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News Letter

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Messages
From the New Director

Rui Wang

Associate Professor, Department of Hydraulic Engineering
Tsinghua University

I am privileged to join the International Press-in Association (IPA) as a new director. I am currently working as an Associate Professor in Tsinghua University. My work mostly focuses on geotechnical earthquake engineering, which includes the seismic performance of pile foundations and liquefaction mitigation using piles.

My first experience with the International Press-in Association and press-in piling technology was in 2018, when Professor Kusakabe visited us in Beijing. He kindly introduced the developments in press-in technology and also the works of IPA. After that meeting, I took a strong interest in press-in piling technology and worked on the translation and reviewing of the Chinese version of "Press-in Retaining Structures: A Handbook", which was published in 2019, and feel very glad that I was able to play a role in the promotion of press-in technology in China.

With the development of urbanization around the world, and especially locally in China, the application of press-in piles and retaining structures in building-tight urban areas will be highly beneficial due to its space efficiency and environmental friendliness. Also, with continuous research and development in the area, I am sure that press-in technology will have even broader applications.

I am very happy to serve with IPA community and would like to thank you very much for welcoming me on board. I look forward to participating in developing and promoting new technologies in the process that will help us shape a better world.

◆ A brief CV of Associate Prof. Rui Wang

Rui Wang is an Associate Professor at Tsinghua University. He received his Ph.D. from Tsinghua University in 2014. He has also worked as a visiting scholar in UCLA, UC Davis, and Lawrence Livemore National Laboratory, USA in 2011-2012, and 2014-2015 respectively. His research mainly focuses on geotechnical earthquake engineering and soil liquefaction. He is the recipient of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) TC203 2020 Young Researcher Award and ISSMGE Bright Spark Lecture Award. He is also a recipient of the Excellent Young Scientists Fund Program from the National Nature Science Foundation of China. Currently, he serves as the vice secretary general for the Chinese Institution of Soil Mechanics and Geotechnical Engineering (CISMGE) and the secretary for TC210 of ISSMGE.

Messages
From the New Director

Majid Ghayoomi

Associate Professor, Department of Civil and Environmental Engineering
University of New Hampshire, USA

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 received my PhD from the University of Colorado, Boulder in 2011 studying seismic compression of unsaturated soil layers and then continued as a research associate working on seismic response of underground systems including underground water reservoirs and cut-and-cover tunnels. Since then, my research has mainly focused on centrifuge modeling of soil-structure systems in soils with different water contents and evaluating civil infrastructure resilience to extreme events.

I joined the University of New Hampshire in 2012 as an Assistant Professor and was promoted to Associate Professor in 2018. In the last ten years, I had the opportunity to work on exciting research projects ranging from soil characterization to infrastructure resilience and adaptation models. Example projects include soil-structure interaction of shallow and deep foundations in unsaturated soil layers with varying water table levels, performance of rocking foundations and the role of soil saturation on soil plastic deformations, cone penetration in unsaturated soils, flooded road assessment and development of a toolkit for road closure/opening decisions after flooding, seismic resilience of Arctic infrastructure and social systems, use of satellite soil moisture data for post-earthquake ground monitoring, resilience of coastal infrastructure, flow-sediment-structure interaction and the role of scour during coastal flooding, and geomechanics of fractured rocks. In 2015, I was awarded ISSMGE TC106 award for best paper by young researchers on applications of unsaturated soils for my work on seismic compression of unsaturated soil layers. Also, in 2018, I delivered Spark Bright Lecture during UNSAT 2018 in Hong Kong, focusing on modeling of soil-structure systems in unsaturated soils. I am very interested in researching the use of press-in technologies, specially looking at the influence of the degree of saturation and site characteristics on performance and response assessment of such technologies.

In addition to IPA, I am an active member of other professional committees and organizations including ASCE Unsaturated Soils Committee (currently serving as the secretary) and Earthquake Engineering and Soil Dynamics Committee. Also, I am a member of NASA SMAP science team using spaceborne soil moisture data for seismic monitoring. I serve as an associate editor for ASCE Journal of Geotechnical and Geoenvironmental Engineering and an editorial board member of ASTM Geotechnical Testing Journal. I have served as a member of organizing team, session chair, or panelist on different international and local conferences and workshops.

I am excited to join the IPA board of directors and looking forward to contributing to the missions and activities of this organization. I hope my background and expertise will broaden the impact of IPA initiatives and help to introduce the platform to a larger network of researchers and engineers.

◆ A brief CV of Associate Prof. Majid Ghayoomi

Majid Ghayoomi is an Associate Professor in the Department of Civil & Environmental Engineering at University of New Hampshire (UNH). Prior to joining UNH, Dr. Ghayoomi was a Research Associate at University of Colorado, Boulder where he also received his PhD. In his career, he has worked on a variety fundamental and applied research projects dealing with resilient infrastructure systems under extreme events such as earthquakes and floods. His research has been funded by different agencies such as United States NSF, NASA, FHWA, NRRA, and ACS and private companies. He is a registered professional engineer in the state of New Hampshire.

IPA News Letter Volume 7, Issue 2 June 2022

Special Contribution

Research Projects at National Institute of Maritime, Port and Aviation Technology, Japan, for Achieving Carbon Neutrality

Yoshiaki Kuriyama

President
National Institute of Maritime, Port and Aviation Technology

ABSTRACT

To meet the target of carbon neutrality by 2050 in Japan, the National Institute of Maritime, Port and Aviation Technology (MPAT), Japan, is conducting research activities in various fields such as offshore wind farm, zero-emission ship, blue carbon and air traffic management. For the floating type offshore wind farm, a feasibility study of spar type floaters for a 15 MW wind turbine was carried out. To estimate a damage probability of a wind turbine as required by a new international standard, MPAT proposed a methodology and presented some calculation results. For the bottom-type offshore wind farm, the technical issues mentioned below were numerically investigated: the seismic stability of a monopile type wind turbine, the behavior of an open-ended pile penetrating the ground, and the dynamic response of a monopile to wind and wave. Blades of an offshore wind turbine may disturb signals from a radar for electronic navigation. MPAT examined its potential using model tests. The vessels containing suspended loads for an offshore wind farm project behave differently from those without the loads, and hence the movement of a vessel with a suspended load in the air and in the water were examined. To reduce the amount of carbon dioxide (CO_2) emitted from ships, the use of ammonia and hydrogen as fuel as well as the injection of air bubbles from the bottom of a ship was investigated. Blue Carbon is CO_2 stored in ocean and coastal ecosystems. The amounts of CO_2 taken by shallow water ecosystems across the globe and in Japan were estimated. Before landing, an airplane descends stepwise and consumes fuel during the level flight to maintain its altitude. To reduce the amount of CO_2 emitted for landing, MPAT proposed a fixed flight-path angle descent and confirmed its usefulness.

Keywords: carbon neutrality, offshore wind farm, zero-emission ship, blue carbon, air traffic management, MPAT

1. Introduction

The Japanese Government declared in 2020 that Japan will achieve carbon neutral by 2050. To tackle with this challenge, our research institute, the National Institute of Maritime, Port, and Aviation Technology (MPAT), is carrying out research projects in various fields including offshore wind farm. In this article, after briefly introducing MPAT, I will describe the outlines of some of the research projects.

2. National Institute of Maritime, Port and Aviation Technology (MPAT)

MPAT was established on April 1, 2016, by merging the National Maritime Research Institute (NMRI), the Port and Airport Research Institute (PARI), and the Electronic Navigation Research Institute (ENRI). Our mission is to implement research and development for strengthening the international competitiveness of transportation industry, enhancing the use of oceans, and preserving the coastal and marine environment.

3. Research projects toward carbon neutrality

3.1 Offshore wind farm

The amount of carbon dioxide, CO_2, emitted in the power industry is not small, and thus the development and deployment of offshore wind farms are highly expected. Offshore wind farm is classified into two types according to its supporting structure: floating and bottom-fixed types, which are suitable where the water depth is larger and smaller than 60 m, respectively. MPAT experimentally and numerically examined various challenges of both types.

a) Floating type

The floating type offshore wind farm is further classified into four types: barge, semi-submersible, spar, and tension leg platform types.

A feasibility study was conducted on spar type floaters for a 15 MW wind

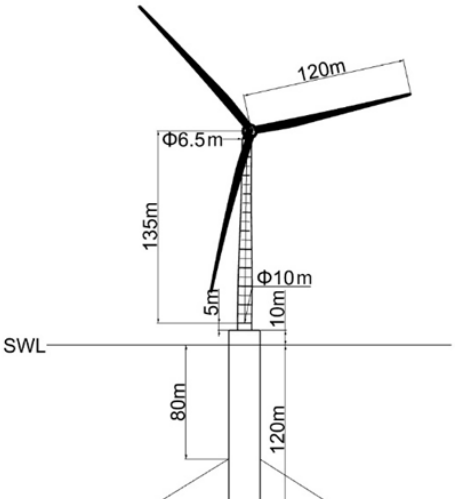

Fig. 1. Proposed spar for 15MW turbine (from Kuroiwa and Chen, 2021)

turbine, which is the largest turbine proposed to date. In this study, two floaters made of concrete and steel were studied. Targets for inclination were set to be smaller than 3 and 5 degrees for the static and dynamic inclinations, respectively. Also, a target for natural period was set to be larger than 20 s, to reduce inclination of the spar in waves. Structural strength was evaluated against bending moment of the spar and pressure of sea water. The evaluations of the inclination, natural period and strength were made by analytical methods or numerical simulations. For both types of floaters, suitable structural dimensions which fulfill the targets and the strength were found (**Fig. 1**).

