No. 67 April 2023

STEEL CONSTRUCTION TODAY & TOMORROW

https://www.jisf.or.jp/en/activity/sctt/index.html

Special Issue

Japanese Society of Steel Construction

Published Jointly by

The Japan Iron and Steel Federation

JSSC Japanese Society of Steel Construction

Tokyo International Cruise Terminal

Prize winners: Yasui Architects & Engineers, Inc., Penta-Ocean Construction Co., Ltd. and Toa Corporation

Integrated Architectural/Civil Engineering Steel Structure Built on the Sea

In the construction of the Tokyo International Cruise Terminal, artificial ground, a civil engineering structure, was first constructed on the sea bottom ground about 10 m under the sea level by means of the jacket pier, on which a 4-story building was then constructed. This construction of a large-scale building on a civil engineering structure built on the sea is a project unprecedented in its kind in Japan.

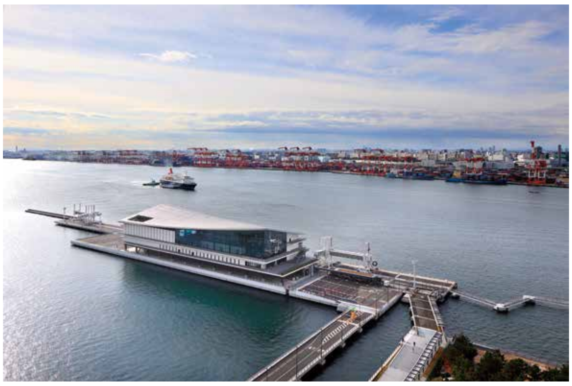
As a structural type for the artificial ground, a steel structure was selected by taking into account the construction term, and a 4-story building was planned with a steel-structure architecture because the steel structure allows for the securement of freedom in space design. As a method to join this civil engineering-architectural structure, a rigid joint was adopted, for which a new joining method was developed that can securely transfer the stress, and absorb the tolerance occurring at the stage of construction of the civil engineering structure preceding to that of architecture. The practical application of the joining method thus developed shows new potential for steel-structure construction.

Compatibility between Space Design-induced Need and Seismic Resistance (1st-floor Concentration Damper)

The size of the cruise ships that arrive and depart varies, and thus the space used for CIQ (customs clearance, immigration and quarantine) differs for each ship. Accordingly, the CIQ space is prepared for each ship by the use of movable partitions and other facilities.

In order to meet diverse situations such as those mentioned above, spaces with less use of columns and braces and high freedom in space construction was required to be provided at the terminal building. Meanwhile, a civil engineering structure was constructed under the terminal building employing the jacket pier in which 4 jackets measuring about 70 m in length and about 40 m in depth were erected as an integrated structure, and therefore this structure was composed of high-stiffness framing in which 800 mm-diameter braces were arranged over the entire structural plane. To that end, at the terminal building with the stiffness lower than that at the civil engineering structure, the response in the event of an earthquake is increased at the 1st floor, a boundary section, due to the sudden change in stiffness.

In light of this, capitalizing on a structural characteristic in which the difference in stiffness between the civil engineering and building structures is high, seismic energy is effectively absorbed by concentratedly arranging response-controlled dampers only at the 1st floor where the stiffness shows sudden change. The reduction of responses thus attained by means of 1st-floor concentration dampers has not only led to the successful securement of the freedom in space construction but also allowed the construction of the building roof with a lightly surging configuration, a notable characteristic in terms of appearance.



Full view of Tokyo International Cruise Terminal (Photo: Naoomi Kurozumi)

Perspective View of Entire Framing

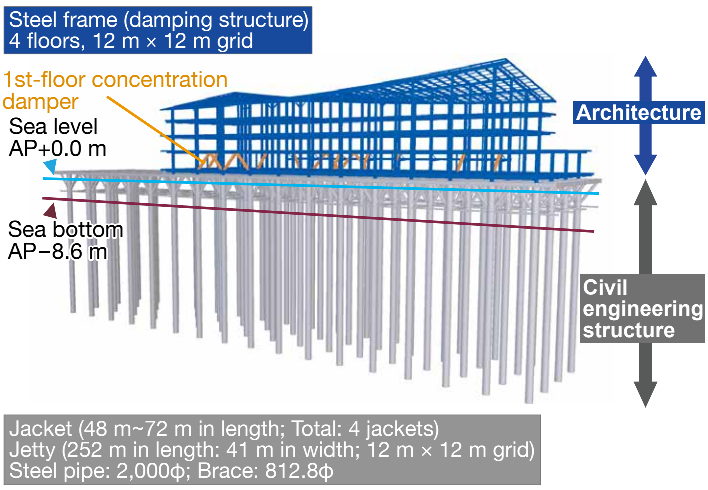
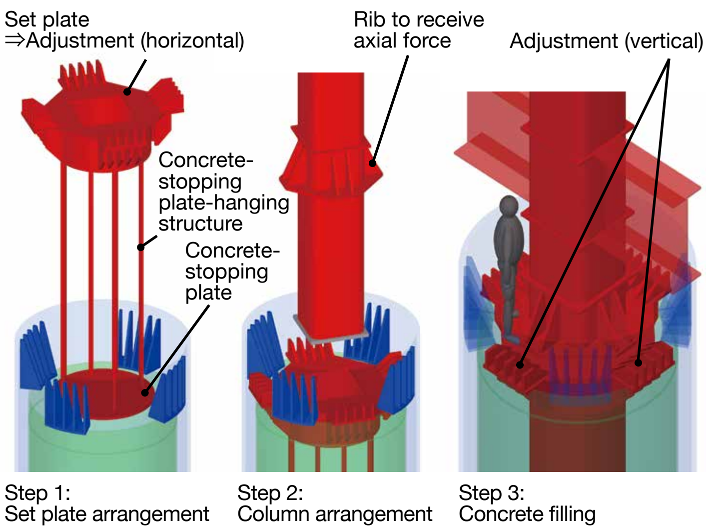


Image of Steps for Joining Architecture and Civil Engineering Structure



Japan National Stadium

Prize winners: Joint Venture of Taisei Corporation, Azusa Sekkei Co., Ltd. and Kengo Kuma and Associates; Taisei Corporation Tokyo Branch

Japan National Stadium is a new national stadium constructed with the concept of a “Stadium in the Forest” in the historical and traditional environment of the Outer Gardens of Meiji Jingu (Shinto Shrine) in Tokyo. With a structural plan of constructing a stadium that is highly disaster-resistant and can boast Japanese identity to the world, an erection plan was worked out in consideration of high construction efficiency.

Stand Structure

The steel structure was adopted as a basic structural type in the construction of the stands, and a steel-reinforced concrete (SRC) composite structure was adopted for the oblique beams (Raker beams) that support the spectator seating and the peripheral columns that support the roof truss. A simple framing structure was chosen in which identical frames are repeatedly arranged in the circumferential direction of the stands, and precast foundation beams and peripheral SRC columns were adopted as extensively as possible, both of which contributed to the improvement of the efficiency of member fabrication and on-site construction work that accompany repetitive operations.

In order to enhance the disaster-prevention performance of the stadium and its neighboring areas, the following measures were adopted: The 2nd to 4th floors were composed of a brace structure with high stiffness, and further a rigid-frame structure employing high-strength steel (550 kN/mm^2 grade) was adopted for the B2 to 1st floors aimed at securing the strength. On top of these, a “Soft-First-Story” response-control system covering 3 layers was put into effect by arranging oil dampers in a well-balanced manner in a radial direction and a circumferential direction.

Roof Structure

For the roof, framing was adopted in which cantilever space trusses with triangular cross sections were continuously arranged in a circumferential direction. The cantilever truss was designed in ways that allow free standing by single trusses at the erection stage, and after the free standing of trusses, the temporary support columns were removed so that the construction of spectator seating under the roof could be started.

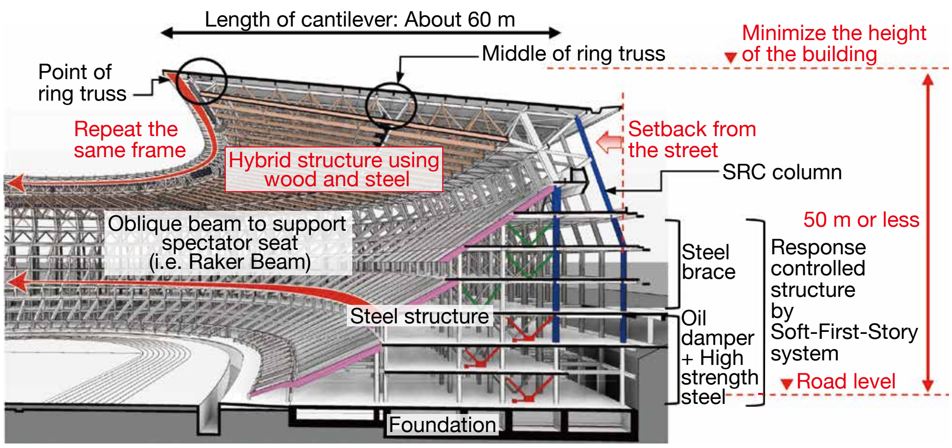
A ring truss was provided to the end and middle of the cantilever truss, through which highly-stiff framing was realized that can resist wind and seismic force over the entire roof structure. For the straight section of the roof at the main side and back side for which the ring effect cannot be demonstrated, the arch effect was added by slightly raising the roof height so that the deformation occurring at the roof end can be controlled to an identical level.

For the roof truss, a hybrid structure composed of steel frames and Japanese larch was arranged as the lower chord member and a hybrid structure composed of steel frames and Japanese cedar was arranged as the lattice member, which led to the successful creation of a stadium space where all athletes and spectators can feel the warmth peculiar to the wood, while at the same time suppressing the deformation of the roof due to earthquakes and strong winds.

Full view of Japan National Stadium

Inner view of stands

Outline of Stadium Structure



Ariake Garden—Theater, Hotel, Mall & Spa

Prize winner: Takenaka Corporation

Outline of Ariake Garden

Ariake Garden is a complex facility planned at Ariake facing the Port of Tokyo and is composed of a theater building, a hotel building and a mall & spa building. The theater building is a music hall with a maximum capacity of 8,000 people, mainly for holding rock and other music concerts. The hotel building is a high-grade hotel with 800 guest rooms. The mall & spa building is a commercial facility with a hot bath facility on the top floor.

Structural Outline

A steel-frame structure was adopted that features a great deal of freedom in design and demonstrates excellent structural performance, through which a dynamic building configuration was realized. Seismic resistance was enhanced by the use of concrete-filled steel tube columns and buckling-restraint braces.

