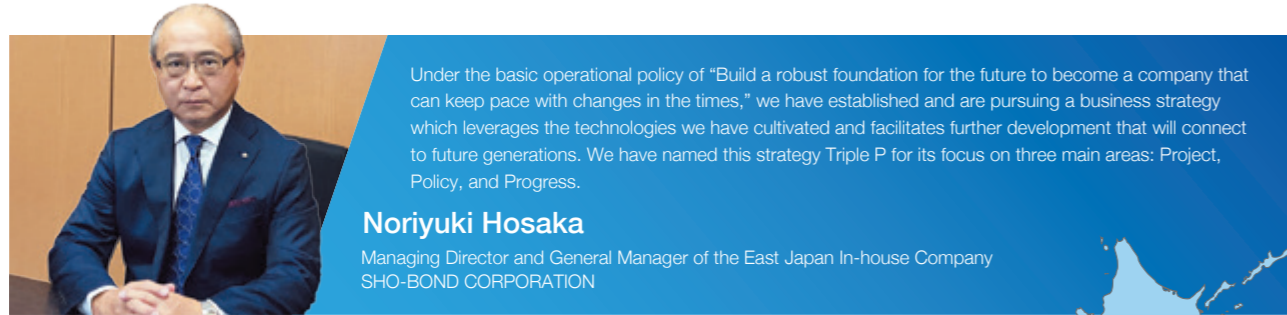


Construction in Japan East Japan In-house Company



Under the basic operational policy of "Build a robust foundation for the future to become a company that can keep pace with changes in the times," we have established and are pursuing a business strategy which leverages the technologies we have cultivated and facilitates further development that will connect to future generations. We have named this strategy Triple P for its focus on three main areas: Project, Policy, and Progress.

Noriyuki Hosaka

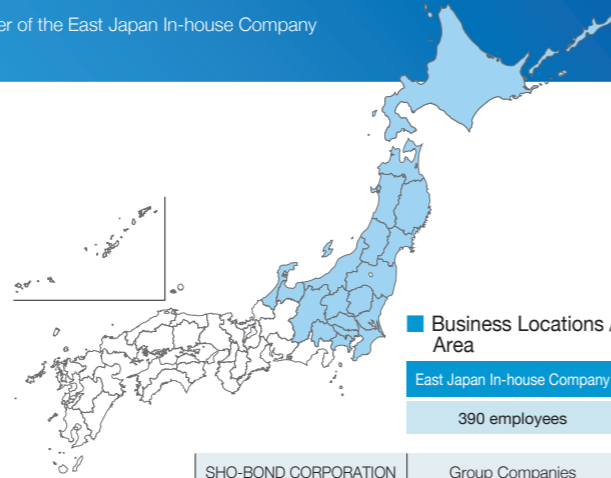
Managing Director and General Manager of the East Japan In-house Company
SHO-BOND CORPORATION

Overview of East Japan In-house Company

The East Japan In-house Company is an organizational framework covering North and East Japan, as shown on the map to the right. We have great expertise in the repair and reinforcement or seismic retrofitting work of a broad range of road structures and buildings. We also have a specialist company under our umbrella (Kyna-Tech) that possesses unique core technology of a high-frequency core drilling method, which is 2.5 times faster than conventional method. It plays an active role in projects both within and outside the Group. We have also started building a framework for carrying out high pressure water jet work as a new business area.

Some of the areas we cover experience heavy snowfall, so in order to keep sales steady, we need to be strategic in how we accept orders, such as taking on large-scale urban construction projects and orders from local governments and the private sector to offset the suspension of work on expressways in these regions during the winter.

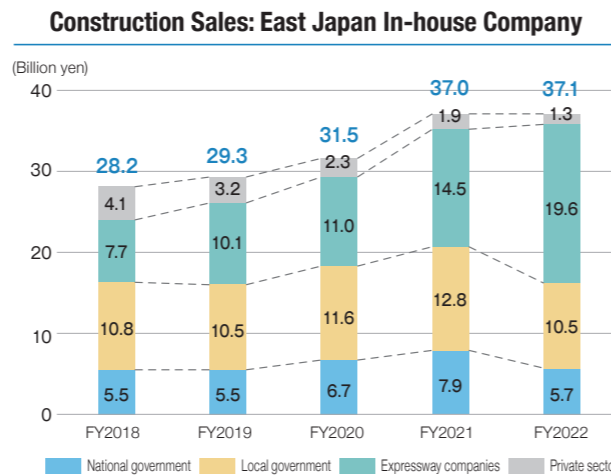
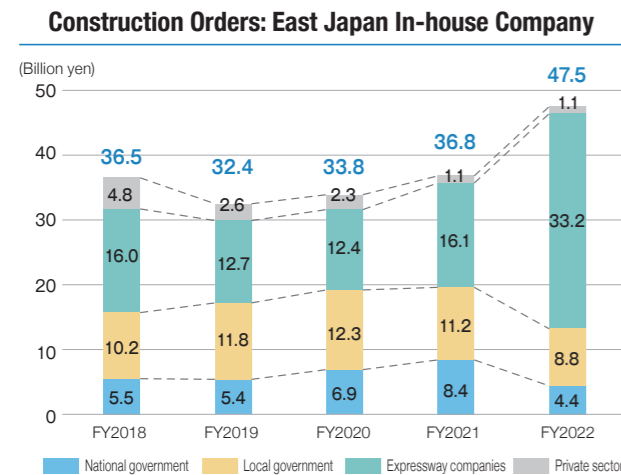
We strive to take on difficult large-scale expressway construction projects in urban areas as a joint venture with bridge manufacturers. In addition to securing profits, we engage in these projects to improve the technical abilities of our young engineers. Also, as the number of large-scale projects we receive is growing, we are using the Tsukuba Training Center and other resources to cultivate the employees of partner companies as well.



