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

News Letter

Volume 5, Issue 4 December 2020

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Messages
From the New Director

Anh Tuan Vu

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It is my great honour to be a Director of the International Press-in Association (IPA) since 2020 June. I have known IPA since 2014 when I was a doctoral student at Kanazawa University of Japan, participating in a workshop on the Press-in technology organized by IPA in Kochi prefecture. Since this event I investigated and gradually understood the important role of the Press-in technology in the construction industry.

A lot of people still remember the Tohoku earthquake in 2011 caused over fifteen thousand deaths and over six thousand injured persons. The tsunami caused by the earthquake overtopped and swept away gravity sea levees on the way of running, meanwhile, some implant structures remained stable. Since then, implant structures have been often applied in Japan to reduce disaster risks in preparation for possible huge earthquakes and tsunami in the future. Kochi prefecture is a typical example of applying implant structure to reinforce and improve the sea levee where Press-in technology is utilized. Due to significant contributions of IPA and GIKEN LTD., Press-in technology is well-known and applied in many countries. Several IPA workshops and seminars held in my country, Vietnam, with the participation of hundreds of engineers, researchers, constructors and governors have gradually improved awareness on pile installation and Press-in technology with concern in environmental protection, safety, speed, economy and aesthetics. IPA also organized a lot of conferences and seminars in other countries as Singapore, Malaysia, Thailand, Philippine, etc. to promote Press-in technology. From my point of view as a civil engineer, a lecturer and a researcher, Press-in technology has great opportunities not only in developing countries but also in developed countries where natural disaster mitigation and environmental protection are attracting interests of the state authorities as well as residents. As for designers and constructors, Press-in technology can bring optimum solutions regarding engineering technique, economy, environmental friendship, and aesthetics, and has advantageous in comparison with traditional construction methods.

Serving as a Director of IPA, I will do my best to support IPA activities, in which preparation for the publication of a handbook on Press-in technology in Vietnamese is a key mission right now. Contribution to organizing conferences and workshops, research collaboration is also important activity that I intend to carry out in future to promote Press-in technology.

◆ A brief CV of Dr. Anh Tuan Vu

Anh Tuan Vu got Bachelor degree from University of Transportation and Communication, Master degree from Le Quy Don Technical University in Hanoi, Vietnam and received Doctor degree from Kanazawa University of Japan. He has worked as a lecturer and researcher at Le Quy Don Technical University since 2006. He is also an executive committee member of Vietnamese Society of Soil Mechanics and Geotechnical Engineering (VSSMGE); Head of Member Developing Board of VSSMGE; a member of International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE).

Messages
From the New Director

Ramin Motamed

Associate Professor, Department of Civil and Environmental Engineering
University of Nevada Reno

As one of the New Directors of IPA, I am honored to write this message and provide a brief introduction about myself and my main areas of research. I joined the University of Tokyo (UTokyo) in 2004 as a PhD student and worked under the supervision of Prof. Ikuo Towhata to study the behavior of pile foundations subjected to liquefaction-induced lateral spreading using 1g shake table testing. During my PhD study at UTokyo, I had the opportunity to work on an exciting research project which involved the use of E-Defense shake table, the world's largest shake table testing facility, in which two full-scale tests were conducted on a group of six piles in laterally spreading liquefied grounds. In the first test, a sheet-pile quay wall was utilized to trigger large lateral movements of liquefied soil. The full-scale tests at E-Defense were followed by an extensive series of complementary medium-scale shake table tests at UTokyo in which I used sheet piles to model quay walls and also as a mitigation measure to reduce lateral forces on the pile groups. The results from my PhD research have been published in several journal papers during 2009-2013 in Soils and Foundations, ASCE Journal of Geotechnical and Geoenvironmental Engineering and Soil Dynamics and Earthquake Engineering. In 2010, I was awarded the prestigious Best Young Researcher Paper Award from the Japanese Geotechnical Society (JGS) for a paper on pile groups in liquefied and laterally spreading grounds.

Upon graduation from UTokyo in 2007, I was awarded the JSPS Postdoctoral Fellowship to join Tokyo Institute of Technology to work on the topic of train-induced ground vibrations under the supervision of Prof. Osamu Kusakabe. After about 2 great years at Tokyo Institute of Technology, I joined the international consulting firm Arup working briefly in its headquarter office in London, then moved to the San Francisco office in California where I spent about 3 years working on several landmark projects.

I joined the University of Nevada Reno (UNR) in 2012 as an Assistant Professor and was promoted to Associate Professor in 2018. Currently, I serve as the Associate Chair of the Civil and Environmental Department at UNR. My current research projects involve a variety of different aspects of deep and shallow foundations, LRFD, liquefaction and mitigation measures, and site response analysis. I am interested in researching the use of press-in technologies to reduce liquefaction-induced ground movement effects on the foundation systems.

In addition to IPA, I am a member of several deep foundation related committees such as Deep Foundation Institute (DFI)'s Seismic and Lateral Loads Committee and ASCE's Deep Foundations Committee. Finally, I would like to invite all the IPA members to consider submitting papers and attend the 46th Annual Conference on Deep Foundations which will be held in Las Vegas, Nevada during October 12-15, 2021. I am the Technical Program Co-chair of this conference which serves as the Deep Foundations Institute's annual conference in 2021.

◆ A brief CV of Associate Prof. Ramin Motamed

Ramin Motamed is an Associate Professor in the Department of Civil & Environmental Engineering at UNR. Prior to joining UNR, Dr. Motamed was an Engineer & Senior Engineer with Arup in San Francisco. In that capacity, he worked on a variety of high-profile projects in California and Nevada. Some of these projects include the Transbay Transit Center (San Francisco, California), War Memorial Veterans Building (San Francisco, California), Apple Campus 2 (Cupertino, California), Gerald Desmond Bridge (Port of Long Beach, California), California High-Speed Rail (California) and High Roller Observation Wheel (Las Vegas, Nevada).

IPA News Letter Volume 5, Issue 4 December 2020

Special Contribution

Disaster Countermeasures and Recovery Technology for Existing Railway Structures

Masayuki Koda

Director, Structures Technology Division
Railway Technical Research Institute (RTRI)

1. Introduction

Huge earthquakes and localized heavy rain, which have been frequent in recent years, have caused damage to different types of social infrastructure, including railway structures. Damage to railway structures has led to disruption or suspension of operations in the past, sometimes up to several years, or relatively shorter periods, depending on the seriousness of the damage. Therefore, this report summarizes the findings obtained from damage to railway structures caused by past earthquakes and rains. In addition, it details disaster countermeasures for railway structures on which Railway Technical Research Institute (RTRI) has been working (preliminary diagnosis, reinforcement technology and technology for detecting damage in the event of a disaster) and recovery examples technically supported by the RTRI. Finally, the report discusses disaster prevention and mitigation technology for further improving railway resilience and future work on early recovery technology.

2. Characteristics and issues of past earthquake damage and rain damage

This section overviews recent earthquakes and rain disasters that damaged railway structures. Here, the 2011 off the Pacific Coast of Tohoku Earthquake and the 2016 Kumamoto Earthquakes, and as for rains, it addressed the Heavy Rain in Northern Kyushu in July 2012 and the 2016 heavy rains caused by Typhoons 7, 9, 10, and 11.

The 2011 off the Pacific Coast of Tohoku Earthquake was an unprecedented huge trench-type earthquake with a magnitude of 9.0[1]. Regarding the earthquake damage of railway structures, there was no collapse of the structures thanks to the effects of shear reinforcement measures and measures to prevent the collapse of bridges that were implemented after the Hyogo-ken Nanbu Earthquake; however, there was a characteristic damage due to a huge earthquake, including utility pole breakage over a wide area, viaduct column damage, damage caused by repeated aftershocks(Fig.1), ground liquefaction damage in the Tokyo urban area, and enormous tsunami damage in Tohoku coastal areas.

The Kumamoto Earthquakes, which were inland earthquakes, included a foreshock with a magnitude of 6.5 due to the Hinagu fault, which occurred on April 14, 2016, and the main shock with a magnitude of 7.3 due to the Futagawa fault which occurred two days later [2]. Observations revealed that the covered concrete at top of viaduct columns forming part of Kyushu's Shinkansen Structure in the plain of Kumamoto had been peeled off and that bridge bearings had been damaged. However, this was within the scope of consequences assumed in Railway Design Standards. On the other hand, many large-scale landslides occurred in mountainous areas and intermountain regions centered on the Minamiaso area, and the subsequent aftershocks occurring in succession caused damage and deformation to progress, leading to more extensive damage (Fig.2).

