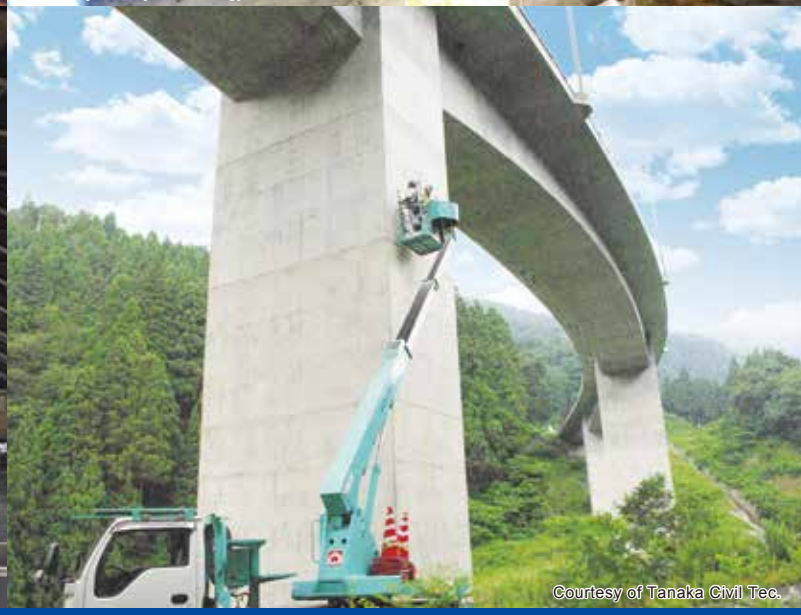
Infrastructure Maintenance, Renovation and Management


Courtesy of Otsuki City Fire Department


Courtesy of Sanyo Technology Consultants Co., Ltd.


Courtesy of Public Works Research Institute


Courtesy of Tanaka Civil Tec.

Turning Technologies into Reality for Safe and Secure Civil Infrastructures


Courtesy of Nagoya National Highway Office, Chubu Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism


Courtesy of Road Department, Kinki Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism


Courtesy of Sumitomo Mitsui Construction Co., Ltd.


Courtesy of Hokuriku Technical and Engineering Office, Hokuriku Regional Development Bureau, Ministry of Land, Infrastructure, Transport and Tourism

SIP Cross-ministerial Strategic Innovation Promotion Program

Introduction; The R&D Project of Infrastructure

Greeting

For Safe and Secure Infrastructure Systems

The Cross-Ministerial Strategic Innovation Promotion Program (SIP), in which the Council for Science, Technology and Innovation (CSTI) plays the role of playmaker, has been established to realize scientific technology innovation. As a cross-ministerial and cross-field program, SIP will drive forward with a focus from basic research to commercialization/industrialization. "Infrastructure maintenance, renovation and management" (hereinafter referred to as "SIP infrastructure") is one of the issues.

Civil infrastructures, such as roads, railways, harbors and airports, support our everyday life and social economic activities. Many of them, however, were built during the high economic growth period. As they get older, the increase in maintenance and repair expenditures, along with the possibility of a serious accident occurring, become serious social issues. This program aims to prevent accidents and reduce the burden of upkeep and maintenance by constructing systemized infrastructure management that utilizes the world's most advanced information technologies and robotics technologies.

Unlike mass production products, such as vehicles and laptop computers, infrastructures are single products that are designed, constructed, and manufactured individually. The initial conditions of infrastructures when they were built vary; as a result, in addition to the difference in usage environment, the speed of deterioration of infrastructures also varies. When they have been used for tens of years, some of them may pose a high risk of accident due to damage. To enable the lean and efficient preventive maintenance management of infrastructures and to establish a safe and secure infrastructure system, it is therefore crucial to have technologies that can precisely diagnose and take appropriate measures by closely examining the enormous amount of infrastructures individually on-site. It is also essential to minimize work that depends on the human hand and to free ourselves from dangerous work. For infrastructure management run by local governments, cost reduction is also a particularly important viewpoint. Currently, infrastructures are being constructed all across Asia; however, maintenance has already become a big issue. "SIP infrastructure" aims at introducing new exciting advanced technologies into the range of infrastructure management technologies. Specific examples include the following: support from or replace with robots for infrastructure inspection; damage detection inside concrete that can be carried out on-site; inspection of tunnels and bridges by mobile sensors that do not require traffic control; technologies to aerially detect damage/deformation of river levees, dams, and harbors; highly accurate deterioration estimation technology for concrete; developing ultra-high durable repair materials; efficient infrastructure management technology using big data processing; and artificial intelligence.

Japan's infrastructure stock is said to be over 800 trillion yen. Infrastructures are used for dozens of years. Our responsibility to the future is to create an infrastructure information platform and to pass on infrastructures that can be used safely with a minimum maintenance burden to the next generation. The objective of "SIP infrastructure" is to establish the system and we will work hard to achieve it.

PD (Program Director)

Yozo Fujino

Distinguished Professor, Institute of Advanced Sciences, Yokohama National University

Biography

Yozo Fujino graduated from the Infrastructure Engineering Division, Department of Civil Engineering, at the University of Tokyo in 1972. After completing his Master's degree (Civil Engineering) at the University of Tokyo, he received the Doctor of Philosophy from the University of Waterloo in 1976. He joined the Earthquake Research Institute, at the University of Tokyo; the Department of Engineering Mechanics and Energy, at the University of Tsukuba; and the Infrastructure Engineering Division, Department of Civil Engineering, at the University of Tokyo. In 1990, he was appointed as a professor of the Infrastructure Engineering Division, Department of Civil Engineering, at the University of Tokyo. In 2014, he joined the Yokohama National University, and has served in his current position from October 2014. He is a Professor Emeritus of the University of Tokyo. His expertise includes structures, vibration, control and monitoring of infrastructures centered on bridges. He was awarded the Purple Ribbon Medal of Honor from the emperor of Japan in 2007, and the 2015 Hattori Hoko Award (The Hattori Hokokai Foundation), among others.

