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

News Letter

Volume 9, Issue 2 June 2024

Inside This Issue

Editorial Board

Message
From the Director

Yukihiro Ishihara
Center Director, Press-in Technology R&D Center, GIKEN LTD.

I have been impressed and inspired by the strength of IPA in pursuing the fusion of theory and practice, since I joined GIKEN and the IPA community in 2007. This pursuit, I believe, stems from the strong awareness of Mr. Akio Kitamura, Emeritus President of IPA, and I have been honored to have opportunities of feeling his love and dedication for the press-in technology. I also feel happy for being engaged in the collaborative research between the University of Cambridge and GIKEN, which has been lasting since 1994 with a great support from Dr. Malcolm Bolton and Dr. Stuart Haigh. In addition, I had another luck of contributing to further strengthening the academic function of IPA, which was strongly pushed forward by Dr. Osamu Kusakabe and was made possible through the efforts of IPA Secretariat at the time including Mr. Kazuyoshi Ishii, Ms. Mutsumi Minami, Mr. Masafumi Yamaguchi and Ms. Hongjuan He. The first international conference (ICPE2018, Kochi) at Kochi University of Technology was the symbolic event to me in this viewpoint.

There are mainly two perspectives in our research team. One is the technology of utilizing information during the press-in construction work, and another is the performance of embedded structures constructed by the press-in method. An essential point is a good understanding on the soil-pile interaction throughout the process of construction and service. For this, we adopt various research methodologies such as the monitoring and observation at the actual construction sites, field testing, outdoor large-scale model testing, indoor model testing and numerical analyses. We are taking advantage of diverse human resource and innovative environment (Fig. 1), to tackle with many challenging issues on our way.

Fig. 1. Research team and Research Building in RED HILL 1967

The third international conference next month (ICPE2024, Singapore) is the first academic conference on Press-in Engineering that is to be held outside of Japan, and will be a new experience to the IPA community. Our research team are eager to contribute through more than 10 papers and presentations. I appreciate all the preparatory work by the conference organizers and the IPA Secretariat, and am looking forward to the oncoming interactions with the participants in this conference.

◆ A brief CV of Dr. Yukihiro Ishihara

Dr. Yukihiro Ishihara is Center Director, Press-in Technology R&D Center, GIKEN LTD. After getting Bachelor's and Master's degrees in Civil Engineering at the University of Tokyo (UTokyo) in 2005 and 2007, he joined GIKEN and has been engaged in R&D activities on the press-in piling process and the pressed-in structures. He received a degree of Doctor of Engineering at UTokyo in 2023, on the use of press-in piling data for estimating subsurface information and pile capacity. He has been Director of IPA since 2017.

Upcoming ICPE2024, Singapore: Call for participants

Chun Fai Leung

President
International Press-in Association

Call for participation

- ICPE2024 Website: https://2024.icpe-ipa.org/
- Regisration Site: https://www.press-in.org/en/event/application/input/39

The Third International Conference on Press-in Engineering (ICPE2024) will be held in Singapore from 3 to 5 July 2024. Press-in piling and engineering works are now commonly employed in many countries. These kind of works are expected to grow further to achieve sustainability and resilience of infrastructure against climate change. As an example, strong coastal and river protection works become necessary in many countries to tackle rising sea level and erratic climate conditions such as flooding and stronger wave forces. In view of the above, the theme of ICPE2024 is 'The Superiority of Press-in Piling towards Sustainable Construction in Tackling Climate Change for Infrastructure Development'.

Two keynote speakers will deliver lectures on the conference theme. Dr. SY Yamaguchi of the United Nations University Japan will present the 'Progress of United Nation's Sustainabe goals and the Synergy with Climate Change Actions'. Professor Ken Gavin of the Delft University of the Netherlands will present 'The Potential Use of Press-in Methods in the Offshore Renewables Industry'. There will be also be a Singapore Theme Lecture to be delivered by three prominent practicing engineers, Dr TL Goh and Mr David Liaw of Singapore and Mr T Nozaki of Japan. They will share their knowledge on 'Development of Press-in Technology in Southeast Asia with Applications on Coastal Protection'. In addition, there will be a special Southeast Asia session with presentations given by prominent researchers/engineers from the region.

ICPE2024 offers opportunities for academics and technicians to intercommunicate with one another and for students and young experts to present their achievements. The ICPE would be grateful to welcome your participation. We would also appreciate your help in disseminating information of this event to your colleagues. We look forward to seeing you at the conference and finding common ground with you.

Program:

Day One: Wednesday, 3 July

SGT (UTC+8)	Lobby		Main Hall (Auditorium 2)	Hall 1 (LT50)
8:30	Registration	Exhibition		
9:00			Welcome and Opening 9:00-10:00	
10:00			Coffee Break 10:00～10:30	
			Keynote Lecture 1 10:30-11:30	
11:00			Keynote Lecture 2 11:30-12:30	
12:00			Lunch 12:30～13:30	
13:00			Session A-1 Pile Performance/Piling Mechanism 13:30-15:00	Session B Climate Change/Infrastructure Development 13:30-15:00
14:00				
15:00			Coffee Break 15:00～15:30	
			Session C-1 Disaster Prevention and Mitigation 15:30-17:00	Session D-1 Project Case Histories/Miscellaneous 15:30-17:00
16:00				
17:00				
18:00			Banquet (18:00~) Kent Ridge Guild House	

IPA News Letter Volume 9, Issue 2 June 2024

SGT (UTC+8)	Lobby		Main Hall (Auditorium 2)	Hall 1 (LT50)
8:30	Registration	Exhibition		
9:00			IPA Handbook (Press-in Retaining Structure - Design & Construction) 9:00-9:40	
			Theme Lecture 9:40-10:30	
10:00			Coffee Break 10:30～11:00	
11:00			Special Singapore Southeast Asia Session 11:00-12:30	Session E Infrastructure Development 11:00-12:30
12:00			Lunch 12:30～13:30	
13:00			Early Career Engineer Presentation	Session A-2 Pile Performance/Piling Mechanism
14:00			Session A-3 Pile Performance/Piling Mechanism	
15:00			Coffee Break 15:00～15:30	
16:00			Session C-2 Disaster Prevention and Mitigation 15:30-17:00	Session D-2 Project Case Histories/Miscellaneous 15:30-17:00
17:00			Closing Remarks 17:00-17:10	

Day Three: Friday, 5 July

SGT (UTC+8)	
9:30	Registration
10:00	Press-in Piling Live Demonstration 1. Zero Clearance Method : Zero Piler JZ100 2. Press-in assisted with Augering : Silent Piler F111 (Crush Mode) 3. Rotary Press-in Piling Method : Gyro Piler SP12 (GRV1230)
11:00	
12:00	Note: 1) Location : 17 Gul Way, Singapore 629194 (Guan Chuan Engineering Pte., Ltd.) 2) The demonstration includes refreshments.

Special Contribution

Residual bearing capacity of scoured shallow foundations and their reinforcement effect by press-in sheet piles

Hidetoshi Nishioka

Professor, Department of Civil and Environmental Engineering
Chuo University

1. Introduction

There have been increasing cases of damage to bridges that cross rivers as flood disasters have become more severe due to climate change in recent years. Many of the bridges built in Japan prior to World War II are still in use today, but many of these bridges are supported by shallow-spread foundations or wood piles, making them particularly susceptible to scouring. Large displacement occurs in scoured foundations, making the bridge impassable even if the bridge does not collapse. The following two contradictory points need to be considered when managing the restoration of bridges, which are important infrastructure, for a country or local community to steadily rebuild after a disaster. The first is for paths to be made temporarily accessible as soon as possible after a disaster, even in cases of limited performance to some extent. The second is to ensure the structure to be strengthened so that the damage does not happen again.

