stories aboveground and four basements, and a height of 192 m. In the low-rise section, commercial facilities and a cinema complex are arranged, in the medium-rise section there are industry/office support facilities, and in the high-rise section there are office floors. In the aboveground structure, oil dampers and buckling-restraint braces are arranged as a response-control device to reduce seismic response. Hi-DAX-R developed by Kajima Corp. was firstly adopted for oil dampers. It demonstrates world-class response-control efficiency and ensures the high safety and business continuity performance of the building.

TOKYO MIDTOWN HIBIYA was opened to the public in March 2018.

Façade Design of TOKYO MID-TOWN HIBIYA

Under the concept of a "dancing tower," Hopkins Architects, a leading UK architectural practice, undertook the design of the building exterior as the master architect. The high-rise tower exterior with an image of elegantly dancing dresses of dancers is composed of champagne-golden aluminum curtain walls prepared by combining vertical fins with delicate details and a pleated configuration. The exterior line that draws a gentle arc has four lapped sections, and an impressive appearance is produced that gives off a florid, complex twinkling.

A dignified design employing a lot of stately stone members was adopted for the low-rise section—a design closely resembling the old Sanshin Building, which emphasizes an image of construction integrated with the neighboring Nissei Theater. The low-rise section is structured by combining 100 mm-thick pure granite finished only by means of chiseling with metallic materials prepared with thin details, which produces a design that gives a stately but sharp, elegant image—a typical design style for Hopkins Architects.

Design Details of the Façade at Low-rise Section and Stainless Steel Application

Various kinds of decorative items employing stainless steel used for the design of the façade at the low-rise section were subjected to minute technical examinations in line with the designer's intention, particularly for the application of diverse processing technologies available for the stainless steel—bending, laser processing of plates and lostwax casting method. The decorative items thus prepared by applying diverse processing technologies were rationally worked up, thereby acquiring high assessments from related fields. Not only commonly-applied SUS304 but SUS405 were applied to realize a structural system of the right materials for the right places.

The upper and lower sections, the main structure of openings in the façade, were structured using stainless steel panels that were prepared by means of bending based on fine details, in which granite frames with natural and simple feeling are arranged using a modern, sharp line (Photo 1).

The lighting equipment for illumination was assembled into the lower section via stainless steel pedestals to gorgeously direct a sunset expression rich in shadow. In the panel at the eaves soffit, a bead blasting processing was applied to the stainless steel surface in or-



Photo 1 Looking up from the low-rise section

der to restrict the illumination reflection. In this way, the building quality is further enhanced by the optimum use of the high finishing workability offered by the stainless steel.

In the second-floor corridor, the decorative mullion and glass canopy, prepared by processing stainless steel pipes and plates, were incorporated into the façade design as important accents in terms of aesthetics (Photo 2).

In order to attach importance to the relationship with the neighboring Nissei Theater, a horizontal glass canopy that gives a continued aesthetical expression was provided, producing a town design that enhances an integrated image as a street. The stainless steel pipe mullion was attached to a strut manufactured by laser-cutting 10 mm-thick stainless steel plates by the use of joining metal fittings prepared using the lost wax casting method. To these ends, the corridor was finished to a fine, sharp configurational structure. (Refer to Fig. 1)

The joint section prepared by the use of the lost wax casting method was finished by means of bead blasting. The joint thus prepared offers an elegant configuration with a tender expression,

which makes a marked contrast with the sharp stainless steel pipe and plate members. That is, the mullion and glass canopy serve as an important element in directing an impressive façade. In this way, the designer's intention has successfully and faithfully been realized by the maximum use of the flexible and diverse processing and finishing methods that stainless steel can offer.

A stainless steel panel was also used for the gate of the office entrance section. In contrast to the tower section having a sharp design, the façade at the low-rise section has an entirely elegant and stately design, and in this façade the gate is designed so that the of-





fice entrance employing stainless steel is emphasized in the total building design. (See Photo 3)

The hair line-finished stainless steel sheet applied in the panel was processed

to a detailed configuration having an extremely sharp edge, which allows for the direction worthy of the office section the direction that draws a clear line between the office and low-rise commercial sections. Further, a combination of lighting equipment high in color temperature and hair line-finished stainless steel sheeting finishes a gate that offers cool beauty.