Outline

In Japan, where infrastructures are aging, the emerging risk of a serious accident such as the Sasago tunnel accident in 2012, and the increase in maintenance and repair expenditures are topics of concern. While the tough fiscal situation continues and the number of skilled engineers is decreasing, systematized infrastructure management utilizing new technologies is essential to both prevent accidents through preventive maintenance and to minimize the life cycle cost of infrastructures. Particularly, technologies that utilize the world's most advanced ICRT* are expected to create new business opportunities in the existing infrastructure maintenance market and to offer business expansion opportunities into Asian countries that face similar issues. To achieve this, we will improve the standard of maintenance by using low-cost preventive maintenance while stressing the necessity to match the needs of infrastructure maintenance with the seeds of technical development, and developing new technologies into more attractive technologies that can be used on-site. By achieving this, we aim to contribute to regional revitalization, as well as maintain the important internal infrastructures to a high standard while backing up a variety of regional economic activities. Furthermore, we will create an attractive and ongoing maintenance market and build a base for overseas expansion based on successful regional examples.

Cabinet Office PD (Yozo Fujino)

- Scale of budget: 3.1 billion yen (FY2016)
- Implementation period: 5 years from FY2014

Sub- PD

- Hajime Asama (University of Tokyo, Professor)
- Yusaku Okada (Keio University, Professor)
- Yoshinori Sakamoto (Kajima Corporation, Managing Executive Officer)
- Masaki Seki (Futaba Railways Industry, President and CEO)
- Tadayuki Tazaki (ITS Technology Enhancement Association, President)
- Kenichi Tanaka (Mitsubishi Electric Corporation, Fellow)
- Toshihiro Wakahara (Shimizu Corporation, Chief Research Engineer)

SIP Infrastructure Promoting Committee

[Overall Coordination]
Chair: PD
Secretariat: Cabinet Office
Members:
Sub-PDs,
Ministry of Internal Affairs and Communications,
Ministry of Education,Culture, Sports, Science and Technology,
Ministry of Agriculture,Forestry and Fisheries,
Ministry of Economy, Trade and Industry,
Ministry of Land, Infrastructure, Transport and Tourism,
JST, NEDO

Project Promoting Council [Research and Development Promotion]

Chair:	PD
Members:	Sub-PDs, advisory committee, Cabinet Office, Ministry of Internal Affairs and Communications, Ministry of Education, Culture, Sports, Science and Technology, Ministry of Agriculture, Forestry and Fisheries, Ministry of Economy, Trade and Industry, Ministry of Land, Infrastructure, Transport and Tourism
Secretariat:	JST, NEDO
Research units:	Universities, National Research and Development Agencies, private enterprises, etc.

*ICRT: ICT (Information and Communication Technology) + IRT (Information and Robot Technology)

Maintenance, Renovation and Management

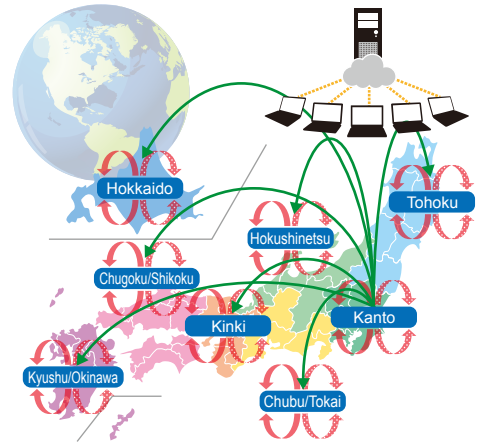
Overall Plan

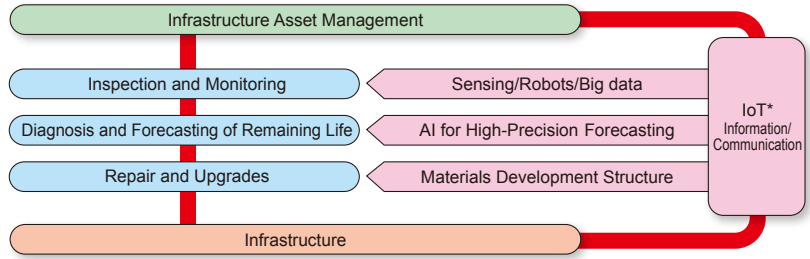
To minimize the opportunity loss of regional revitalization resources such as logistics, service, and tourism, it is vital to implement efficient and highly economical maintenance, renovation, and management, in order to always retain the functions of our infrastructures which are assets that belong to us all, and are used by us all, such as our roads, railways, harbors, and airports.

The following points are important in achieving the efficient maintenance and management of infrastructures, which are said to be worth a total of 800 trillion yen.

- Cooperation with a wide range of advanced technology fields including civil engineering and ICT/robotics technologies
- Coordinating technologies based on adaptations on-site
- Technical specifications menu based on the various different situations of end users
- Technical managerial viewpoint including organization management to utilize the technology appropriately
- Sustainable support system for technical development

Without relying only on the results of technical development at each ministry, national research institute, university, and private company, an unprecedented cooperation system also needs to be developed to achieve the above. Further, we believe that we must actively roll out a new viewpoint concerning infrastructure maintenance through the related ministries and local governments to the various users and residents. This includes providing the society with new values created by the appropriate maintenance of infrastructures such as the safety of users and our reputation as judged by users, as well as directly solving issues regarding the current methods of infrastructure maintenance.





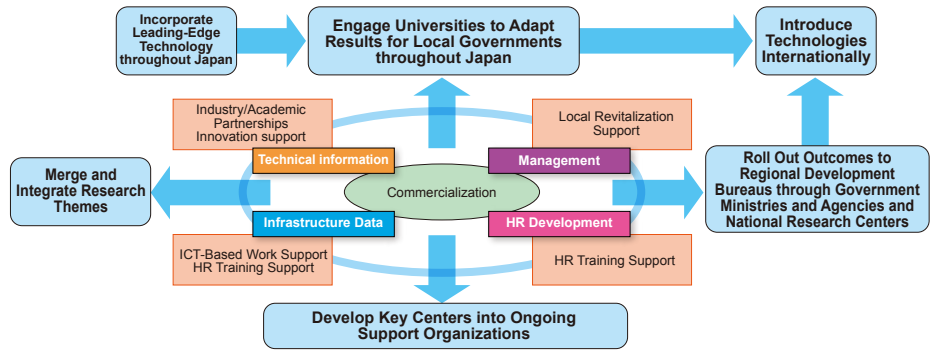
Achieve Society 5.0, the world's first super smart society

