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Message

From Vice President

Kenichi Soga

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I am very happy to write this message in this issue of the IPA Newsletter as one of the directors of the IPA. My association with Giken Seisakusho and then IPA started when I joined the Cambridge University Geotechnical Group as a lecturer in 1994. Prof. Malcolm Bolton told me that there is an exciting piling technology from Japan and he is starting to develop a research collaboration with them. I remember meeting President Kitamura and his colleagues immediately after that and this was then followed by the long relationship between the company and the university, which still keeps on going. I visited Koichi several times during the initial kick-off stage of the collaboration and enjoyed very much in taking part in research idea development as well as joining social events afterwards. The latter includes going to a very tiny restaurant that serves exotic pork dishes and singing at Karaoke shops.

Although most of the collaborative projects were mainly led by my Cambridge colleagues (Bolton, White and Haigh), my former PhD student Chris Chau and I once conducted an IPA sponsored research in collaboration with Duncan Nicholson of Arup and Dr Toru Inui of Kyoto University to examine the environmental impacts of the press-in system compared to other piling methods using embodied energy (EE) and waste gas emissions such as CO2 during constructions. Three cases were considered: 1) A theoretical installation processes, comparing the Silent Piling Technology (SPT) with commonly available hammering technologies for a range of ground profiles, 2) A back calculation on 5 sites where piles were constructed using the SPT and 3) the prospect of using steel piles as part of the load bearing foundations by designing a theoretical equivalent pile layout to a CFA core for a building in London. The cost, EE and CO2 emissions of the project were calculated.

The results revealed that the main advantage of the SPT system is its self-erecting property: when temporary works were not required, the environmental impacts of the two systems were similar. However, when temporary works were required for the hammering system, the EE and CO2 emissions of the hammering system exceed the SPT system by 20-1000% depending on the engineering properties of the ground and the distance the fill materials were imported from. The materials energy account for over 80% of the total energy where the installation energy accounts only 10%. This implies that for the wider picture of sustainability, in addition to optimization of the installation process, the design of foundation systems to minimize the use of materials is crucial to reduce the overall environmental impacts.

After 22 years at Cambridge University, I recently moved to the University of California, Berkeley in 2016. In the past 15 years during the Cambridge years and now at UC Berkeley, I have been promoting the concept of Smart Infrastructure. Design, construction, maintenance and upgrading of civil engineering infrastructure require fresh thinking to minimize use of materials, energy and labor. This can only be achieved by understanding the performance of the infrastructure, both during its construction and throughout its design life, through innovative monitoring. Advances in sensor systems offer intriguing possibilities to radically alter methods of condition assessment and monitoring of infrastructure. I believe that the future of infrastructure relies on smarter information; the rich information obtained from sensors within infrastructure will act as a catalyst for new design, construction, operation and maintenance processes for integrated infrastructure systems linked directly with user behavior patterns. To realize this smart infrastructure concept, we have been developing various sensor technologies such as distributed fiber-optics sensors, computer vision, wireless sensor networks, low-power micro-electromechanical systems, energy harvesting and citizens as sensors. This initiative led to the development of the Cambridge Centre for Smart Infrastructure and Construction (CSIC) (www-smartinfrastructure.eng.cam.ac.uk) and now spinning out as new research activities at UC Berkeley (geomechanics.berkeley.edu).

In the context of IPA, Smart Foundation is one of the Smart Infrastructure outcomes. Design limits are frequently based on strain developing in the structure. Although strain measurement is well established, current practice has until recently been restricted to measurement of point-wise strains by means of vibrating wire or metal foil strain gauges. When instrumenting building components such as columns or beams where the strain distribution is merely a function of the end conditions and applied loading, point sensors are suitable to define the complete strain profile. However, where structures interact with soil, (e.g. underground infrastructure such as foundations, tunnels or pipelines) or indeed in the case of a soil structure (road or dam embankments), the state of the structure is not fully understood unless the complete in situ strain/stress regime is known. When monitoring strain in piled foundations or retaining walls, capturing the continuous strain profile is often invaluable to pinpoint localized problem areas such as joint rotations, deformations and non-uniformly distributed soil-structure interaction loads.

In the past 15 years, we have been conducting research on Smart Foundation using distributed fiber optic strain measurement technology. The novel aspect of this new technology lies in the fact that tens of kilometers of fiber optic cable can be sensed at once for continuous distributed strain measurement, providing relatively cheap but highly effective monitoring systems. The distributed measurement nature of this technology clearly differentiates from the other discrete point-wise strain measurement technologies. We have been demonstrating the importance of distributed strain measurements to monitor the performance of building foundations at field sites in the UK and US and developing a design tool that optimizes the performance of foundations that require rehabilitation, repair and reuse. Further details can be found in Soga et al. (2015), Kecharvazi et al. (2016) and Pelecanos et al. (2017). The current internet-of-things (IoT) revolution is proving us a great opportunity to move the smart foundation concept forward and to make a significant step change in our industry. I finish this message by encouraging the IPA community to further develop technologies that allow us to realize the concept of Smart Foundation.

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◆ A brief CV of Prof. Kenichi Soga

Kenichi Soga is a Chancellor’s Professor at the University of California, Berkeley. He obtained his BEng and MEng from Kyoto University in Japan and PhD from the University of California at Berkeley. He was Professor of Civil Engineering at the University of Cambridge before joining UC Berkeley in 2016. While at Cambridge, he and his colleagues initiated the Centre for Smart Infrastructure and Construction (CSIC, www-smartinfrastructure.eng.cam.ac.uk). The strategic aim of CSIC is that emerging technologies from its pioneering research will transform the construction industry through a whole-life approach, achieving sustainability in construction and infrastructure in an integrated way. He has published more than 400 journal and conference papers. His current research activities are Infrastructure sensing, Performance based design and maintenance of infrastructure, Energy geotechnics, and Geotechnics from micro to macro. He is a Fellow of the UK Royal Academy of Engineering and a Fellow of the Institution of Civil Engineers. He is recipient of many awards including George Stephenson Medal and Telford Gold Medal from the Institution of Civil Engineers and Walter L. Huber Civil Engineering Research Prize from the American Society of Civil Engineers.

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Special Contribution

Potential Damage to Steel Pipe Piles During Installation

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ABSTRACT

Steel pipe piles are widely used both onshore and offshore because of their good bending stiffness and ease of installation. They are generally vibrated, driven or jacked open-ended, although internal plates or even complete end-closures may be used to improve their bearing capacity. Large diameter, thin-walled open-ended piles are susceptible to distortion at the tip, particularly when installed into stratified sediments where the soil conditions may vary spatially, both with depth and within planes normal to the pile axis. A particular form of damage is extrusion buckling where progressive distortion of the pile occurs, starting from the tip, as it penetrates through the soil. Case histories illustrating this form of collapse are shown and possible triggers for damage discussed.

1 INTRODUCTION

Piles are vulnerable to damage during jacking or driving into strong soils or weak rock. This may often go undetected, with the only indication being a driving resistance that deviates from the expected profile. Figure 1 shows two contrasting examples from onshore pile driving. In one case tip buckling of an H-pile has occurred due to encountering unweathered basalt at a shallower depth than anticipated; in the other case a thin-walled casing has become distorted during driving, possibly due to encountering a buried object within made ground.

(a) Tip buckling of H-pile

(b) Distortion of thin-walled casing

Figure 1 Examples of damage during driving

A more general case of widespread damage in the vicinity of the pile tip, which went completely unnoticed during the original installation, is shown in Figure 2 (Broos et al. 2017). The piles, which were extracted during widening a harbour basin in Rotterdam, were 1420 mm diameter with 17 mm wall thickness in the region of the tip. They had been installed by driving at a rake of 1 in 5, bearing in medium to dense sands with cone resistance of 25 to 40 MPa. It is quite likely that the raking angle (around 11 degrees) contributed to the distortion, since the pile tip would have encountered any stronger stratum at one edge.

The relatively large diameter to wall thickness ratio (D/t) of 84 for the piles shown in Figure 2 may be viewed in the context of the current trend in open-ended pile geometries, in particular the very large diameter monopiles now in use for European offshore windfarms. A typical monopile is shown in Figure 3. Over much of the pile length the wall thickness may be no more than 75 mm (D/t of 100), but with thicker sections in regions of high bending moment (near the seabed surface) and at the pile tip where the pile is reinforced internally with a driving shoe.

The concern for piles with large D/t ratios is the potential for damage to occur during transportation and installation. Typically, construction tolerances on 'out of roundness' are for maximum deviation from a true circle of ~0.5 % of the pile radius (DNV 2010). While such tolerances may be verified immediately prior to installation, heterogeneities within the soil can trigger distortion. Indeed progressive elliptical (and beyond) distortion of pipe piles in the offshore environment, a process referred to as 'extrusion buckling' has been identified on several occasions, as indicated in Figure 4. The API guideline shown for comparison, and which is often used as the basis for choosing the pile wall thickness at the tip, targets a different form of tip damage, linked to generation of excessive axial stresses during installation by driving. It is evident that it does not provide safe guidance for gradual distortion that occurs in extrusion buckling.

Figure 2 Evidence of extrusion buckling at the toe of tubular king piles extracted from the port basin in Rotterdam

Figure 3 Photograph of 7.5 m diameter monopiles for the Gode Wind farm

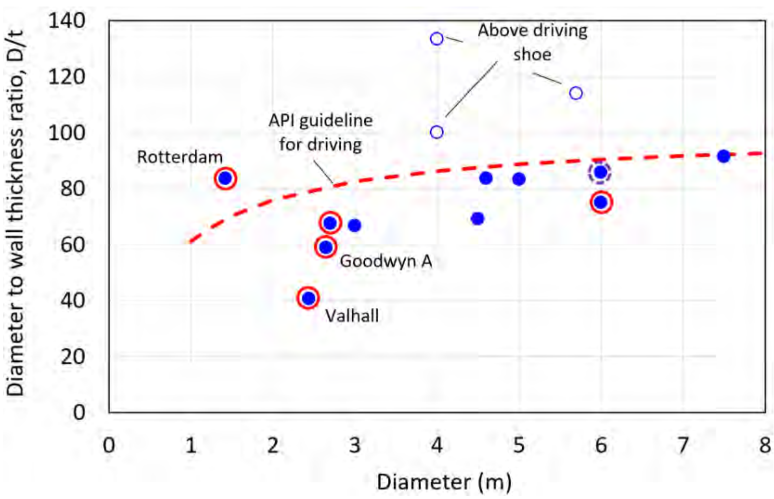


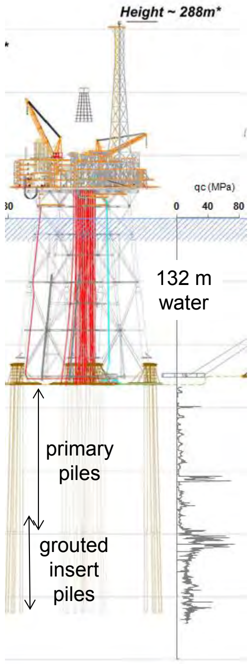
Figure 4 Trends in open-ended pile geometries. Confirmed and suspected extrusion buckling damage indicated by red and purple circles respectively

2 CASE STUDIES

Two well-studied case studies of extrusion buckling are summarised briefly below.

