公益社団法人 土木學會 Japan Society of Civil Engineers

Committee on Steel Structures

No. 1, 2024

Newsletter

Contents

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Message from the Committee Chair

Professor Takashi Yamaguchi, Osaka Metropolitan University

Chair, Committee on Steel Structures, JSCE

Committee on Steel Structures, Japan Society of Civil Engineers (JSCE), has decided to publish this newsletter to provide the public with the latest information on steel structures in Japan and the activities of the committee.

Committee on Steel Structures, JSCE, was established in 1971 as one of the research committees of JSCE by reorganizing Bridge Structure Committee. It is active in research on steel bridges and steel structures. The committee is engaged in the development of design standards such as Standard Specification for Steel and Composite Structures and Recommendations for Erection Design and Construction of Steel Structures, solving technical issues of the time, and coordinating, collecting, and publishing technical information. The results of these activities are published in book form to disseminate technical information widely.

In Japan, many long-span bridges have been constructed, including the Akashi-Kaikyo Bridge (suspension bridge, center span: 1991 m), the Tatara Bridge (cable-stayed bridge, center span: 890 m), the

Meiko Nishi Bridge (cable-stayed bridge, center span: 405m, Figure 1), and so on. Various technical problems have been overcome in the process. The committee played a central role in this process, and its achievements are still of great value today. We have a mission to pass them on to the next generation.

Today, Japan's infrastructure development has progressed to a certain degree following the period of rapid economic growth in the 1960s. We are now faced with the challenge of dealing with the aging of the large number of structures that were initially built. For example, it is estimated that 70% of the 700,000 bridges under management in Japan will be over 50 years old by 2030. Under these circumstances, more resources are being directed to solving technical problems related to the maintenance and management of structures, such as repair, reinforcement, and renewal, rather than new construction. The committee is actively engaged in the development of technologies for diagnosing structural integrity, repair/reinforcement by patch plates, repair/reinforcement using new materials such as FRP, and demolition/reconstruction, as well as the introduction of the latest findings. The results of our activities are used in the maintenance and repair of actual structures and are highly appreciated by structural management organizations.

The committee also conducts public relations and educational activities through the planning and execution of various lectures to foster steel structure engineers and researchers. This is done to maintain and develop the academic system of steel structural engineering and bridge engineering, and to pass it down to the next generation.

We hope you will look forward to this newsletter, which will introduce you to some of the activities of the committee and the state-of-the-art of steel structures in Japan.

We, Committee on Steel Structures, hope to deepen and promote exchanges with overseas engineers and researchers through the dissemination of this information. By doing so, we also hope to contribute to the further development of steel structure engineering and bridge engineering.

Finally, we believe that this letter will be an opportunity to further promote technical and research exchanges in the field of steel structures worldwide.

Yours sincerely,
Prof. Takashi YAMAGUCHI
Chair, Committee on Steel Structures,
Japan Society of Civil Engineers (JSCE)

Figure 1 Meiko Nishi Bridge (completed in 1985 and 1997), Nagoya, Japan

Publications

Introduction of Standard Specifications for Steel and Composite Structures

Based on the results of research and study activities conducted by several subcommittees, Committee on Steel Structures, Japan Society of Civil Engineers (JSCE) published "I General Provision, II Structural Planning, III Design" in 2007 (Figure 2), "IV Seismic Design" in 2008 (Figure 3), "V Construction" in 2009 (Figure 4), and "VI Maintenance" in 2014 (Figure 5). Although all editions of the "Standard Specification for Steel and Composite Structures" have been published, "I General Provision, II Structural Planning, III Design " was revised in 2016, "IV Seismic Design" and "V Construction" in 2018, and the "VI Maintenance" in 2019 in order to maintain it as an advanced specification. The following sections provide an overview of each of these specifications.

I General Provisions, II Structural Planning, and III Design (2022)

Figure 2 Standard Specifications for Steel and Composite Structures

I General Provisions, II Structural Planning, and III Design

Performance-based design method based on the limit state design approach incorporating the latest technology and knowledge - Aiming for steel and composite structures with excellent safety, serviceability, durability, workability, and maintainability.

In response to recent cases of bridge damage caused by earthquakes and heavy rainfall, redundancy and structural robustness considerations have been strengthened in the structural design. This book also includes additional considerations for finite element analysis of interface structures, such as member connections and interfaces between different materials, and for structural analysis applied to the performance evaluation of existing structures. In addition, from a maintenance perspective, structural considerations for improving corrosion resistance have been expanded, and material and member strength using stainless steel and methods for improving fatigue strength by weld toe treatment have been added.

This book provides essential information for understanding the various performance requirements and limit states of steel and composite structures. We hope you will find this book useful in the design and research and development of steel and steel composite structures that are safe, durable, and economically sound.

Note: The first edition of this book, published in 2007, is translated into English, and you can download it from the following link.

https://www.jsce-int.org/system/files/Standard.pdf

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IV Seismic Design (2018)

Figure 3 Standard Specifications

for Steel and Composite Structures

IV Seismic Design

A new specification for next-generation seismic design has been published, actively incorporating not only the latest findings, concepts, and technologies, but also the lessons learned from damage caused by massive earthquakes that have occurred since the Hyogo-ken Nanbu earthquake (1995), the Tohoku earthquake (2011) and the Kumamoto earthquake (2016). In recent years, "unforeseen" damage to social infrastructure facilities has become less socially acceptable, and this book is characterized by the inclusion of two contents that are in line with this trend. The first is a practical method for more accurately verifying seismic performance by calculating the three-dimensional dynamic response of a structure to the assumed multidirectional seismic motion component based on seismic information at the site. The second is a method for dealing with the case where the response of a structure exceeds the safety limit due to earthquake motion beyond the expected seismic response. The appendix presents specific verification examples for continuous viaducts, truss bridges, and arch bridges, and explains the contents of this specification in an easy-to-understand manner.

V Construction (2018)

Figure 4 Standard Specifications

for Steel and Composite Structures

V Construction

The Construction Edition Subcommittee of Standard Specifications for Steel and Composite Structures has summarized a revised edition, nine years after the first edition was published in 2009. First, the erection performance requirements are reorganized and harmonized with other editions of Standard Specifications for Steel and Composite Structures and other standards. In addition, descriptions related to Steels for Bridge High Performance Structure (SBHS) have been added, F11T high-strength bolts have been deleted, and descriptions such as enlarged holes have been added. The need to ensure safety during erection, which has been emphasized in recent years, is also described. With these additions, this is the most up-to-date specification of standards required for erection of steel structures in general.