Fig. 1. View during the flood [1]

This article introduces examples where this form of management was successful in railway bridges in Japan [1],[2]. **Fig. 1** shows the situation during flooding, where a shallow foundation was scoured, resulting in a residual settlement of approximately 300 mm and a residual inclination of approximately 50/1000. Emergency restoration was implemented at an early stage (approximately one month after the disaster) after confirming with loading tests up to 90% of the maximum train load (**Fig. 2**) that the structure had the minimum bearing capacity to withstand slow train operation. In this case, in exchange of forgoing foundation reinforcement work, train speeds were restricted, and an electronic monitoring system was also used, thereby ensuring safety. Afterwards, steel pipe piles were pressed in around the scoured foundation in order to reinforce and integrate the structure (**Fig. 3**). These types of reinforcement work were carefully conducted during periods of low rainfall (autumn and winter in Japan) while trains were running. The reinforcement work was completed, and the train speed restrictions and electronic monitoring systems were lifted approximately six months after the disaster.

Fig.2. View of Static loading test by water tank [2]

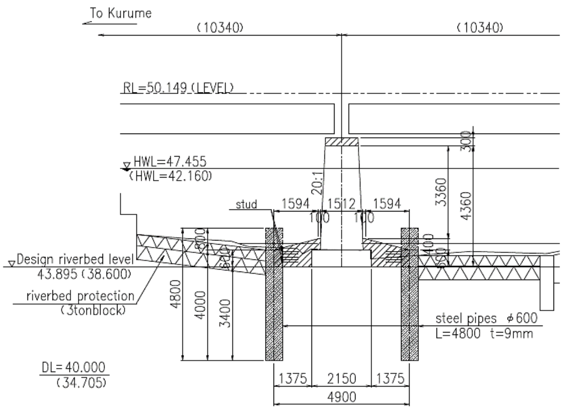


Fig.3. General drawing of the restoration with Press-in Steel pipe piles [1]

Generalizing this form of good practice experience requires clarifying the mechanism by which the residual bearing capacity of shallow foundations is expressed even after being damaged by scouring and establishing quantitative design methods for the reinforcement effect by press-in sheet piles. In this article, we introduce model experiments using an aluminum-rods model ground that we are conducting for these purposes.

2. Overview of experimental technology using aluminum-rods model ground

The aluminum-rods model ground is a mixture of aluminum rods (specific gravity 2.7) of different diameters of several millimeters and stacked together with the rods aligned in the same direction as shown in **Fig. 4**, where a two-dimensional granular material is simulated. The nonlinearity of the stress-strain relationship and the dilatancy properties are similar to those of a medium dense sand. Another major advantage is that the information on displacement and porosity changes in the model ground can be easily obtained from the end face of the aluminum rod through image analysis. Because of these features, aluminum-rods model ground has sometimes been used as one of the basic techniques for conducting model experiments targeting two-dimensional boundary value problems in the field of geotechnical engineering since the 1960s[3],[4].

In this experiment, we used a mixture of three types of aluminum rods with diameters of 1.5 mm, 2.0 mm, and 3.0 mm in a weight ratio of 1:1:1. A comparison of its grain size distribution with that of Toyoura sand, which is widely used in model experiments in Japan shows that the uniformity coefficient U_c is similar, with a mean diameter D_{50} of around 2 mm, which is about 10 times that of Toyoura sand. Furthermore, the unit weight of the aluminum rods model ground with this grain size distribution is still within a relatively narrow range of around 21–22 kN/m^3 even after changing the compaction method and degree. Additionally, the grain size effect should be noted in conditions where clear shear bands tend to occur in the ground, such as in bearing capacity tests. This grain size effect is thought to occur because the shear band thickness is proportional to the grain diameter. For example, Toyosawa et al. reported from bearing capacity tests in centrifuge model tests using dense river sand that the bearing capacity may increase due to the grain size effect in cases where the breadth of footing B is less than 50 times the D_{50} value[5]. Using this as a reference, then when conducting bearing capacity tests with a shallow foundation in this aluminum-rods model ground with these grain size distributions, then the breadth of footing B should be at least 100 mm (approximately 50 times the D_{50} value).

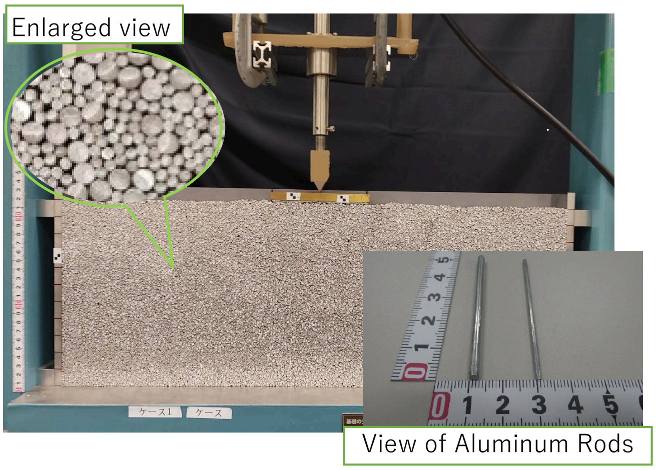


Fig. 4. Overview of aluminum rods model ground

The internal friction angle of the aluminum rods model ground is often easily estimated by an angle of repose test in which an aluminum rod is placed in a sample box and tilted, and the angle of repose obtained as the tilt angle at the time of collapse is around 29–33°. Additionally, back calculation using the Rankine earth pressure equation from the passive coefficient of earth pressure and active coefficient of earth pressure obtained from a retaining wall earth pressure experiment conducted separately yielded an internal friction angle of 28–31°, which is about the same as the angle of repose[6]. Furthermore, back-calculation of the bearing capacity factor N_γ, and N_q from bearing capacity tests on the same aluminum rods model ground also resulted in an internal friction angle in the range of 29-30 degrees.[7]

Additionally, in model experiments using aluminum rods model ground, the ground materials themselves considerably differ, making it difficult to determine a scaling factor of various physical quantities based on a strict similarity rule. Therefore, the similarity rule in aluminum-rods model ground generally uses the idea that a dimensionless quantity (e.g., bearing capacity factor N_γ, N_c, N_q, coefficient of earth pressure K) for the physical phenomenon to be reproduced is made equal between the prototype and the model as needed.

3. Bearing capacity tests of scoured shallow foundation

We conducted vertical loading tests under conditions that artificially simulated the condition in which the ground at the bottom of the foundation was washed away by scouring in order to determine the relationship between scour depth and residual bearing capacity exerted after a disaster [8],[9].

Fig. 5. shows a reproduction of scouring. The condition in which a hole is created by scouring on the upstream side of a

bridge pier is reproduced by removing an aluminum rod, and the scour depth *d* is used as the main parameter. After the scouring was simulated, vertical load was applied by using a jack, and the relationship between the vertical load and settlement was measured. Fig. 6 shows the results.

In **Fig. 6**, the settlement was set to zero before simulating scouring (extracting aluminum rod). Additionally, the dead load (65 N) was approximately 1/3 of the ultimate bearing capacity under conditions where no scouring occurs. The displacement when this dead load was applied represents the residual displacement after a disaster. The results showed that the residual displacement after a disaster increased with increasing scour depth *d*.

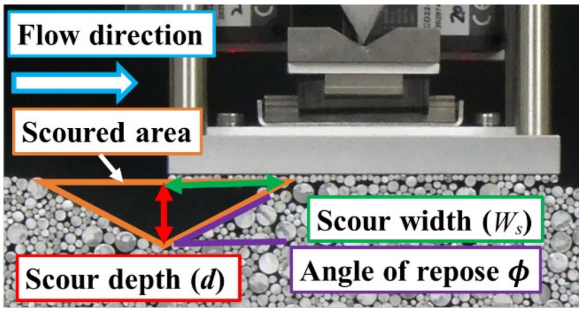


Fig. 5. Modeling scour by removing aluminum rods

Meanwhile, as the loading continued, the load tended to increase from the vicinity of the residual displacement, showing that the maximum load (i.e., residual bearing capacity after disaster) increased to about the same level as in the case with no scouring. In other words, even if scouring caused damage that induced residual displacement, the expected residual bearing capacity itself after the disaster may not decrease by much. This is consistent with the actual cases of emergency restoration shown in **Figs. 1–3**, where the residual bearing capacity needed for train operation could be expected without reinforcing the foundation.