The Heavy Rain in Northern Kyushu in July 2012 was described by the Japan Meteorological Agency as "rain of unprecedented intensity for Japan". The total recorded rainfall was over 800 mm in three days and caused major river disasters to northern Kyushu, mainly in Kumamoto, Oita, Fukuoka, and Saga Prefectures [3]. The heavy rainfall also damaged valley fills, embankments, and river bridges, including the Hohi Main Line, which runs through the intermountain region (Fig.3).

The heavy rains in 2016 was caused by Typhoons 7, 9, 10, and 11. Three typhoons landed in Hokkaido in succession over a single week, and heavy rain caused flooding of rivers and sediment-related disasters mainly in eastern Hokkaido. Subsequently, heavy rain generated by a front at the end of August and the approach of Typhoon 10 caused great damage such as the outflow of river bridges on the Nemuro Main Line and coastal revetments on the Hidaka Main Line (Fig.4) [4].

Fig. 1. Example of damage caused by aftershocks from the 2011 off the Pacific Coast of Tohoku Earthquake

Fig. 2. Example of damage caused by the Kumamoto Earthquakes in 2016 (Minamiaso Area; assumed bridge deformation shown by yellow lines)

Fig. 3. Example of damage caused by Heavy Rain in Northern Kyushu in July 2012

Fig. 4. Example of damage caused by Typhoon 10 in 2016 (river bridge)

These examples illustrate recent natural external forces due to earthquakes or rain have become extreme. In the case of earthquakes, multiple succession of earthquake motion, including the main shock, cause initial damage to railway structures to progress and expand. In the case of rain, localized short-term heavy rain causes sudden rises in water levels, resulting in overflow exceeding the height of railway structures, which leads to extensive damage.

The performance or function of a railway structure before and after a disaster change rapidly (Fig.5). The curve declines sharply immediately after the disaster and returns to its original height of form as recovery is made. In this figure, both “the avoidance of catastrophic conditions”, that is, the suppression of performance degradation, and “the early recovery of the functionality of the overall system” are defined as "resilience". To increase the railway resilience, we need to take pre-disaster action (disaster prevention and mitigation technology) and post-disaster action (judgment technology for an early train operation restart and early recovery technology) on this curve.

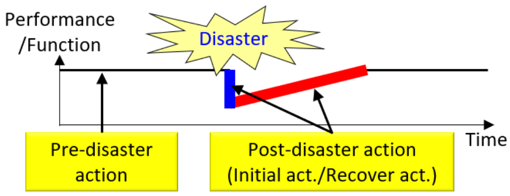

Fig.5. Performance and function of structures before and after the disaster

3. RTRI’s disaster countermeasures - Pre- and Post- disaster action

For pre-disaster action, it is important to have a reinforcement technology that can extract weak points on a railway line in advance and then enables work to make them more toughness. For post-disaster action, technology that be able to facilitate detection of damage to railway structures, to determine if damage is minor immediately after a disaster, leads to rapid resumption of train operations. In the case of more serious damage, a post-disaster diagnosis to determine whether the structure is reusable by reinforcement or should be replaced, leads to implementation of reinforcement technology (Fig.6). This section describes a series of disaster countermeasures on which the RTRI has been working, including pre- and post-disaster actions (initial and recovery actions).

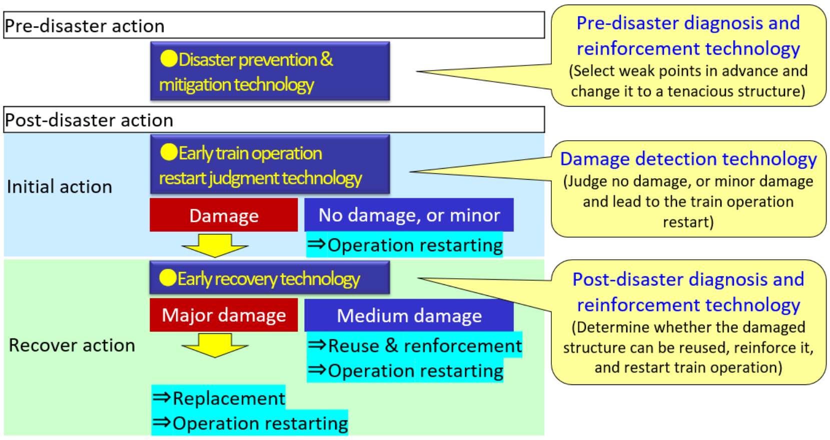

Fig.6. Railway disaster countermeasures (pre- and post-disaster actions)

3.1 Pre-disaster diagnosis and reinforcement technology

Intermountain regions and valley terrains, called catchment terrains, tend to collect groundwater, and embankments constructed in such places generally have low seismic resistance. To establish a seismic diagnostic technology that takes into account changes in soil strength caused by groundwater inflow or outflow, RTRI has developed a method which represents soil as a three-phase material consisting of soil particles, water and air, and makes it possible to perform seismic diagnosis of an embankment on a catchment terrain by continuously analyzing the seismic response from saturated / unsaturated seepage analysis considering the groundwater inflow and outflow(Fig.7)[5]. From a precipitation experiment and shaking table test in the gravitational field using a 1/10 model, we verified that a series of saturated / unsaturated seepage analyses and seismic response analyses were able to precisely express the two experimental results of the embankment model with an impermeable layer and the embankment model without an impermeable layer.

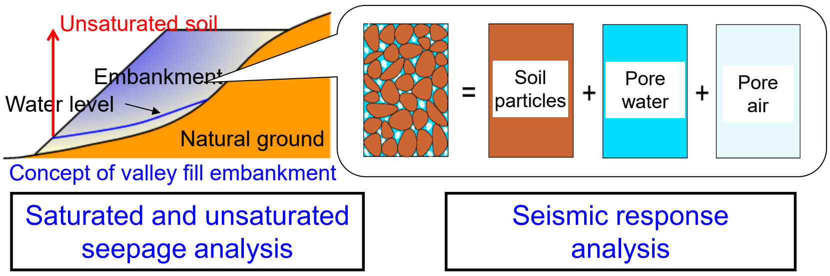

Fig.7. Seismic diagnosis of embankment on the catchment terrain

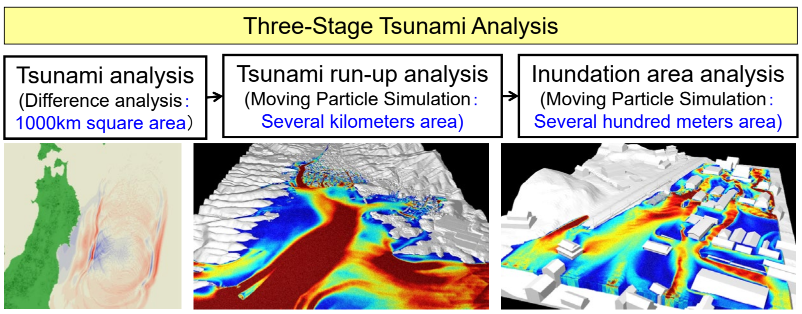

Fig.8. Three-Stage Tsunami Analysis with the difference analysis and moving particle simulation methods

Damage caused by tsunamis may be unprecedented or extremely rare depending on the area. However, should one occur, damage is likely to be huge. By combining the difference analysis and the moving particle simulation (MPS) method, RTRI developed a Three-Stage Tsunami Analysis that can estimate the occurrence of a large-scale tsunami, tsunami run-up, and then the inundation area while taking in outflows (i.e. with floating matters) (Fig.8) [6]. By reducing the analysis area at each stage and matching the inflow and outflow of each boundary condition, the calculation time can be shortened while performing a more detailed analysis. The occurrence of the tsunami was analyzed using a two-dimensional difference method from the assumed fault displacement of the 2011 off the Pacific Coast of Tohoku Earthquake (1000km square); next, the run-up of the tsunami in Kesennuma Bay was analyzed by the three-dimensional moving particle simulation method (4km×2km); finally, the inundation area of the tsunami near Shishiorikarakuwa Station on the Ofunato Line was analyzed by the three-dimensional moving particle simulation method (180m×150m). Based on the result of the first step in the tsunami analysis, the run-up analysis of the tsunami in Kesennuma Bay in the second step, and the inundation analysis of the tsunami near Shishiorikarakuwa Station in the third step, it was verified that we can almost trace the measured values of the tsunami height due to the 2011 off the Pacific Coast of Tohoku Earthquake, the observed values of the inundated area, and the actual damage.