	SHO-BOND CORPORATION	Group Companies
Kita-Nihon Regional Office	<ul style="list-style-type: none"> Hokkaido Branch Minami-Tohoku Branch Kita-Tohoku Branch 	<ul style="list-style-type: none"> TOHOKU KAKO CORPORATION
Shutoken Hokuriku Regional Office	<ul style="list-style-type: none"> Tokyo Branch Chiba Branch Kanto Branch Hokuriku Branch 	<ul style="list-style-type: none"> KAKO CORPORATION KANTO KAKO CORPORATION YOKOHAMA KAKO CORPORATION NIIGATA KAKO CORPORATION Kyna-Tech
	7 branches	6 group companies

Construction Orders and Net Sales

We take on construction orders from expressway companies, national and local governments in a well-balanced manner. In particular, we receive a lot of orders from local governments in the capital region, including the Tokyo. In regard to expressway construction, we have been driving growth in orders since FY2022, after the Tokyo Olympics. We have also been trying out new technologies through joint ventures with partners, including major construction companies and bridge manufacturers.



Main Initiatives

In order to build a foundation for the future, we think it is important to cultivate people, both our own employees and those of partner companies, so we are focusing our energy on safety initiatives and the development of human resources.

Creating a Safety Culture

We have formulated an action plan for creating a safety culture within the in-house company and we are implementing initiatives in accordance with this plan.

This includes making communication the highest priority, so we are implementing measures for enhancing both organizational and individual capabilities of ensuring safety on construction sites.

Specifically, we are working to deepen mutual understanding between the in-house company, our employees, and partner companies by carrying out conversation-based patrols and issuing in-house newsletters.



Empowering Female Engineers and Non-Japanese Employees

We are actively employing female engineers at construction sites and some of them take a lively part in on-site jobs balancing work and family life. Currently, we have nine female engineers on staff, one of whom is non-Japanese.

We are also actively working to recruit and develop non-Japanese human resources so that we will be able to respond to future changes in the business environment. We have already launched an initiative to recruit non-Japanese engineers and we are actively engaged in developing them, including at partner companies. This development is not only being carried out through on-site instruction, but also through measures such as educational support that enables them to gain official Japanese qualifications.

Non-Japanese employees recruited (2020 to present)	2
Non-Japanese employees in training	7

Note: As of June 30, 2022



A non-Japanese employee and female engineers

Topics

Dispatching Instructors to the Tsukuba Training Center

As part of our human resource development efforts, we have dispatched more than 10 veteran engineers to act as instructors for construction management training aimed at less-experienced employees and workers from partner companies. The in-house instructors are leveraging their experience to create their own courses and study programs and these have been well received by the trainees.



Recycling Work Clothes and Helmets

We are carrying out an initiative for recycling unneeded work clothes, helmets, and other equipment. The clothes, helmets, and equipment collected at each of our business locations are put to good use as an industrial resource.

FY2022 Collection Results (East Japan In-house Company)
Work clothing: 298 pieces
Helmets: 27
Other (cold weather protection, etc.)



In-house Newsletters

Each of our regional offices creates its own in-house newsletter. The Kita-Nihon Regional Office's newsletter has been named *Eco-Hiiki* (Eco Promoter) and includes content that aims to strengthen ties with partner companies. The Shutoken Hokuriku Regional Office's newsletter is called *Anzen Dayori* (Safety News) and it aims to inform staff of revisions to laws and regulations and foster a strong awareness of safety in accordance with in-house rules. We will continue to issue newsletters as a tool for fostering communication within the in-house company and with partner companies.



Construction in Japan West Japan In-house Company



At the West Japan In-house Company, we aim to achieve further growth by positioning “maintaining growth,” “employee education,” and “strengthening our base” as priority issues. Accordingly, we will strengthen our foundation through investment in people. When we receive orders for large-scale construction projects from expressway companies, we decide whether or not to take an order to establish a proper workforce framework and personnel allocation.

Tsuyoshi Koga

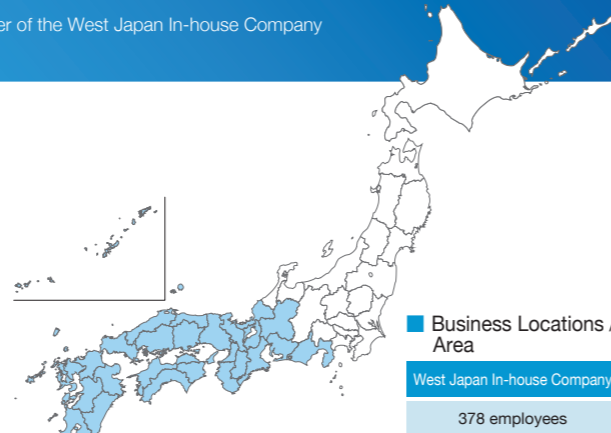
Managing Director and General Manager of the West Japan In-house Company
SHO-BOND CORPORATION

Overview of West Japan In-house Company

The West Japan In-house Company comprises three regional offices (Chubu, Kinki, and Nishi-Nihon) and each of these regional offices is affiliated to the Kako Group companies. We operate over a wide area covering South and West Japan.

Each branch of SHO-BOND CORPORATION primarily undertakes general construction contracts with a focus on large-scale projects. The Kako Group companies receive orders from national and local governments taking advantage of being based in the district, as well as undertake subcontract work from major construction companies. We ask our partner companies to take on work within the in-house company on a cross-regional basis and these partners are playing an important role in strengthening our overall construction framework.

When taking on large-scale projects, we compile information from each region under the company’s area, while cooperating with the head office, such as anticipated expressway construction orders and personnel information, so that it is available on the in-house company-wide basis. For human resources development, we approach skill improvement from a peculiar perspective. We carry out a questionnaire of all young trainees in advance and then plan experience-based training programs that cover topics identified through the results.