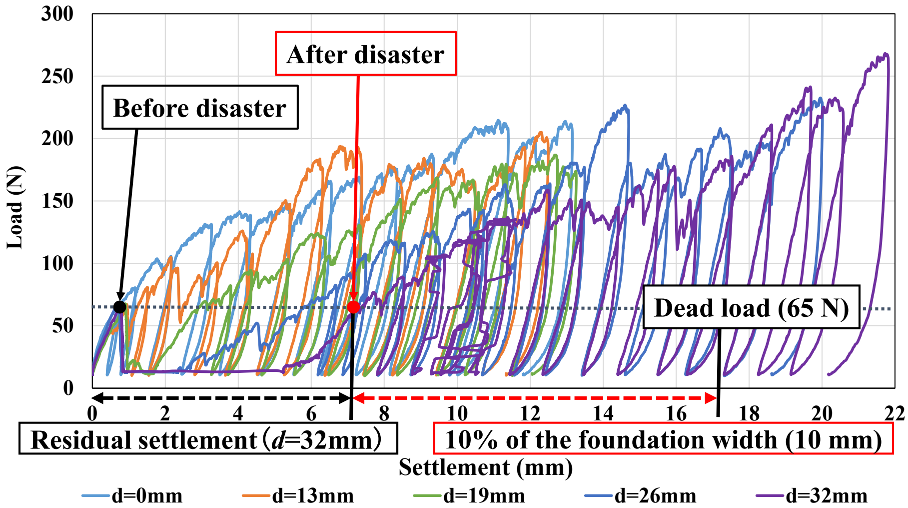


Fig. 6. Load-settlement curves after scour

4. Bearing capacity test of shallow foundation reinforced with press-in sheet piles

The restoration of foundations damaged by scouring (or preventative reinforcement prior to the disaster) requires work in rivers, so construction methods that do not use cement or concrete (or use only a small amount) are advantageous for water quality conservation, and the use of press-in construction methods is expected. Sheet pile foundations that combine sheet piles and footings have previously been developed[10],[11],[12], and they are also used to reinforce river bridge piers[1]. In general, sheet piles and footings should be rigidly connected and integrated in order to obtain high reinforcement effect with less material. However, in the case of reinforcement for scoured foundations in the river, construction efficiency and economy can be improved by eliminating the construction period, cost, and space required for integrating the existing footing with the additional sheet pile. Therefore, an experiment was conducted to confirm the reinforcement effect when integration with the existing footing was omitted (however, the heads of the added sheet piles were connected)[13].

Fig. 7 shows the experimental setup. A sheet pile model (aluminum plate) was installed around the footing with a breadth of footing *B* = 100 mm, and a vertical load was applied. The sheet piles and footing were not connected, but the sheet piles on both sides were connected at the head. The main experimental parameter was the penetration length L of the sheet pile model.

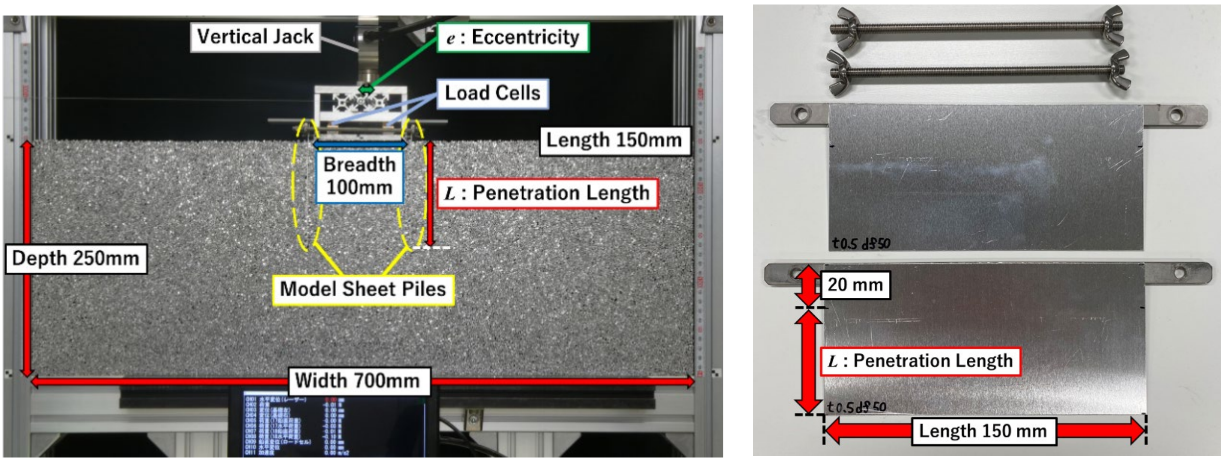


Fig. 7. Experimental setup for confirming reinforcement effect by sheet piles

Fig. 8 shows the load-displacement relationship from unreinforced cases (Case L0) to cases reinforced with sheet piles with penetration length *L* = 20–140 mm (0.2–1.4 times the breadth of footing *B*) (Case L20–Case L140). It can be confirmed in the figure that the bearing capacity increases due to penetration.

Fig. 9 shows the relationship between penetration length L and ultimate bearing capacity (maximum vertical load up to 10 mm settlement). The results confirmed that the reinforcement effect is not proportional to penetration length L but rather changes in a step-wise manner with 0.8 times the breadth of footing *B* (*L* = 80 mm) as the boundary.

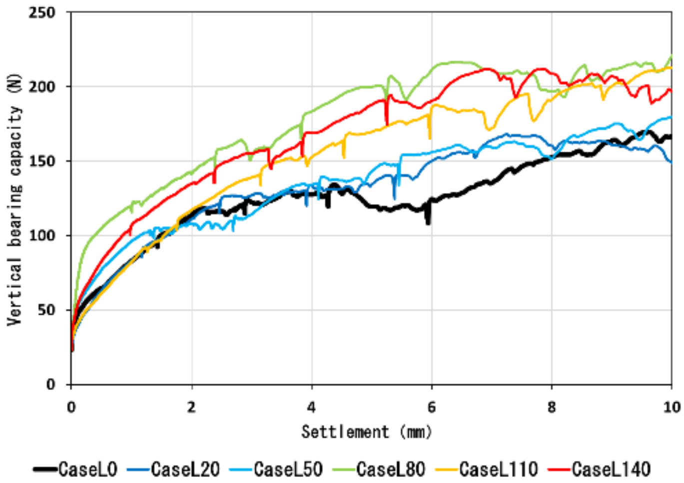


Fig. 8. Load-settlement curves (effect of penetration length *L*)

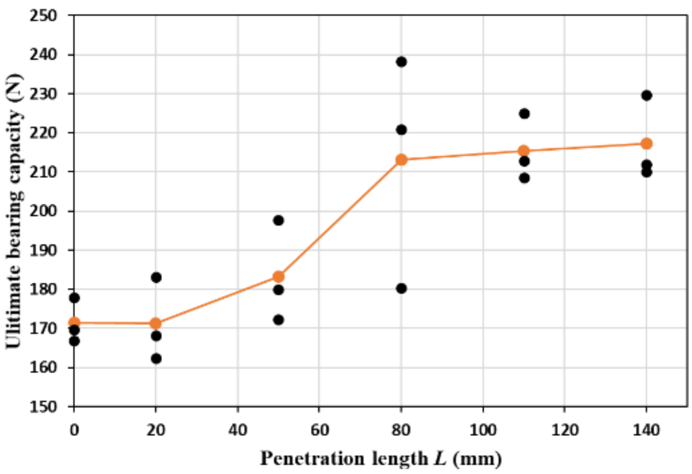


Fig. 9. Relationship between *L* and ultimate bearing capacity

5. Conclusion

The press-in construction method is very much suited for post-disaster restoration and preliminary reinforcement work for river bridge pier foundations, where there is increasing risk of scouring damage, but there is still insufficient accuracy of evaluating the mechanical performance before and after reinforcement. In this article, we introduced experimental examples of residual bearing capacity immediately after a disaster and the effects of advance reinforcement. Evaluations are currently limited to those that are independent from each other, but in the future, we plan to conduct combined evaluations as well as consider seismic performance after reinforcement. We hope to continue these examinations and establish a logical evaluation and design method to contribute toward the realization of a safe and more secure society.

