International Press-in Association
www.press-in.org

News Letter

Volume 3, Issue 2 June 2018

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Editorial Board

Messages from Director

Prof Koichi Maekawa

Department of Civil l Engineering
Yokohama National University

I am so pleased to write my message in this issue of the IPA Newsletter as one of the directors of the Association. In 2005, I could have the first technical contact with Giken with the introduction of Prof. Dr. Hajime Okamura, former President and Chairman of Kochi University of Technology. At that time, I and my colleagues were developing the method to assess the safety and long-term serviceability of underground RC-PC structures. The Press-in Pile driving system which I saw at site was a great impact, and President Kitamura showed his idea to visualize the ground by means of the silent piling.

This idea attracted me so much, because I was involved in visualizing the kinetics of gravels' particles inside fresh concrete in the process of developing self-compacting concrete headed by Prof. Okamura in 1980s. Though the technical communication with Giken over the year and collaboration with Dr. T. Uchimura at the University of Tokyo (current: Saitama University) , data assimilation of the numerical model and Press-In data at site was conducted. Through these experiences, I could learn a lot about the common mechanics of soil foundation and fresh concrete. Thanks to this, I could also expand technical views with great pleasure. Afterwards, my students of concrete engineering and construction could join seminars, workshops and symposiums organized by IPA, the greatly open mind body.

Currently, I am serving as a Chair of some committees and projects on productivity improvement of concrete design, construction and maintenance in practice. Here, the smooth installation of machine and information technology is one of core issues. As a matter of fact, past great innovation and core technology were realized with open minded integrated ideas (Fig. 1). I can say that IPA technology and their deep knowledge are one of top runners and I expect the Press-in and IPA will play a leading role to reform the construction industry for sustainable upgrading of the worldwide.

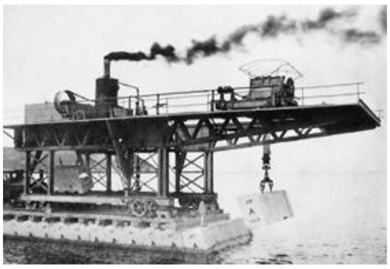

Fig. 1 Innovated machine (steam engine named Titan)-segment construction system for beak water at Otaru Horbor in 1890s: The first massive infrastructure of the modern Japan. (Photos from Hokkaido Agency Civil Engineering Department)

◆A brief CV of Dr. Kochi Maekawa

Dr. Koichi Maekawa is a professor of civil engineering at Yokohama National University and a professor emeritus of the University of Tokyo. His major is concrete engineering and construction, hydro-mechanics and the mo-dynamics of cementitious composites, and the principal developer of the computer code named DuCOM-COM3D and WCOMD platforms. He serves as a Chair of Concrete Committee of Japan Society of Civil Engineers (JSPS) and was the former Vice President. Dr. Maekawa is steering the Council on productivity improvement of concrete works in practice under the Japanese Government, and asset management team in Strategic Innovation Program (SIP) under the Cabinet Office. He is a member the 25th term of Japan Science Council and its Vice Chair of Civil Engineering and Architecture Committee.

Message from Director

Dr. Dang Dang Tung

Faculty of Civil Engineering
Ho Chi Minh University of Technology, HCMC, Vietnam

I am pleased to write a message for the present issue of IPA Newsletter. My involvement with IPA dates back to July 2014 in Kochi, Japan, where I attended the Press-in Seminar. I then coordinated the 5th IPA Workshop held in Ho Chi Minh City, Vietnam in December 2014. The Workshop speakers included lectures from both Vietnam and overseas and was well attended by practicing engineers from the government authorities, consultants and contractors from Vietnam.

I also co-organized the seminar on “Applying steel sheet-pile as permanent structures”, collaborated by Technical Committee 3, IPA and Ho Chi Minh City University of Technology in October 2017 in HCMC University of Technology (HCMUT). The seminar was also supported by Vietnam – Japan Civil Engineering Collaboration Promotion Center (VJCE) known as a branch of Japan Society for Civil Engineers (JSCE) in HCMC. The participants consist of university lectures, Japanese companies, domestic companies and students. Through the seminar, many Vietnamese and Japanese experts had good chance to share their experiences and to discuss research proposals in order to find out suitable solutions for the development of Vietnam's infrastructure. The use of press-in technology in Vietnam is still poor. Vietnamese contractors have been using press-in technique recently with standard press-in machines employed in some projects. In near future, with more powerful press-in machines available, I hope that Vietnamese engineers will employ the powerful machines to install sheet piles and steel pipe piles in soft ground conditions with success in Mekong river delta.

Seminars and workshops can be held to share the advancement of the technology and highlighting projects that press-in technology is superior to other conventional methods. Cost is a often a great concern in construction projects, I hope to relate the message to all stakeholders including government authorizes, consultants and contractors that one should look construction as a whole including safety, stability, time, environment and cost to arrive at the most optimum solution for construction.

In view of the above, currently I am working with engineers in Vietnam to evaluate the efficiency aspects of press-in piling versus existing piling methods. I hope to share with you on the findings in the near future.

◆A brief CV of Dr. Dang Dang Tung

Dr. Dang Dang Tung is a lecturer in Faculty of Civil Engineering and Vice Director of Office for International Study Programs, Ho Chi Minh City University of Technology, Vietnam. He graduated from Nagaoka University of Technology with Bachelor in Civil Engineering and took the Doctoral Degree in Nagaoka University of Technology in 2007. He has taken on the research and development on the bridge engineering for many years and engaged in a lot of committees of governments and academic societies. He is now the co-director of Vietnam – Japan Civil Engineering Collaboration Promotion Center (VJCE) known as a branch of Japan Society for Civil Engineers (JSCE) in HCMC.

Special Contribution

Innovative management system for infrastructure by utilization of 3D point cloud data based on GIS platform

Dr. Hiroshi DOBASHI

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The Metropolitan Expressway Co., Ltd.
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In recent years, much of the infrastructure that was constructed in the high-economic-growth period in Japan has begun to age. At the same time, the number of maintenance engineers for this infrastructure has become insufficient due to a decrease in working-age population as well as budget deficits. With respect to the large change in the social environment as described above, the advanced maintenance system of the infrastructure should be developed and required to improve efficiency and accuracy of maintenance works on roads and other structures, based on the platform utilizing GIS (Geographic Information System) and the point cloud data. By using this innovative system, a variety of data related to structures such as drawings, inspection results and repairs or reinforcing records are managed easily through a digital map on the GIS. This developed system also offers the function to create 2-D and 3-D CAD data or FEM models, and simulations of inspections and repair works, utilization of the 3D- point cloud data measured by an MMS (Mobile Mapping System). In addition, the deformation of structures detected by using the 3D-point cloud data has been examined and the accuracy of deformation verified. This paper describes the innovative management system based on the GIS platform to support maintenance work on infrastructures using the point cloud data.

Keywords: infrastructure, maintenance, point cloud data, GIS, MMS (Mobile Mapping System)

1. Introduction

In recent years, much of the infrastructure such as roads, bridges and tunnels that was constructed in the high economic growth period in Japan has begun to age. In addition, the number of inspection and maintenance engineers for this infrastructure will become insufficient based on the estimation of future working-age population by the Ministry of Internal Affairs and Communications, as well as the issue of budget shortages. In order to solve the above issues, an innovative management system for infrastructure based on the GIS platform has been developed.

The computerized system named as “InfraDoctor” which is a core technology of the innovative management system, will be able to improve efficiency and accuracy of maintenance works on roads and structures, utilizing GIS and the point cloud data. By using this system, a variety of data related to structures such as drawings, inspection results and repair or reinforcing records can be handled on a digital map of GIS. This system also has the ability to create 2-D and 3-D CAD data and FEM models for structural analyses and deterioration prediction analyses, and to simulate the inspection and repair works with utilization of the point cloud data measured by an MMS. Furthermore, inspection work can be carried out efficiently with accuracy by detecting the change in displacement or damage of structures using point cloud data measured over a certain period. In this paper, various functions of the “InfraDoctor” are introduced and innovative management system for infrastructure named “i-DREAMs” (intelligence-Dynamic Revolution for Asset Management system) which has been implemented by the Metropolitan Expressway Co., Ltd. since August 2017, is described.

2. Outline of InfraDoctor

The “InfraDoctor” has been developed to improve efficiency and accuracy of maintenance works on structures such as roads, bridges, tunnels, buildings and so on, utilizing the GIS platform and 3D-point cloud data. This computerized system consists of the following elements.

2.1 GIS platform

The “InfraDoctor” is based on the GIS platform. In the portal of the system, a digital map is shown in the browser on the computer screen. Through this digital map on the GIS platform, any data such as various ledgers can be searched for easily and quickly.

The “maintenance ledger” has the information concerning the number, dimension and material of structures and appendages. The “inspection history ledger” has inspection-result records. The “repair history ledger” has records of repair and reinforcement works carried out based on the inspection results. All data in these ledgers has the coordinates and is connected to the digital map. This data can also be searched by using various keywords such as the name, type, material and so on, of the structures. Using other information connected to the searched data, they can be sorted easily and quickly for various purposes, such as confirming the quantity and locations of same-type structures or members, comparing between inspection results or repair work history, for example.

The point cloud data and the all-around video data which is described later, are also managed on the GIS platform and can be shown on the computer screen by specifying the location from the digital map on the browser shown in Figure 1.