VI Maintenance (2019)

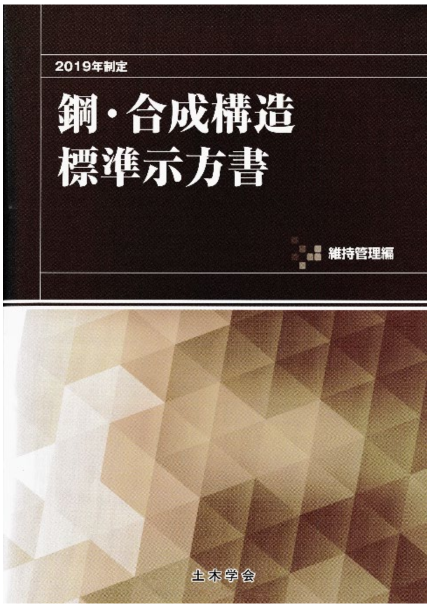

Figure 5 Standard Specifications for Steel and Composite Structures VI Maintenance

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It has been about five years since the first edition of Standard Specification for Steel and Composite Structures, VI Maintenance, was published in 2013. During this time, the maintenance and management environment has changed dramatically, with active technical development in many areas. In light of this background, the latest knowledge on the maintenance and management of steel and composite structures has been incorporated into this edition, and the overall specifications have been improved by including evaluation methods such as grading evaluation based on appearance deformation, while maintaining consistency with other related specifications. In addition, the reference section contains a wealth of practical examples and methods for detailed investigation methods, performance evaluation using load rating and finite element analysis, and repair and strengthening measures. This book can be used for various purposes, such as maintenance and management practice of steel and composite structures, preparation of standards and guidelines, research and development, and study of maintenance and management techniques.

Research

About Subcommittees

Committee on Steel Structures establishes subcommittees as necessary to conduct surveys and research, and holds lectures and symposiums as needed, and presents research results.

List of Reports on This Issue

The following reports were issued in 2023 and briefly introduced on this issue.

No. 1	
Category	Earthquake-resistant design
Report	Report on Research and Study on Seismic Performance Verification of Steel Bridges Using High-Precision Numerical Analysis Methods
Committee	Subcommittee on Seismic Performance Verification of Steel Bridges Using High-Precision Numerical Analysis Methods
No. 2	
Category	Other
Report	Activity Report of the Research Subcommittee on Innovation Technologies for Obtaining Condition Information on Steel Structures
Committee	Subcommittee on Research and Study on Innovative Technologies for Obtaining Condition Information on Steel Structures

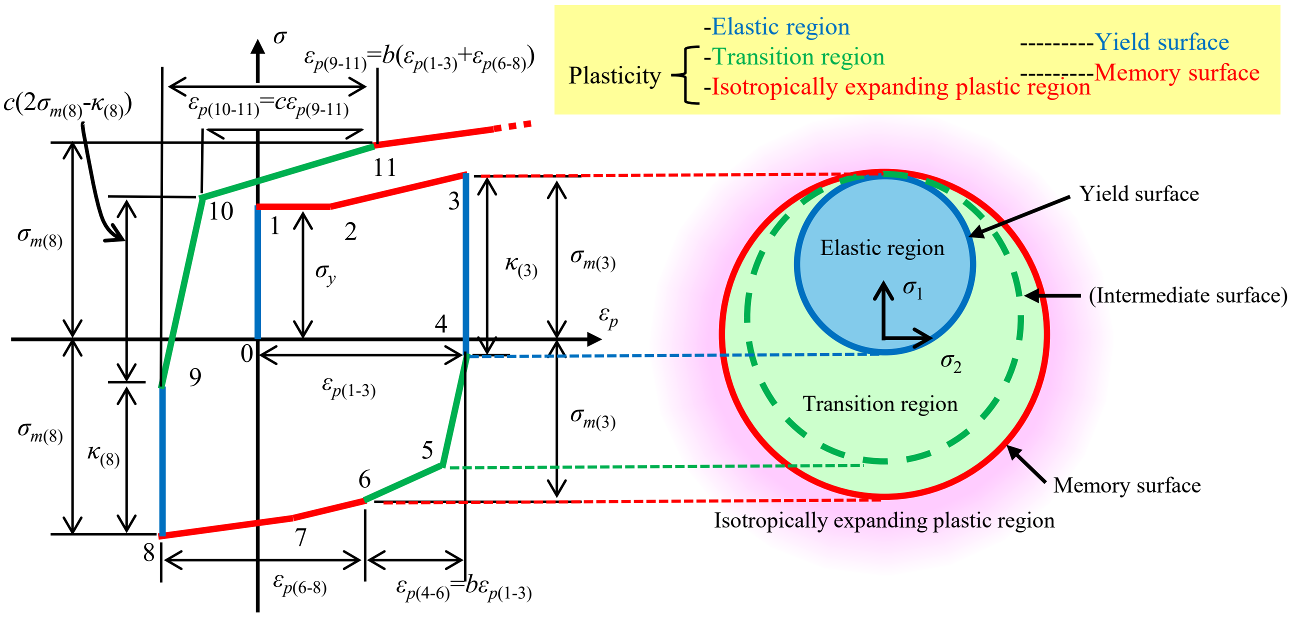
Other reports (in Japanese):

http://library.jsce.or.jp/Image_DB/committee/steel_structure/index.html

Summary of "Report on Research and Study on Seismic Performance Verification of Steel Bridges Using High-Precision Numerical Analysis Methods"

