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News Letter

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Messages
From the Vice President

Nor Azizi bin Yusoff
Head of Center
Research Center for Soft Soil (RECESS), UTHM, Malaysia

I am delighted to write this short message for the IPA Newsletter. I still clearly remember, my journey with IPA started in 2007 as a postgraduate student with Prof. Adrian Hyde at The Sheffield University, United Kingdom. The experience was wonderful! I have been given a chance to develop a Rowe Cell-Vane Shear Apparatus and exploring the relationship between Press-in Technology and the rate effects. I would like to take this opportunity to thank Prof. Adrian Hyde for bringing me to IPA. These beautiful journeys inspired me to know more about this technology and try to widespread the advantages of the technology to the construction industry, mainly in Malaysia and if possible, the Asia Pacific region. I returned back to Malaysia in 2011 and from there I initiated various activities to promote the R&D and implementation of Press-in Technology for construction industry in Malaysia. I am now the Head of Research Center for Soft Soil (RECESS), Institute for Integrated Engineering (IIE), Universiti Tun Hussein Onn Malaysia (UTHM) and at the same time as a lecturer at The Faculty of Civil and Build Environment. The profession allows me to link the academic needs and the needs of the country in a context of civil engineering.


NATION
Quiet start to remedial piling wor

For developing countries such as Malaysia, the implementation of Press-in Technology is still at the elementary level. The first Press-in construction project can be traced back in 2006. Since that, many more construction projects using the technology was triggered. However, the implementation level is still very low. In order to enhance the application, there are many stakeholder's engagements that had been initiated with the relevant industries, young engineers, university students and even at the school level!

Fig. 1 Local media reported the first project in Malaysia

In my point of view, the stakeholder's engagements are necessary in promoting the Press-in Technology as the applicable state-of-art technology. I believe this should be a great step for the Press-in technology to be appreciated and penetrated into the real world, not only in Malaysia. Therefore, I would like to encourage everyone to share our technical knowledge of Press-in Technology to as many people as possible. It is not only good for IPA, it is also will hopefully leading the world towards more sustainable and greener way of life. For the start, we may contribute our ideas and research findings through the next coming edition of this IPA Newsletter. Let's join us!

◆ A brief CV of Dr. Nor Azizi bin Yusoff

Nor Azizi bin Yusoff got Bachelor and Master from Universiti Teknologi Malaysia and received PhD from The University of Sheffield in 2011. He joined Universiti Tun Hussein Onn Malaysia as a lecturer since 2002, he is the head of center right now. He has engaged in a number of research projects and consulting works on a wide variety of geotechnical engineering fields. He did research collaborations with IPA, GIKEN LTD., AtsuNEW Giken Pte. Ltd. and other organizations to disseminate the Press-in Technology.

Messages
From the New Director

Junichi Koseki

Professor, Department of Civil Engineering
The University of Tokyo

I am delighted to write a message for this issue of IPA Newsletter. As one of the new directors who joined IPA Board this year, I would like to introduce my research interests, while touching on their possible links with the Press-in Technology. For my bachelor and master thesis researches in the middle of 1980's, I conducted a series of triaxial and torsional shear tests at the Soil Mechanics Lab. in the Univ. of Tokyo to study liquefaction properties of saturated sands. After I started working as a researcher at Public Works Research Institute, Japan in 1987, I enjoyed the opportunities of conducting many model shaking tests to reveal effects of several types of ground improvements against earthquake-induced liquefaction. Even after moving back to the Univ. of Tokyo in 1994, I maintained my research interest in the liquefaction and its countermeasures.

One of the popular countermeasure methods adopted in Japan is sand compaction piles, on which my colleagues and I are currently conducting model tests by putting efforts to simulate the process of executing the compaction procedures employed at the construction sites as closely as possible. In the course of this research, I have realized that the pre-stressing effects induced by the compaction process on the liquefaction resistance of surrounding soils are significant, which would also be the case with soils near the Pressed-in piles. Another research topic I would like to mention herein is the use of AE (acoustic emission) in geotechnical engineering. After having experiences with applying this technology to non-destructive monitoring of subsoil behaviors during model pile penetration, we are currently working on evaluation of soil particle interactions, including particle crushing and inter-particle sliding, in triaxial tests on different types of soils. Meanwhile, I have learned that such microscopic behaviors are closely related with formation of failure planes (or shear bands) and change in local densities (either densification or loosening). Similar responses may be observed with the soils near the Pressed-in piles, which would increase the degree of soil heterogeneity, and thus lead to greater complexities as well.

Let me conclude my message by adding my personal expectation on the effective use of the data that are monitored and recorded during the Press-in process. By collecting and analyzing reliable sets of data, together with the information on the actual soil conditions, I do hope that they can be used in a supplemental manner for characterizing the in-situ soil conditions, which would also enable us to execute the Press-in works in a more rational way.

◆ A brief CV of Prof. Junichi Koseki

Junichi Koseki is a professor at Department of Civil Engineering, the University of Tokyo (Utokyo). He obtained his Bachelor, Master and Doctoral degrees from UTokyo. During the period of 1987-1994, he worked as a researcher at Public Works Research Institute, Ministry of Construction, Japan. In 1994, he moved to UTokyo as an Associate Professor at Institute of Industrial Science. After promotion to a Professor in 2003, he moved to the current position in 2014. His research fields include liquefaction and its countermeasures, deformation and strength properties of geomaterials, and seismic behavior of earth structures. He received the C.A. Hogentogler Award from Committee D-18 on Soil and Rock, ASTM in 2000 and 2004, and the Best Paper Awards from the Japanese Geotechnical Society in 2007, 2009, 2010, 2012 and 2016. He was also the 2010-2011 Mercer Lecturer endorsed jointly by the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) and the International Geosynthetics Society, and the fifth Bishop Lecturer endorsed in 2019 by TC101 of ISSMGE on laboratory stress strain strength testing of geomaterials.

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Special Contribution

Updating Dutch national guidelines for determining the axial capacity of piles in sand

Kenneth Gavin

Professor of Subsurface Engineering, Geo-Engineering Section
Delft University of Technology

Introduction

The Cone Penetration Test (CPT) developed in Delft in the 1950's provides a continuous indirect profile of the strength and stiffness of soil. The test is currently one of the most widely used in-situ test methods in both the onshore and offshore sectors. The widespread use of the CPT and the similarity between the stress-strain response during installation of the cone and displacement pile installation has resulted in the development of many direct correlations between CPT end resistance, q_c and pile resistance. In the current Dutch code, the pile shaft and base resistance components are linked directly to the cone end resistance, q_c measured during the CPT test using constant reduction factors α_s and α_p for the unit shaft, τ_f and the base resistance, $q_{b0.1}$ mobilised when the pile base displacement reaches 10% of the pile diameter:

$$\tau_f = \alpha_s \cdot q_c \qquad (1)$$

$$q_{b0.1} = \alpha_p \cdot q_c \qquad (2)$$

A range of constant α_s and α_p values for common pile types used in Dutch practice are shown in Table 1.

Table 1. α_p and α_s factors from the 2017 Dutch Standard.

Pile type	α_p	α_s
1. Driven pre-cast concrete closed-end	0.7	0.01
2. Driven Steel Tube with closed end	0.7	0.01
3. Driven Steel tube with open end	0.7	0.006
4. Screw injection Pile (SiP)	0.63	0.009

Because of the inherent variability of natural soils and the large strains necessary to form pile foundations, a number of features affecting the axial behaviour of deep foundations are poorly understood. Recent research on displacement pile behaviour indicates that the soil state around a pile that governs axial capacity is affected by issues such as cyclic degradation of shear stress due to installation (friction fatigue), residual stresses, soil ageing, plugging and pile roughness amongst other factors (Randolph 2003, Gavin et al. 2015 and Jardine 2019). For the displacement pile types no's 1 to 3 in Table 1 the α_s values from the current standards do not directly account for any of these impacts. The shaft and base resistance factors in Table 1 are amongst the highest values in use across Europe. However, Van Tol et al. (2015) note that there are hidden safety factors included in the design approach. One of which is that the design q_c value is limited. In Eqn.1 this limit is between 12 and 15 MPa, depending on the thickness of the soil layer. The design q_c used in Eqn.2 is determined using the Koppejan averaging technique. The base resistance determined is then limited to a upper-bound value of 15 MPa. This averaging method typically results in a lower design value than for other popular methods e.g. the French method where q_c design is determined by averaging q_c in the zone ±1.5D around the pile tip, See Gavin et al. (2019).