Traveling & Lifting-up Construction Method

A large-span truss framing measuring 63 m×72 m was adopted in the construction of the roof of the theater building, for which the "traveling & lifting-up method" was developed. A major feature of this method lies in that part of the permanent truss framing is structured at the hall stage side, and this partial structure is used as the provisional gantry. Specifically, the divided truss framings were assembled on the provisional gantry, and after repetitive traveling of these framings, the provisional gantry was finally lifted up to complete the roof framing.

The construction term of the theater building was drastically reduced due to the simultaneous construction of the balcony structure in the arena section.

Large-scale Vibration-reduction Floating Floor

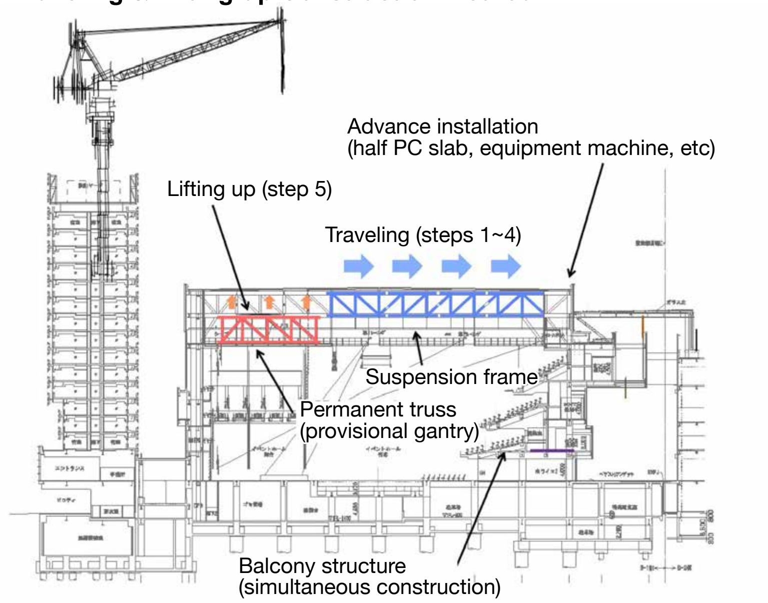
When the audience performs rhythmic movements along with the music played at concerts, vibrations occur at the theater building. These vibrations are transmitted to the ground and shake the neighboring buildings, which could cause a problem—impairment of habitability.

To remedy this situation, a large-scale floating floor system was developed and installed for the arena floor of the theater building to sharply mitigate the occurrence of vibrations. The floating floor is composed of 1.2 m-thick concrete floors, large-size coil spring units and viscous dampers. In order to treat the natural frequency of rhythmic movements (2~3.5 Hz), that of the floating floor was set at 1 Hz in ways that avoid the occurrence of resonance, leading to the realization of dramatically improved vibration-reduction performance. 10% vibration damping was added to further mitigate the occurrence of vibrations.

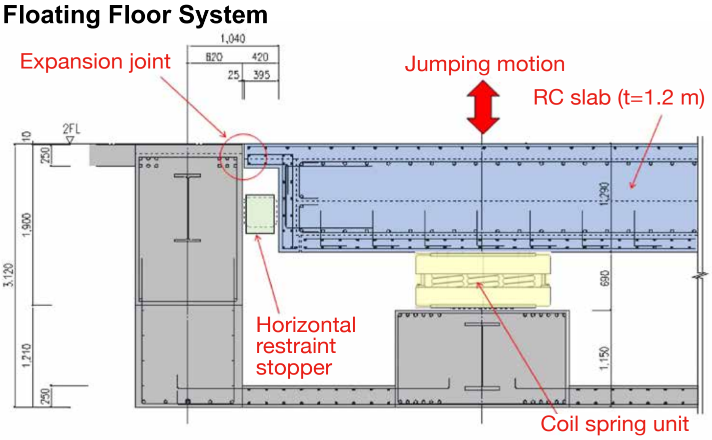
Appearance of theater and hotel buildings

Appearance of hotel and mall & spa buildings

Traveling & Lifting-up Construction Method



Floating Floor System



—Outstanding Achievement Awards

Base-isolation Seismic Retrofitting of Nagoya TV Tower

Prize winners: Nikken Sekkei Ltd. and Takenaka Corporation

The Nagoya TV Tower (currently Chubu Electric MIRAI TOWER) is a steel tower with a maximum height of 180 m. It was constructed as Japan's first aggregated radio tower in Nagoya in central Japan. In 2005, it was registered a national tangible cultural property. While the tower had served as a radio tower for many years, it ended its role following the termination of terrestrial analog television broadcasting in 2011.

Tasks of Seismic Retrofitting and Solutions

Four major tasks involved in seismic retrofitting of Nagoya TV Tower and the solutions proposed to cope with these tasks are shown below:

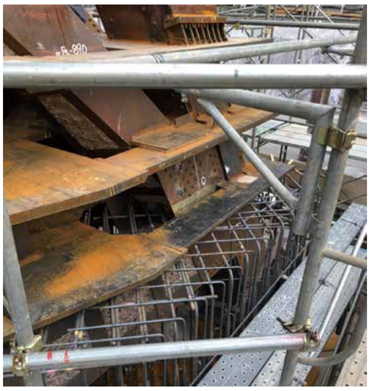
- Enhanced seismic resistance: Adoption of base-isolation seismic retrofitting by capitalizing on the "low center of gravity" so as to reduce horizontal external force
- Protection of the value as the cultural property: Proposal of the retrofitting method (shallow-floor base-isolation method) that does not affect the bustling space located under the first floor connected to the park
- Observing the law: Addition of an EV stair building for securing an evacuation route, acquisition of approval for fire-protection coating
- Higher operating income: Toward realization of the tower that can yield profits through optimum use of its hotel and other facilities

Approaches Conducive to Developing and Diffusing Steel and Steel/Concrete Composite Structures

In the process of studying base-isolation seismic retrofitting, its planning, analysis and verification were examined from the perspectives of not only design but erection plan, the results of which were incorporated into the seismic retrofitting plan. Among major approaches obtained in the examination were:

- Confirmation of member strength employing full-scale members
- Design of the joints that can accommodate the inclination of existing steel framings and errors in construction
- Testing to confirm the adhesiveness between steel-frame column base and SRC-structure arch
- Development of the intermittent stiffening method for steel shape compression members that is applicable in the erection even at heights
- Development of the fire-protection coating legally applicable to the built-up compression members
- Development of wind-resistant stoppers and wind monitoring for confirming fatigue property
- Development of a thrust transfer mechanism employing tension force control device

The "thrust-free base-isolation mechanism," an essential part of seismic retrofitting plan, was worked out through integrated use of the above-mentioned approaches, and seismic retrofitting was successfully achieved. The reformed tower was registered a national important cultural property in December 2022. It is hoped that the Chubu Electric MIRAI TOWER will continue to be affected as a landmark in the city of Nagoya in the future as well.



Joint of column base

Base-isolation device installed for seismic retrofitting

Photo: Koji Okumura, Forward Stroke inc.

Full view of Chubu Electric MIRAI TOWER

Photo: SS, Inc.

Bustling scenery at Chubu Electric MIRAI TOWER

Cycling Properties of Concrete-filled Square Steel Tube Beam-Columns under Constant Amplitude Cyclic Loading

Prize winners: Toshiyuki Fukumoto, Koji Morita, Keigo Tsuda, Masae Kido and Yasuo Ichinohe

Toshiyuki Fukumoto
(representative winner)
1979: Entered Kajima Corporation
1983: Assigned to Kajima Technical Research Institute
2005: General Manager at Kajima Technical Research Institute
2015: Executive Researcher at Kajima Technical Research Institute
2002: Received the Prize of Architectural Institute of Japan Award (Papers)

Aim of Study

Since the Tokachi-oki Earthquake of 2003, the occurrence of long-period, long-duration seismic motion (Fig. 1) is becoming apparent. These seismic motions are forecast to be multiple repetitively input into a building with long natural periods like high-rise buildings. In light of this, in the structural design of high-rise buildings employing concrete-filled steel tube (CFT) beam-columns, it is urgently required to establish a method to assess the structural performance of CFT beam-columns under multi-cyclic loadings in the event of long-period seismic motions, in addition to assessment by means of conventional seismic design.

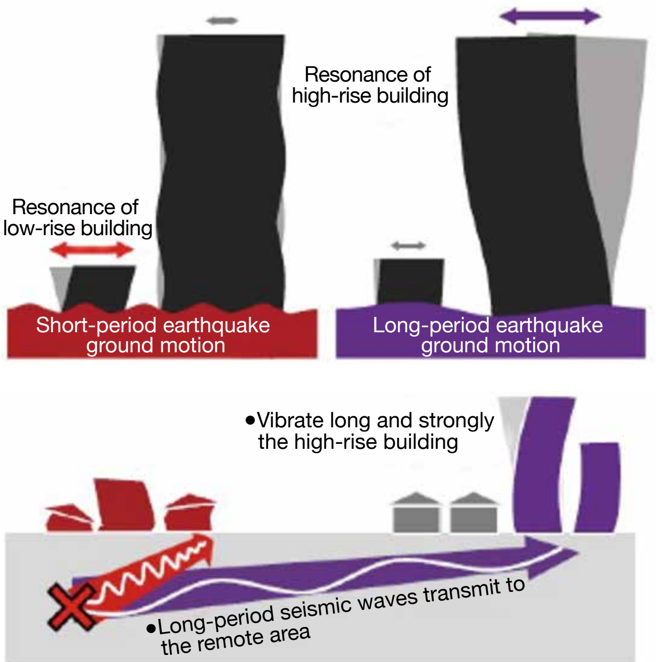
Outline of Study

Targeting the square CFT beam-columns currently in wide use, this paper examined the number of cycles for the limit state in constant amplitude cyclic loading under constant axial force, which is most basic in repetitive, variable amplitude cyclic loading in the plastic region (refer to Fig. 2). Specifically, with the aim of proposing a simple assessment formula applied in the structural design and based on diverse kinds of previous flexural shear test results for CFT beam-columns, an investigation was made of amplitude rotation angles, axial force ratio and other factors that affect the cycling properties of CFT beam-columns.

Based on the investigation thus far made, authors proposed an assessment formula for the number of cycles for the limit state, which was obtained by using as the basic formula the relationship between the rotation angle and the number of cycles for the limit state and based on a form of Coffin-Manson Formula pertaining to the low-cycle fatigue curve of metallic materials, and then by multiplying this basic formula with the correction magnification that depends on the specific factor of CFT beam-columns. Further, examinations were made of the assessment of the number of cycles for the limit state under variable amplitude cyclic loading by applying the proposed assessment formula for the number of cycles for the limit state to the linear cumulative damage rule and based on the test results for incremental displacement-amplitude cyclic loading.

It is understood that the calculation result employing the proposed formula coincided well with the test results (Fig. 3).

