CAESAR

Center for Advanced Engineering Structural Assessment and Research, Public Works Research Institute

Core research function in the Safety Management of Road Bridges

The Center for Advanced Engineering Structural Assessment and Research **(CAESAR)** is one of the five research units of Japan's Public Works Research Institute (PWRI). The PWRI, which was founded with the inauguration of a road-material test center in the Civil Engineering Bureau of the Ministry of the Interior in 1921, has now a history of 90 years as a national research institution, an independent administrative corporation, and a National Research and Development Agency. Throughout its history, CAESAR has established itself as the core research function in the formulation of technological standards for the construction of structures, technology development, and disaster prevention measures.

Fracture of the truss member of Kisogawa-ohashi Bridge

Collapse of a highway viaduct of Route 3, Kobe route, of the Hanshin Expressway during the 1995 Hyogo-ken Nanbu Earthquake

Besides exposure to heavy traffic demand and severe natural environment, Japan's infrastructures are starting to age, urging the development of technologies to evaluate the performance of structures to maintain and renew them accordingly.

Therefore, the PWRI reorganized and developed the research units and founded CAESAR on April 1, 2008, as an integrated research institution concerned with construction technologies dedicated to the safety management of road bridges.

<CAESAR's Role>

1. Technical support for Administrators

Technical support for Administrators can be described as providing diagnosis and prescription for the structures having several technical issues, in response to the requests from road administrators. These difficult issues may include damages or deformations caused by aging, earthquakes, and other natural disasters, as well as design and construction problems. In addition, the data of each case are compiled as a knowledge base and offered to the site in the form of electronic information or a manual.

2. Research and Development

The researcher themes include improvement in the efficiency and reliability of maintenance cycles, as well as technologies aimed at renewing or building new social infrastructures to prolong their useful life and maintain them more efficiently. We also develop earthquake-resistant technologies to enhance the resilience of infrastructure facilities. The results obtained are reflected in the formulation of guidelines of periodic inspection and specifications of road bridges.

3. Dissemination and exchange of information

As an example of a "Dissemination and exchange of information," we hold free events such as lectures and meetings where the participants can gather and exchange the most recent technology-related information.

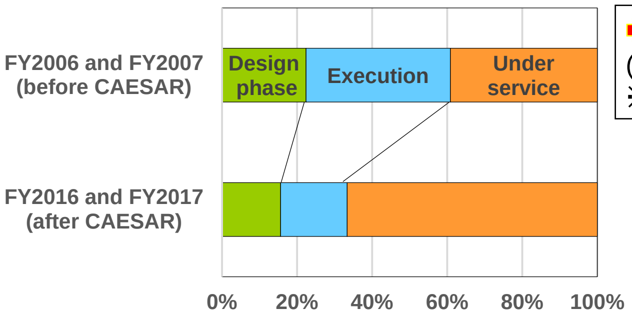
Acronym in English – The acronym CAESAR was inspired by Gaius Julius Caesar, the hero who built the cornerstone of the Great Roman Empire, which spanned over a thousand years with a solid grand design based on constantly innovative policies.

Cover Photos – Upper left: Field examination of a bridge that suffers salt damage; Upper right: Direct diagnosis of an aging bridge; Lower left: disaster examination - The 2011 earthquake off the Pacific coast of Tohoku; Lower right: fluidization countermeasure open experiment

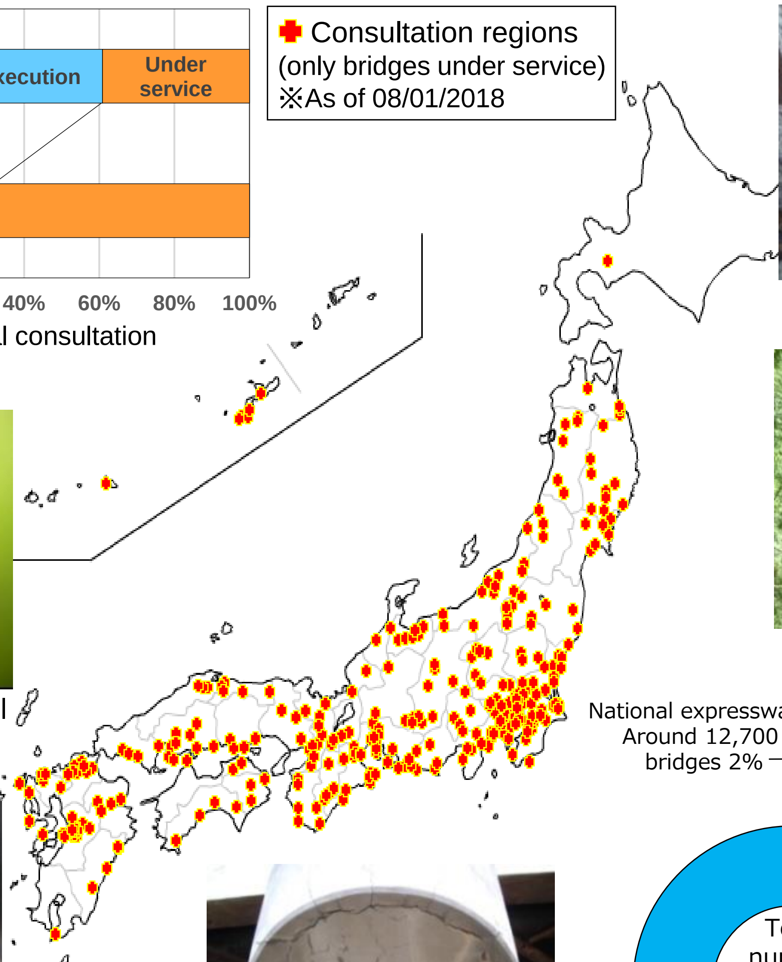
Technical Support for Administrators
– Technical consultation –

CAESAR collaborates with the National Institute for Land and Infrastructure Management (NILIM) to provide technical consultations to road administrators facing issues related to bridges and other structures.
We provide various forms of technical support to issues being faced by the road administrator of each bridge, such as damages or deformations caused by aging, earthquakes, and other disasters, as well as design and execution-related problems. Through close cooperation with the administrators, we propose methods to examine and evaluate the bridge, diagnose the cause of the damages and suggest reinforcement methods, dispatch technicians to the site according to its request, etc.