In order to update the Dutch design code a national research project was initiated with the aim to:

1. Perform full-scale pile tests in two distinct geological formations on the 3 most common pile types used in the Netherlands. These tests will be used to investigate installation effects, friction fatigue, residual stresses, ageing and whether limiting values of shaft and end bearing resistance are necessary for design.
2. Centrifuge tests will be performed in the small centrifuge at TU Delft and the large centrifuge at Deltares will investigate the effect of layering and CPT normalization method on the q_c reduction factors.
3. Through a combination of field measurements and probability based numerical modelling, pile design factors for use in design codes will be determined. Machine learning approaches will be investigated for developing geological and pile response models using more than 100,000 CPT profiles available at the first field test site located in the Port of Rotterdam.

4. Life-cycle analyses will consider the life-time capacity of the different pile systems (as influenced by both the geological and loading history) their costs (financial and environmental) and assess their long term impacts.

The project is being undertaken by a consortium including TU Delft, Deltares, Port of Rotterdam, Fugro, Rijkswaterstaat, Gemente Rotterdam and the Dutch Piling Association.

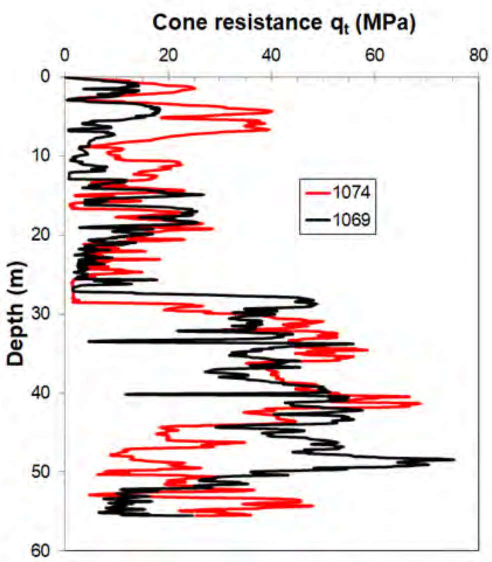
Work Completed to Date

The project started in October 2019. To date the first field test programme has been completed with a series of load tests being performed at in the Maasvlakte II region of the Port of Rotterdam in December 2019 and January 2020. Details of the test piles are given in Table 2.

Table 2. Piles tested at Port of Rotterdam

Pile type	Pile No.	Penetration Length (m)
Driven pre-cast concrete	1	31.74
0.4m square	2	31.29
	3	31.80
Driven Steel Tube with closed end	4	32.50
Shaft casing diameter 0.38m	5	32.47
Base plate width 0.48m	6	32.47
	7	32.46
Screw injection Pile (SiP)	8	37.02
Shaft casing diameter 0.61m	9	37.06
Pile base diameter 0.85m	10	34.98
	11	34.02

The CPT profiles at the test site are shown in Fig. 1a. The soil profile consists of a recent upper fill layer of sand (less than 10m thick) underlain by a mostly sand deposit interbedded with clay layers. Very strong Pleistocene sand deposits were located at approximately 29m below ground level with CPT values ranging from 20 to 80 MPa. This deposit was also interbedded with occasional thin, stiff clay layers. The test pile lengths were chosen such that all test piles were installed with the pile tip between 7 and 11 pile diameters in the very strong Pleistocene sand layer. The piles were all instrumented with two fiber optic strain gauge systems, BOFDA's that provide a continuous profile of strain along the pile depth and Fiber Bragg Gratings, FBGs that provide discrete measurements. The test site is shown in Figure 1b.



(a)

(b)

Fig. 1. (a) CPT profile at the test site (b) Set-up of the load test frame over one pile

The load-displacement response of the driven square precast concrete piles are shown in Fig. 2. The first two tests were performed between 4 and 5 weeks after installation. In order to check whether an additional aging period provided enhanced the final pile was tested 11 weeks after installation. The overall load-displacement response of all piles was similar. The driven steel tubes developed capacities of between ≈ 7MN and 9.5 MN. In order to check the sensitivity of the resistance of SiP piles to the q_c in the vicinity of the pile base, two piles were installed to shorter lengths with the bases near the weaker sand layer. The shorter piles had capacities of 18-19 MN, whilst the longer piles developed capacities of 21 to 24 MN. The results of the tests are currently being analysed and reports are being prepared with updated α_s and α_p values and recommendations for the adoption of unlimited q_c values in Eqn's 1 and 2. According to the national design rules these results can only be applied at this site or one with very similar soil conditions. In order to change the values in Table 1 a 2nd test site in a geologically diverse material is required.

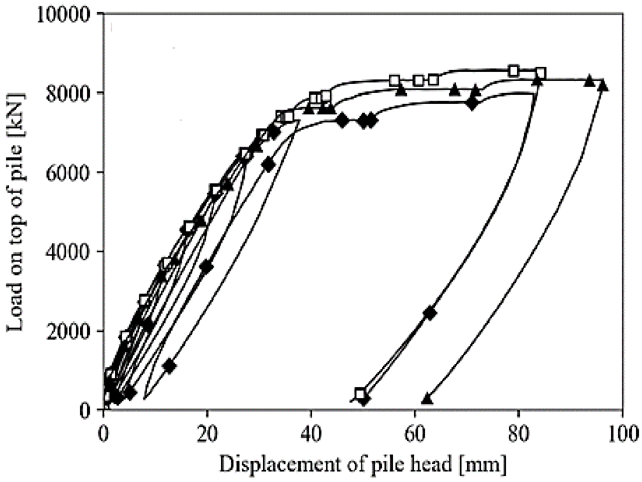
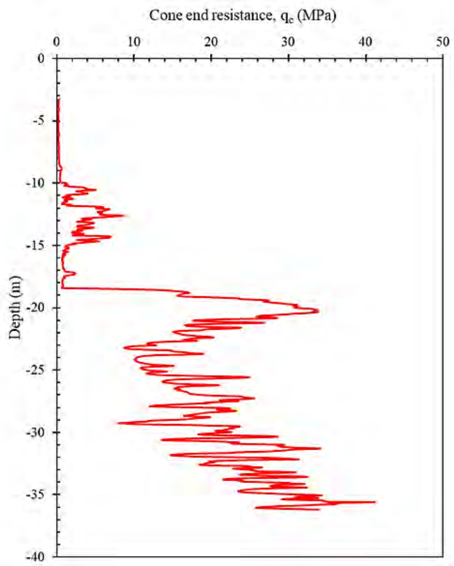


Fig. 2. Load-displacement test results from driven concrete piles at Port of Rotterdam

Work Ongoing

The Maasvlakte is an area of reclaimed land and therefore the ground conditions e.g. the absence of upper soft organic deltaic soils evident over much of the Western Netherlands and the very high CPT values of the deep Pleistocene sand are not typical Dutch soil conditions. They even differ from the conditions found in the city of Rotterdam and the majority of the Port area. In order to verify if the findings from this test site are nationally applicable a second test in more typical conditions is required. The Randstad is a megalopolis containing the four biggest cities (Amsterdam, Rotterdam, The Hague and Utrecht) in the Netherlands, the ports of Rotterdam and Amsterdam along with Schiphol airport. The region is home to half the population of the Netherlands. The majority of this area is underlain by the Kreftenheye formation derived from fluvial deposits originating from the Rhine river system. A sand layer with CPT q_c values typically between 15 MPa and 60 MPa is found at about 20m to 25m below ground level in this formation. The 2nd test site for the project was chosen at the headquarters of project partner Deltares. The CPT profile at the site is shown in Fig. 3a, the piles will be installed to the lower sand layer with CPT q_c of around 15 to 30 MPa.