Business Locations / Area

West Japan In-house Company

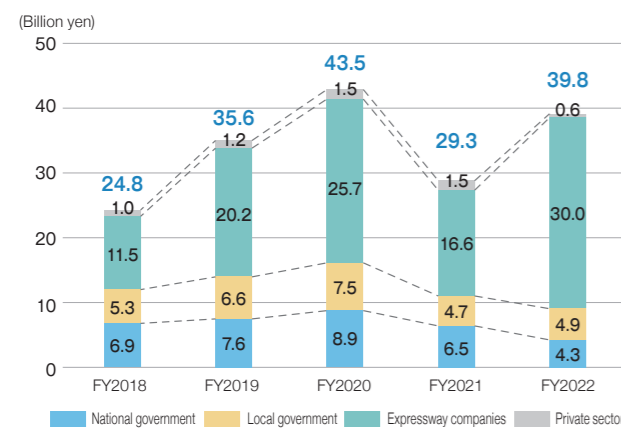
378 employees

	SHO-BOND CORPORATION	Group Companies
Chubu Regional Office	<ul style="list-style-type: none"> Nagoya Branch Shizuoka Branch 	<ul style="list-style-type: none"> CHUBU KAKO CORPORATION
Kinki Regional Office	<ul style="list-style-type: none"> Osaka Branch Kyoto Branch Kobe Branch 	<ul style="list-style-type: none"> KANSAI KAKO CORPORATION
Nishi-Nihon Regional Office	<ul style="list-style-type: none"> Chugoku Branch Shikoku Branch Kyushu Branch 	<ul style="list-style-type: none"> CHUGOKU KAKO CORPORATION SHIKOKU KAKO CORPORATION KYUSHU KAKO CORPORATION
	8 branches	5 group companies

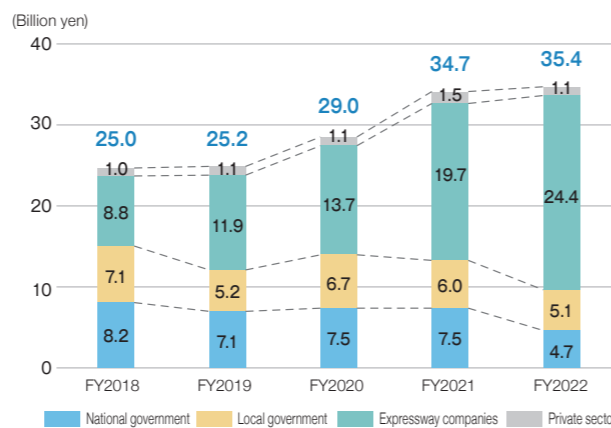
Construction Orders and Net Sales

We actively undertook large-scale construction orders from expressway companies to advance the Group’s aims of taking on larger construction projects and leveling off operation. We have even taken on two large-scale construction contracts with an initial value in excess of ¥7 billion. In addition to building a construction framework suitable for handling large-scale projects, we have been improving the gross margin of construction work under strict cost control.

Construction Orders: West Japan In-house Company



Construction Sales: West Japan In-house Company

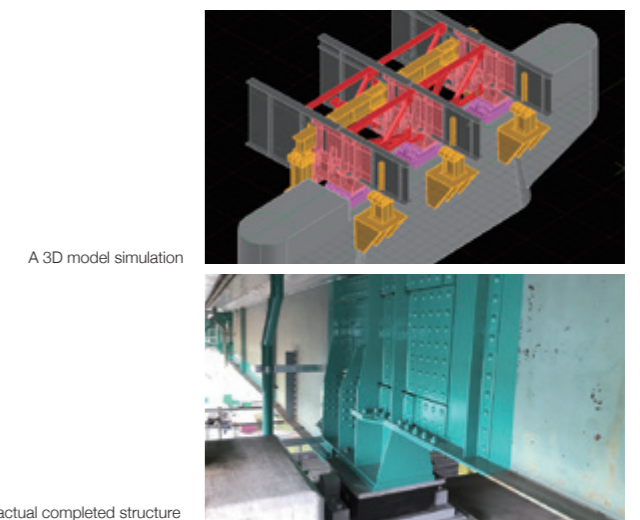


Main Initiatives

In order to further enhance the Group’s strengths and accelerate growth, we are working on upgrading the order receipt strategy and more activities for large projects and construction work capability (the targets of the current Medium-term Business Plan). At the same time, we are advancing the following initiatives to develop human resources and establish a robust safety culture.

Utilizing 3D-CAD at Construction Sites

We are gradually introducing 3D-CAD to construction sites in order to raise productivity and quality and to visualize construction processes. 3D models enable users to check the condition of a structure from various angles, and they can be used to improve construction quality by discovering inconsistencies between drawings and the actual structure, as well as by identifying any points of interference between newly added members and the existing structure. Issues can be solved before work even begins by using 3D model simulations at the design stage. This contributes to making construction processes more efficient and to raising productivity. It is also possible to use 4D models, which are 3D models with a time axis added, at the same time. This enables the visualization of the entire construction process, from the pre-construction stage to completion, facilitating a shared awareness among large numbers of people. In terms of safety, 4D models can also be used to check each step of a work process in advance to understand and predict potential hazards, thereby enhancing safety.



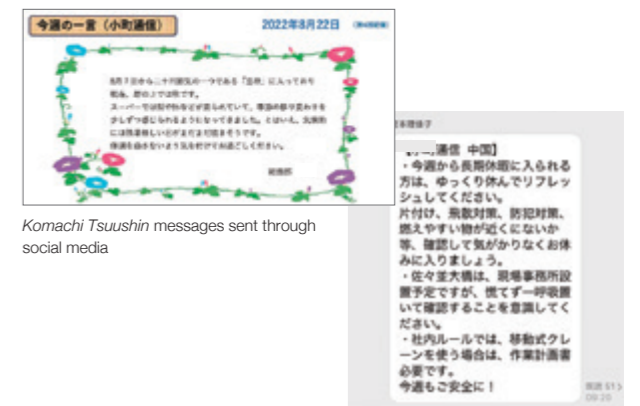
A 3D model simulation

The actual completed structure

Unique Communication that Improves Safety and Team Unity

The Nishi-Nihon Regional Office has started sending all team members *Komachi Tsuushin*, which are communications aimed at improving safety awareness. Female administrative staff, who usually stay at office, use social media to send safety awareness messages to construction sites every Monday. This raises their interest in the sites and fosters greater unity among the entire team, including administrative departments. At the same time, the regional office’s Safety Management Section is sending Safety Alerts that inform workers of potential onsite hazards identified from the weekly construction schedule as a way to encourage the sharing of information and realize a greater alertness to danger among all employees.