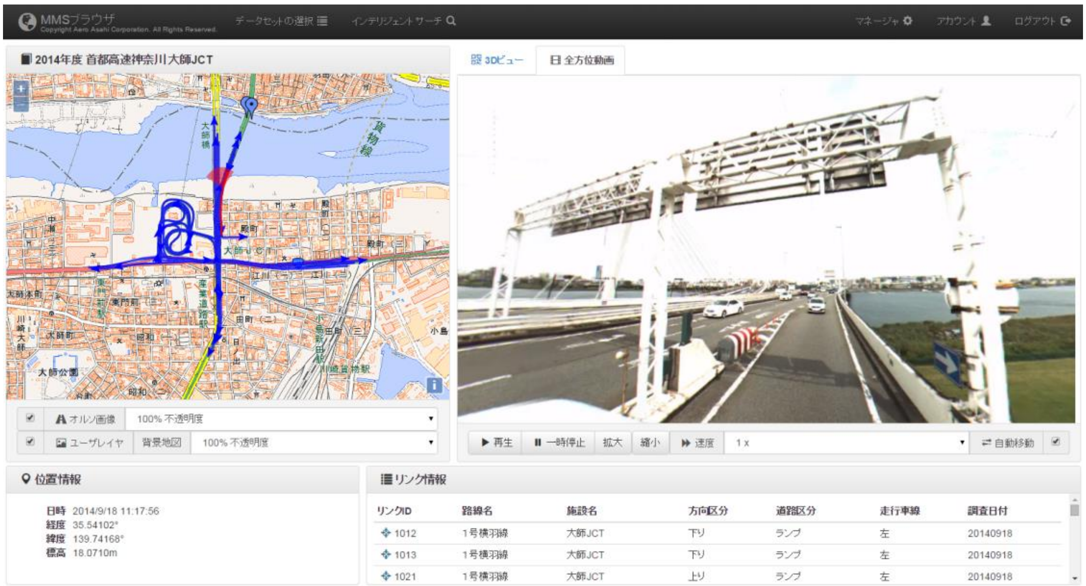

Figure 1 GIS browser with all-around video image

2.2 All-around video

All-around video images are captured using a vehicle called an “MMS” shown in Figure 2, while travelling. All-around video is recorded as still images at every 4m of interval when the vehicle with an MMS is travelling at 60 kilometers per hour. The resolution of an image is about 12 mega pixels.

Using this all-around video, the condition of structures and their surroundings can be confirmed on a computer screen without an actual investigation at the site. Because the all-around video enables objects on a road to be seen from not only the direction that the MMS is moving ahead but also any direction from the point of the MMS, the condition of the site can be grasped quickly and precisely at the office. Even the back of a sign board can be looked at, as seen in Figure 1, for instance.

Figure 2 Mobile Mapping System (MMS)

2.3 Three-dimensional point cloud data

Two laser scanners are installed on the MMS described above, and three-dimensional point cloud data are obtained while the MMS is travelling at a speed of 40km/hr. These laser scanners emit a million of the laser beams for a second and capture the position of an object which reflects the laser beams from the scanner. A laser beam can usually reach an object about 800 meters away from the MMS. The MMS also equipped with a GNSS antenna and an IMU, which stands for “Inertial Measurement Unit”, and the error of measured coordinates due to vibration or rotation of the vehicle are revised using those devices. In general, the degree of an error for coordinates of an object is about 10 centimeters for absolute value of position with respect to the surveying coordinate and a few millimeters for relative errors regarding the position of each point recorded in one measurement if the target is an expressway road bridge with a height of about 10m from the surface road. The degree of an error, however, is changed depending on the distance between the target object and the laser scanner, velocity of the MMS, the condition of road surface which affects the vibration of MMS, existing tall buildings or structures which interrupt or reflect radio waves for GPS antennae from satellites, and so on.

When a structure is modelled in three dimensions using the point cloud data, the vehicle with the MMS should be driven several times around the target structures to cover its blind spot. Therefore, registration is required to integrate those point cloud data groups measured separately. It has been confirmed that an error of a few tens of millimeters may occur during a registration work. In order to solve this problem, a program which can carry out the registration work while correcting the error automatically, is now under development and being prepared for commercialization.

The MMS is also equipped with some HD digital cameras and the color data of the image captured by those cameras can be exported to each point in the point cloud data. As a result, the point cloud data look like a video image as seen in Figure 3 and this makes it easier and more precise to recognize the shape and positional relationship of structures.

When the structures such as bridges are spanning over a wide river or existing in a mountainous area without roads available for the MMS, all the necessary point cloud data of a target structure cannot be captured. In these cases, a portable scanner fixed on a tripod, a human carrying type scanner or drone equipped with a scanner can substitute and the point cloud data captured by those different scanners can be integrated with that from the MMS.

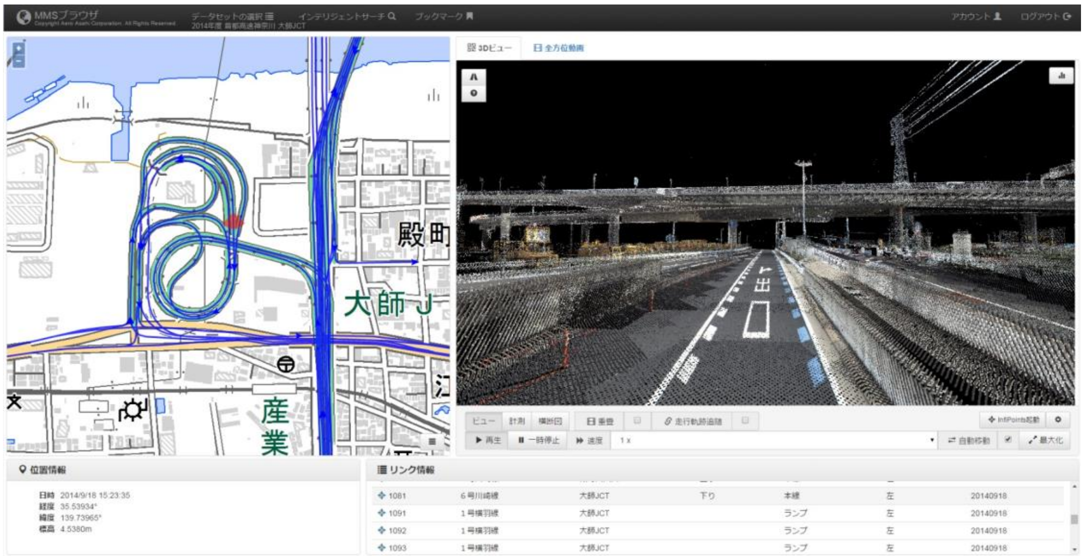

Figure 3 GIS browser with point cloud data

3. APPLICATIONS OF POINT CLOUD DATA

3.1 Detection of damage and displacement of structures

Since viaducts are above those intersections with heavy traffic or railroads, a remote inspection technique to detect damages where a close visual inspection is difficult is highly recommended, especially in urban areas to protect people from injury and cars from damages due to spalling and delamination of surface concrete. Therefore, a technology to detect spalling and delamination on the surface of concrete structures has been developed using the point cloud data, by taking the difference of positions between the measured points and a “reference surface” which is an average plane of the concrete surface created from the point cloud data. In addition, it is expected that the propagation of the damage will be also detected by comparing the point cloud data measured in time series.

In a trial measurement, some delamination on the concrete surface with 3 or 4 millimeters of protrusion were detected when measured by a scanner on the MMS about 10 meters away shown in Figure 4. In this trial, the point cloud data measured in one measurement was used to eliminate the error induced by the registration. A further study is still necessary to obtain higher accuracy with this remote inspection method. Moreover, it is also possible to find displacement, deformation or lack of the appendages, structural members or the structure itself when subjected to a large external force, such as a large earthquake or tsunami, by comparing the point cloud data measured after the event with the one formerly recorded.

3.2 Three dimensional measurements

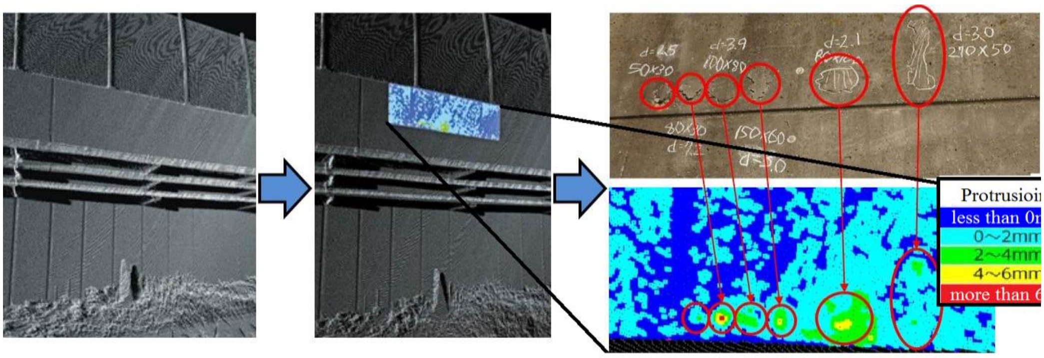

Figure 4 Detection of damage on concrete surface

It is possible to measure the dimension of and distance between structures in the 3D space created by the point cloud data on the GIS browser of the "InfraDoctor". Using this function, it is possible to confirm the positional relationship between structures where the traffic regulation is needed for measurement, and where inspectors cannot easily reach, or different organizations own. All the existing structures that are not described on the same drawing can be integrated and the construction space can be checked three-dimensionally for inspection, repair and reinforcement work, as well as both clearance between structures and the traffic clearance in this 3D space shown in Figure 5.

This digital platform also has a function to create a contour map by providing a color to each point sequentially different depending on its position in the height direction of the pavement for instance. From this contour map, the inclination and rutting depth on the pavement surface will be measured as shown in Figure 6, and the location of a ponding place or flooding range can be confirmed. As a result, these data show a reference for determining whether the road surface is required to be repaved or not and are stored in the inspection database corresponding to the GIS map information.

Figure 5 Clearance check in the space by point cloud data

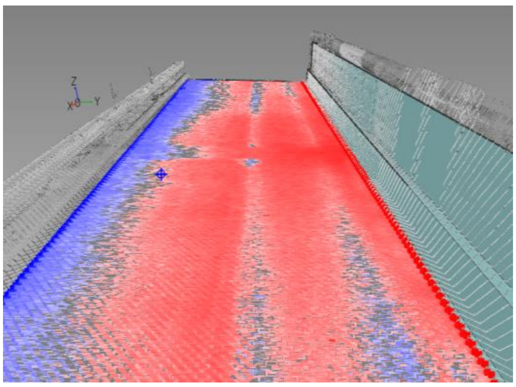

Figure 6 Contour of rutting depth on pavement surface.

3.3 Creation of two-dimensional CAD drawing

By extracting the point cloud data in each direction of the cross-section, it is possible to create a CAD drawing in two-dimensions. In conventional applications, a drawing is created by manually tracing the outline of the cross-section of the structure on the point cloud data. On the other hand, the "InfraDoctor" can automatically generate outlines of the cross-section of the structure and complete a drawing much easier and faster than the conventional method. Since each point of the point cloud data has a value in x, y, z-coordinates, the dimension and the distance of structures can be obtained at any section and a general drawing of a structure with the dimensions, as shown in Figure 7, can be generated semi-automatically in a short time.

In Japan, there are about 700,000 bridges with a length longer than 2 meters. However, it seems that the original drawings of approximately 300,000 old bridges among them may have been lost. This current situation is surely hindering maintenance work for bridges. In addition, since the appendages and the reinforcing members are installed on a structure after the construction is completed, these drawings are not often well conserved. In these cases, creating drawings of the current state of the structure using this computerized system will greatly contribute to the repair or retrofit design and efficient maintenance work.