Centrifuge testing will involve creating uniform sand samples at a range of q_c value from 10 to 50 MPa in order to investigate limiting shaft and base resistance values. In addition the effect of layering on pile base resistance will be undertaken. The tests will be performed in the small centrifuge at TU Delft and a new centrifuge that will be opened in Deltares in 2020. This new facility is an Actidyn C72-31 beam type centrifuge, with a platform radius of 5.0 m, See Fig. 3b. The project expects to provide an updated National guideline document by 2022.



(a)

(b)

Fig. 3. (a) CPT Profile at the 2nd test site (b) Geo-Centrifuge at Deltares

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A brief CV of Prof. Kenneth Gavin

Kenneth Gavin is a Professor of Subsurface Engineering at TU Delft since April 2016. He received his Bachelor's degree from Queens University Belfast in 1994 and his PhD in Geotechnical Engineering from Trinity College Dublin in 1998. Ken worked for Arup Consulting Engineers before moving to University College Dublin in 2001. His main fields of research relate to the performance of pile foundations and the impact of climate change of civil engineering infrastructure. In the area of pile foundations, he has been involved in a number of Joint Industry Projects in the offshore wind sector. Regarding the impact of climate change he has led a number of European collaborative research projects with a particular focus on ageing rail infrastructure. Throughout his academic career Ken has continued to provide consulting services on technically challenging projects across the globe.

Serial Report

Development History of SILENT PILER (Part 1)

Masaaki Ono

Director, GIKEN LTD.

The Birth of SILENT PILER

The history of the "SILENT PILER", a hydraulic pile press-in/extraction machine begins in 1973, when Mr. Akio Kitamura, a founder of GIKEN LTD., brought the idea to Mr. Yasuo Kakiuchi, a former president of Kakiuchi Shop (currently known as KAKIUCHI Co., Ltd.), who ran a machine manufacturer locally in Kochi City, Kochi Prefecture, Japan.

At that time, excessive vibration and noise generated in foundation works, especially when steel sheet piles were driven in for earth retaining walls, were social problems as a form of industrial pollution. To their best knowledge then, there was no pile driving machinery anywhere in the world, not to generate noise and vibration.

Mr. Kitamura, who held up the sign of a "company with antipollution measures", felt that his own company should not be a source of construction pollution and explored ways to install steel sheet piles using a completely different system from conventional impact or vibratory hammers. One day, he recalled a scene from the construction site for a new hotel where a hole passed through the H beam for the earth retaining wall was cracked by the lifting wire when it was pulled out by a service crane. It was often experienced at construction sites that temporarily installed steel sheet piles would not be easily pulled out due to soil sticking around them. This vivid memory brought a great idea to him. Paying attention to the fact that "piles once driven would not come out easily", he came up with a system to install a pile, gripping some piles previously driven in, and using their resistant forces against being pulled out as a reaction force.

Photo 1. Model KGK-100A

Based on this idea, Mr. Kakiuchi and Mr. Kitamura worked together by trial and error, from design to production. In the development, nothing could be referred to as a model, so the required movement and force of each machine part were decided by Kitamura's intuition and experience. Then, in 1975, the first memorable unit was finally completed. Mr. Kitamura named it "SILENT PILER", which literally means "a quiet piling machine". Taking the initials of Kitamura, GIKEN, and Kakiuchi, and the press-in force capacity of the unit (100 tons) into consideration, the machine model was named “Model KGK-100A” (Photo 1).

Practical Use and Commercialization

The initial unit was a prototype to demonstrate Kitamura's idea. He immediately asked Mr. Kakiuchi to design and manufacture a practical version. He made it an absolute requirement for the practical type itself to be as lightweight and compact as possible. The machine was thus made significantly lighter and smaller by separating the hydraulic pump of the power source from the machine main body, and a remote-controlled operation was selected to improve its operability. Consequently, the model KGK-100B (Photo 2) was completed as the second unit.

From the model KGK-100C which is the third unit, preparations were made to commence examining the quality of some main components (i.e. the use of cast steel for structural parts) and producing commercial units. However, due to insufficient strength of the components, failures such as broken centre shafts and cracked clamps occurred, and further improvement was essential to achieve the required performance close to that of the original concept.

There were some problems still remaining in the model KGK-100D (Photo 3), which is the first commercial unit. It was assumed that the machinery might break down on site, which customers understood before the purchase. Predictably, mechanical failures frequently occurred. The quality of the main components (i.e. Chuck, Clamps) as well as a hydraulic system composed of pumps, valves, joints, motors and other apparatus was still low and their strength was not sufficient for the piling operation. In any case, the machinery did not reach a high degree of perfection. However, with the sale of four units in the following three months, Mr. Kitamura decided to establish a manufacturing and sales company, Giken Seisakusho Co., Ltd (currently known as GIKEN LTD.). To become a full-fledged construction machinery manufacturer, it was necessary to supply high-performance machinery in a stable manner and to provide mechanical support that would be trusted by customers, thus, a new maintenance plant was built. By improving the maintainability and durability of the machine, the model KGK-100H (Photo 4) was produced through the use of high-quality parts and the technical knowledge already accumulated.

Approximately 100 units of the first mass production machine, the model KGK-100H, were sold from 1978. The SILENT PILER began to be sold widely as an industrial product manufactured on the production line. In addition, any newly developed machine was subjected to proof testing in the construction department of GIKEN before marketing. This way, the production perfection was being improved.

Photo 2. Model KGK-100B

Photo 3. Model KGK-100D

Photo 4. Model KGK-100H

Self-Walking Function

In 1981, GIKEN launched the model KGK-80C, the first model with a self-walking function in the first in-house design. For the SILENT PILER the self-walking function was truly revolutionary. Heavy cranes to move machine locations were no longer needed. The function also enabled various piling systems in places with overhead restrictions such as power lines and bridges, and in places close to existing structures. Firstly, the press-in force was reduced from 100 to 80 tons by narrowing down the practical range of the press-in force and four clamps were reduced to three, which meant that the weight of the main body was reduced to 5.8 tons. In addition, the installation method of the main cylinder was changed. Before the model KGK-80C, the tube side of the main cylinder had been fixed to the leader mast, and the machine height was the same at the top and bottom of the press-in stroke (Fig. 1).

In contrast, the KGK-80C aimed to slim down by reducing the machine height at the lowest position of the press-in stroke, fixing the rod side of the main cylinder to the leader mast. It was also successful in simplifying the mechanism by eliminating the auxiliary cylinder required when pulling out piles. Furthermore, the chuck-up speed in no-load state was greatly improved, incorporating a hydraulic differential circuit. The most important improvement beside the weight reduction was to install two sheet piles: one adjacent to the reaction piles and the other to the following pile, using the same reaction piles by moving the saddle and slide frame, enabling press-in piling machines to self-walk on previously installed piles rather than relocating by a service crane.

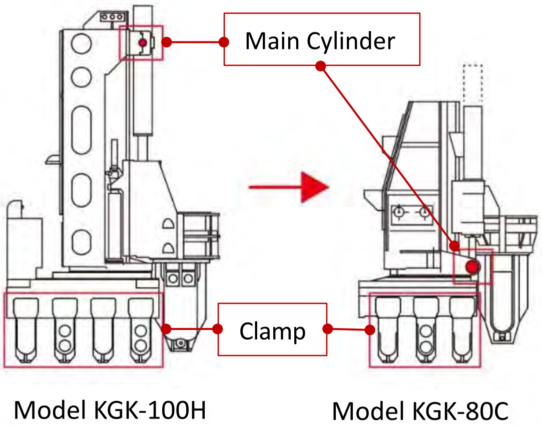

Fig. 1. The difference of 100H and 80C

By the end of 1985, two models, the model KGK-80C4 (Photo 5) and model KGK-130C4 (Photo 6), could self-walk at right angles. These models were equipped with a function so that two piles right and left could be installed from the same location before the machine self-walks to the corner, achieved by modifying the way to grip and rotate a pile in the chuck. Hence, improved drivability by easing restrictions and keeping reaction force on the corner piling was achieved (Fig. 2).