Acknowledgements

The author expresses sincere gratitude to the following graduate students of Chuo University who performed the model tests shown in this article: Ms. Yuna Sasaki, Ms. Moeka Hirano, and Mr. Ryuto Shikakura. And some part of this work was supported by the JSPS KAKENHI Grant-in-aid for Scientific Research (c) (Grant Number JP20K04687).

References

[1] Kuroki, Y., Nishioka, H., Kumabe, K. and Koda, M. (2018): Reinforcement of Damaged Bridge Pier by Scouring Using Steel Pipe Piles, Proc. of the First Int. Conf. on Press-in Engineering 2018, Kochi, pp.549-554. https://www.press-in.org/ja/publication/freefile/86/180

[2] Nishioka, H., Shinoda, M., Sumi, Y. and Yamate, H. (2013): The Vertical Loading Test and Train Running Test to the Bridge Pier of Spread Foundation which was Damaged by Scouring Settlement, 48th Japan National Conference on Geotechnical Engineering, pp.203-204. (in Japanese)

[3] Matsuoka, H. (1974): A Microscopic Study on Shear Mechanism of Granular Materials, Soils and Foundations, Vol.14, Issue 1, pp.29-43. https://www.jstage.jst.go.jp/article/sandf1972/14/1/14_1_29/_article/-char/en

[4] Kikumoto, M., Nakai, T., Zhang, F. and Shahin, H. (2008): Two Dimensional Model Tests Using Aluminum Rods Mass, The Japanese Geotechnical Society, Geotechnical engineering magazine, Vol.56, Issue 10, pp.12-15. (in Japanese)

[5] Toyosawa, Y., Itoh, K., Kikkawa, N., Yang, J.-J., and Liu F. (2013): Influence of model footing diameter and embedded depth on particle size effect in centrifugal bearing capacity tests. Soils and Foundations, Vol.53, Issue 2, pp.349-356. https://doi.org/10.1016/j.sandf.2012.11.027

[6] Nishioka, H., Matsumoto, N., Fukuda, F., and Ono, K. (2022): Model excavation tests simulating the collapse of high bending rigidity cantilever-type earth retaining walls and proposal of a simple calculating method for the reasonable embedding length, Japanese Geotechnical Journal, Vol. 17, Issue 3, pp. 401-420. (in Japanese) https://doi.org/10.3208/jgs.17.401

[7] Yoshida, H., Isobe, Y., and Nishioka, H (2023): Assessing Residual Settlement in Column Foundations After an Earthquake Using Horizontal Loading Model Tests, Proc. of 13th Int. Conf. on Geotechnique, Construction Materials & Environment, Mie, pp. 334-338.

[8] Sasaki, Y., and Nishioka, H. (2022): Vertical Loading Tests on Local Scoured Spread Foundation on Aluminum Rods Model Ground, Int. J. of GEOMATE, Vol.23, No.98, pp.17–23. https://geomatejournal.com/geomate/article/view/1472

[9] Hirano, M., Sasaki, Y., and Nishioka, H. (2023): Evaluation of the bearing capacity of scoured bridge foundations using aluminum rod ground model tests, Abstract Proc. of the 2nd Int. Conf. on Construction Resources for Environmentally Sustainable Technologies, Fukuoka, pp.55-58.

[10] Nishioka, H. (2017) Case-history Development of Sheet Pile Foundation, IPA Newsletter, Vol.2, Issue 4, pp.13-16. https://www.press-in.org/_upload/files/Newsletter/Newsletter%20vol.2%2C4.pdf

[11] Nishioka, H., Koda, M., Hirao J. and Higuchi S. (2008): Development of Sheet-Pile Foundation that Combines Footing with Sheet Piles, Quarterly Report of RTRI, Vol.49, Issue 2, pp. 73-78. https://doi.org/10.2219/rtriqr.49.73

[12] Nishioka, H., Koda, M., Hirao, J. and Higuchi, S. (2010): Vertical and combined loading tests for sheet pile foundation. Int. J. of Physical Modelling in Geotechnics 10: 25-34, 2010. https://doi.org/10.1680/ijpmg.2010.10.2.25

[13] Shikakura, R., Nishioka, H., Yamakuri, Y., Arai, Y. and Hirano, M. (2024): Experimental study on the influence of penetration length and eccentricity on the bearing capacity of sheet pile foundations, Proc. of the 3rd Int. Conf. on Press-in Engineering, Singapore. (in press)

Directors' research and development activities

Performance of winged monopile in calcareous sand ground

Vu Anh Tuan

Associate Professor, Civil Engineering Department
Le Quy Don Technical University, Hanoi, Vietnam

Abstract

This study aims to investigate the behaviors of winged monopiles subjected to cyclic loading in a calcareous sand through numerical analysis. Axial load tests (push-in or pull-out) of monopiles with and without wings in a calcareous ground are simulated using a three-dimensional finite element software, PLAXIS 3D. Prior to these simulations, triaxial tests on a calcareous sand sampled from Vietnam were carried out to investigate the mechanism behaviors of the calcareous sand, aiding in the selection of an appropriate soil model and the evaluation of the corresponding soil parameters. The hypoplastic model was adopted to simulate the sand. Interface elements were employed to simulate the slippage between the pile shaft and the soil. The analyzed results show that the resistance of the winged pile is considerably higher than that of the pile without wings.

1. Introduction

In the sea areas of Southeast Asia, especially around Truong Sa Island in Vietnam, calcareous sand is quite commonly distributed. A problematic feature of the calcareous sand is high crushability of soil particles when subjected to high confining pressure, shear stress, and cyclic loading. A monopile foundation is usually used for supporting offshore structures subjected to cyclic loading caused by sea waves and/or winds as well as to vertical loading. To improve the shaft resistance, the use of a winged monopile, where reinforcement wings are implemented along the outer surface of the pile, is a feasible solution.

The physical and mechanical characteristics of calcareous sands have been summarized in [1, 2]. In a natural state, calcareous sediments behave differently from terrestrial silica sands, the most significant distinguishing feature being their tendency to exhibit volume reduction upon shearing, even at relatively low normal stresses. It was pointed out in [2] that the tendency for volume reduction due to shearing plays a dominant role in the foundations of calcareous sediments. A numerical study was conducted on the behavior of a single pile subjected to cyclic loading in the coral sand [3]. Al-Douri and Poulos [4] compared the predicted and observed performance of cyclic load tests on small-scale single piles jacked into dry calcareous sand to study the accumulation of permanent displacement of the piles.