*IoT: Internet of Things

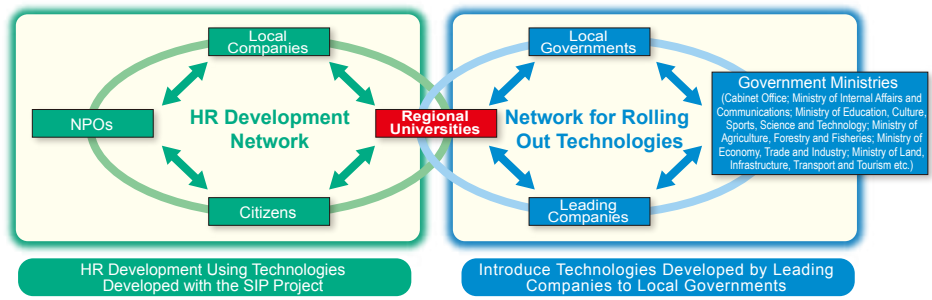
Exit Strategies

Since there is a diverse range of situations, targets, and technologies of infrastructure maintenance, we intend to implement infrastructure maintenance by optimally putting individual technical development together in the asset management phase. In the meantime, the development of IoT and other related technologies is remarkable, and construction of a platform that includes networked heterogeneous technologies, such as monitoring and sensing by robots and traveling vehicles, is rapidly becoming more of a real possibility. As a result, this has become a major strength that will allow us to drastically reform infrastructure maintenance. Therefore, we will predominantly promote cooperation with newly developed individual technologies by constructing an IoT platform to develop a scheme which will advance the integration of technologies through both asset management and the IoT platform.

As the base of this exit strategy, we will actively cooperate with key universities, regional universities, national research institutes, the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Land, Infrastructure, Transport and Tourism, and local governments to create a unique framework for infrastructure related research. Specifically, we are considering the following business deployment patterns: "unique technological developments that have an individual theme," "deploying business to local governments through regional universities," "deploying business to the state administrative system through national research institutes," "establishing a permanent organization system to support industries," and "exporting and globally deploying technology." Of these patterns, we place greatest importance on "custom-made technical implementation support that suits regional characteristics," and investigate a technical support system from the base institutes, a fund support system, and the establishment of various technologies and sustainable support in local governments. In addition, we plan to implement a business model that will both help regional revitalization, and prepare an environment for business, by establishing a technical strategy plan based on reputation management.



Basic Aspects of Infrastructure Maintenance, Renovation, and Management Exit Strategies



Roll Out Infrastructure Maintenance and Renovation Management in the Regions

Universities, etc.

SIP

Cross-ministerial Strategic Innovation Promotion Program

The 5 Research and Development Topics for Infrastructure Maintenance

Asset Management Technologies

Implement infrastructure management for the technologies produced from individual research results. Develop asset management technologies for efficient operations management making the most of limited financial and human resources

Structural Materials, Deterioration Mechanisms, Repairs, and Reinforcement Technologies

Develop simulation technologies to assess the deterioration mechanism of structural materials; create a structural deterioration forecast system.

Inspection, Monitoring and Diagnostics Technologies

Develop technologies that provide efficient, effective inspection and monitoring capabilities to assess infrastructure damage.

Information and Communications Technologies

Develop data management technologies utilizing enormous volume of information generated by infrastructure maintenance, management, renovation, and repair systems.

Robotics Technologies (For Inspection, Disaster Measures, etc.)

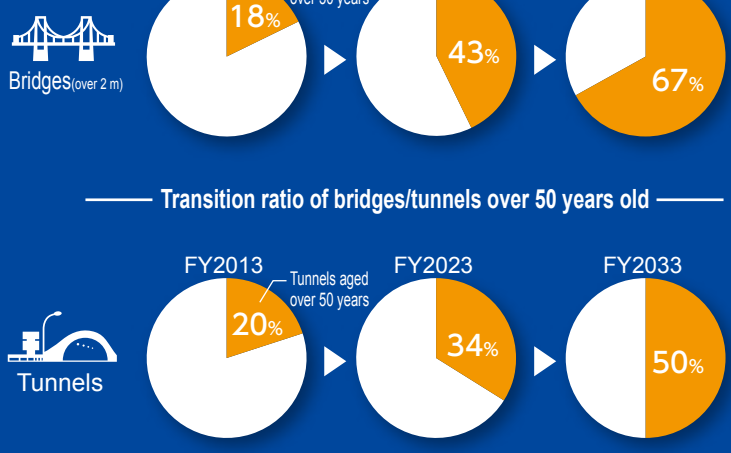
Develop robotics technologies to inspect, diagnose, operate, manage, and repair infrastructure elements efficiently and effectively; develop robots to perform surveys and excavation in dangerous situations such as disaster areas.

Companies

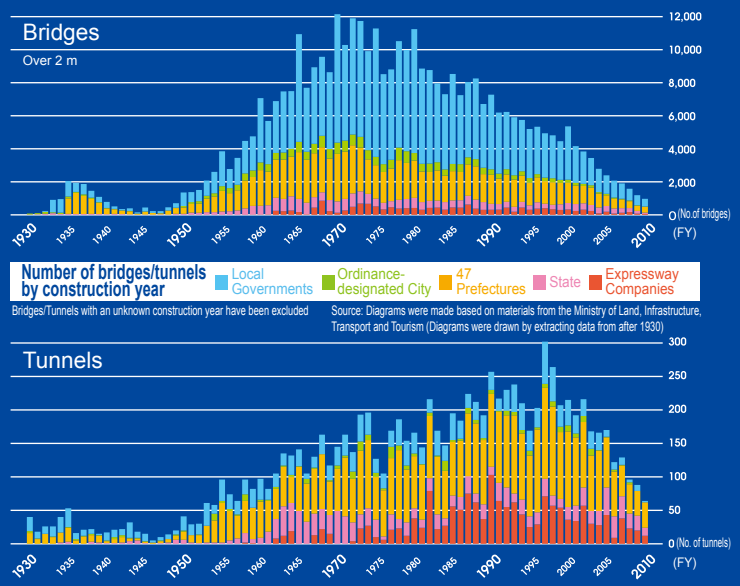
Cooperation

Ministries of Japan

Implement for Domestic and Overseas Infrastructures



Bridges/Tunnels with an unknown construction year have been excluded.
Source: Diagrams were made based on materials from the Ministry of Land, Infrastructure, Transport and Tourism