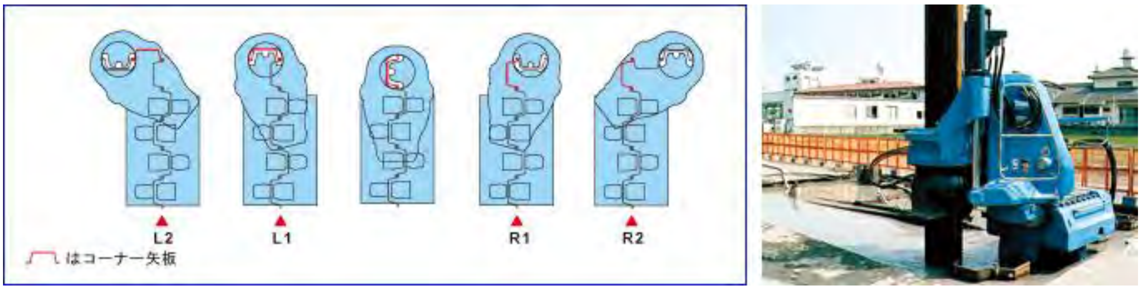

Fig. 2. Corner installation

After that, the following model FT70 (Full-turn 70) (Photo 7) was launched in 1987. The most important function was to set the top of the previously installed pile, which is behind the machine, on the ground level, by rotating the leader mast 360 degrees on the centre pin and re-pressing it in.

Photo 5. Model KGK-80C

Photo 6. Model KGK-130C 4

Photo 7. Model FT 70

Automatic Operation and Optimal Design

In 1991, the model AT Series was unveiled. In fact, they were the first machine equipped with a computer control technology (Photo 8). The advantage they offered was to enable automatic pressing-in and extracting operations, which let operators to start improving their productivity. In terms of mechanical appearance, the rounded shape was adopted to disperse stress, like a light but strong "eggshell." The components were made of a special cast steel with excellent toughness and hardness, manufactured by Sumitomo Heavy Industries Cast and Training Co., Ltd. (currently known as SUMITOMO HEAVY INDUSTRIES HIMATEX CO.,LTD.) at the request of GIKEN. The cast steel was twice as strong as conventional ones at that time. It greatly contributed to the realization of optimal design, such as reducing the thickness of the components for considerable weight reduction.

In 1995, the SA Series was developed. While the automatic operation system of AT Series controlled the press-in/pull-out stroke on an hourly basis, a more accurate automatic operation became available with the SA Series, by adopting a magnetic type stroke sensor that could detect the upward and downward motion distance of the chuck, and controlling the settings of the press-in and extraction forces together (Photo 9). In addition, the development of the super jet reel for the water jetting* that could be easily attached to/detached from the main body of the press-in piling machine, was a great innovation that improved the drivability and workability of piling operations (Photo 10).
*Water jetting is a type of driving assistance where piles are installed while injecting pressurized water into the ground from a nozzle, fitted onto the pile toe, to reduce penetration resistance (toe resistance, shaft resistance). It may also reduce interlock resistance.

Photo 8. Model AT90

Photo 9. Model SA75

Photo 10. SA75 with super jet reel

Model Applicable to Hard Ground

The Crush Piler SC100 (Photo 11) was the first model applicable to hard ground, of which the development began after the SA Series in 1997. Former units of SILENT PILER had a weakness in that it was difficult to install piles into hard ground. Even press-in piling assisted with water jetting was not able to install piles into stiff and hard ground such as cobbles, boulders and rocks.

Mr. Kitamura was aware of the need for machines applicable to hard ground since the beginning of the first unit development. He had repeatedly produced prototypes since the 1980s. At last, in 1997, the piling technique " simultaneous inner augering" was established in which a casing auger was mounted on the chuck. The gravel was bored with it, then the pile was pressed in while extracting the casing auger. The product was introduced to the market as a Crush Piler SC100.

In the following year, the successor model SCU-400M (Photo 12) applicable to harder ground conditions was developed. This model accomplished difficult construction to install steel sheet piles into weathered rock, including approximately 5m diameter boulders in Hong Kong. With the model SCU-400M, the driving assistance applicable to hard ground was improved, and applicable ground conditions were dramatically expanding.

Starting with the model SCU-400M, various augering parts (i.e. casings, augers and other apparatus) were developed and improved, particularly auger heads which affects the performance of Crush Piler. Hence, the shape of auger heads, and the material, shape, arrangement and angle of bits were further developed, in order to enhance the boring performance while minimizing the impact on surrounding ground (Photo 13).

Photo 11. Model SC100

Photo 12. Model SCU-400

Photo 13. Various auger heads

To be continued

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Reports

Recent technological development at Japan Construction Method and Machinery Research Institute

Hiroyuki Takenouchi

Engineering Adviser
Japan Construction Method and machinery Research Institute

Outline of Japan Construction Method and Machinery Research Institute

History and research philosophy

Japan Construction Method and Machinery Research Institute (JCMMRI) was established in October 1964 as an affiliated organization of Japan Construction Machinery and Construction Association (Photo 1). The purpose of its establishment is to contribute to our nation's economic development by promoting technology improvement and rationalization of construction projects through research and testing in the area related to construction machinery and mechanized construction works.

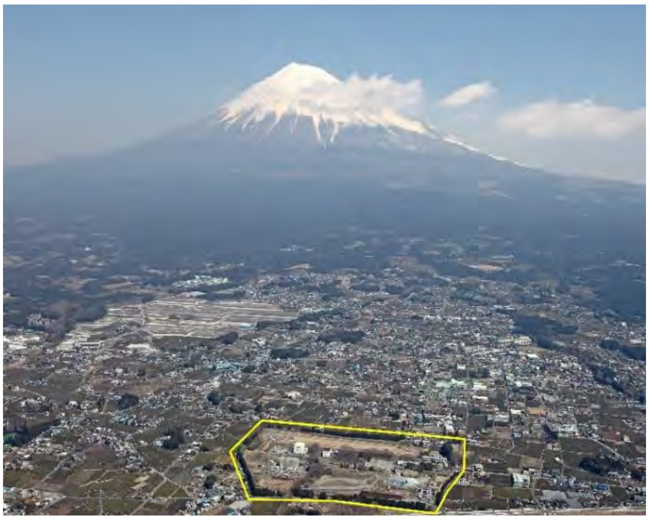

Photo 1. JCMMRI at the foot of Mt. Fuji

Ever since the establishment, commissioned by related organizations such as the national government and private companies, we have been conducting various tests, surveys and researches on construction method and machinery in wide diversity of works and projects such as roads, bridges, tunnels, and dams, including notable major projects in Japan for more than half a century. We have also focused on construction safety and environmental issues such as noise, vibration, and exhaust gas countermeasures.

We are determined to play the leading role as Japan's only comprehensive testing and research institute for construction machinery and mechanized construction, while maintaining the tradition of "think with our own head, investigate with our own feet, and test with our own hands" from the beginning.

Activities

The work carried out by JCMMRI covers a wide range of fields, such as research and study, performance test and evaluation, technology development, and technical support. In addition to on-site survey and experiments using test facilities, we also perform all kinds of work related to construction technology which requires advices and judgment as the third party, such as surveying and analysis on construction productivity data and equipment ownership cost for construction cost calculation.

Researches and studies have been conducted on various issues related to construction methods, maintenance of structures, and construction machinery throughout construction work. As the recent tendency, the number of researches related to maintenance, repair and reinforcement is increasing, as the importance of maintenance has been strongly called out again. As for bridges, for examples, we are taking measures to prevent fatigue damage to steel decks, fatigue durability of bridge expansion joints and PC decks used for floor deck replacement work (Photo 2). As for tunnels, field verification of Robot technology for the purpose of inspection developed by private companies was carried out (Photo 3).