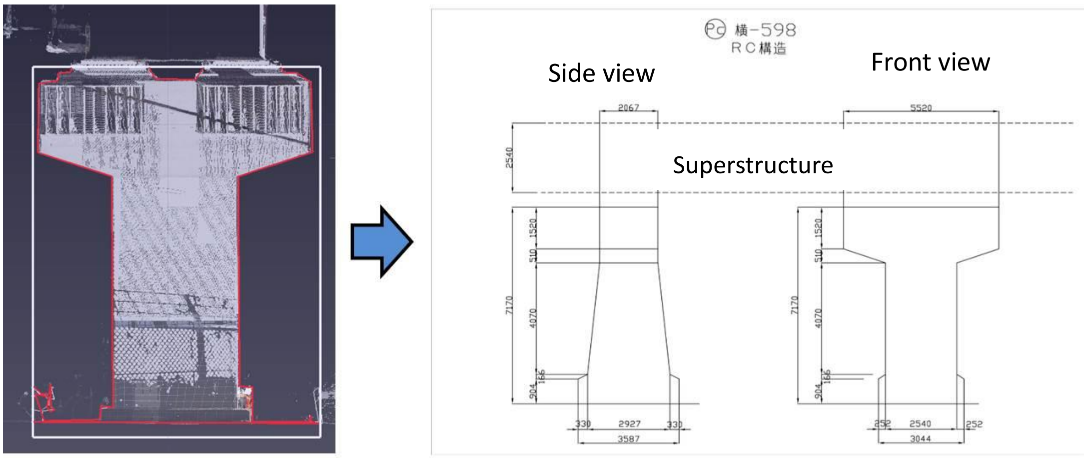

Figure 7 2D-CAD drawing created from 3D-point cloud data (bridge pier)

3.4 Creation of three-dimensional CAD model

Three-dimensional CAD model can be also created in a short time by automatically generating the planar or curved surface of a structure from the 3D-point cloud data, using the “InfraDoctor” as shown in Figure 8. This model will be used for three-dimensional structural designs and analyses. In addition, a three-dimensional FEA (Finite Element Analysis) model can be created from the three-dimensional CAD data by meshing automatically. Currently the development of three dimensional FEA is remarkable and it would be possible to estimate residual or ultimate strength, and degree of damage of structures. Combining with the inspection results which are used as the boundary condition in the FEA analysis, evaluation of the structure with high-precision can be carried out. Therefore, this function will be a great help to analyze the strength of a structure effectively and to carry out a design of repair, retrofit or reinforcement, using the obtained structures in the current situation with the damage or deformation caused by deterioration, natural disasters or other external loadings.

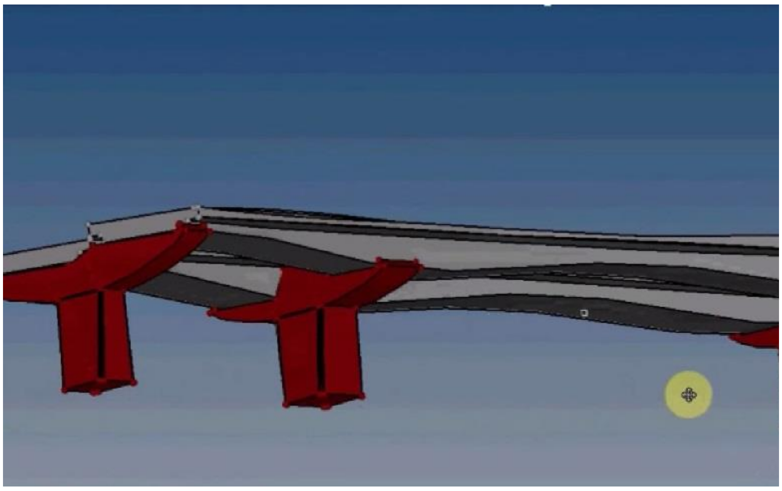

Figure 8 3D CAD model created from 3D-point cloud data

4. Smart Infrastructure Management System, *i*-DREAMs

To achieve the effective maintenance work with accuracy, various data made or obtained at the stage of survey, design and construction such as design statements, drawings, material data, methods or conditions of construction work, inspection results including construction errors, repair records before operation, are very much required. Combining the Construction Information Modeling (referred to as CIM) with “InfraDoctor”, the initial data required for the maintenance work will be transferred continuously from the design phase to the maintenance phase shown in Figure 9. As a result, comprehensive evaluation of deterioration and damage of the structures will be carried out based on the accumulated data of the platform. In addition, it is possible to integrate the database of inspection, repair and reinforcement into the use of ICT and IoT technologies on this platform.

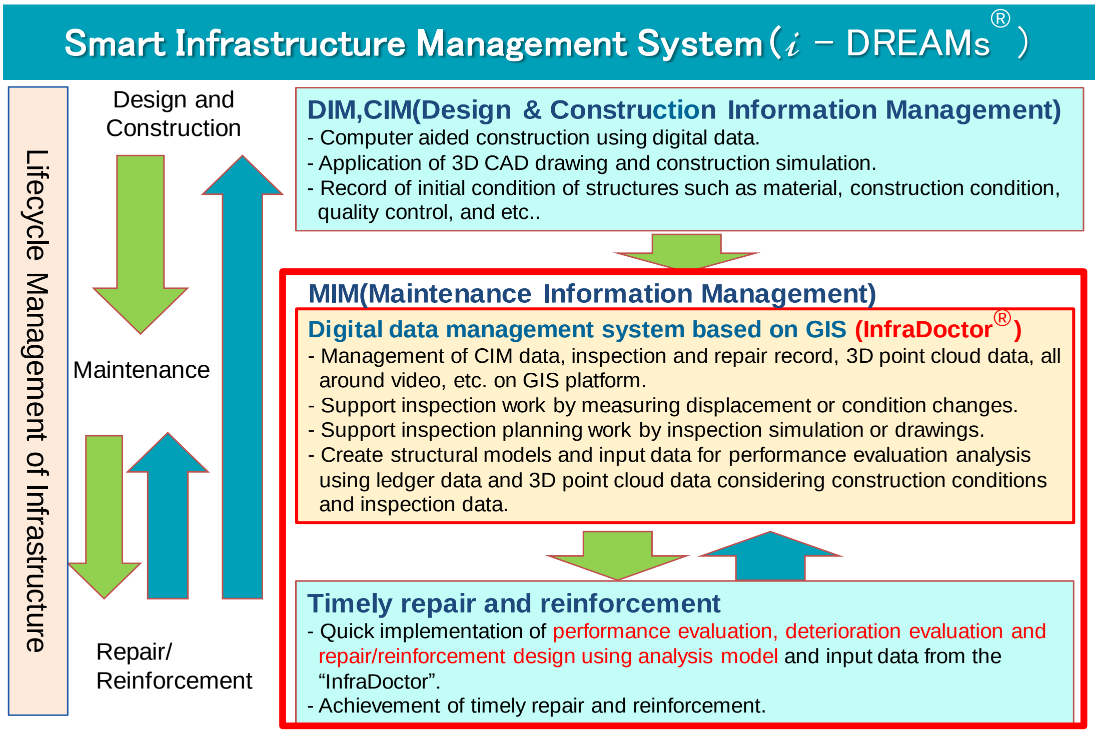

Figure 9 Future development for smart infrastructure management system

Making use of this initial data from CIM and the boundary condition obtained by inspection, a deterioration prediction, deterioration diagnosis and performance evaluation of structures with high-precision can be determined by making use of this initial data from CIM and the boundary condition obtained by inspection, and even by the structural analysis with FEM models generated by "InfraDoctor". Consequently, it is expected that proper repair and reinforcement at an appropriate time will be carried out, and efficient and smart maintenance work on infrastructure can be achieved. These experiences of infrastructure management can be applied not only to maintenance work but also to better design and construction. Furthermore, by processing the big data such as integrated data of traffic volume, axle weight and environmental conditions as well as inspection data, sensing data with the use of IoT (Internet of Things) utilizing AI engine, the innovative platform of *i*-DREAMs (intelligence Dynamic Revolution of Asset Management system) makes it possible to evaluate the damage and performance of structures efficiently with high accuracy shown in Figure 10.

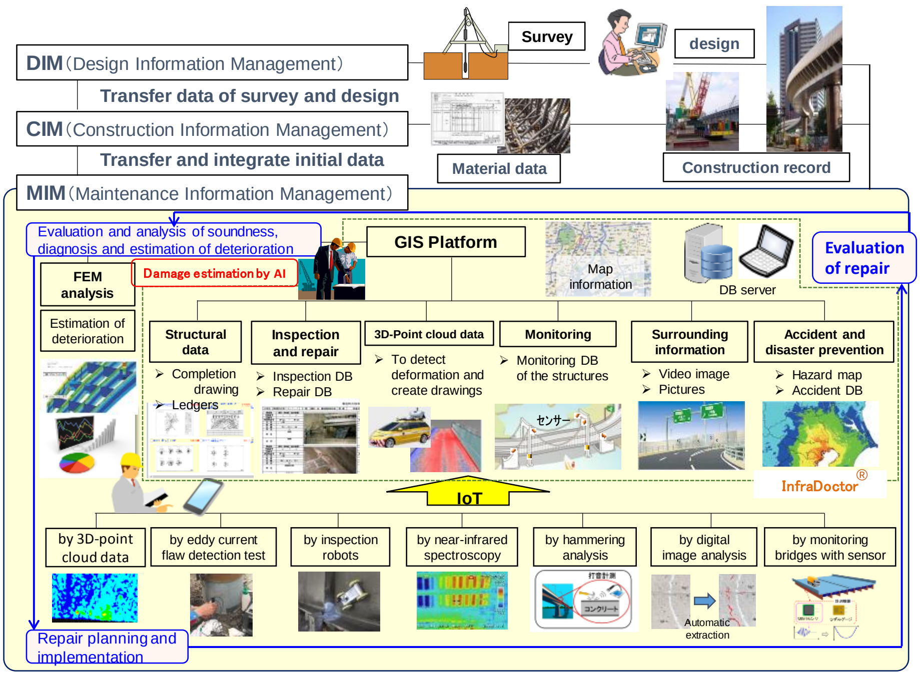

Figure 10 Innovative infrastructure management system (*i*-DREAMs)

5. Summary

Maintenance work of infrastructure has become increasingly important due to ageing, deterioration and severe use of structures. Periodical close visual inspection of road structures with every five years was legalized four years ago by the Japanese Government. However, there still exist areas where inspection is very difficult, and the number of inspectors is still limited due to a decrease in population, especially the working age population. Therefore, development of the advanced and innovative inspection technologies is required for accurate and efficient inspection as well as for education and training of inspectors.