It can be said that the high quality and flexibility offered by stainless steel has played a role in imparting enhanced gorgeousness and beauty and a high-grade appearance to the entire building structure capitalizing on Hopkins Architects' design.

Good Start as a New Cultural Base After the grand opening of TOKYO MIDTOWN HIBIYA in March 2018, it has gained a high assessment and many people have visited there. It has made a good start as a base to creating a new culture. All the parties concerned are pleased with this and also hope that the TOKYO MIDTOWN HIBIYA area will attain further development in harmony with its surrounding environment. ■



Photo 2 Decorative mullions on the second floor



Photo 3 Office entrance gate

JSSC Commendations for Outstanding Achievements in 2018—Outstanding JR GATE TOWER

Prize winners: Toshiharu Ninomiya, Yoshinori Somiya, Junji Toyama and Machiko Sugimura, and Joint Venture of Taisei Corporation and Kajima Corporation

JR GATE TOWER is a complex facility building that is connected directly with Japan Railway (JR) Nagoya Station. It is a high-rise building with 46 stories aboveground (220 m in height) and six basements (35 m in depth). (See Photo 1)

Location Conditions for Planned Site

The planned site is located in an area sandwiched between two existing railway lines that run on the east and west sides of the site. In the first to third basements, the Nagoya Railroad (MEITETSU) railway line crosses the site, and in the fifth to sixth basements, there is space of part of the station for the future Chuo Shinkansen SC-MAGLEV (bullet train line) at the site. Due to these location conditions, it has been required to provide an underground structure having a depth of 35 m in which there is a box structure for the MEITETSU railway line. (Refer to Figs. 1 and 2)

In order to cope with these strict location conditions, advance measures have been adopted-appropriate column grid plan, transfer truss plan and rectangular concrete-filled steel tube (CFT) columns.

Rectangular High-strength CFT Permanent Structural Columns

Because of the adoption of an inverted construction method, the steel frame that

PHOTO: CENTRAL JAPAN RAILWAY COMPANY



Photo 1 Appearance of JR GATE TOWER

is built-in in the underground steel-reinforced concrete column was designed as a permanent structural column. In terms of the construction process, the axial force of the column to be installed just beneath the high-rise section reaches as high as 90,000 kN at its maximum in the sixth basement (75% that at the stage of completion).

In cases when a steel-frame column is to be adopted for the column just beneath the high-rise section, its maximum plate thickness reaches about 90 mm, which poses some concerns-strict conditions for lifting the permanent structural column with lengths of 40 m or more and a significant increase of on-site welding. Then, CFT column was adopted for the permanent structural column, which led to a reduction in plate thickness to 40 mm.

Regarding the range of CFT column insertion into the pile, in order to secure the filling property of the pile concrete, it was required to adopt a cross H configuration or an open section for the pile. Then, the

Fig. 1 Location Environment for **Planned Site**

following two measures were adopted: In the range of the upper pile head section (1)in Fig. 3), the section of the steel-frame column was converted from a square configuration to a cross H configuration and further structural design was made so that the axial force borne by filling concrete was transferred to the steel frame by the use of stud bolts. In the range of the pile insertion section (2) in Fig. 3), structural design was made so that the axial force was transferred from the steel frame to the pile by the use of stud bolts and bearing pressure of the pile head. (Refer to Fig. 3)

Efforts to Meet Diverse Requirements

In the construction of the JR GATE TOW-ER, in order to satisfy diverse conditions arising from the plan, location and construction period, conferences between designers and construction companies were held from the design stage, and various kinds of tests that simulate the construction conditions were carried out.