Photo 2. 4MN fatigue testing machine

For construction machinery, we have been conducting research on performance improvement and development of new models in the fields of disaster prevention and restoration measures, environmental measures and safety measures. Performance tests, evaluations and ratings are also conducted. Automatic control and remote operation have become recent important issues for snow removal work (Photo 4) and early recovery work from natural disasters to reduce social impact. With regard to information and communication technology-oriented construction, so called ICT-construction, which has been strongly promoted by the Ministry of Land, Infrastructure, Transport and Tourism, we have been providing support for the vision and strategy, and spreading the actual practice in construction field (Photo 5). We also have been engaged in the establishment of technical standards for ICT-construction by making use of our accumulated knowledge on elemental technologies such as machine control and machine guidance and 3D measurement technology.

Photo 3. Verification test in the simulated tunnel

Photo 4. Automatic control of snow removal work

Photo 5. Hands-on workshop for ICT-construction

Technology development such as new models, new methods and new materials has been conducted through joint research projects with construction companies and private companies handling construction machinery and materials, in addition to contracting from the ordering party. In this report, two cases of recent technical development through joint research with private companies and universities are introduced.

Case (1) Development of Multi-divided Precast Lining System for Mountain Tunnel

Background and purpose

It is assumed that securing labor will become more difficult due to the shortage of manpower in the construction industry from now on, and improving productivity to reduce the number of workers in construction is one of the urgent tasks to be tackled today. In the construction of mountain tunnels, there often occurs cases where rapid construction of the entire tunnel work is required to shorten the construction period or to recover the process delay. For such cases, in general, application of precast lining can be considered as a rapid lining work. But, in the current precast lining work, the size of precast members is significantly large because the lining is commonly divided into two sections. This leads to the difficulty of transportation, loading, and erection of precast members during excavation work going on at the same time. And so, the applicability in a narrow tunnel space becomes an issue. With these backgrounds, aiming at significant improvement of the productivity of the lining concrete construction, the joint research team has been developing Multi-divided Precast Lining System that enables more than double the speed of conventional construction.

Outline of Multi-divided Precast Lining System

Multi-divided Precast Lining System was developed for highway tunnels with two lanes where the general cross section is about 80 m^2. The basic structure of multi-divided precast lining consists of 6 pieces for 1 ring with the width of 1.0 m. The arc length of one piece is reduced to about 2.8 m, one-third of the conventional one, so that workability of transportation, loading and erection can be greatly improved. For the purpose of quick assembly, the wedge joint between pieces and the pin insertion joint between rings are adopted, which are common in shield tunnel construction (Fig. 1).

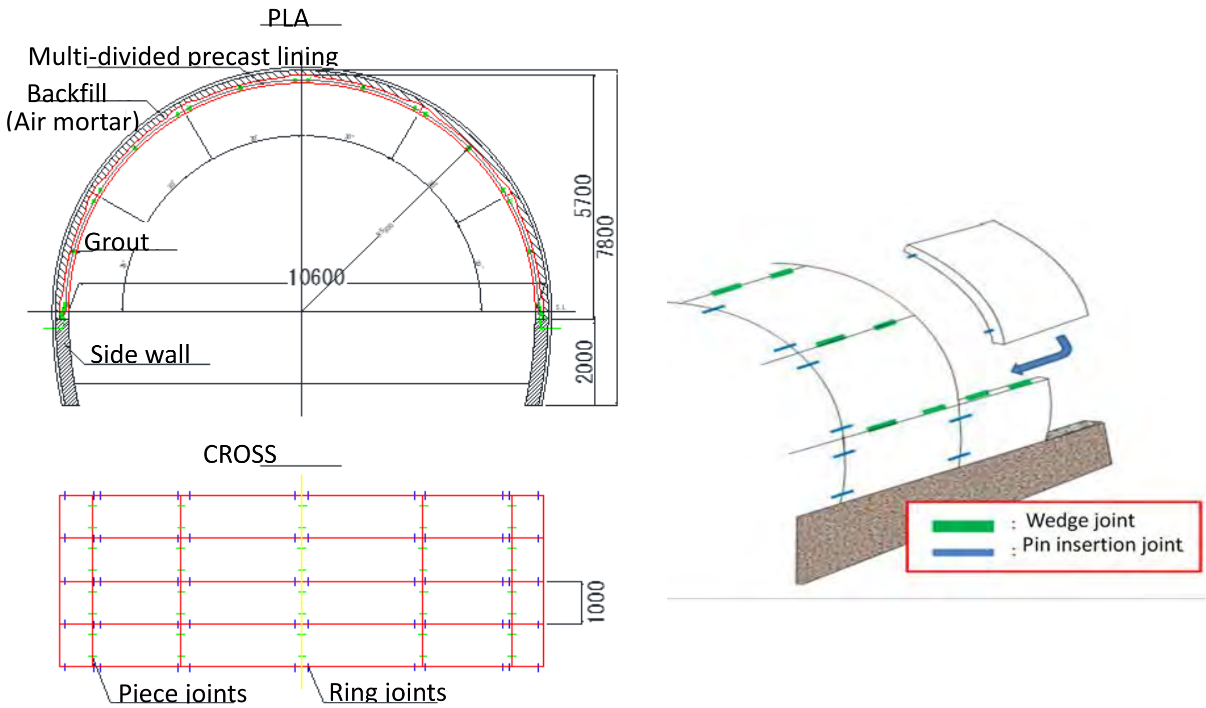

Fig. 1. The basic structure of multi-divided precast lining

The connecting part of the leg of the side wall concrete is designed as a pin structure, and the wedge joint between the pieces is designed as a rotating spring structure. As for the ring arrangement in the tunnel axial direction, the straight joints arrangement was adopted after the study on both of staggered arrangement and straight joints arrangement. Regarding the structural stability, following three states were examined; the self-supporting state after the ring was erected, the biased pressure loading state during backfilling performed from the grout holes of each piece, and the loading state of the ground load after backfilling.

The erection machine for the multi-divided precast lining system is a gantry type, unlike conventional heavy machines, that allows other vehicles to pass through the lower space. Therefore, excavation work and lining work can be done in parallel. This erection machine is composed of an erector-equipped assembly device and a shape retention device for retaining the ring shape after assembly (Photo 6). It travels on rails installed on the tunnel roadbed in the same manner as the travelling arch center. Multi-divided precast linings are erected by the assembly device in order from one side, and the shape of the erected linings are maintained by the shape retention device immediately after erection.

Photo 6. Erection machine for multi-divided precast lining

Full-scale verification experiment

2 rings of full-scale precast lining were assembled on the steel pedestal to check the assemble performance. And, assembled precast lining was jacked down to stand by itself to confirm the stability in the state (Photo 7). No significant deformation was observed in the self-supporting state.

In addition, the bending test of the joint specimens of 2 pieces was carried out, and it was confirmed that the breaking load was higher than the design bending proof load specified by the material.

Photo 7. 2-ring assembled precast lining

Future outlook

Currently, in parallel with the experiment, we are comparing the performance of the multi-divided precast lining and the conventional lining by non-linear analysis. Demonstration tests are now being carried out in the full-scale simulated tunnel to confirm the workability (Photo 8). After the experiment, we plan to apply this system to new tunnel constructions and renewal projects that require rapid construction of lining concrete.

This research and development have been carried out by the joint research with Shimizu Corporation and IHI Kenzai Kogyo Co., Ltd.