Through these daily initiatives, we aim to foster an organization-wide safety culture by facilitating communication and building trust.



Komachi Tsuushin messages sent through social media

Topics

Training for Young Employees

As a leading company for repair and reinforcement work, we position human resource development, particularly the development of young employees and passing down of skills, as an important issue.

We are focusing on developing young engineers by leveraging the experience of senior employees in construction, sales, and engineering departments to implement experience-based training programs. Content includes operational methods used at construction sites and ways to solve technical issues. We are also actively working to further advance this training by incorporating environmental improvements (including DX).



An experience-based training session

Feature Various Repair and Reinforcement Construction Projects

Expressways

Large-scale Expressway Renewal and Repair Project

There are many structures that have been in use for over 50 years and as they age, damage and deformities of these structures are becoming apparent. Therefore, expressway companies are launching the large-scale renewal and repair project in order to restore these structures to their original state and even enhance performance and functionality, thereby ensuring the long-term soundness of the expressways. One of the main characteristics of renewal work is that it has a large impact on society because traffic needs to be restricted and sometimes detours are set up for long sections of road during long construction periods. Also, construction on expressways in urban areas is often difficult due to restrictions such as limited working space where the expressway passes directly over a major arterial road.

PR Representative for Expressway Renewal Work

Expressway renewal work is carried out on a section of a major transportation network so it has a considerable effect on society. Therefore, we work to gain the understanding of road and transportation administrators regarding the importance of renewal work, and request their cooperation with publicity activities aimed at regular road users, including by posting notices of construction work on electric signs and distributing leaflets. We also open sections of our construction sites to visitors such as the press and educational institutions in order to communicate the current status of social infrastructure to wider society and promote the importance of renewal work.

Passing on Social Infrastructure to Next Generation

Due to the social importance of expressways, carrying out construction work while they are in operation involves various restrictions, including in terms of safety and scheduling.

Advancing construction on a structure involves a wide range of different organizations, such as the organizations managing the roads leading in and out the section of road and other roads that run alongside it. Coordinating all these organizations requires a great deal of time. Despite these difficult conditions, once work has been safely completed and the structure is in sound condition for use, it becomes social infrastructure that can be passed on to next generation, which is enormously satisfying.



Renewal work underway

Local Governments

Overview of Construction Works for Local Governments – The Repair of Mino Bridge as a Case Study

There are approximately 730,000 bridges in Japan and about 90% of these are managed by local governments. Mino Bridge is a 116-meter-long steel stiffened suspension bridge which crosses the Nagara River in Mino City, Gifu Prefecture. It started service in 1916, giving it significant historical and technological value as Japan's oldest modern suspension bridge. We were able to participate in the repair of the valuable bridge. Although the contract for this project was with Mino City, as the bridge is an Important Cultural Property, construction was carried out under designs and supervision by the Japan Cultural Heritage Consultancy, a design company entrusted with the project by the Agency for Cultural Affairs.

Unravelling the History

This project was the first large-scale repair work carried out on Mino Bridge since its designation as an Important Cultural Property. When checking the specifications of the steel parts, one of the main themes of the Japan Cultural Heritage Consultancy's work was checking the roots and repair history of each member of the structure. We actively contributed to these investigations. The investigation was a success, with the results revealing that the initial steel members that are still in use today were manufactured at the Imperial Steel Works in Yawata.

Receiving Double Awards

As an Important Cultural Property, the bridge needed to be repaired without any changes to its original form under the Act on the Protection of Cultural Properties. Therefore, during the work we had to be extremely careful, keeping records of the position of every member that was removed and the diameter of each rivet, as well as carefully sorting the separated members by type and organizing them in a way that made it clear where and how it should be reattached. This required a large amount of time and manpower, but we were able to repair and restore the bridge without losing any of its value as a cultural property. As a result, the Group received double awards for the first time in our history, the Japan Society of Civil Engineers' 2021 Tanaka Award (Renovation Category) and a 2021 Japan Construction Engineers' Association Award.



Mino Bridge (Photos: Japan Cultural Heritage Consultancy)

Ministry of Land, Infrastructure, Transport and Tourism

Measures for Building National Resilience

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) is carrying out many projects under its Fundamental Plan for National Resilience, including measures to tackle aging infrastructure and strengthen seismic functions. We are engaging in these projects, primarily for seismic strengthening work. We are focusing on tackling these projects not only from a technical perspective, but also by raising efficiency and productivity through the introduction of construction DX. We are actively incorporating measures for improvement of construction industry advocated by MLIT, and in FY2022, we were evaluated highly by the ministry and designated as a company of excellence in construction by its several regional offices.

Maintaining and Managing Structures through Cooperation with Bridge Doctors

In order to extend the service life of highway bridges, MLIT has established the Bridge Doctor system, which aims to apply technical guidance and advice from experienced academic experts to infrastructure maintenance. We helped this initiative by the attachment of sensors that continually monitor the damage situation of a bridge and initial data collection. We are also participating in social infrastructure maintenance and management projects operated through industrial-governmental-academic partnerships.

The Difficulty of Construction Work On What is Already There

Seismic strengthening work involves attaching aseismic devices using anchor bolts, so there is a risk that boring will damage important members within a structure. There are many instances when construction cannot go forward according to the original contracted plans because the interior of the existing structure is not visible. As a company specializing in maintenance, coming together and leveraging our ingenuity to overcome successive problems like these is worthwhile work. In FY2022, we received several awards from regional offices of MLIT due to our efforts in this area.