Record of Technical Support for Administrative Bodies
- Consultations about the safety of bridges under service account for the majority

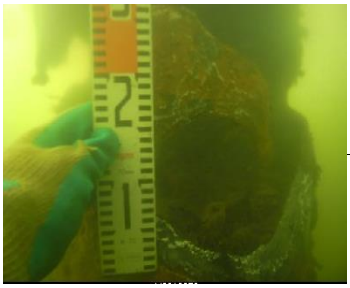


Ratio of technical consultation



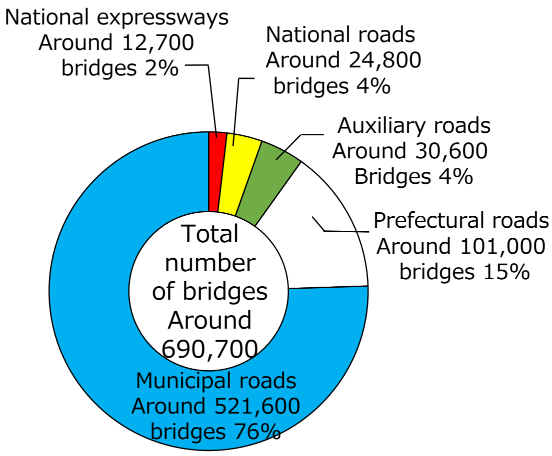

Rupture of PC wire of a concrete bridge


Collapsed bridge after an earthquake


Corrosion/Cross-sectional defect in a pile vent

Crack detected at steel floor slab


Damage by ASR



Number of bridges in Japan by road type 2 m or more
From the road statistics annual report 2017

Technical Support for Administrators - Bridge Diagnosis -

The local governments that manage large numbers of facilities require increasingly more financial and technical support to counter the issue of aging roads. Since FY2014, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) has conducted direct diagnosis on bridges that are more likely to require urgent and high-level technical power, as a form of support measure to local governments. A direct diagnosis by the head equator occurs when further assistance is required in consideration of the technical capacity of the local governments (e.g., cases with a complex structure, with severe damages, and high social importance) despite a rule that determines “road facilities such as bridges and tunnels must be managed responsibly by each road administrator.” In such cases, the state dispatches a “road maintenance technical group” composed of personnel of NILIM and Regional Development Bureaus to provide technical advice. CAESAR then joints the technical group along with NILIM and gives technical support.

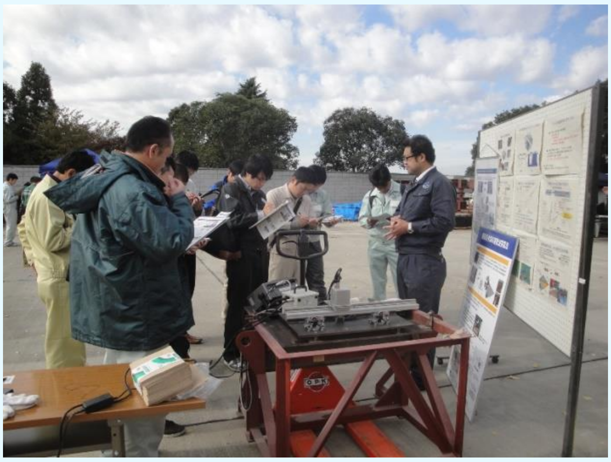
Scene of a direct diagnosis

Report from the road maintenance technical group to the road administrators

Technical Support for Administrators – Technology Transfer to Local Engineers –

In the management of structures, it is essential to continuously engage in the development of human resources to maintain and improve the technical capacity of the local administrators that supports it. To this end, we designate some of our personnel to give lectures on the design, construction, and maintenance of road bridges in technical training for in-house engineers of road administrators and public training institutions of the state and local governments, as well as a wide range of technical courses dedicated to general technicians.

In addition, by receiving technicians and researchers from road administrators (including local governments), universities, and private companies to solve a problem together, we are constantly engaged in the development of human resources that support the management of structures. We believe that this initiative can not only improve the individual technical capacity but also promote an internal technology transfer in their organization of origin.



Practical exercise of nondestructive inspection to road administrators (carried out as part of the training of the College of Land, Infrastructure, Transport and Tourism)

Examination practice at an exhibition facility of removed members (Carried out as part of the training of the College of Land, Infrastructure, Transport and Tourism. The case is studied with a deteriorated member who has been removed)

Providing support to investigate and restore bridges afflicted by an earthquake is one of the most important roles of CAESAR. In cooperation with NILIM, we receive the request from the road administrators, investigate the damage, give advice on traffic regulation, provide support for urgent technical measures, and assist with emergency restoration and full-scale recovery plans. We also analyze the cause of the damages, based on the examination results, and conduct research and development on countermeasure technologies.

When the earthquake struck the Pacific coast of Tohoku in March 2011, we immediately sent a group of technicians to the area and examined approximately 200 bridges. The investigation body during that period, consisting of as many as 240 man-days with CAESAR technicians alone, conducted examination activities to provide the bridge administrators with continuous technical support for emergency restoration and full-scale recovery of the afflicted bridges.