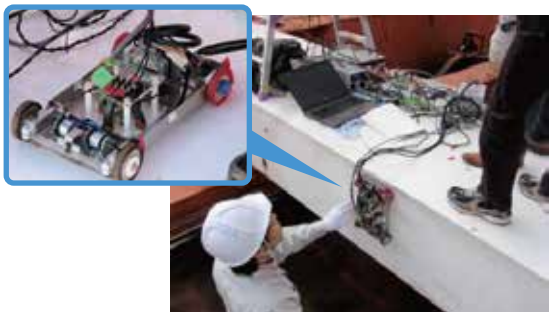
Bridges/Tunnels with an unknown construction year have been excluded

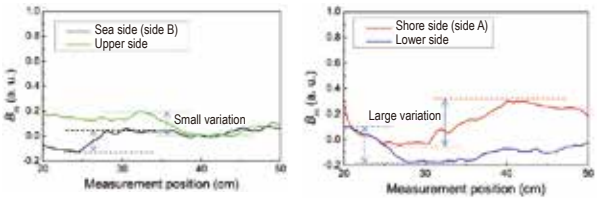
Source: Diagrams were made based on materials from the Ministry of Land, Infrastructure, Transport and Tourism (Diagrams were drawn by extracting data from after 1930)

Inspection, Monitoring and Diagnostics Technologies

Inspection, monitoring and diagnostic technologies have been developed in order to fully estimate damages of civil infrastructures. R&D subjects such as an internal defect inspection technology using supersensitive magnetic nondestructive testing, an integrated diagnostic system using high-speed traveling noncontact radar, remote diagnostic technology using supersensitive near infra-red spectroscopy, a pavement inspection system, floor slab deterioration detection using onboard underground probe radar, and the displacement monitoring technique for infrastructures using Satellite SAR (Synthetic Aperture Radar) are in progress.

Ultrasensitive magnetic nondestructive testing for deterioration evaluation and creating a preservation plan of infrastructures



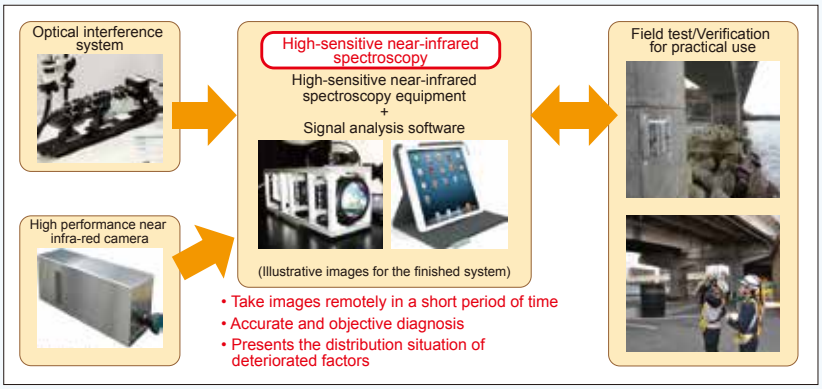


Minor internal corrosion　　Major internal corrosion

Inner defects inspection for tunnel lining using rapidly scannable non-contact radar and synthetic soundness diagnosis system

Illustrative images for inspection and diagnosis using non-contacting radar

Remote sensing of concrete structure with the high-sensitive near-infrared spectroscopy



Near infra-red imaging technology that can analyze the deteriorated components of concrete remotely in a short period of time and at a low cost

Simple pavement inspection system utilizing an airport ground vehicle

A monitoring site demonstration on the runway of an airport

Wide area displacement monitoring for early detection of deformation or damage of civil engineering structures using satellite SAR*1

Efforts for site verification using Satellite SAR technology

*1 SAR: Synthetic Aperture Radar

Detection of floor slab deterioration using the onboard underground probe radar

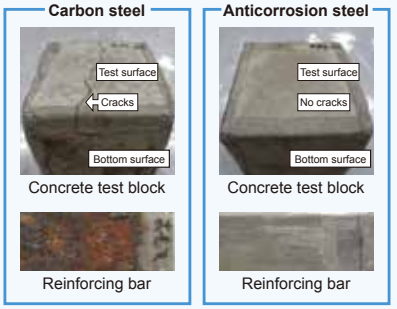
Detection of deteriorated portions inside a floor slab using an onboard high speed scan radar

Structural Materials, Deterioration Mechanisms, Repairs, and Reinforcement Technologies

Main R&D goals in this category of the SIP project are ;
- To develop simulation models for the deterioration mechanisms of structural materials and innovative estimation system for deterioration progress of infrastructures
- To organize a core base for R&D of structural materials and to develop effective maintenance technologies, and
- To promote the commercialization and wider application of precast members using highly-durable concrete for society

Investigation of structural deterioration mechanisms and efficient maintenance systems

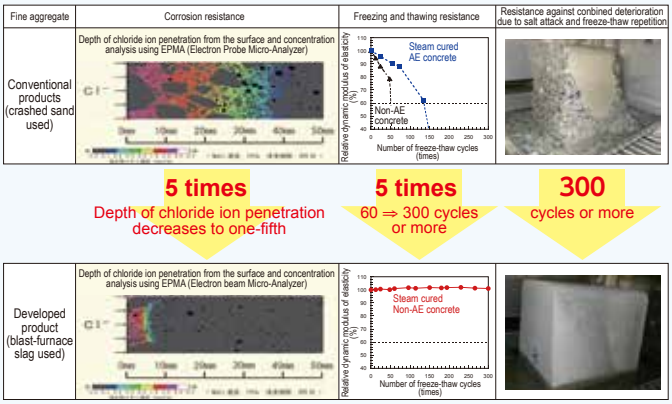
Comparison of two-year exposure test results between normal carbon steel and anticorrosion steel (at Irabu Ohashi Bridge)



Exposure test of a PC test beam deteriorated by ASR*2

*2 ASR: Alkali Silica Reaction

Precast products using high-durability concrete

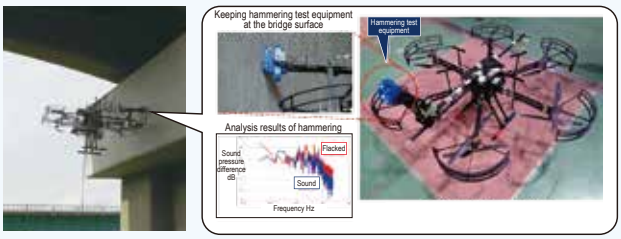


Robotics Technologies (For Inspection, Disaster Measures, etc.)