One of the two conditions that International Electrotechnical Commission (IEC) Technical Specification (TS) requires for not necessarily taking into account the damage stability of an unmanned floating offshore wind turbine, is that "The joint probability of loss of stability and subsequent total loss of the structure does not exceed the probability of failure corresponding to the safety level used for assessing the structural integrity of the structure." As the joint probability, MPAT proposed the product of the probability of collision with cruising ships around a floating offshore wind turbine and that of structural total loss due to the ship collision. As trial calculations, the former value was obtained using Automatic Identification System (AIS) data, and the latter was estimated using an FEM model and multi-body dynamics analysis.

b) Bottom-fixed type

The bottom-fixed type offshore wind farm is classified into four types: gravity, monopile, tripod, and jacket types.

To examine the seismic stability of a monopile type wind turbine, a simulation program for coupled analysis of wind and earthquake loads was developed. The developed program is based on finite element analysis (FEA) and models a wind turbine as the combination of beams and nonlinear Winkler springs. In a simulation, first, the seismic response of ground during an earthquake is estimated by an external program that is able to reproduce the details of soil liquefaction. Second, the estimated response of ground is transferred through the soil-structure interaction springs to the next calculation for the structure, in which its displacement and bending moment are estimated. Some of the simulation results for a 2 MW wind turbine showed that the estimated bending moments of the pile were smaller than those obtained by combining the values separately estimated using the wind and earthquake loads (**Fig. 2**). This result indicates that the wind suppressed the movements of the wind turbine caused by seismic motion and hence suggests that the accurate simulation leads to more economical design of pile. The estimated bending moments were also smaller than those estimated by not considering the liquefaction. The liquefaction-induced flow in a sloping stratum caused a non-negligible force acting on the pile.

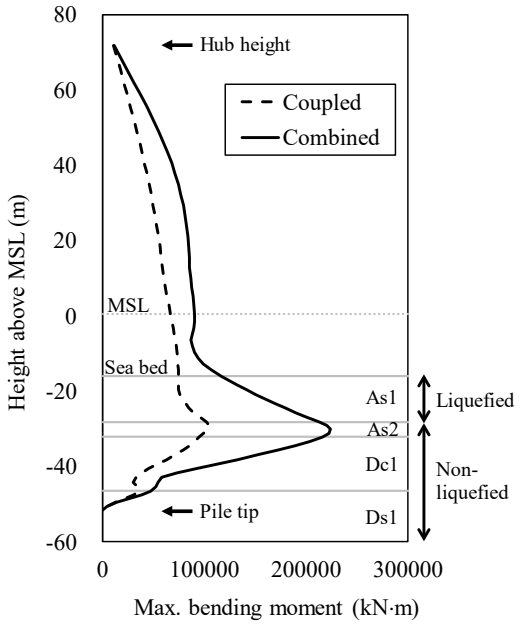

Fig. 2. Comparison of maximum bending moment.

The diameters of monopiles for offshore wind turbines are generally much larger than those for other infrastructures, and the characteristics of the lateral resistance of such large diameter piles are not well understood. In order to estimate the lateral capacity of such piles, it is necessary to accurately predict the ground deformation caused by pile driving. Hence, MPAT simulated the behavior of an open-ended pile penetrating the ground quasi-statically and the stress induced by the pile penetration using material point method (MPM). For this simulation, the frictional contact algorithm in which a rigid body is incorporated in MPM was newly developed. The pile was treated as a rigid body, and the ground was discretized by the particles of the MPM. One of the simulation results successfully represents the soil plugging as shown in **Fig. 3**, which is an important phenomenon in pile driving. In the next step, the effect of pile diameter on the lateral resistance will be investigated.

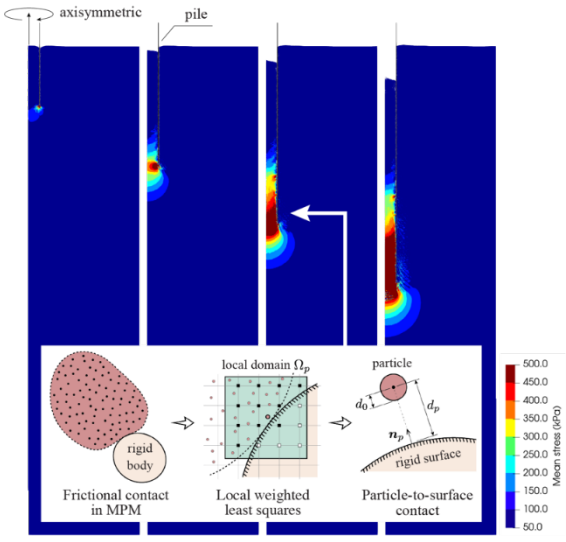

Fig. 3. Mean stress caused by pile penetration simulated using MPM and its frictional contact algorithm (from Nakamura et al., 2021)

The dynamic response of a monopile type offshore wind turbine to wind and wave was tested using the numerical simulation code called FAST (Fatigue, Aerodynamics, Structures, and Turbulence) developed by National Renewable Energy Laboratory in USA, which couples wind and wave forces. The simulation results for a 5 MW wind turbine at a water depth of 20 m show that the wave-induced bending moment took place at the sea bottom, depended on the wave height rather than the wave period, and became large for waves just before breaking in the shallow water region, in which the water-depth-wave-length ratio is below 0.5 (**Fig. 4**).

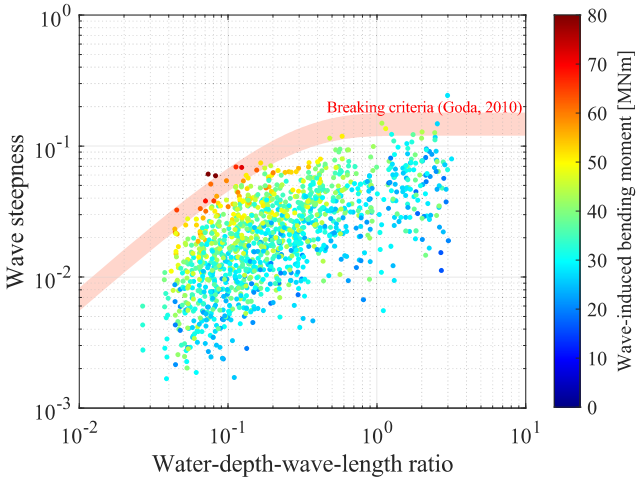

Fig. 4. Occurrence of wave-induced bending moment at a wind speed of 8 m/s

c) Influence of blade on electronic navigation system

The positions of airplanes are detected using signals from VHF omni-directional radio ranges (VORs) and radars. Those signals may be disturbed by the blades of an offshore wind farm. Hence, model experiments for a 2.3 MW wind turbine at scales of 1/144 and 1/72 were carried out in a large anechoic chamber (32 m × 6.2 m × 4.2 m, **Fig. 5**). One of the results showed that in some conditions, the signals from a radar were scattered by the rotating blades, which indicates that the potential scattering should be tested in planning an offshore wind farm.

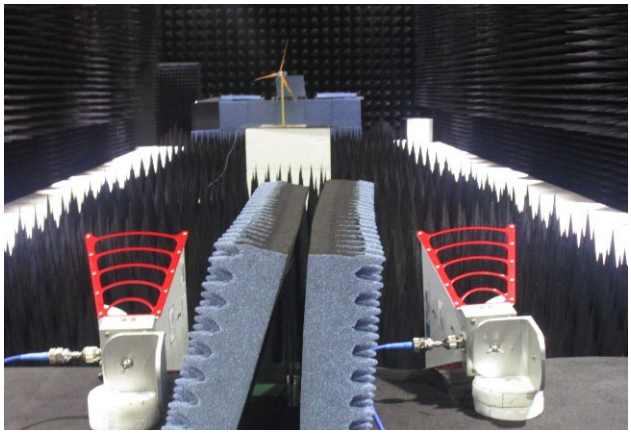

Fig. 5. Measurement setup for radio scattering by the rotating wind turbine

d) Vessel movement with suspended load

For construction, operation, and maintenance of an offshore wind farm project, vessels load, transfer, and unload materials. The vessels containing suspended loads behave differently from those without the loads, and hence the movement of a vessel with a suspended load in the air and in the water were examined in laboratory experiments, in which the model scale was 1/30 and the displacement and the immersed load weight were 6129 t and 176 t, respectively. One of the results showed that the natural period became longer and shorter by 10 to 30 % when the suspended load was in the air and half in the water, respectively (**Fig. 6**). A numerical simulation confirmed the result and further showed that the differences in the natural period increased with the increase in the distance between the vessel and the suspended load.