For the purpose of making steel girders / abutment type bridges earthquake-resistant without rebuilding the bridges, we proposed an integrated method using steel girder, abutments and backfills by connecting the abutment and the backfill with nail-reinforced members, forming a rigid-frame structure by RC rolling up of the steel girder and the abutment, that is, Integrated Bridge with Nail-Reinforced Soils(Fig.9). It is an epoch-making construction method that aims to improve the function by changing the steel girder / abutment / embankment boundary, which was a weak point in the boundary of the structure, to a continuous structure [7]: it can also let to increase the outflow resistance of steel girders against river-bridge overflow.

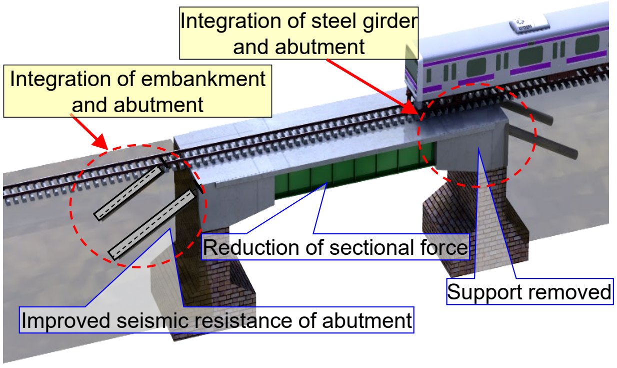

Fig.9. Integrated structural method of steel girder, abutments and backfills (Integral bridge with nail-reinforced soils)

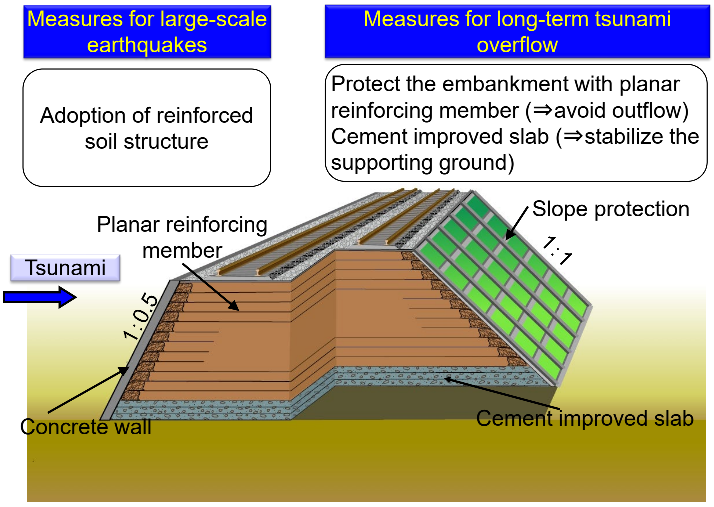

Fig.10. Embankment structure for tsunami and resistance

As a technology to prevent the outflow of embankments due to tsunamis, we proposed an embankment structure using a geosynthetic reinforced soil structure and cement-improved slab (Fig.10) [8]. These structures are intended to prevent an outflow of soil particles by planar geosynthetic reinforcing and to stabilize the embankment by cement improved slabs against a tsunami overflow that continues over a long period of time. As a result of our overflow experiment using the conventional 1/10 embankment model and an embankment model of the proposed structures, the conventional embankment exhibited an eroded slope and sudden downward flow, resulting in progress and expansion of the scouring. With the new proposed structure, no erosion occurred on the embankment and the embankment remained stable, although the supporting ground on the back surface was scoured. The same concepts as the proposed structure were applied to the tsunami countermeasures for the existing embankment: to install a nail-reinforced member, slope protection to prevent the outflow of soil particles, and an enclosing method using steel sheet piles to prevent scouring of the supporting ground.

3.2 Post-disaster diagnosis and reinforcement technology

Once a railway structure is damaged, diagnosis of the damaged structure and reinforcement are required. This subsection introduces the technical supports provided by RTRI for recovery after the disaster caused by Heavy Rain in Northern Kyushu in July 2012, and after the 2016 Kumamoto Earthquakes.

Following the Heavy Rain in Northern Kyushu in July 2012, at the Kumanoue River Bridge on the Kyudai Main Line, the supporting ground on the foundation bottom surface was sucked out and scoured due to flooding, and the P2 pier sank about 350 mm. Although the soundness diagnostic test for viaduct pier “Impact Vibration Test” conducted after the disaster confirmed that the pier was less sound, the existing girders and pier were deemed to be reusable based on a loading test, etc.. Train operations were able to restart after eliminating looseness in the supporting ground, and after completing loading tests. Specifically, a vertical loading test with a water tank (loading up to 90% of locomotive load DE10) showed convergence of settlement, and a locomotive running test, including a train stop test that applied braking load, demonstrated that the settlement had almost converged. A series of these loading tests led to the train operations being able to restart about one month after the disaster. The foundations were reinforced with Sheet Pile Reinforcement Method, and then speed restrictions were lifted in April 2013(Fig.11).

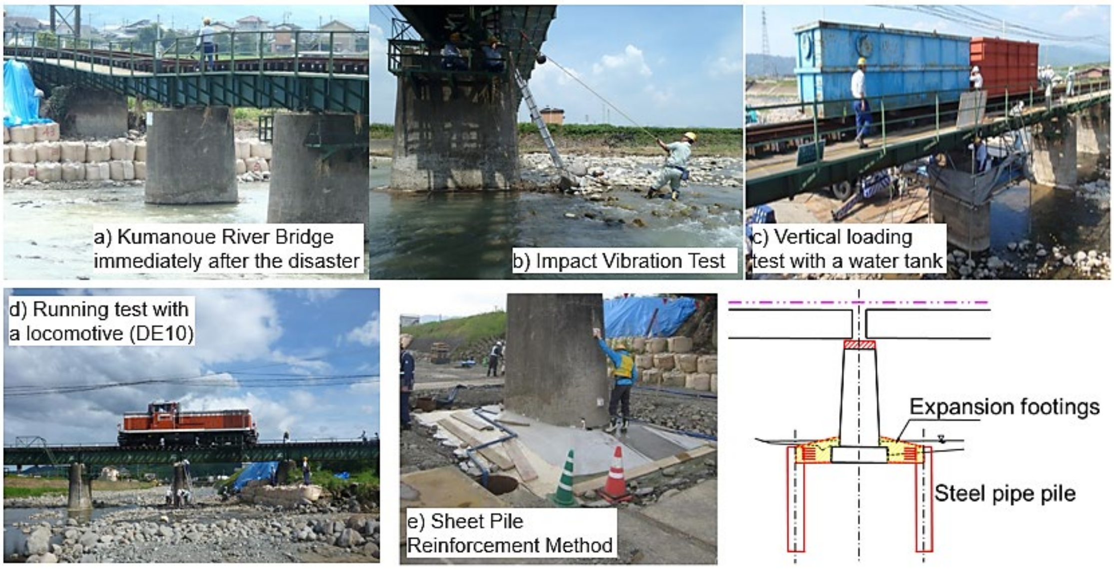

Fig.11. Technical support for diagnosis and reinforcement of the Kumanoue River bridge damaged by Heavy Rain in Northern Kyushu in July 2012

Fig.12. Technical support for the diagnosis of the Kyushu Shinkansen viaduct damaged by the Kumamoto Earthquakes in 2016

The Kumamoto Earthquakes damaged the rigid-frame viaduct columns and bridge bearings on the Shin-Tamana to Shin-Yatsushiro section of the Kyushu Shinkansen line. There were well over 1000 columns and bearings, and there was concern that it would take a long time to investigate each damaged location, formulate a recovery plan, and then carry out repairs. As such, a strategy was adopted, where recovery would be achieved step-by-step: damaged sections would be ranked by degree of damage, and based on an index of whether they needed to be repaired or not prior to resumption of train operations. Operations would then be resumed with speed restrictions, which could then be gradually lifted. As a result, train operations restarted on the Hakata-Kumamoto section on April 23, 2016 (9 days after the disaster) and restarted on all the Kyushu Shinkansen lines on April 27(Fig.12).