After the Kumamoto earthquake of April 2016, a group of specialists from the PWRI team corresponding to nearly 200 man-days was dispatched to the area to verify the damages. In the case of areas that were severely affected, a group representing the state was responsible for disaster restoration. A restoration analysis project team (PT) was formed for each road structure to conduct detailed analyses and study restoration methods.

Technical support at the area affected by the earthquake off the Pacific coast of Tohoku in 2011

Damage examination of road bridges following the Kumamoto earthquake

Contribution to the Restoration of Roads in Kumamoto Reconstruction Project

In the Kumamoto Reconstruction Project, we provided technical support concerning repair/reinforcement methods and monitoring* through the Kumamoto Restoration PT. Alongside NILIM, the PWRI played a leading role in the project, contributing, for example, with an early resumption of the main route that connects the city of Kumamoto and the village of Minamiaso (including Aso-Choyo-ohashi Bridge).

* To verify the effects of the repairs during the execution

Restoration of Aso-Choyo-ohashi Bridge: In order to make it less susceptible to the influence of slope failure because of weathering or earthquake in the future, and not to be fatal damaged, we advised the road administrator on bridge structures, its alignment, and elimination of the unstable ground

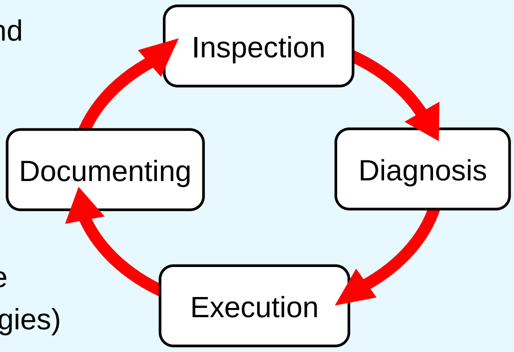
Research and Development – Improvement in Efficiency and Reliability of Maintenance Cycles –

The rapidly aging social capital of Japan is becoming a serious problem, causing deterioration-related damages that result in fatalities, such as the accident in the Sasago Tunnel in 2012. To respond to such issue, it is necessary to execute the maintenance cycles consistently and guarantee proper performance of the social capital. This study aims to provide solutions to the technical issues faced in each phase of the maintenance cycle (inspection/examination, diagnosis, execution (repair and reinforcement), documenting), create a virtuous circle on the technical aspect of the maintenance cycle, and thereby contribute to ensuring the soundness of the social capital.

①Inspection/Examination: technologies that improve the efficiency and reliability of examination and monitoring to generate a more reliable diagnosis

②Diagnosis: Method of sorting out the parts that require action and defining urgency (priority)

③Execution: The best-suited maintenance and repair methods for the existing phenomena and local conditions (evaluation of new technologies)



Promotion of Clinical Research

There are many causes of deterioration damage or deformation of existing bridges, and not all of them can be simulated in a laboratory. Therefore, it is necessary to adopt approaches such as medical science and compile the cases, the examples of the dismantling of removed bridges, the experiments of residual strength and repair and reinforcement effect using samples, followed by an epidemiological analysis to examine the damage form by age. We call this series of studies using actual bridges “clinical research.” CAESAR, through collaboration with NILIM and in cooperation with MLIT Regional Development Bureau and local governments – the road administrators, is installing sensors in the bridges to observe the progress of deterioration and damage and collecting members of bridges removed due to deterioration and damage.

Removed bridges

・Damage state examination
・Visual inspection

Loading test of removed bridges

Test with loaded vehicle

Overall behavior measurement by loading test before removal (comparison with structural analysis; e.g., the combined effect of beams and floor slabs and load distribution)

Loading test using a part of a removed bridge

Development of bearing capacity evaluation technology according to damage state

Nondestructive examination with removed beams

Development of nondestructive inspection technologies applicable to actual bridges and methods to evaluate the performance of these technologies

・Examination with various nondestructive inspection technologies
・Examination opportunity offered to the private with actual bridges

Verifying the applicability of maintenance technology of the private promotes a practical technology development.

Dissection of removed beams

Corrosion state of steel material
(E.g., external damage state and residual steel)

Conditions of concrete
(Amount of salt and crack progress status)

Arrangement of steel material
(Old bar arrangement method)

Tensile test of extracted rebar
(Strength test of old material)

After the on-site dismantling, pieces of the removed beam and member are thoroughly dismembered at the lab to determine the damage state.

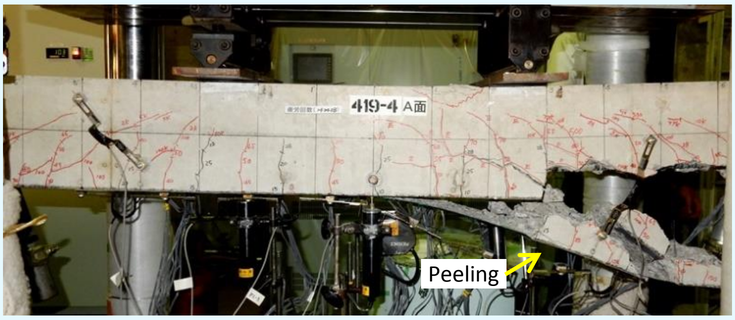
Performance Evaluation for Existing Bridges and its Repair/Strengthening Methods

As the periodic inspection progresses, the number of bridges requiring repair or strengthening is expected to increase rapidly, but a method to select the most appropriate countermeasure according to each situation is yet to be established. For this reason, we are engaged in the research and development of reliable repair and strengthening technologies that do not end up in increasing the maintenance workload due to re-deterioration or maintainability decrease.