For this reason, “InfraDoctor” has been developed as an advanced database system based on the GIS platform to support the maintenance work on road and structures, integrating various ledger data, the inspection data, and repair and reinforcement records of structures, all-around video and point cloud data. By utilization of this platform, the operation and maintenance work will be more efficient and laborsaving without sacrificing accuracy. In addition, the seamless infrastructure management system such as i-DREAMs combining with “InfraDoctor”, CIM and numerical analyses such as FEM, is a more integrated system which enables efficient maintenance of infrastructure. As a result, timely and appropriate repair and reinforcement of structures following deterioration diagnosis and prediction connecting with the initial data, the boundary condition such as inspection results and FEM analyses will be achieved.

The group companies of the Metropolitan Expressway Co., Ltd. are carrying out a trial operation of this platform to verify applicability and accuracy for the maintenance work in practical use. With the results of trial operation, the system will be further improved and implemented in the actual maintenance work. It is expected that this innovative GIS platform will contribute to efficient management of infrastructure not only in Japan but also in various countries around the world in the near future.

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A brief CV of Dr. Hiroshi DOBASHI

Dr. DOBASHI is a director, Maintenance and Traffic Management Department of the Metropolitan Expressway Company limited, Japan. He is currently in charge of maintenance work and traffic management service of the Metropolitan Expressway. He has developed an innovative infrastructure management system to achieve comprehensive management of infrastructure. Especially he specializes in the field of tunnels. He has developed the shield tunnel enlargement method, the first of its kind in the world.

Case-history

Steel Tubular Pile Cofferdam Foundations in Bangladesh

Mr. Tsunenobu Nozaki

General Manager
International Construction Design and Planning Department
Giken Ltd.

1. Introduction

The Japanese ODA loan project, named the Kanchpur, Meghna and Gumti 2nd Bridges Construction and Existing Bridges Rehabilitation Project, was undertaken in Bangladesh. This is the biggest ODA project ever, in Bangladesh, which aims at shortening travel times and increasing the freight capacity of Dhaka-Chittagong National Highway No.1 (NH-1).
The project involves the rehabilitation and retrofitting of existing bridges and the construction of 2nd bridges alongside the existing bridges. In order to construct high quality infrastructures, Japanese technologies, such as Tubular Pile Cofferdam Foundations and narrow box steel girder type monolithic with Steel Concrete Composite Slab, were adopted on the project. In this report, the Tubular Pile Cofferdam Foundation and the selected construction method, "The Press-in Method", are highlighted.

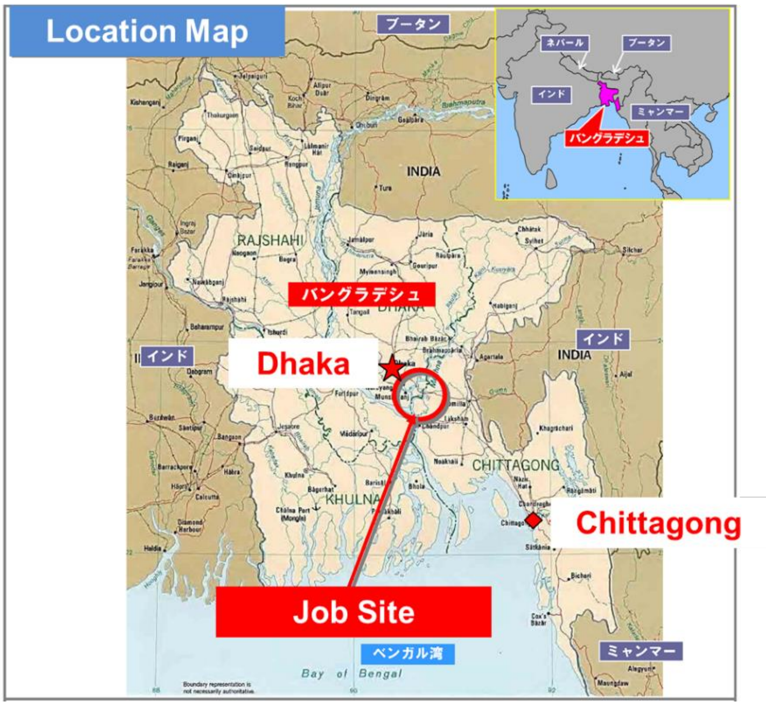


Fig 1 Project Location Map

2. Background of the Project

In Bangladesh, the economic growth was steady in the 2000's, maintaining a GDP growth rate of around 6% per annum. The amount of freight has increased at a rate of 6-7% in recent years at the same pace as the GDP growth.

<u>Profile of Bangladesh</u>
Population: 159M (the 8th largest in the world), Land area: 147,000 square kilometers, GDP: 227.9B US dollars.

<u>Reasons for Project Demand</u>
1) Substantial shortage of capacity for present and future traffic demand
The traffic capacity on the main roads connecting the major cities and metropolitan areas in Dhaka cannot keep up with the year-after-year increase of traffic volume, and eliminating bottlenecks on distribution routes is the major priority.

The NH-1, namely the Dhaka-Chittagong Highway, is the lifeline for the economy of Bangladesh. The capacity, Annual Average Daily Traffic (AADT), of the NH-1 is 25,000 vehicles. The NH-1 will be a part of the Asian Highway that connects with neighboring countries. Along this highway, the existing Kanchpur, Meghna and Gumti Bridges are major structures which cross the Lakhya, Meghna and Gumti Rivers. The Government of Bangladesh has planned to widen the NH-1 into 4-lanes in order to increase traffic capacity and remove traffic bottlenecks in the earthwork section. However, these existing bridges remain critical bottlenecks hindering the widening of the NH-1.

In 2012, the Average Daily Traffic (ADT) of the NH-1 was 75,000PCU at the existing Kanchpur Bridge and 65,000CPU at the existing Meghna/Gumti Bridges. The amount of ADT has already exceeded its traffic volume capacity by more than 10% at the Kanchpur Bridge and 60% at the Meghna/Gumti Bridges. In addition, due to the increase traffic trend, the forecast traffic volume in 2025 will exceed capacity by 100% at the Kanchpur Bridge and 200% at the Meghna/Gumti Bridges. It is obvious that the existing bridges will fail to cope with the increase traffic volume of the NH-1. This will cause serious traffic congestion. Therefore, the construction of new 2nd Kanchpur, 2nd Meghna and 2nd Gumti Bridges became an essential issue.

2) Introduction of new seismic design standards

In addition, the "Bangladesh National Building Code (BNBC)" was implemented in 1993, and Bangladesh earthquake standards were raised in 2006, which mean existing bridges no longer meet the earthquake standards. The existing bridges were designed in accordance with the seismic coefficient of 0.05. The revision of the BNBC (2006) substantially increased the coefficient to 0.15. Therefore, the restoration and reinforcement of the bridges have undoubtedly become a pressing issue.

Thus, in June 2011, the Government of Bangladesh requested JICA to undertake a study for the repair and reinforcement of the existing Kanchpur, Meghna and Gumti Bridges on the NH-1, and the construction of the 2nd Kanchpur, 2nd Meghna and 2nd Gumti Bridges. The Kanchpur, Meghna and Gumti Bridges are important bridges, located on the NH-1 connecting Dhaka and Chittagong which is the key corridor that supports the economy.

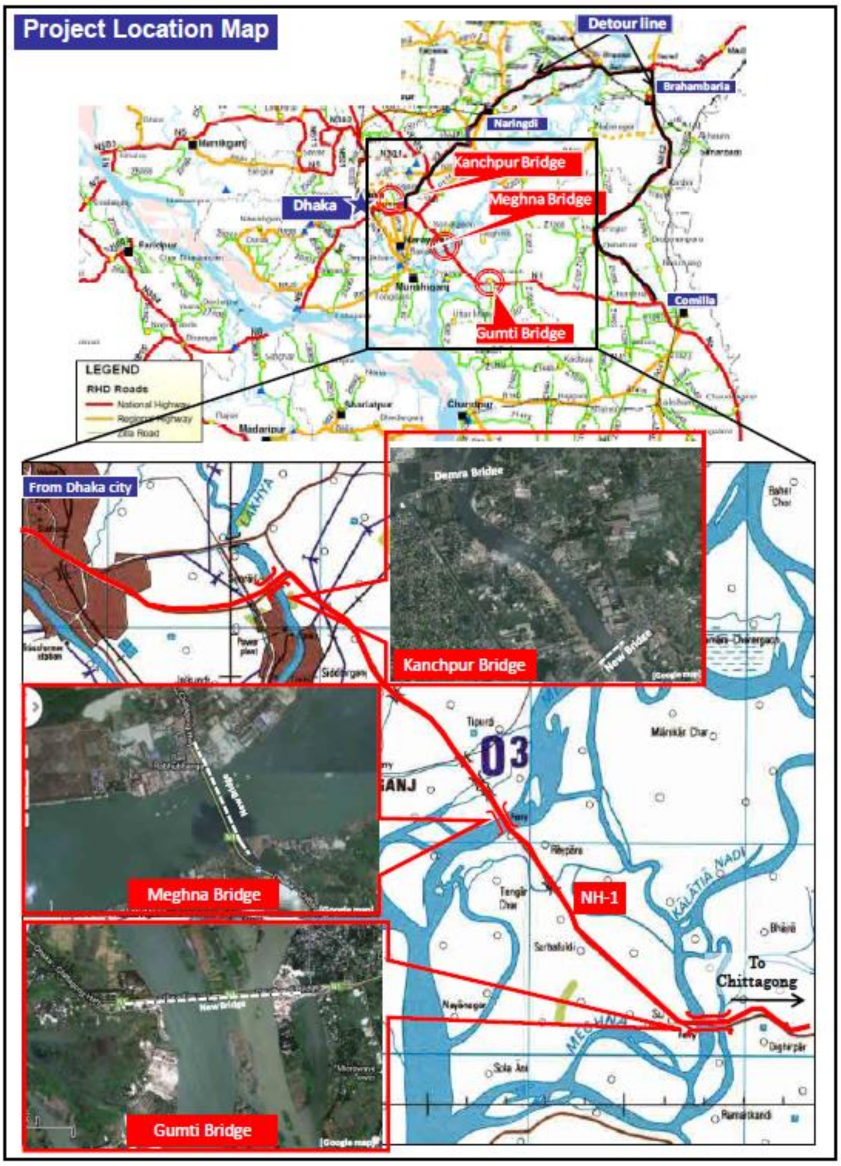


Fig 2 The NH-1 and Existing Bridges

3. Project Objectives

In accordance with the context of the preceding section, it was concluded that the three existing bridges needed to be retrofitted and three new 2nd bridges needed to be constructed to meet the increase traffic demand of the NH-1. As such, the overall objective of this project consists of the rehabilitation of the three existing bridges and the construction of three new 2nd bridges.