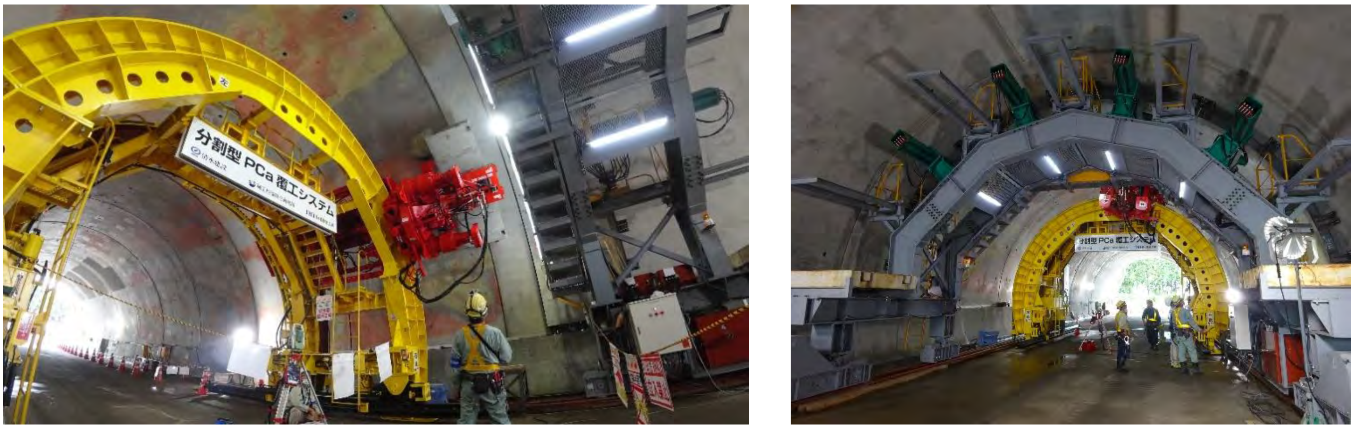

Photo 8. Demonstration test in the simulated tunnel at JCMMRI

Case (2) Development of On-Site Shot Printer

Background and overview

In the field of concrete, as one of the three pillars of i-Construction undertaken by the Ministry of Land, Infrastructure, Transport and Tourism, precast construction with factory products is being promoted. But there still exists more room left for research and development in this field, compared to productivity improvement in other fields. The joint research group has reached to the idea that the technology improvement required by the present society for the concrete field is not only the shift from on-site casting to application of precast factory products, but the development of a concrete structure manufacturing technology based on a completely new concept. Based on this idea, the group has been promoting research and development focusing on the resent 3D printing technology. In this research, we proposed a technology to build concrete structures by direct print modeling on-site, namely On-Site Shot Printer system. This technology is a combination of 3D printing technology and ICT construction technology, which have been active in recent years. In order to realize this system, the spraying technology of cement-based material, which is indispensable to this system, was deeply studied and succeeded to develop a new hybrid spraying system that has the advantages of conventional technologies of both "dry mix shotcrete" and "wet mix shotcrete".

Hybrid Spray System

Direct print molding on-site requires long-distance transport of material for molding. At the same time, it is important to secure the strength of the shaped article as a structure. The "dry mix shotcrete", in which the materials are individually conveyed and mixed and sprayed at the nozzle, is advantageous for long-distance transport. On the other hand, the "wet mix shotcrete", in which premixed materials are directory sprayed from the nozzle, is effective to obtain secure strength. Since both performances are necessary for the On-Site Shot Printer, we have developed the new Hybrid Spraying System that has the advantages of both technologies (Fig. 2).

In order to confirm the performance of the Hybrid Spray System, we conducted a spraying experiment aiming at the material transport distance of 160 m (the maximum performance of the system is 300 m) under the conditions that discharge volume is 18 kg / min and mortar flow is 170 mm. As the result of this experiment, it was confirmed that the mortar was stably supplied and sprayed with expected quality by the Hybrid Spray System.

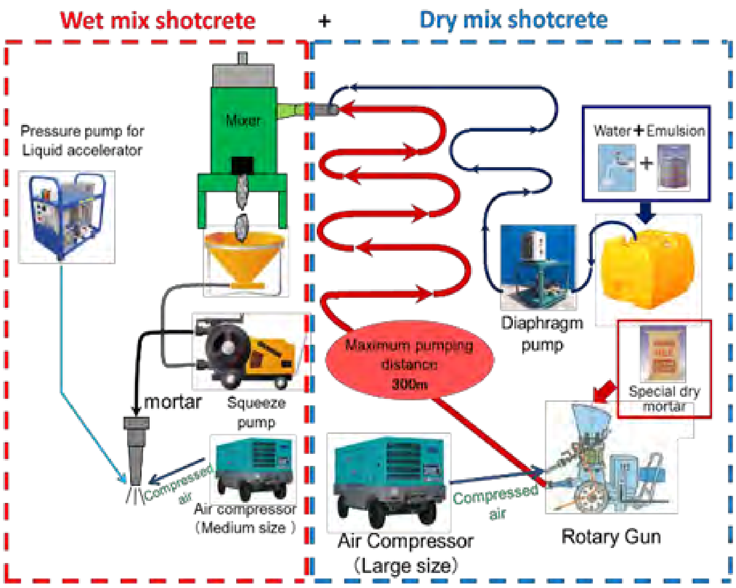

Fig. 2. Hybrid Spray System

Direct print molding on-site by utilizing ICT construction machinery

In order to build concrete structures by direct spraying on-site, the position and the movement of the spray nozzle must be properly and precisely controlled automatically. For this control, ICT construction equipment was decided to be utilized because they can be controlled by the computer program and is resistant to sever site conditions such as rain, wind and dust. The spray nozzle is attached to the bucket of the ICT aided hydraulic excavator. The position and the movement of the spray nozzle are controlled by the design data created and input to the ICT aided hydraulic excavator. By utilizing these ICT construction machine technologies, we succeeded in direct printing and molding concrete structures assuming walls and buried formwork at present.

Photo 9. Direct print molding of a wall

Photo 10. Direct print molding of buried formworks

Demonstration experiment was conducted at the field of JCMMRI. In this demonstration experiment, it was confirmed that a wall with about 1 m height and about 1.8 m width can be formed in about 60 minutes (Photo 9). Photo 10 shows a molding situation assuming buried formworks to be placed on the outer surface of a rectangular pillar with 1 m width × 1 m depth ×2 m height. It was molded up to a height of 1.5 m on each surface in about 25 minutes. These specimens were successfully constructed by direct print molding without any material crushing or peeling off.

Target utilization scene

At the present stage, the feasibility of using it as a buried formwork has been mostly verified, and the following uses are envisioned as directions for future research and development.

Phase1: Current stage
Buried formworks, especially for construction with difficulty in material transportation
Phase 2: Accurate and safe control stage (Fig. 3)
Large structural members of substructure such as abutment, pier, caisson, etc.
Phase3: Delicate control stage (Fig. 4)
Structural members of bridge superstructures such as floor slabs, guard walls, etc.

This research and development have been carried out by the research and development group consisting of Gifu University, JCMMRI, Sumitomo Osaka Cement, Shimizu Construction, NIPPO, Maruei Concrete Industry and FTS. It is supported by the Construction Technology R & D Grant System of 2019 (the Ministry of Land, Infrastructure, Transport and Tourism).

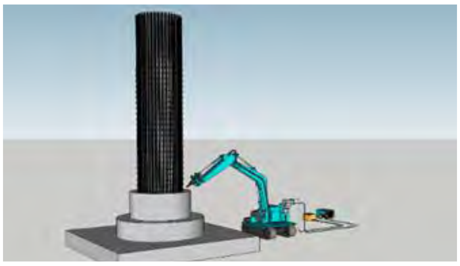

Fig. 3. Image of Phase 2

Fig. 4. Image of Phase 3

A brief CV of Mr. Hiroyuki Takenouchi

Hiroyuki Takenouchi is the engineering adviser of Japan Construction Method and Machinery Research Institute. He joined the institute upon graduating from the Department of Civil Engineering of Tokyo Institute of Technology in 1974. Since then he has engaged in a number of research and development works on wide variety of construction method and machinery. He specializes in strength and durability technology of structures such as bridges. He is also the President of MK Engineering Inc., engaged in consulting business to protect infrastructure with knowledge, practice, and industry-government-academia networks.

Reports
From IPA's Japan Regional Office

Yuta Kitano

Technical staff, ODA Promotion Section
GIKEN LTD.

I have been carrying out technical support for Japanese and overseas market with Giken subsidiaries and promoting Press-in Method in the world including ODA (Official Development Assistance) projects in GIKEN Head Office (Tokyo). We have invited a lot of customers from Netherlands, China, Thailand, etc. to Japan to visit Press-in construction sites. We are certain that this activity will help to promote Press-in Technology towards the achievement of Press-in construction.