In both cases, early recovery was achieved by diagnosing the railway structures following the disaster and by repairing and reinforcing them based on these diagnoses. The case of the Kumamoto Earthquakes was the first example where a large number of damaged locations in a wide area were classified based on severity of damage, and divided into sections in the recovery plan, so that speed restrictions could be lifted progressively for each section after train operations resumed.

4. Toward further improvement of resilience

This section describes future work which will aim to further improve railway resilience.
Flood or tsunamis are accompanied by infiltrations, overflow, erosion (scouring), sedimentation, and outflow (of driftwood, piers, girders, etc.), which exhibit complex phenomenon caused by flowing water. For the effects of these infiltrations, erosion (scouring), sedimentation and outflows, the damage caused by floods or tsunamis can become widespread and serious. For example, the Heavy Rain in Northern Kyushu in July 2017 generated large amounts of driftwood and landslide outflows which extended the damage. There is the lack of data on similar events, and then this means to unprecedent in past time. Forecasting possible damage and extracting vulnerable points are more important in such an inexperienced event. In addition, also as for recovery, expanded and more enormous damage being caused by a flood or tsunami in future is no choice but to deny the concept of unreinforced recovery.

By estimating the tsunami inundation area and damage by the Three-Stage Tsunami Analysis, flowing water, suspended matter, and structures were expressed, but deformation or destruction of a structure such as an embankment or bridge were not expressed in present. When a flood or tsunami occurs, outflows are mixed in addition to water, soil and structures, and the flow will change due to the interaction among these. At that time, the deformation and destruction of soil and structures progressed due to flowing water, infiltration, erosion (scouring) and sedimentation, lead to more extensive damage (Fig.13). Thus, in the estimation of the damage caused by an unprecedented flood or tsunami, the existing three-stage tsunami analysis is considered to be required to develop a large-scale deformation / destruction analysis in consideration of infiltration, erosion(scouring), sedimentation, deformation / destruction, and outflow of structures (embankments and bridges): and there is demand for such analysis methods. Developing a large-scale destruction analysis of soil and structures accompanied by erosion(scouring) and sedimentation with flood is an advanced research and development subject, which is also difficult at an academic level.

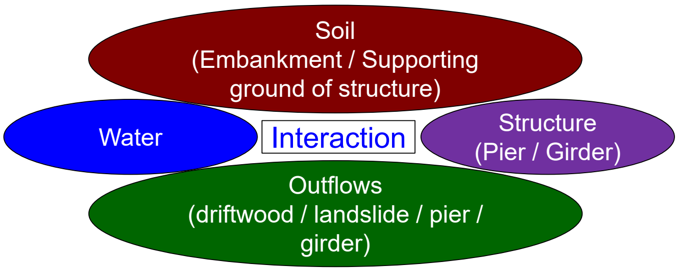

Fig.13. Interaction between water, soil, structures, and outflows during flood or tsunami

In the case of structures damaged by floods, earthquakes, or tsunamis, we must also consider shifting our approach from unreinforced recovery to reinforced recovery. As such, this demands step-by-step reinforced recovery technologies, which enable step-by-step reinforcement to allow early resumption of train operations and avoid catastrophic damage to railway structures in the event of a new disaster (Fig.14). Consequently, there is also demand for a step-by-step reinforced recovery technology applicable to a range of structures that can be easily implemented for early recovery and for reinforced recovery.

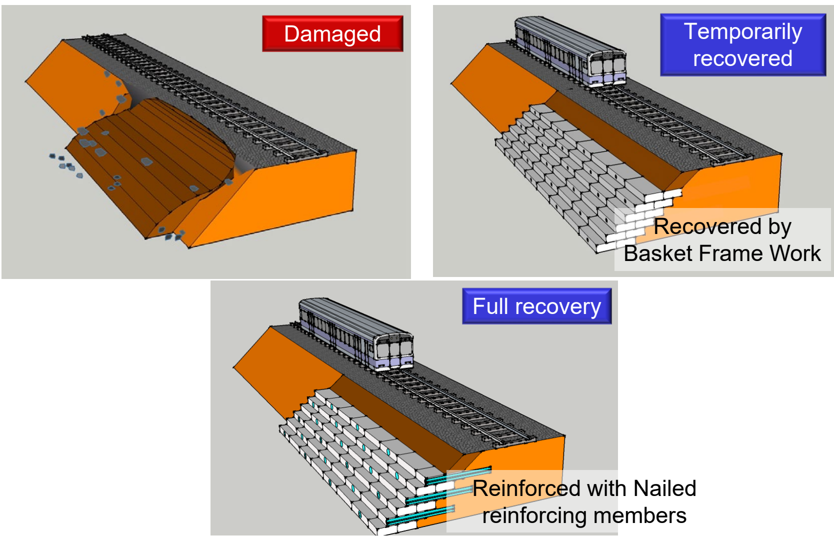

Fig.14. Example of step-by-step reinforced recovery of a damaged embankment

5. Conclusions

This report gave an overview of findings obtained about damage to railway structures caused by past earthquakes and heavy rain. Then, the pre-disaster action and post-disaster action on which RTRI has been working, with a special focus on disaster countermeasures of railway structures for the purpose of improving the railway resilience, were introduced. The followings were obtained from the discussions.

Since infiltration, erosion(scouring), sedimentation and outflows exacerbate damage caused by flood or tsunamis, the simulation technology in the pre-disaster action to estimate accurately a wide-area disaster, and the step-by-step recovery technology in post-disaster action would further improve the railway resilience. The RTRI will continue the research and development that contributes to improving railway resilience, aiming for practical development.

The integrated structural method of steel girder, abutment and embankment presented in the text, was implemented with the support of subsidies for railway technology development from the Ministry of Land, Infrastructure, Transport and Tourism.

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◆ A brief CV of Dr. Masayuki Koda

Masayuki Koda is the Director of Structures Technology Division, Railway Technical Research Institute in Japan (RTRI), also holds the Head of Foundation & Geotechnical Engineering Laboratory. After completing the master's degree from Tokyo Institute of Technology (TITech) in 1993, he joined RTRI. In 1995, he moved to the post of researcher associate at department of civil engineering in TITech for three years temporally. In 1999, he came back to RTRI and received the doctor in engineering from TITech in 2000 for the thesis of "Study on Lateral Resistance of Single Pile in Sandy Ground". He has worked on R&D for foundation engineering of railway structures, and for geotechnical engineering. He is a code writer for the series of Design Standard for Railway Structures in Japan. He is also one of the developers of the newly foundation with multiple sheet piles, "Sheet Pile Foundation, and Sheet Pile Reinforced Structure Method for existing foundations". He is one of Directors of International Press-in Association.

IPA News Letter Volume 5, Issue 4 December 2020

Serial Report

Development History of SILENT PILER (Part 2)

Masaaki Ono

Director, GIKEN LTD.

Environmental Considerations and IT Enabling

The model ECO100 (Photo 1) was marketed as a successor model of the SA Series in 2002. Advanced environment-conscious technologies and information technologies were introduced to promote reducing the overall burden on the environment across the machine lifecycle as well as during construction.

Photo 1. Model ECO100

Fig. 1 shows the names of the components of SILENT PILER™ for readers' reference. In terms of structure, the rails for the sliding parts, such as upward/downward motion and rotation of the chuck, and front/backward motion and rotation of the leader mast were increased in length to reduce loads and prevent backlash. In terms of materials, special alloy steel and high-tensile steel plates corresponding to loads and morphology were used to save weight. Also, forged parts of more tenacious materials were used instead of cast parts in the chuck and the like, where stress was concentrated, to take advantage of fiber flows*. Thus longer life of the machine was realized. The gripping force of the clamp claws was improved to obtain larger reaction force on this and later models (Fig. 2).