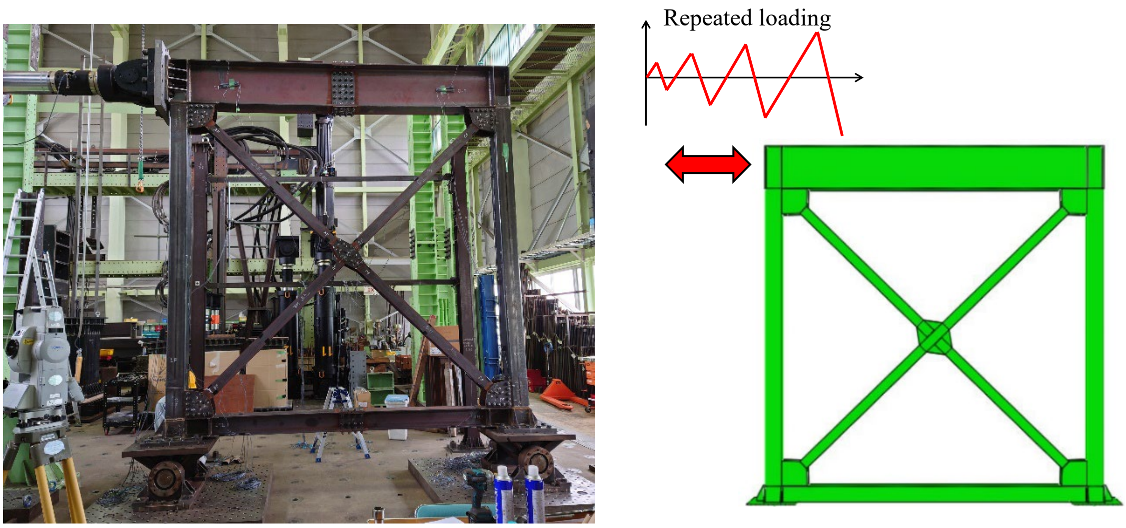
The subcommittee has proposed that the use of high-precision numerical analysis methods can allow the plasticization of major members of steel arch bridges and steel truss bridges and enable rational seismic retrofit design. This report summarizes the results of the study and the contents of the proposed method. Specifically, the following is presented.

First, the material constitutive law of steel is important to allow plasticization of steel members. The report covers the basic material constitutive laws used in practice commonly and advanced ones, and also outlines the characteristics and limits of use of each material constitutive law. In particular, the material constitutive laws mainly for steel members of steel arch bridges and steel truss bridges, which were researched and developed during the activities of this subcommittee, are described in detail. This constitutive law is a constitutive law that can consider cyclic plastic history in the same way as the existing advanced constitutive laws for steel piers (see Figure 6) and is intended for practical use. The analytical model is also important in relation to the material constitutive law. In high-precision numerical analysis methods, an analytical model would often be a rigorous modeling of



(a) Stress-strain relation under uniaxial cyclic loading (b) State in multiaxial stress space

Figure 6 Multiaxial multilinear model



(a) Test specimen and loading device (b) Loading conditions

Figure 7 Public experiment of sway bracing panel at the support point of steel truss bridge

(a) Comparison of load-displacement curves (b) Experimental result (c) Fiber model (analysis result)

Figure 8 Experimental and analytical results of sway bracing panel

the target structure using shell elements, etc. However, the subcommittee places great importance on modeling that can reproduce the experimental results (analytical model verified by experiments) by conducting experiments under cyclic loading (see Figure 7), which is the most characteristic feature of this subcommittee (see Figure 8). When local buckling of a steel member occurs and cannot be represented by a beam element (fiber element), it is modeled by a shell element. In many cases, modeling with fiber elements is sufficient because hot-rolled steel sections are typically used for the main members under consideration (e.g. sway bracings at the support point) and are not susceptible to local buckling. For this reason, this report focuses on modeling with fiber elements (see Figure 9).

Next, for the seismic verification method, the verification method basically follows the verification method of Standard Specification for Steel and Composite Structures - IV Seismic Design (hereinafter referred to as "the current specification") of Committee on Steel Structures, Japan Society of Civil Engineers (JSCE), which was established in 2018. However, since the current specification does not allow for plasticization in major members (such as sway bracings at the support point), "semi-energy-absorbing members" are newly defined to make it easy to allow plasticization in seismic design. In the current specifications, members are classified into "energy-absorbing members" and "non-energy-absorbing members," but the subcommittee's cyclic loading tests

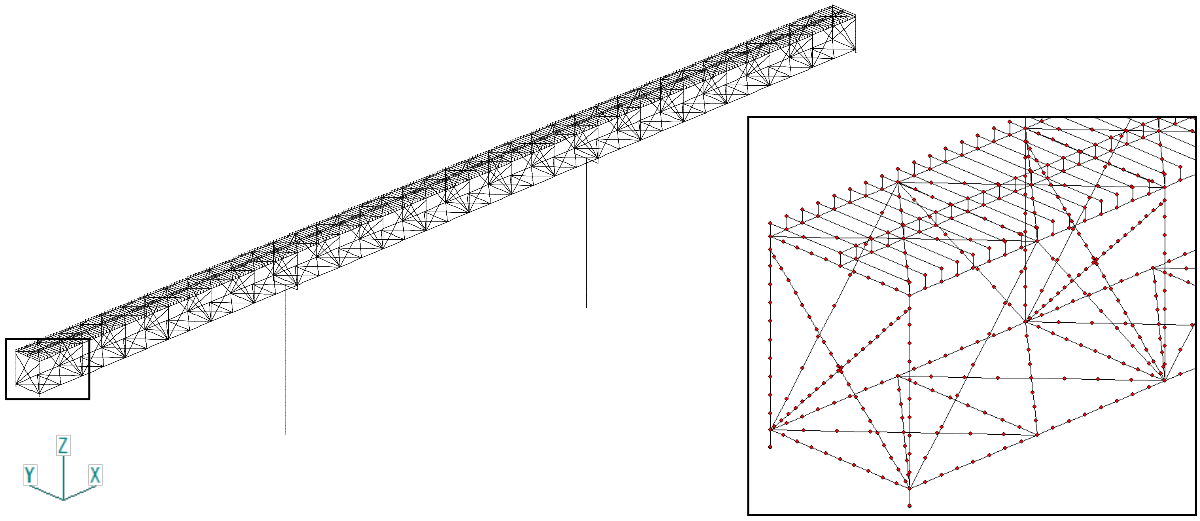


Figure 9 Analysis model of steel truss bridge using fiber elements (framework representation)

for a sway bracing (see Figure 8(a)) have shown that although they do not absorb energy as actively as the "energy-absorbing members," they have stable hysteresis loops and little load drop after the maximum load, judging that a certain degree of plasticization is acceptable so that they are defined. In addition, the method of calculating and verifying the load-bearing capacity of the entire structure accurately by modeling the entire bridge with shell elements (full-shell model) is also presented in anticipation of the next seismic performance verification method.