The Press-in Method was recently utilized for two ODA projects for the first time in Africa. One of them was the retaining wall works which were part of major construction works for building new hospital facilities in Cairo, Egypt (Fig. 1). Since the working space was quite limited, the Silent Piler was utilized for the installation of sheet piles for building a cofferdam in order to avoid affecting adjacent buildings.

The other project is being carried out for repairing quays using the "Gyropress Method" for an ODA project at Dakar port in Senegal (Fig. 2). The Dakar port is extremely important for West African countries which are developing rapidly and for which the deterioration of port is a serious problem. Therefore, this project is planned to rehabilitate and renovate the port to accommodate bigger ships. This is one of the projects to which the Press-in construction site tour in Japan contributed.

For more information about above-mentioned projects, please refer to the following URLs.

https://www.giken.com/en/release/05_aug_2019/
https://www.giken.com/en/release/may_29_2019/

IPA launched TC5 (Technical Committee) titled "Influence of operator skill and experience on field performance of Press-in Piling" this year. The Japan Regional Office is supporting the TC5 activities. For example, we conducted a research survey together which was a comparison between "performance of Press-in Machine" and "operator's experience and skill". The research survey revealed that performance of Press-in Machine is affected by operator's skill and experience. We will continue focusing on this issue and conclude these data for improving Press-in technology all over the world with IPA.

I will keep supporting IPA's activities such as planning an on-site interview like I did last year, cooperating with TC5 and so on. I hope we can improve Press-in technology and contribute to the public through these activities.

Fig 1. CG of Cairo project

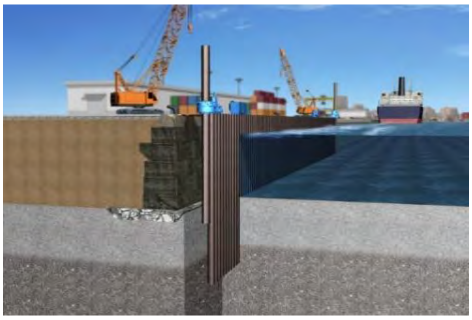

Fig 2. CG of Dakar project

Reports

Activity Report: IPA TC-5 "Technical Committee on Influence of operator skill and experience on field performance of Press-in Piling"

Shinichiro Sato

Department Leader, Construction Solutions Department
GIKEN LTD.

In order to correctly and efficiently install piles by the press-in piling method, in accordance with a construction plan, a press-in piling machine should normally perform and function as designed and an operator should operate the machine appropriately. However, actual piling operations are not usually conducted under ideal conditions. In reality, some mechanical accidents (i.e. malfunction, failure) and operator experience and skill are assumed to adversely affect the field performance.

The new IPA technical committee No.5 (hereinafter called IPA TC-5) is hereby established to clarify the various influences of operator experience and skill on performance in the field, by focusing on an aspect of press-in piling machine and operation. This committee plans to act for three years from the fiscal year 2020, and is composed of the following members: Dr. Osamu Kusakabe as chair (Executive Director, International Press-in Association), Mr. Kiyoshi Minami as co-chair (Muramoto Corporation), Mr. Masayuki Kitamura as secretary general (GIKEN SEKO CO., LTD.), seven additional members and me as deputy secretary general. Please note that we will always be looking for new members.

So far, one preparatory meeting was held in March 2020 and one technical committee meeting was held online in July 2020. Before the preparatory meeting, a questionnaire survey was conducted with some operators of the press-in piling machine. As a consequence of the discussion regarding the survey result, the members decided to conduct an additional questionnaire survey of initial settings and re-settings of press-in parameters (i.e. values of press-in force, press-in speed and so on) on rotary press-in piling operation (the Gyro-press method), following a request to analyze the quantitative data. Some useful information regarding the activity of TC-5 was acquired from these surveys.

This year, one paper will be prepared and submitted to the Second International Conference on Press-in Engineering (ICPE) 2021, which is to be held in Kochi, Japan, in June 2021, subject to confirmation. After the members of TC-5 approve the activity plan, an actual survey of the rotary press-in piling to install tubular piles and a questionnaire survey on the press-in piling to install steel sheet piles will be conducted in the fiscal year 2021. Additionally, an activity report on press-in parameters, information for automatic operation and Artificial intelligence (AI) training data will be prepared and submitted to the IPA.

I believe that our activity will be useful for the technological advancement of the press-in piling method. Should you have any questions or suggestions for us, please get in touch through the IPA Secretariat (tokyo@press-in.org).

Event Report

ATU-NET Virtual University Presidents Forum 2020 Series 2

Chun Fai Leung

President of IPA and Professor of National University of Singapore

Nor Azizi Bin Yusoff

Vice President of IPA and Senior Lecturer of Universiti Tun Hussein Onn Malaysia

The Asia Technological University Network (ATU-NET) was formed in 2016 with over 30 universities as its members. In view of Covid-19 situation, ATU-Net organized series of Virtual University Presidents Forum 2020 (Virtual UPF 2020). The Series 1 was held on 15th July hosted by Universiti Teknologi Malaysia (UTM). The Series 2 was held on 12th August hosted by Universiti Tun Hussein Onn Malaysia (UTHM) with the theme "Building Academic Resilience in the Post COVID-19 World". IPA President Prof. C F Leung and Vice President Dr. Nor Azizi Bin Yusoff were among the invited guests of Series 2. Over 80 delegates from Malaysia, Singapore, Brunei, Philippines, China, and Japan attended the online forum.

The Series 2 Forum started with the welcoming address and opening keynote by Prof. Datuk Ts. Dr. Wahid Razzally, Vice Chancellor of UTHM. He highlighted the issue of "How do we understand resilience as a process and outcome" and went on to emphasis the use of new capabilities and to build adaptability. This is followed by the guest of honor and distinguished speaker, Yang Berhormat Dato' Dr Noraini binti Ahmad (Fig. 1) who is the Minister of Higher Education of the Malaysia government. Besides welcoming the delegates at the Forum, her speech concluded with the keywords of "Planning, Adopting and Applying" to tackle the ever-changing circumstances arising from Covid-19. The next keynote speaker is Prof. Dr. Dayang Hajah Zohrah Haji Sulaiman who is the Vice Chancellor from University Technology Brunei. She highlighted the change in conducting lectures/tutorials and other practices in her university to overcome the Covid-19 crisis.

Fig. 1. Yang Berhormat Dato' Dr Noraini binti Ahmad, the Minister of Higher Education of the Malaysia presented her keynote address

After speeches from the ministry and universities, the next keynote speaker is from the industry given by Mr. Bruce Lim on behalf of JD.Com, a very large multi-national listed company originated from China. Mr. Lim discussed various issues concerning cross-border e-commerce which is certainly striving under the current Covid-19 situation. Prof. CF Leung then presented a keynote in the capacity of IPA President. He briefly introduced the activities of IPA and its next major conference ICPE 2021. By first highlighting the challenges faced by IPA such as face-to-face meetings could not be conducted among Board of Directors and technical committees, he emphasized the current adverse situation could provide opportunities for associations to strive. There will be no border among countries and associations from various countries can join hand to co-organize online events to attract many participations worldwide.

The Forum concluded with the launch of online classroom by ATU-NET.

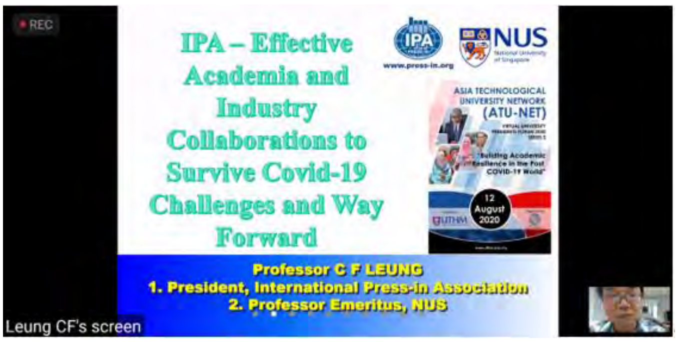

Fig. 2. Prof. C F Leung presented a keynote address in the capacity of IPA President

Fig. 3. The virtual environment of the attendees provided by Zoom e-meeting environment

Young Members Column

Hoang Thi Lua

Ph.D. Student, Kanazawa University

My name is Hoang Thi Lua and I am Vietnamese. I received my bachelor's degree in Hydraulic Engineering in 2011 and my master's degree in Geotechnical Engineering in 2014 at Thuyloi University. After graduation, I decided to pursue a teaching and researching career in the field of Geotechnical Engineering, so I came to Japan to start my Ph.D. course at Kanazawa University since 2017, and I am now a final year Ph.D. student.