Fig. 2 Floor Beam Framing Plan at 2nd **Basement**





Chievement Awards **KYOBASHI EDOGRAND**

Prize winners: Yuji Yamano, Kazuhiko Yoshida, Takashi Fukushima and Satoshi Yagi

KYOBASHI EDOGRAND is an urban redevelopment project promoted in the downtown of Tokyo. On the theme of securing a new pedestrian moving line due to the disuse of existing local roads caused by the enlargement of streets, a semi-outdoor open space including a galleria has been provided just beneath a high-rise office building. The final goal is to structure a dynamic space in this redeveloped area. (See Photo 1)

The structural feature lies in the adoption of an intermediate base-isolation layer in which the base-isolation layer is arranged between the galleria and the high-rise office area (Fig. 1), due to which seismic motions are reduced, and structural members other than base-isolation members can be kept in an elastic state even during large



Photo 1 Full view of KYOBASHI EDOGRAND

Fig. 1 Structure of KYOBASHI EDOGRAND





Photo 2 Full view of elastic locking mechanism

earthquakes. To that end, an open, dynamic space has been realized by making clear the flow of force in the galleria surrounded by a low-rise section composed of three blocks.

Development of New Base-isolation Members Employing High-strength Steel Products

The building constructed in the current redevelopment project is a high-rise building with a height of 170 m, which is thus subjected to large wind loads. In cases where common measures are adopted, the number of dampers to be used surpasses the optimum amount to be required during earthquakes, which causes a deterioration of the seismic response performance of the building.

To cope with such situations, an elastic locking mechanism that adopts highstrength HSA700 steel products for flexural beams has been developed and applied in this high-rise building. The application of the new high-strength base-isolation steel members not only solved the task pertaining to wind resistance but also realized a base-isolation structure with an optimum use of dampers.

Elastic Locking Mechanism

A mechanical joining using shear pins was adopted as the device that joins the upper and lower floors of the base-isolation layer (See Photo 2). During earthquakes that frequently occur, seismic energy is absorbed by the oil dampers in order to ensure the operation of the elevators.

In the event of large earthquakes such as the Minami-Kanto Earthquake or Nankai Trough Earthquake that are forecast to occur in the future, shear pins will cause fractures, and not only dampers but also elastic sliding bearings will jointly absorb the seismic force. In this way, a system that can absorb greater seismic energy was put into practical application in the KYO-BASHI EDOGRAND with the development of an elastic locking mechanism. (Refer to Fig. 3). ■

Fig. 2 Seismic Design Criteria and Conditions of Respective Seismic-isolation Members

External force I	evel	During medium earthquake and strong wind	During large earthquake
Seismic resistance		Securement of applicability	Securement of safety
		Small-amplitude seismic isolation (effect of controlling response concentrated on specified layer)	Effect of base isolation attained by optimum use of damper
Displacement at base-isolation layer		δ Elastic locking	δ Unlocking
		<i>δ</i> ≤7.2 cm	<i>δ</i> ≤50 cm
Condition of base-isolation member	Oil damper	Absorption of seismic energy	Absorption of seismic energy
	Elastic sliding bearing	No sliding	Sliding and absorption of seismic energy
	Elastic locking mechanism	Locking; Returning to original position after earthquake	Unlocking of locking

Fig. 3 Elastic Locking Mechanism



During occurrence of large earthquake In the case when a large earthquake with a magnitude higher than that of the East Japan Great Earthquake of 2011, locking is unlocked due to the fracture of shear pin. Not only dampers but also sliding bearings jointly absorb large seismic energy.



-Outstanding Achievement Awards Improved Seismic Resistance of **Existing Bridge Columns** -Application of Bridge Columns Integrated by Multiple **Steel Pipes**-

Prize winner: Hanshin Expressway Company Limited

With the aim of further enhancing the convenience of highway networks in Osaka, a project was promoted to reconstruct the Nishisenba Junction of the Hanshin Expressway. Its aim is the construction of additional lanes and crossover lines in order to connect the No. 1 Loop directly with the No. 16 Osakako Route of the expressway network.