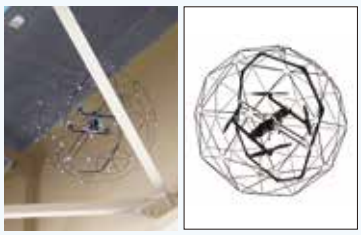
Various robots are developed to inspect civil infrastructures, such as bridges and tunnels, safely and economically. At the same time, tasks are ongoing for;
- a study of suitable structures for the introduction of robotics technologies, and
- establishing an integrated database to centrally manage the information for the effective utilization of robotics technologies.

With these efforts, the implementation in society of robots for infrastructure maintenance is projected.

Hammer test flying robot system for bridge/tunnel inspection



Hammer inspection multicopter

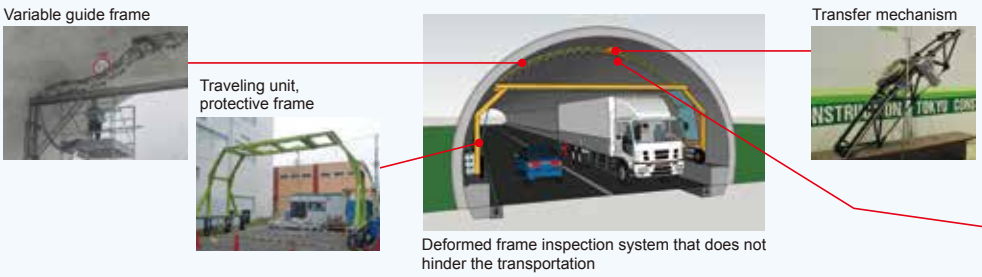


Multicopter with passive rotating spherical shell

Semi-submerged work robot using remote control

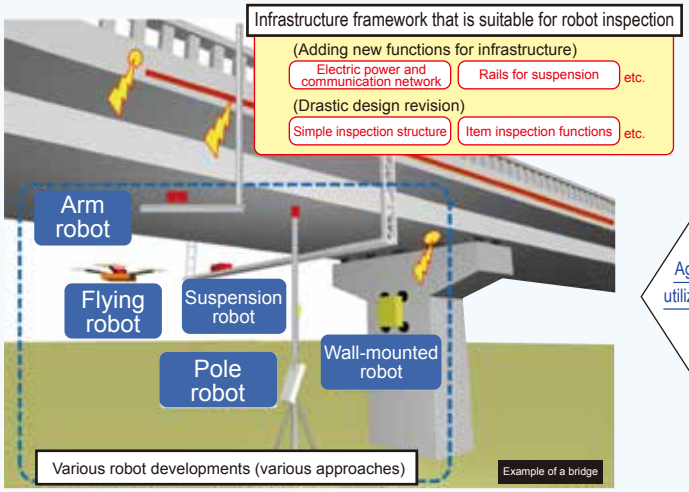
Transport robot for unmanned construction in the semi-submerged environment

The variable guide frame vehicle for inspection of tunnel

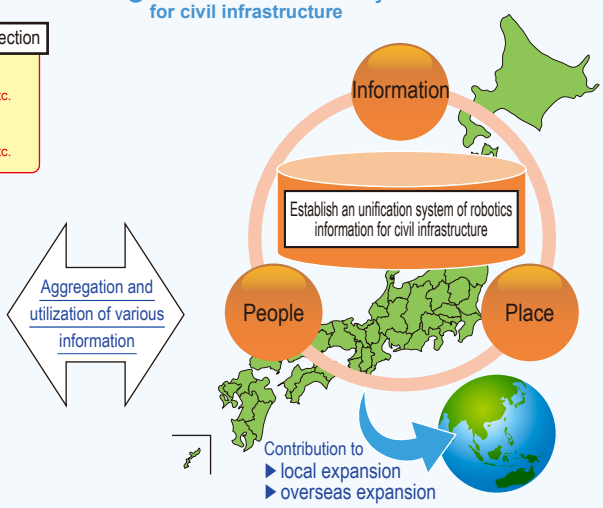


Deformed frame inspection system that does not hinder the transportation

Infrastructure framework that is suitable for robot inspection



Establish an unification system of robotics information for civil infrastructure



Information and Communications Technologies

The main subject of R&D is to develop data management systems fully utilizing information and communication technologies (ICT) to take advantage of the enormous amount of information on maintenance, repair and renewal of civil infrastructures for contributing to the real application of advanced ICT for society. Specific R&D fields are data screening based on integrated large-scale sensor information for pavements and bridges and so on, data management enabling comrehensive control of a variety of information and data analysis and visualization technologies for making the stored data effectively applicable for real operation on-sites.