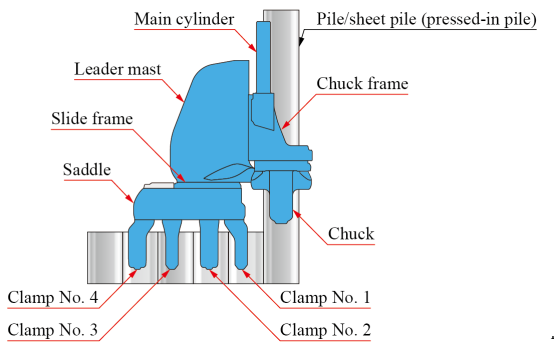


Fig.1. Names of the components of SILENT PILER

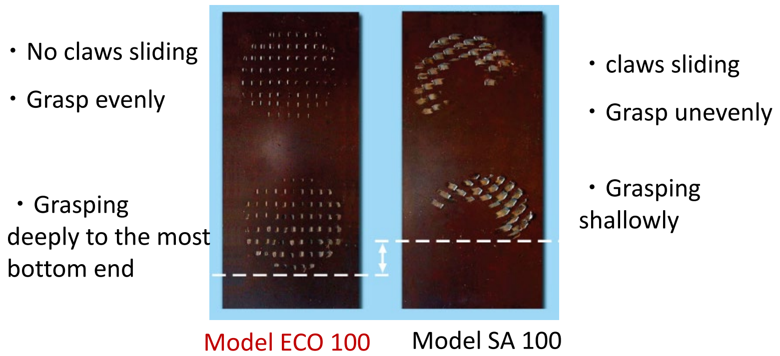


Fig.2. Improvement of gripping force, marks of clamp claws

Fuel consumption of the power unit was reduced by 7% to 10% due to electronic control, and the tier-2 exhaust gas regulations of the time, in and outside Japan, were met. The ECO mode was newly provided to reduce the engine speed of the power unit by about 20% compared to the power mode and reduce the rated output, having a lower noise level than the regulatory standards. Consequently, the machine can be operated at low fuel consumption and a low noise level while maintaining hydraulic force unless high-load/high-speed operation is required in the construction site. In terms of IT, as for the hydraulic force and operation status of the machine, "GIKEN IT System" was introduced in which values from the press-in sensor and stroke sensor in the machine and operation information were collected in a controller of the press-in piling machine and displayed in real time by the maintenance software through the mobile communication network. This allows the operation status of the piler to be checked from a remote location with a PC and appropriate advice to be provided to local operators on the site from the information center.

In 2007, the multi-model of press-in piling machine SCU-ECO400S (S Series) (Photo 2) with the function for hard ground conditions mounted as standard, was launched. A single unit of this model can perform press-in piling with augering, as well as standard press-in and press-in piling with water jetting, by attaching and detaching the hose reels and standard press-in attachment (Fig. 3).

For the S Series machines, the main body and pile auger were light-weighted and downsized compared to the dedicated machines applicable for hardground conditions, in order to be used as a general-purpose machine. To achieve its maximum excavation efficiency despite the downsizing, a Chuck Lock function (Fig. 4) was newly equipped, in which a lock-plate fixed on the chuck was held and fixed using the hydraulic cylinder mounted on the chuck frame. In addition, a Leader Mast Lock function was also equipped, in which the lock plate on the center pin of the slide frame was held and fixed using a hydraulic cylinder mounted on the side of the leader mast to secure the rotating part of the main body firmly during augering. This is the structure that prevents the loss of force. This enabled reliable transmission of auger torque supported by a solid reaction base, resulting in an improvement of the efficiency and accuracy of pile installation. Around this time technologies for hardground conditions were being developed including auger head test equipment, and so on.

* “Fiber flows” are fibrous flows of metal structure formed when metal materials are forged; metal structure flows in the rolling/forging direction. When fiber flows flow along the shape of a forged product, the impact value as well as the fatigue strength are higher than when they are discontinued.

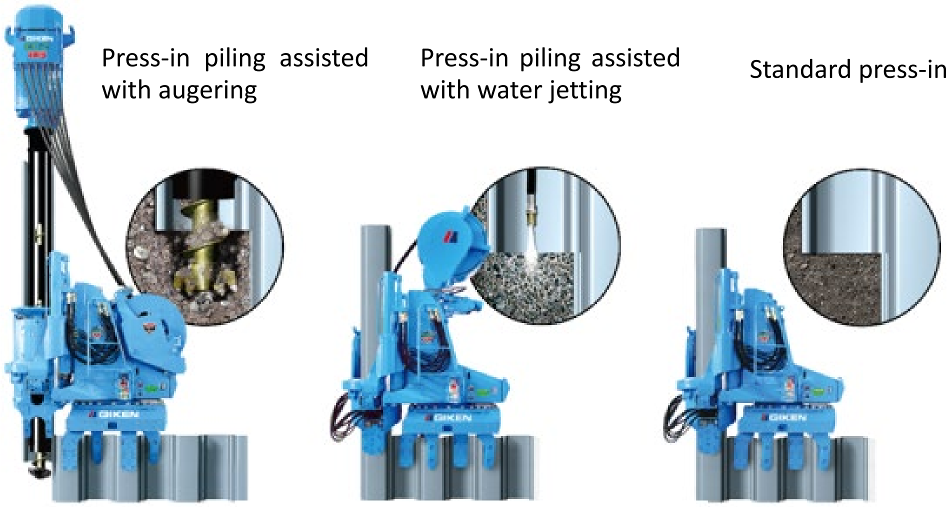


Photo 2. Multi-model SCU-ECO400 (S Series)

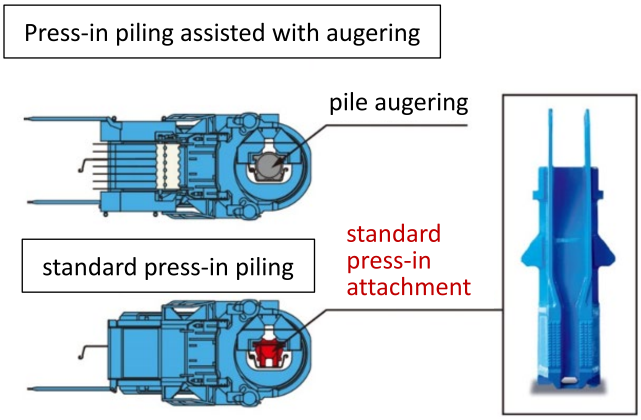


Fig.3. Press-in attachment

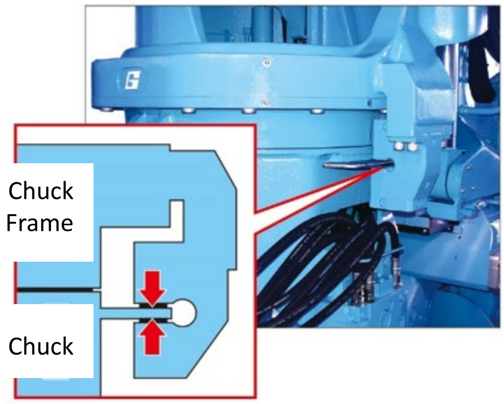


Fig.4. Chuck Lock Function

Modularization design

Although the S Series was a single unit that is applicable to a wide range of conditions, further cost-down and higher production efficiency were needed for the purpose of global business development. In 2011, the 25 models that had been developed before were integrated into 5 types of base machines. The production efficiency was improved by modularizing main components including the leader mast and saddle. This is the birth of the F Series (Photo 3). Starting with the model F201 marketed overseas in 2013, the model F301 (Hat Piler), model F101 (U Piler for 400 mm wide sheet piles), and the model F111 (versatile press-in piling machine for 400 mm wide sheet piles) were marketed by 2015. In 2016, 2 models, F401 and F501, which were applicable to a “Gyropress Method”, were announced.

Model F101

Model F111

Model F201

Model F301

Model F401

Model F501

Photo 3. F Series machines

Approach to installation conditions and piles

The development of piling machines is directly linked to the development of press-in piling methods. There were various barriers in construction sites other than ground conditions and each of them has been overcome. There are various types of SILENT PILER (Photo 4): “Clear Piler” for the condition under the overhead restriction such as under bridge, “Zero Piler” for zero clearance to adjacent structures such as buildings, “Concrete Piler” for concrete sheet piles, “Tubular Piler” for steel tubular piles with interlock, and “GYRO PILER” that installs steel tubular piles directly in existing concrete structures with rotary cutting to reinforce the structure. Technology is still evolving.

Clear Piler

Zero Piler

Concrete Piler

Tubular Piler

GYRO PILER

Photo 4. Types of SILENT PILER

Latest model “SMART PILER”

The latest model, Smart Piler SX1 (Photo 5) was released in April 2020. This model drastically improved the upward/downward motion speed and responsivity of the chuck. The highest press-in speed is 1.5 times higher than that of the model F101, and 3 times higher than that of the model SA75. The responsivity was improved by eliminating time lag in switching the valve to reverse the upward/downward motion of the chuck; the penetration and extraction, that is, press-in at the highest speed and instant shifting to extraction, can be repeated automatically at high speed. This prevents plugging and forming a pressure bulb to realize the smart press-in piling work, in which piles are penetrated while keeping press-in force low. Moreover, the lightest body in the history (3,850 kg) * led to an improvement of the operating efficiency.