Fig. 1 Long-period Earthquake Ground Motion



Reference: "Earthquakes and Tsunamis" of Japan Meteorological Agency — Long-period Seismic Motions (https://www.jma.go.jp/jma/kishou/books/jishintsunami/jp/jishintsunami_jp.pdf)

Fig. 2 Relation between Rotation Angle (*R*) and Number of Cycles for Limit State (*N*) in Constant Amplitude Cyclic Loading Tests

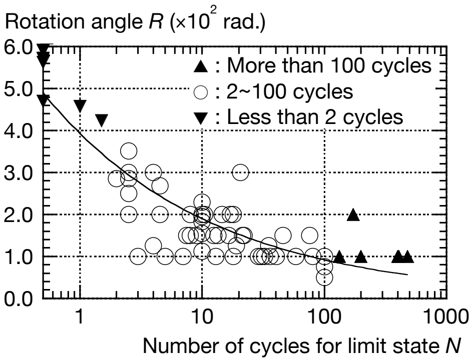
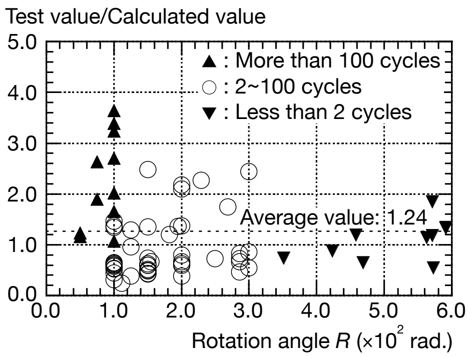


Fig. 3 Comparison between Test Value and Calculated Value of Number of Cycles for Limit State in Constant Amplitude Cyclic Loading Tests



—Thesis Awards

Study on Fatigue Strength of Lean Duplex Stainless Steel Base Metal

Prize winners: Eitaro Horisawa, Kunitomo Sugiura and Yasuo Kitane

Eitaro Horisawa
2019: B. Eng., National Institute of Technology, Nagaoka College
2021: M. Eng., Kyoto University
2021-present: Doctor program in Civil Engineering, Kyoto University

Introduction

Stainless steel is getting widely used in civil structures due to its high corrosion resistance. One of the factors essential to apply the material for bridges is its fatigue behavior considering long-term service. However, in Japan, fatigue tests of stainless steel and structures made of stainless steel have rarely been conducted, and currently proposed design guidelines for stainless steel structures treats them as the material similar to mild carbon steel without accumulating sufficient test data.

In this study, fatigue tests of stainless steel base metals were carried out as basic experiments to clarify its fatigue properties.

Fig.1 Stress-Strain Curves of Stainless Steels

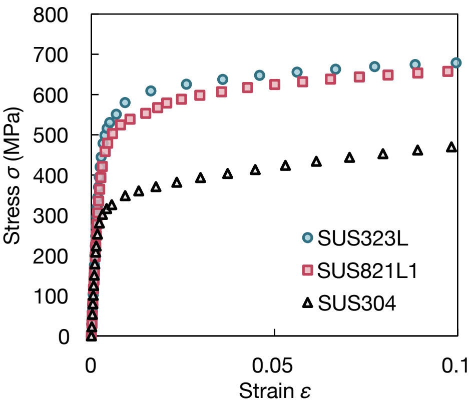


Table 1 Mechanical Properties of Stainless Steels

Grade	0.01% proof stress (MPa)	0.2% proof stress (MPa)	Tensile strength (MPa)
SUS323L	342	524	701
SUS821L1	313	484	693
SUS304	190	308	642

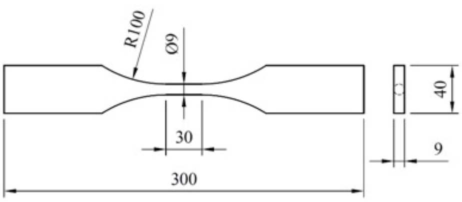
Materials and Methods

High-cycle fatigue tests were conducted on 15 specimens for each of two lean duplex grades (SUS323L and SUS821L1) and one austenitic grade (SUS304), in addition tensile tests were also performed on the same materials. Fig. 1 and Table 1 show the stress-strain curves and mechanical properties of the stainless steels, respectively. It is obvious that the stainless steels have no clear plastic plateau, and the lean duplex grades exhibit superior strength. The test specimens which were cut from steel sheets along the rolling direction shown in Fig. 2, were prepared, and subjected to cyclic stressing at two different stress ratios of 0 and 0.3. All tests were carried out at room temperature for up to two million cycles.

Results

Fig. 3 shows the relationship between stress range and fracture life (S-N diagram) for all specimens obtained in the tests. It is obvious that the fatigue strength of the stainless steel base metal is correlated with its static strength and stress ratio. Comparing the test results with the fatigue design curves for the general steel shown by solid lines in the figure, the fatigue strength of stainless steel base metal is evaluated to be on the safe side by grade C. Meanwhile the strength is much larger than the fatigue limit of the grade, and the slope of the test data is gentler than the design curves.

Fig. 2 Nominal Dimensions of Fatigue Specimens (unit: mm)



Considering these unique characteristics of stainless steel, fatigue design curves for lean duplex grade were proposed as the solid lines in Fig. 4 based on regression analysis of the test results. These curves show that the fatigue strength of the stainless steel is larger than the design curve by at least 100 MPa, and the slope is one-third of the one of the design curves.

Summary

This study shows that the fatigue properties of stainless steel base metals tend to differ from those of carbon steel, exhibiting higher strength and a gradual gradient. It is desirable to establish a rational fatigue design method for stainless steel structures by accumulating test data for various steel grades, joint types, stress conditions, and environmental conditions.

Fig. 3 S-N Diagram of Stainless Steel Base Metals

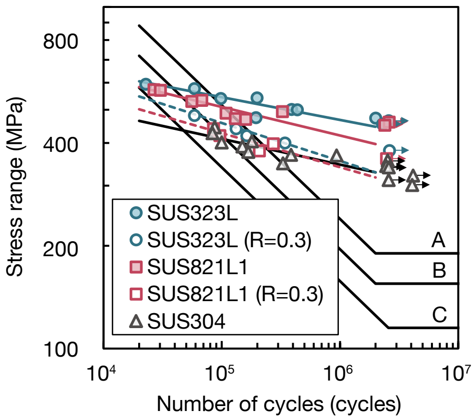
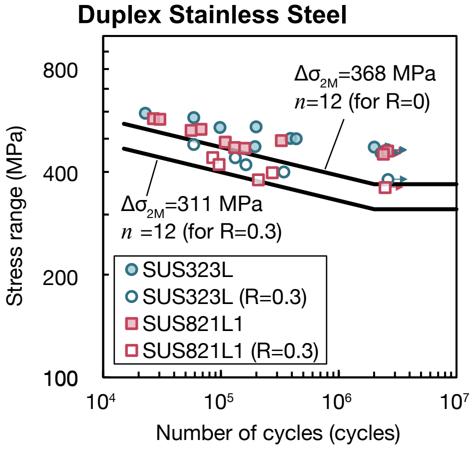


Fig. 4 Fatigue Design Curves for Lean Duplex Stainless Steel



Collapse Temperatures of Steel Plane Frames Considering Fire Spread

Prize winners: Yukina Iwai and Fuminori Ozaki

Yukina Iwai
2021: Finished Graduate School of Environmental Studies, Nagoya University
2021: Entered Nihon Sekkei, Inc.

Introduction

In the fire-resistant design of buildings, it is important to settle fire compartment so as to secure a route for evacuation and fire fighting in the event of fire. In the *AIJ Recommendations for Fire Resistant Design of Steel Structures* published by the Architectural Institute of Japan, the assessment method for the collapse temperature is proposed in which redundancy in the event of fire is taken into account. In these *AIJ Recommendations*, it is expected that the frame has the capacity to re-distribute the load to the ambient-temperature members located outside the fire compartment, and this is premised on the fire separation being sound. However, quantitative evaluation has not yet been established pertaining to the relationship between the collapse temperature and redundancy in the event of fire when the fire compartment does not function to cause the fire spread.

In this study, supposing a horizontal fire spread within an identical floor and the fire spread to the upper floor in a steel-structure building, nonlinear FEM analysis was conducted in ways that parametrically change three factors—the number of floors in the building, loading condition, and member temperature within the fire compartment at the stage of fire spread initiation, through which the behavior and the collapse temperature of steel frames in the event of fire spread were made clear.

Analytical Results

In the analytical model shown in Fig. 1, the load re-distribution capacity was not demonstrated when a fire simultaneously occurred on an identical floor, and when the inner span column buckled due to high temperature, the frame exhibited the overall collapse. Fig. 2 shows the analytical results obtained by setting the load re-distribution capacity of framing on the horizontal axis and the collapse temperature on the vertical axis. As shown in the figure, while the collapse temperature was slightly lowered in the case when the fire spread occurred at an earlier stage of the fire, the load re-distribution capacity was demonstrated even when the fire spread occurred in many analytical results, and as a result the effect of load re-distribution capacity on the improvement of collapse temperature was confirmed.

Conclusion

It was learned from this study that the effect of fire spread in the event of fire on the load re-distribution capacity and the collapse temperature was slight. Meanwhile, the main target of fire-resistant design is to protect the lives and assets of people, and thus their protection by means of providing fire compartment is very important.