Furthermore, using the aforementioned analytical model, material constitutive law, and seismic verification method, two types of analysis examples are presented: a basic model bridge and a realistic model bridge. The basic model bridges are typical steel arch bridges and steel truss bridges, and the examples are shown from the analysis results of the current bridge conditions to seismic verification and reasonable seismic retrofitting. For the real model bridges, road administrators and engineers with extensive experience in seismic design actively participated in the study, and the results of the study for each of the three actual steel arch bridges and steel truss bridges are summarized. However, since the actual retrofitting method of real bridges may not be determined from the analysis results alone, the examples are limited to the analysis of the existing conditions and comments on the retrofitting. In addition, the detailed modeling of the real model bridges, which is not studied in the basic model bridges, is performed, and the modeling is expected to be very useful in the practical seismic resistance evaluation work.

Finally, the results of the study on the excess action over the design earthquake motion are summarized using examples of viaducts with concrete-filled steel piers and steel arch bridge end posts. In addition, the subcommittee members have provided valuable topics for discussion at each meeting, and the current status of the limit state of friction type high-strength bolted connections and low-cycle fatigue evaluation of welds are summarized from these topics.

As mentioned above, a wide range of topics from the latest research results to analytical examples of actual bridges are presented in the report, and it would be a great pleasure if many practicing engineers, road administrators, and researchers involved in seismic design would refer to this report.

Link to the report (in Japanese):
http://library.jsce.or.jp/Image_DB/committee/steel_structure/bklist/66066.html

Summary of "Activity Report of the Research Subcommittee on Innovation Technologies for Obtaining Condition Information on Steel Structures"

This report is based on the discussions in the "Subcommittee on Research and Study on Innovative Technologies for Obtaining Condition Information of Steel Structures" established in Committee on Steel Structures, Japan Society of Civil Engineers. The discussions in the subcommittee led to some basic considerations, such as what innovation technology is and how it should be defined, and the committee faced some difficult and interesting issues in deciding what to cover in the study. In addition to information based on conventional inspections, various new types of information on the condition of structures are being obtained, and it is important to know how to make use of this information. It is generally difficult to define and judge whether the various technologies proposed so far are innovative or not, the subcommittee came to recognize that each expert has a different perspective on what kind of technology is innovative and how, through the discussion. Therefore, the subcommittee decided to discuss what kind of technology each member considers innovative. In cases where an innovation was created by a subcommittee member, how it overcame hurdles and challenges and broke through them was focused on.

The so-called innovations and innovative technologies are born and developed in any field, and these new developments may trigger the next generation of engineers to deepen their interest in the field. This report has been organized so that the presentation and contents will be as easy to understand as possible for the next generation of engineers and the younger generation. The reason for this policy is that the subcommittee, which deals with innovative

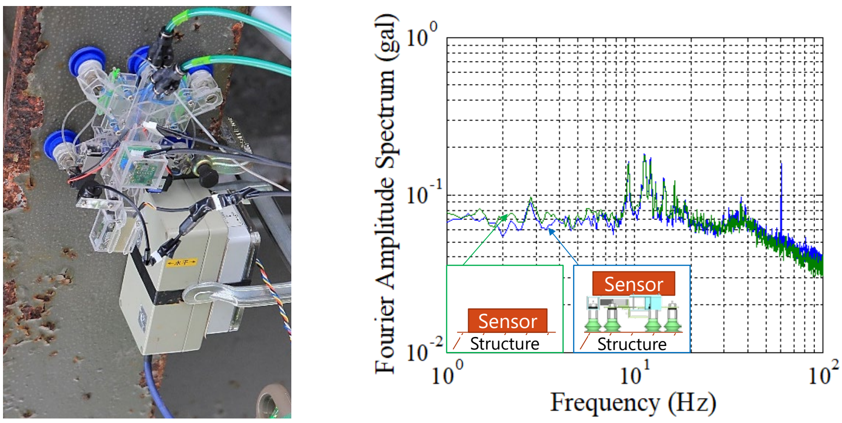


Figure 10 Vibration measurement by a compact inspection robot that moves on a corroded steel by surface adsorption