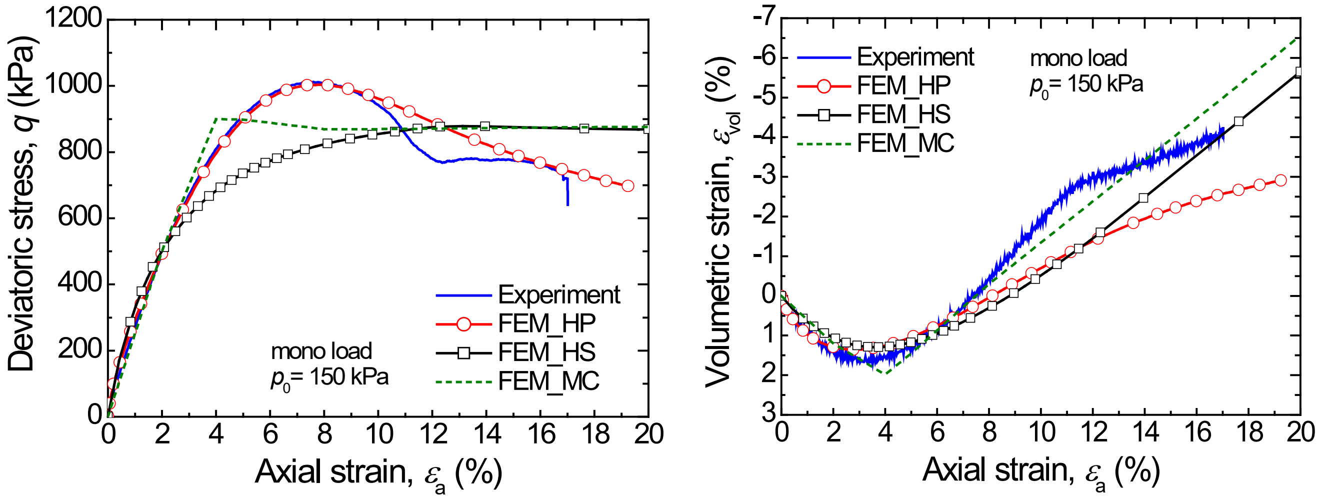
This study investigates the behavior of winged monopile subjected to cyclic loading in calcareous ground through numerical analysis. In the analyses, axial load tests (push-in or pull-out) of monopiles with and without wings in a calcareous ground are simulated using a three-dimensional finite element program, PLAXIS 3D [5]. Triaxial tests on a calcareous ground sampled in Vietnam are carried out prior to the analyses of the load tests to investigate the mechanical behavior of the calcareous ground and to select an appropriate soil model as well as to evaluate the corresponding soil parameters. In this study, the hypoplastic model [6] is used to model the ground. Interface elements are employed to simulate the slippage between the pile shaft and the soil. The analyzed results show that the resistance of the winged pile is considerably higher than that of the pile without wings.

2. Triaxial Tests of The Calcareous Sand and FEM Simulation

The calcareous sand collected from Truong Sa Island in Vietnam was used in this study. Only soil particles having a particle diameter, d, smaller than 4.75 mm were used in the experiments. Triaxial monotonic and cyclic CD compression tests on calcareous sand with a relative density, Dr, of 70% were conducted at a confining pressure, p_0, of 150 kPa. Cylindrical specimens with a height of 100 mm and a diameter of 50 mm were used in the tests.

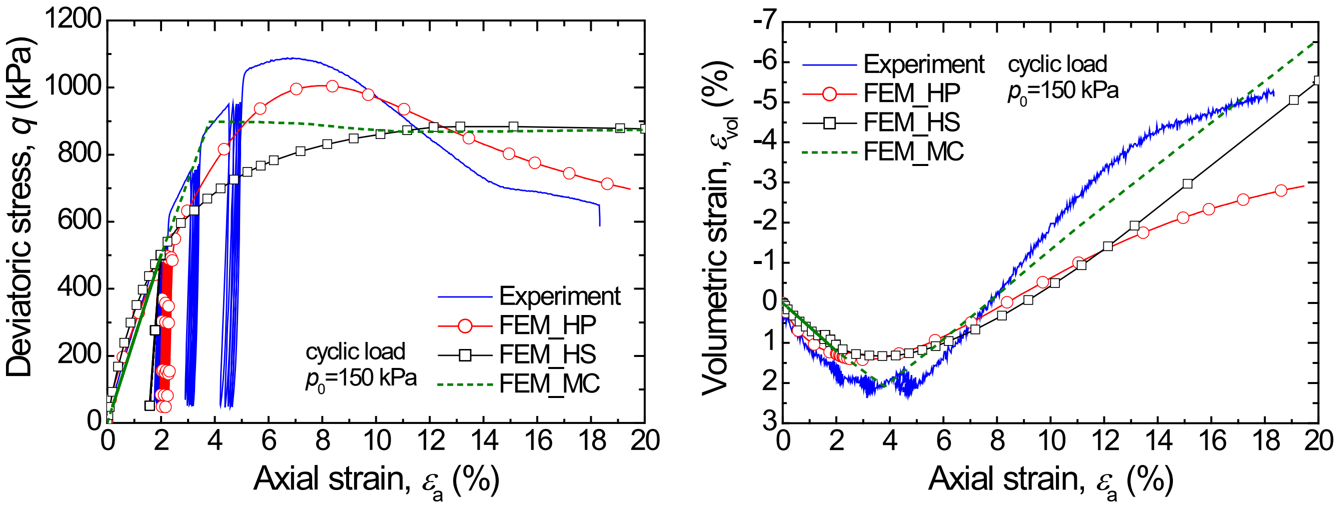
Fig. 1 and 2 show the experimental and simulation results of the triaxial tests for monotonic and cyclic loading, respectively. The experimental results indicate that post-peak softening behavior is observed, and dilatancy decreases with increasing axial strain. Specifically, in the case of cyclic loading (Fig. 2a), the accumulative strain increases with the number of loading cycles.

Simulations of the triaxial tests were carried out to select an appropriate soil model and to evaluate the soil parameters. In this study, soil models such as Mohr-Coulomb (MC), Hardening Soil (HS) [7] and Hypoplastic (HP) were used for the simulations. The FEM simulations results of the triaxial tests are also shown in Fig. 1 and 2. It is evident that MC and HS models cannot simulate the post-peak softening behavior (Figs. 1a and 2a) and the reduction of dilatancy (Figs. 1b and 2b) with increasing axial strain, ε_a. In particular, the MC and HS models are unable to simulate the accumulative strain due to cyclic loading (see Fig. 2b). Meanwhile, the HP model [6] generally simulated the measured q vs. ε_a of the calcareous sand well, both qualitatively and quantitatively, although there are differences in dilatancy curves between the experiments and the simulations. The hypoplastic model will be employed for model ground in numerical analyses of monopiles, which are presented in Section 3.



(1a) Deviatoric stress q versus axial strain ε_a (1b) Volumetric strain ε_{vol} versus axial strain ε_a

Fig. 1. The experimental and simulation results of the triaxial tests for monotonic loading.



(1a) Deviatoric stress q versus axial strain ε_a (1b) Volumetric strain ε_{vol} versus axial strain ε_a

Fig. 2. The experimental and simulation results of the triaxial tests for cyclic loading.

3. Numerical Analysis of Monopiles in Calcareous Sand

3.1. Description of Numerical Model

Case studies considered in this paper are close-ended monopiles with and without wings, subjected to vertical loading (push-in or pull-out loading) in calcareous sand ground. The monopiles made of steel have a total length of 25 m, with 24 m embedded and 1 m free-standing. They have an outer diameter of 1 m and a pile wall thickness of 0.015 m. The reinforcement wings of the winged pile have a width of 0.5 m (0.5D), with an opening angle of 120 degrees and a thickness of 0.01 m. The wings are spaced at 1 m interval, as shown in Fig. 3.

Model ground in this numerical study consists of calcareous sand, with properties presented in the Section 2. Groundwater influences the initial effective stress conditions, although for simplicity, a fully-drained condition was assumed during loading, resulting in uncoupled analyses. Fig. 4 shows the dimensions of the model ground. The side boundary extends laterally to 6 m (6*D*, *D* is the pile diameter) from the pile axis with restrained (fixed) horizontal displacements applied. The base boundary, located 10 m (10*D*) from the pile tip, has restrained vertical and horizontal displacements applied.

To model the pile, a hybrid model was used, consisting of a beam element surrounded by solid elements, according to Kimura and Zhang [8]. In the hybrid model of this paper, beam element carried a large proportion of the axial stiffness, *EA*, and bending stiffness, *EI* of the pile.