Photo 5. SMART PILER SX1

* Within machines for 400 mm wide U-shaped steel sheet pile

Development History of Gyropress Method™

Birth of Tubular Piler

One of many types of SILENT PILER is “Tubular Piler”, a press-in piling machine for steel tubular piles with interlock, which are the piles suited to port construction works, flood and tidal surge protection in river basins, anti-seismic strengthening of bridge pillars, bridge foundations, and so on.

Tubular Piler started to be developed in 1986. During the development, a different method to hold piles was needed for the sheet piles and for the tubular piles. While the sheet piles are held by a clamp from outside to mobilize the fictional force, the tubular piles are likely to buckle if they are excessively held from outside. Then the method adopted was to expand a clamp part from inside the tubular pile, mobilizing the frictional forces between the clamp and the inner surfaces of the piles as shown in the Photo 6. Thus, Tubular Piler was completed and first used on a construction site in 1990. The tubular piles are applicable to different design requirements by altering the pile diameter and thickness, which allows efficient construction of many various structures for different purposes. However, it had a big issue of soil plugging at the pile toe. If piles are plugged, a higher press-in force is necessary and eventually piles cannot be penetrated. As the countermeasures for this issue, water jetting was initially used to assist in pile installation. However, it was not possible to install piles into stiff and hard ground in many cases, and then pile augering was used instead. The machine for hard ground conditions was launched in 1997 and its use was expanded rapidly. Yet pile installation was frequently hindered by very stiff base rock layers or existing concrete structures (Photo 7). To solve this problem, GYRO PILER started to be developed.

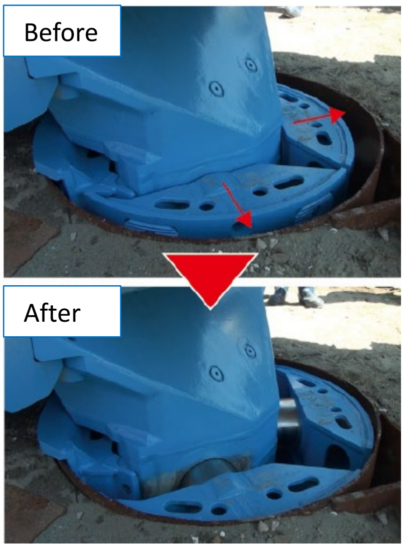


Photo 6. Clamps of Tubular Piler

Photo 7. Construction in Ibaraki Prefecture with Tubular Piler for hard ground

Birth of “GYRO PILER”, steel tubular pile rotary press-in piling machine

The press-in piling machine presses in piles using static load, so it had a weakness to overcome in that it was difficult to install piles into hard ground. Mr. Kitamura, the developer, had been wanting to solve this issue for years. After trying several ideas, in 1982 he conducted a demonstration experiment of Prototype 1, which installed steel tubular piles by rotating them into the ground. Subsequently in 1986, a demonstration experiment of Prototype 2 was conducted, which was the model KGK-100H with the chuck changed into a rotary type. However, the rotary type was difficult with technologies and part performance of the time, so the development was stopped once. Even so, it was essential to overcome the ultra-hard ground conditions to expand the market of implant structures on the permanent construction. Then, full-scale development of the rotary press-in piling machine was started in 2002. At the same time, it was decided that steel tubular piles with pile toe ring bits (Photo 8) would be developed to press piles by rotating them into harder ground, providing the proposal to Nippon Steel Corporation, the major blast furnace steel manufacturer.

Photo 8. Tubular Piles with pile toe ring bits

“GYRO PILER”, which was unveiled at the New Technology Presentation (Ariake, Tokyo) in the fall of 2003, installs steel tubular piles with pile toe ring bits by rotating them into the ground. It was first applied in a project in Hokkaido in 2004 (Photo 9). Because it was a reinforcement construction project of bridge pillars on the conglomerate ground with extrapolated SPT N-value of 1,500, it was considered difficult to install piles by the conventional piling methods. The construction was successfully completed using GYRO PILER GRA1030 (Photo 10); thus the new construction method “Gyropress Method” (Fig. 5) was established.

Photo 9. First installation in Hokkaido

Photo 10. Model GRA1030

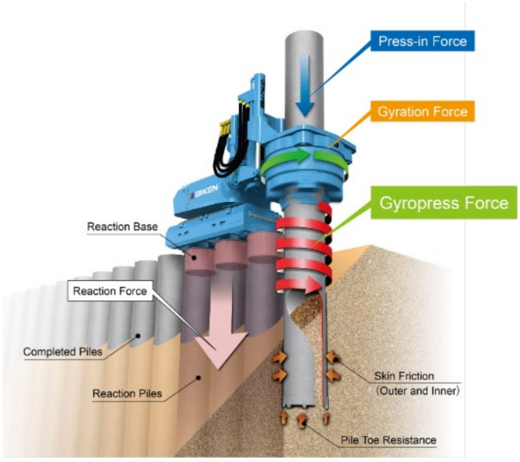


Fig. 5. Gyropress Method

Gyro Piler, which presses in piles penetrating through ultra-hard ground to build implant structures, was used increasingly more as it became well-known. Especially after the Great East Japan Earthquake in 2011, it was used for embankment improvement works implemented by National Government and restoration works in Tohoku district as the construction method which rapidly builds the structures that firmly withstand earthquakes and tsunamis. This led to the construction method being used widely at a rapid speed across Japan. Kitamura also encouraged development of GYRO PILER for large diameter piles immediately after the Great East Japan Earthquake, and developed the ultra-large model GRV2540 (Photo 11) which can rotary-press in steel tubular piles with 2,500 mm O.D. in the following year. It is capable of building the implant structures that withstand massive tsunamis, being of an exceptional scale (body weight 105 tons, maximum press-in force 4,000 kN, maximum rotation torque value 2,940 kN-m). Currently, there are various models including machines for batter pile installation and machines for ultra-low overhead clearance, in addition to the 6 models applicable for piles with 500 mm to 2,500 mm O.D.

Photo 11. Ultra-large model GRV2540

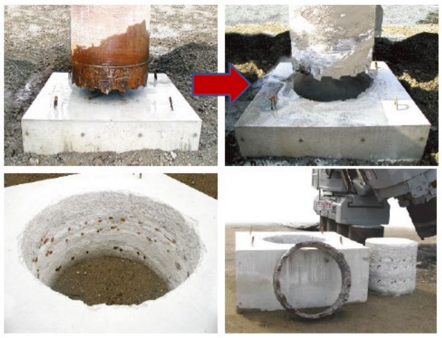


Photo 12. The test of concrete structures with rotary press-in piling

The use of Gyropress Method has grown rapidly in recent years and it became one of the representative implant methods. Its notable feature, the main factor of the growth, is not only that the method is applicable for the ultra-hard ground, but that it is not necessary to remove existing reinforced concrete structures by using customized steel tubular piles with an appropriate number of cutting bits set according to the pile diameter and hardness of the ground. It can build the firm implant structure rapidly by pressing in piles through concrete structures, which is an inestimable advantage (Photo 12).

Combi-Gyro Method™

The Combi-Gyro Method (Fig. 6) (Photo 13) is a construction method of walls having excellent functionality and economy, combining steel tubular piles with high rigidity and hat-shaped steel sheet piles with excellent water tightness, using one unit of press-in piling machine. It was developed jointly with the Nippon Steel Corporation, applying the Gyropress Method. One of its features is that it can build walls with the strength required in terms of design at low cost, by optimizing the combination of the pitch, diameter, and thickness of steel tubular piles. The walls can be used widely such as earth retaining walls and cutoff walls. This method is applicable for constructions of retaining walls for highways, river revetments, sea embankments, anti-seismic strengthening, liquefaction countermeasures, and the like.