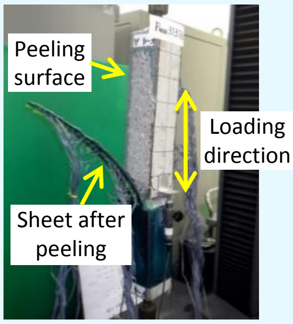
Our goal is to establish the proper method to evaluate bridge performance including the load-bearing capacity and thereby contribute to improving the diagnostic technique of road administrators of the entire country. To verify the residual bearing capacity of an existing PC bridge that suffered salt damage, we performed the first destructive test with the main beam of an actual bridge in Japan.

On-site loading test on a bridge to be removed, until it collapses

We are working to clarify the fatigue damage mechanism of concrete bridge decks strengthened with fiber sheets and the required performance of strengthening materials. We are also proposing a design method for strengthening the decks with the fiber sheets, which is compatible with various materials, and contributing to the development of the most suitable method for maintaining and repairing the decks.



Sheet peeling in a flexural test

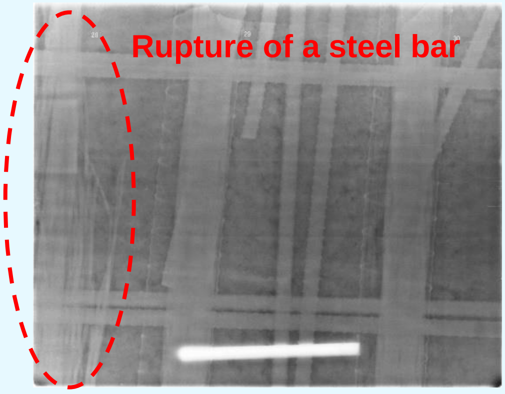


Sheet adhesion test

Development of Nondestructive Test and Monitoring Technology

CAESAR is engaged in the research of inspection technologies to determine the status of a bridge both efficiently and logically, which includes a nondestructive inspection technology that reveals the internal conditions of a structure and a measurement and monitoring technology that detects the occurrence and progress of damages in a timely and efficient manner. We are also working to develop a maintenance management system that includes a technology for storage and application of information.

Knowing that the steel inside the concrete members suffers corrosion by salt damage, we developed, in collaboration with The university of Tokyo and Riken, a technology that uses a high-power X-ray and neutron beam to visualize the problems that are difficult to be detected in a regular inspection. This enables to detect insufficient filling of grout and rupture of steel bars at deeper parts of the members, as well as the amount of salt in the concrete.



Examination of concrete interior with X-rays

Japan's social capital stock was mainly built in the period of high economic growth, which raises the concern about a rapid increase in the number of aged stocks. It is essential that these cases be renewed without interrupting the related services. In order to steadily renew and build a new social infrastructure under harsh financial conditions, it is indispensable to have a system that is precisely aligned with the level of importance of each structure.

The road structures that compose the most vital routes of the country, for example, need to have high durability and a low life-cycle cost and maintenance workload. On the other hand, there are smaller structures that, despite not being demanding in terms of management, exist in vast numbers. For these cases, it is advantageous to build a structure that allows to identify which parts require renewal, as well as when they require it, with a simple inspection.

Therefore, this research aims to develop the material and evaluation method required to implement new technologies that suit the social needs as in the case above.

Methods to Improve the Quality and Reliability of New Bridges

■Verification of applicability of dynamic loading test of single pile

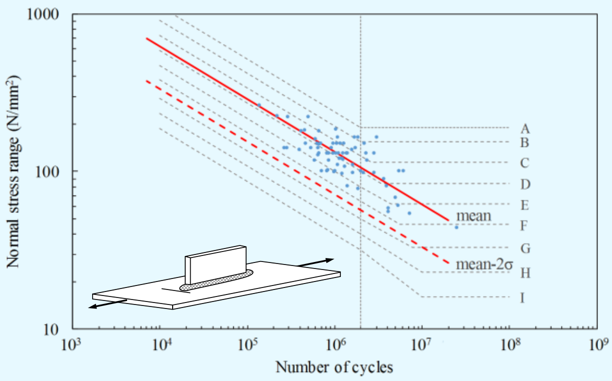
We compared the results of ultimate bearing capacity measured by rapid loading test, one of the dynamic loading tests, with the one measured by static loading test currently set as the standard.

The result of comparison shows the one measured by rapid loading test is on the same level with the one measured by static loading test, and revealed that the rapid loading test is applicable to the bearing capacity evaluation at the pile head. Thus, we contributed to the rationalization and improvement of the reliability which bearing capacity of piles is evaluated under complex soil conditions or when applying a new construction method.

Rapid loading test (with an actual pile) being conducted

■Analysis of Reliability Improvement in the detail category for expressing Fatigue Strength

To improve the reliability of the design and evaluation method of fatigue durability of steel bridges, we analyzed the factors that influence the fatigue strength of welded joints using the multivariate analysis method and suggested which test conditions should be recorded as the fatigue test data to be used as the basis of fatigue strength setting.



Calculated with the conditions of "Current of 260 A or less" and "gusset length of 100 mm or less"

■Development of a durability design method that reflects the difference in reliability of quality

To clarify the deterioration mechanism of a bridge in a severe salt damage environment, we obtained the initial physical property values of the concrete of the pier of Irabu Bridge when it was built to conduct a long-term state observation.