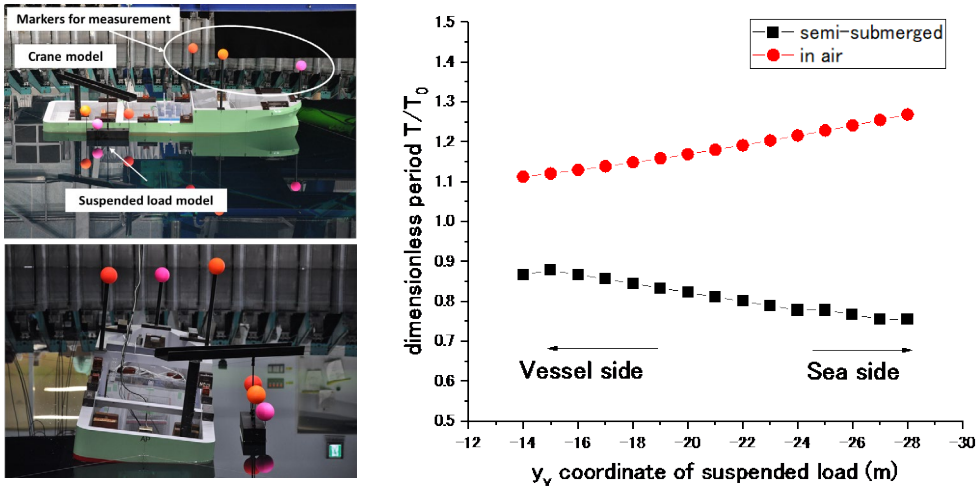

Fig. 6. Model experiments (left) and the variation of natural period with suspended loads in the air and half in the water (right). T_0 is the natural period without load

3.2 Zero-emission ship

The International Maritime Organization (IMO) declared in 2018 that the amount of the emission of CO_2 in international shipping is reduced by 50% by 2050 than the 2008 level. To meet this goal, several methods to reduce the amount of CO_2 emission are being examined. One of the methods is to use as fuel a mixture of petroleum fuel and ammonia, NH_3, or that of methane, CH_4, and hydrogen, H_2.

When NH_3 is used, one of the problems is the emission of nitrous oxide, N_2O, which has the greenhouse gas (GHG) effect about 300 times that for CO_2. MPAT experimentally showed that the double injection of light fuel oil, in which the oil is lightly injected before the main injection, drastically reduced the amount of N_2O. The reduction rate of N_2O reached 84% for a mixture of fuel containing 45% NH_3 and 55% light fuel oil by lower heating value. As a result, the reduction rate of GHG became 46%.

Adding H_2 into Liquified Natural Gas (LNG), of which about 90% is CH_4, reduced the amount of unburned CH_4, which has GHG effect 25 times that for CO_2. The unburned CH_4 was reduced more by controlling excess air ratio. To confirm the validity of those methods, MPAT conducted experiments by using city gas instead of LNG. The reduction rate of CH_4 was about 50% for a mixture of 20% H_2 and 80% city gas at a load factor of 25% and increased to about 80% by controlling the excess air ratio in addition. As a result, for a mixture of 60% H_2 and 40% city gas at a load factor of 25%, the reduction rate of GHG reached 70%. The emission of NOx, which is also a problem when LNG mixed with H_2 is used, was reduced by water injection.

Another method for the reduction of CO_2 emissions is to decrease the frictional resistance of a ship by injecting air bubbles from the bottom of the ship and make it flow more efficiently. Model experiments conducted in a 400 m towing tank showed that air bubbles repetitively injected with intervals reduced the frictional force by at most 5% than continuously injected bubbles (**Fig. 7**) and by at most 20% than no air bubbles.

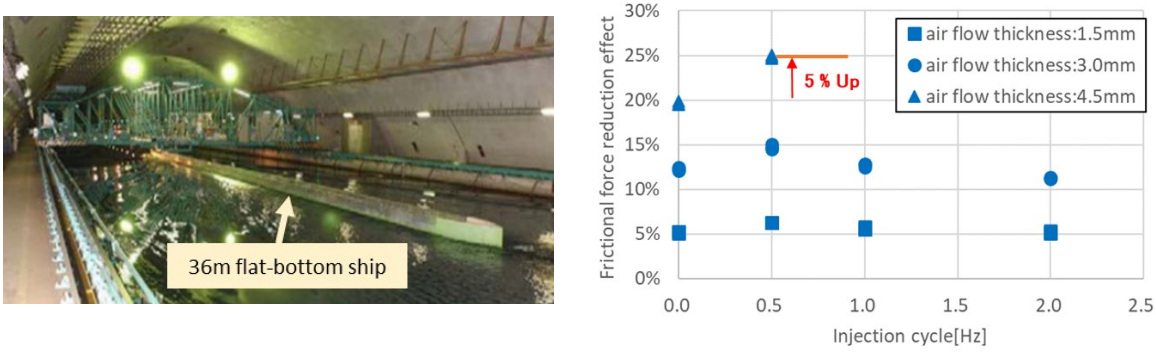

Fig. 7. Resistance test in a 400 m towing tank (left) and reduction effect of frictional force at a towing speed of 8m/s (right)

3.3 Blue Carbon

Blue Carbon is CO_2 stored in ocean and coastal ecosystems, which was firstly used in United Nations Environment Programme (UNEP) in 2009. Thus, Blue Carbon is relatively new research topic, and MPAT is one of the leading research institutes for the Blue Carbon research.

CO_2 is captured in particular in the shallow water region including seagrasses, mangroves, and salt marshes as well as seaweeds, tidal flats, and coral reefs. The amount of CO_2 taken by shallow water ecosystems across the globe was estimated based on the values listed in articles and reports. The estimated value was 1.07 billion t C/year (3.92 billion t CO_2/year) on the average (**Fig. 8**). Then, the value in Japan was estimated using more detailed parameters according to the Intergovernmental Panel on Climate Change (IPCC) guidelines. It is 1.32 million t CO_2/year on the average and 4.01 million t CO_2/year at most.

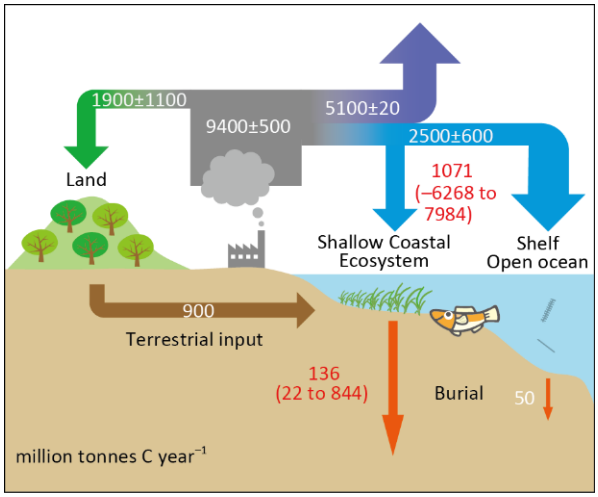

Fig. 8. Global carbon cycling (from Kuwae and Crooks 2021)

In the CO_2 sequestration in the shallow region, the storage of organic carbon, C_{org}, is one of the vital processes. The C_{org} accumulation rate and the controlling factors for 8,000 years in two lagoons in Japan were investigated using isotopic and elemental signatures. The results showed that the C_{org} accumulation rate was larger in salt marshes than in seagrasses and that it increased as the sediment accumulation rate increased during the period of the relative sea level rise (**Fig. 9**).

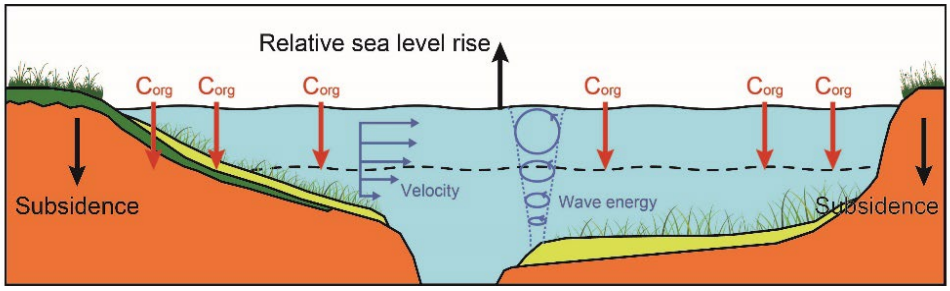

Fig. 9. C_{org} accumulation rates increased in response to relative sea-level rise (from Watanabe et al. 2019)

3.4 Fixed Flight-Path Angle (Fixed-FPA) Descent for efficient aircraft arrival operations

Aircraft generally follows a descent profile (altitude and speed) calculated by the onboard Flight Management System which is adjusted according to Air Traffic Control (ATC) instructions for safe separation with surrounding traffic. Continuous Descent Operation (CDO) is a potential aircraft operating technique for reducing CO_2 emissions which enables a descent profile optimized to the operating capability of the aircraft as a continuously descending path with idle-thrust. However, CDO can disperse significantly depending on the aircraft making trajectory prediction a daunting challenge for ATC. This leads to relatively long intervals between aircraft to maintain safe separation. As a result, CDO is not preferrable during high-traffic conditions. As a solution, MPAT proposed fixed flight-path angle (Fixed-FPA) descent in which an aircraft continuously descends at a fixed flight-path angle with near-idle thrust. **Fig. 10** depicts the proposed concept design. Fixed-FPA descent consumes slightly more fuel compared to CDO but significantly increases the trajectory prediction accuracy which is vital for reducing low-efficient level-off / holding procedures at high-traffic environment. Various fast-time and full-flight simulations were conducted at the Kansai International Airport for procedure validation.