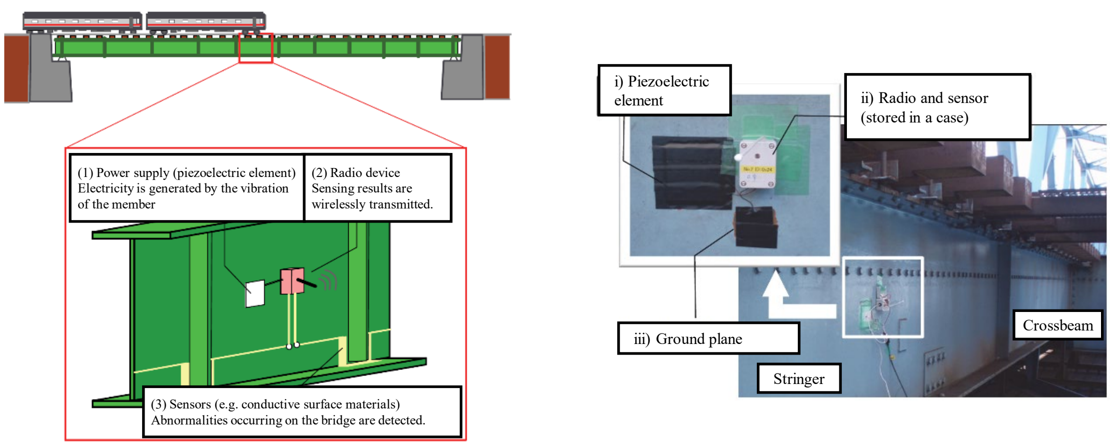


Figure 11 Monitoring system for bridges using vibration power generation

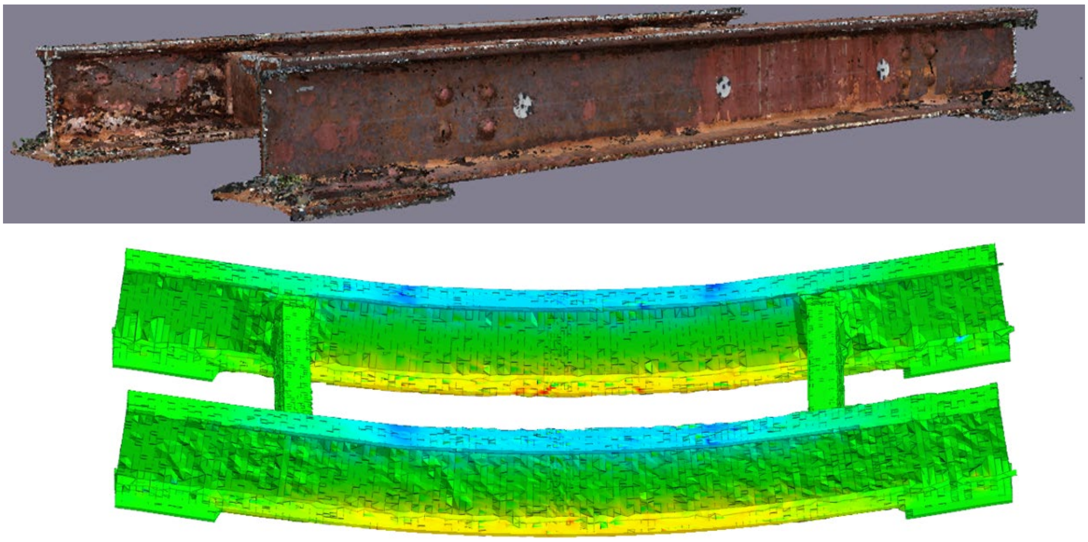


Figure 12 Conversion technology from point clouds to FEM models

technologies, considers it important to convey the attractiveness of steel structures and civil engineering to the next generation, as it was pointed out through the research discussion session held by the subcommittee (jointly with Subcommittee on Public Relations) and Committee on Steel Structures.

In this sense, this report is composed of four chapters in the hope that it will provide hints for the creation of new technologies in the future, rather than covering all the technologies that have been developed so far, by providing information on what new and innovative technologies are, and on some aspects of the process for creating such technologies.

Chapter 1 defines innovation and innovative technology and summarizes the concept of creating innovation with reference to recent trends. Chapter 2 presents examples of technologies that have been developed in recent years related to the condition assessment of steel structures in several categories such as inspection and summarizes the points where innovations can be found and breakthroughs for solving problems, while also mentioning ingenuity in the development process (Figures 10 to 12).

Chapter 3 describes examples of projects that attempted to apply new measurement technologies. Chapter 4 summarized expectations and thoughts of each subcommittee member about how it will have an impact to maintenance, disaster prevention, and the future, while imagining the possibilities of innovation. The subcommittee hopes that this glimpse into the viewpoints of engineers currently engaged in cutting-edge research and development will be conveyed to the younger generation.

Link to the report (in Japanese):
http://library.jsce.or.jp/Image_DB/committee/steel_structure/bklist/66103.html

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Awards

Introduction to JSCE Award Related to Steel Structures: The Tanaka Award

The late Dr. Yutaka Tanaka, the first head of Bridge Division of Board of Capital Reconstruction / Bureau of Reconstruction during the reconstruction of the capital following the Great Kanto Earthquake in 1923, is widely known even today as the man responsible for the construction of many famous bridges familiar to the general public that have become symbols of Tokyo. These include the Eitaibashi and Kiyosubashi bridges spanning the Sumida River. At that time, Dr. Tanaka was an authority on bridge and structural societies. In light of his achievements, it would be fitting to call him the father of Japan's bridge and steel structure industries.

After the passing of Dr. Tanaka, his family contributed to Japan Society of Civil Engineers (JSCE) a fund for the purpose of promoting his profession. In 1965, following the earlier initiative by volunteers, it was proposed to set up a venture to commemorate the professor's achievements, 'Dr. Yutaka Tanaka Commemorative Foundation'. Since then, numerous individuals and groups have contributed further donations to the fund. Using these donations, JSCE, on behalf of the Commemorative Foundation, decided to award an annual prize, 'Japan Society of Civil Engineers Tanaka Award, for excellence in bridge and steel structure engineering, In 1966, the awarding of The Tanaka Award, which is just one of the JSCE Awards, was started. Over the last fifty years or more, numerous volunteers, together with the assistance and cooperation from many other people, have helped establish this award as one of extremely high honor and value, and have also contributed greatly to the dissemination of bridge engineering technology.

The Tanaka Award is made up of the following four awards:

(1) Division of Professional Bridge Engineer Recognition (Engineer Division)

Awarded in recognition of outstanding achievement for the advancement and development in the field of bridge engineering. This Award was created in 1993, so it is relatively new, but has already established itself, having been awarded to some of the most eminent bridge engineers in the country.

(2) Division of Outstanding Research Publication (Paper Division)

This Award is selected of a paper (thesis or academic report) presented in a JSCE publication, relating to the planning, design, fabrication, construction, maintenance administration, invention of devices, or history etc. of bridges, and which is recognized for the significant contribution it makes to the development of bridge engineering.

(3) Division of Outstanding Bridge Design, Construction and Retrofit (Project Division)

A bridge, or related structure, whose planning, design, construction, retrofit or otherwise, is selected in recognition of its special features. This Award, acknowledging that the collaboration of many people is involved in producing a bridge, is different from other JSCE Awards in that it is not awarded to a single individual, but rather to the grouping of the developer, designer, contractor and entire organization responsible for producing the work.

(4) Division of Outstanding Bridge Technologies (Technology Division)

Aimed at recognizing outstanding or innovative technologies applied to bridges or similar structures, which exhibit distinctive features in aspects such as planning, design, fabrication, construction, maintenance, renovation, restoration, demolition, and removal, and contribute to the advancement of bridge engineering.

Reference (in Japanese):
https://committees.jsce.or.jp/tanaka_sho/node/3

The Tanaka Award (Division of Professional Bridge Engineer Recognition)

"Contribution to the development and dissemination of design, construction, and maintenance technology for steel bridges"

Takeshi Mori (Professor Emeritus, Hosei University)

Professor Takeshi Mori has conducted numerous studies on the fatigue and joints of steel bridges, publishing his findings in journals such as Journal of Japan Society of Civil Engineers. He has been awarded various honors, including the JSCE Paper Award, the JSCE Research Achievement Award, and The Tanaka Award (Paper Division) from Japan Society of Civil Engineers, as well as the Paper Award from Japanese Society of Steel Construction.

At Japan Society of Civil Engineers, he has served as the secretary-general and chair of Committee on Steel Structures. As the chair of the subcommittee on investigation and research, he compiled influential guidelines such as "Recommendations on Design, Construction and Maintenance for Friction Type of High Strength Bolted Connections" and "Fatigue of Orthotropic Steel Bridge Deck (2010)," which have been widely utilized by steel bridge engineers. Additionally, he has played a leading role in the creation and revision of fatigue design and construction standards and guidelines for national and expressway management agencies and operators.