Coring analysis is performed regularly in collaboration with the road administrators

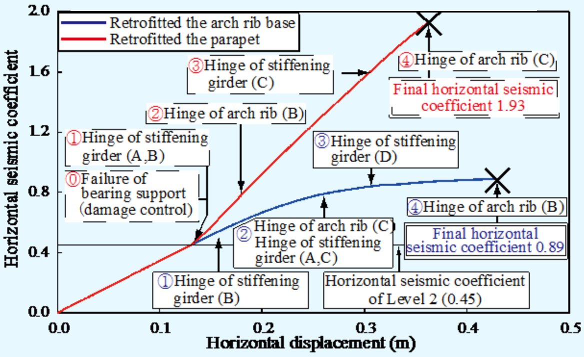
In the earthquake of 2011 off the Pacific coast of Tohoku, a powerful tremor and a huge tsunami struck an extensive area of the Pacific coast, from Hokkaido to the Kanto region, causing enormous damages. Now, the large-scale earthquakes expected to hit the Nankai Trough and the Tokyo area pose imminent threats, demanding more resilience (i.e., becoming stronger and more flexible) against such potentially major earthquakes.

This research is aimed at the development of countermeasure technologies to prepare for earthquakes of unprecedented scales and the other combined disasters that follow. With these studies, we wish to devise a method to evaluate the performance of earthquake-resistant road bridges, road earthwork structures, and road /river structures, and develop and upgrade earthquake-resistant technologies. Ultimately, we hope that the practical application of the developed technologies and proposals to apply these to standards and businesses contribute to building a resilient society that can minimize the damage to its infrastructure and quickly restore its functions in the event of major earthquakes.

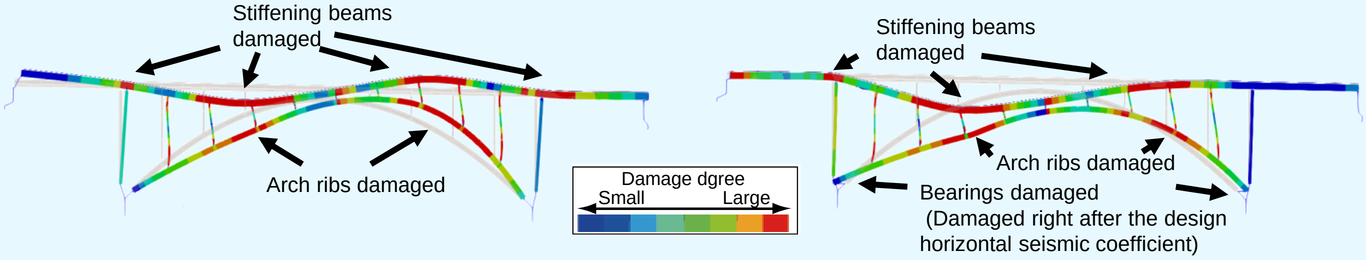
Resilience Technology of Road bridges against Excessive External Force

With the objective of establishing the concept of a structure that prevents fatal damages as much as possible and can easily recover its functions, even in the event of an action that exceeds its design earthquake motion, we are studying a method to design the damage scenario of bridges.

By assigning different strength levels to the bridge members to control the order they are damaged, the damage form of the entire bridge system changed and the seismic horizontal coefficient at which the bridge collapses improved. With this, we confirmed the possibility of reducing the chances of a bridge to collapse.



Relation between horizontal displacement and horizontal seismic coefficient



Damage state of the main member immediately before the bridge collapsed
(left: with reinforced bearings; right: with bearings damaged in advance)

Research on Seismic Performance Evaluation Technology and Earthquake-Resistant Reinforcement Technology of Entire Bridge System including Soil and Foundation

■Countermeasures for Fluidization on Liquefied Ground

We are studying the countermeasures for fluidization on liquefied ground through a world-class experiment using E-Defense in collaboration with the National Research Institute for Earth Science and Disaster Resilience (NIED), as well as through a collaborative research with the Tokyo Institute of Technology (Tokyo Tech) and the Japanese Association for Steel Pipe Piles (JASPP). This is one of our initiatives to further improve our seismic performance evaluation methods and earthquake-resistant countermeasure technologies for bridge foundation.

Experiment using E-Defense to develop earthquake-resistant reinforcement technology for bridges on liquefied soil

Contribution to the 2017 Specifications for highway bridges

The “Specification for highway bridges and its commentary” (by Japan Road Association) was revised in 2017. In the revised Road Bridges Specifications, partial safety factor design method was adopted to clarify the relation between the action and resistance assumed in the design, as well as the meaning of the safety margins. In the past, CAESAR engaged in the research on variation in material strength, which is considered a premise for design, as well as the variation in the formula of load-bearing capacity (e.g., the shear bearing capacity of concrete members). Both are required in to provide partial safety factor in the specification. We also studied the influence of uncertainty of the soil reaction coefficient in the calculation of the response and bearing capacity of pile foundation and researched the performance evaluation of new materials, such as the high-strength bolt S14T. The revised Road Bridges Specifications also specifies partial coefficients that consider these analysis results, as well as new inspection standards for a few new materials.

Moreover, based on the results and expertise accumulated from planned inspections across the country, the Specifications determines that structural designs should, to the extent possible, avoid parts that are difficult to be inspected and repaired/reinforced. It also states that the method of renewal and repair reinforcement needs to be studied in advance, and that the structures should be designed to reduce uncertainty in design such as local stress concentrations and stagnant water.