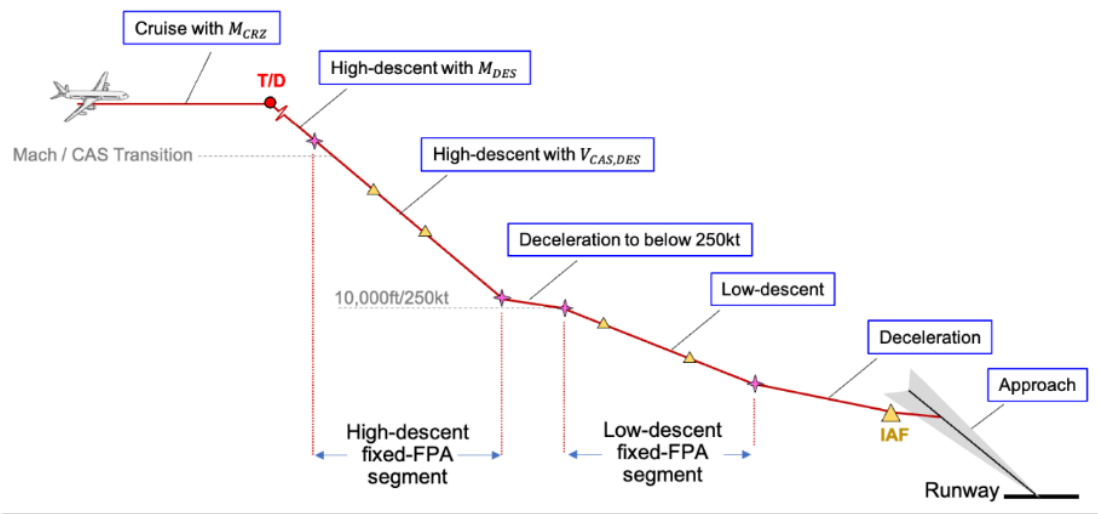

Fig. 10. Fixed-FPA Descent concept design

4. Future development

In this article, I introduced some of our research projects towards carbon neutrality. Our institute, MPAT, has scientists and engineers in a relatively wide range of fields in transportation engineering such as shipbuilding, ocean development, marine and coastal environment, ports and airports, and air traffic management. To contribute to the achievement of the government's challenging target in 2050, discussion and interaction across various research groups in our institute are important. However, not only those actions but also cooperation and collaboration with industry, universities and other research institutes are crucial. By promoting such joint activities, we will expand and develop our research for the future carbon-free world.

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◆ A brief CV of Dr. Yoshiaki Kuriyama

Yoshiaki Kuriyama is the President of the National Institute of Maritime, Port and Aviation Technology (MPAT) in Japan. He graduated from the Department of Civil Engineering, Tokyo Institute of Technology, and joined the Port and Harbour Research Institute (PHRI), Ministry of Transport, in 1983. Since then, he has been conducting the research work on waves, currents, and sediment transport in the nearshore zone. He was appointed as the Director General of the Port and Airport Research Institute (PARI), the successor of PHRI, in 2016 and as the President of MPAT in 2020.

Directors' research and development activities

Redefining the way sustainable construction is delivered

Jignasha Panchal

Technical Manager
Keltbray Piling, London, UK

Background

The deep foundations industry has largely remained unchanged since the 1960s when CFA (continuous flight auger) piling was established, with much of the plant and construction methodologies remaining the same. Therefore, piled foundations have largely continued to be designed and constructed using traditional codes and standards, which use very high factors of safety, with little regard for optimizing in-life efficiency or end-of-life reuse.

After existing developments have been demolished there is little motivation to reuse existing piled foundations as their load bearing capacity and structural integrity cannot be verified. Therefore, piling contractors are increasingly spending more resources on coring through existing piles, only to then replace these with larger diameter or deeper piles. This is incredibly resource intensive and a very unsustainable way of delivering construction projects.

Many of the earlier structures were demolished, only to be redeveloped in 20–30-year lifecycles. During redevelopment, a superstructure is typically demolished which results in an unloading of the existing piles. The removal of the vertical stress triggers the process of basal heave causing the ground, and all its inclusions, to move upwards. This heave can result in a differential displacement along the lengths of the piled foundations and therefore cause cracking along the length of a pile, rendering piles unusable. This is one of the many reasons that piled foundations are not typically reused.

Additional challenges involved with pile reuse occur as a result of the piles being unavailable for inspection or survey until the structure has been demolished. At this stage the majority of the design is complete and relying on accurate historic as-built data is considered high risk. Therefore, it is easier to disregard any existing foundations at concept stage, and allow the piling contractor time to remove any obstructions. Whilst this presents a low risk approach it is very unsustainable as the ground in cities is becoming increasingly congested with foundations.

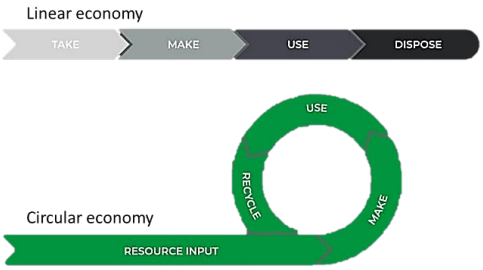


Fig. 1. Linear vs. circular economy model

More foundation appraisal options must be developed to enable the foundations industry to move away from the linear economy model, towards a circular model which promotes and supports the reuse of existing foundations, as shown in **Fig. 1**.

HIPER® Pile

The HIPER® Pile is a new foundation technology that was developed by Keltbray, a specialist engineering and construction company based in the UK. The product combines a range of innovations specifically designed to minimize carbon emissions during construction, occupancy and at end of service.

The HIPER Pile stands for Hollow, Impression, Precast, Energy generating, and Reusable Pile. Each of the innovative strands were developed in collaboration with partners including, City, University of London, G-Core energy. Significant efforts were required to develop the technology to enable the full potential to be demonstrated on the development of a new accommodation block for HS2 Euston Station.

The benefit of this foundation solution is that it enables access to the pile during occupancy as the load is transferred directly into the annulus, see **Fig. 2**. Access permits an assessment of the pile to measure the length, as-built the

coordinates, take core samples, and so on, to confirm whether the pile can be successfully reused. As this evaluation can be completed during occupancy it allows the design to progress with the relevant information to mitigate any risk of changes as the project proceeds.

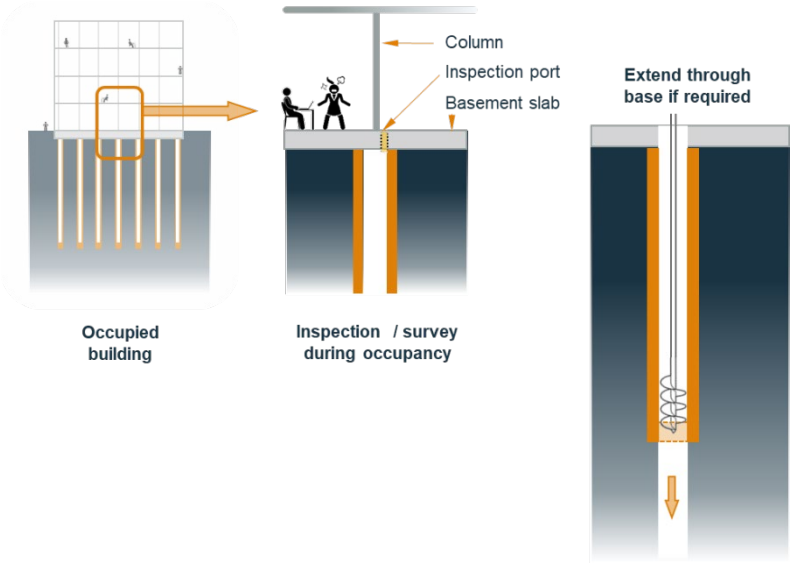
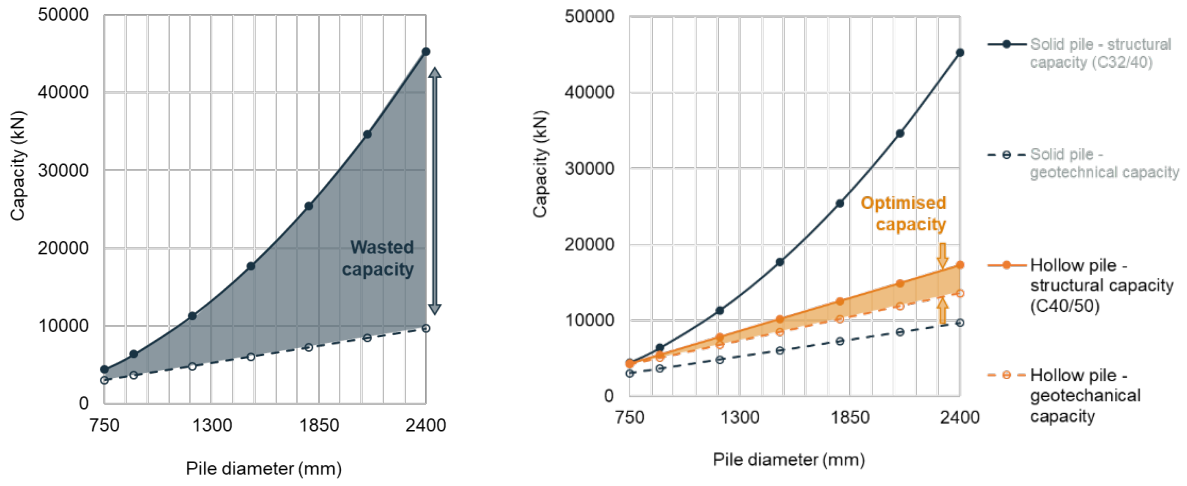


Fig. 2. Inspection of hollow piles during occupancy

Furthermore, there are environmental challenges associated with constructing increasingly large and deep piles, such as inefficiencies between the structural and geotechnical capacities of the pile. For example, a 2.4m large diameter pile constructed with 40N concrete has a capacity of 4.5MN. However, in typical ground conditions in London, the geotechnical capacity of the pile may be limited to 2MN. Therefore, there is a significant volume of concrete that is redundant, see **Fig. 3**.