Fig. 1 Analytical Model

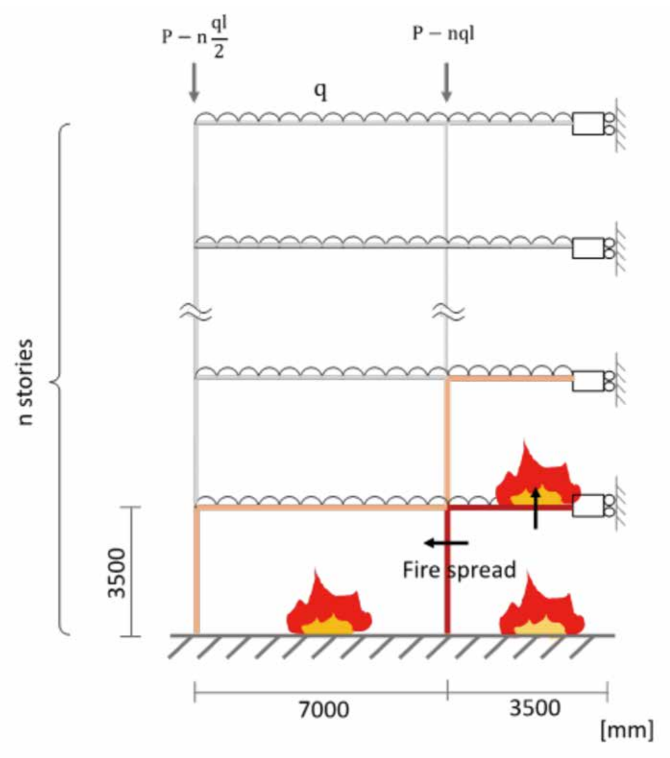
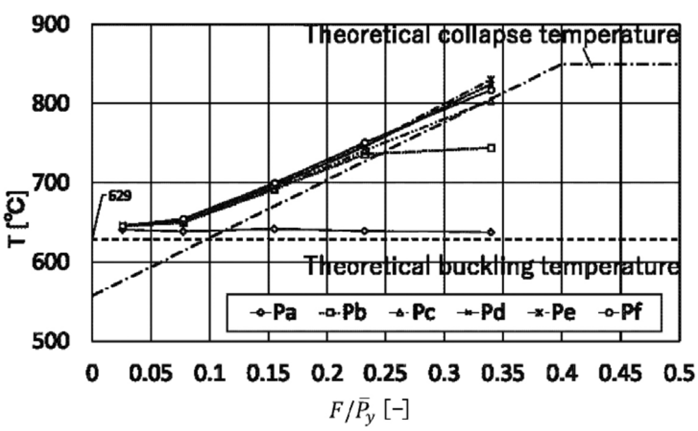


Fig. 2 Analytical Results



Flexural Shear Performance of Concrete-filled Box Section Column Made of Ultra-high Strength Steel Assembled by Undermatched Welds

Prize winners: Shintaro Matsuo, Akihiko Kawano, Yasuo Ichinohe, Yukio Murakami and Hiroshi Ito

Shintaro Matsuo
2009: Graduated from Doctoral Course of Graduate School of Engineering, Kyoto University
2009: Researcher, Nippon Steel Corporation
2010: Assistant Professor, Kyushu University
2014: Associate Professor, Kyushu University

Introduction

A prerequisite in the assembly of structural members currently in general use is to adopt an overmatched weld (OM weld) that employs welding material having strength equal to or higher than that of base metal. However, in assemblies employing ultra-high strength steel members, strict restrictions are imposed on the welding conditions, thereby posing a problem—the lowering of fabrication efficiency in member manufacture. On the other hand, if the undermatched weld (UM weld) can be applied, restrictions on welding conditions can be eased and the fabrication efficiency enhanced.

Targeting concrete-filled box-section columns employing ultra-high strength steel (H-SA700B) for use in high-rise building construction, this study aimed the clarification of the structural performance of concrete-filled box-section columns in the case of applying UM welds to the corner joint and proposed its assessment method.

Experiment Outline and Performance Assessment

In order to survey the effect of diverse experimental parameters, we conducted a test in which cyclic incremental amplitude loading was applied to a cantilever-type concrete-filled box-section column under constant axial force (Fig. 1). Experimental parameters adopted in the test were the strength of corner joints employing UM and OM welds (Fig. 2), width-to-thickness ratio B/t, axial force ratio n, concrete strength Fc and loading direction.

Fig. 3 shows the Q-R relationship of typical UM and OM specimens (B/t=16.7, n=0.4, Fc=150). Respective specimens showed elastic behavior up to the rotation angle of nearly R=1.5~2%, then local buckling occurred, and along with the deterioration of strength, they reached the ultimate state due to the fracture of the corner joint weld and other parts. While there were cases in which UM specimens showed slightly earlier development of local buckling and axial-direction contraction, most specimens showed stable elasto-plastic behaviors regardless of the weld strength.

Fig. 4 shows the comparison of experimental strength between UM and OM welds. The UM weld showed strength about 5~10% lower than that of OM welds, but as a result of examination of the strength calculation/experiment values for UM and OM welds (Fig. 5), it was confirmed that the strength of UM welds can be evaluated to the safe side by the use of the current evaluation formula.

Fig. 1 Loading Condition

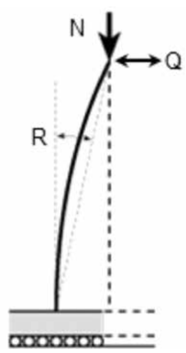


Fig. 2 Stress-Strain Curves of Materials

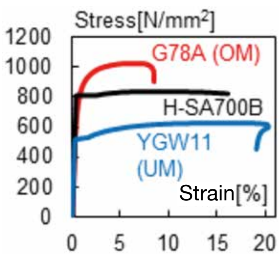


Fig. 3 Typical Q-R Relationships and Ultimate States of Specimens

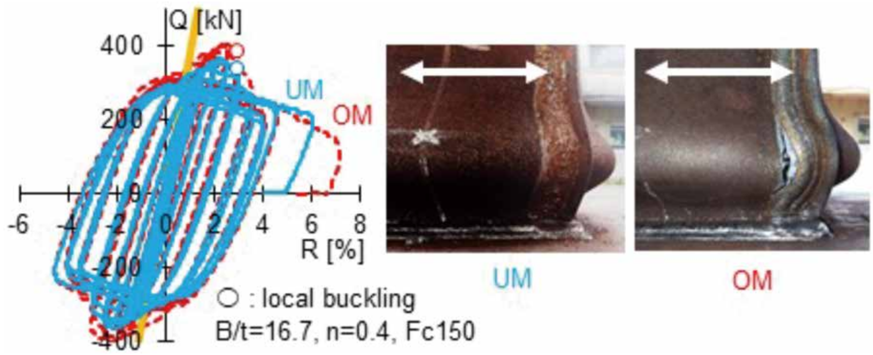


Fig. 4 Comparison of Strength of UM and OM Welds

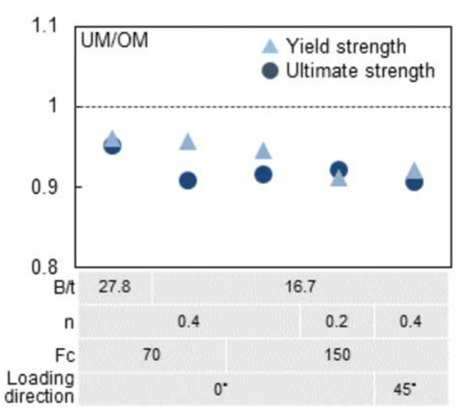
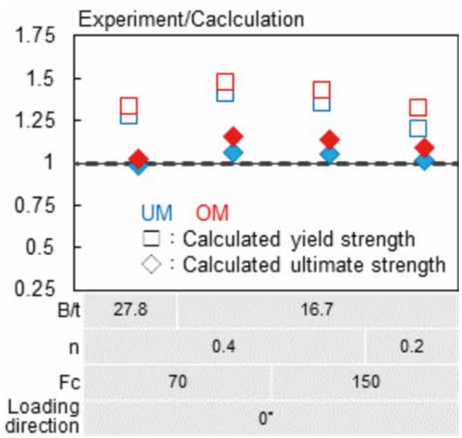


Fig. 5 Experiment and Calculation Results



Current Tasks and Future Development of CIM and BIM Applications

by Hitoshi Furuta and Azusa Aoki

Hitoshi Furuta: He is currently a specially-appointed professor, Osaka Metropolitan University, and Professor Emeritus of Kansai University. His main areas of expertise are structural reliability, structural optimization, life-cycle cost analysis and design of bridge structures, and applications of artificial intelligence. He has chaired and organized several international structural engineering conferences. In 2009, he was the chair of ICOSSAR2009 held at Osaka and the chair of IALCCE 2014 held at Tokyo. He is the vice president of IALCEE. He received several international awards, including Fuzler Khan Medal.

Azusa Aoki: Graduated from Kansai University in 2016 and joined Pacific Consultants Co., Ltd. Currently working for Osaka Head Office, Transportation Infrastructure Business Department, Structures Office, Pacific Consultants

Recent Trends in Construction Information Modeling (CIM) and Building Information Modeling (BIM)

Recently, there has been increasing attention to the steady shift to contactless and remote work styles as part of countermeasures against COVID-19 infection as well as the drastic enhancement of productivity and safety. In order to securely develop these trends, the Ministry of Land, Infrastructure, Transport and Tourism is strongly promoting digital transformation (DX) in the field of infrastructure by capitalizing on 5th-generation communications systems and other core technologies.

As to CIM and BIM applications, the administrative policy was formulated in FY2019 for CIM and BIM to be introduced as a general rule in all public works projects by FY2025. However, based on the DX promotion measures mentioned above, there has been a renewed policy in which the target year for CIM and BIM introduction is to be advanced from FY2025 to FY2023.

Ongoing Efforts towards the Application of CIM and BIM in Japan

• CIM

At the Ministry of Land, Infrastructure, Transport and Tourism, the examination of CIM introduction system started in FY2012, and in FY2016 the "guidelines on CIM introduction" (draft) was worked out. Since then, revisions of the guidelines and the expansion of related procedures have steadily been promoted. As a result, examples of the practical application of CIM in public works projects has shown yearly increases, and the accumulated number of practical applications by FY2021 has exceeded 1,500. In the future, the study of the contract methods mainly using three-dimensional (3D) CIM models and the establishment of rules for these contract methods will be promoted, and it is expected that these models will be developed into 4D versions imparted with time information.

"i-Construction" is one of the productivity reforming projects being promoted by the Ministry of Land, Infrastructure, Transport and Tourism and is a measure aimed at improving the productivity of an entire construction production system by capitalizing on information and communication technology (ICT). In this i-Construction project destined for the civil engineering works, systems and standards are being prepared in ways that allow the application of 3D CIM models not only in the field of earthworks but also in the management of contract work results and inspection procedures, the preparation of 3D deliverable delivery manuals and other operations in the field of survey and inspections.

In addition, based on the premise of using 3D models, the method for CIM operation in the management of contract work results in pavement works and the preparation of key points of delivery manuals (draft) in the field of inspection of tunnel and bridge construction works is being examined.

• BIM

A project to promote the introduction of BIM was set out in FY2010, and in FY2014 the "guidelines on BIM introduction" was worked out. While the BIM thus delivered was the 2D version, examinations are being made of how to improve efficiency in the preparation of building construction processes by introducing BIM models.

In 2019, the "architectural BIM promotion council" was established, and currently examinations are being promoted of the operation mainly of the 3D model that assumes application into an entire building construction production process as with the case of CIM.

CIM and BIM are increasingly being applied as an effective tool for enhancing the productivity and safety in construction operations (for detail, see pages 14~15).

• Towards the Effective Application of CIM and BIM

Until now, efforts have been made toward the institutionalization of CIM, targeting mainly social infrastructure facilities and as part of measures to promote public works projects, as an initiative of the national government. In public works projects, a series of operations such as preliminary design, detailed design, member manufacture and erection are separately divided for order placement as often seen in steel bridge construction projects, and thus the companies in charge of these respective operations often differ.