In addressing the ethical concerns raised by the welding defects in bridge fall prevention devices, Professor Mori, as the chair of the expert committee, proposed measures to prevent recurrence. He also investigated the causes and countermeasures for fatigue issues in orthotropic steel bridge decks, summarizing the results in various management and operator committees. At Japanese Society of Steel Construction, he served as the secretary during the publication of "Fatigue Design Recommendations for Steel Structures (2012)" and as the chair during its revision, ensuring that the recommendations reflected the latest knowledge and his research outcomes.

Furthermore, he proposed and realized the establishment of the certification system for civil steel structure inspectors, contributing to the dissemination of maintenance technology and the development of engineers.

In summary, Professor Mori's substantial contributions to the development and dissemination of technology related to the design, construction, and maintenance of steel bridges through his research and the creation and revision of standards have earned him The Tanaka Award from Japan Society of Civil Engineers.

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"Improving Durability of PC Bridges and Clarifying the Role of PC Structures in Creating a Sustainable Society"

Masamichi Tezuka (Director of Quality Control Department, Sun Environmental Planning Co., Ltd. (Former Executive Officer at Oriental Shiraishi Co., Ltd.))

Dr. Masamichi Tezuka joined Oriental Concrete Co., Ltd. (now Oriental Shiraishi Co., Ltd.) in 1977 and has made significant contributions primarily in the research and development of prestressed concrete (PC) bridges. During that time, the deterioration of PC bridges, known for their high durability, began to manifest due to issues like salt damage. Dr. Tezuka was one of the first to engage in research and development aimed at enhancing the durability and advanced maintenance of PC bridges. Notably, he focused on aramid fiber for reinforcement and applied it to actual structures as the movement to apply continuous fiber reinforcement materials to bridges began domestically. In addition to research and development, he also worked on the construction of PC bridges, including the Kiso River Bridge on the Isewangan Expressway.

Dr. Tezuka has also significantly contributed to the advancement of PC bridges through academic societies. He served as a standing committee member of Concrete Committee at Japan Society of Civil Engineers, where he worked on environmental performance evaluations and addressing defects in PC bridges. He held positions as director and vice president of Japan Prestressed Concrete Institute, where he focused on standardizing durability improvements and maintenance of PC bridges, clarifying the role of PC structures in a sustainable society, and archiving PC technology. At Japan Prestressed Concrete Contractors Association, he served as the chair of Subcommittee on Environmental Impact Reduction and contributed to evaluating concrete durability and efforts towards forming a low-carbon society.

Through these activities, Dr. Tezuka's contributions to the development of bridge technology in Japan have been recognized as highly significant, making him a deserving recipient of The Tanaka Award from Japan Society of Civil Engineers.

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The Tanaka Award (Division of Outstanding Research Publication)

Dynamic Response Characteristics of Continuous Girder Bridge during Train Passage and its Simple Evaluation Method

Munemasa Tokunaga, Manabu Ikeda (The Railway Technical Research Institute): Japanese Journal of JSCE, No.79, Vol.1, 22-00185, 2023.
https://doi.org/10.2208/jscejj.22-00185

For continuous girder bridges in high-speed railways, systematic knowledge about dynamic responses at high speeds has not been organized, making it impossible to design using practical evaluation methods.

This paper comprehensively analyzes the dynamic response of continuous girders during train passage. It reveals that the resonance speed of each natural vibration mode shows multiple peaks in the deflection impact factor, with different vibration modes amplified depending on whether the number of spans is odd or even. It also shows that as the number of spans and span length increase, the natural vibration modes become less distinct, and the impact coefficient tends to decrease. Based on these findings, the paper proposes a simplified evaluation method for deflection, bending moment, and reaction force impact coefficients, applicable up to speeds of 400 km/h. This allows for simple and rational prediction of dynamic responses during train passage without performing dynamic analyses. Furthermore, the validity of this method is verified through comparisons with dynamic interaction analysis results between vehicles and bridges, as well as with actual measurement results from 10 bridges, including composite and PC bridges. This unified the evaluation method for impact coefficients, which were previously different for steel and composite girders and concrete bridges.

As such, this paper enables the rational design of continuous girder bridges in high-speed domains, which was previously impossible, contributing to the smooth advancement of design practice. It is expected to enhance the international competitiveness of Japan's bridge technology and make a significant contribution to bridge engineering, thus recognized as deserving of The Tanaka Award.

Study on Application of CFRP to Emergency Bridge for the Self-Defense Forces

Hiroshi Suzuki, Junichi Yamada, Tomotaka Ichikawa, Toshikatsu Mayama, Taichi Asakura, Mitsuhiro Nakata (Ground Systems Research Center, Acquisition, Technology & Logistics Agency): Japanese Journal of JSCE, Special Issue (Hybrid Structures), Vol. 79, No. 14, 22-14007, 2023.
https://doi.org/10.2208/jscejj.22-14007

This paper summarizes the application of Carbon Fiber Reinforced Plastics (CFRP) as the main structural material for emergency bridges for the Self-Defense Forces that are capable of supporting heavy vehicles. It includes the overview design of the proposed bridge, the manufacturing of test specimens for strength testing, and the validation of the design through structural analysis using the Finite Element Method (FEM). The results confirmed that the designed bridge can sufficiently bear the expected loads and achieves a weight reduction of approximately 26% compared to traditional aluminum alloy structures.

The application of advanced materials such as CFRP to emergency bridges capable of supporting vehicles is still in the research stage in other countries. In Japan, GFRP pedestrian bridges are in the practical application stage, but this is the first domestic research case for CFRP bridges that can support vehicles. This research targeted a lightweight bridge over 20 meters long, considering division for vehicle loading, and conducted both experiments using scale models and simulations with structural analysis models. The mutual complement of experiments and simulations demonstrated the applicability of CFRP to emergency bridges, marking an advanced achievement globally.

The outcomes of this paper are expected to enhance the disaster response capabilities of the Self-Defense Forces by applying them to future emergency bridges and to have a ripple effect on the research, development, and practical application of similar structures using CFRP as the main structural material. Therefore, it is considered to significantly contribute to the advancement of bridge technology in Japan, making it worthy of The Tanaka Award of Japan Society of Civil Engineers.