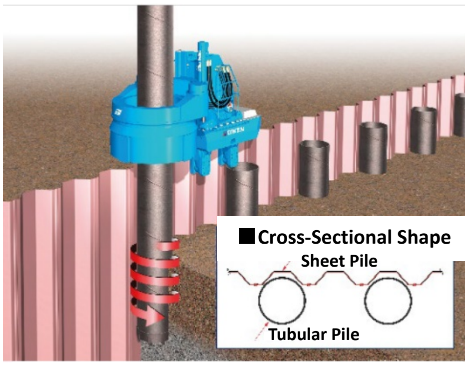


Fig. 6. Combi-Gyro Method

With the Combi-Gyro Method, firstly, hat-shaped steel sheet piles are pressed in contiguously and secondly, steel tubular piles are pressed in by rotating them using the steel sheet piles as a reaction force on the side of the steel sheet piles so as to support the steel sheet piles. The dedicated machines for the Combi-Gyro Method have been developed, a single unit of which can press in the hat-shaped steel sheet piles and steel tubular piles, by changing the chuck.

Photo 13. The construction site in Miyagi Prefecture with Combi-Gyro Method

Skip Lock System

The Skip Lock system is the system of more efficient mono pile installation, that is installing steel tubular piles with a constant spacing between piles. GYRO PILER with the originally developed “Skip Lock attachment” is used. Conventionally for mono pile installation by only GYRO PILER, dummy short piles needed to be pressed in between the permanent steel tubular piles, because only some clamps were able to grip piles due to the space between piles and then sufficient reaction force was not obtained (Fig. 7). However, the dummy piles needed to be removed finally, which resulted in unnecessary construction cost and period. Then the Skip Lock attachment was developed to secure a reaction force without dummy piles.

The attachment can be moved by a crane. Three attachments are fixed on the 3 installed mono piles and connected at the connection parts on the front and back of the apparatuses. Each attachment has 2 holding holes for the clamp. The 3 attachments make a bridge on the piles, which makes 6 holding holes for the clamp. During pile installation, all attachments and mono piles are unified by the hydraulic pressure, so it can secure a reaction force from 3 piles to fix the machine body firmly.

The Skip Lock system has been used mainly for constructing the disaster prevention infrastructure, such as foundation piles for sea embankments and landslide prevention piles, since it was first used in tide embankment construction in Fukui Prefecture in 2013. It was also used in the tide embankment reconstruction in Iwate Prefecture (Photo 14) that suffered a great damage from the Great East Japan Earthquake. Lately, it was used for installing landslide prevention piles in the construction site of the Kyushu Shinkansen in Nagasaki Prefecture (Photo 15) for the first time.

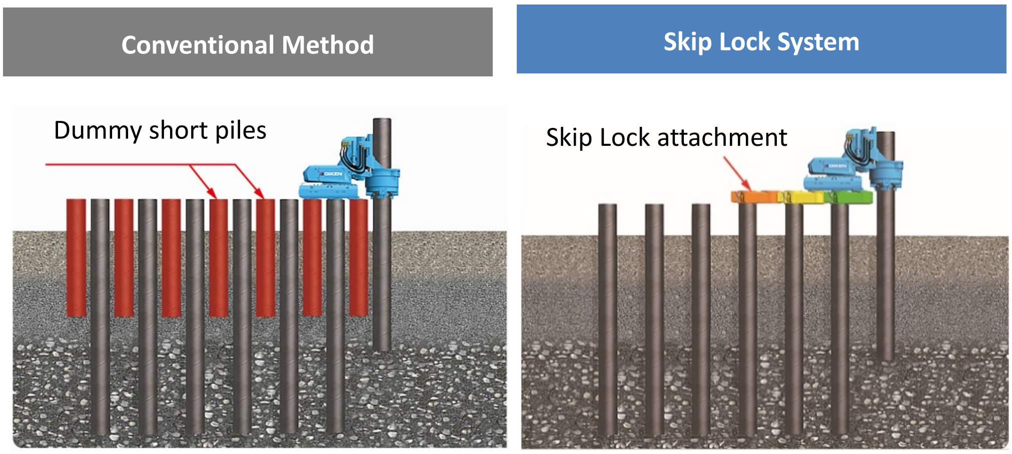


Fig. 7. The difference of conventional Method and Skip Lock System

Photo 14 Construction in Iwate Prefecture

Photo 15 Construction in Nagasaki Prefecture

(To be continued on Part3)

Event Report

IPA Press-in Engineering Seminar in Tokyo 2020

Hongjuan He

Secretary, IPA

The 12th IPA Press-in Engineering Seminar was held by the Research Committee of International Press-in Association (IPA) on 30th November 2020 in an online (Zoom meeting) due to the Covid-19 pandemic. The seminar was attended by more than 100 participants including clients, engineers, designers, academics from all over Japan.

After the opening address by Prof. Kikuchi (Chair of Research Committee), the presentations around 2 main themes were delivered by the IPA's Technical Committee (TC)1 and TC3 that covered the following topics:

- **Report of TC1 "Application of cantilever type steel tubular pile wall embedded to stiff ground**" – Mr. Sawada, Secretary-General of TC1, introduced the overview of TC1; Mr. Suzuki presented the case studies of large diameter steel tubular pile wall; Associate Prof. Takemura, Mr. Toda and Associate Prof. Isobe explained behavior analysis of large diameter steel tubular pile wall; Mr. Sanagawa showed the tasks of large diameter steel tubular pile wall on design; Associate Prof. Takemura, the chair of TC1 summarized the activities of TC1.

- **Report of TC3 "Expansion of Applicability and Assessment of Seismic Performance of Partial Floating Sheet-Pile (PFS) Method"** – Prof. Otani, chair of the TC3, introduced the PFS Method and activities of TC3; Associate Prof. Kasama reported some PFS cases in Kumamoto Prefecture which were implemented by the investigating group; Associate Prof. Nakai presented the analysis results of the effect by PFS Method; Prof. Tobita presented the outcomes of centrifugal model test using PFS Method; Prof. Nishioka reported the activities of design group; Mr. Taenaka, Secretary-General of TC3, remarked the outcomes of TC3 activities finally.

These 2 reports will be detailed in the Volume 6, Issue 1 2021.

At last, Prof. Matsumoto, Vice President of IPA, gave the closing address, stating the advantages of Press-in Method and introduced "The Second International Conference on Press-in Engineering 2021, Kochi (ICPE 2021)" which will be held in June 2021.

A questionnaire survey was conducted after the seminar to get feedback from the participants. According to the results of questionnaire, 95% of the respondents were satisfied with the seminar's contents and smoothy audio, 67% said they are interested in Press-in Technology. In addition, some participants said it is a good way to hold a seminar online for no location limitation as well as time saving. Prof. Kikuchi commented that the seminar was very successful for the first online seminar and Research Committee will take advantage of the results of the questionnaire survey for the next seminar.

Photo 1 Associate Prof. Takemura is presenting at the meeting room

Photo 2 Group photo

Young Members Column

Adnan Anwar Malik

Assistant Professor, Department of Civil and Environmental Engineering
Saitama University

I started my academic career in 2018 as an assistant professor at the department of civil and environmental engineering (Saitama University, Japan). Before that, I had worked as a professional geotechnical engineer in various engineering firms like National Development Consultants – Pakistan, National Engineering Services Pakistan (NESPAK) and Ammico Contracting Company – Qatar. My professional experience includes broad geotechnical engineering areas such as field geotechnical investigations (soil/rock), design of embankment dams, deep and shallow foundations and deep excavation support systems. In order to expand my knowledge in the field of geotechnical engineering, I enhanced my qualifications during my professional experience, and completed Master of Engineering and Doctor of Philosophy degrees from Saitama University – Japan in 2011 and 2015 respectively.

The population of the world is increasing every passing day, and it demands an increase in infrastructure development, which results in expanding cities not only horizontally but also in elevation. This expansion in urban areas creates environmental problems such as air pollution due to construction activity, noise pollution due to heavy machinery, vibrations in the surrounding buildings due to heavy machinery. In addition to this, space constraint is another problem in urban areas for the construction of new structures. In the field of geotechnical engineering, researchers and professional engineers are striving hard to develop innovative construction ways so that space constraints and environmental issues can be overcome without affecting the performance of the engineering structures. In this regard, my research focuses on the performance enhancement of new piling techniques such as press-in and screw pile systems during pile installation and loading carrying stage in difficult grounds. I feel that the International Press-in Association provides a great platform to the engineers and researchers from different organizations and institutions to share their experiences and findings, which will help to develop innovative technologies for the betterment of the society.