Because the reconstruction site is located within a main trunk road site, restrictions were imposed on reconstruction execution width, and reinforcement of existing bridge columns, required to widen the road width, was difficult to undertake. Then, bridge columns integrated by multiple steel pipes were newly constructed between the existing bridge columns to make the newly-installed bridge column positively bear horizontal forces occurring during earthquakes. To that end, the prescribed seismic resistance could be secured for Nishisenba Junction without the reinforcement or reconstruction of existing bridge columns and by changing the structural system of the entire highway bridge structure.

Directions in Design to Ensure the Seismic Resistance of Existing Highway Bridges

Stoppers were installed in the bridge columns integrated by multiple steel pipes





to bear only the horizontal force during earthquakes, and the vertical load was borne only by existing bridge columns (Fig. 1). In the bridge column integrated by multiple steel pipes, the shear panel was arranged on the horizontal tie beam, and a damage control design was introduced with the aim of the absorption and control of seismic energy during earthquakes. The horizontal seismic force to be borne by the existing bridge column was reduced by the replacement of the bearing of these columns and other measures.

Capitalizing on the measures mentioned above, a "Seismic Performance Level 2" that can withstand Level 2 Seismic Motions (strong seismic motion with extremely low occurrence frequency during the service of the structure) was able to be secured for Nishisenba Junction without the reinforcement of existing bridge columns.

Compact Design of Foundation Structures

For the foundation structure for use for the bridge column integrated by multiple steel pipes, a socket-type bridge column integrated by multiple steel pipes with directly connected pipes was adopted in which the

Fig. 2 Image of Bridge Columns Integrated by Multiple Steel **Pipes with Directly Connected Pipes**



bridge column is inserted into a pile with a diameter larger than that of the bridge column and concrete is filled into the gap between the bridge column and the pile. The adoption of this type of foundation has allowed for smoother force transfer to the foundation and has realized a compact foundation structure without a footing. (Fig. 2)

Erection of Bridge Columns

Under the site conditions of a narrow execution yard and strict restrictions on overhead clearance, an erection platform was installed in joining the foundation piles and bridge columns to secure erection accuracy, and at the same time advanced execution control was carried out in the erection and joining of the column not only to prevent contact with the girders of the expressways in service but also to secure the prescribed quality. In this way, this reconstruction project to improve the seismic resistance of the existing bridge columns at the Nishisenba Junction was safely and successfully completed. (Refer to Photos $1 \sim 5$).



Photo 1 Installation of erection platform on levelling concrete

Photo 2 Frection of lower column





low overhead clearance





Photo 5 Completion



JSSC Commendations for Outstanding Achievements in 2018—Thesis Awards A Loading Tests in the Large Deformation **Range for RHS Columns with Different Manufacturing Processes**

Prize winners: Seiji Mukaide, Nobuyuki Oku, Katsuya Matsuo and Motohide Tada



Seiji Mukaide 2002: Finished Graduate School of Engineering, Osaka University 2002: Entered General Building Research Corporation of Japan (GBRC)

2005: Assistant Professor, Osaka University 2016-: Associate Professor, Osaka Institute of Technology

In the current study, in order to clarify the collapse mechanism of buildings and the strength deterioration behavior of steel frames during collapsing, we conducted loading tests in the large deformation range for rectangular hollow section (RHS) columns-in the range where the strength significantly deteriorates due to local buckling. The aim was to investigate the strength deterioration behavior of RHS columns produced by employing different manufacturing processes. In addition, we proposed a restoring force model with easy applicability, and compared the results obtained in the test with the proposed model to verify the performance of the proposed model.

Outline of Loading Tests

The parameters used in the test were the

Fig. 1 Relationship between Dimensionless Member-end Bending Moment and Member Drift Angle



RHS column manufacturing process, steel grade, width-to-thickness ratio, axial force ratio *n*, loading hysteresis and loading direction, and a total of 25 test specimens were used. The loading method applied was the flexural shear loading under constant axial force and the drift angle θ was 0.3 rad, the loading limit value.