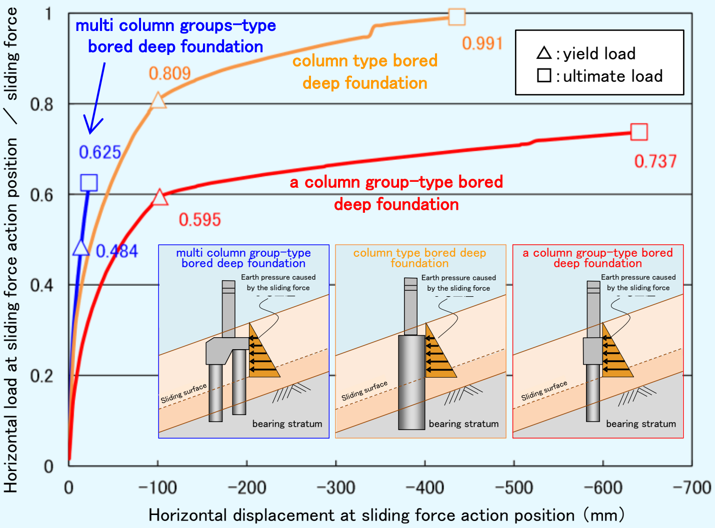
〇Consideration of repair reinforcement

〇Improved inspection space

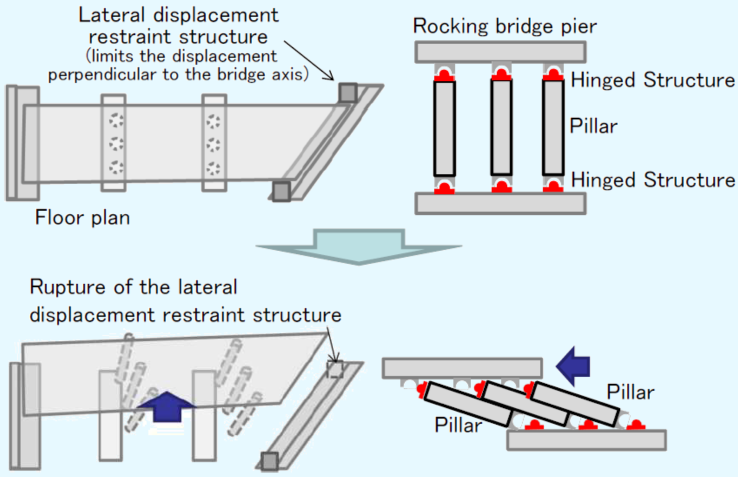
Inspection and renewal of superstructures made easier

Furthermore, CAESAR’s research results and the knowledge obtained with response to the 2011 earthquake off the Pacific coast of Tohoku and Kumamoto earthquake were applied to the specifications.

- We analyzed the mechanism of the damages caused by the tsunami due to the 2011 earthquake off the Pacific coast of Tohoku region and the ground deformation or the slope collapse due to the Kumamoto earthquake. Moreover, we proposed restoration methods that considers these events.
- We analyzed the mechanism of bridges with rocking pier that fell and suggested to stop using such an unstable structure.



Analysis of the mechanism of damages caused by soil deformation



Hypothetical mechanism of collapse of a bridge with rocking bridge piers

Dissemination and exchange of information – Lectures –

With the objective of offering information about road bridge maintenance as well as a place for engineers to interact, we hold our “CAESAR Lecture” once a year. This program consists of pertinent keynote speeches and lectures from a wide range of professionals, such as professors involved in the maintenance of local road bridges, road administrators of the state and local governments, road companies, and private groups.

The lecture is attended by over 400 people every year (with a total of 4,130 attendees until the 10th assembly), including road administrators and private groups involved in the design, construction, and maintenance of bridges, as well as professionals from different fields including materials, telecommunications, and nondestructive testing. After each edition of the event, we receive many positive comments from participants, saying that the lectures were meaningful, useful in their workplace, and that they would like to participate again.

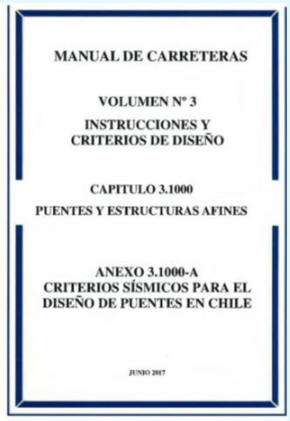
Picture of the 10th assembly of CAESAR lecture

Dissemination and exchange of information – International Activity –

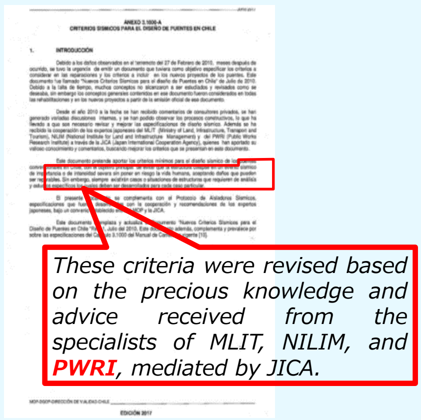
At CAESAR, besides the dissemination of Japanese technology abroad, we promote activities such as information exchange and research cooperation on technical issues shared by research institutions and road administrators overseas. In the event of earthquakes and other disasters in other countries, we conduct field examination and provide restoration support as needed.

When an earthquake struck Chile in 2010, CAESAR sent specialists to the affected area to examine the damaged bridges and introduce Japan’s seismic design criteria to the technicians of the Chilean government. In July of the same year, the country formulated its provisional criteria, which included some of the seismic technologies developed in Japan. In addition, from 2014, a technical cooperation that supports the permanent revision of the seismic design criteria was coordinated by JICA, with CAESAR providing technical support based on JICA’s requests. During this partnership, Japanese and Chilean technicians exchanged opinions about the seismic design criteria on site, and TV conferences between Japan and Chile were held for Q&A sessions and discussions with the Chilean technicians that had been sent to Japan. In 2017, the Chilean seismic design criteria for bridges were revised. The new criteria included a few Japanese technologies, such as the liquefaction prediction method and the bridge unseating prevention system. Later, not only did the PWRI receive a letter of appreciation from the Chilean Ministry of Public Works but it was also cited in the preface of the seismic design criteria the cooperation of the institutions that sent specialists to provide on-site support.