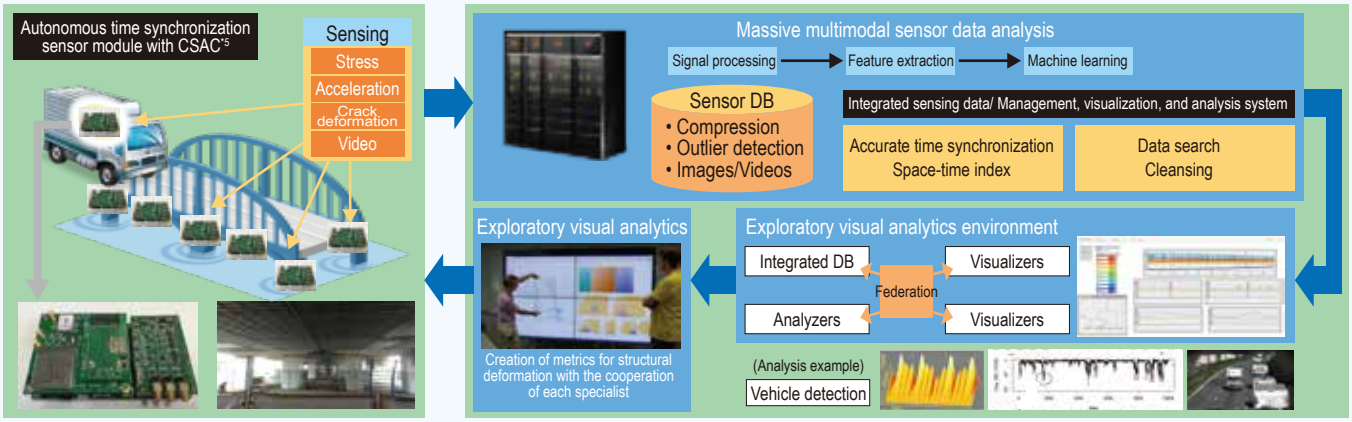
Research, development, and social implementation of screening technologies on pavement and bridges based on large-scale sensor information fusion toward preventive maintenance of infrastructure

*3 iDRIMS (Measurement) is an iOS application that measures the condition and quality of the road surface using acceleration/angular velocity sensors installed in the iPhone/iPod touch.

*4 IRI:International Roughness Index
Ride comfort index

Integrated data management platform for civil Infrastructure sensing

Support tool for road maintenance planning (for road administrators)



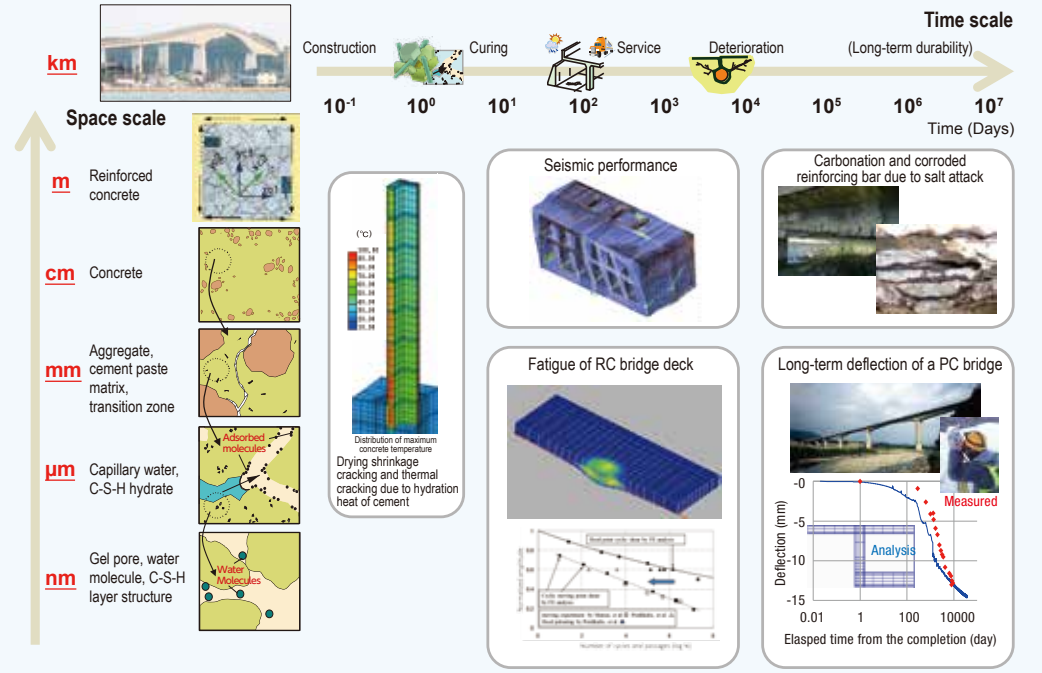
*5 CSAC: Chip Scale Atomic Clock

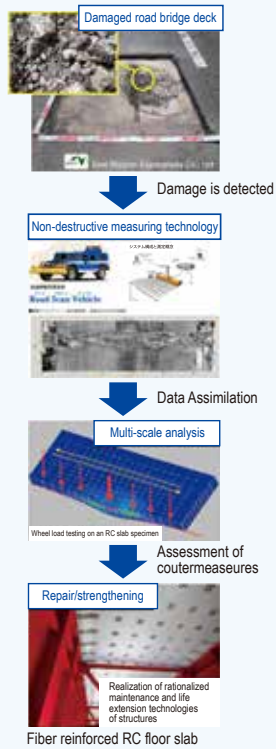
Asset Management Technologies

Along with real applications of R&D outcomes for society, SIP contributes to secured and safe infrastructures by cooperating with infrastructure administrators. The advanced technologies including non-destructive test methods and innovative numerical analysis have been developed for maintenance of road structures. In addition, SIP also proposes a highly sustainable asset management system from the viewpoints of contract scheme, human resource training, private sector utilization, and collaboration with the local residents in order to maintain enormous number of infrastructures which local governments have to manage with a limited budget.

Multi-scale analysis and data assimilation with non-destructive testing data

Multi-scale modeling and simulation with regard to the space and the time domains





Fiber reinforced RC floor slab

Project Organization
–Infrastructure Maintenance, Renovation and Management–

Program Director

Yozo Fujino
Yokohama National University

* In Japanese syllabary order
* Affiliations are as of December 2016

Sub-PDs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Masaki Seki
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内閣府 Cabinet Office

Ministry of Internal Affairs and Communications

Ministry of Education, Culture, Sports, Science and Technology

Ministry of Agriculture, Forestry and Fisheries

Ministry of Economy, Trade and Industry

Ministry of Land, Infrastructure, Transport and Tourism

Funding Agencies / Related Ministry

Ministry of Land, Infrastructure, Transport and Tourism

JST Japan Science and Technology Agency

NEDO New Energy and Industrial Technology Development Organization

Research Units

Universities

National Research and Development Agencies

Private Enterprises, etc.