Fig. 1 shows examples of the relationship between the dimensionless member end bending moment *M/Mpc* and the member drift angle θ (monotonic loading). Any specimens show strength deterioration due to local buckling. As shown in Photo 1, the local buckling condition differs depending on the specimens applied, and it is understood from the photo that the local buckling in which the flexural compression side surface gets dented develops only by one wave in most specimens with a loading direction of 0 degree.

Comparison between Existing Analytical Models and Practical Behaviors

The skeleton curve proposed by Kato and Akiyama is cited as a restoration force model that takes into

Results and Proposed

Test Model

D/t = 19D/t = 25

D/t = 33

.<u>θ</u>/οθρ

40

<u> Θ</u>Ιέθρ

40

Model

10

10

20

20

30

30

2.0

2.0

1.5 1.0

0.5

0.0L

1.5

1.0

0.5

0.0

0

account the strength deterioration caused by local buckling. We proposed an analytical model prepared by the revision of the above model. Fig. 2 shows a comparison between the revised analytical model and the test results. As can be seen in the figure, the revised analytical model can appropriately evaluate strength after the strength deterioration reaches about a half of the maximum strength.

Conclusion

The knowledge obtained in the current study is enumerated in the following:

- Experimental confirmation of the behaviors of RHS columns in the large deformation range in which strength deteriorates significantly
- Proposal of an analytical model prepared by revising the existing analytical model that can comparatively simply express the behavior of strength deterioration due to local buckling, and confirmation of improvements to the measure that can appropriately deal with practical strength deterioration behavior by the use of the proposed analytical model



Photo 1 Deformation conditions

A Trial on Improvement of Fatigue Crack Detection of Eddy Current Test by Applying C-scope Imaging

Prize winners: Yusuke Koto, Takuyo Konishi, Chitoshi Miki and Hidehiko Sekiya



Yusuke Koto 2007: Graduated from Advanced Course of The National Institute of Technology, Akashi College 2007: Entered Oriental Consultants Co., Ltd.

2011: Seconded to Atec Co., Ltd.

2013-: Doubled as Assistant Fellow, Advanced Research Laboratories, Tokyo City University

Predominance of Eddy Current Flaw Detection Tests

In the inspection of steel bridge fatigue cracks occurring in weld beads, the magnetic particle test (MT) is commonly applied. However, MT is an approach that requires the treatment of coating films, spraying magnetic powder and magnetization, and further there are cases in which the arrangement of magnetization devices becomes difficult in narrow spaces and complex-shaped weld joints.

On the other hand, the eddy current flaw detection test (ET), a non-destructive inspection approach similar to MT, can easily detect flaws in coating films, and is an approach with a detection efficiency much higher than that of MT. However, ET offers some problems such as difficulty in understanding flaw detection results and low performance in the recording and reproduction of flaw detection results in narrow spaces and unstable weld surface in box welding. (Refer to Fig. 1) As a result, ET has not yet been applied in the inspection of fatigue cracks in steel bridges.

Imaging of Flaw Detection Results

In the current study, we have developed a system that can simply and accurately detect weld flaws such as fatigue cracking by means of C-scope imaging. Specifically, in the developed system, information on voltage and phases that display changes in impedances is taken out and combined with position information, or the information thus obtained is converted to C-scope images.

The developed system is composed of a general-purpose eddy current flaw detection device, an encoder to obtain position information, a probe holder to improve flaw detection scanning stability and a personal computer, and the flaw detection results are subjected to image processing to confirm the detection results. The change in phases can be displayed in colors, and the change in voltages amplitudes can be displayed in the length of color line in the normal direction of the scanning locus, which has thus made it possible to visually confirm the changes in impedances in the detection position. (Refer to Fig. 3)

Improved Performance in Weld Fatigue Crack Detection

With C-scope imaging, it has become possible to understand the information on not only flaw detection signals in sound weld zones and the separation of crack detection signals from the above signal but also crack positions, which has led to the solution of problems with ET. The application of the developed system is expected to contribute towards a reduction in detection costs and the improvement of recording performance, objectivity and weld flaw detection efficiency.