The Tanaka Award (Division of Outstanding Bridge Design, Construction and Retrofit, New Construction)

Kuzuryu River Bridge / Shin-Kuzuryu Bridge

Client:
Japan Railway Construction, Transport and Technology Agency, Hokuriku Shinkansen Construction Bureau
Fukui Prefecture, Fukui Civil Engineering Office
Designer:
Substructure: Yachiyo Engineering Co., Ltd.
Superstructure (Railway): Yachiyo Engineering Co., Ltd.
Superstructure (Road): Kouzou Sekkei Co., Ltd.
Contractor:
Joint Venture of Tekken Corp., AbeNikko Corp. and Shimizugumi for Construction of Kuzuryu River Bridge in Hokuriku Shinkansen, NIPPON P.S Co., Ltd.

This bridge represents the first shared-use bridge in the Shinkansen network where railway and road utilize a common substructure, realized through the collaboration of different sectors. The bridge not only facilitates road development but also contributes to the development along the roadside, providing scenic views for all users, including rail, road, and pedestrian traffic, thus establishing a new landmark.

From a design perspective, the seismic design of the integrated substructure meets the standards of both railway design specifications and road bridge guidelines. The supports were verified through time-history response analysis to ensure that the railway girders (using rubber bearings and damper stoppers) and road girders (using seismic isolation bearings) do not collide during earthquakes. Additionally, the running safety of the Shinkansen during Level 1 earthquakes was verified by examining the angular distortion and vibration displacement in relation to adjacent structures.

The integration of the substructure significantly reduced construction costs, shortened the overall project timeline, and minimized river environmental impact by preventing scouring through the construction of separate piers in close proximity. During construction, the riverbed section used a temporary bridge and staging method for the construction road, while the girder erection utilized the cantilever method, eliminating the need for river diversion and showing consideration for river environment preservation.

In terms of durability and maintenance, measures were taken to prevent salt damage to the railway girders from de-icing agents used on the roads. The durability was ensured through verification of PC grout filling, and maintenance of the Shinkansen track was facilitated by applying general-purpose fasteners with a girder gap of less than 250mm.

In summary, this bridge project, achieved through the collaboration of different sectors, demonstrated

cost reduction, project timeline shortening, and environmentally conscious design and construction, while ensuring seismic performance and maintenance, contributing significantly to the advancement of future bridge construction. This achievement is recognized as deserving of The Tanaka Award from Japan Society of Civil Engineers.

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Braila Bridge

Client: Romanian National Company for Road Infrastructure Administration
Designer & Contractor: Webuild S.p.A. - IHI Infrastructure Systems Co., Ltd. JV

The Braila Bridge is a steel three-span continuous suspension bridge with a central span length of 1,120 meters and a total length of 1,974 meters, spanning the Danube River in eastern Romania. The main towers are 190 meters high and made of reinforced concrete, consisting of two tower columns and an upper horizontal beam.

This bridge adopts a three-span continuous bridge

structure, omitting the vertical bearings at the main tower and the horizontal beam directly below the girder. The air spinning method was used for the main cable installation, reducing the number of strands and making the anchorage structure more compact, resulting in an economical structure through a design-build approach for both the superstructure and substructure.

The design concept emphasizes 100-year durability of the main structure, maintainability, and environmental conservation. The durability of the main structure is ensured through a probabilistic seismic hazard analysis using earthquake motions with three different recurrence intervals, and permanent anti-corrosion measures are implemented by introducing an air circulation drying system inside the stiffening girders, cables, and anchorages. For maintainability, the entire suspension bridge can be continuously inspected using inspection vehicles, and structural health monitoring is conducted continuously. Environmental conservation is also considered by adopting a drainage system that prevents bridge deck runoff from directly entering the Danube River.

During construction, the adoption of slip form construction for the RC concrete of the main towers and the use of precast segments for the horizontal beams at the tower tops contributed to shortening the construction period. The bridge opened to traffic in a short period of approximately 4.5 years from the start of the substructure construction.

In summary, the effort to evolve and apply domestically cultivated long-span bridge technology to overseas projects is recognized as significantly contributing to future long-span bridge construction. This achievement is therefore deemed worthy of The Tanaka Award from Japan Society of Civil Engineers.

The Tanaka Award (Division of Outstanding Bridge Design, Construction and Retrofit, Grand Prize, Existing Bridge)

Daishi Bridge renewal project

Client:
Metropolitan Expressway Co., Ltd.
Designer:
Chodai Co., Ltd., Taisei Corp., Toa Corp., IHI Infrastructure Systems Co., Ltd., Yokogawa Bridge Corp.
Contractor:
Taisei Corp., Toa Corp., IHI Infrastructure Systems Co., Ltd., Yokogawa Bridge Corp.

The Kousoku Daishi Bridge, located over the Tamagawa River on the Metropolitan Expressway Route 1 Haneda Line, was originally opened to traffic in 1968. The bridge is 292 meters long with a three-span continuous steel deck box girder superstructure, utilizing a closed-section rib (Y-type rib) for the steel deck. While the Y-type rib contributed to the lightweight superstructure, it also resulted in a flexible structure. Due to the high traffic volume of approximately 80,000 vehicles per day, numerous fatigue cracks were observed throughout the bridge. Despite continuous repairs, new fatigue cracks kept appearing, necessitating a large-scale renewal project to replace the bridge.

The superstructure of the new bridge maintains the same three-span continuous steel deck box girder as the existing bridge, with open-section ribs adopted for the steel deck of the roadway to enhance fatigue durability. The river piers were designed in a portal frame format to avoid interference with the removal of the existing T-shaped piers. The columns are made of concrete, and the beams are steel, forming a composite structure. The concrete parts employ highly durable embedded formwork with excellent salt resistance.

To minimize social impact (traffic disruption) in the Tokyo metropolitan area, as well as impacts on the river and nearby residences, the new bridge was constructed downstream of the existing bridge. After constructing wall parapets and the base layer of pavement, the new bridge and the existing bridge were slid upstream using a lateral slide method, replacing the approximately 4,500-ton bridge within a two-week traffic closure period.

In summary, this large-scale renewal project was completed in a short period, contributing to the advancement of large-scale renewal technologies expected to increase in the future. This achievement is therefore deemed worthy of The Tanaka Award from Japan Society of Civil Engineers.

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Large-scale renewal of the Higashimeihan Expressway Yatomi Viaduct (down line)

Client:
Central Nippon Expressway Co., Ltd., Nagoya Branch
Designer:
Joint Venture of Obayashi Corp., Honma Corp. and Kato Construction Co., Ltd.
Contractor:
Joint Venture of Obayashi Corp., Honma Corp. and Kato Construction Co., Ltd.