However, the benefits of the HIPER pile allow the designers to optimize the pile efficiencies and match the structural capacity closer to the geotechnical capacity. Enhancing the shaft capacity of the pile also positively impacts the geotechnical capacity, further closing the gap between the structural and geotechnical capacity.



(a) (b)

Fig. 3. Inefficiencies between structural and geotechnical capacity based on pile diameters for (a) solid piles and (b) hollow piles

HS2 HIPER Pile case study

This technology was deployed on the first live contract which called for the installation of forty HIPER Piles beneath the new welfare units for the HS2 Euston Station development. The client was keen to use this project as an opportunity to innovate and understand the benefits of the technology, with a view to adopting this at scale across other stations along the route.

The piles were bored with a 900mm diameter auger designed with 500mm diameter voids. The piles were impressed with a bespoke tool that enhances the skin friction before a void forming liner was installed in the center of the bore. The concrete is placed to the base and the annulus before the pile is temporarily capped. To support the thermal energy system the voids are filled with water during the platform excavation and geothermal u-loops are plunged into the piles (see **Fig. 4**).

A previous study (Panchal et. al., 2019) was carried out to compare the load bearing capacity of a solid stiff pile against a lower stiffness pile modelling a hollow pile. **Fig. 5** shows the improved capacity of the lower stiffness hollow pile compared with a traditional solid stiff pile. This is owing to the pile displacing under load which in term mobilizes more of the soil strength.

A further full scale instrumented preliminary test pile was installed and tested at the HS2 Euston site. This was constructed as a hollow, impression pile cast with in-situ concrete technology. The arrangement and construction phase are illustrated in **Fig. 6(a) and (b)**. The pile was installed with seven levels of strain gauges installed along the length of the pile. The safe working load (SWL) of the pile was 2.1MN and loaded up to the capacity of the test frame (5.6MN), however the pile had still not reached ultimate capacity. Using Chin's method (1970) the estimated pile capacity was 6.2MN as shown in Fig. 6(b). The improved capacity of this hollow test pile demonstrates the benefits of adopting a new construction method over traditional methods.

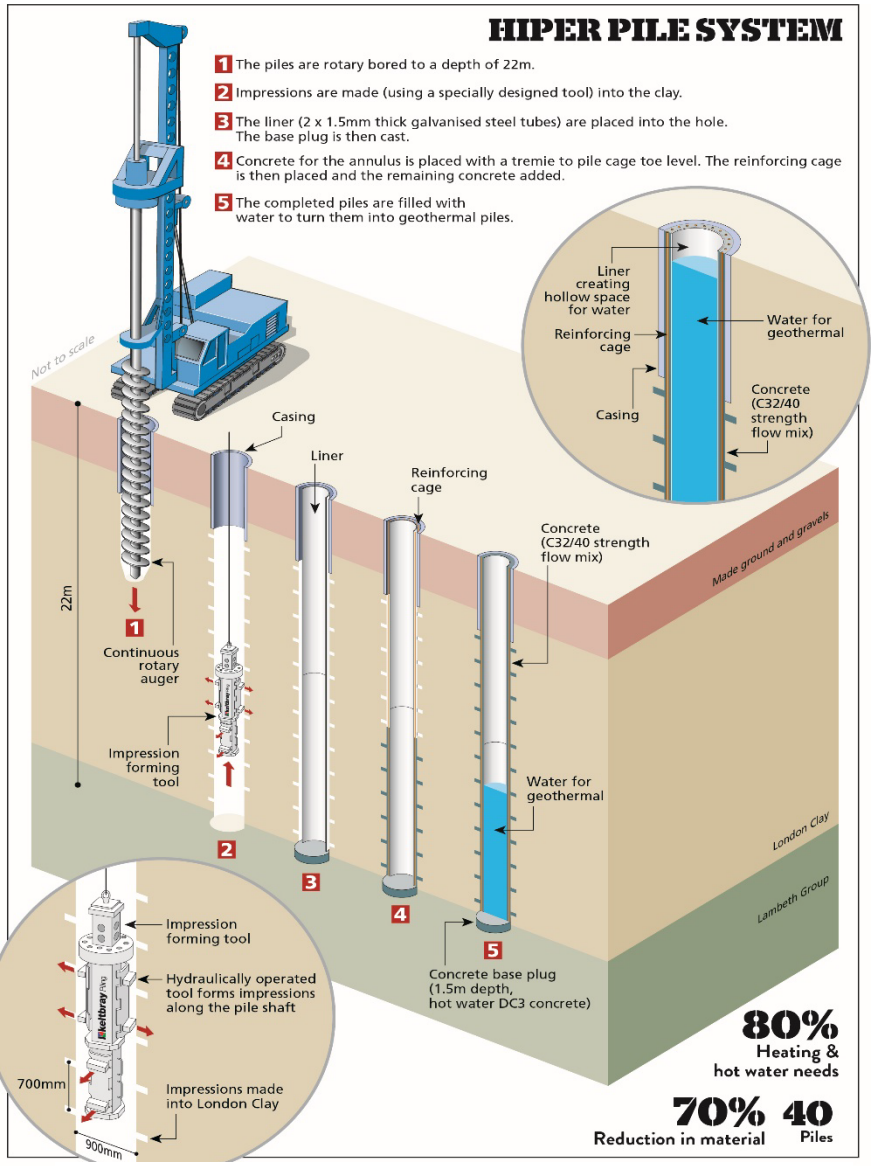


Fig. 4. HIPER Pile construction (NCE, 2022)

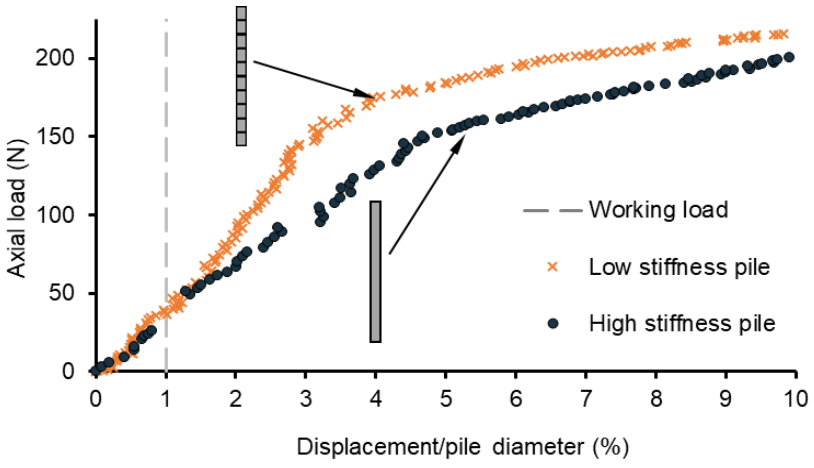
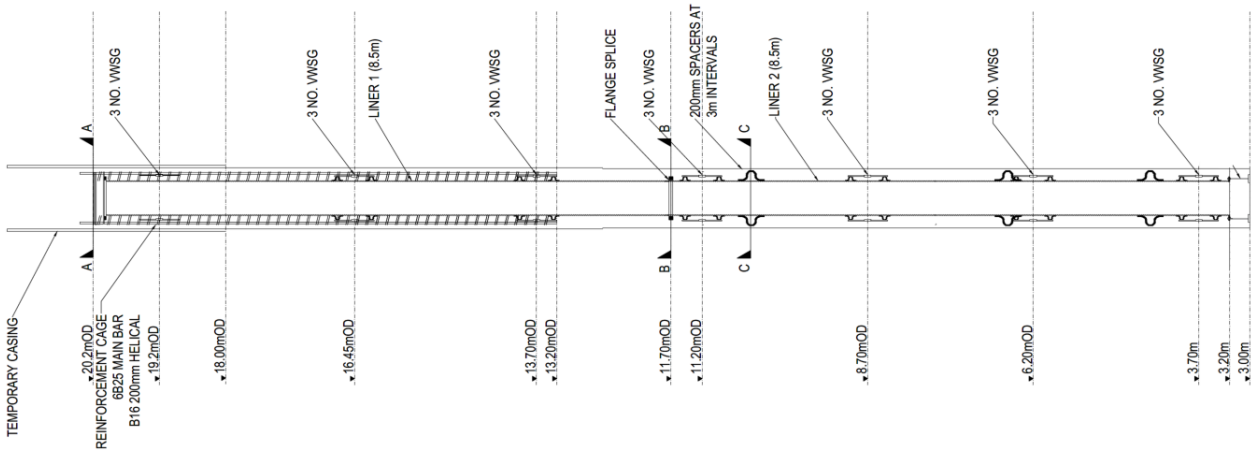
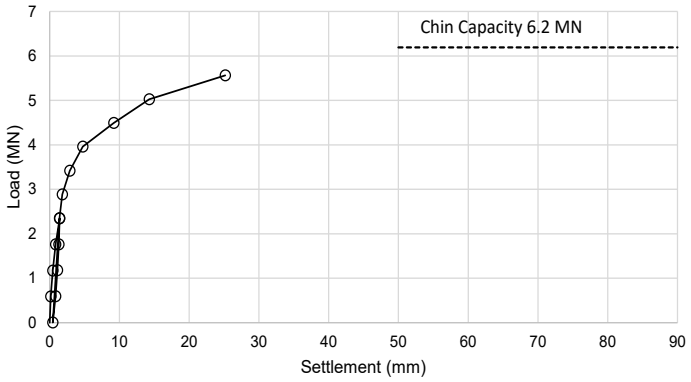


Fig. 5. Hollow pile increase capacity (Panchal et al., 2019)



(a)

(b)



(c)

Fig. 6. Preliminary test pile (a) details at HS2 Euston, (b) installation of void former for the test pile and (c) interpolated load-settlement curve

Conclusions

There is an urgent need to adapt current design and construction practices to support sustainable development. The HIPER Pile is a new technology that has been through a rigorous R&D programme, taking the idea from concept to fruition with a full scale project delivered an entirely HIPER pile foundation scheme. The product combines a range of technologies to reduce the volume of material used and encourage foundation reuse through accessible data acquisition; thereby limited embodied carbon.