Fig. 3 C-scope Imaging of Flaw Detection Results



JSSC International Events IABSE Young Engineers Colloquium in East Asia

The 1st IABSE Young Engineers Colloquium in East Asia was jointly organized by the Japanese, Chinese, and Korean Groups of IABSE. The colloquium was initiated by Profs. Shunichi Nakamura, Limin Sun and Hyun-Moo Koh in April 2018 and was held on Oct. 24-25 2018 in Shanghai (Photo 1). The Japanese Society of Steel Construction (JSSC) serves as a secretariat of Japanese group of IABSE (International Association for Bridge and Structural Engineering).

Major Aim of IABSE Young Engineers Colloquium

Many young engineers want to participate in the IABSE congresses and symposiums, which provide good and educational opportunities for them. However, these events are held world-wide and not affordable for them all. It is, therefore, desirable to have regional colloquiums for young engineers in East Asia which provides the same outcomes with much lower cost both in travel expenses and registration fees. Furthermore, this event encourages young engineers to be more actively involved in IABSE activities.

The organizers intend to keep this event in small size so that participants have sufficient time to enable deep academic exchange at feasible schedule, which makes this event sustainable. Eventually, this colloquium offers young engineers the opportunity to present interesting researches, projects or construction practice to an audience of senior structural engineers and researchers.

Outline of 1st IABSE Young Engineers Colloquium

The program includes a keynote lecture and three technical sessions on the first day, and the technical tour to four places of interests in Shanghai on the second day. The keynote lecture, titled "Form and Function in Design of Bridges", was given by Mr. Naeem Ullah Hussain (Photo 2), Director/ Global Bridge Leader of ARUP. The lecture based on his experience of design and construction of the actual bridge projects including the Stonecutter Bridge (Hong Kong) and the Øresund Bridge (Denmark and Sweden) was useful and educational for young engineers.

At the technical sessions, a total of 22 young engineers (9 from Japan, 8 from China, and 5 from Korea) presented interesting research papers and technical reports of construction projects. The topics include damaged bridges in Kumamoto Earthquake, development of new TMD, proposal of new type of bridge, structural design of new national stadium in Japan, evaluation of ERW pipe structural performance, push-out tests of PBL strip, steel fiber reinforced PFC beam, application of new materials to structures, performance of box girders subjected to thermal history due to fire, wave loads acting on water foundation, training general bridge damage detection deep net, design and construction of actual bridge projects, and so on.

There was a total of 50 participants, including 22 young engineer speakers, 18 experts and 10 audience from Japan, China, Korea, and Hong Kong. After the presentation, the presenters were all on stage back and Q&A and discussions were carried out between young engineers and senior structural engineers and researchers at each session, which was very active (Photo 3). They also exchanged information on the latest technologies and knowhows with other engineers throughout the colloquium.

Presentations are evaluated by quality of paper, quality of presentation and Q&A and, in addition, age of presenters. One of three winners of the Outstanding Young Engineer Best Paper Award was Mr. Yusuke Takahashi (Photo 4), Osaka Institute



Photo 1 Presenters and participants

of Technology.

The 2018 IABSE Colloquium Shanghai was organized with Chairs of three national groups, Profs. Yozo Fujino, Yaojun Ge and Ho-Kyung Kim, and Committee members consisting of experts in three countries. The Colloquium is characterized by the following four features.

- Affordable. The registration fee is as low as 8,500 yen including lunch and banquet, which is about 1/10 of the usual symposium.
- Small Size. The small number of presenters allows longer discussion with deeper exchange. This also leads to inexpensive venue cost and less organization efforts.
- Deep Exchange. This event allows 10-min presentation and 20-min discussion for each session. Academic exchanges are made throughout the Colloquium.
- Young Engineer Oriented. Speakers are all young engineers and all the events are aimed at them. Senior engineers encourage discussions and give advice to young engineers.

It is announced that "The 2nd IAB-SE Young Engineers Colloquium in East Asia" will be held at Tokyo Institute of Technology, Japan, on 7th and 8th November 2019.