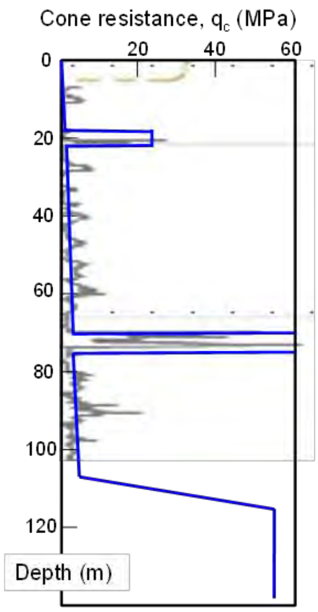
2.1 Case study 1: Goodwyn A, North-West Shelf of Australia

The Goodwyn A platform was installed on the North-West Shelf of Australia in the late 1980s. The seabed comprised relatively low strength calcareous silt and sand layers down to a depth of about 110 m, below which calcarenite was found. Given the low shaft capacity of driven piles in calcareous soils, the adopted foundation design consisted of primary piles driven through the uncemented sediments, below which grouted insert piles were to provide the main axial support (Figure 5). The platform included 20 piles, 5 at each corner, with diameter 2.65 m and wall thickness 45 mm (D/t = 59). However, when attempts were made to drill out the soil plug within the driven primary piles, to enable construction of the grouted insert piles, it was found that 16 of the 20 piles had undergone progressive distortion to the extent that the pile tips had become almost closed into a peanut shape. The distortion started at about the depth of a layer of cemented material (3 to 5 m thick, with cone resistance upwards of 60 MPa) embedded within the calcareous silt and sand layers (Figure 6).

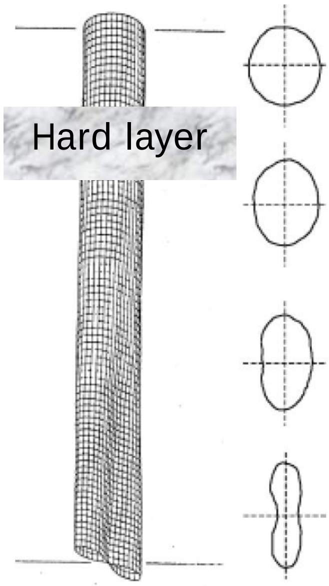


(a) View from the air (b) Elevation of platform and foundations

Figure 5 Overview of Goodwyn A platform on North-West Shelf of Australia



←(a) Profile of cone resistance



←(b) Progressive pile distortion below hard layer

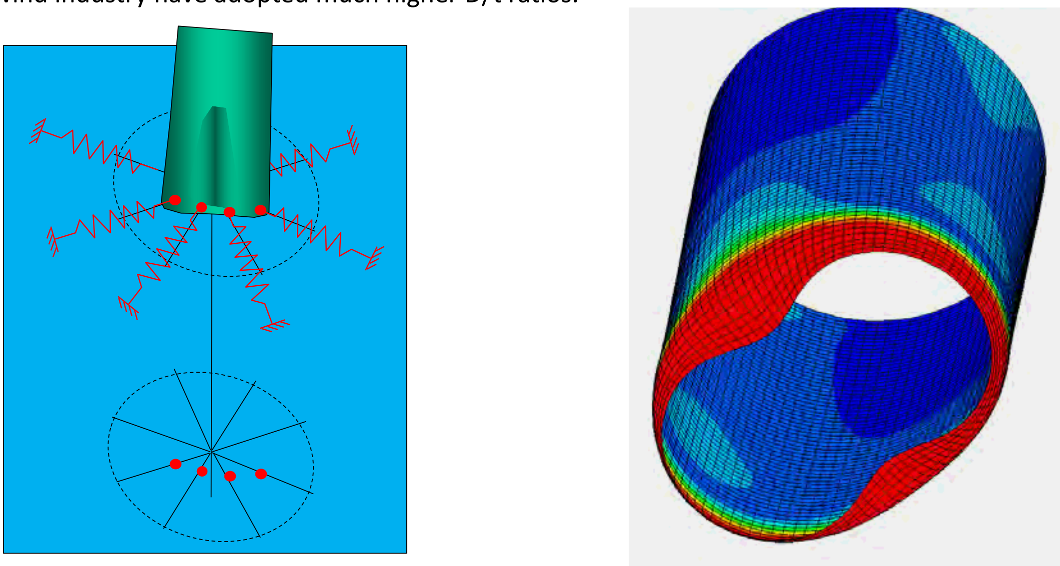
Figure 6 Soil strength profile and measured growth in pile distortion

In order to understand the process of extrusion buckling, a numerical technique (BASIL) was developed within ABAQUS (Barbour & Erbrich 1995, Erbrich et al. 2010). The pile-soil interaction is represented by layers of 'hair' springs distributed around (and along the length of) the embedded section of the pile (Figure 7a). The zero force and displacement for each spring is taken from the point where the pile tip 'cuts' the hair spring. As the pile advances further, any forced radial movement of the spring (for example, if the pile wall is not parallel to the direction of advance) will invoke a force acting on the pile wall.

The analysis typically starts with the pile pre-embedded to some depth, and with the pile tip distorted according to the shape of a radial buckle (mode 1), with the maximum out of roundness adjusted in a parametric fashion, but typically 0.5 to 2 % of the pile radius. The pile is then advanced through the sets of soil springs, each of which has been pre-assigned an appropriate non-linear load-displacement response curve.

An example outcome from a BASIL simulation of extrusion buckling of a Goodwyn A pile is shown in Figure 8 (see also Erbrich et al. 2010). In order to achieve the progressive distortion, an initial out of roundness of 25 mm (1.9 % of the pile radius) was needed, which is somewhat outside the specified tolerance (Figure 7b). Notwithstanding potential limitations of the numerical analysis, the need to apply a more significant initial distortion indicates that some external factor might have contributed to initial damage of the pile tip prior to installation, either a structural collision during stabbing of the pile or lateral heterogeneity of the cemented sediment layer.

At the time of the Goodwyn A platform installation, the pile D/t ratio of 59 was somewhat greater than in routine practice in the offshore oil and gas industry. However, as discussed above, many of the very large diameter monopiles used in the offshore wind industry have adopted much higher D/t ratios.



(a) Soil represented as 'hair' springs[28] (b) Initial imperfection (exaggerated)

Figure 7 Numerical modelling approach to investigate extrusion buckling

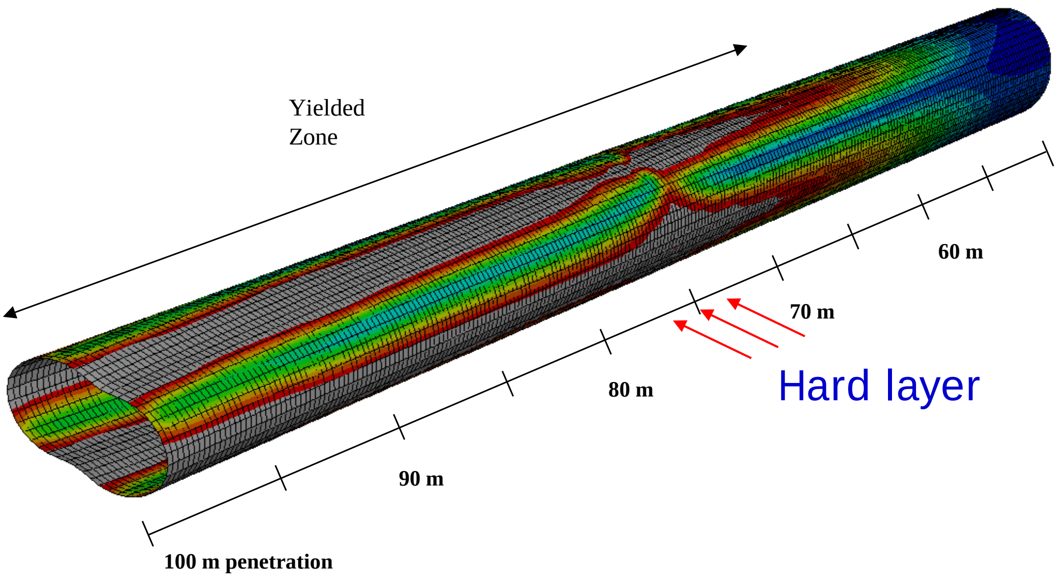
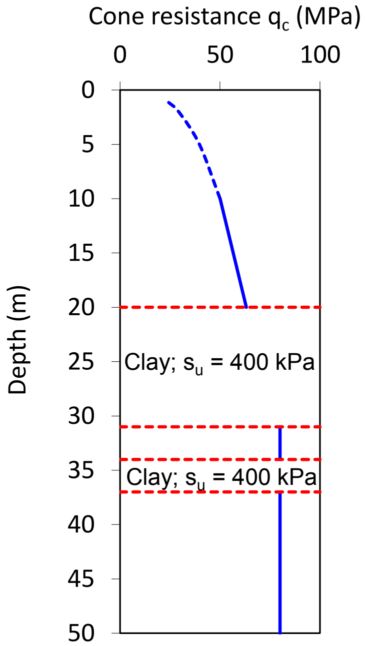


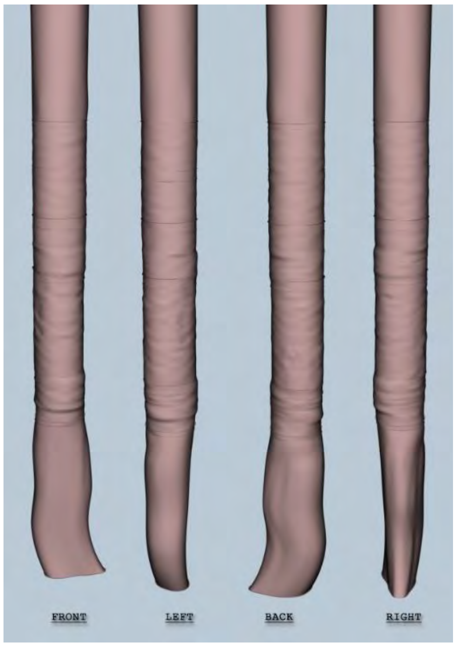
Figure 8 Example pattern of plastic strains for a pile pushed 25 m beyond the hard layer

2.2 Case study 2: Valhall, North Sea

The Valhall water injection platform was installed in the North Sea in 2002, but encountered problems when 5 of the 8 piles reached refusal at penetrations between 45 and 55 m, compared with the target penetration of around 70 m (Alm et al. 2004). The premature refusal meant that external weld beads, and the profiled variations in pile wall thickness, were then not at their anticipated design depths relative to the jacket structure. Investigations revealed that the piles that met refusal had undergone extrusion buckling to the extent that the tips were almost closed (Figure 9). The soil stratigraphy below about 37 m comprised very dense sands, with cone resistances estimated as about 80 MPa. The piles were 2.44 m in diameter, with a wall thickness of 60 mm (so D/t of 40), hence consistent with routine practice.
During investigations into the cause of the pile distortion, attention focused on what might seem a relatively minor design detail, in the form of an external chamfer that was applied to the pile tips (Figure 10). In the context of the 2.44 m pile diameter, it is perhaps surprising that this detail could have such ramifications for pile installation. However, analysis suggests that the chamfer may indeed give rise to significantly greater external radial stresses acting on the pile wall, hence triggering distortion.