An inspection by a Bridge Doctor

Private Sector and Others

Work on Private Sector Structures

We provide a one-stop service that delivers solutions to issues such as damage to harbor facilities and buildings caused by aging, revisions to laws and regulations, damage from natural disasters, and changes to a structure's purpose. This service covers everything from investigations and diagnoses to design and construction work. In our construction efforts, we have raised the value and extended the service life of the buildings we have worked on by making them safe, secure, comfortable, and resilient to disasters. We have also contributed to conserving Japan's beautiful cultural heritage by participating in the renovation of historic buildings.

Valuing Relationships of Trust with Customers

We take a wide-ranging approach to the private sector customers of our group companies and other partner companies, and if any issues arise, we go to the site to survey the actual situation and offer a variety of solution proposals. By building in-person relationships with customers in this way, we are able to detect any issues at an early stage, contributing to extending the service life of facilities. The relationships of trust we build with our customers are long-lasting, including providing maintenance and operational management support after renewal work has been completed.

Combining Construction with Service

A large proportion of renovation works are carried out while a facility is still in use, so we take a customer-first approach. Compared to new construction, renewal work requires that more attention is paid to curtailing public nuisances, such as vibrations and noise, and controlling waste emissions, and there are many other challenges, including a tendency toward longer construction schedules.

Despite such difficulty, we work closely with our customers to ensure that construction moves forward without issue and that we can safely hand over the completed structure. Seeing our customers using their renovated buildings brings us the greatest joy.



Reinforcement work in progress

Manufacturing and Sales of Construction Materials SHO-BOND MATERIAL CO., LTD.

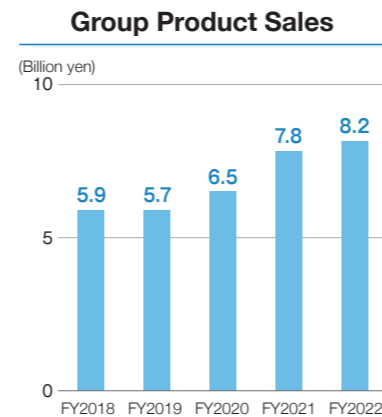


We are contributing to maintaining and updating social infrastructure by supplying products with excellent performance in relation to cost that can meet customers' needs and earn their trust. We work to build frameworks for safe and efficient production activities, highly reliable quality assurance activities and the accurate supply (delivery) of products.

Shigeru Naraoka
President and Representative Director
SHO-BOND MATERIAL CO., LTD.

Overview of SHO-BOND MATERIAL CO., LTD.

SHO-BOND MATERIAL CO., LTD. is a core Group company that engages in the manufacturing and sales of construction materials. We were established in July 2016 through the merger of SHO-BOND Chemical and SHO-BOND Coupling to become both a manufacturer and seller of resin products, construction materials, and pipe joints. We produce new construction materials and methods that accurately respond to changes in the maintenance market and the needs of our customers by combining chemical and civil engineering technologies within a comprehensive framework spanning from design and development through to manufacturing and sales. The product improvement and new construction method ideas we gain from hundreds of SHO-BOND CORPORATION construction sites across Japan are the driving force behind our product development capabilities. We continuously evolve our resin products and construction materials alongside construction sites and boast a broad lineup of products tailored for the various effects of deterioration and damage that afflict structures.



Activity Report

1 Diversifying Product Sales Methods

In February 2022, we independently acquired a construction license in order to expand sales of new products and meets customer requests that we carry out work onsite. This has enabled us to take on construction service contracts so that we have been accepting construction orders that incorporate sales of our products. In particular, we had been having trouble growing sales of CPJ-L, a concrete with a low-elasticity latex and ability to harden very quickly that we added to our lineup in October 2020, as it was difficult to meet customer needs through just product sales. However, being able to mix and apply the product onsite ourselves using a specialized mixer has led to a large increase in sale volumes. Furthermore, we are also able to leverage our advantage of selling adhesives for pouring concrete to construction joints. Going forward, we will develop sales of products paired with onsite construction across Japan.

2 Stainless Steel Mechanical Pipe Joints (Straub Pipe Couplings)

We have been manufacturing and selling Straub couplings for 40 years, from 1982 to 2022, as mechanical pipe joints for air conditioning and sanitary equipment piping. Over this period, we have developed lightweight, improved fastening, high pressure-resistant, and other products in response to numerous requests from our customers. These have greatly pleased workers and clients on actual construction sites by saving labor and shortening construction schedules. We will continue striving to meet the expectations of our customers.

As a measure to grow sales in new fields, we have jointly developed a fire-resistant coupling for flammable gas pipes with the Japan Gas Association and five gas companies, and this is now being launched to market. The product has been highly evaluated by gas-related work sites and has received the Japan Gas Association's 2022 Award for Engineering in recognition of its excellent workability. Also, our couplings are made from stainless steel, giving them long service lives and semi-permanent recyclability. This contributes to lowering environmental impact, including reduction of industrial waste and CO₂ emissions.



Construction site (CPJ-L)



Example of a Straub pipe coupling (Straub Grip G-type)

Overseas Businesses SHO-BOND & MIT Infrastructure Maintenance Corporation

SHO-BOND & MIT Infrastructure Maintenance Corporation (SB&M) combines SHO-BOND's technological capabilities with the network and business development capabilities of MITSUI & CO., LTD. (Mitsui) to provide solutions using SHO-BOND's technology for infrastructure and private facilities owned and managed by customers in Japan and overseas. The company builds and develops new business foundations for the SHO-BOND Group and promotes activities that create a safe and secure social environment.