For that reason, it has become important to secure the continuity (unification of data) of 3D models that allows for collaborative application between different contractors in charge. Efforts are underway to prescribe such 3D models in order specifications, and at the same time to take into account its probable application eventually to maintenance.

Meanwhile, in the case of BIM, a lot of companies with varied operating scales are often involved in the structure, design and equipment of a single project as seen in building construction projects. Therefore, in order to share BIM and allow its joint application among many companies with different scales, it has become necessary to enable the visualization of the advantages of BIM introduction from the various standpoints of participating companies. In light of this, noting mainly the enhanced operating efficiency, BIM is often worked on by pursuing the advantage obtained by means of concurrent engineering that places importance on the concurrent and parallel undertaking of diverse operations at the design stage such as for structures, aesthetics and equipment.

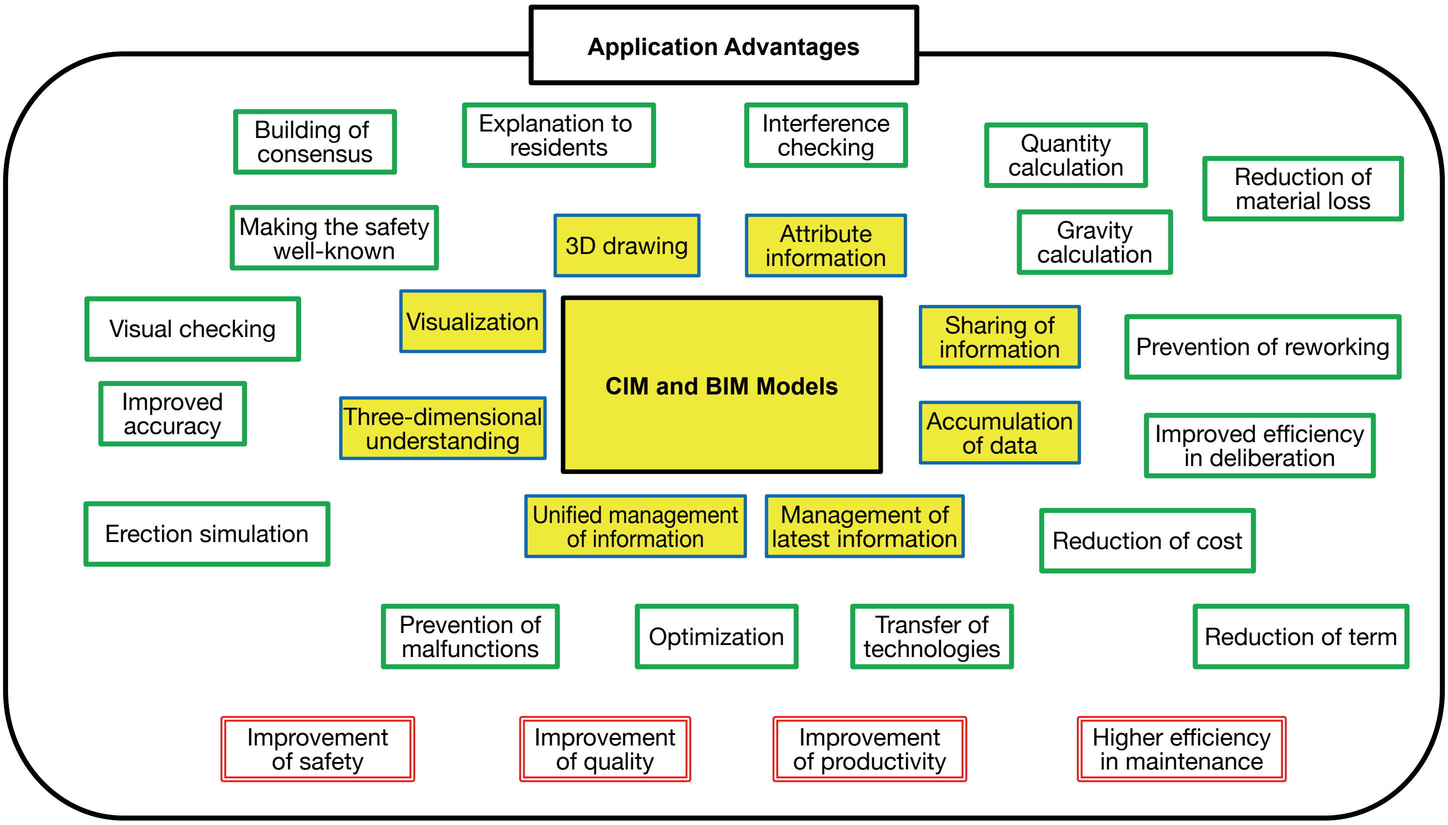
Purpose of CIM and BIM Applications

"CIM and BIM models" that capitalize on 3D models and are composed of attribute information allow the visualization of 3D figures and the unified management of information, thereby offering diverse application methods peculiar to these models. As a result, it is said that safety and productivity can be greatly improved by the use of CIM and BIM models. Specifically, interference checking, prevention of reworking and other advantages are available with the use of CIM and BIM models. They are conducive not only to improving safety, quality and productivity but also to enhancing the maintenance efficiency. (For details, refer to Fig. 1)

For example, because bridges and other similar structures can be visualized three-dimensionally by means of CIM models, common recognition can be shared among related parties and consensus can rapidly be built with no reliance on their capability to read and understand drawings and reports. Further, up-to-date information can be shared among all related staff through the unified management of CIM models.

In the preparation of bridge member manufacturing information, work duplication and reworking can be eliminated and preparation efficiency can be enhanced by the use of a CIM model, which will not only lead to reduced construction term but allow the earlier detection of malfunctions by means of three-dimensional interference checking. In terms of on-site erection, work safety can be enhanced and consensus with related administrative organizations and local residents can easily be built with the three-dimensional visualization of on-site erection conditions. In addition, efficient and comprehensive maintenance can be carried out by accumulating CIM models covering various kinds of bridge structures and preparing a database into which these CIM models are incorporated.

Fig. 1 Advantages by the Use of CIM and BIM Models



A typical example of a CIM application in bridge construction is explained above. Meanwhile, with the continued sophistication of information technology, it is considered that CIM will have a great potential to expand its fields of application.

Taking into account the current situation surrounding CIM and BIM mentioned above, explanations are given below as to the advantages of CIM and BIM applications and tasks for promoting their application, as well as how to tackle productivity innovation by maximizing the use of CIM and BIM:

Advantages Brought about by CIM and BIM Applications

• CIM

In order to specify the advantages brought about by the application of CIM, operations involved in the entire steel-structure construction process were classified into the following five phases—preliminary design, detailed design, member manufacture, erection and maintenance, and then more than 90 papers available in Japan were surveyed. As a result, the keywords relating to application advantages were extracted as shown below:

- Building of consensus
- Selection of optimum design
- Unified management
- Interference checking
- Automated calculation of the amount of materials required
- Automated preparation of drawings
- Rapid collation and deliberation
- Prevention/exclusion of reworking
- Improved accuracy in member manufacture
- Reduction of material loss
- Elimination of dependency on individual skills
- Application of manufacturing robots
- Visualization
- Improvement of work safety
- Prevention of errors
- Advancement of construction technologies
- Accumulation of data
- Introduction of robotic operations
- Reform of the construction industry

It was confirmed from these keywords that CIM has many application advantages, which are shown in Table 1.

• BIM

For the advantages of BIM application, operations involved in the entire building construction process were classified into the following six phases—basic plan, basic design, detailed design, member manufacture, erection and maintenance, and the same papers used for CIM were surveyed to extract the keywords relating to BIM application advantages, which are shown below:

- Front loading
- Building of consensus
- Optimization of project costs
- Quality in design, member manufacture and erection
- Simultaneous execution of multiple tasks
- Mutual tie-up
- Reduction of construction term
- Safety training
- Utilization of information
- Nurturing of human resources

It was learned from these keyworks that BIM has application advantages as shown in Table 2.

Table 1 Advantages by the Use of CIM

Operating phase	CIM application advantage
Preliminary design	Efficiency in building the consensus and selecting optimum design pertaining to civil engineering projects can be enhanced
Detailed design	Occurrence of design errors and reworking can be prevented by means of interference checking; Efficiency in quantity calculation can be enhanced
Member manufacture	Conducive to enhancing the productivity through elimination of reworking and improvement of member manufacturing accuracy and to advancing the construction technology such as introduction of manufacturing robots
Erection	Conducive to improving the safety and reducing the construction term and cost and to advancing the construction technology such as introduction of VR technology
Maintenance	Inspection efficiency can be enhanced; Effective maintenance can be implemented by accumulating and sharing data
Entire phase	Entire construction process can be optimized by incorporating robot introduction and AI technology and by renovating the operating structure

Table 2 Advantages by the Use of BIM

Operating phase	BIM application advantage
Basic plan	Design concept that takes into account the business feasibility of project owner is prepared by capitalizing on the experience of all related parties and the proposal of new development
Basic design	Requirement specifications of project owner are arranged, and basic design model (basic design drawing) is prepared
Detailed design	Detailed design model (detailed design drawing) is prepared in ways that transfer the requirement specifications prepared in basic design to the contractor so as to obtain the approval of project owner
Member manufacture	Design quality prepared in detailed design is converted into the information that can be understood by manufacturing staff and applied to member manufacture employing fabricating machines
Erection	Information used for combining manufactured members is arranged and the information about products is connected with the information about people so as to smoothly manufacture the end products
Maintenance	Prepared information is retroactively is applied to improve maintenance operations
Entire phase	Satisfaction from all stakeholders is obtained through mutual understanding of operations in every phase so as to link to next development

Tasks in Applying CIM and BIM

While it has been accepted from the above that CIM and BIM have various application advantages in every construction-related operation phase, it was also clear from the result of the survey of more than 300 papers that there are several tasks for promoting their application in the following respects:

- "Content of definition" of a model that can make the most of CIM and BIM applications in every operation phase
- "Functions" that the model should possess in realizing the "content of definition"
- "Data delivery" that allows the transmission of necessary model between respective operation phases
- "Data management (interface)" required for exchanges on the model that interfaces with the user in respective phases

In addition, it was noticed that the following three tasks exist for the entire operation flow, and it was learned that these three tasks work as factors that impede the wide-spread use of CIM and BIM.

- Task of "systems" or the mechanisms required to accomplish operations such as adding methods/standards and delivery methods
- Task of "human resources" required for training the technological capability of users and improving their technological capability
- Task of "equipment" relating to the environment for operating hardware/software equipment

Measures to be Tackled for the Promotion of CIM and BIM

• Quantification of Advantages of CIM and BIM Applications

The accumulated application results clearly show that CIM and BIM have great advantages in application. However, any measures to convert these application advantages to the cost are currently unavailable, and thus the validity of CIM and BIM applications is not widely shared. In the civil engineering structure industry in particular, because the design phase and the member manufacture/erection phase are divided at the stage of order placement by the project owner, it is difficult to assess the optimization of CIM and BIM applications throughout the entire process of a project by means of front loading.