(a) Simplified cone profile



(b) Typical distortion of lower part of pile

Figure 9 Soil profile and surveyed pile distortion for Valhall

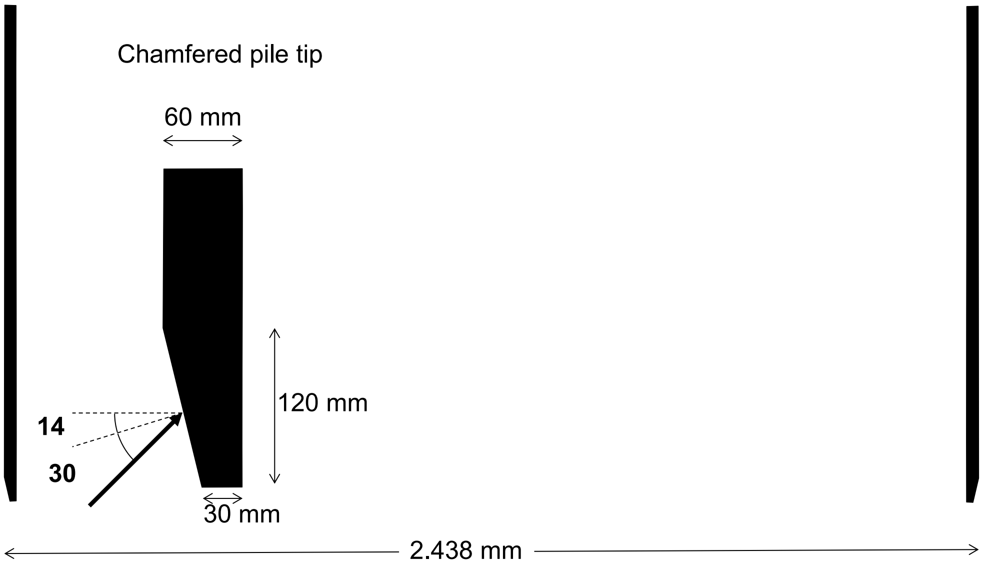


Figure 10 Detail of chamfered pile tip

Analyses using BASIL were carried out to explore conditions for triggering extrusion buckling, allowing for the radial stress enhancement of the chamfered tip. Figure 11 (Erbrich, private communication) shows example output for an initial out of roundness of 0.8 % of the pile radius. The pile was pre-embedded to 10 m and then pushed to a penetration of 50 m. Although full collapse was not achieved, significant outward (in one plane) and inward (in a perpendicular plane) movements occurred, hence initiating extrusion buckling.

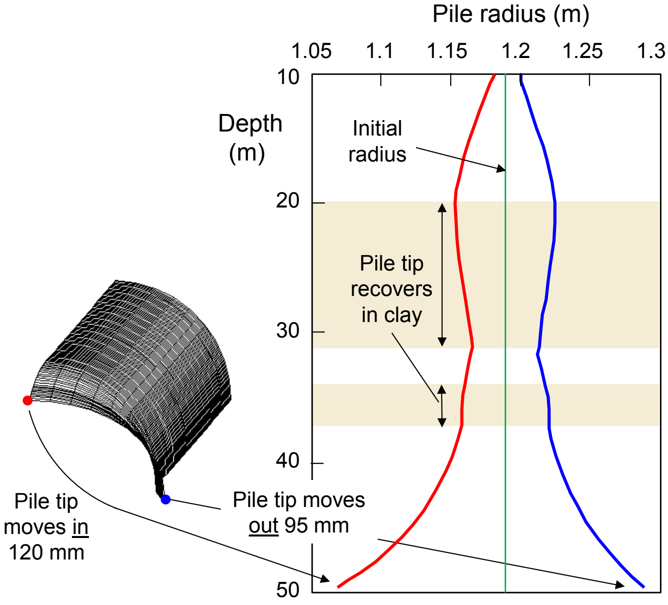


Figure 11 Soil profile and surveyed pile distortion for Valhall

3 INITIATION AND PROPAGATION OF EXTRUSION BUCKLING

Extrusion buckling can be initiated during driving of pipe piles by a variety of conditions that include:

(1) initial out of roundness of the pile cross-section with non-verticality of the pile wall;
(2) high differential internal and external stresses acting on the pile wall from the soil;
(3) heterogeneous soil conditions.

In each case, it is necessary for the soil to be sufficiently stiff to overcome the elastic hoop stiffness of the steel, and also – in the case of (2) and (3) – to generate differential radial stresses of sufficient magnitude. Conditions (1) and (2) are considered the most likely primary causes of the pile distortion discussed above in case studies 1 and 2. Clearly any plastic distortion of the circularity of the pile section near the tip would be expected to propagate further during driving through strong soils. Equally, if the differential stresses across the pile wall exceed the radial buckling pressure (the Bresse pressure, HSE 2001), then potential instability of the pile circularity can be initiated.

The effect of heterogeneous soil conditions is illustrated in Figure 12. An eccentric zone of stronger soil, a layer dipping relative to the horizontal, or a raking pile encountering a stronger horizontal layer, will tend to apply localised pressure in one region of the cross-section. For high D/t ratios the hoop stiffness of the pile is significantly lower than the corresponding soil stiffness, hence the soil will distort the pile rather than the other way round.

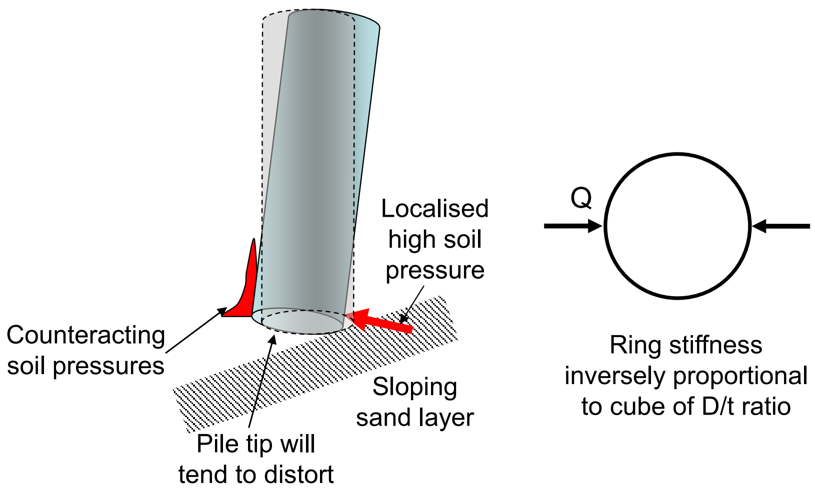


Figure 12 Initiation of pile tip distortion in heterogeneous soil

The hoop stiffness and critical radial buckling pressure are given by

$$\text{Hoop stiffnes (Figure 12):} \quad \frac{Q}{\delta E_{steel}} \sim \frac{10}{(D/t)^3}$$

$$\text{Critical Bresse pressure:} \quad \frac{p_e}{E_{steel}} = \frac{2}{(D/t)^3} \tag{1}$$

Both quantities are inversely proportional to the cube of the diameter to wall thickness ratio (D/t). Thus, for a D/t ratio of 80, the hoop stiffness and critical Bresse pressures would be about 4 MPa and 0.8 MPa respectively. The latter figure is of the same order of magnitude as the external radial stresses expected in relatively uniform layers of dense sand with cone resistance in excess of 50 MPa, but the low hoop stiffness is the more critical factor in initiation of pile tip distortion. The hoop stiffness may be compared with the initial gradient of a load transfer curve for lateral pile response. This would exceed the pile hoop stiffness for soil with shear modulus greater than about 1 MPa – so easily satisfied in all but quite soft soils. This is consistent with a similar assessment, although for somewhat thicker walled piles, by Aldridge et al. (2005).

For heterogeneous or dipping soil layers such as shown in Figure 12, localized increased soil stresses across the relevant vertical plane will initiate distortion of the pile tip, provided the soil stiffness is sufficiently high. Extrusion buckling is then likely to proceed, since minor distortion exacerbates the increased external stresses in that plane, while increased internal stresses will be generated across the perpendicular plane. The process is illustrated in Figure 13, considering a situation where the originally circular pile section has been distorted into an elliptical shape. If the pile wall at any given location around the tip attempts to advance vertically (parallel to the pile axis) as the pile penetrates further, the external stresses will be increased further across the minor axis of the ellipse, while the internal stresses will be increased across the major axis of the ellipse. This provides a feedback loop, which will instead encourage the pile wall to advance parallel to its current direction in each vertical plane (see dashed arrows in Figure 13).

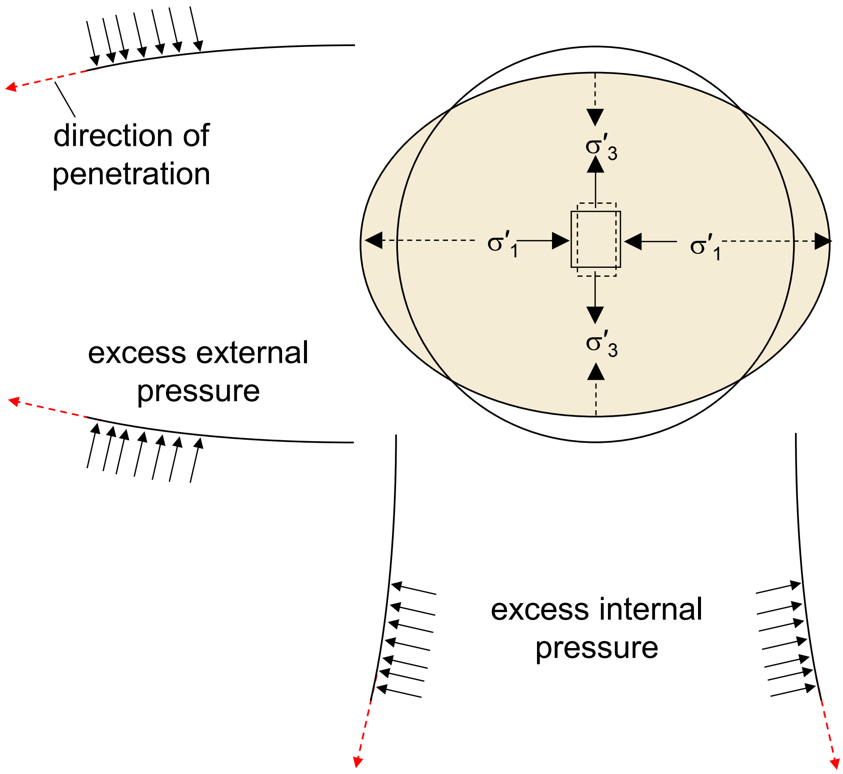


Figure 13 Schematic of extrusion buckling kinematics

4 CONCLUSIONS

The offshore oil and gas and renewable energy industries have provided incentive towards ever increasing diameters of open-ended steel piles to support jacket structures and offshore wind turbines. Fabrication techniques have developed in parallel, now enabling piles with diameters of 8 m or more to be constructed to tight tolerances. However, one aspect that has received less attention than it deserves is the construction risk associated with installing large diameter piles with very high ratios of diameter to wall thickness.