Overview of SB&M

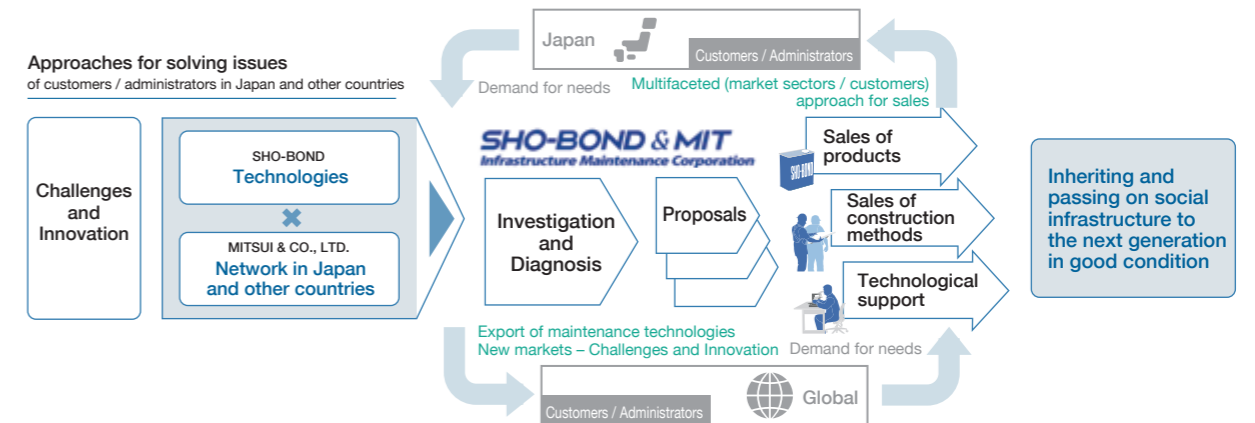
SB&M was established in April 2019 with a 51% investment by SHO-BOND Holdings Co., Ltd. and a 49% investment by MITSUI & CO., LTD. It is the first joint venture company in the history of SHO-BOND. A total of nine employees seconded from both companies work together to develop new businesses in cooperation with SHO-BOND Group companies and Mitsui. The company's business represents a new challenge for the SHO-BOND Group. We are working to create new business areas both in Japan and overseas.

In November 2020, the company established a joint venture company (CPAC SB&M Lifetime Solution Co., Ltd.) with the Concrete Products and Aggregate Co., Ltd. (CPAC), a subsidiary of the Siam Cement Group (SCG), a major conglomerate in Thailand, to develop infrastructure maintenance business in Southeast Asian countries starting from Thailand.

SB&M is working to expand sales of products and construction methods, listening to structural maintenance issues of customers in Japan and overseas and taking a problem-solving approach. Based on SHO-BOND's technology, the company handles a wide range of products, including structural repair resin, earthquake-resistant equipment and expansion equipment for bridges, and various pipe joints. It also introduces high-quality repair products from overseas into Japan.

At the Thai joint venture company, two seconded employees are currently playing a leading role to transfer SHO-BOND's technology. Thailand is experiencing a stage where aging infrastructure issues are beginning to surface. We are conducting educational activities to raise maintenance awareness and sales activities to show maintenance benefits from the perspective of life cycle costs. SB&M cooperates with SHO-BOND Group companies to support local businesses.

The company is also considering the development of new overseas businesses to contribute to other countries by exporting the technologies and knowledge it has cultivated and gained in Japan.



Activity Report

Taking Advantage of the Joint Venture's Strengths to Move Forward Despite the COVID-19 Pandemic

In FY2022, SHO-BOND and Mitsui, as well as SB&M and CPAC, worked together both in Japan and overseas to advance business while leveraging their respective strengths.

Travel and behavioral restrictions during the protracted COVID-19 pandemic significantly impacted our Thai and other overseas businesses. Even seconded employees of the Thai joint venture company could not visit sites or customers. However, we utilized web meetings connecting multiple locations and developed sales operations by exchanging ideas between local and Japanese employees. We also secured repair projects for ports and cement factories with the support of the sales network of SCG, CPAC, and MITSUI & CO. (THAILAND) LTD.

Similarly, overseas business development in countries other than Thailand has made steady progress through the Web, taking advantage of Mitsui's overseas network of offices in 62 countries worldwide.

While overseas businesses faced difficulties, our sales activities in Japan increased even under behavioral restrictions. We have been getting more and more positive feedback by responding flexibly to customers' needs, for example, by conducting online sales to new customers through Mitsui's network and repeating site visits to lead up to mockup (trial construction) and product sales.

SB&M will continue to make steady progress toward business growth by leveraging the strengths of a joint venture and combining the capabilities of the Group and its partner companies.



Scenes of operations in Thailand



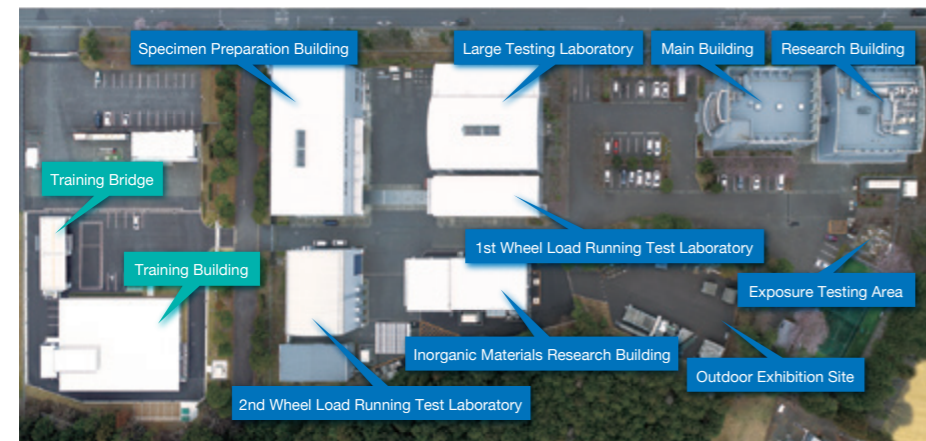
A port repair site in Thailand

Research and Development Technical Research Institute

As a leading company in the structure maintenance business, we are contributing to realizing a safe society through our advanced technological development capabilities. Our development themes are based on the diverse needs of customers in various fields and our construction sites. In cooperation with public and private research institutes, we use open innovation research and development methods to enhance the results and speed up the process.