Field survey after the earthquake in Chile



Cover of the new bridge seismic criteria



Preface

CAESAR’s activities in the United States and Japan Conference on the Development and Utilization of Natural Resources (UJNR)

UJNR, a US-Japan government meeting, was established for the two countries to learn as much as possible about the effective use and maintenance of the natural resources around the world, as well as solutions for problems concerning the human living environment through a partnership.

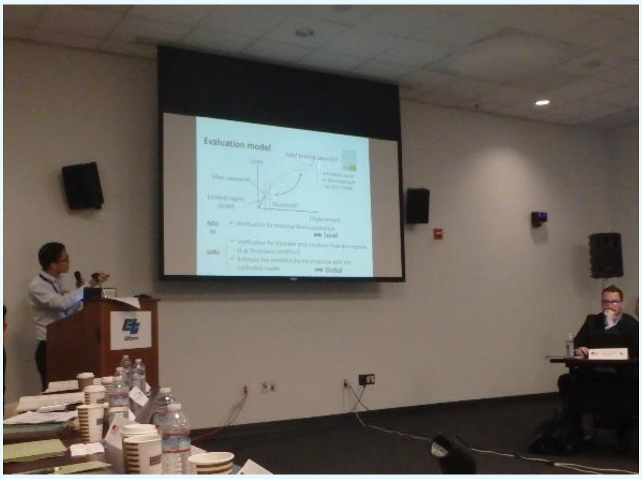
Considering that both Japan and the United States are countries that suffer damages from earthquakes, strong winds, high tides, and tsunamis, the UJNR founded a special committee called Wind and Earthquake-Resistant Structures Special Committee. It was established to enable professionals of the area to apply the results of their development research to design methods of wind- and earthquake-resistant structures and exchange ideas.

In addition, CAESAR is responsible for the office of the Working Group G: Transit System, one of the working groups of the Wind and Earthquake-Resistant Structures Special Committee. As part of its activities, so far, we have held bridge workshops and exchanged information with governmental institutions, such as the Federal Highway Administration (FHWA) and state transit authorities, to establish partnerships.

In July 2018, we held a Japan-US bridge workshop at the California Department of Transportation as an opportunity to discuss issues concerning road bridges.

In this workshop, both countries explained the status of the respective technical standards for bridges, and then discussed four topics (Topic 1: Rehabilitation and Retrofitting for Enhanced Durability and Preservation, Topic 2: Bridge Instrumentation and Health Monitoring, Topic 3: Guidelines and Use of Refined Numerical Calculations for Design and Bridge Assessment, Topic 4: Innovative Materials for Bridges Design and Construction). The discussions were significant, and there was a consensus on the importance of continuing to exchange ideas in the future.

California Department of Transportation



Topic leader’s proceeding and presentation

Q&A session

Study tour (observation of cable-stayed bridge construction site)

PWRI

- Tsukuba Central Research Institute
- Civil Engineering Research Institute for Cold Region
- ICHARM, International Center for Water Hazard and Risk management, under the auspices of UNESCO
- CAESAR, Center for Advanced Engineering Structural Assessment and Research
  - **Bridges and Structures Research Group**
    - Director of Bridges and Structures Research (Acting Director of CAESAR)
    - Chief Researchers (Principal Investigators)
      - Management System and Substructures
      - Structural Assessment and Superstructures
      - Rehabilitation and Earthquake Engineering
      - Inspection Technology and Concrete Structures
    - Ad hoc Specialized Unit
  - Director for Earthquake Engineering
- iMaRRC, Innovative Materials and Resources Research Center

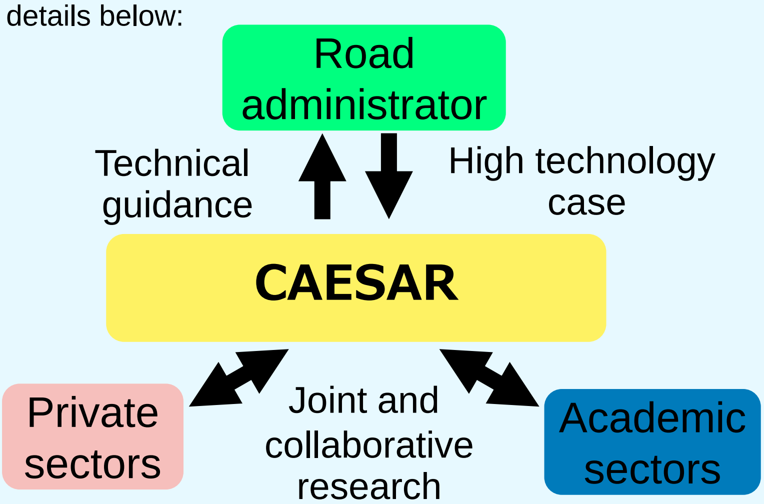
CAESAR develops technologies and research on matters concerning the maintenance of bridges and prevention and mitigation of earthquake damage to civil structures, as well as concrete structures that include superstructures and substructures of bridges. It is a comprehensive organization formed by technicians and researchers specialized in a holistic maintenance system that integrates the repair, soundness prediction evaluation, inspection technology, design and construction, and seismic design of bridges. In addition, if the road administrator requests support for an urgent issue that requires an intensive and high-level technical collaboration, we can flexibly form a temporary specialized unit to work on it on a full-time basis.

If a research concerns the properties of materials that contain earth, painting, or is mainly related to cold weather-specific phenomena, we follow CAESAR's plans and coordination and try to solve the issue through collaborative research with concurrent members from the Tsukuba Central Research Institute and the Civil Engineering Research Institute for Cold Region, as well as cooperation with related fields.