List of Research and Development Themes
–Infrastructure Maintenance, Renovation and Management–

	No.	Research and Development Theme	Principal Investigator (Affiliation)
(1) Inspection, Monitoring and Diagnostics Technologies	1	Interdisciplinary R&D of NDE Techniques for Innovative Maintenance	Masahiro Ishida(Public Works Research Institute)
	2	Development of the Laser Ultrasonic Visualization Technology for the Degradation Diagnosis of Steel Bridges	Junji Takatsubo(Tsukuba Technology Co., Ltd.)
	3	Ultrasensitive Magnetic Nondestructive Testing for Deterioration Evaluation and Creating a Preservation Plan of Infrastructures	Keiji Tsukada(Okayama University)
	4	R&D of Laser Directive Noncontact Diagnosis System for Maintaining Degraded Infrastructures	Katsumi Midorikawa(RIKEN)
	5	Development of Automatic Technology on Pavement & Embankment Survey and Evaluation	Atsushi Yashima(Gifu University)
	6	Non-destructive Inspection of Rebar Corrosion in Concrete	Kenji Ikushima(Tokyo University of A&T)
	7	R&D of Backscatter X-ray Imaging System for Concrete Inspection	Hiroyuki Toyokawa(AIST)
	8	R&D of Vibration Imaging Radar	Hitoshi Nohmi(Alouette Technology Inc.)
	9	Inner Defects Inspection for Tunnel Lining using Rapidly Scannable Non-contact Radar and Synthetic Soundness Diagnosis System	Toru Yasuda(Pacific Consultants Co.,Ltd.)
	10	Remote Sensing of Concrete Structure with the High-Sensitive Near-infrared Spectroscopy	Kazuhiro Tsuno(Shutoko Engineering Co., Ltd.)
	11	R&D of Learning-Type Hammering Echo Analysis Technology	Masahiro Murakawa(AIST)
	12	Inspection and Diagnosis System of Port Structure Using Radio Controlled Boat	Tetsuya Ogasawara(Penta-Ocean Construction Co., Ltd.)
	13	Development of the Special GPR Including a Chirp Radar in the Survey of a Cavity and a Settlement of the Back-fill Material	Shigeji Yamada(KAWASAKI Geological Engineering Co., Ltd.)
	14	Development of the Monitoring System for Port Facilities using Satellite and SONAR	Takeshi Nishihata(Penta-Ocean Construction Co., Ltd.)
	15	Monitoring by using Ground-Base Synthetic Aperture Radar and Array-type Ground Penetrating Radar	Motoyuki Sato(Tohoku University)
	16	Monitoring System for a Round of Airport Paved Road Inspection, Utilizing a Technique for Detecting Cracks Automatically from High-resolution Images	Toru Hara(Alpha Product Co., Ltd.)
	17	R&D of the Crack Detection System for Runways with a 3D Camera and all Direction-moving Robot	Yasuo Kimura(NTT Advanced Technology Corp.)
	18	R&D of a Simplified System for Monitoring the Airport Pavement Surfaces Using Maintenance Vehicles	Yusho Ishikawa(The University of Tokyo)
	19	Development of Wide Area Displacement Monitoring for Early Detection of Deformation or Damage of Civil Engineering Structures using Satellite SAR	Masafumi Kondo(National Institute for Land and Infrastructure Management)
	20	Understanding the Scouring Situation by ALB (Airborne Laser Bathymetry)	Hiroaki Sakashita(PASCO Corp.)
	21	R&D of Monitoring System for Bridge Performance Assessment Based on Vibration Mode Analysis	Tadao Kawai(Osaka City University)
	22	Creation of Monitoring System using Equipment with Robotic Camera and etc. for Bridge Inspection	Yasuhisa Fujiwara(Sumitomo Mitsui Construction Co., Ltd.)
	23	R&D of Quantitative Evaluation System of Cracks on Distant Slabs by Digital Image Analysis Technology	Kenichi Horiguchi(Taisei Corp.)
	24	Field Validation of the Continuous Remote Monitoring System with Power saving Wireless Sensor	Hideshi Nishida(Omron Social Solutions Co., Ltd.)
	25	R&D of the Technology which Monitors the Displacement Rate of an Artificial Structure with High Accuracy and Efficiency	Minoru Murata(NEC Corp.)
	26	R&D of Monitoring System for Detecting Surface Failure by pore Pressure Sensor with Inclinometer	Yasunori Shoji(OYO Corp.)
	27	R&D of Early Warning Monitoring System of Slope Failure using Multi-point Tilt Change and Volumetric Water Content	Lin Wang(Chuo Kaihatsu Corp.)
	28	Mole (Small Animals) Hole Detection System Attached to Large Weeding Machine	Kiyoshi Suzuki(Aero Asahi Corp.)
	29	Electric Resistivity Monitoring System for the State of Water Contents in River Levee	Hideki Saito(OYO Corp.)
	30	R&D of Monitoring System Including a Detection of River Levee Deformation	Shunsuke Sako(Japan Institute of Country-ology and Engineering, General Incorporated Foundation)
	31	Effective Use of Satellite SAR Observation for River Embankment	Takeshi Katayama(Infrastructure Development Institute)
	32	Monitoring System for Internal State of River Levee utilizing Geophysical Exploration and Ground Water Observation	Akira Shinsei(OYO Corp.)
	33	Improvement for More Advanced and Efficient Road Structure Maintenance using Monitoring Technology	Atsushi Homma(Research Association for Infrastructure Monitoring System)
	34	Maintenance and Management of Social Infrastructure utilizing IT (Inspections, Diagnosis)	Ministry of Land, Infrastructure, Transport and Tourism
(2) Structural Materials, Deterioration Mechanisms, Repairs, and Reinforcement Technologies	No.	**Research and Development Theme**	**Principal Investigator (Affiliation)**
	35	Deterioration Mechanism of Infrastructures and Materials Technology for Efficient Maintenance	Koichi Tsuchiya(NIMS)
	36	Developing Hybrid Mechanoluminescence Materials for Visualization of Structural Health	Chao-Nan Xu(AIST)
	37	Technology of Repairing the Corrosion Damage and Deterioration to Steel Structures using Newly Developed Flame Coating Material	Kenji Higashi(Osaka Prefecture University)
	38	Precast Practical Application of PCa with Super-High Durability Concrete	Toshiki Ayano(Okayama University)
(3) Information and Communications Technologies	No.	**Research and Development Theme**	**Principal Investigator (Affiliation)**