In addition, in order to improve the operation efficiency of an entire construction process by means of CIM and BIM applications, it is necessary to promote CIM and BIM applications not only by the main contractor but with concerted efforts among all related companies.

A regrettable fact is that, because most related companies have been able to successfully implement projects by the use of conventional systems, the need for CIM and BIM applications has not yet filtered down to them. In light of this, if the advantages brought by the use of CIM and BIM applications vs the conventional operating frame could be quantified, it is expected that CIM and BIM applications would be further promoted to the construction industry as a whole.

• Enhanced Efficiency in CIM and BIM Model Preparation

The amount of information on CIM and BIM models is vast and thus the preparation of these models requires a heavy burden, which has resulted in hindering their wide-spread application. Fig. 2 shows an image of the measures that are taken to ease the burden required to prepare CIM and BIM models. Setting the burden required to prepare CIM and BIM models at the vertical axis and the time thus required at the horizontal axis, the workload at each phase in the project promotion is expressed in term of area in the figure.

In CIM, the data linkage between related companies that differ in each phase is being explored in the project promotion phase (refer to Fig. 2-a). This approach aims to reduce the work loss occurring in the business type in which the contract is made for each phase.

In BIM, on condition that the data linkage between phases is already put into practical use, a measure for front loading is being used in which the model involved in the downstream phase is prepared in the upstream phase (Fig. 2-b). While a greater burden is borne by the upstream phase, this approach aims at reducing the reworking load by solving in advance any problems involved in the downstream phase. This approach is based on reducing the overall workload of the project.

The final goal of these approaches is to further enhance the overall efficiency of projects by optimizing the use of the peculiar feature of CIM and BIM models—that the unified management of these models is feasible.

• Delivery of Data between Phases

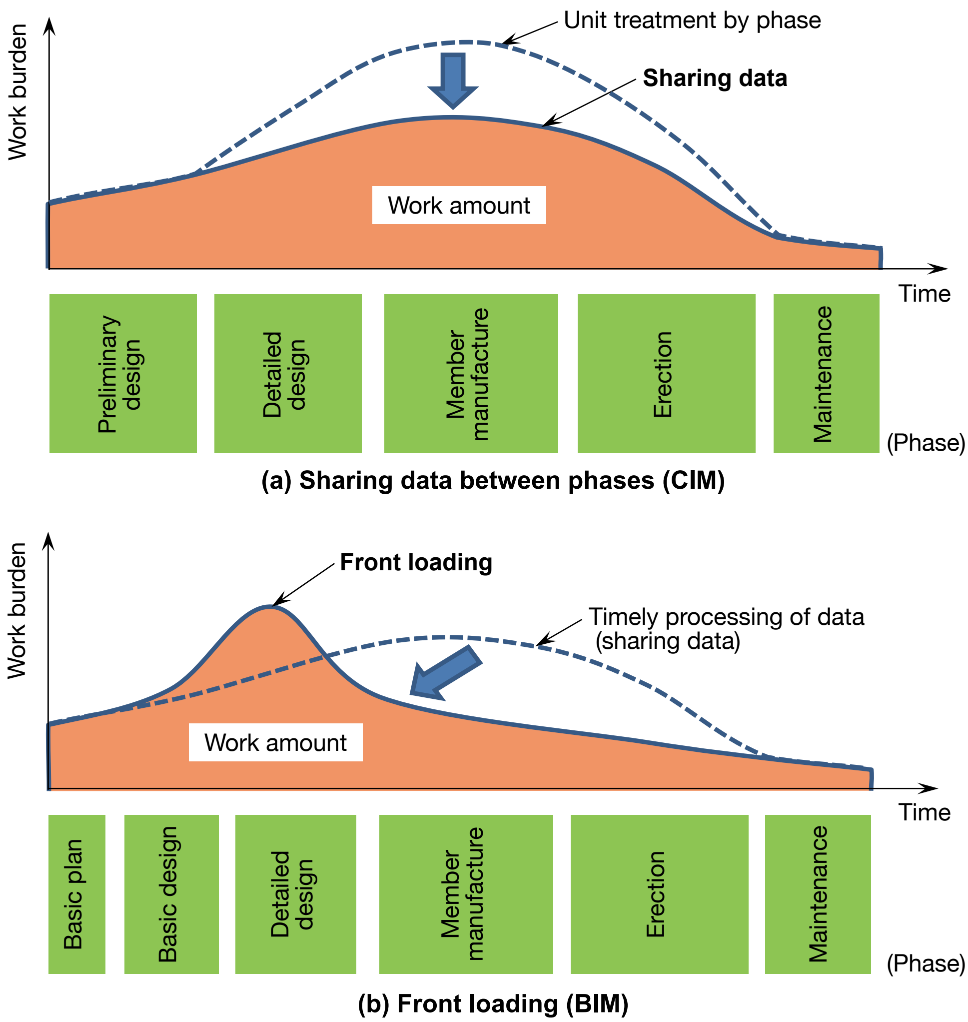
While effective application is being promoted for CIM and BIM models in every phase covering from design, member manufacture and erection to maintenance, there is a case in which across-the-board application over respective phases is not sufficient. Currently, the tool for use for the preparation of 3D models in the design phase differs from that in the member manufacture and erection phases and at the same time the tools even in identical phases differ depending on those in charge of preparation, requiring the time necessary to establish data exchange systems.

However, the early launch of measures to improve the productivity of CIM and BIM models is considered feasible through the standardization of the item of commonly applicable attribute information, the 3D model structure or the level-of-detail in the CIM and BIM models. In addition, it is considered that the following measures can be put into practical use early so as to treat the task of the delivery of data between phases.

—Interference checking in the design phase

Interference checking in the design phase leads to the front loading that prevents reworking in the erection phase.

Fig. 2 Enhanced Efficiency in Preparation of CIM and BIM Models



—Transfer of attribute information concerning maintenance

In the span from construction period to in-service period of structures, most of the span is accounted for by the period required for maintenance, and accordingly it is possible not only to enhance maintenance efficiency and to implement advanced maintenance but also to reduce the life-cycle cost of maintenance by organizing and providing maintenance information in the design and erection phases.

—Effective utilization of three-dimensional surveys

The content of surveys in conventional use covers the plane surveying, longitudinal surveying, and cross-sectional surveying of typical sections, and for sites not subject to plane surveying and profile leveling, it has been impossible to grasp detailed height information. To remedy this situation, it is effective to take the following measures: the application of three-dimensional surveying at the surveying stage prior to the design stage, the obtainment of point cloud data and then transferring this data to subsequent processes.

Point cloud data can not only be applied in the design phase but also in working out the construction plan and the plan for allocating heavy machinery in the erection phase, thereby leading to front loading.

• CIM and BIM for Use as Communication Tools

Currently, the operating structure of the construction industry is undergoing a large-scale transition from being based on conventional two-dimensional drawings to being centered on three-dimensional drawings. Given this, in cases when the 3D model will be filtered in the operating structure and its application and diffusion as a communication tool will be promoted, it is expected that a new age will emerge in which the content of design, erection and other operations can be understood by the use of 3D models and entire construction operations can be similarly managed.

Currently, a great amount of labor is expensed for the preparation of operating results produced by the combined use of 2D and 3D models and the delivery and modification of the data required for the execution of projects. But in order to achieve the reform of operating structures at an earlier stage, it is desirable to develop and disseminate tools that allow the mutual reflection of communications only using 3D models.

On top of these, the ideal desired by the construction industry is for labor saving over the entire construction process through not only the integration of drafting tools and design tools employing 3D models but also through the automation of such operations as design calculation, model preparation, quantity calculation, project cost calculation and attribute information assignment similarly employing 3D models.

On the other hand, regarding the transfer of building construction and civil engineering technologies, which has so far been handled by the so-called apprentice system, there are some concerns that the transfer initiative itself would be weeded out in the surge of ongoing business reform. Given this situation, how to transfer basic building construction/civil engineering technologies may be a future task to be solved, and it will therefore be necessary to tackle this transfer issue in parallel with the issue of technology inheritance.

Examples of the Practical Application of CIM and BIM

The measures to be addressed for the wider application of CIM and BIM are quite wide-ranging, and the scope and priority of application differ depending on the standpoint of various CIM and BIM users.

Given this, the solutions for efforts addressed at their practical application and dissemination are explained in the following with examples of CIM and BIM that have already been put into practical use. It is expected that these examples will serve as a help to promote the examination of future applications and the dissemination of CIM and BIM.

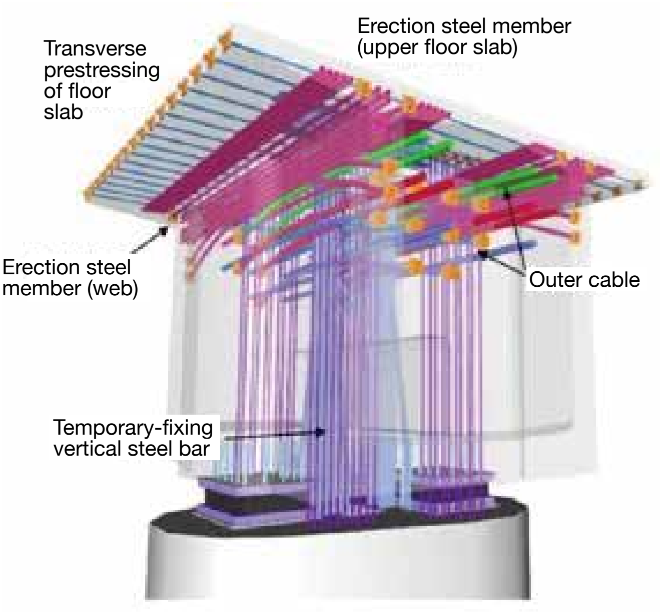
• Application Example 1: Reconstruction of a Bridge Following River Improvement

The figures show examples of 3D CIM model of the bridge completion prepared for use for deliberation with related organizations and the CIM models prepared aimed at drawing the construction step with the time axis and further preventing the complicated crossing of vertical and horizontal arrangements of the reinforcing bars from occurring.