This paper has provided some background information illustrating a process of gradual tip distortion referred to as extrusion buckling. Although the process may be simulated using numerical analysis, this is more commonly undertaken retrospectively, after a problem has arisen, rather than during the design phase. The mechanism is well understood, but the analysis is relatively complex and at present there are only very limited guidelines to guard against situations where extrusion buckling may occur.

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A Brief CV of Professor Mark Randolph

Mark Randolph holds the Fugro Chair in Geotechnics in the Centre for Offshore Foundation Systems at the University of Western Australia. His two main research interests are piled foundations and offshore geotechnics, co-authoring books in each area, Piling Engineering, now in its third edition, and Offshore Geotechnical Engineering, as well as over 250 journal articles. Professor Randolph interacts closely with industry, both in research and through his role as Technical Authority within Fugro AG. He is a Fellow of several learned academies, including the Royal Society and the Australian Academy of Science. He is a former Scientist of the Year in Western Australia and holds an honorary doctorate from ETH Zurich.

On-site Interview

Gyropress (Rotary Cutting Press-in) Method in Disaster Recovery Project (Kagoshima Prefecture, Japan)

Ms. Hongjuan He

IPA Secretariat

I interviewed Mr. Tsukasa Hashida and Mr. Issao Umiji who belong to GIKEN SEKO CO., LTD. and were working on the project "Disaster restoration on the No. 759 Road, Kagoshima Prefecture". The steel tubular piles were installed by the Gyropress Method as an earth retaining wall. I thank them for giving us valuable insights during this interview.

Photo 1 Construction overview

Profile of Mr. Tsukasa Hashida, Project Manager of GIKEN SEKO CO., LTD.

Mr. Hashida entered the GIKEN Group in 1979. Until now, he has been operating various models of Silent Piler including the KGK-100D which was firstly sold in 1978. He has worked on many sites for 38 years and has been engaged in the Press-in Method such as the Hard Ground Press-in Method, the Gyropress Method and others. He was the prime operator in this project. He has qualifications of “First-class Civil Engineering works Execution Managing Engineer”, “First-class Press-in Operation Engineer”, the licenses for various cranes and etc.

Profile of Mr. Issao Umiji, Project Manager of GIKEN SEKO CO., LTD.

Mr. Umiji has been working for GIKEN Group since 1980 with 11 year experiences in the Press-in Method such as the Gyropress Method, the Hard Ground Press-in Method and others. He had experiences of working on abroad such as Asia and Europe. He was responsible for operating in this project. He has the qualifications of “First-class Civil Engineering works Execution Managing Engineer”, “First-class Press-in Operation Engineer”, the licenses of various welding and etc.

Q1. Please tell us about the background and summary of the project.

Mr. Hashida: In June 2016, a heavy rainstorm occurred in Kyushu region in Japan, which caused serious flooding and overflowed their banks and flooded neighboring areas. Furthermore, there occurred serious flow disasters. This construction site is at the Udo Bridge located on the Kagoshima prefecture road 72. The massive landslide around the abutment occurred due to the heavy rain, eventually (Photo 1). This is a disaster recovery project conducted by the Gyropress Method, preventing the bridge abutment from collapsing.

Q2. Can you tell us why the Gyropress Method was adopted and what the features of this construction?

Mr. Umiji: The key feature of the project was to use the “Non-staging Method”, which could work on a slope near the bottom of the bared abutment (Photo 2). If the conventional construction method had been adopted, it should have built an embankment and a temporary platform as a working space on the eroded slope firstly. Then the installation of the steel tubular piles were carried out. Actually, the Non-staging method does not require temporary works, meaning that additional works are not necessary. Due to the advantages of the Non-staging Method (i.e. short construction period, low cost and safety), our proposal was adopted.

Photo 2 Non-staging Method

Q3. Was the project completed in accordance with the plan? If there were any difficulties, can you tell us about it and how did you solve it?

Mr. Hashida: The press-in operation for which we were responsible was successfully completed (Photo 3). I think the most difficult thing in this operation was to decide the installation line. The longest steel tubular pile was as long as 24.5m, which the projecting length was 9m from the ground surface to the pile top (Photo 4). There was nothing around the steel tubular pile above the ground, it was very difficult when we decided the installation line. This was also the curve piling, and the angle of the installation line between adjacent steel tubular piles was different. In a narrow area with a radius of 10 meters, the operation was really tough. We used the pile laser to determine the location of the piles with the main contractor. It took 4 hours to fix the location of a steel tubular pile.

Photo 3 A view of after Press-in operation

Photo 4 Construction yard

Photo 5 Water lubrication System

Mr. Umiji: I also think it was difficult to decide the installation line. One of the reasons for the difficulty was that we did not have the soil data, so we could not assume underground conditions before the installation. At the beginning of the piling work, the steel tubular pile hit hard rock in a shallower place where we did not anticipate the existence of it. We used the water lubrication system which can reduce pile toe resistance and the plugging inside the steel tubular pile (Photo 5). But when we used the water lubrication system, the sludge, which soil and water were mixed, was discharged to the foot of the mountain. Because there were farmland at the foot of the mountain, so the main contactor had to conduct the turbid water treatment. The turbid water treatment was not directly involved in the procedure of the press-in operation for which we were responsible, however, the duration of the project was extended.

Q4. Please share with us your impressive experience.

Photo 6 KGK-100D type of Silent Piler

Mr. Hashida: The most impressive experience was that I drove the Silent Piler firstly when I just entered the company. Our company firstly sold the KGK-100D model of Silent Piler in 1977 (Photo 6). My first press-in operation was to drive this Silent Piler. At that time, the maximum SPT *N* value in the soil boring log was only about 10, which I considered that the operation should be easy. But when the Silent Piler pressed-in the steel sheet pile to about 10m deep, the machine tilted forward and it was difficult to continue the operation. At that time, I didn't know how to recover the situation because there were not any construction manuals. This experience was very remarkable to me. Now, a variety of machines have been manufactured, and the automatic driving system has become real. I really amazed the rapid progress of Press-in Technology.

Mr. Umiji: For me, the experience of the first overseas construction in 1983 was the most impressive. In fact, this construction was also the first achievement of the Press-in Technology used overseas. The place of the construction was in Giessen city, Germany. The project was to build a new city government office, and the Press-in technology was utilized to construct the retaining wall of the office building. Because I was only one Japanese on the site in Germany, I had a strong anxiety about language and culture. And the ground condition of the site was very stiff, overall, the piling progress was not very smooth. Through the interpreter to help me to train the local staffs, we completed the project with our local staffs together.

Q5. Were there any differences when you operated in Germany?

Mr. Umiji: Yes. I think there is a great difference between the working culture of Germany and Japan. In Germany, the break time was clearly defined. Even when the installation into the ground was undergoing, if it comes to the break time, they had a break immediately. If this happens in Japan, Japanese labors should have a break after the completion of the installation. Because I didn't know the culture, the progress of the project was not the way I expected. I think it's important to understand different local culture and rules in overseas constructions.

Q6. What is your prediction about the future of the Press-in Technology?

Mr. Hashida: I guess that fully automated operation will be true in 10 or 20 years. When I just entered the GIKEN Group, I had no operation manuals and learned the Press-in Technology through ten years of work. I think that the handbook will be improved, the technology of AI and mechanism will be evolved, and everyone will be able to be a good operator shortly in the future. I do not want young generation to spend 10 years, learning the Press-in technology like me. As you know, Japan's population is decreasing sharply. If the operation could be fully automatically conducted, it may solve the issue of insufficient labor population. And it could be safer to conduct even in dangerous places.

Mr. Umiji: In the future, I hope geological visualization can be achieved by using Press-in technology. Now, we do not know how the toe of the piling works, nor can we assume the underground obstructions. If you can watch the condition of the underground, the machine's autopilot technology should also improve faster. I don't know if it's going to come true, but for example, installing a small camera at the toe of the pile so that we can watching video while installing the piles.

★ Comments

This time I did not visit the site of the construction, but through the communication with the Mr. Hashida and Mr. Umiji, let me understood the whole situation of the project. Mr. Hashida has been in construction for 37 years, and he has been driving from the KGK-100D model of Silent Piler to the latest series of Pilers. It seemed to me that he grew up together with Silent Pilers to witness the history of Silent Piler's development. Mr. Umiji broke through the barriers of language and culture to complete the project in Germany by himself. I really admire his unremitting perseverance. I also felt strongly that in this construction, Mr. Hashida and Mr. Umiji made great efforts to achieve the project. I really thank them for giving us valuable insights during this interview.

Photo 7 The view of interview

Photo 8 Mr. Hashida is driving the Piler

Photo 9 Mr. Umiji is driving the Piler

I would like to express my sincere appreciation toward Mr. Hashida, Mr. Umiji and all who are concerned in this interview. Thank you so much.
We welcome the on-site operators who are able to accept the interview. If you have any questions, please contact to IPA Secretariat address to Ms. Hongjuan He (ipa.ka@press-in.org). We are waiting for you!

IPA News Letter Volume 3, Issue 1 March 2018

Report

Activities for the Reinforcement of Existing Foundations

Tomoyuki Suzuki

Group Leader of Steel Pipe Sheet Pile Foundation Team,
Technical Committee of Road and Railway,
Japanese Technical Association for Steel Pipe Piles and Sheet Piles

Much infrastructure, including roads, bridges and rivers, had been constructed during a period of rapid economic growth in Japan. It is thought that the age-related problems of these structures will become more tangible and accelerated, and measures to mitigate them are imperative. According to the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), the percentage of road bridges over 50 years after construction was about 18 % in 2013 and is expected to be about 65 % in 2033. Under these circumstances, MLIT began to issue a “basic infrastructure life elongation plan” and to carry out intensive examinations and inspections. Accordingly, they have started taking measures such as renovation and reinforcement.