1) Construction of new 2nd Kanchpur, 2nd Meghna and 2nd Gumti Bridges to facilitate the increase traffic demand

Table 1 shows vehicle traffic forecasts and required additional lanes for the bridges. The traffic volume of the Kanchpur Bridge was 76,732 cars per day in 2012 and will be 123,301 in 2021 and 192,687 in 2030. This sharp increase requires an additional 4 lanes to the current 4 lanes. The traffic volume of the Meghna and Gumti Bridges was 65,008 cars per day in 2012 and will be 105,374 in 2021 and 165,168 in 2030. These 2 bridges also require an additional 4 lanes to the current 2 lanes. Therefore, the new 2nd Kanchpur, 2nd Meghna and 2nd Gumti Bridges are all designed as 4-lane bridges.

Bridge	Vehicle Traffic (cars / day)			Number of Lanes	
	2012	2021	2030	Current	Add
Kanchpur	76,732	123,301	192,687	4	+4
Meghna/Gumti	65,008	105,374	165,168	2	+4

Table 1. Traffic Demand and Traffic Forecast

Taking into consideration the above project objectives, a survey work was carried out in order to appraise the Japanese ODA loan that will cover the total project cost, the project implementation framework and the environmental and social aspects of the construction.

2) Retrofitting of the existing bridges

The three existing bridges are damaged due to the use of much overloaded trucks and the continual scouring on the bridge piers over time. At the same time, they were designed in accordance with the outdated seismic design standard and need to be upgraded using the new seismic design standard of BNBC (2006). The extent of rehabilitation of the existing bridges depends on the inspection and assessment of their above condition and retrofitting them to secure their reliability as bridge structures.

4. Outline of the Project

1) Project Name: The Kanchpur, Meghna and Gumti 2nd Bridges Construction and Existing Bridges Rehabilitation Project
2) Execution Agency: RHD (Bangladesh Roads and Highways Department) under Ministry of Communication
3) Main Contractor: Obayashi-Shimizu-JFE Engineering -IHI Infrastructure Joint Venture
4) Construction Budget: International Yen Loan of JPY29 Billion
5) Project Duration: 7 years and 8 months from December 2015
6) Duration of Piling Works: February to October 2017

5. Type of Foundation

In order to satisfy the design requirements, a “Steel Tubular Pile Cofferdam Foundation” was adopted on the project. A steel tubular pile cofferdam foundation comprises steel tubular piles with interlocks, which form an enclosed area. The wall acts as a cofferdam during the construction of the substructure and each interlock is initially emptied and filled with grout to provide necessary water tightness for the cofferdam. After dewatering and excavation to the required depth, the tubular piles are joined to the base RC slab as a permanent substructure. The tubular piles are then cut off at the top of the RC slab to allow water flow around the foundation.

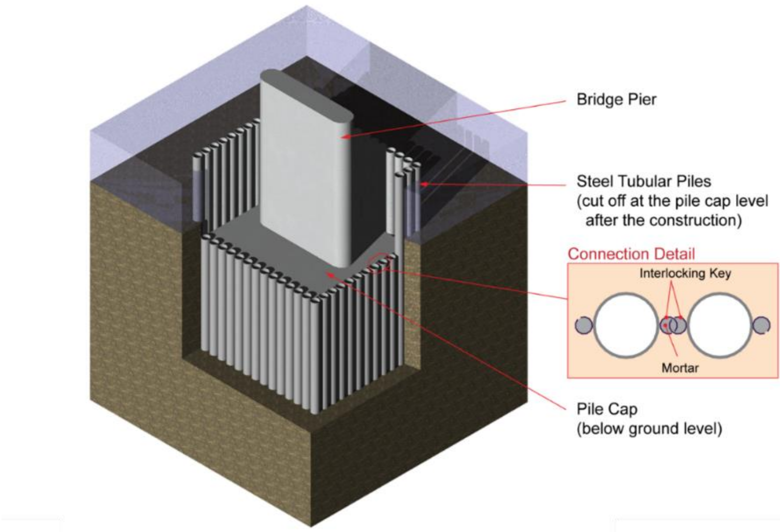


Fig 3 Overview of Steel Tubular Pile Cofferdam Foundation

The steel tubular pile cofferdam foundation originated in Japan and can achieve substantial cost savings for bridge foundations that need to be constructed underwater or under soft ground conditions. The main advantage of this foundation system it that it acts as both a temporary cofferdam and a permanent foundation, leading to a reduction in construction costs and time simultaneously. Also, this system is very effective as it provides anti-seismic reinforcement and scour protection for bridge piers.

Fig 4 shows the comparison of a steel tubular pile cofferdam foundation and a traditional RC pile foundation. New bridge piers are constructed adjacent to existing piers, enclosed with a shared cofferdam and joined together.

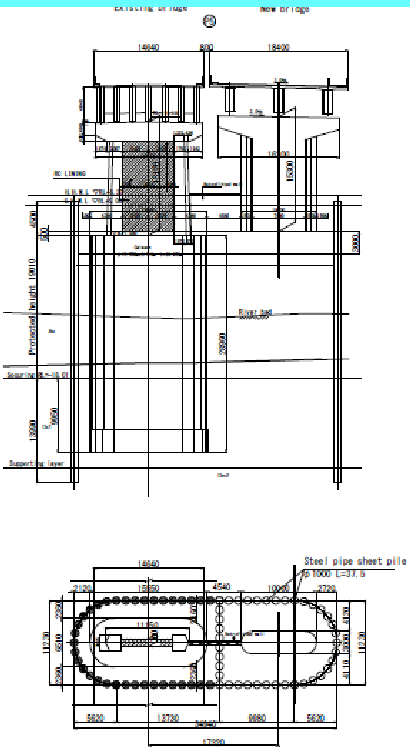
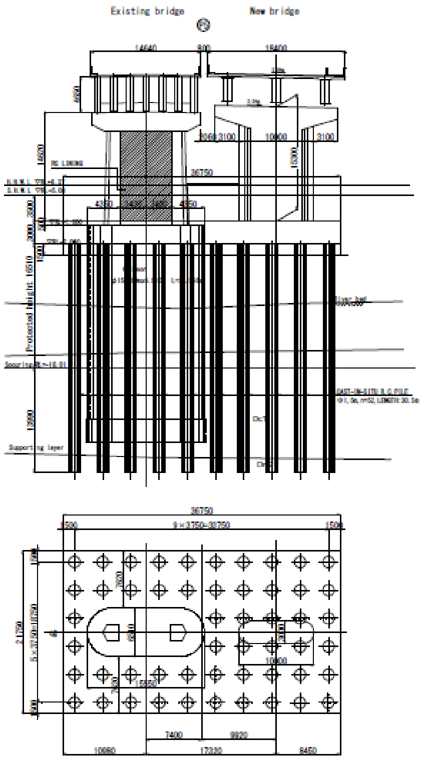
	Steel Tubular Pile Cofferdam Foundation	Plan B: RC pile
Image		
Cofferdam	Not required	SP
Foundation size	Small	Large
Cost	1.00	1.92
Evaluation	◎	

Fig 4 Comparison of Steel Tubular Pile Cofferdam Foundation and RC Pile Foundation

RC pile foundations require a temporary sheet pile cofferdam to provide a dry working space, for a piling machine to carry out RC pile installation in a water environment. Also, the footprint of the RC pile foundation is much larger than that of the steel tubular pile cofferdam foundation. This results in nearly twice as much construction cost and time using the RC pile foundation, compared to the steel tubular pile cofferdam foundation, on this particular project.

6. Overview of the Foundation

1) Kanchpur Bridge. (Fig 5)

Bridge Length: 400m with 6 piers.

Steel Tubular Piles: 352 no. 1,000mm diameter tubular piles L=28m - 41.5m

Existing Bridge

Completion Image

Fig 5 Kanchpur Bridge

2) Meghna Bridge. (Fig 6)
Bridge Length: 930m with 11 piers.
Steel Tubular Piles: 765 no. 1,000mm diameter tubular piles L= 45.5m - 56m

Existing Bridge

Completion Image

Fig 6 Meghna Bridge

3) Gumti Bridge (Fig 7)
Bridge Length: 1,410m with 16 piers.
Steel Tubular Piles: 510 no. 1,000mm diameter tubular piles L=41.5m - 55m (6 piers only)

Existing Bridge

Completion Image

Fig 7 Gumti Bridge

7. Ground Conditions and Pile Installation Method

The typical ground condition on this project is layered soil, comprised of clay, silt and sand as shown in Fig 8. As the maximum SPT N value exceeds 30 or 50, the Press-in with water jetting mode was utilized.