A case study was outlined and by adopting HIPER piles on the HS2 station site in London, a total of 280m^3 of concrete was eliminated, and each of the piles were shortened by an average of 4m by enhancing the shaft with impressions. This corresponds to material and vehicle movement savings of over 40%. The hollow piles provided ground source energy; if a conventional foundation scheme was adopted, would have required either full length reinforcement cages which would use 70% more reinforcement than was required on this scheme, or the installation of more than 60no boreholes drilled to depths in excess of 100m. All of these contributing factors present carbon savings in excess of 35% compared with a traditional piled scheme.

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Chin, F.K., 1970. Estimation of the ultimate load of piles from tests not carried to failure. Proceedings of the Second Southeast Asian Conference on Soil Engineering, pp83-91.
Panchal, J.P., McNamara, A.M., Halai, H., 2019. Centrifuge modelling to determine the influence of pile stiffness on pile capacity, Proceedings of the XVII ECSMGE-2019, Reykjavik, Iceland
Smith, C., 2022. First impressions count on HS2 | Piling to prove new concept, Proceedings of the New Civil Engineer Magazine, February 2022 edition

IPA News Letter Volume 7, Issue 2 June 2022

Case-History

Steel sheet pile earth retaining wall in flood control work (Jinan City, China)

Yunxiang Wang

Shanghai Office, GIKEN LTD.

Hongjuan He

Secretariate, IPA

In recent years, with the progress of global warming, abnormal weather such as intense heat, heavy rain, typhoons and hurricanes have frequently occurred in various countries around the world. China is no exception, and last year, in 2021, they suffered severe flood damage in Henan Province, which is located in the central part of China, with a record heavy rainfall. As awareness of disaster prevention increases, the number of projects where the press-in piling method is adopted is increasing in disaster prevention and mitigation works where disaster countermeasures are urgently needed.

This paper introduces a case of temporary earth retaining work to improve drainage function as part of flood control measures carried out in Jinan City, Shandong Province.

1. Project Overview

The main content of the whole project is the new construction of a box culvert. The location of this work is in Jinan City, Shandong Province, China (**Fig. 1**). Jinan City is located in the western part of Shandong Province and occupies an important position in terms of business and administration as a provincial capital. The Yellow River flows through the city and is vulnerable to floods caused by heavy rains. In 2020, the roads in the construction section of the project were flooded due to a strong typhoon, which caused many inconveniences to the movement and livelihoods of residents in the area, and also caused economic damage in some areas. The Jinan City Government decided to renovate the drainage system to solve the inundation problem in this section.

Fig. 1. The Map of Jinnan City

As shown in **Fig. 2**, the total length of the entire construction section will be about 1,200 m, and the construction started in January 2021 and will be completed in September 2022. Since there are many residential areas and factories in the construction area, it was necessary to make arrangements for half road closures and detours and so on.

Fig. 2. The map of construction site area

The press-in piling work in this project is the construction of a temporary retaining wall accompanying the new construction of a box culvert. The press-in piling method combined with the water jetting was adopted, and it was constructed with U-shaped steel sheet piles (pile lengths 9m and 12m) using the press-in piling machine F111.

2. The Press-in Piling Work

As mentioned above, this site is a densely populated area with houses and factories, and it was required that it would not affect the surrounding economic activities during the construction period as well as vibration and noise should be minimized during the piling work. In addition, preliminary research had revealed that the underground buried utilities and building waste were mixed in the ground. For the above reasons, the press-in piling method was recognized as the most suitable method, and it was decided to adopt it for the project. In addition, since the soil was clay, the construction method combined with the water jetting was adopted.

The challenge for this construction was to pay close attention to the surrounding environment during the construction. As shown in **Fig. 3**, the existing utility poles and high-voltage lines are in close proximity to the steel sheet pile work line at the construction site. When a crane was used to lift the 12m and 9m long steel sheet piles, careful consideration was taken to keep sufficient distance from the high-voltage lines.

Fig. 3. The view from above

Fig. 4 is a photograph taken during the construction in proximity. As shown in the photo, there were many construction sites close to the existing structures in this case. Since the press-in piling machine is more compact than a general pile driver, it was possible to do the installation work in the minimum space even in a narrow site between an adjacent structure and a steel sheet pile retaining wall. Since the ground vibration and noise during construction were extremely small compared to the conventional construction methods that require impact and vibration, the construction was able to be carried out safely without significantly affecting the surrounding environment.

Fig. 4. Construction in proximity

3. Press-in assisted with water jetting method

According to the Handbook[1], *Press-in assisted with water jetting method which was adopted in this project, as shown in* ***Fig. 5****, is a pressing technique where water jetting is used as a driving assistance. Piles are installed while injecting high-pressure water into the ground from a nozzle that is fitted onto the pile toe to reduce penetration resistance (toe resistance, shaft resistance). Press-in assisted with water jetting has the following three advantages.*

- *The water pressure generates an increase in pore water pressures associated with a decrease in effective stresses around the toe of the pile, resulting in a decrease in shear resistance of the soil.*
- *The upward water flow generated along the interface between the pile and the surrounding soil spreads the effect of reduced effective stresses and reduces shaft friction between the soil and the pile.*
- *Prevents the soil clogging inside interlocks, which reduces the frictional resistance between interlocks.*

In this work, steel sheet piles to be used for temporary work were used. As mentioned in the previous newsletter (Vol, 6.4), used sheet piles are often used for temporary steel sheet pile retaining walls in China. By using a water jetting together, the press-in/extraction force can be optimized, the damage to the steel sheet pile is minimized, and thus future reuse is possible.

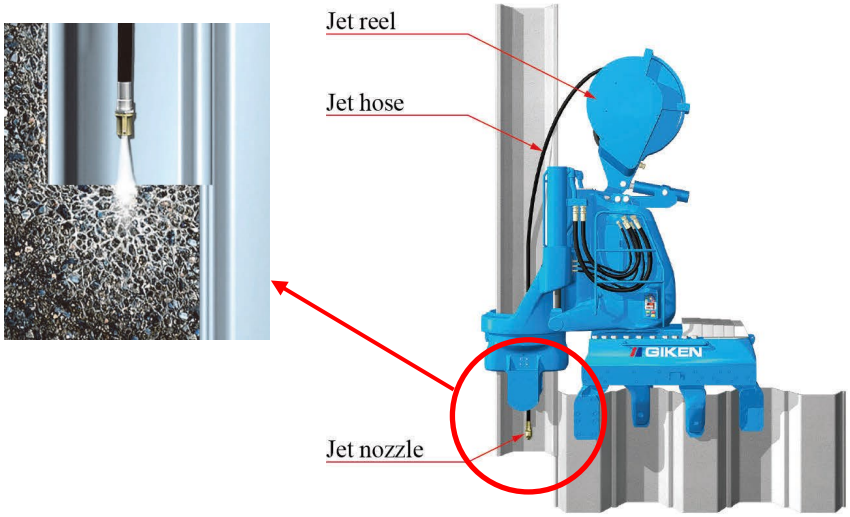

Fig. 5. The image of press-in assisted with water jetting method[1]

4. Summary

In disaster prevention works in urban areas, it is often difficult to secure a large work space, and there are generally many restrictions on construction conditions. By means of the press-in piling method, we were able to reconfirm the usefulness of maintaining the functions of surrounding facilities, minimizing vibration and noise, and performing safe and secure construction at this site. In China, the development of disaster prevention infrastructure is being promoted intensively, and it is expected that the press-in piling method will be more activated in the future.

References

1) International Press-in Association (IPA) (2021) Press-in Retaining Structures: A Handbook Second, Edition, 2021, 200p.

Report from USA

Geotechnical and Foundation Engineering Societies and Industry Associations in the United States (Part 2)

Takefumi Takuma

GIKEN LTD., c/o Giken America Corporation

There are multiple geotechnical and foundation engineering societies as well as related industry associations based in the United States. Giken America Corp. and some of its employees, including the author, have joined these societies and have been participating in some committee activities. As the second article of the series on these societies, let us look at the Pile Driving Contractors Association (PDCA).