In response to this trend, the Japanese Technical Association for Steel Pipe Piles and Sheet Piles (JASPP) has conducted various studies for the reinforcement of existing foundations. As one of the main activities, utilization of steel pipe sheet pile foundation will be introduced in the next sections.

1. Characteristics of Steel Pipe Sheet Pile Foundation

The structural characteristics of steel pipe sheet pile foundation (Fig. 1) is that steel pipe sheet piles are installed in an enclosed form of circle, oval or rectangle, and the rigidity of the structure is increased by filling materials such as concrete mortar in the P-P shaped interlock. Features from the behavioural characteristics of wall structures such as those made of steel pipe sheet piles are that they depend mainly on the horizontal resistance of the ground, while the steel pipe sheet pile foundation depends on vertical resistance from the pile toe resistance and skin friction as well as horizontal resistance. From this viewpoint, the behaviour of steel pipe sheet pile foundation is closely related to the ground condition, and a more careful ground evaluation and more reliable construction are both required to secure highly reliable foundation structures. Therefore, several evaluations of the foundation performance including on-site loading test have been carried out, and standardized application methods have been shown only for structures and construction methods of which the execution management methods are specified in the Japanese Bridge Standard and all that. For the steel pipe sheet pile foundations, the pile driving method or foot protection method with inner excavation is currently regarded as the standard construction method, whereas the Press-in Method and the Press-in Method assisted with water jetting have not been generally used. For these two methods, it is prescribed that the pros and cons of their use and the design application be evaluated by carrying out construction tests and loading tests at each construction site. From the advantage that the cofferdam to build a bridge pier can be co-used, the steel pipe sheet pile foundation has shown itself to be highly economical as a foundation construction method in water areas,

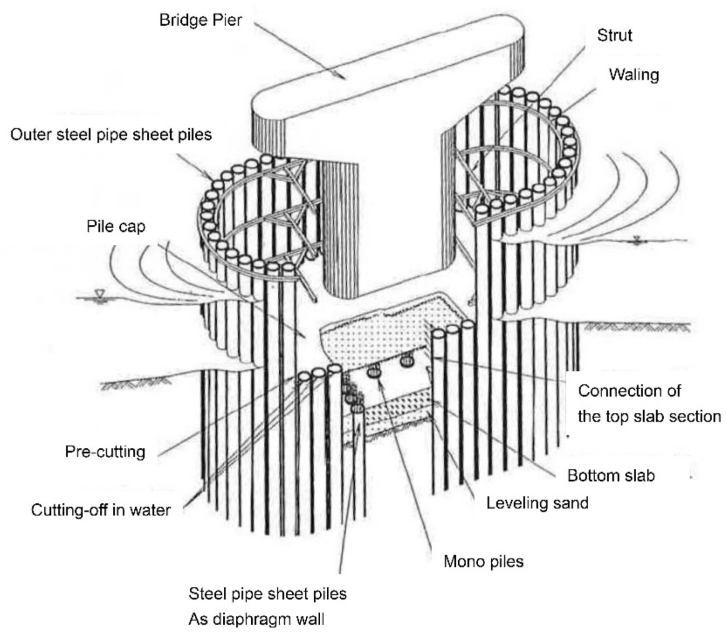


Fig. 1 Schematic view of steel pipe sheet pile foundation that is simultaneously used as temporary cofferdam

and its application has increased. To further increase its use, it is indispensable issue to develop a construction method that is highly applicable and reliable, so that the method can cope with many different ground and construction conditions.

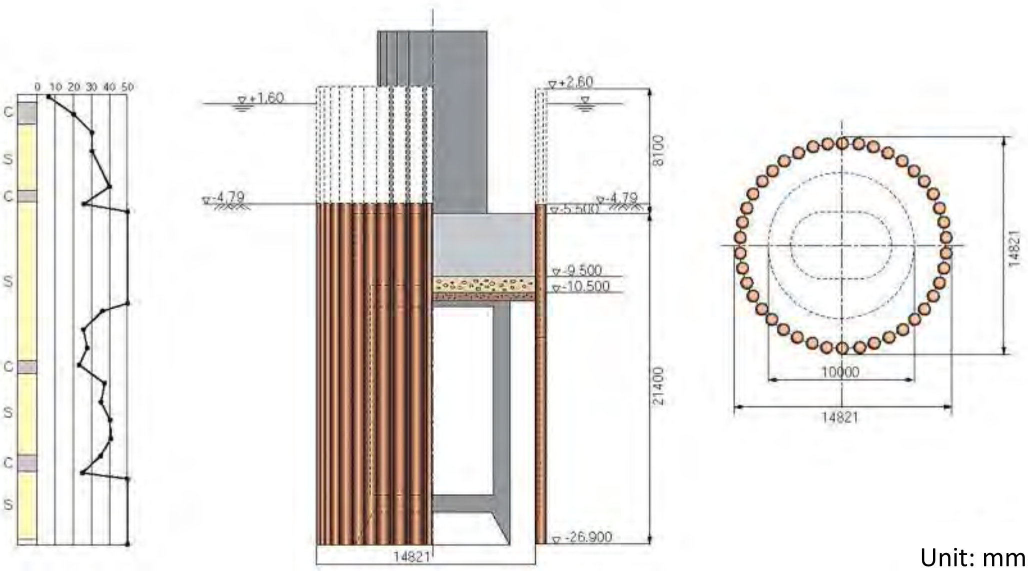
2. Activities for Reinforcement of Bridge Pier Foundation

Reinforcement methods of existing foundations may be divided into those increasing bearing capacity of foundation, e.g., by ground improvement, and those increasing bearing capacity structurally. Typical examples of the latter case maybe a method to add foundation piles by enlarging footing, and steel pipe sheet pile foundation extension method 1), 2). In the steel pipe sheet pile foundation extension method, steel pipe sheet piles are installed in such a way as to enclose an existing foundation, and a combined footing structure is formed by connecting the piles with the existing foundation using pile caps and so on. Table 1 shows main past records by the steel pipe sheet pile foundation extension method, while Fig. 2 depicts a reinforcement case. The reinforcement cases by the steel pipe sheet pile foundation extension method have increased since the restoration works of the Great Hanshin Earthquake Disaster. As described earlier, the steel pipe sheet pile foundation has an advantage that it can be used as a temporary cofferdam in reinforcement woks in water. In addition, there are key advantages of the Press-in Method, such as construction conditions of limited overhead clearance under bridge girders, and piling with limited harmful effect on existing foundations.

Table 1 Main reinforcement records by steel pipe sheet pile foundation extension method

Location In Japan	Existing foundation	Reason for reinforcement	Steel pipe sheet piles OD(mm)/Length(mm)	OD of coffer dam	Construction method
Miyazaki	Caisson foundation	Wash out	612.8/25500	Oval 11835 x 7593	Inner excavation + pre-boring
Wakayama	Caisson foundation	Upper work extension	600/10000	Oval 16254 x 6834	Inner excavation (cement milk)
Hyogo	Caisson foundation	Aseismic reinforcement	600/15500	Circular 7634 x 7634	
Hyogo	Caisson foundation	Aseismic reinforcement	600/13500	Circular 11635 x 7593	
Hyogo	Caisson foundation	Aseismic reinforcement	600/44600	Circular 8711 x 8711	JV (Vibro with WJ*)
Hyogo	Direct foundation	Wash out	600/8500	Oval 22078 x 11600	Inner excavation (cement milk)
Hyogo	Caisson foundation	Bridge widening	600/21500	Circular 14821 x 14821	Press-in Method (with WJ*)
Hyogo	Caisson foundation	Wash out	600/14000	Rectangular 14460 x 7200	Inner excavation
Osaka	Caisson foundation	Wash out	600/28500	Oval 15216 x 6834	Press-in Method (with WJ*)
Nara	Caisson foundation	Upper work extension	600/20500	Circular 10158 x 10158	--
Tokyo	Pile foundation	Aging	1000/36500	Oval 20079 x 42539	Press-in Method

*WJ: Water jetting



Unit: mm

Existing foundation: Caisson foundation Circular 10000 x 10000 x L21500
Reason of reinforcement: Reinforcement of the foundation for the increase in the vertical load after widening the bridge
Specification of the steel pipe sheet piles: 800mm dia. x t12 x L21500 Circular 14821x14821
Installation method: Press-in associated with water jetting

Fig. 2 Reinforcement example by the steel pipe sheet pile extension method

On the other hand, from a structural design viewpoint, a clearer understanding of the behavior has been regarded important in Japanese bridge foundations. Combined foundations, in which foundations with different resistant characteristics are combined, have not been generally used. For this reason, there are no unified design methods for the steel pipe sheet pile foundation extension method. In the actual design, evaluation has been carried out in each case. It seemed often the case that the design for the actions arising during earthquake was performed in such a way that only steel pipe sheet pile foundation would carry the seismic load, because not enough was understood regarding the resistance exhibiting ratio between the existing and extended parts, and on the stability of the structure as a combined foundation. Consequently, in consideration of more economical foundation reinforcement works, establishment of a rational design method became an issue, in which the load exhibiting ratio between the existing and extended portions is clarified. As a result, JASPP organized a study group to build a design method of the steel pipe sheet pile foundation extension method, and to develop more rational structures. The study group conducted centrifuge model experiments and a 3-D FE-analysis. In addition, based on the results of the study, applicability of the 2-D analysis was examined. All the study summary will be described in the following sections.

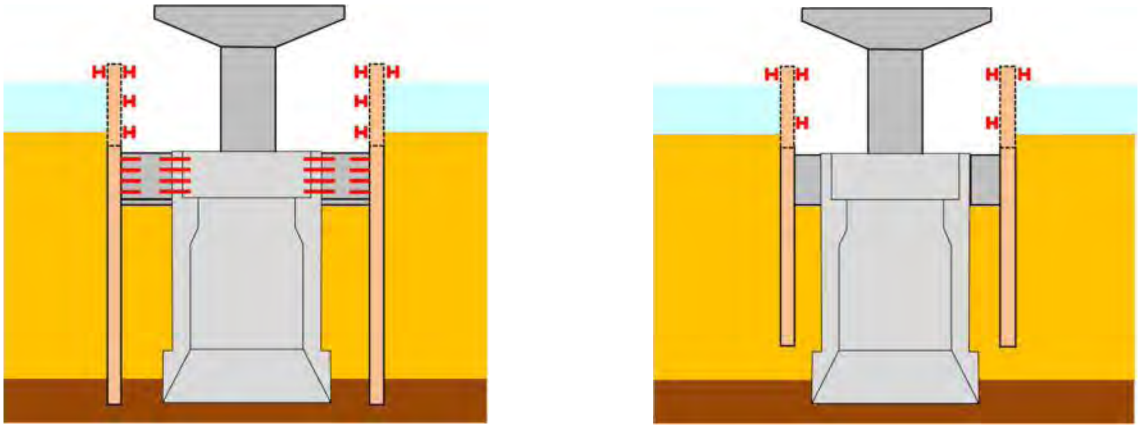
2.1 Centrifuge Model Test

Centrifuge model tests were carried out for 3 models, paying attention to the bonding structure of the steel pipe sheet pile foundation for existing caisson foundations: 1) rigidly fixed structure with pile caps; 2) semi-rigidly fixed structure with pile caps; and 3) unconnected structure without pile caps. Schematic diagrams of rigidly fixed and semi-rigidly fixed structures are observed in Fig. 3a and 3b, respectively. The following behavioral characteristics became clear:

1) Rigidly fixed structure
From the beginning of loading, large reinforcement effect, horizontal yield strength of combined foundation divided by that of existing caisson foundation only, is shown. In the end, horizontal yield strength more than about 2.7 times the original value was obtained, compared with the situation before reinforcement by extension.