1) Ground Conditions

Kanchpur Bridge (Nmax>50) | Meghna Bridge (Nmax<50) | Gumti Bridge (Nmax>50)

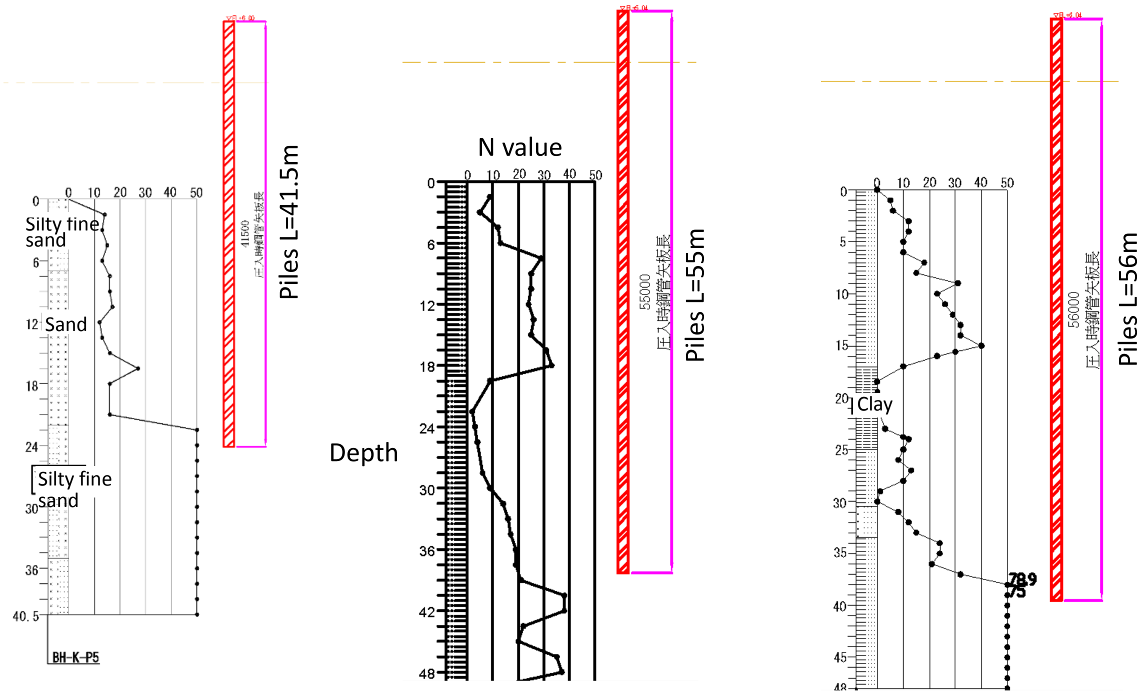


Fig 8 Typical Borehole Logs

2) Pile Installation Mode

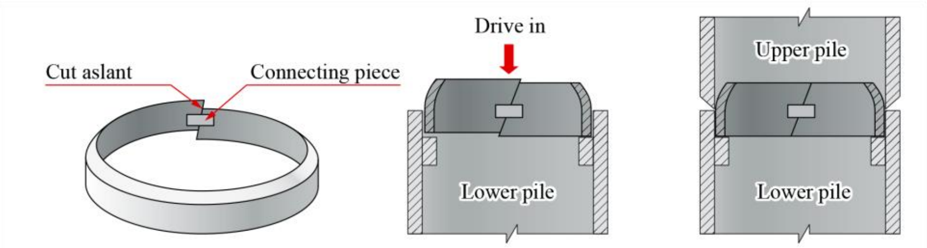
When the ground is medium dense/stiff or denser/stiffer, pile installation by the standard Press-in Method can be difficult due to the increase of installation resistance. The water jetting mode is suitable for dense or stiff ground conditions with STP N value of up to about 50 or undrained compressive strength Cu of up to about 150kPa. The water jetting can minimize the tendency of pressure bulbs and pile plugs, which are created at the pile toe during press in operations. At the same time, the water jetting can temporarily reduce skin friction during pile installation. The operation of Press-in with Water Jetting comprises the Silent Piler, the Piler Jet Reel atop the Silent Piler, the Power Unit of the Silent Piler and the Water Jet Unit, as shown in Fig 9.

Fig 9 Machine Layout of Press-in with Water Jetting

3) Overhead Clearance Method

On such projects, the steel tubular cofferdam foundations are installed within a low headroom under the existing bridges. Therefore, during pile installation work, after the bottom pile is installed, the next pile is spliced atop. This process is repeated until the full length of pile is installed. On these projects, the traditional circle welding method was utilized to spliced piles. Before the steel tubular piles were delivered, they were cut into designated lengths in accordance with the available overhead clearance under the bridges. The bottom of each upper spliced pile was beveled to allow full penetration butt welding with multiple passes. At the splice joint inside each pile, a backing strip is tightly fitted prior to welding. This provides support for a fully penetrated root pass. The circle welding is carried out in the vertical position and care should be taken to prevent the overflow of welded material. A temporary copper strip is attached to the top of the lower pile, to help to prevent this overflow. Some of the details of the execution of the projects are given in Fig 10 to Fig 13.

<u>Details of Backing Strip</u>



<u>Details of Copper Strip</u>

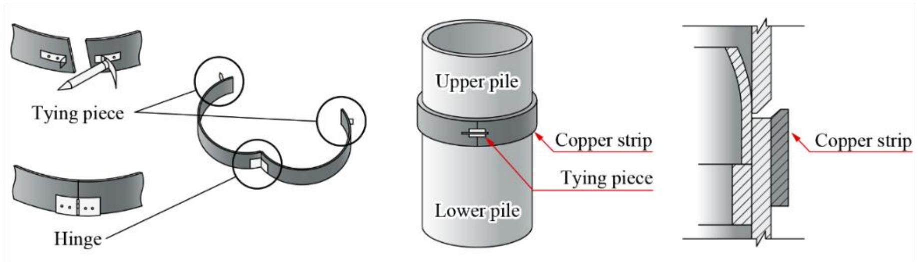


Fig 10 Preparation Details for Circle Welding

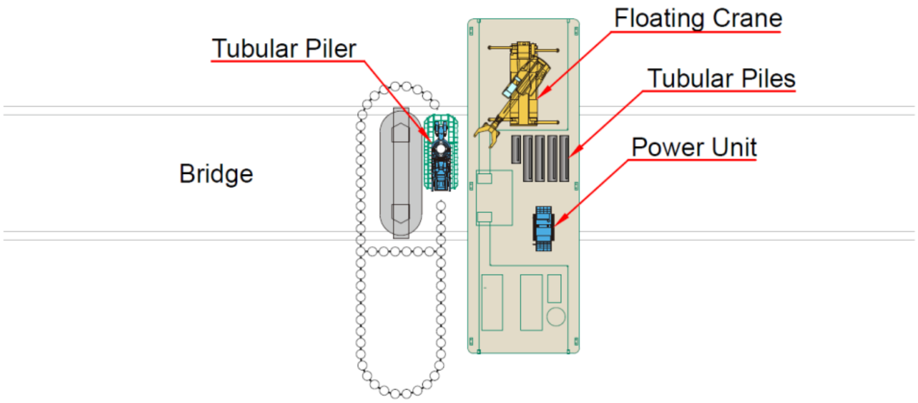


Fig 11 Machine Layout (Plan)

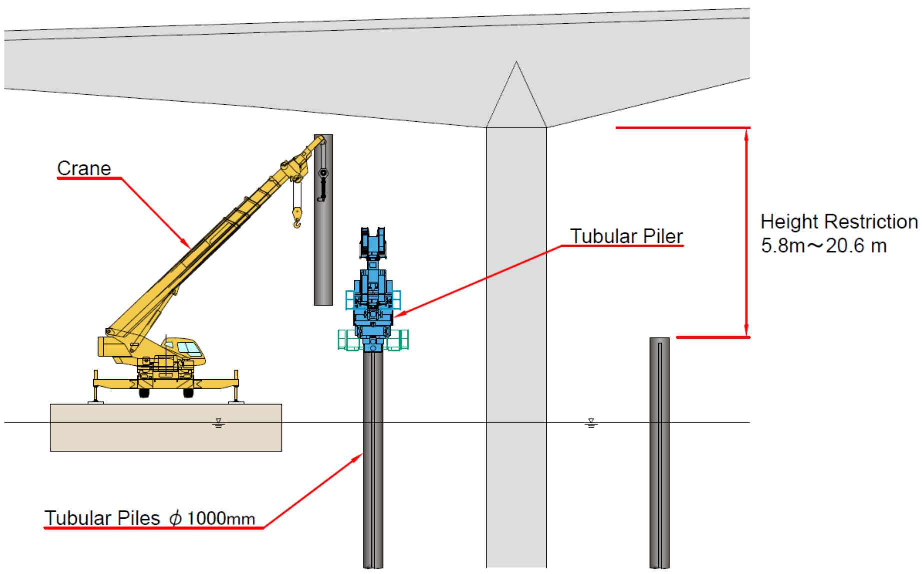
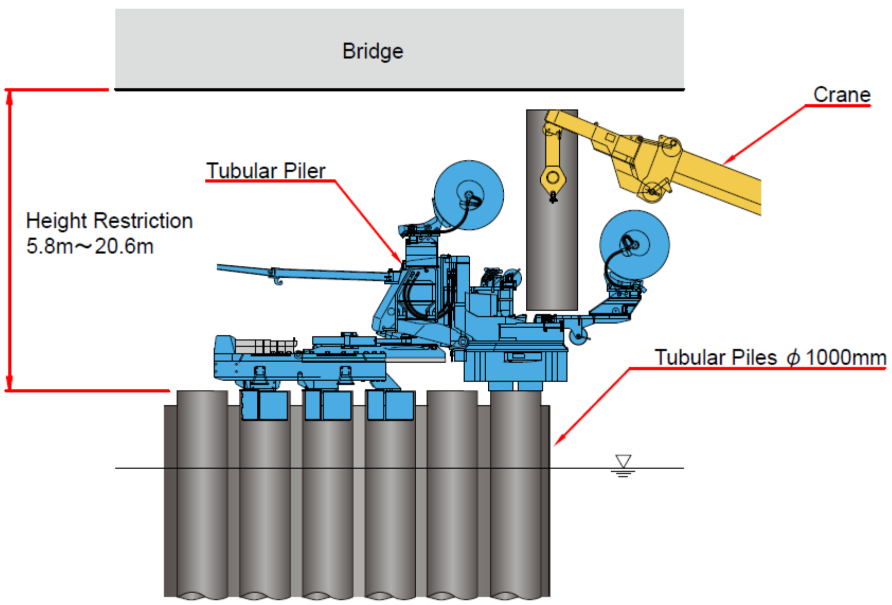


Fig 12 Machine Layout (Front View)



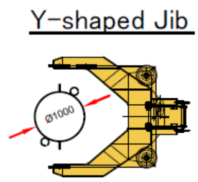


Fig 13 Machine Layout (Side View)

8. Conclusion

In urban construction scenarios, working conditions are much more complicated when upgrading/retrofitting infrastructures as the construction often needs to be carried out adjacent to existing everyday activities. Also, space limitation as a result of existing infrastructures is especially hindering on foundation construction, as it usually restricts implementation of the works.

Steel tubular pile cofferdam foundations are effectively used not only for new bridge foundations, but also these types of bridge foundation retrofitting works. This simple and effective solution enables bridge foundations to be constructed within a minimal period of construction time. With the Press-in Method, steel tubular pile cofferdam foundations can be constructed under extremely restricted working conditions, such as overhead restrictions, restricted working platforms or hard ground conditions without impacting on the surrounding environment.