Interface elements were assigned along the pile shaft to simulate the slippage between the pile and the ground. An innterface cohesion of 1 kN/m^2 and an interface angle of 32 degrees were assumed, based on the triaxial test results and the strength interface reduction factor of 0.67.

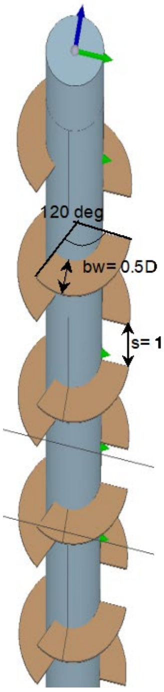


Fig 3. Dimensions of reinforcement wings.

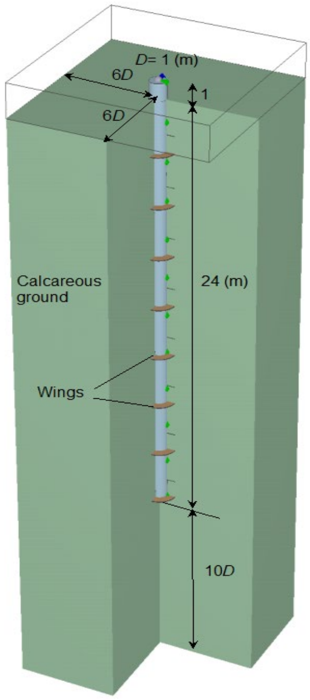


Fig 4. Dimensions of the model ground.

3.2. Numerical Results and Discussions

Fig. 5 shows the analyzed results for the monopiles (with and without wings) subjected to push-in loading including monotonic and cyclic load. Clearly, the winged-pile shows much greater resistance than the pile without wings under both monotonic and cyclic loading. Firstly, consider the load-settlement curves of the pile without wings. It is interesting to notice the difference in the pile resistance, which is influenced by loading types. The resistance of the pile after the cyclic loading decreases compared with that of the monotonic loading. Meanwhile, in the case of winged-pile, the pile resistance is almost the same between the monotonic and cyclic loading cases.

Fig. 6 shows the load-displacement curves of the piles in the case pull-out loading, in which the pile resistance is contributed by only the pile shaft resistance. Clearly, the resistance of the wing-pile is much greater than that of the pile without wings. As for the single pile without wings, the shaft resistance attained to the ultimate value of around 2300 kN after the pile head displacement reached about 0.01 m (w/D = 0.01). Meanwhile, the resistance of the winged pile increased with the increase of the pile head displacement and attained a stable behavior even until the displacement reached 0.1 m (w/D= 0.1). The resistance of the winged pile at w/D = 0.1 is 17000 kN which is over 7 times larger than that of the pile without wings, indicating a significant effect of the reinforcement wings on the pile shaft resistance. Note here that the resistance of a pile at w/D = 0.1 is considered as the pile capacity in design specification of many countries. The differences in pile resistance between monotonic and cyclic loading are insignificant.

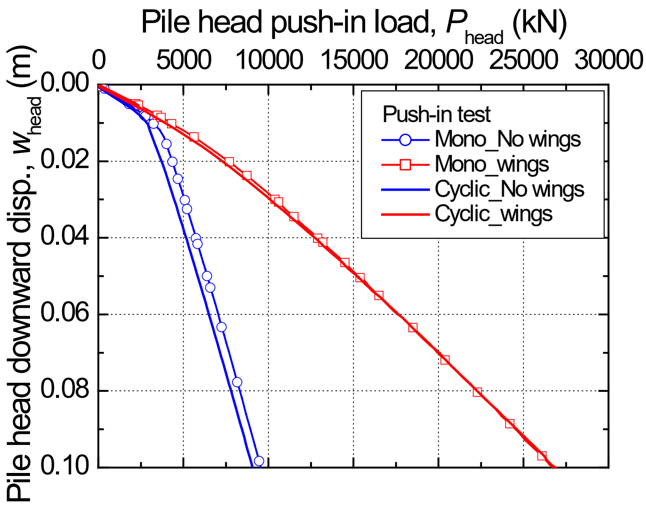


Fig 5. Load-displacement curves in push-in test.

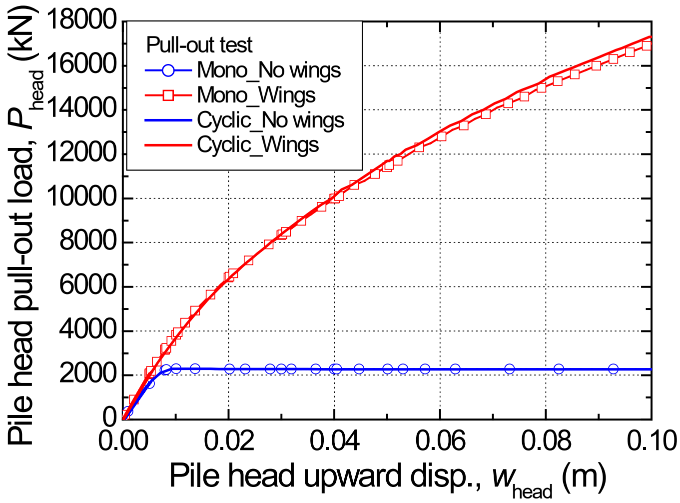


Fig 6. Load-displacement curves in pull-out test.

4. Conclusion

In this study, triaxial tests of a calcareous sand sampled from Truong Sa Island of Vietnam were conducted to investigate the mechanism behaviors under monotonic and cyclic loading. After that, numerical simulations of the triaxial tests were carried out to select an appropriate soil model and evaluate the corresponding parameters for numerical analyses on behaviors of monopiles in the calcareous sand ground.

The results from both experimental and simulation of triaxial tests indicate that the Hypoplastic soil model is more suitable than the Mohr-Coulomb or Hardening soil models for simulating calcareous sand, particularly under cyclic loading.

The numerical results show that the winged pile has considerably greater resistance than the normal pile without wings, both in pull-out and push-in loading tests, indicating its high performance efficiency of the winged pile. However, in this numerical study, the pile installation effect was not considered. Consequently, conducting experiments through small-scale models and/or full-scale models, wherein the pile installation effect is considered, are necessary to evaluate the performance efficiency of the winged pile in practical applications.

References

1. Murff, J.D. Pile capacity in calcareous sands; State of the art. Journal of Geotechnical Engineering, 113(5), 490-570 (1987).

2. Poulos, H.G. The mechanics of calcareous sediments. Australian Geomechanics, 8-41 (1988).

3. Kusumaningsih, D.A., Vu, A.T. and Matsumoto, T. Numerical study on behaviour of single piles in a coral sand. Proc. Soft Soils 2016 Conf., Bandung, pp. D1-1 to D1-6 (2016).

4. Al-Douri, H.A. and Poulos, H.G. Predicted and observed cyclic performance of piles in calcareous sand. Journal of Geotechnical Engineering, 121(1), 1-16 (1995).

5. Vu, AT., Matsumoto, T. Numerical Analysis on Behaviors of Winged Monopile Subjected to Cyclic Loading in a Calcareous Ground. Lecture Notes in Civil Engineering, 18, 217-223 (2019).

6. Wolffersdorff, P.A. A hypoplastic relation for granular materials with a predefined limit state surface. Mechanics of cohesive-frictional materials 1, 251-271 (1996).

7. Schanz, T., Vermeer P.A. and Bonnier, P.G. The hardening soil model: formulation and verification. In: Brinkgreve RBJ, editor. Beyond 2000 in computational geotechnics. Rotterdam: Balkema, 281-290 (1999).

8. Kimura, M. and Zhang F. Seismic evaluations of pile foundations with three different methods based on three-dimensional elasto-plastic finite element analysis. Soils and Foundations. 40(5), 113-132 (2000).

Report

Ordinary General Assembly 2024

The IPA Ordinary General Assembly 2024 was held from 13 to 24 May, 2024. The total votes have achieved the quorum and all the presented Agendas were resolved in accordance with Article 22 of Constitution.