Three-dimensional Model of Bridge Completion

Drawing of Erection Steps

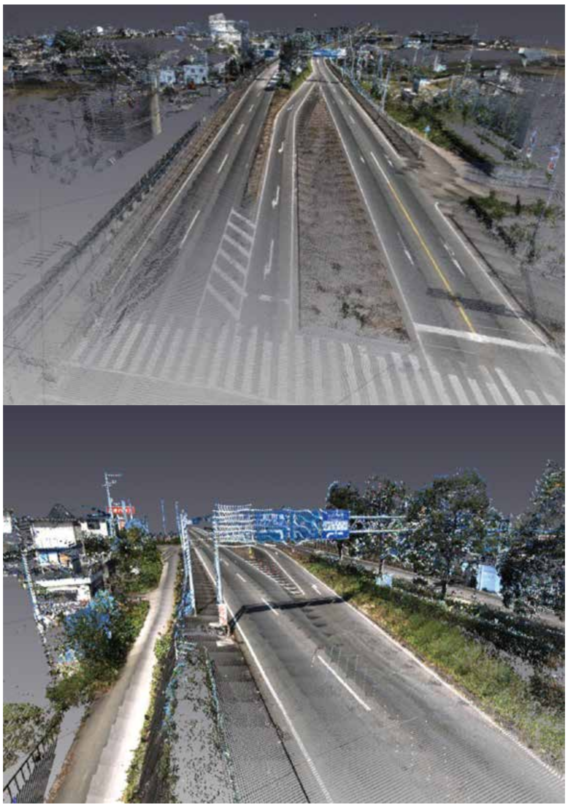
Arrangement of Reinforcing Bars in Pier Structure (Interference Checking)



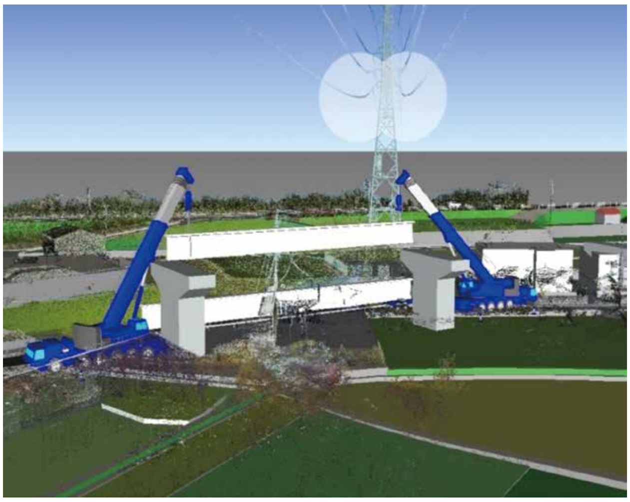
• Application Example 2: Erection of a Bridge in a City Area

Making the most of point cloud data and 3D models, the CIM model was prepared with the aim of solving various issues arising from bridge construction in the city area. Specifically, the 3D model prepared for new bridge construction was superimposed on the existing bridge restored by means of three-dimensional surveying to share the points of attention for the new bridge construction.

Restoration of Existing Facilities by Means of Three-dimensional Surveying



Superimposing of New Bridge Three-dimensional Model on Existing Bridge



Renovation of Operating Processes in the Construction Industry

The Japanese Government has recently released the “future society Japan should aim for”—Society 5.0 that goes beyond the Society 3.0 (industrial society) and Society 4.0 (information society). In light of this, various kinds of technologies conducive to realizing Society 5.0 are steadily being developed and improved.

In the construction industry, it is accepted that the effective application of CIM and BIM will be adapted to this initiative for realizing the future society shown above. Meanwhile, the key issue cited for promoting their effective application is the timing of the input and output of information and also the sharing of information.

Further, the following is expected to demonstrate a greater effect on their effective application: the simultaneous tackling by related parties of the respective phases from planning to maintenance.

When taking into account ongoing situations such as the shift to the new society, the key issues required for the effective application of CIM and BIM and maximizing the effectiveness of CIM and BIM applications, what the construction industry should work on in the future is to work out the mechanism that can maximize the benefits of CIM and BIM applications and to change the current mechanisms of CIM and BIM applications. For example, in order to make front loading effective for productivity improvement, it is important to promote an approach that reexamines the current ordering system in which design and construction are separated.

Towards Further Improvement of Productivity

The construction industry too is experiencing the hardship of the move towards the digitalization of its operations, and DX (digital transformation) is raised as an urgent issue even in construction operations. In order to steadily get on board with these emerging trends, it is important how the new tools represented by CIM and BIM will smartly be applied.

Currently the construction industry is not able to get over these hardships. Given this, it is desirable to build a new work flow by doing the best of all related parties right now, and to attain this goal, it will be necessary for all parties such as project owners, designers and contractors to make every possible effort.

From now on, it is expected that industry, government and academia will work together to solve these emerging tasks without being restricted by conventional rules and accepted concepts and to make the most of new knowledge to attain the final goal: the dramatic improvement of productivity.

Concept of Landscaping the Sumida River Terrace Connecting Bridge

—Beautiful Duplex Stainless Steel Bridge That Evicts the Memory of Edo, the City of the Water—

by Kumiko Itagaki
CEO, Greenery Technology and Landscape Planning

Outline of the Landscaping Project

The Sumida River is a river that flows through central Tokyo. The Japanese song "*Hana*" that sings of nostalgic scenes of the Sumida River is a popular song for schoolchildren. The river not only served as a pivotal route for water transport in the Edo period (around 1600~1867) but was also known as a noted place in Edo (currently Tokyo) that thronged with people until late at night.

Then, the way of life of people showed radical changes, and in the period of high economic growth (middle of the 1980s to beginning of the 1990s), the so-called "razor embankment" (embankment constructed using concrete and having a narrow width and a steep slope surface) had been prepared, which led to the isolation of people's lives from the waterside. As time has passed, the Tokyo Metropolitan Government has recently started the construction of high-spec embankments that take into account enhanced water affinity with two aims: improvement of the seismic resistance of embankments and the preparation of the Sumida River Terrace (a promenade along the Sumida River) provided to function as a promenade.

Given this, the Tokyo Metropolitan Government is currently implementing seismic retrofitting of floodgates on the Sumida River and subsequent landscaping of these floodgates, and at the same time connection of the Sumida River Terrace that was divided into parts by the tributary. In connection with this project, two connecting bridges spanning each of the Tsukishimagawa floodgate and the Oshimagawa floodgate were constructed in April 2020. In the construction of these two connecting bridges, resource-saving duplex stainless steel (SUS821L1) was applied as the main structural material.

Concept of Designing the Floodgate and Connecting Bridge

While the main theme to be treated in this article is the connecting bridge employing duplex stainless steel, the starting point of the bridge construction project was the landscaping design of floodgates, and thus its design concept is first introduced.

In the proposal of the "landscaping basic design for the seismic retrofitting of floodgates and other facilities" held by the Bureau of Construction, Tokyo Metropolitan Government in 2013, our company was designated to take charge of landscaping basic design. In the proposal, our company proposed the connection of the Sumida River Terrace that had been divided into parts by the floodgates and furthering the design of the connecting bridge to be constructed as a link to the floodgate landscaping design.

The target discussed in the proposal of landscaping the floodgate and other facilities covered 10 facilities such as the Tsukishimagawa, Sumiyoshi, Oshimagawa, Shin-onagigawa, Tatekawa, Genmorikawa and other floodgates and the Kiyosumi drainage facility. While their scale and location differ one by one, we proposed a unified landscaping design. Incidentally, our proposal was officially commended with the Award of the Chief of the Bureau of Construction of the Tokyo Metropolitan Government.

The design concept of the floodgates and connecting bridge are as shown in the following:

Realization of Historic Characteristics peculiar to the Sumida River

- The Sumida River and its ranging waterways are the important remnants of Edo, the city of the water.
- Image of floodgates and bridges is expressed in the design as "products" or "events" that invoke Edo, the city of the water.

Under the concept in which the "products" invoke a memory of a place and with the design theme that recalls the streets in old-time Edo, we have proceeded with the design of floodgates and the connecting bridge with the design motif of Japanese traditional products such as lattices, bamboo blinds and paper-shaded lamps. Regarding the coloring design, black was chosen as a basic color from among the traditional colors used in Edo, and the other colors of the rainbow were arranged as accent colors. The rainbow colors thus adopted acquired a high-level assessment from the Landscape Deliberation Council of Koto City in Tokyo, and it is fresh in our memory that a council member desired to have a sample of the rainbow colors.

Specifically, continuously-arranged windows were installed on the entire wall surface of the floodgate shed, and a lattice was arranged on the exterior wall and the window. Further, in order to prepare the lighting window on the entire window surface, a line illumination apparatus was provided inside of the floodgate shed. The exterior wall of the shed was finished with dense grey color, and the metallic structural section was finished with a grey color denser than that used for the exterior wall, and the rainbow colors as accent colors were applied to the handrail. The name of the floodgate was expressed on the paper-shaded lamp signs using the lettering found at the Japanese storyteller's theater. (See Photo 1)

Photo 1 Landscaping design of the Oshimagawa floodgate (with a lattice motif)

Basic Design of Connecting Bridge

• Design Concept

In response to the above-mentioned floodgate landscaping design, our company took charge of the basic design of the Sumida River Terrace connecting bridge project in 2014. The design target covered the five floodgates at Oshimagawa, Tsukishimagawa, Sumiyoshi, Katagawa and Genmorigawa. Of these five floodgates, the Oshimagawa and Tsukishimagawa floodgates were subjected to landscaping design prior to the other three floodgates.

The landscaping design concept of these two floodgates was worked out based the "streets of Edo" that have taken root in the memory of Edo, and the connecting bridge was designed with a motif of *yakatabune* (traditional roofed pleasure boats sailing on the Sumida River) in conformity with the "streets of Edo" mentioned above.

The landscaping design proceeded placing importance on the relationship between "the look" and "being looked at" pertaining to the Sumida River, floodgate and connecting bridge. At the same time, two types of landscaping designs for the connecting bridge and floodgate that show the lapse of time were prepared—landscaping design for daytime light and nighttime light. (See Photos 2 and 3)

Photo 2 Design of the connecting bridge at the Tsukishimagawa floodgate—Daytime (floodgate: designed with a bamboo blind motif)

Photo 3 Design of the connecting bridge at the Tsukishimagawa floodgate—Nighttime

• Configuration

In the design of the configuration of the connecting bridge superstructure, a "plane" was provided in front of the handrail to impart a sense of safety to pedestrians by avoiding pedestrians looking at the water surface of the Sumida River just beneath the handrail. In addition, the design was made in ways that allow well harmonization between the bridge superstructure and the floodgate in the background and make the floodgate stand out. (See Photo 4)

In the plane direction, the "plane" expands at the pedestrian's feet toward the plane center to bring about the depth of the floor surface. In the elevation direction, the height of the "plane" is lowered toward the plane center to make an open visual field so that pedestrians can see the water surface on the Sumida River and obtain a sense of unity with the water. As the pedestrian walks, the "plane" becomes lowered and their sense of openness becomes stronger.