2) Semi-rigidly fixed structure

Horizontal resistances at the beginning and the end of loading increased by 60 % and more than 20 %, respectively.



a) Rigidly fixed structure b) Semi-rigidly fixed structure

Fig. 3 Schematic view of pile cap connection method

3) Without pile caps

Effect by extension reinforcement was not noticeable.

From the result of the centrifuge model experiments, it may be concluded that the rigid fixing of extended structure with the existing foundation is the most effective connection method, and that the semi-rigidly fixed structure can be rational due to its simple connection structure, depending on the level of reinforcement effect required.

2.2 Three-Dimensional FE-analysis

To verify the reinforcement effect on real structures, a 3-D FE-analysis was conducted. The following points were clarified:

1) From the simulation analysis of the centrifuge model experiment, analytical conditions suitable for the steel pipe sheet pile foundation extension method were identified, and it was confirmed that the reinforcement effect could be quantitatively evaluated in the 3-D FE-analysis.

2) Though the increment ratio in horizontal yield strength may decrease for both rigidly fixed and semi-rigidly fixed structures as displacement increases, an increase in the yield strength of 1.5 to 2.0 times the original value was obtained. In the cases where pile caps were not used, the increase in horizontal yield strength was about 1.1 times the original value, not as good a reinforcement effect as in the centrifuge model test.

2.3 Two-Dimensional Analysis

To build a more simplified design method in lieu of a 3-D FE-analysis, 2-dimensional simulation analysis was carried out using real structural models, and its applicability was examined. The following points were clarified:

1) Load-deformation curves are compared between the 3-D FE-analysis and the 2-D analysis in Fig. 4. It may be seen in the figure that the load-deformation curves are generally in good agreement with each other. They are in good agreement, especially in the quasi-elastic range, where the horizontal seismic intensity is small. After the yield point, deformation in the 2-D analysis is somewhat larger.

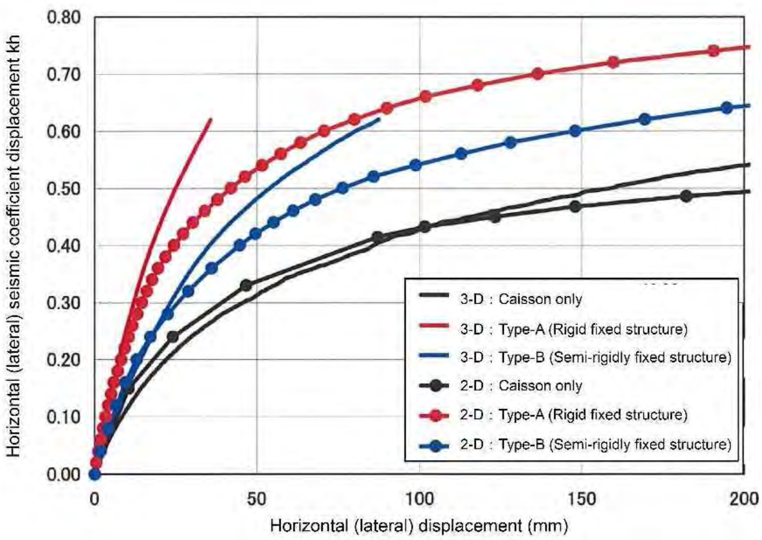
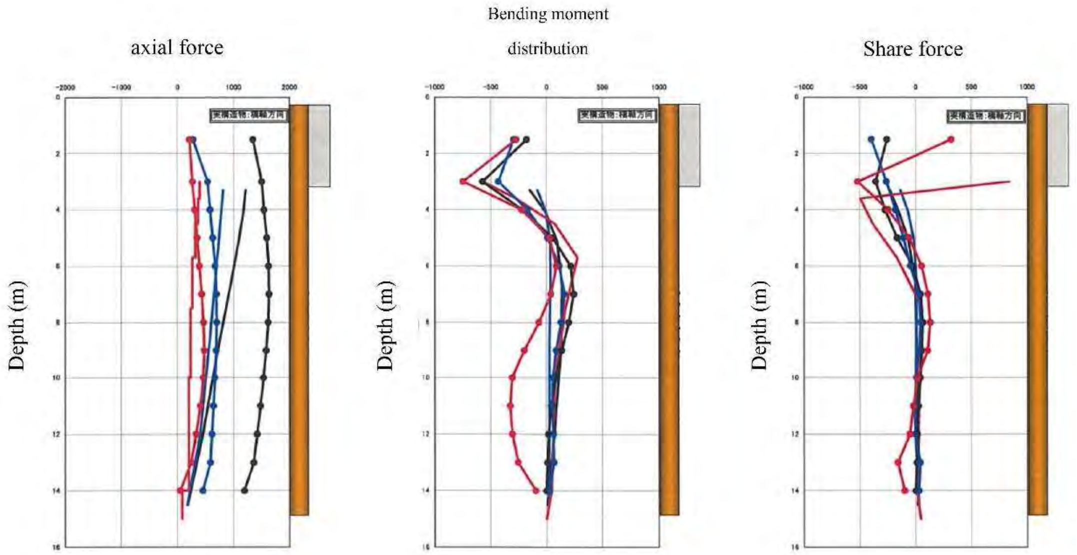


Fig. 4 Load-deformation curves: comparison of 2-D and 3-D analyses

2) As shown in Fig. 5, distributions of section force of the steel pipe sheet piles are generally consistent with each other, though there are some discrepancies between the two. There is a tendency that the absolute value of the section force is larger in the 2-D analysis result.



A) axial force distribution B) Bending moment distribution C) Shear force distribution

Fig. 5 Distribution of section forces exerted on steel pipe sheet pile

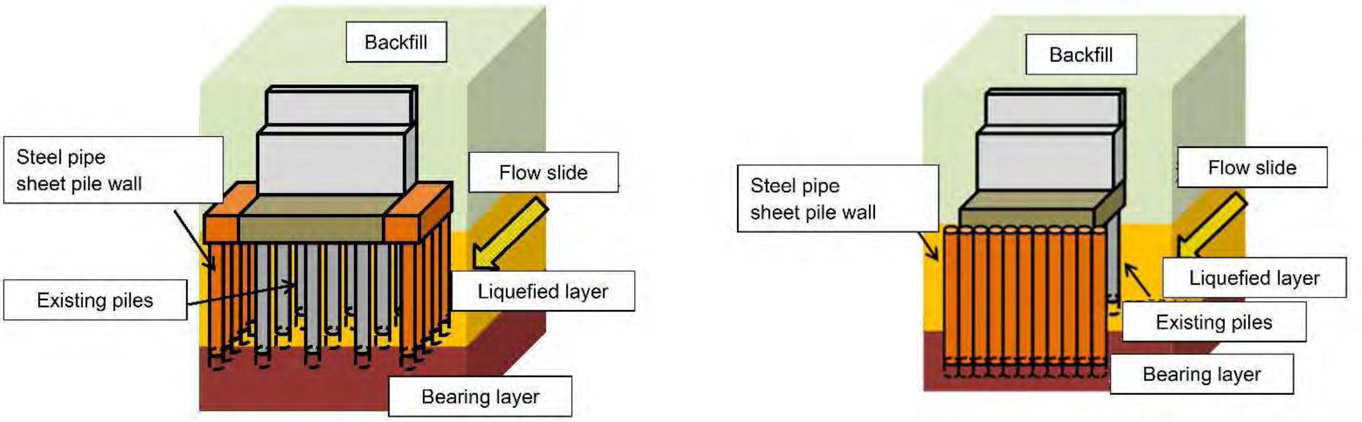
From the results obtained above, it may be concluded that the 2-D analysis can simulate relatively well the behavior of the foundation reinforced by the steel pipe sheet pile foundation extension method, that it gives more conservative results, and that it is applicable as a practical design method. Research results to date on aseismic reinforcement of existing foundations by the steel pipe sheet pile foundations have been discussed. From the findings obtained through this study, design method (draft) on reinforcement has been compiled as “Design manual for the steel pipe sheet pile foundation extension method (draft)”. For details, reference 2 may be referred to.

3. Activities for Reinforcement of Bridge Abutment Foundation

As a collaborative research with Research and development agency, Public Works Research Institute (PWRI), in a 4-year plan since 2015, JASPP has been developing reinforced structures of bridge abutment foundation on ground susceptible to liquefaction. The activities of this research have been carried out in a public-private partnership, as a “resilient reinforcement of disaster prevention/mitigation performance”, one of the Cross-ministerial Strategic Innovation Promotion Program (SIP)3) (termed SIP collaborative research, hereinafter). With the damage experienced at the time of the Great East Japan Earthquake as lessons learned, it is aimed to build a resilient society and reinforce disaster prevention/mitigation performance against the Nankai Megathrust Earthquake and any future earthquake that directly hits the Tokyo area. Fig. 6 shows a case study where a bridge abutment was damaged by the lateral movement due to liquefaction of the ground.

Fig. 6 Example of structure damaged by lateral movement due to liquefaction of ground

In this study, as a premise of taking reinforcement measurements while using road bridges, considered are the reinforcement methods that can produce a specified effect under the conditions such as no hindrance of common use of existing bridges, and limitation of construction area depending on road and structure conditions. An image of the reinforcement method is illustrated in Fig. 7.



A. steel pipe sheet pile wall, laterally integral type
B. steel pipe sheet pile wall, front isolated type

Fig.7 Image of reinforcement method

As concrete activities, centrifuge model tests and shaking table experiments have been performed to date. Here, an overview of the shaking table tests and their results are explained 4). Schematic overview of the shaking table test is shown in Fig. 8, while two of the test cases performed are listed in Table 2. No reinforcement measure was taken in Case 1, whereas reinforcement by the laterally integrated type steel pipe sheet pile wall was made in Case 5. In the latter case, it is intended to suppress the deformation of the abutment by the steel pipe sheet pile wall during earthquake, and to secure the passability of the bridge after strong shake owe much to its vertical bearing capacity. Note that the shaking table tests were carried out using the 3-dimensional large-scale shaking table and a large scale rigid chamber with dimensions of 6 m wide, 3 m deep and 2 m high, both owned by PWRI.