Overview of Technical Research Institute

The SHO-BOND Group has contributed to society through the research and development of its own repair technology, believing that the combination of chemical and civil engineering technologies is important for effective infrastructure maintenance. Technical Research Institute played a central role in this effort. In 1996, the year after the Great Hanshin-Awaji Earthquake, SHO-BOND opened its third research laboratory (with a site area of approximately 22,000 m²) in Tsukuba Science City. We named the institute the Technical Research Institute based on the philosophy of raising repair skills to the level of scientific research. The institute focuses on clarifying the mechanisms of structural deterioration and damage, improving fatigue durability against large vehicles, and researching and developing effective reinforcement technology for earthquake disasters. The research facility specializing in the repair and reinforcement of structures and equipped with a lot of state-of-the-art equipment is unique in Japan, and many materials and construction methods developed have been adopted as standards for repair methods. The research staff consists of researchers with backgrounds in chemistry (organic materials) and civil engineering (inorganic materials and structures).

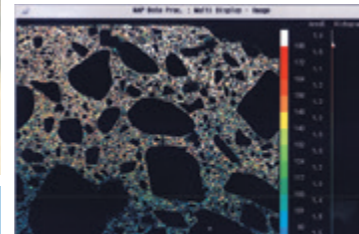


Tsukuba Training Center Technical Research Institute (SHO-BOND CORPORATION)

Aerial view of the Technical Research Institute and Tsukuba Training Center



Wheel load running test



Example of EPMA analysis

Various Research and Development Themes

In recent years, we have been working on the following research and development themes:

- Concrete coating methods with few work processes that can be easily conducted by non-skilled workers, and one-pack type coating materials that are easy to handle
- A method to ensure that anticorrosive agents for reinforcing bars penetrate from the surface of the concrete to the interior as a preventive maintenance to be applied before the deterioration of structures
- Special anchors for adhesive injection and special concrete placing systems for the surface replacement to repair deck slabs that have deteriorated significantly due to repeated heavy traffic loading

In addition to these themes, we are constantly conducting research and development on several other themes.

In February 2022, the Institute received the Special Award at the First Infrastructure Maintenance Awards from the Japan Society of Civil Engineers (JSCE) for its longstanding research and development activities that have contributed to the development of infrastructure maintenance.



CPJ-L demo attended by customers



Bending test of deck slabs repaired by resin injection

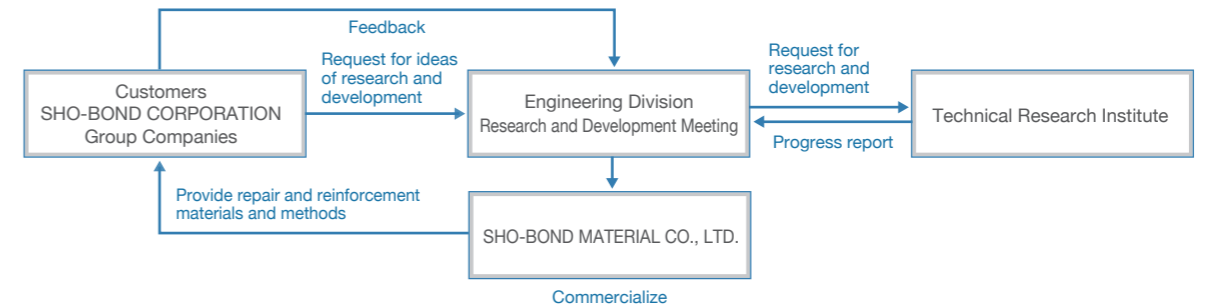


Received the Special Award at the First Infrastructure Maintenance Awards from JSCE

[JSCE Infrastructure Maintenance Awards website \(Japanese version only\)](https://inframaintenance.jsce.or.jp/hyoushou/announcement1/)
<https://inframaintenance.jsce.or.jp/hyoushou/announcement1/>

Cooperation Among Divisions and Group Companies

Led by the Engineering Division, which gathers information on issues faced by customers and the Group, the Group conducts research and development at the Technical Research Institute and commercializes products at SHO-BOND MATERIAL CO., LTD.



Development Examples

1 A High-performance Anti-falling Method with Excellent Transparency (SHO-BOND New Clear Cloth Method)

With the aging of infrastructure constructed during the period of high economic growth, concrete pieces falling from elevated bridges and other structures have become apparent, and anti-falling measures have been implemented. In addition, since the Sasago Tunnel Ceiling Collapse, inspections have become mandatory every five years, and facility managers are required to conduct a close visual inspection. For this reason, there is a need for a method that allows direct visual inspection of concrete conditions even after anti-falling measures are implemented, but the transparency has been insufficient with existing methods.

To meet this demand, we have developed a high-performance anti-falling method that is transparent and has excellent visibility of the substrate. The method combines excellent transparency with load-bearing performance and deformation performance to support falling objects and demonstrates sufficient performance even in the temperature range of -30 to 50°C. We expect this method will contribute to the maintenance and management of concrete structures and the prevention of third-party damage.

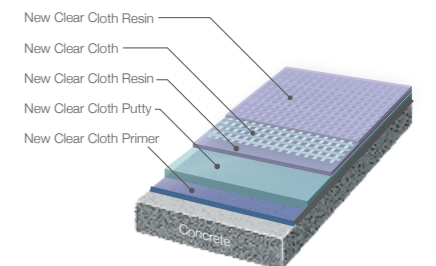


Illustration of SHO-BOND New Clear Cloth Method

2 Life Extension Methods for Small and Medium-sized Bridges (CPJ-L, SBJT, and SB Primer)

Small and medium-sized bridges are important infrastructure for community roads regardless of their traffic volume. However, they are often managed by local governments lacking both financial and human resources, requiring general-purpose construction equipment, workability, and economic efficiency. To meet these needs, we have developed life extension methods that satisfy these requirements and provide sufficient durability. This method involves removing the existing pavement from the concrete deck slab, applying a highly permeable primer (SB Primer) and an adhesive for jointing (SBJT) to the top surface of the concrete deck slab, and then placing paving and reinforcement material, a low-elasticity latex modified fast curing concrete (CPJ-L) mixed with a small mixer. The main material, CPJ-L, has various features, such as fast curing that leads to a shorter road closure time, durability, and load resistance. We expect it to become an effective tool for local governments to promote longer bridge life.