In the service phase, functional adaptations of infrastructures may be required due to a higher demand of functional requirements, shorter structural lifetimes than planned or the necessity of further usage of the same structure at the end of its planned life. To meet the functional adaptations, traditional structures with the "Scrap & Build" design concept ultimately need high renovation construction and demolition costs. However, with the above combination, structures can more effectively and efficiently satisfy the stipulated functional adaptation. Therefore, the total investment costs i.e. construction, operational, maintenance, renovation construction and demolition costs can meet the optimum cost/quality balance.

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[1] Japan International Cooperation Agency: Website https://www.jica.go.jp/english/index.html
[2] Preparatory Survey for Dhaka-Chittagong National Highway No.1 Bridge Construction and Rehabilitation Project Final Report 55

Special Talk with a corporate member

IPA Secretariat

Dr. O. Kusakabe, the President of IPA interviewed Mr. David Liaw Wie Sein, the Managing Director of Guan Chuan Engineering Construction PTE Ltd., in Singapore, on April 24 Tuesday 2018 at IPA office in Tokyo.

Dr. Kusakabe: David, welcome to the IPA headquarters and I am very grateful for having this opportunity. IPA places a special importance on the role of operators in Press-in Engineering. Operators' experiences of solving unexpected difficult problems during piling operation and their feedback to project managers, geotechnical designers and machine designers plays an essential role for improving geotechnical design, mechanical design and satisfactory accomplishment of projects. That is why IPA newsletter includes on-site interview regularly, trying to convey messages from operators to IPA members.

Figure 1 Dr. O Kusakabe

Mr. David Liaw Wie Sein: Thank you for inviting me for the interview. I cannot agree more what you have said. Yes, I fully agreed that operators are taking the most important roles in piling projects.

Q: Let me ask, first of all, why you entered in piling business.

A: Having some working experiences in Hong Kong after my study at university, I joined the father's business. He was doing a bit of sheet piling business. When I took over his business, the major problems were dealing with hard ground. I have experienced some accidents as my dark side. In the 1990s, the most, I would say 70%, of accident caused on sheet piling works were toe failure due to insufficient penetration depth into the hard ground. I had gone through the stages where I used electric hammer, diesel hammer, and vibro-hammer, causing prolong vibration and noise.

Q: What is your view on those toe failures occurred?

A: I thought there are two major reasons behind there. First one is "poor workmanship" and second one is "poor machinery" to deal with hard ground. Then, I also learned through my experience that the design on sheet piling is the other problems too. Excessive design because of the designers' liabilities concerns and the deviation between design and construction site conditions are the essential reasons, I believe.

Figure 2
Mr. David Liaw Wie Sein

Nicoll Highway collapsed on 20 April 2004 was a very important wake-up call for Singapore Authorities and construction industry. Singapore learned from this bitter experience. The whole things were changed, and regulations became strict such as an allowable movement limit on Earth Retaining Structures. Concurrently, Building and Construction Authority (BCA) issued the new Submission Requirements and Procedures.

Then we decided to purchase a Crush Piler for sheet piling to deal with hard ground some ten years ago, though it was so expensive. Now we are an integrated design and build specialist in hard ground and sensitive environment piling work. Our website (http://guanchuan.com/) compiles completed projects, including Singapore General Hospital project as our remarkable one.

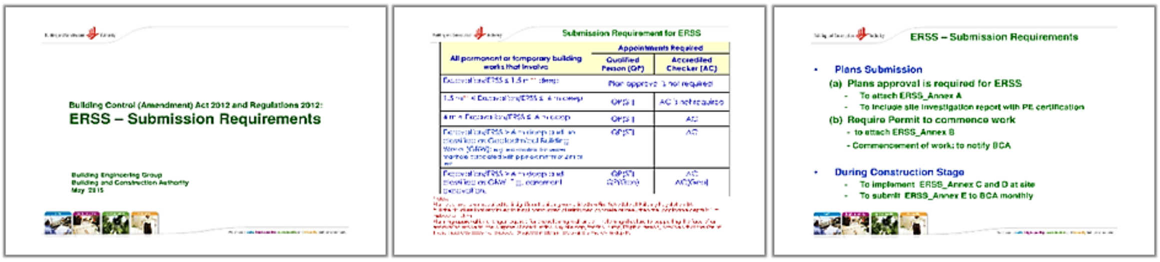


Figure 3 Submission requirement for Earth Retaining Stabilizing Structure (ERSS) issued by BCA

Figure 4 Singapore General Hospital

Q: What is your opinion to deal with those criteria?

A: As I said, toe failure is the biggest concerns and major cause of accidents, so my objective is to guarantee sufficient penetration depth with high quality of workmanship and machinery to satisfactory comply with the strict guidelines and regulations. In my view, the quality of workmanship by operators is very important not only for the proper piling execution under the constrained circumstances but for feedback of site conditions to the client and designers to minimize deviations in design and actual site realty.

Q: How do you train operators from the views of both skill-up and mindset?

A: I strongly believe that there are several key points for operators' skill-up. Firstly, the operators have to be skillful with good understanding on machine mechanism. Secondly, the operators should have basic understanding on soil characteristics and piling mechanism. Thirdly, the operators should have a right mindset to accomplish works safely.

In order to train operators and to share the same understanding of my company's' policy with operators, I hold "regular morning meeting" on a daily basis and also hold "internal weekly meeting" for problem finding and solving to share accumulated experiences among operators/workers who are actually conducting piling works on site. Further, I am very keen to provide continuous trainings for operators by the proper trainer deployed by the manufacture and I have continued this training every year ever since I purchased Silent Piler. I always made a request to the trainer to accurately evaluate our operators as his view. I also sent a few operators to the manufacture for initial training at the time. I guess this continuous training on operators is very essential not only to maintain the quality of operators since I employed many foreign operators but also to properly disseminate the Press-in Method in Singapore.

Q: Can you share with me of your company's achievement with introduction of some successful projects?

A: All the past projects are introduced on my company website at http://guanchuan.com/crush-piler-page1/ . My business philosophy is to produce the high quality of work with safety assurance for piling work, not a profit making.

As everyone is aware that Land Transport Authority (LTA) is the most stringent Government Authority in Singapore, may be in the world. One day, I was invited by LTA to present the project plan with pricing on the particular project under tough situation and I raised all concerns and predicted difficulties with my solution scheme in detail. As the consequence, my company was directly nominated by the Authority to be a specialty contractor without price negotiation even before a prime contractor was selected by bidding. Then, the Authority provided a special condition in the project specification to select my company to be a nominated subcontractor in the bid document for the selection of prime contractors. I was very proud of it and had a confidence on my approach.

I was also invited to IPA Workshop held in Singapore in 2012, a few years later I purchased a Crush Piler, and having an opportunity to introduce my experiences utilizing a Crush Piler in Singapore market. My speech was introduced as an article on newspapers and magazine so that I was able to demonstrate Press-in technology for hard ground and that was one of my good turning points to have a wider awareness of Press-in technology for hard ground.

Q: How do you foresee the future of Press-in technology?

A: This is the way to forward though it is still limited use in Singapore. But I believe that it is the matter of time to gain a wider acceptance of the technology. I must say that there is still a room, even in Singapore, to improve awareness of the Press-in technology. I set the business targets sharing with all employees including operators, which are accumulating “Self-confidence”, aiming for “Good achievement” without accidents, obtaining “Satisfaction” from Authorities and finally making “Contribution to society”

Europe and USA may have some difficulties, though. There are Union issue, strong vested interest on conventional methods and the maturity degree on codes and regulations in construction industry, in my view. Therefore, the other approach may have to be considered for positive acceptance of Press-in technology as compared to Asian region.

Q: What kind of messages do you want to convey to operators?

A: Again, I like to send a strong message to operators as “be responsible on quality of piling”, “proud of your skill with continuous effort to improve” and “maintain good mindset” as qualified operators. Again, as I mentioned earlier and agreed on Dr. Kusakabe’s view that operators’ role is very essential without any doubt.

Q: Considering the recent move to automated construction machine for higher productivity in the construction industry, it would lead to change of role of operators. What is your view on this?

A: I totally agree with your view. It is very essential issue to equalize quality with higher productivity. I believe that even achieving that direction, good feedback from operators and site engineers on design and further development on machineries are of essence.

David, I thank you to visit IPA headquarters today to share very valuable information and you’re thought on Press-in technology. Receiving of your message will be published on the next IPA newsletter then to be distributed over 2000 readers throughout the world.

Figure 5 Picture with Mr. David Liaw Wie Sein after the interview

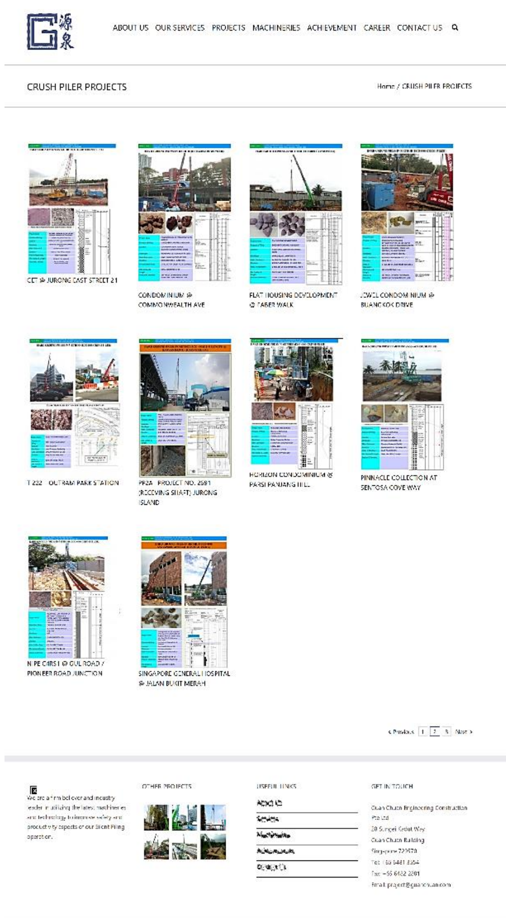
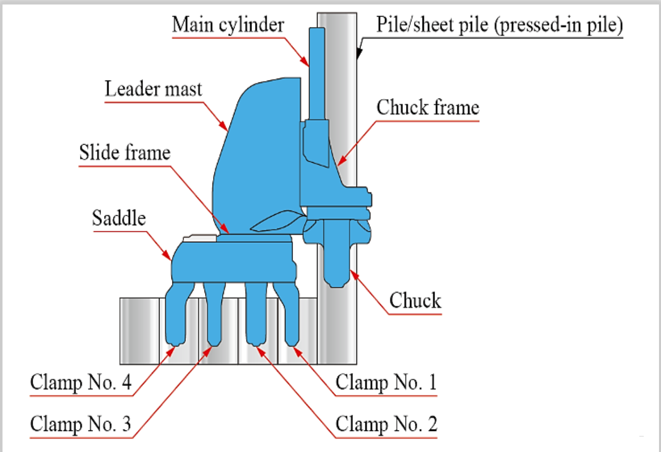


Figure 6 Guan Chuan Engneering Construction PTE Ltd. home page

Serial Report

Terminologies in Press-in Engineering (Part 2)

IPA Editorial Committee



The "**Press-in retaining structures: a handbook (First edition, 2016)**" was issued in December 2016 and the seminars on Press-in technology by utilizing this handbook were held 4 times in Singapore, Malaysia, Thailand and Philippines so far.