The bridge configuration was designed so that, when looking up at the bridge from boats passing along the river, the bridge seems like a *yakatabune* due to the expanded "plane." Also, the views of the connecting bridge consecutively change—from the bridge floor slab to the walking space, and then to the Sumida River.

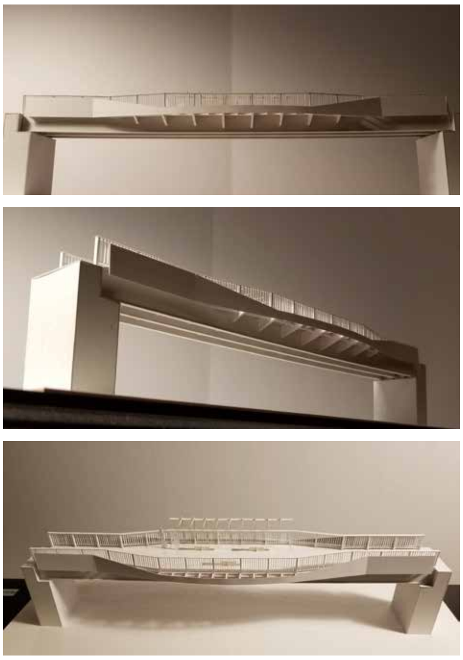


Photo 4 Model used to design the connecting bridge

In addition to the passage width, a "staying space" produced by inflating the plane center section was provided. Pedestrians can see the water surface of the Sumida River in the space surrounded by a handrail and "plane" to allow for them to obtain a sense of the unity with water.

• Structural Type

A simple girder bridge was selected as a structural type for the connecting bridge superstructure.

The girder bridge has been adopted for a long time and is familiar to people, and further, it is a bridge type that is high in terms of landscaping effect because it is unassertive, which led to the adoption of the girder bridge type.

• Structural Material

Duplex stainless steel was selected as the material for the main structural members of the bridge superstructure.

Stainless steel features high corrosion resistance, which is conducive to realizing an infrastructure with long service life. In particular, resource saving-type duplex stainless steel (SUS821L1) is high in both corrosion resistance and strength, which allows the lightweight construction of structures. Further, this is accepted as a rational material that allows the reduction of initial costs.

In terms of decorativeness, the surface finish (white, satin) peculiar to duplex stainless steel is beautiful and thus is most suitable as a material for use in the landscaping design of the connecting bridge.

Among other reasons attributable to the selection of resource saving-type duplex stainless steel are as follows: Because the bridge location site is in a coastal area, it was required to prevent the occurrence of corrosion due to flying air-borne salt. The bridge is always seen by people, and thus it was required to keep the occurrence of spot rusting as small as possible. Because the under-girder clearance is narrow and it is difficult to install scaffolding for use for the repainting of the bridge superstructure, it was necessary to adopt a structural material that needs no repainting.

Meanwhile, for the floodgate door subjected to seismic retrofitting, duplex stainless steel has been applied from the viewpoint of maintenance. As a result, matched seismic resistance and maintenance were secured for both connecting bridges and floodgates, further achieving landscaping integrity between them.

While there have only been two cases of bridges in Japan in which duplex stainless steel has been applied for the main structural members, the connecting bridge at the Sumida River Terrace is the first of its kind as a bridge having lengths of 40 m to 50 m.

Enhanced Comfort of the Sumida River Terrace

The Sumida River Terrace was constructed with the effective use of a foundation consolidation structure for the tide embankment. It is a promenade that is comfortable and high in water affinity.

In the construction of the two connecting bridges spanning each of the Tsukishimagawa floodgate and the Oshimagawa floodgate, the Sumida River Terrace that was divided into parts was connected at the confluence section of the tributaries where the floodgates are located, thereby enhancing the access and migration performance for pedestrians. Because such connection bridge projects are scheduled to be promoted in the future too, walks on the Sumida River Terrace will be even more enjoyable.

Concurrent with the construction of the connecting bridge, lighting is also being installed at the Sumida River Terrace, for which our company took charge of the design. Specifically, with the "streets of Edo" as a design concept, the lighting was designed so that warm lights gently expand along the Sumida River. For the design of the lighting, duplex stainless steel was also applied as the structural members. (See Photo 5)

The memory of "Edo, the City of the Water" is still alive at the Sumida River, and on the Sumida River Terrace, new landscapes depicting the floodgate, connecting with the bridge, and illumination designed with a motif of the inheritance of these memories of Edo are appearing. It was an unexpected pleasure for our company to be able to be continuously involved in the landscaping design. In these landscapes, stainless steel appears as a high-performance structural member and in varied forms of application.

Capitalizing on the infinite high application potential offered by stainless steel, we wish to exert our design endeavors toward the creation of more comfortable urban spaces.

Photo 5 Lighting at the Sumida River Terrace

JSSC International Committee

Message from the Chairman

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

The Japanese Society of Steel Construction (JSSC) has conducted a wide range of activities pertaining to steel construction—surveys and research, technological development and the dissemination of steel construction for Japan and overseas. It has also promoted tie-ups with related overseas organizations. Aimed at spreading Japan's steel construction technologies and developing overseas markets, the JSSC's International Committee took charge of editing Issue No. 67.

Issue No. 67 features Special Topic: Current Tasks and Future Development of CIM and BIM Applications. In Japan, plans call for the application of CIM and BIM in all public works project by 2023. Major discussions in this special topic are the advantages of their application, tasks for future dissemination, practical examples of application and productivity improvements in the construction industry by capitalizing on CIM and BIM. In the Special Article: Stainless Steel, the landscape design concept for the Sumida River Terrace Connecting Bridge is introduced. The bridge has connected the Sumida River Terrace, a promenade along the Sumida River in Tokyo, which was divided into parts by the tributary. The bridge was constructed using duplex stainless steel as the main structural material. It is the longest of its kind in Japan and has also proved to be useful in creating a new waterfront cityscape.

In addition, this issue introduces the JSSC Commendations for Outstanding Achievements in 2022 in the field of steel construction (four projects) and thesis (four papers).

On the JSSC Events page, a report is given of the 8th China-Japan-Korea Tall Building Forum held in Korea on August 26, 2022, which was held by video conference. This Forum is one of the operations of CTBUH.

In 2022 as well, due to the impact of coronavirus infection, JSSC's global activities were held by means of remote tools. As efforts towards carbon neutrality are being called for internationally, JSSC plans to set up a research group and to start discussions in cooperation with related organizations. We would like for everyone to understand the activities of JSSC and at the same time we would like to hear your opinions at any time.

8th China-Japan-Korea Tall Building Forum in 2022

by Dr. Masayoshi Nakai, Director of CTBUH Japan Structures Committee; International Committee of Japanese Society of Steel Construction

A hybrid conference based at Seoul was proposed in the same way as last year due to the continuing pandemic of the COVID-19. In the afternoon of Friday, August 26, 2022, the 8th forum was held, using the videoconference system "Zoom" for Japanese and Chinese participants.

At the beginning of the forum, Prof. Myung Sik Lee from Dongguk University gave opening addresses as the representative of Korean Council on Tall Buildings and Urban Habitat, followed by Dr. Masayoshi Nakai from Takenaka Corporation on behalf of CTBUH Japan Structures Committee and Dr.Yushu Liu from Tongji University, China.

At the forum, Korea delivered four lectures related to high-rise buildings on construction using AI technology, structural health monitoring and evacuation safety systems in case of fire. Among them, it is reported that so-called smart technologies such as GPS measurement, BIM, and 3D scanning have been widely used for quality and safety controls in the construction of high-rise buildings, which are producing good results.

Three lectures were given by China on vibration control technologies to improve the seismic performance and habitability, structural design and various issues in the construction related to high-rise buildings. With regard to "Raffles City Chongqing (Photo 1)" that consists of 8 skyscrapers with heights of 250 to 350 m in Chongqing, the structural design in which the tops of the 4 buildings are connected by a skybridge was introduced, including the characteristic changes of whole structure depending on the connection conditions, and the arrangement of dampers and sliding bearings. "Wuhan Center Tower" which is a 443 m tall skyscraper in Wuhan was introduced and the design concepts of embedded steel plates in shear walls and joint methods of outriggers were explained while stating that improving workability was the most important issue in its structural design.

There were three presentations from Japan. Professor Hiroyasu Sakata from Tokyo Institute of Technology gave a lecture on the current status and future challenges of high-rise wooden buildings in earthquake-prone country, Japan. Dr. Hiroto Kataoka from Obayashi Corporation made a presentation on the conventional applications of computational fluid dynamics, CFD in the early stages of planning for high-rise buildings and recent applications such as snow sticking to the materials of building façade. In addition, Mr. Hiroki Mukai from Nihon Sekkei Inc. introduced the structural design including PBSD of the latest high-rise building, "Toranomon Azabudai Project, Block A" which will be the tallest building in Japan at 325 m when completed in 2023.

In addition to the onsite participants in Seoul, the number of online participants was about 100 at its peak, which contains more than 50 from Japan, and there were active questions and discussions, including the use of the Zoom chat function.

At the closing, Dr. Kwangryang Chung from Dongyang Structural Engineers Group on behalf of Korean CTBUH expressed his appreciation for the active discussions with many participants about all presentations from three countries, which unfortunately took place online due to the COVID-19 outbreak. Finally, the conference concluded successfully with hopes that the next year's forum will be held in one place (Photo 2).

Photo 1 Raffles City Chongqing (© Yukio Tamura)

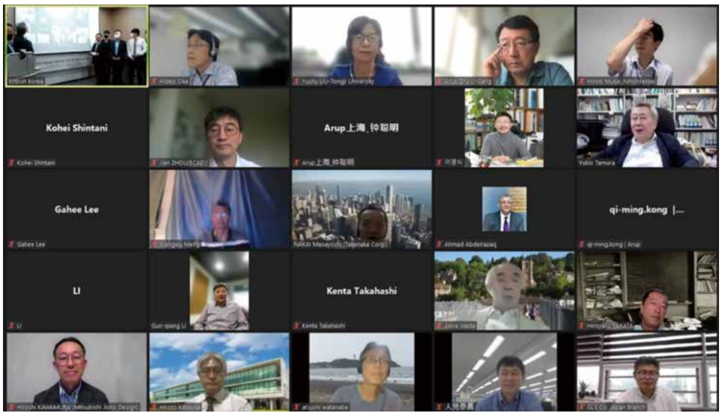


Photo 2 PC screen right after the online meeting

STEEL CONSTRUCTION TODAY & TOMORROW

Published jointly by

The Japan Iron and Steel Federation
3-2-10, Nihonbashi Kayabacho, Chuo-ku, Tokyo 103-0025, Japan
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Edited by
Committee on Overseas Market Promotion, The Japan Iron and Steel Federation
Chairman (Editor): Keiji Ando

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