This U.S.-based industry association has the following motto since its inception.
"A driven pile is a tested pile!"

It was founded in 1996 by a group of pile driving contractors and related suppliers in the U.S., Canada, Mexico, and some other countries to have it represent the pile driving industry and to promote the use of driven piles, such as pipe piles, sheet piles, precast concrete, and timber piles.

PDCA's webpage says, "The Pile Driving Contractors Association (PDCA) is an organization of pile driving contractors that advocates the increased use of driven piles for deep foundations and earth retention systems. To do this, we:

- Promote the use of driven pile solutions in all cases where they are effective.
- Support educational programs for engineers on the design and efficiency of driven piles and for contractors on improving installation procedures.
- Encourage and support research that will improve the reliability, usefulness, and cost effectiveness of driven piles.
- Give contractors a larger voice in establishing procedures and standards for the installation and design of driven piles."

PDCA's webpage: https://www.piledrivers.org/about-pdca/

Pile driving contractors can join the PDCA as contractor members, while material and equipment suppliers like Giken America Corp. can join as associate members and engineering consulting companies as engineering affiliates. The makeup of the membership is 35% contractors, 35% associates, and 30% engineering affiliates. The PDCA is primarily based on corporate memberships while it does have individual-based membership categories for interested individuals in academia, government agencies, retirees, and students although they are small in numbers. The members, regardless of which categories they are in, can join any of the following committees and participate in their missions on a volunteer basis (an applicant needs to follow a certain process to be admitted, however).

Associate Members Council, Communications, Contracts & Risk, Education, Membership, Safety & Environmental, Steel Sheet Pile, and Technical.

The author and some of his colleagues are active in the Associate Members Council, Steel Sheet Pile, and Technical Committees. As an example of the fruit of these committees' activities, the Steel Sheet Pile Committee compiled three Sheet Pile Guides, i.e., "Sheet Pile Installation Guide", "Steel Sheet Pile Corrosion Guide", and "Retaining Wall Cost Comparison Guide". Use the following link to purchase these guides at a nominal fee (free for members).
URL: https://www.piledrivers.org/pdca-technical-library/sheet-pile-guides/

In addition to the above-mentioned guides, one might be interested in checking the "Noise & Vibration Database", "Hammer Database & Guide", and other piling related information also available in the "Technical Library" section of its webpage. Most of them are free to access.

Chapters are geographically organized groups of the members for their local networking and pursuit of common goals for

the regions. The following Chapters are currently active;
Gulf Coast, Northeast, Texas, Pacific Coast, and South Carolina.

The PDCA holds annual conferences and other seminars, such as “Annual Design and Installation of Cost-Efficient Piles Conference”, “Deep Foundation Dynamic Testing & Analysis Seminar” in collaboration with a dynamic pile testing equipment manufacturer, and “Contractors Foundation Institute’s Driven Pile Academy”, which was a classroom and hands-on workshop on safety and pile driving procedures of various pile driving equipment held as its inaugural event in April 2022.

In response to the COVID-19 global health crisis, in 2020 the PDCA quickly adapted to providing online education for its members and other industry professionals through Zoom with remote presenters. With the success of the online format, the PDCA has continued to offer webinar education, such as the ongoing “PDCA 2022 Value Driven Webinar Series”. The series focus on driven pile case studies, cost saving analysis, actual project conversion methods, job site safety, driven pile types & benefits, legalities to consider, etc. Non-members can attend the webinars for a nominal cost (free for members). The details can be found at the following link.

https://www.piledrivers.org/conferences-and-events/pdca-2022-value-driven-webinar-series/

The bi-monthly “PileDriver” magazine is PDCA’s official publication which is edited and distributed by a contracted publisher for PDCA members. See **Fig. 1** for the cover of a recent issue.

Additionally, there is a different industry association to represent contractors in the field of drilled shaft piles, auger cast piles, micro piles, etc. (ADSC).

The author appreciates the assistance provided by Matt Bisbee and Kathy Harper of the PDCA, and Ian Vaz of Giken America Corp.

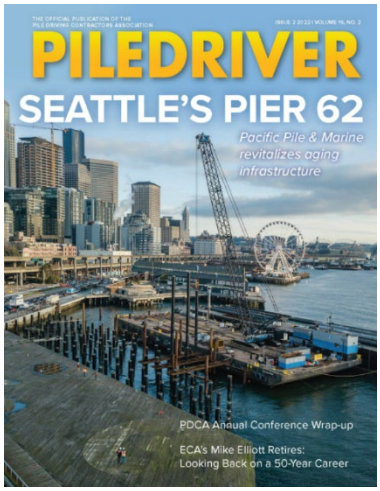

Fig. 1. The cover of PileDrive Magazine

Report

Ordinary General Assembly 2022

The IPA Ordinary General Assembly 2022 was held from 16 to 27 May, 2022. The total votes have achieved the quorum and all the presented Agendas were resolved in accordance with Article 22 of Constitution.

- Period: 16 to 27 May 2022
- Meeting place: IPA Website (On-line voting through the Members Site)
- Agendas: https://www.press-in.org/en/page/general_assemblies
- Number of eligible members: 742（Individual Members: 689, Corporate Members: 53）
- Quorum: 372 （a majority of members）
- Total votes: 466 ［achieved quorum］（Turnout 63%）

Votes on each Agenda:

	Agendas	Affirmative votes	Dissenting votes	Results
Agenda 1	Activity Plan for FY 2022	464	2	Approved
Agenda 2	Budget for FY 2022	465	1	Approved
Agenda 3	Election of Directors and Auditors for the term 2022–2023	465	1	Approved

The list below shows the incoming and outgoing members of IPA Directors and auditors. Thanks to the outgoing directors and auditor for their great contributions during the terms and very welcome the new directors and auditor.

Incoming Directors and Auditor

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Majid Ghayoomi
Associate Professor
University of New Hampshire
United States of America

Director

Shinji Taenaka
General Manager
Nippon Steel Corporation
Japan

Director

Katsutoshi Ueno
Associate Professor
Tokushima University
Japan

Director

Rui Wang
Associate Professor
Tsinghua University
China

Director

Mark Albert H. Zarco
Professor
University of the Philippines, Diliman
Philippines

Auditor

Tsuyoshi Tanouchi
Operating Officer
GIKEN LTD.
Japan

Outgoing Directors and Auditor

Director

Limin Zhang
Professor

Director

Kenichi Soga
Professor

Director

Junichi Koseki
Professor

Director

Taro Uchimura
Professor

Auditor

Yoshihisa Fujisaki

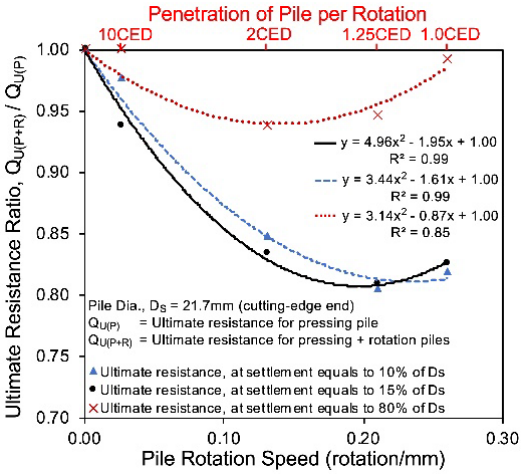
Young Members Column

Faisal Shahzad

Master Student, Department of Civil and Environmental Engineering
Saitama University

I am Faisal Shahzad from Pakistan. I completed my bachelor's degree majoring in Civil Engineering from the University of Engineering and Technology (UET), Lahore - Pakistan, back in 2013. Currently, I am a Master's second-year student at the Department of Civil and Environmental Engineering, Saitama University, Japan. Right after my graduation, I got a job as a Junior Engineer in the Geotechnical and Geo-environmental Engineering (GT&GE) division of one of Pakistan's leading consultancy organizations, "National Engineering Services Pakistan (NESPAK)". I was assigned a field job at 969 MW "Neelum Jhelum Hydroelectric Project" in Azad and Jammu Kashmir (AJK), Pakistan. It was a great opportunity for me to learn actual field practices and apply my theoretical knowledge while working on such a mega project at the start of my professional career. I have been involved in ground excavation works to the designed lines and gradients, dam foundation treatment, slope stabilizing works using shotcrete and wire mesh, rock anchorage and main boundary thrust (MBT) treatment, etc.

Throughout my professional career, it was my sheer desire to pursue higher studies to broaden my knowledge related to Civil Engineering. I was fortunate to get admitted to the Geotechnical and Geosphere Research Group of Saitama University with an ADB-JSP scholarship for my Master's degree. During the first year, when my main focus was on the coursework part, I got a chance to get involved in the research work of my colleague, Mr. Muhammad Azhar Saleem, and support him in his experiments. His research work titled "Performance evaluation of model displacement piles under axial load in dense ground conditions" mainly focused on the end shape of steel pipe pile and helix pitch of screw pile effect on the installation effort and bearing resistance. One of the key outcomes related to steel pipe piles with cutting-edge ends showed that the ultimate bearing capacity decrease with increased rotation speed (rotation/mm). However, if the pile is installed with penetration equal to cutting-edge depth in one rotation, the decrease in ultimate bearing capacity can be reduced.