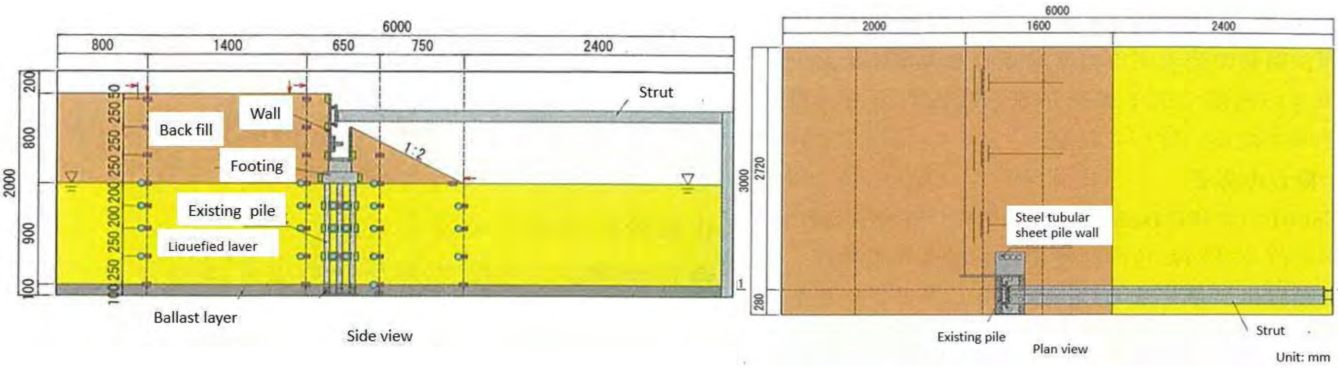


Fig. 8 Schematic view of shaking test

Table 2 Experimental cases considered

Case	Foundation dimensions	Reinforcement method
1	Prefabricated RC pile Diameter 450 mm, 8 x 3	No reinforcement
5	Prefabricated RC pile Diameter 450 mm, 8 x 3	Steel pipe sheet pile wall (laterally integrated type) 8 no. 600 mm dia., t = 9 mm piles (4 on each side)

Distributions of bending strain of existing piles at maximum response are shown in Figs. 9a and 9b, while that of reinforcement steel pipe sheet pile is shown in Fig. 9c. From the figures, the following observations may be made:

1) Distribution of bending strain of existing pile at maximum response

From Figs. 9a and 9b, it is shown that the magnitude and the distribution pattern of bending strain of the existing pile are both similar to those in Case 1, suggesting a similar range of earth pressure to that in Case 1 acted on the existing pile in Case 5. In addition, as in Case 1, at the top and in the middle section of the existing pile in Case 5, bending strain largely exceeded the yield strain.

2) Distribution of bending strain of reinforcement steel pipe pile at maximum response

Most bending strain of reinforcement steel pipe pile stayed within an elastic range.

From the results above, it may be said that even though bending strain of the existing pile largely exceeded the yield strain, aseismic property was still secured as a whole foundation after the existing pile was damaged, since reinforcement by the laterally integrated steel pipe sheet pile wall was a structure consisting of integrated steel pipe sheet pile wall and existing bridge abutment. Note that following these test results, a demonstration test with a large-scale model was carried out in February 2018, at a full-scale 3-dimensional vibration failure test facility (E-defense) owned by the research and develop agency, National Research Institute for Earth Sciences and Disaster Prevention (NIED). The test results are currently under compiling.

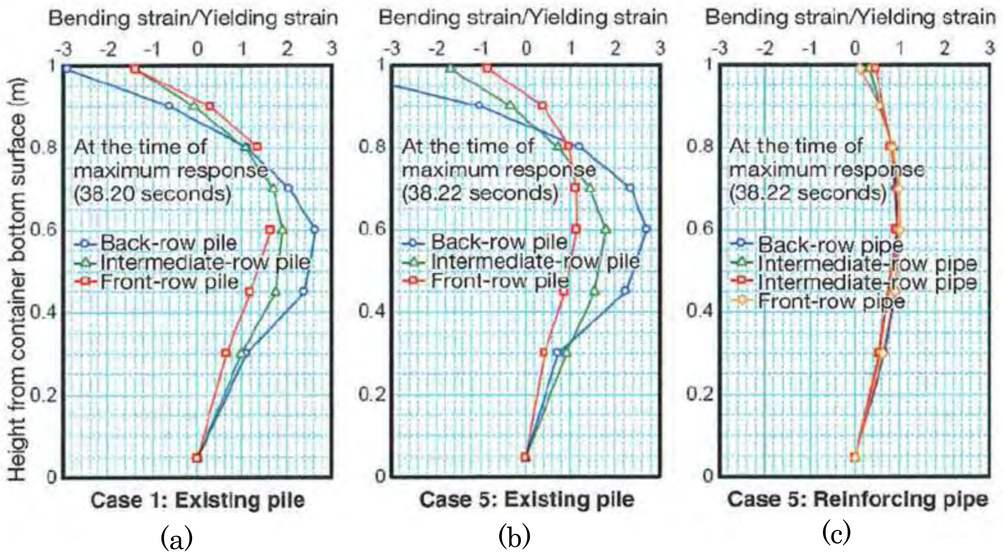


Fig. 9 Results of non-reinforcement (Case 1) and reinforcement by laterally integrated

4. Summary and Conclusions － Things Expected for the Press-in Method

When considering retrofitting of existing structures, the Press-in Method is expected to be one of the most effective construction methods, from the points of view of construction environmental conditions and effect on existing structures. In this case, the capacity that can install objects at a specified location is naturally required. In addition, another important factor may be the capacity to be able to accomplish this without disturbing the ground that is supporting the structures. More concretely, required for the construction method selected may be minimization of scattering the effects of the construction method on the ground, reduction in the vertical and horizontal resistance characteristics of constructed piles and steel pipe sheet pile, and improvement in reliability of load bearing performance. Specifications for highway bridges in Japan has been revised in a partial coefficient format based on reliability technique. Unfortunately, the observation data and analysis evaluation in views described above are not sufficient. As discussed in Section 1, the Press-in Method has not been regarded yet as a standard construction method for the Specification adopted for Road Bridges. Regarding further development of steel pipe sheet pile foundation in future and foundation piles installed by the Press-in Method, it is felt the urgent issue is to establish an execution management method that can guarantee standardization of construction and demonstration of specified performance and accumulate data on load bearing performance and its reliability.

Translated by Mr Masafumi Yamaguchi, IPA Secretariat

Reference

[1] Japan Road Association: Reference material on reinforcement of existing road bridge foundations, February 2000 (in Japanese).

[2] Study group of aseismic reinforcement, JASPP: Research report on steel pipe sheet pile foundation extension method, March 2007 (in Japanese).

[3] Cabinet Office of Japan: Website http://www8.cao.go.jp/cstp/gaiyo/sip/ Cross-ministerial Strategic Innovation Promotion Program (SIP) (in Japanese).

[4] Civil Engineering Journal: Shaking table experiment on aseismic reinforcement technology of existing bridge abutment foundation in liquefiable ground, Volume 59, No. 9, 2017 (in Japanese)

Serial Report

History of Cambridge – GIKEN collaboration research (Part2)

Yukihiro Ishihara, Giken, Ltd.

Stuart Haigh, University of Cambridge

The Cambridge – Giken collaboration research started in 1994, based on the strong awareness of Mr. Akio Kitamura, President of Giken, Ltd., of issues relating to construction. Every summer two students visit Kochi, Japan, to carry out field and model tests using the press-in machines and other facilities of Giken, in order to learn this technology by experience. In some cases, they also conduct model tests or numerical analyses in their own laboratories on their return to Cambridge. In this report, research related to the tests carried out in Kochi from 2004 to 2010 are presented.

[2004-2006]

Project title : Penetration resistance / Soil plug and bearing capacity

Outline of tests in Kochi : Cone Penetration Tests (CPTs) and load tests on pressed-in closed-ended tubular piles were conducted at two different sites in Kochi. The closed ended-pile had an outside diameter of 318.5mm and was equipped with a load cell on its base to measure the base resistance. It was found that the load-displacement curves for base resistance and shaft resistance during the load test was well modelled by a parabola considering G_0/q_c, where G_0 is the small strain shear modulus and q_c is the cone resistance in CPT. The load test results, together with this parabolic model, as shown in **Fig. 1**, suggested a higher stiffness of the pressed-in piles compared to conventional piling technologies.

Main students : Melvin Hibberd, Helen Dingle, Andrew Jackson

Related publications : Dingle, H., 2006. The testing and analysis of jacked foundation piles. M.Eng. Project Report, Cambridge University Department of Engineering, 50p.

White, D. J. and Deeks, A. D., 2007. Recent research into the behavior of jacked foundation piles. Advances in Deep Foundations, pp. 3-26.

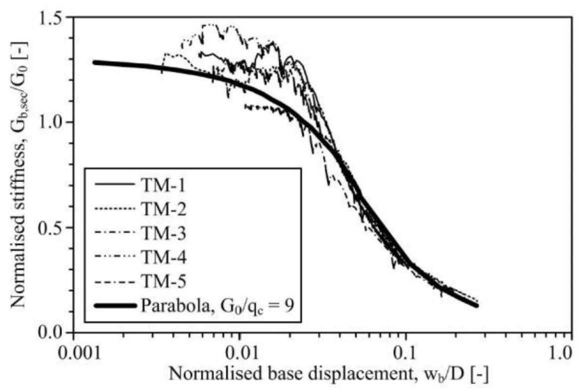


Fig. 1 (from White & Deeks, 2007)

[2006-2007]

Project title : Mechanism of increase in pull-out resistance

Outline of tests in Kochi : Three types of piles were used in this project: a U-shaped sheet pile with a width of 400mm (SP-III), a hat-shaped sheet pile with a width of 900mm (25H) and a closed-ended tubular pile with an outside diameter of 318.5mm. The closed-ended pile was equipped with a load cell on its base and several pore water pressure transducers on its shaft. Extraction resistance was investigated with different lengths of curing period. Although set-up was confirmed, the extent of set-up was not clearly linked with the dissipation of excess pore water pressure. In some tests, the peak value of extraction resistance appeared not at the commencement of extraction but when the pile was extracted by a substantial distance (more than 1m), as shown in **Fig. 2.** It was suggested, on the other hand, that the penetration resistance could be well expressed by modifying the UWA-05 pile capacity prediction method.