Following terminologies Press-in Engineering (Part 1) in Volume 2, Issue 1, Part 2 presents "Functions of each component on Silent Piler" as follows:

Functions of each component on Silent Piler

Components	Functions
Clamps	a component of Silent Piler for obtaining reaction force to press-in piles/sheet piles by clamping the previously installed piles/sheet piles (3 or 4 clamps, depending on the type of Silent Piler)
Saddle	a component to hold Leader mast with Slide frame and to connect with clamps.
Slide frame	a component to slide inside of Saddle and Leader mast are mounted. Function to decide the longitudinal location of the pile/sheet pile, sliding the leader mast in the forward/backward direction.
Leader mast	a component to guide pile/sheet pile for upwards and downwards movement with Main cylinder and to keep pile/ sheet pile in appropriate right and left direction. It is also a storage space for other mechanical and electrical components with important functions.
Main cylinder	Hydraulic cylinder to press piles/sheet piles into the ground by moving them up and down
Chuck frame	a component to hold rotating Chuck and move upward and downward together with Chuck by Main cylinder.
Chuck	a component of Silent Piler, which grips piles/sheet piles by claws to press piles/sheet piles into the ground. It can rotate inside of Chuck frame
Multi-purpose monitor	Monitor mounted on the side of Leader Mast to indicate the press-in force, inclination angle and the open/close state of Chuck for the operator to check the installation status during machine operation with either wired or wireless control device.

(to be continued on Part 3)

IPA News Letter Volume 3, Issue 2 June 2018

Event Report

IPA Seminar on Press-in Technology in Thailand

Dr. Pastsakorn Kitiyodom

Co-chair of Local Organizing Committees
Deputy Managing Director of Geotechnical & Foundation Engineering Co., Ltd.

The IPA Seminar on Press-in Technology was successfully held in Bangkok, Thailand, on 18 May 2018. The Seminar was organized by **the IPA Local Organizing Committee**, together with **The Engineering Institute of Thailand (EIT), Thailand Geotechnical Society (TGS), Thailand Underground & Tunneling Group (TUTG**) as the Co-organizer. Further, the Seminar received a strong support from **TEAM Consulting Engineering and Management Co., Ltd.** and **Geotechnical and Foundation Engineering Co., Ltd. (GFE)** and also received sponsorship by **GIKEN LTD.** and **Thai Fullmore Co., Ltd.** as Gold Sponsors.

Overview

Date:	18th May 2018, Friday 09:00 – 16:10
Venue:	The Engineering Institute of Thailand (EIT) 487 Soi Ramkhamhaeng 39, Ramkhamhaeng Road, Bangkok 10310, Thailand
Participants:	103

Local organizing committee (LOC)

Chair: Dr. Suttisak Soralump
(President of TGS)

Honorary Chair: Dr. Noppadol Phienwej
(President of the Southeast Asian Geotechnical Society – SEAGS)

Chair: Dr. Apichart Sramoon
(President of TUTG)

Co-chair : Dr. Pastsakorn Kitiyodom (Managing Director of GFE)

The Seminar was commenced with the opening address by Dr. Aphichat Sramoon, President of TUTG followed by the eight (8) meaningful presentations from various fields as follows:

Presentation 1 Title: "**Application of Physical Modeling on Retaining Structure**"
Lecturer: Dr. Jiro Takemura (Assoc. Prof. at Tokyo Institute of Technology IPA Director)

Presentation 2 Title: "**Overall current practice of piling work in Thailand**"
Lecturer: Dr. Wanchai Teparaksa (Assoc. Prof. at Chulalongkorn University)

Presentation 3 Title: "**Fundamentals of Press-in machine technology and Future potential projects in Thailand**"
Lecturer: Dr. Ittichai Boonsiri (Geotechnical Engineer at GFE)

Presentation 4 Title: "**Press-in Retaining Structures: A handbook (Design)**"
Lecturer: Dr. Jiro Takemura (Assoc. Prof. at Tokyo Institute of Technology / IPA Director)

Presentation 5 Title: "**Press-in machine usage experience in Thailand and difficult condition to be applied**"
Lecturer: Mr. Visanu Vivatanaprasert (Managing Director of Altemtech Co., Ltd.)

Presentation 6 Title: "**Press-in Retaining Structures: A handbook (Construction)**"
Lecturer: Mr. Kohei Takata (GIKEN SEISAKUSHO ASIA PTE., LTD.)

Presentation 7 Title: "**The Best Practice Notes for Water Jetting**"
Lecturer: Mr. Tsunenobu Nozaki (GIKEN LTD.)

Presentation 8 Title: "**E-site visit (Introduction of the Press-in applications)**"
Lecturer: Tomotaka Hirose (GIKEN LTD.)

Some presentations as collaborated efforts among industry-academia-government to introduce the current construction trends and concerns in Thailand were made by the invited local representatives and those presentations were conducted in Thai language for easier understanding.

Following those presentations, a guidance on the use of the "**Press-in retaining structures: a handbook (First edition 2016)**" which being published by the **International Press-in Association (IPA)** was presented by Prof. Takemura. This Handbook was published to update the latest development on Press-in technology with highlighting important issues regarding the both design and construction aspects of the Press-in technology. This Handbook consists of over 500 pages, stored in PDF form, and can be purchased on IPA website (https://www.press-in.org/en/publication/index/1) for JPY 10,000.

"E-site visit" as the Presentation 8 was conducted by the GIKEN LTD. staff with visual materials such as videos, computer graphics and pictures. These materials were well organized to demonstrate the various features of the Press-in Method as well as a mechanism of Press-in principles.

A discussion forum chaired by Dr. Pastsakorn Kitiyodom was held after the 8 presentation sessions. During the Forum, many questions were raised by the audience related to the construction and cost aspects of the Press-in technique. Questions raised by the audiences were comprehensibly answered by presenters for clear understanding.

As the last part of the seminar, the closing remark was addressed by Prof. Osamu Kusakabe, IPA President with expressing an appreciation towards the all participants, the Local Organizing Committee, supporters and sponsors for the successful Seminar. Also, an announcement of the next IPA Seminar to be held in the Philippines on 21 May 2018 was made.

Photo 1 Dr. Aphichat Sramoon (President of Thailand Underground & Tunneling Group) gave a opening speech

Photo 2 Prof. Jiro Takemura (Assoc. Prof. at Tokyo Institute of Technology / International Press-in Association Director) had a presentation

Photo 3 Prof. Osamu Kusakabe (The President of International Press-in Association) addressd a closing remark

Photo 4 Group photo of the IPA Seminar in Bangkok

Announcement

ICPE 2018

The First International Conference on Press-in Engineering

2018, Kochi, Japan September 19 to 20

Special Lectures

Title: "The damage due to the 2011 Tohoku earthquake and tsunami, and issues for their future mitigation"
Lecturer: **Fumihiko Imamura**
(Professor, Tohoku University/Director, The International Research Institute of Disaster Science)

Title: "Introduction of ICT to construction machines and advancement in construction technology"
Lecturer: **Kenjiro Shimada** (Team Leader, Komatsu Ltd.)

More Details

ICPE 2018,Kochi

Event Diary

Title	Date	Venue
■ IPA Events https://www.press-in.org/en/event		
International Conference on Press-in Engineering (ICPE) 2018, Kochi	September 19-20, 2018	Kochi, Japan
International Society for Soil Mechanics and Geotechnical Engineering http://www.issmge.org/events		
GEOTECHNICAL CONSTRUCTION OF CIVIL ENGINEERING & TRANSPORT STRUCTURES OF THE ASIAN-PACIFIC REGION	July 4-7, 2018	Yuzhno-Sakhalinsk , Russia
9th International Conference on Physical Modelling in Geotechnics	July 17-20, 2018	London, United Kingdom
5th GeoChina International Conference-Civil Infrastructures Confronting Severe Weathers and Climate Changes: From Failure to Sustainability	July 23-25, 2018	Hangzhou, China
11th International Conference on Geosynthetics	Sept. 16 -21, 2018	Seoul , South Korea
Urban Planning Below the Ground Level: Architecture and Geotechnics	Sept. 19-21, 2018	Saint Petersburg, Russia
■ Deep Foundations Institute http://www.dfi.org/dfievents.asp		
SuperPile 2018	June 27-29, 2018	New York, United States
Energy Foundations Seminar	Sept. 18, 2018	Chicago, IL
■ Construction Machinery Events		
11th China Leasing Summit 2018 http://www.duxes-events.com/leasecn/	June 21-22, 2018	Hangzhou, China
Project Lebanon http://www.projectlebanon.com/	June 26-29, 2018	Beirut, Lebanon
■ International Geosynthetics Society http://www.geosyntheticssociety.org/calendar/		
Geotechnical Construction of Civil Engineering & Transport Structures of the Asian-Pacific Region	Jul 4-17, 2018	Yuzhno-Sakhalinsk, Russia
■ Others		
2nd International Conference on Natural Hazards and Disaster Management	July 1-4, 2018	Melbourne, Australia

New Corporate Members

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Editorial Remarks

The Editorial Board is pleased to publish Volume 3, Issue 2 on schedule. This issue contains messages from Prof. Maekawa and Prof. Dang, directors of IPA, a case history report of Bangladesh application, and an event report of IPA Seminar on Press-in Technology in Thailand. It is the fist time to publish a special talk with an IPA Corporate member, Guan Chuan Engineering Construction PTE Ltd., in Singapore.

This issue also includes a special contribution about "Innovative management system for infrastructure by utilization of 3D point cloud data based on GIS platform" written by Dr. H Dobashi, The Metropolitan Expressway Co., Ltd., to which The Editorial Board is most grateful.

Please feel free to contact the Editorial board members below with email address or IPA Secretariat (tokyo@press-in.org) for your clarifications and/or suggestions.