	39	Research, Development, and Social Implementation of Screening Technologies on Pavement and Bridges based on Large-scale Sensor Information Fusion toward Preventive Maintenance of Infrastructure	Masataka Ieiri(JIP Techno Science Co., Inc.)
	40	R&D on Technologies for Collecting, Transmitting, and Processing Sensing Data of Civil Infrastructures (Underground Structures)	Shuichi Yoshino(NTT)
	41	R&D of Integrated Data Management Platform for Civil Infrastructure Sensing	Jun Adachi(National Institute of Informatics)
	42	Development of Technologies on Wide Variety of Data Processing, Storage, Analysis and Application to Achieve Advanced Infrastructure Management	Isao Ueda(East Nippon Expressway Co., Ltd.)
	43	R&D on Data Store/Management/Utlization Technologies for a Variety of Data Relating to Maintenance and Replacement of Civil Infrastructures	Toshihiro Kujirai(Hitachi, Ltd.)
(4) Robotics Technologies	No.	**Research and Development Theme**	**Principal Investigator (Affiliation)**
	44	Development of Infrastructure Inspection System using Semi-autonomous Multi-copter equipped with Flexible Electrostatic Adhesive Device	Tadahiro Hasegawa(Shibaura Institute of Technology)
	45	R&D of Diagnostic Technology Based on Measurement and Analysis by Multi-copter	Toshio Fukuda(Meijo University)
	46	Development of Intuitive Teleoperation Robot using the Human Measurement	Shigeki Sugano(Waseda University)
	47	Development of Bridge Inspection Robot System Supported by the Provisional and Flexible Scaffolding Structure	Shigeo Hirose(HiBot Corp.)
	48	R&D of Flying Robot for Bridge/Tunnel Inspection	Toshihiro Nishizawa(NEC Corp.)
	49	R&D of the Variable Guide Frame Vehicle for Inspection of Tunnel	Satoru Nakamura(Tokyu Construction)
	50	Development of Unmanned Aerial Vehicles for Observing and Hammering Aged Bridges at Short Range	Kazunori Ohno(Tohoku University)
	51	R&D of a Multicopter-based Inspection Robotic System with Visual Observation and Hammering Test Devices	Hideki Wada"(Shinnippon Nondestructive Inspection Co.,Ltd.)
	52	Development of a Bridge Inspection Support Robot System that uses Proximity-images with Geotag and a Two-wheeled Flying Robot	Naoyuki Sawasaki(Fujitsu Ltd.)
	53	New Development of Unmanned Construction ～Realization of Remote Operated Working System in Shallow Water Area～	Shin'ichi Yuta(New Unmanned Construction Technology Research Association)
	54	Research and Development of Infrastructure Structures and Inspection Devices for Advanced Inspection of Civil Infrastructure	Kenichi Fujino(Public Works Research Institute)
	55	Research and Development Concerning Mechanized Mobile Object Inspection Methods and Structure Forms that Aim to Save Energy and Improve Accuracy of Inspection	(Changed to Joint Research with the Public Works Research Institute)
	56	Establish an Unification System of Robotics Information for Civil Infrastructure	Ministry of Land, Infrastructure, Transport and Tourism
(5) Asset Management Technologies	No.	**Research and Development Theme**	**Principal Investigator (Affiliation)**
	57	Global R&D on the Management Cycle of Road Infrastructures	Koichi Maekawa(The University of Tokyo) *
	58	Resolution of Early-aged Deterioration Mechanism & Development of Total Management System Based on Evaluation for Material and Structure Quality Performance	Kazuyuki Torii(Kanazawa University) *
	59	Development of Life-cycle Management System for Port and Harbour Facilities - Integrated Framework from Inspection to Assessment	Ema Kato(National Institute of Maritime, Port and Aviation Technology)
	60	R&D of Development of Strategic Asset Management Technologies for Trunk Agricultural Water Facilities	Isamu Nakajima(National Agriculture and Food Research Organization)
	Regional implementation support team (including *)		
	61	Research on Regional Cooperation for Applications of Asset Management for Civil Infrastructuers	Yasushi Takamatsu(Hokkaido University)
	62	Conversion to a Regional-Autonomous System as Next-Generation Water Infrastructure Management	Ken Ushijima(Hokkaido Research Organization)
	63	Establishment and Promotion of the Tohoku Infrastructure Management Platform	Makoto Hisada(Tohoku University)
	64	Implementation of Effective SIP Maintenance Technologies by the ME Network	Keitetsu Rokugo(Gifu University)
	65	Framework of Infrastructure Maintenance in Kansai/Hiroshima Regions and Actual Deployment of New Technologies	Hitoshi Furuta(Kansai University)
	66	Development of Civil Infrastructure Maintenance Systems for Local Governments Through Multi-Phased Diagnosis	Tamotsu Kuroda(Tottori University)
	67	Development of Local Government Support Systems Focusing on Risks of Serious Accidents	Pang-jo Chun(Ehime University)
	68	Research and Development of Implementation in Society of Innovative Advanced Technology for Civil Infrastructure Maintenance	Hiroshi Matsuda(Nagasaki University)
	69	Development of Bridge Maintenance Technologies for Subtropical Islands and Training Diagnostic Experts	Yasunori Arizumi(University of the Ryukyus)
	70	Development of Models for Improving Service Life of Civil Infrastructures Through Cooperation between Business Administration, Science and Engineering, and Economics	Atsuomi Obayashi(Keio University)
	71	Research and Development Concerning Introduction of Asset Management Technologies to Local Governments, etc.	Toshihiko Doi(Japan Foundation for Regional Vitalization)

For Safe and Resilient Civil Infrastructure Systems

Cross-ministerial Strategic Innovation Promotion Program (SIP)
Website (Cabinet Office)
http://www8.cao.go.jp/cstp/panhu/sip_english/sip_en.html

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