Marc Arthur Go

Master Student, Institute of Civil Engineering
University of the Philippines – Diliman

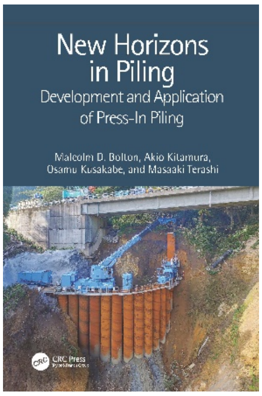
I am a graduate student, currently taking my master's degree in Geotechnical Engineering under the Institute of Civil Engineering (ICE) at the University of the Philippines – Diliman (UPD). I am also a geotechnical evaluator for a geotechnical contracting and soils laboratory testing company. My first encounter with the IPA was during the 4th international seminar on Press-in Technology in the Philippines, last May 2018. IPA, in partnership with ICE and Philippine Society for Soil Mechanics and Geotechnical Engineering (PSSMGE), presented the press-in method of pile installation - an alternative to the more commonly used diesel and pneumatic pile driving methodology in the local construction industry. Designers and contractors are often limited to the traditional installation of piles due to the available technologies in the local industry. Having other pile driving options (e.g. press-in method) makes the construction easier, especially in areas with special restrictions (e.g. limited working space, vibration limitations, etc.) Recently, I have been recommended and was advised by mentor and PSSMGE President, Prof. Alexis Acacio, to join the IPA editorial board to broaden my knowledge on the geotechnical engineering practice in the global scene and also to impart some of the practice here in our country.

As a practicing geotechnical evaluator, I am made aware of the problems in geotechnical engineering practice in the Philippines. One of the challenges in doing evaluation and design is the characterization of soils. Due to cost restraints, subsurface investigation is often limited and / or scarce to fully characterize the subsurface condition of an area. Thus, local engineers are compelled to use correlations in determining design geotechnical parameters. Although this practice is generally accepted, the applicability of these empirical correlations to the local soils are not guaranteed. This problem led me to my research on the characterization of undrained shear strength of Philippine soils. My research aims to gauge how well these existing correlations perform in local soils by comparing them to actual laboratory test results. By doing this research, I hope to provide geotechnical engineers with a better model in obtaining the strength of local soils.

Announcements
Publishing “New Horizons in Piling”

Malcolm Bolton

Emeritus Professor, University of Cambridge
Founding President, IPA



(From CRC press website)

I am pleased to announce the arrival of our book New Horizons in Piling: Development and Application of Press-in Piling, published by CRC Press / Balkema, inspired by Mr. Akio Kitamura and his life’s achievements with GIKEN LTD., and written by Dr. Masaaki Terashi and Prof. Osamu Kusakabe with a few contributions from me. This book serves as an introduction for readers who are not familiar with Press-in piling, including project owners, design engineers and site engineers as well as researchers and students. Its aim is to be an explanatory guide, and it accordingly contains 156 figures.

Remarkably, there is a perfect match between the challenges to be faced by the construction industry in the coming decades and the visionary principles laid down at its foundation in 1967 by Mr. Kitamura for the mission of GIKEN and the development of its unique press-in technology which gave us the first Silent Piler in 1975. The book offers an account of that development which has enabled steel implant structures simultaneously to satisfy the requirements of safe construction practice, social and environmental responsibility, serviceability during normal life, and resilience in the face of severe threats such as earthquakes and tsunamis. Those still unfamiliar with the wide range of challenging projects that have been undertaken using press-in technology will find detailed examples of urban redevelopment on constrained sites, the upgrading of transport corridors without the need for diversions or the suspension of services, the retrofitting of bridge improvements, and the renovation of canal containments. Since the sponsors of these schemes preferred implant structures to traditional construction methods, the economic case for implant structures must have been convincing when the speed and precision of construction, the absence of temporary works, the avoidance of disruption to existing services, and the added assurance of performance in service are taken into account. A later chapter focuses on opportunities for the use of press-in technology which have emerged more recently or which are still to be fully exploited, including the upgrading of ports and harbors, the provision of coastal protection against tsunamis, the reinforcement of foundations against earthquakes, and more bespoken applications to serve special requirements such as the provision of underground bicycle parks.

The final chapter looks at the pile-soil interactions which are seen as the key to the success of press-in piling. These geotechnical interactions have been studied for the last 25 years in research at Cambridge University which was carried out in collaboration with GIKEN LTD.. They include the quantification of the reduced level of ground vibrations found when piles are pressed-in rather than driven by conventional means, the clarification and prediction of installation forces and the role of plugging, the possible advantages and disadvantages of cyclic installation in different ground conditions, and the response of a tubular pile to rotary installation which is used to embed implant structures in the hardest ground conditions. In each case references point the reader to source documents for further information.

New Members (September – November 2020)

Members who joined IPA from September to November as follows.

- **New Individual Members (3)**
  Koji Watanabe   Barry Michael Lehane   Akihiro Nishigawa

- **New Student Members (4)**
  Sora Kadowaki   Yusuke Tsuno   Genki Hashimura   Fuyuki Kawatake

- **Numbers of members as of 30th November 2020**
  Individual Members: 690   Students Members: 29   Corporate Members: 55

Event Dairy

Title	Date	Venue
IPA Events https://www.press-in.org/en/event		
The Second International Conference on Press-in Engineering, Kochi (ICPE 2021)	June 19-21, 2021	Kochi, Japan
International Society for Soil Mechanics and Geotechnical Engineering http://www.issmge.org/events		
14th Baltic Sea Geotechnical Conference 2020 & 18th NGM Nordic Geotechnical Meeting	January 8-19, 2021	Online
CPEG2020 3rd International Symposium on Coupled Phenomena in Environmental Geotechnics	March 17-19, 2021	Kyoto, Japan
International Conference on Challenges and Achievements in Geotechnical Engineering	March 31 – April 2, 2021	Albania, Tirana
The 2nd Vietnam Symposium on Advances in Offshore Engineering	April 22-24, 2021	Ho Chi Minh City, Vietnam
Deep Foundations Institute http://www.dfi.org/dfievents.asp		
DFI 2021 Middle East Conference	February 16-18, 2021	Online
DFI-PFSF Piling & Ground Improvement Conference	March 10-12, 2021	Sydney, Australia
DFI Midyear Technical Committee Week	March 22-26, 2021	Online
46th Annual Conference on Deep Foundations	October 12-15, 2021	Las Vegas, Nevada, USA
International Geosynthetics Society http://www.geosyntheticssociety.org/calendar/		
EUROENGEO 3rd European Regional Conference of IAEG	April 8-12, 2021	Athens, Greece
Others		
Structures Congress 2021 https://www.structurescongress.org/	March 10-13, 2021	Seattle, Washington, USA
CREST 2020 1st International Symposium on Construction Resources for Environmentally Sustainable Technologies https://crest2020.com/	March 9-11, 2021	Fukuoka, Japan or Online

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ナラサキ産業 株式会社
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Editorial Remarks

It is with great pleasure that I write this editorial remark for December issue. As the world are shaded by COVID-19 pandemic, I'm hoping that this IPA Newsletter will still be available for everyone in enhancing our understanding of this innovative technology. On behalf of IPA, welcome to our new directors, Dr. Anh Tuan Vu and Associate Prof. Ramin Motamed to our IPA family.

The Special Contribution section features an interesting article by Mr. Masayuki Koda on disaster countermeasures and recovery technology for existing railway structures. This report summarizes the findings obtained from damage to railway structures caused by past earthquakes and rains. In addition, it details disaster countermeasures were also been highlighted. Mr. Masaaki Ono of GIKEN provides a part 2 of the development of Silent Piler including a historical perspective; Environmental Considerations and IT Enabling; Modularization design; Approach to installation conditions and piles; Development History of Gyropress Method and many more associated innovations.

COVID-19 pandemic encourages the Research Committee of International Press-in Association (IPA) to conduct the 12th IPA Press-in Engineering Seminar in an online (Zoom meeting) platform. Ms. Hongjuan He reported that the seminar was attended by more than 100 participants from all over Japan. What a good start! For young members column, Dr. Adnan Anwar Malik and Mr. Marc Arthur Go shared their background and views on this particular technology. Lastly, Prof. Malcolm Bolton publishing **"New Horizons in Piling"**. This book serves as an introduction for readers who are not familiar with Press-in piling. You may place your order now. I hope this book will inspire many more in appreciating the beauty of this technology.

We look forward to your contributions for the coming newsletter and support to share it widely within your professional networks. I hope you enjoy your reading!

Nor Azizi Bin Yusoff

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