From: https://doi.org/10.12989/gae.2020.23.6.523

Currently, I am working on open and closed-end screw piles. My research work titled "Behavior of open and closed-ended screw piles driven into the Bearing Layer" mainly focuses on the performance of open and closed-end screw piles by installing them into the bearing layer only, by pressing and rotation method. Generally, during an open-end steel pipe pile installation, the pile passes through the top loose strata, and it reaches the dense bearing layer either in partially plugged mode or in the fully plugged mode. Because of this soil plugging, the performance of an open-end steel pipe pile is quite similar to that of a close-end pile at greater depths. However, not enough studies are available on screw piles. Therefore, the prime objective is to investigate the effect of the open and close end conditions of the screw pile on the installation effort (load and torque), bearing response, and surrounding ground disturbance during penetration in the bearing layer. This research work will help to design the deep foundations more efficiently and the performance of piles can be enhanced.

Announcement

IPA Case Histories of the Year Awards Program for the press-in piling method

The International Press-in Association (IPA) is pleased to open the 2022 Case Histories of the Year Awards Program for the press-in piling method. Your entries are invited for consideration by the panel of judges.

In recent years, the number of projects utilizing the press-in piling method have increased steadily. The method has been used in more than 40 countries so far. At the same time, the press-in piling method is being utilized for a wider range of quality, state of the art geo-structures, due to its high applicability. Because of this, there is an increasing number of more specific inquiries about the compatibility and advantages of the press-in piling method.

As a result, the IPA is going to advertise for design/construction project case histories of the press-in piling method as shown in “Application Guidelines for Case Histories”. In this way, we would hope that we can enhance the advantages of the press-in piling method so as to increase its project applicability.

After evaluation, prizes will be awarded and selected case histories will be highlighted and included in a professional journal or a newsletter. You are cordially invited to take part in the awards program.

Organizer: International Press-in Association

Application Deadline: 31st March 2023

Overview of the program

URL: https://www.press-in.org/en/page/casehistories_award

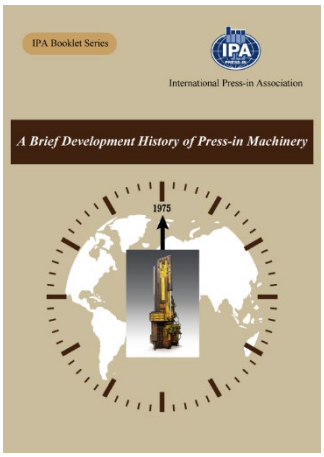
“A Brief History of the Press-in Machinery” was published

A Brief History of the Press-in Machinery was published with English and Japanese version in February by International Press-in Association. The booklet provides a history of development of mechanical aspects of press-in machinery over a half century, and a few recent developments related to data collection and processing for press-in piling with a high precision. The PDF version is now available on the IPA members’ website, please access the following URL to download.

■Member’s website: https://member.press-in.org/en/login
After logging in, please click "Technical Documents on Press-in Technology" to download.

■Please click the following link if you would like to acquire it.

URL: https://www.press-in.org/en/publication/index/1



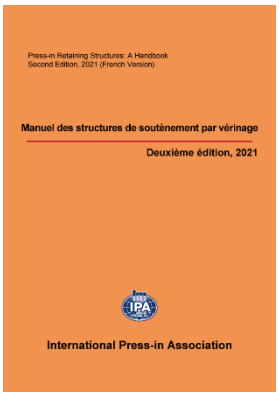
French, Spanish, Portuguese and Vietnamese Version of "Press-in Retaining Structures: A Handbook" was published

The International Press-in Association (IPA) is pleased to announce the publication of the "Press-in Retaining Structures: A Handbook" (French, Spanish, Portuguese and Vietnamese). The handbook is a translated version of the original English version, which was published in June 2021.

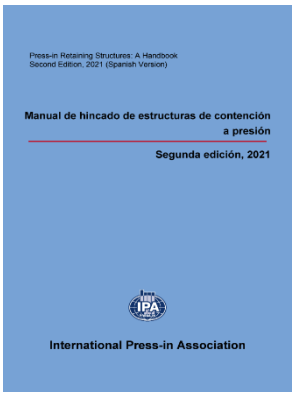
We have been translating it into multiple languages, Portuguese, Spanish, French, Thai, Russian and Vietnamese. We would appreciate it if engineers in making good use of the handbook for their actual projects, research & development and training etc.

The handbook is available at the IPA webpage. Please click the following link if you would like to acquire it.

URL: https://www.press-in.org/en/publication/index/1

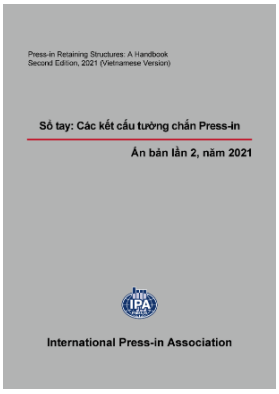


French Version



Spanish Version

Portuguese Version



Vietnamese Version

New Members

Members who joined IPA from January to May 2022.

- New Individual Members

  Rui Wang Gülin Yetginer

- New Student Members

Faisal Shahzad	Yassine Zmerli	Slimen Salma	Evy Elvysia Benson	Aoto Minatogawa
Roeders Niels	Teruma Hamano	Rui Iga	Ritsuma Oobayashi	Nami Miyashita
Masahiro Kamitaka	Sakito Tsutsui	Mitsuki Hamaguchi	Nur Shafiqah Abdullah	

- The number of Members (as of 31 May 2022)

  Individual Members: 686 Student Members: 52 Corporate Members: 53

Event Dairy

Title	Date	Venue
■ **IPA Events** https://www.press-in.org/en/event		
The Third International Conference on Press-in Engineering (ICPE 2024)	TBD	Singapore
International Society for Soil Mechanics and Geotechnical Engineering http://www.issmge.org/events		
GEOTECHNICAL ASPECTS OF UNDERGROUND CONSTRUCTION IN SOFT GROUND - TC204 CAMBRIDGE 2022	June 27-29, 2022	Cambridge, United Kingdom
Fifth International Conference on New Developments in Soil Mechanics and Geotechnical Engineering	June 30-2 July, 2022	Nicosia, Cyprus
4TH INTERNATIONAL CONFERENCE ON INFORMATION TECHNOLOGY IN GEO-ENGINEERING	August 4-5, 2022	Singapore
4TH INTERNATIONAL SYMPOSIUM ON FRONTIERS IN OFFSHORE GEOTECHNICS	August 28–31, 2022	Austin, United States
11th International Symposium on Field Monitoring in Geomechanics	September 4-8, 2022	London, United Kingdom
10th International Conference on Physical Modelling in Geotechnics 2022	September 19-23, 2022	Daejeon, South Korea
■ **Deep Foundations Institute** http://www.dfi.org/dfievents.asp		
SuperPile 2022	June 15-17, 2022	Missouri, United States
DFI-India 2022: 11th Annual Conference on Deep Foundation Technologies for Infrastructure Development in India	September 15-17, 2022	Tirupati, India
47th Annual Conference on Deep Foundations	October 4–7, 2022	Maryland, United States
■ **Others**		
ISARC 2022: 39th International Symposium on Automation and Robotics in Construction https://evento.uniandes.edu.co/en/isarc2022/Home/	July 12-15, 2022	Bogota, Colombia

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Japan

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KAKUTO CORPORATION
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China

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Japan

KAKIUCHI Co., Ltd.
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Japan

Kanamoto Co., Ltd.
Japan

Editorial Remarks from persons in charge

Dr. Jignasha Panchal
(Technical Manager, Keltbray Piling)

It is well appreciated that innovation and ground breaking discoveries come from combining a diverse range of knowledge, technologies and experiences, so it is a pleasure to welcome the new directors to the IPA who each have their own specialisms and research interests.

The articles presented here cover a range of topics from members at various stages of their career, and allow the readers to benefit from a deeper understanding in sheet pile performance and applicability in novel use cases.

This News Letter presents a huge opportunity for the members of the IPA to work collectively to transition towards more sustainable construction techniques. I am confident that the work of the IPA and the members is very well suited to become a leading example of how cross sector, international network can share their experiences to overcome difficult construction challenges in a positive way.

I hope that the articles included in this News Letter will inspire and encourage readers to consider think outside the box to push boundaries and actively drive change in our industry with a stronger focus on the three pillars of sustainability.

Dr. Nor Azizi Bin Yusoff
(Head of Research Centre for Soft Soil (RECESS), Universiti Tun Hussein Onn Malaysia)

Welcome once again to our IPA News Letter, Vol.7, Issue 2. In the wake of the Covid-19 pandemic, the IPA Newsletter is still maintaining its function to widespread the beauty of Press-in Technology. I wish to welcome our incoming directors and thank you for all of our outgoing directors. Over the years, our directors had brought so many benefits to the association and are actively involved in developing the technology. I hope the same rhythm will continue for many years to come. Welcome to our new individual and student members too.

For this issue, we had some views from our directors and worldwide contributions from various countries such as The United State of America, Japan, the United Kingdom, and China. It is interesting to note a wide perspective of views from industries, universities, and industrial-based research organizations such as the National Institute of Maritime, Port and Aviation Technology (MPAT), Japan. Thank you for all contributors!

IPA is pleased to announce the publication of the “Press-in Retaining Structures: A Handbook” in French, Spanish, Vietnamese and Portuguese. We hope that you will enjoy your reading and exploring new possibilities in the area of innovative construction practice. Who knows, you may be the next contributors for the next coming newsletter edition. Thank you.