As of August 1st, 2018
Enrolled researchers
22 in-house, 2 specialized, and 16 visiting researchers
24 research tasks and 15 collaborative researches with industries, government, and academia
Main full-scale experiment facilities
Removed member storage facility for clinical research, wheel-load running test machine, 1,000 kN fatigue test machine, member seismic strength experiment facility, large-scale structure repeated loading test device, structure repeated loading device, 30 MN large-scale structural member all-purpose test machine

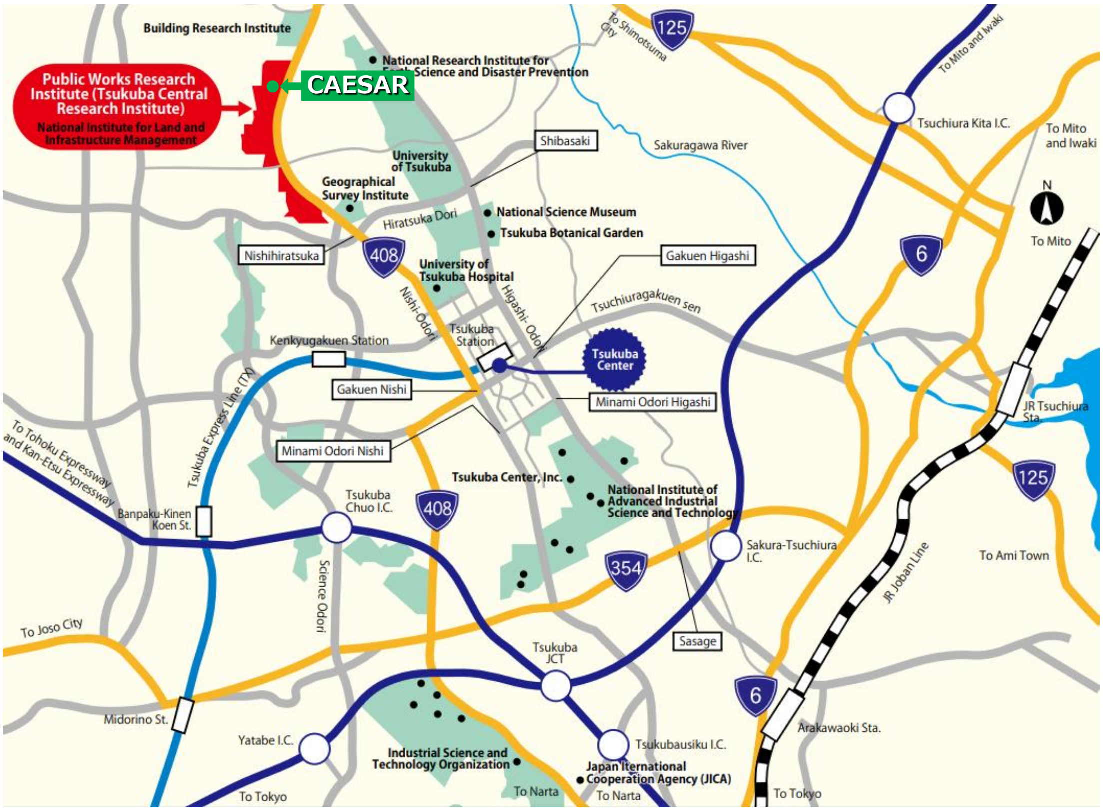
Contact

Based on an abundant wealth of knowledge accumulated over the years, CAESAR provides technical guidance and support to road administrators on the design, seismic reinforcement, and damages (salt damage and alkali-aggregate reaction, fatigue, and others) of road structures. Moreover, as a research unit engaged in the design, seismic reinforcement, and damages of road structures, we conduct collaborative research with the industry and academia as necessary. For more information, please contact us at the details below:



National Research and Development Agency
Public Works Research Institute
Center for Advanced Engineering Structural Assessment and Research
Address: 1-6 Minamihara, Tsukuba, Ibaraki, Japan 305-8516
TEL: 029-879-6773
Email: caesar@pwri.go.jp
URL: http://www.pwri.go.jp/caesar/index-j.html

Access to CAESAR



Train	Akihabara Sta.	Tsukuba Express Line (about 50 minutes by semi-rapid)			Kenkyu-Gakuen Sta.	Tsuku-bus bound for Teragu (about 25minutes)	Doboku Kenkyusho Mae (PWRI)
		Tsukuba Express Line (about 45 minutes by rapid) Tsukuba Sta.			Tsukuba Sta. (Tsukuba Center)	Kantetsu Bus, Gate No. 5 bound for Shimotsuma Sta. or Kenchiku Kenkyusho /Building Research Institute (about 25 minutes)	
	Ueno Sta.	JR Joban Line (about 60 minutes)	Hitachinoushiku Sta.	Kantetsu Bus bound for University of Tsukuba (about 25 minutes)			
		JR Joban Line (about 60 minutes)	Arakawaoki Sta. (West Exit)	Kantetsu Bus bound for University of Tsukuba (about 25 minutes)			
		JR Joban Line (about 70 minutes)	Tsuchiura Sta. (West Exit Bus Terminal 2)	Kantetsu Bus bound for University of Tsukuba (about 25 minutes)			
Highway Bus	Tokyo Sta.	At Tokyo Station, go to bus gate No. 5 Yaesu South exit. Take Tokkyu (express) Tsukuba-Go bound for Tsukuba Center or University of Tsukuba (about 70 minutes).					
Car	Tokyo	Shuto Kosoku (Metropolitan Expressway)	Misato I.C.	Joban Expressway (about 30 minutes)	Yatabe I.C. or Sakura-Tsuchiura I.C.	Suitable route (about 20 minutes)	

2018.8.1