- Period: 13 to 24 May 2024
- 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: 719 (Individual Members: 671, Corporate Members: 48)
- Quorum: 360 (a majority of members）
- Total votes： 452 ［achieved quorum］ (Turnout 63%）

Votes on each Agenda：

	Agendas	Affirmative votes	Dissenting votes	Results
Agenda 1	Activity Report for FY 2023	452	0	Approved
Agenda 2	Income and Expenditure Statement for FY 2023	451	1	Approved
Agenda 3	Activity plan for FY 2024	452	0	Approved
Agenda 4	Budget for FY 2024	452	0	Approved
Agenda 5	Election of the Directors and Auditors (2024-2025)	452	0	Approved
Agenda 6	Amendments to Constitution	452	0	Approved

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

Incoming Directors:

Director	**David, Ko-Wei Lin**	President & Representative Director Chuen-Chang Enterprise Co., Ltd. Taiwan
Director	**Marawan M. Shahien**	Professor Tanta University Geotechnical Engineering Consultant Egypt
Director	**Cristina de Hollanda Cavalcanti Tsuha**	Professor University of São Paulo Brazil

Outgoing Directors:

Director

Masaaki Terashi
Technical Advisor
GIKEN LTD.
Japan

Director

Lei Yang
Vice President
SHANGHAI TUNNEL ENGINEERING CO., LTD.
China

Event Report

iconNECt Seminar on Introduction of a Green Approach for Preventing Landslides in the Philippines, 1 December 2023

Mark Albert H. Zarco

Professor, University of the Philippines, Diliman

The National Engineering Center of the University of the Philippines Diliman in partnership with Daisho Company Limited and the Department of Public Works and Highway (DPWH)of the Republic of the Philippines hosted through its i-conNECt program and, organized a seminar entitled *Introduction of a Green Approach for Preventing Shallow Landslides in the Philippines* last 1 December 2023. The seminar was offered to the public for free in partnership with Daisho Company Limited. Opening remarks were given by representatives from the DPWH Regional Office for the Cordillera Administrative Region.

Resource speakers included IPA Directors Prof. Tatsunori Matsumoto and Prof. Mark Albert Zarco, together with Dr. Shota Yoshida of Daisho Co. Ltd, and Dr. Xiong Xi of Kanazawa University. Also, in attendance were Mr. Jiro Oshima, Senior Representative, Japan International Cooperation Agency (JICA) Philippines Office, and Mr. Ryuichi Hara, JICE Technical Expert. The seminar was attended by more than 90 representatives from government, academe, and private sector. The event was covered by the Daily Manila Shimbun. During the seminar, updates on a demonstration project in the Cordillera Administrative Region funded by JICA and implemented by Daisho Co. Ltd together with the Department of Public Works and Highway were presented.

Prof. Zarco spoke about Llandslides in the Philippines. Mr. Hara talked about slope disaster mitigation project provided by JICA in the Philippines. Mr. Paragas of talked about Rockfall Slope Protection Systems. Dr. Yoshida presented a slope reinforcement technology that does not require cutting trees. Prof. Emeritus Matsumoto lectured on the behavior of the slope ground during heavy rains. Ms. Mimu Yoshida and Ryoei Kusumoto presented on the use of 3D data in slope disaster prevention.

The i-conNECt series of seminars/webinars aims to disseminate information and provide a venue for discussion among the industry, academe and the government on important issues affecting the nation. It aims to spread awareness about relevant topics in engineering and how they affect the lives of ordinary people.

Photo 1. Resource Speakers pose for a picture at the end of the seminar on *Introduction of a Green Approach for Preventing Shallow Landslides in the Philippines* held last 1 December 2023 at the National Engineering Center, University of the Philippines Diliman, Quezon City, Philippines.

Photo 2. Open forum during seminar on Introduction of a Green Approach for Preventing Shallow Landslides in the Philippines last 1 December 2023.

Young Members Column

Determination of Peat Thickness in North Ayer Hitam State Forest Reserve, Muar, Johor by Using Non-Destructive Testing (NDT) for mitigation of peatland forest fire

Muhamad Firdaurs bin Abdullah

PhD Student, Faculty of Civil Engineering and Built Environment
Universiti Tun Hussein Onn Malaysia (UTHM)

I'm Muhamad Firdaurs bin Abdullah, a PhD student of Faculty of Civil Engineering and Built Environment, Universiti Tun Hussein Onn Malaysia (UTHM). I have completed my Master's degree in Civil Engineering from UTHM back in 2017. As a graduate student researcher, the author worked under Dr. Nor Azizi Yusoff on a variety of research assignments. I was involved in research projects headed by Dr. Azizi such as green roof thermal performance, soil-roots reinforcement, vertical garden, compact soil extruder, silent piling technology and visiting many geotechnical project sites. Throughout my graduated study, the author has co-authored five papers in areas of Soil Bio- and Eco-engineering.

Currently, I am working on the project for water sustainability for peatland in North Ayer Hitam State Forest Reserve Muar, Johor, Malaysia. This project is funded by National Conservation Trust Fund for Natural Resources (NCTF), under the Ministry of Natural Resources and Environmental Sustainability. Malaysia contains about 3 million hectares peatland which cover 8% of its total land. The depth of peat varies depending on the area. It helps to maintain water levels, acts as a flood control and water supply system for communities as well as downstream ecosystem. The study is aimed to determine the thickness of peat in Ayer Hitam Utara Forest Reserve, Muar, Johor by using a Non-Destructive Testing (NDT). The survey data on peat thickness was collected at 10 sites located inside the forest. The resistivity data consisted of six-line wenner-schlumberger short arrays and were recorded in-situ using SAS 4000 ABEM Lund Imaging System, together with a relay switching unit (Electrode Selector ES 10-64), two multiconductor cables, steel rod electrodes and jumpers. The data, namely electrode spacing, depth of investigation, sub-surface resistivity, type of material and horizontal data coverage was used to assess the thickness of peat. The recorded data were then processed using RES2DINV software to obtain 2-D inversion model of the sub-surface. The data were also equipped with ten models of inverse resistivity section for all sites showed a varies thickness of peat in range between 5 to 15 m. The data obtained can be used by the government and stakeholders for peatland fire prevention program to mitigate haze in Malaysia and conservation of Ayer Hitam Utara reserve forest. The application of silent piling technology might be useful in order to sustain the water balance of the forest reserve by retaining huge amount of water from leaving the forest at fast rate. Thus, the prevention of peatland forest fire can be made more effectively.

Fig. 1. Resistivity line survey conducted of few locations inside North Ayer Hitam State Forest Reserve, Muar, Johor

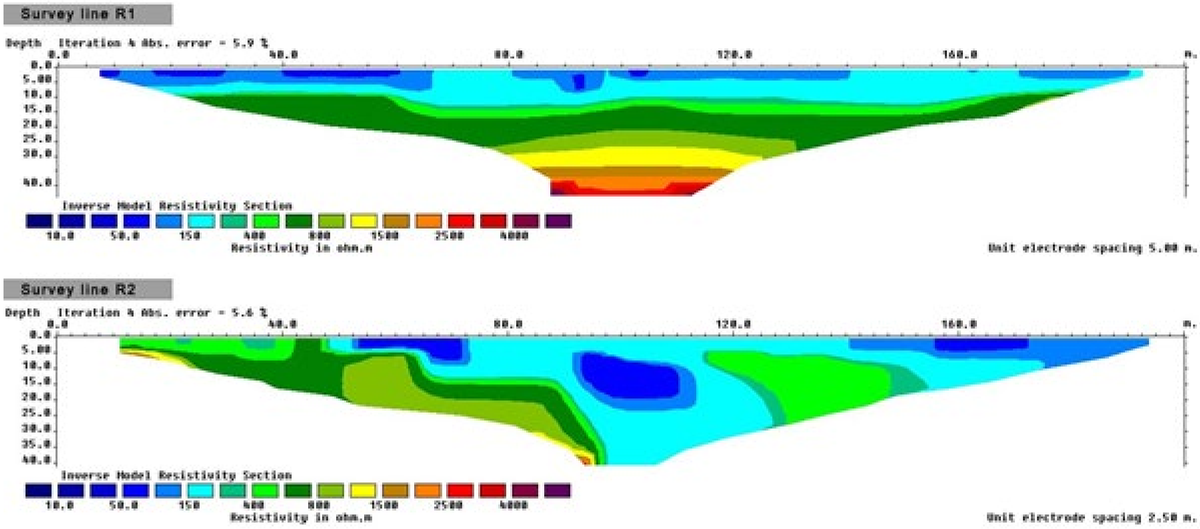


Fig. 2. Output image processed using RES2DINV software to obtain 2-D inversion model of the sub-surface of peatland