My country, Vietnam - a developing country with a population of over 97 million - is experiencing a period of rapid economic growth. To make Vietnam an attractive destination for foreign investors, Vietnam has been investing a lot in human capital and infrastructure. In densely populated places such as big cities and industrial zones, new construction projects including residential buildings, hospitals, schools, roads, offices, factories and commercial centers are becoming increasingly common requirements. This calls for the need of civil engineers, especially geotechnical engineers to find safe, efficient, and economical construction solutions. While the need for infrastructure development is urgent, Vietnam also needs to address related challenges regarding local geological and geotechnical features, and natural disasters such as soft soil, complex groundwater, ground subsidence, soil erosion, landslides, and flooding. These demands require workers in the construction sector to improve their performance, learn from experiences, and update technology from developed countries to adapt to the demands of the country in the new era.

Ms. Lua (left side) at Geotechanoi 2019

My research topic focuses on pile foundation engineering, especially piled raft foundations supported by displacement piles which will be one of the economical and promising foundation solutions for the construction industry of Vietnam. As an important part of my research topic, I pay attention to pile-related issues. I have attended some geotechnical engineering conferences, read related papers to keep up with new information on the field of foundations in general and displacement piles in particular. Fortunately, Prof. Matsumoto introduced me to the International Press-in Association (IPA) as well as The Second International Conference on Press-in Engineering (ICPE) 2021 which will be held in Kochi. ICPE 2021 is really exciting to me, and searching on the internet, I have found useful information related to the IPA and ICPE, and the topic of ICPE really attracts me. I believe that I will gain a lot from IPA to improve my research. I will also introduce IPA to my colleagues so that more people may have opportunities to expand their knowledge and skills towards a more sustainable country development.

Wentao Guo

Master Student, Kanazawa University

Originally from Tianjin, China. Now I am a master student of Environmental Design at Kanazawa University, located in Hokuriku. Prior to that, I studied in the School of Architecture at the University of Tianjin. I moved to Kanazawa in the 2018. The Second International Conference on Press-in Engineering (ICPE) in Kochi will be my first time to attend an international conference as a student member, and it will be a good opportunity for me to learn and communicate with other researchers from all over the world.

My research focus on pile foundation, which is a foundation form with high bearing capacity, wide application scope and a long history. With the improvement of production level and the development of science and technology, the type, process, design, calculation method and application scope of pile foundation have been greatly developed, and are widely used in high-rise buildings, ports, bridges and other projects. Nowadays, the challenges to companies are to reduce costs and at same time keep safety. These are also my research subjects. With the development of China's urbanization, Civil Engineering will inevitably face more complex environmental and geological conditions, more difficult design and construction tasks of ultra-deep foundation as well as planning and construction of more large-scale underground space infrastructure. I hope that the Press-in Technology will be available in China in the near future.

New Members (June – August 2020)

Members who joined IPA from April to May as follows.

- **New Individual Members (46)**

Khalaf Al-Wadeyah (Australia)	Takuya Funahara (Japan)	Misa Nomoto (Japan)	Atsushi Teramura (Japan)
Masami Shibuya (Japan)	Yasuhiro Oishi (Japan)	Nobuo Inoue (Japan)	Yuki Murakami (Japan)
Yuna Nishimori (Japan)	Masaaki Chikazawa (Japan)	Sena Omote (Japan)	Takanori Taniguchi (Japan)
Naoyuki Okamoto (Japan)	Erina Ito (Japan)	Masaya Wada (Japan)	Yudai Kobayashi (Japan)
Shuren Kutani (Japan)	Masaya Kakemizu (Japan)	Hiroto Suzuki (Japan)	Shiho Hamano (Japan)
Tomoaki Taniguchi (Japan)	Makoto Yamamoto (Japan)	Reiju Oka (Japan)	Takashi Hamada (Japan)
Keitaro Kuninori (Japan)	Keitaro Tamura (Japan)	Ying Yang (China)	Yukinori Toda (Japan)
Keishin Kadowaki (Japan)	Hikaru Kitaoka (Japan)	Sho Nishimura (Japan)	Reo Kobuchi (Japan)
Daiya Yokoyama (Japan)	Takumi Eguchi (Japan)	Yujiro Kida (Japan)	Aoi Fujihara (Japan)
Munehiro Yokota (Japan)	Kosuke Takano (Japan)	Rirai Kuraishi (Japan)	Yuma Yano (Japan)
Konan Nishimori (Japan)	Ryosuke Komatsu (Japan)	Mao Inoue (Japan)	Airi Ishikawa (Japan)
Mai Takaoka (Japan)	Rikuma Nagai (Japan)		

- **New Student Members (5)**

Xi Xiong (China)	Naoya Matsumoto (Japan)	Siriwan Waichita (Japan)	Miho Suzuki (Japan)
Yuki Sasaki (Japan)			

- **New Corporate Member (1)**

Oobu Co., Ltd (Japan)

- **Numbers of members as of 31st August 2020**

Individual Members: 689
Students Members: 26
Corporate Members: 55

Announcements

Call for nomination for Distinguished Research Award

The IPA recognizes and honors distinguished research outcomes written in English and published in the scientific/academic journals, engineering magazines or conferences/symposia proceedings that contributed to the advancement of the press-in engineering significantly.

Nomination deadline: 15 December 2020, Tuesday

Awardee: Author(s) of an article

Eligibility:
Distinguished research work on Press-in Engineering. Press-in engineering is multi-disciplinary engineering for improving the planning, design and construction of embedded structures and walls. It covers, but is not limited to, geotechnical engineering, environmental engineering, mechanical engineering, measurement-surveying-monitoring engineering, data and information processing.

Nomination:
An individual member or a corporate member of IPA may submit nomination material electronically to the Award Committee (ipa.award@press-in.org) no later than the nomination deadline.

Nomination form: https://www.press-in.org/en/news/detail/74

Concurrently, the award committee may nominate candidate research contributions based on the research papers published in the scientific/academic journals, engineering magazines or conferences/symposia proceedings including those submitted to The Second International Conference on Press-in Engineering 2021, Kochi (ICPE 2021).

Award Information:
The Award will be presented at ICPE 2021 by the IPA President.

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		
GEOAMERICA 2020	October 26-29. 2020	Rio de Janeiro, Brazil
GEOMEAST 2020 INTERNATIONAL CONGRESS AND EXHIBITION	November 8-12, 2020	Cairo, Egypt
14TH BALTIC SEA GEOTECHNICAL CONFERENCE 2020	January 18-20, 2021	Helsinki, Finland
■ **Deep Foundations Institute** http://www.dfi.org/dfievents.asp		
45th Annual Conference on Deep Foundations	October 27-30, 2020	Online
DFI-India 2020: Conference on Deep Foundation Technologies for Infrastructure Development in India	November 19-20, 2020	Online
■ **International Geosynthetics Society** http://www.geosyntheticssociety.org/calendar/		
88th Annual Meeting of the International Commission on Large Dams and Symposium on Sustainable Development of Dams and River (ICOLD)	November 28-December 3, 2020	New Delhi, India
■ **Construction Machinery Events**		
2nd International Conference on Infrastructure and Construction https://www.scientificfederation.com/infrastructure-construction-2020/	September 23-24, 2020	Online
■ **Others**		
ASCE Convention https://www.asceconvention.org/	October 28-31, 2020	Online