This project involved the replacement of the deck over approximately 1.6 km of the heavily trafficked Higashimeihan Expressway, using a widthwise split method (half-section construction), which has seen limited application in Japan. By adopting this method, the project minimized social impacts, such as traffic congestion, while also widening the road in a short time.

During the construction, the half-section method allowed for the replacement of deck slabs one lane at a time without closing the road entirely. Additionally, lane widening was carried out simultaneously to secure sufficient lanes during both the southbound works and the future northbound works. The widening was achieved without needing to reinforce piers or foundations by strengthening pier beams with external PC cables and carbon fiber sheets, thereby avoiding impacts on local roads.

Furthermore, the Yatomi Viaduct, which has an S-curve alignment, employed a new deck slab connection structure. This structure used ultra-high-strength fiber-reinforced concrete (UFC), which cures at room temperature, allowing for fine adjustments during the slab connection in both bridge longitudinal and transverse directions. This innovation ensured high precision in the joining of the half-section precast PC slabs, while also enabling labor savings and rapid construction.

For the delivery and removal of deck slabs, a method that did not utilize the expressway was adopted to avoid congestion and accidents with general traffic. Three lifting systems were placed on the service roads, and a rail system on the bridge deck was used to transport the slabs to the construction sites via self-propelled trolleys. This technique avoided the use of construction vehicles on the main expressway and successfully completed the slab replacement.

In summary, this project minimized the impact on expressway traffic while achieving labor savings and rapid construction, contributing to future bridge maintenance projects. For these reasons, it was deemed worthy of The Tanaka Award from Japan Society of Civil Engineers.

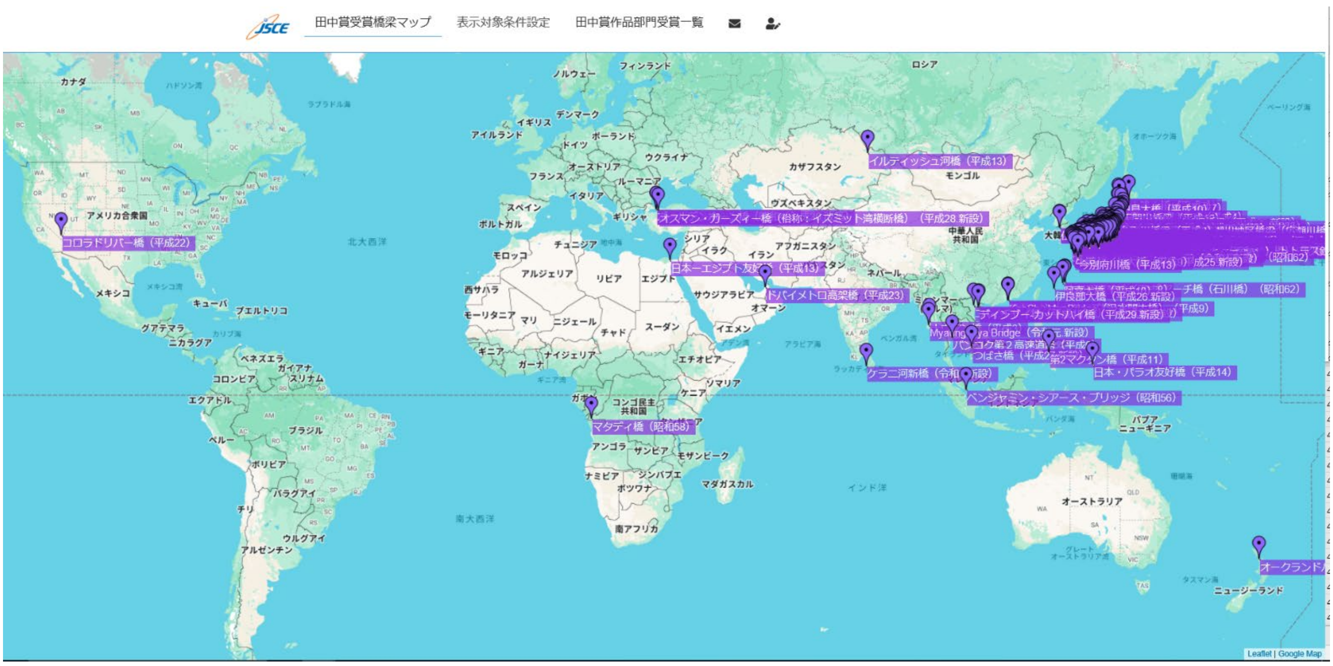
令和5年度田中賞　作品部門受賞関連資料

投稿者:事務局 投稿日時: 月, 2024-05-13 13:44

受賞作品	部門	内容説明動画	関連資料
高速大師橋更新事業	最優秀作品賞 作品･既設	内容説明動画	大師橋更新事業 パンフレット 高速大師橋リニューアル
九頭竜川橋梁･新九頭竜橋	作品･新設	内容説明動画	新九頭竜橋　一般県道 福井森田丸岡線(福井市寺前町から福井市上野本町) 【福井県】『新九頭竜橋が開通しました！！』 国内初の新幹線･道路一体橋 ／北陸新幹線、九頭竜川橋りょう他工事【鉄建建設】 九頭竜川橋梁パンフレット_鉄建JV 九頭竜川橋梁現場概要資料_鉄建JV 新九頭竜橋完成パンフレット
ブライラ橋	作品･新設	内容説明動画	
東名阪自動車道弥富高架橋(下り線)の大規模更新	作品･既設	内容説明動画	東名阪弥富(下り線)床版取替パンフレット

Figure 13 Materials related to The 2023 Tanaka Award winning bridges (in Japanese).

(a)　Japan



(b)　World

Figure 14 Map of The Tanaka Award winning bridges

References on The Tanaka Award

Materials related to The 2023 Tanaka Award for Division of Outstanding Bridge Design, Construction and Retrofit (Figure 13, in Japanese):
https://committees.jsce.or.jp/tanaka_sho/node/87

Map of The Tanaka Award winning bridges for Division of Outstanding Bridge Design, Construction and Retrofit (Figure 14, in Japanese):
https://committees.jsce.or.jp/tanaka_sho/map
https://soumu.jsce.or.jp/tanaka_award/

The JSCE Awards (in Japanese):
https://www.jsce.or.jp/prize/index.shtml

For more information

This newsletter is available at JSCE website: https://committees.jsce.or.jp/steel47/.

Please email the editors for more on the contents of this newsletter.

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