Fig. 3. An expedition by UTHM team to assess depth of peat in the forest (left) and the peat sampling made using a peat sampler during the expedition (right)

Event Diary

Title	Date	Venue
■ **IPA Events** https://www.press-in.org/en/event		
The Third International Conference on Press-in Engineering (ICPE 2024)	3-5 July 2024	Singapore
■ **International Society for Soil Mechanics and Geotechnical Engineering** http://www.issmge.org/events		
7Th International Conference on Geotechnical and Geophysical Site Characterization	18-21 June 2024	Barcelona, Spain
28TH EUROPEAN YOUNG GEOTECHNICAL ENGINEERS CONFERENCE 2024	25-29 June 2024	Demir Kapija, North Macedonia
5th International Conference on Environmental Geotechnology, Recycled Waste Materials and Sustainable Engineering	4-6 July 2024	Warsaw, Poland
14th International Symposium on Landslides 2024	7-12 July 2024	Chambery, France
The 6th International Conference on Geotechnical Engineering	21-23 July 2024	Semarang, Indonesia
XVIII European Conference on Soil Mechanics and Geotechnical Engineering	25-30 August 2024	Lisbon, Portugal
4th International Conference of International Society for Intelligent Construction (ISIC 2024)	10-12 September 2024	Orlando, Florida
77th Canadian Geotechnical Conference and the 16th Joint CGS/IAH-CNC Groundwater Conference	15-18 September 2024	Montreal, Canada
Nordic Geotechnical Meeting - NGM 2024	18-20 September 2024	Göteborg, Sweden
IS-Grenoble 2024: International Symposium on Geomechanics from Micro to Macro	23-28 September 2024	Grenoble, France
■ **Deep Foundations Institute** https://www.dfi.org/events/		
DFI S3: Slopes, Support and Stabilization	6-8 August 2024	Aurora, Colorado
DFI-India 2024: 13th Annual Conference	19-21 September 2024	Panaji, Goa, India

Corporate Members

IZUMO GIKEN LTD.
株式会社 出雲技研
Japan

GUAN CHUAN
Guan Chuan Engineering Construction Pte Ltd
Singapore

THAI FULLMORE CO., LTD
Thailand

MIYAZAKI KISO CONSTRUCTION Co. Ltd
宮崎基礎建設 株式会社
Japan

DAIWA
DAIWA-KIKO CO., Ltd
大和機工 株式会社
Japan

NARASAKI
NARASAKI SANGYO CO., LTD.
ナラサキ産業 株式会社
Japan

TUNGALOY CORPORATION
株式会社 タンガロイ
Japan

SEG Corporation
Japan

Sakiyamagumi, Ltd
株式会社 﨑山組
Japan

JFE Steel Corporation
JFE スチール 株式会社
Japan

Endo Kogyo Co., LTD.
株式会社 遠藤工業
Japan

ITOCHU TC CONSTRUCTION MACHINERY CO., LTD.
伊藤忠TC建機 株式会社
Japan

Fuji Tokushu Co., Ltd.
株式会社 フジ特殊
Japan

Ishii Kiso-Contstruction Co., Ltd.
株式会社 石井基礎工事
Japan

株式会社 角藤
KAKUTO CORPORATION
Japan

SHANGHAI TRUST MACHINERY IMPORT & EXPORT Co., Ltd.
China

SATO JUKI Corporation
株式会社 佐藤重機建設
Japan

SUGISAKI KISO CO., LTD.
杉崎基礎 株式会社
Japan

NIPPON STEEL CORPORATION
日本製鉄 株式会社
Japan

Kuroda Tekkou Co., Ltd.
有限会社 黒田鉄工
Japan

Akatsuki Industrial Co., Ltd.
株式会社 暁産業
Japan

YOKOHAMA INDUSTRIAL PRODUCTS JAPAN CO., LTD KINKI COMPANY
横浜ゴムMBジャパン 株式会社
近畿カンパニー
Japan

GIKEN
GIKEN LTD.
株式会社 技研製作所
Japan

Kajikawa Construction CO., LTD
株式会社 梶川建設
Japan

Yagojidousha Seibi Koujyou Co., Ltd.
株式会社 矢後自動車整備工場
Japan

Yokoyama-Kiso Co., Ltd.
株式会社 横山基礎工事
Japan

Takeuchi Crane Industry
竹内クレーン工業
Japan

CKK GROUP
中部工業 株式会社
Japan

FUJIIGUMI Co., Ltd.
株式会社 藤井組
Japan

CHIBAKOBEX Co., Ltd
株式会社 千葉コベックス
Japan

Corporate Members

KAKIUCHI Co., Ltd.
株式会社 垣内
Japan

株式会社ヨネイ
YONEI & CO., LTD.
Japan

Daishin Kikou Co., Ltd.
有限会社 大晋機工
Japan

SANKOH MACHINERY CORPORATION
三興機械 株式会社
Japan

RINKO KORPORATION
株式会社
リンコーコーポレーション
Japan

有限会社オオブ工業
Oobu Co., Ltd
Japan

CITEC INC.
シーアイテック 株式会社
Japan

DAIICHI KISO CO., LTD.
株式会社 第一基礎
Japan

Mizuho Jyuki Co., Ltd.
有限会社 瑞穂重機
Japan

THE BANK OF KOCHI, LTD.
株式会社 高知銀行
Japan

Sakamoto Sangyo Co., Ltd.
サカモト 産業株式会社
Japan

株式会社カナモト
Kanamoto Co., Ltd.
Japan

MC Chugoku Construction Machinery Co., Ltd.
エムシー中国建機 株式会社
Japan

株式会社 小澤土木
Ozawa Civil Engineering and Construction Co. Ltd.
Japan

SEKO
GIKEN SEKO CO., LTD.
株式会社 技研施工
Japan

Kyoeisangyo co., Ltd
共栄産業 株式会社
Japan

Maruka Corporation
株式会社 マルカ
Japan

CHOWA KOUGYOU KYUSYU CO., LTD.
調和工業九州 株式会社
Japan

Editorial Remarks from persons in charge

Welcome to the IPA Newsletter, Volume 9, Issue 2. Thank you for giving me an opportunity to work in the editorial group for this issue. On behalf of the persons in charge, I wish to express my appreciation to the authors and the secretariat for their outstanding contributions to this issue.

As Message from the President, Prof. Chun Fai Leung introduces about the 3rd International Press-in Conference which is coming on 3-5 July 2024. The theme of this international conference is 'Superiority of press-in piling towards sustainable construction in tackling climate change for infrastructure development.' We look forward to your participation at the conference (https://2024.icpe-ipa.org).

This Newsletter issue has presented a number of interested articles on the bearing capacity problem. It also introduces a use of the press-in technology for post-disaster restoration and preliminary reinforcement work for river bridge pier foundation. Also included in this issue is a report on recently held international semiar on Introduction of a Green Approach for Preventing Landsliides in the Philippines held last December 2023 in Philippines.

We wish you all the best, and thank you for reading the newsletter.

Pastsakorn Kitiyodom

Michael Doubrovsky

Adnan Anwar Malik