Before construction



After construction

3 AI-based Repair Design Productivity Improvement System (AI Shindanshi*)

Traditionally, causes of deterioration of concrete structures have been identified based on detailed site investigation and material analysis results of samples taken from deteriorated parts. In addition, the repair method had to be selected from various choices corresponding to the identified causes of deterioration according to site conditions.

As a tool to improve the productivity of this process, we have developed an artificial intelligence (AI) system for diagnosing deterioration and selecting repair methods (AI Shindanshi). The basic system is constructed by deep learning by AI based on abundant in-house repair work examples. The system enables the identification of deterioration factors and the immediate proposal of optimal repair methods simply by providing deterioration images and location information of the target structure. We plan to utilize "AI Shindanshi" as a tool for making technical proposals in planning for extending the life of structures of customers and other activities to contribute to improving business efficiency.

*AI Shindanshi ("AI診断士") is a registered trademark of SHO-BOND CORPORATION in Japan as of March 2023.

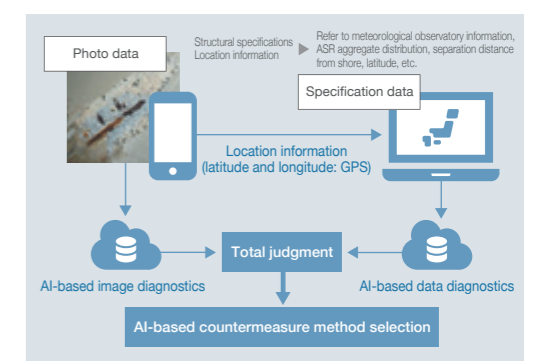


Diagram of AI diagnosis

Tsukuba Training Center

Motivation for Establishment

Providing Learning Opportunities Based on Practical Training

Recently, a wide variety of structural repair methods, including preventive maintenance, anti-deterioration, seismic reinforcement, and component replacement methods have been developed. Materials have also become diverse, including concrete, steel, resin materials, and new materials such as aramid and carbon fiber. Familiarity with these methods and materials is essential to ensure construction quality. In addition, the Group's abundant proprietary methods and materials are valuable assets, and we consider it an important task to ensure that these technologies are passed on to the next generation. In order for all employees to master these technologies, we decided that a full-scale training center would be necessary because the existing classroom lectures and on-the-job training at construction sites were insufficient. For these reasons, in October 2021 we established the Tsukuba Training Center with an area of approximately 5,000m² near the Technical Research Institute.



Full view of Tsukuba Training Center

Concept of the Facilities

The concept of the facilities is to provide classroom lectures on the intention of adopting each construction method and material, points to note in construction, safety, and others, and then to provide practical training during the training period to consolidate the knowledge. With an eye on training not only for our employees but also for employees of domestic and overseas partner companies that have little experience in repair work, we use the same repair objects and materials in the practical training as those at the construction site so that they can experience the feeling of the site. The main facilities are a seminar room, a construction training room, a safety training room (with a real scaffold, mannequins, danger experience equipment, and VR danger experience equipment), and a full-scale training bridge (a two-span simply supported three I-girder bridge).



Training bridge

Overview of the Facilities

Training building (total floor space of approx. 1,000m²)

- Seminar room: A classroom for up to 54 participants
- Construction training room: A seminar room where participants can learn how to handle repair materials
- Safety training room: A seminar room where participants can experience the significance of safety activities

Training bridge (10m x 20m)



Hanging experience of a safety belt



Classroom seminar



Morning meeting practice



Practical training in applying organic materials



Practical training in installing bridge fall prevention equipment (at the training bridge)



Practical training in finding rebars location

Investigation / Diagnosis / Design Maintenance Technology Inc.

Overview of Maintenance Technology Inc.

Maintenance Technology Inc., established in 2011, is the only company in the Group engaging in construction consulting services. As of July 2022, the company has 23 employees and three sales offices: Tokyo, Nagoya, and Osaka. The breakdown of the company's operations is 75% consulting services and 25% operations within the Group. The consulting services include investigation, diagnosis, analysis, and repair design of bridges, tunnels, and other public structures. The operations within the Group mainly include a shape measurement of structures using 3D scanners, a photographic measurement using digital cameras, and an analysis of SHO-BOND resin products.



Site investigation

Introduction of Operations

The following are two representative operations of Maintenance Technology Inc.

1 Structure Measurement and 3D-CAD Data Preparation Using 3D Scanners

Repair and reinforcement work consists primarily of installing or replacing members on existing structures. For this reason, accurate measurement is often difficult when existing structures have complex shapes or narrow spaces. In response to this problem, Maintenance Technology Inc. has begun using a recently developed high-performance 3D scanner device to measure the dimensional relationships of existing structures accurately, safely, and quickly. We also convert the point cloud data obtained from 3D scanners into 3D-CAD data to check the degree of interference between members and the scope of construction.



Structure measurement using a 3D scanner

2 Photographic Measurement Using Digital Cameras

As the scale of construction projects increases, it is difficult to ensure measurement accuracy using the conventional method of manually measuring the drilling position of concrete. Accordingly, we calculate 2D and 3D coordinate positions using photographic measurement technology with a digital camera to accurately determine the coordinate positions to be found, such as the drilling position of concrete. Based on the measurement results, members are manufactured in factories.



Photographic measurement



The above two measurement operations involve technologies for accurately measuring existing structures, which are very important for repair and reinforcement work. We will stay up-to-date with the latest trends in new technologies, and contribute to improving the construction quality on sites.