(Prepared by Shunichi Nakamura, Tokai University, Vice President of IABSE)



Photo 2 Keynote lecture by Naeem Hussein



Photo 3 Discussion with presenters and audience



Photo 4 Presentation by Mr. Y. Takahashi

PSSC2019

The 12th Pacific Structural Steel Conference (PSSC2019) will be held at the Tokyo Institute of Technology in Tokyo from Saturday November 9 to Monday November 11, 2019. It will be organized by the Japanese Society of Steel Construction (JSSC).

This conference is hosted every three years on an alternating basis among the 11 nations of the Pacific Council of Structural Steel Associations. The 12th conference will be the first one held in Japan since the third conference about 30 years ago in 1992.

In the conference titled "Steel Structures with Resilience and Sustainability," diverse technological issues that many nations are facing will be shared among the participating nations—natural disaster prevention and control technologies, longer service life of infrastructure and the maintenance and renewal of infrastructure. In this regard, it is believed that the conference will provide a good opportunity to deepen exchanges between Japanese and overseas experts relating to these issues. The keynote addresses are planned to deliver by inviting worldwide authorities in this field.

The PSSC2019 is expected to serve as the venue for reporting papers and exchanging opinions pertaining to steel structures in an interdisciplinary field covering from civil engineering to building construction. To that end, JSSC is hoping that many people will participate in the PSSC2019.

For more details, refer to the following:

- Website: http://pssc2019.jp/
- Inquiry: pssc2019@ec-intl.co.jp
- Conference: 9 (Saturday) to 11 (Monday) November, 2019
- Banquet: November 9 (Saturday), 2019
- Technical tour: November 11, 2019 (Planned visit sites: Facilities of the Olympic and Paralympic Games Tokyo 2020 and renewal project for Metropolitan Expressway)
- Registration fee and other fees (See the table below)

	PSSC'19
	Tokyo
The 12th Pacific Structur	al Steel Conference

Category	Early-bird registration April 1 to June 30 2019 (JPY)	Late/On-site registration July 1 to October 10 2019 (JPY)
Registration fee – Regular – Student – Accompanying person – Media	55,000 20,000 5,000 Free	60,000 25,000 5,000 Free
Banquet – Regular – Accompanying persons	12,000 7,000	
Technical tour	2,000	

Message from Chairman of International Committee

Hiroshi Katsuchi, Chairman, International Committee of Japanese Society of Steel Construction (Professor, Yokohama National University)



The Japanese Society of Steel Construction (JSSC) has conducted a wide range of activities in the form of surveys, research and technological devel-

opment aimed at promoting the spread of steel construction and at improving associated technologies, and at the same time has extended cooperation to related overseas organizations. With the aim of spreading Japanese steel construction technologies overseas and developing overseas markets, the International Committee of JSSC was responsible in editing the No.56 issue of *Steel Construction Today & Tomorrow.*

Issue 56 features outstanding Japanese technologies utilized for ongoing steel-structure projects in the Tokyo area. Among the projects introduced in the feature articles are a large-scale renovation of the more than 50-year old section on the Metropolitan Expressway and the construction of new athletic facilities related to the Olympic and Paralympic Games Tokyo 2020 including the New National Stadium. A technical tour visiting these facilities is planned at the PSSC2019 (12th Pacific Structural Steel Conference) to be held in Tokyo in November 2019.

November 2019.

Edited by

design using stainless steel in a highrise building of TOKYO MIDTOWN HIBIYA—is also introduced. Further, this issue introduces the JSSC Commendations for Outstanding Achievements in 2018: JSSC awards for excellent steel construction and thesis.

Regarding JSSC's international events in 2018, the 1st IABSE Young Engineers Colloquium in East Asia held by IABSE (International Association for Bridge and Structural Engineering) in October 2018 in Tongji University in China is reported.

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

In addition, a special article-façade

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Committee on Overseas Market Promotion, The Japan Iron and Steel Federation Chairman (Editor): Kei Teshima

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