Main students : Andrew Jackson, Marcus Gillard

Related publications : Jackson, A., 2007. The setup of jacked piles. M.Eng. Project Report, Cambridge University Department of Engineering, 49p.

Jackson, A., M., White, D. J., Bloton, M. D. and Nagayama, T., 2008. Pore pressure effects in sand and silt during pile jacking. Proceedings of the 2nd BGA International Conference on Foundations, CD, pp. 575-586.

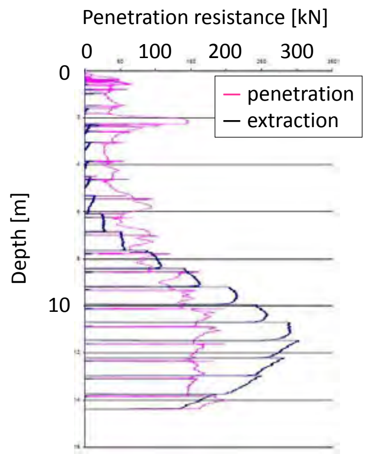
[2007-2008]

Project title : Penetration resistance and set-up

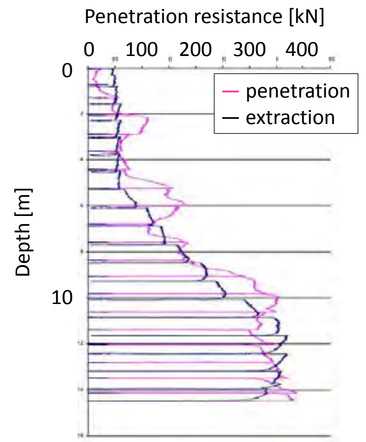
Outline of tests in Kochi : A closed-ended tubular pile with an outside diameter of 318.5mm, instrumented with a load cell on its base and several pore water pressure transducers on its shaft, was pressed-in at 3 different penetration rates (2, 12 and 30 mm/s). After 3 different curing periods (0, 15 and 60 min.), the pile was extracted to confirm the extent of set-up in extraction resistance. The base resistance was reduced at higher penetration rates, while the shaft resistance showed the opposite trend. Set-up in extraction resistance was confirmed. In some tests, peak values in extraction resistance were found not at the commencement of extraction but when the pile was extracted by more than 1 m. This tendency was more apparent for tests with shorter curing periods.

Main students : Marcus Gillard, Paul Shepley

Related publications : Ishihara, Y., Ogawa, N., Horikawa, Y., Kinoshita, S., Nagayama, T., Kitamura, A. and Tagaya, K., 2009. Utilization of pile penetration test data for ground information. Proceedings of the 2nd IPA International Workshop in New Orleans, Press-in Engineering 2009, pp. 105-120.



(a) U-shaped sheet pile with zero curing period



(b) Closed-ended tubular pile with zero curing period

Fig. 2

[2008-2009]

Project title : Plugging during press-in

Outline of tests in Kochi : A double walled open-ended tubular pile with outside and inside diameters of 318.5 mm and 199.9 mm, as shown in **Fig. 3**, was used in this project. The pile was equipped with 3 earth pressure transducers on its base to measure the base resistance. Four earth pressure transducers and pore water pressure transducers were placed inside the pile. The pile was pressed-in at two different penetration rates (2 and 10 mm/s), followed by load tests with different curing periods (85 minutes, 1 day and 10 days). It was confirmed that the strength of the soil plug was greater if the penetration rate was low. The set-up ratios at 10 days were confirmed to be around 1.5 and 2.5 for base and shaft resistance respectively.

Main students : Paul Shepley, Olusomi Delano

Related publications : Shepley, P., 2009. An investigation into the plugging of open-ended jacked-in tubular piles. M.Eng. Project Report, Cambridge University Department of Engineering, 47p.

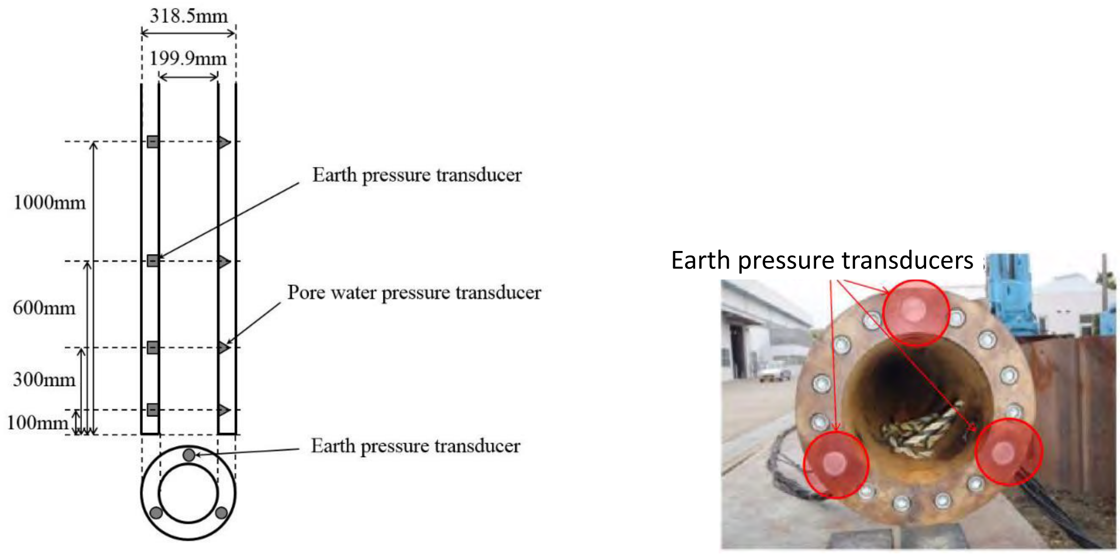
[2009-2010]

Project title : Effect of repeated penetration and extraction

Outline of tests in Kochi : Two types of piles were used in this project: a U-shaped sheet pile with a width of 400 mm (SP-III) and a closed-ended tubular pile with an outside diameter of 318.5 mm. The closed-ended pile was equipped with a load cell on its base and several pore water pressure transducers on its shaft. The pile was pressed-in monotonically or with repeated penetration and extraction, at different sets of combination of rates and displacements of penetration and extraction. The results showed that shaft resistance was reduced by repeated penetration and extraction, regardless of the ground condition (penetration depth). On the other hand, base resistance was reduced in layers where cohesive soils were dominant. No clear trend was found between the pore water pressure and the penetration resistance in repeated penetration and extraction.

Main students : Olusomi Delano, Thomas Bond

Related publications : Delano, O., 2010. The application of surging on jacked-in piles. M.Eng. Project Report, Cambridge University Department of Engineering, 49p.



(a) Specification of pile (b) View from the base

Fig. 3

Event Report

International Conference “CHALLENGES IN GEOTECHNICAL ENGINEERING”

Prof., Dr. Michael Doubrovsky

IPA Director
Head of Department “Sea, River Ports and Waterways”,
Odessa National Maritime University

The second edition of this conference was jointly organized by scientists and geotechnical engineers from Ukraine and Poland in cooperation with the Ukrainian Society for Soil Mechanics, Geotechnics and Foundation Engineering, Polish Academy of Sciences, Polish Society of Theoretical and Applied Mechanics under the patronage of the International Society of Soil Mechanics and Geotechnical Engineering. The event took place in Kiev, Ukraine 20-23 November 2017 (at the Kiev National University of Construction and Architecture).

The conference aimed to improve scientific and technical levels in solving geotechnical problems. The conference program highlighted the most relevant and promising areas of solving geotechnical issues, including:

- Analysis of the interactions of the elements in the "soil - foundation - structure" system.
- Construction of high-rise buildings and deep foundation pits.
- Numerical simulation.
- Ensuring slope stability.
- Construction in the seismically dangerous areas or under dynamic loads.
- Installation of foundations under difficult geological conditions.
- Areas with a complex geological and glacitectonic structures
- Modern methods of soil research and other geotechnical and related issues.

There were delegates from 19 countries of Europe, South America and Asia (including Japan with presentation from Waseda University). Presented reports covered a lot of very interesting and complicated geotechnical projects in Poland, Ukraine, Italy, Dubai, Brazil, Iran and other countries. Discussions and considerations of different case histories as well as innovative approaches related to civil and maritime engineering were at rather high scientific level and gave the possibility to gain new useful experience.

The delegates of the Conference met with interest presentation of IPA Director, Prof. Michael Doubrovsky titled “New developments of Press-In Method applications: innovative technologies and comprehensive Handbook”. Also IPA brochures “Implant Structure” (Ukrainian and Russian editions) were in good demand.

During technical tour Conference’s delegates had unique possibility to discover peculiarities of deep underground construction in the vicinity of great Dnepr River where geotechnical engineers cooperate with archeologists because of discovering ancient settlements with antique buildings on wooden piles and masonry. Another technical excursion was at the construction site of huge modern multi-storage building based on long bored reinforced concrete piles; serious geotechnical problems should be solved because of site located on steep hills with collapsible slopes. The next International Conference “CHALLENGES IN GEOTECHNICAL ENGINEERING” will take place in Poland at the University of Zielona Gora on 2019.

Figure 1 Three co-chairmen of the Conference Plenary Session. LTR: Prof Michael Doubrovsky (Ukraine), Prof. Jakub Marcinowski (Poland) and Prof. Rolf Katzenbach (Germany).

Figure 2 Conference poster

Figure 3 Press-In Method and IPA Handbook presentation by Prof. M.Doubrovsky

Event Report

The International Symposium on Coastal Erosion & Environment

Dr. Azizi bin Yusoff

IPA Director
MANAGING DIRECTOR, UTHM HOLDING SSDNBHD

The International Symposium on Coastal Erosion & Environment was successfully organized at The Everly Hotel, Putrajaya, Malaysia on 12-14 February 2018. The symposium was officiated by The Honorable Datuk Seri Dr. Haji Wan Junaidi Bin Tuanku Jaafar, the Minister of Natural Resources and Environment.

The symposium organized by Ministry of Natural Resources and Environment Malaysia gathered more than 250 experts and researchers in the field of coastal erosion and environment studies. The theme of the symposium is 'preserving the coast together'. The event enabled the participants to exchange of experiences and good practices between the government, authorities, civil society and private entrepreneurs on the coastal environment management, best engineering design and practices as well as new technologies involved.

For this symposium, we were greatly honored to be invited as one of the speakers. This presentation was jointly delivered by Universiti Teknologi Tun Hussein Onn Malaysia (UTHM) colleague, Professor Dr. Ir. Amir Hashim. The presentation somehow shared a positive effort between UTHM research entity (Research Centre for Soft Soils (RECESS) and Micropollutant Research Centre (MPRC)) and International Press-in Association (IPA). Our session was during the second day of the symposium under Session 4: New Technology/ Best Engineering Design and Practice. Since the intention was to share some of my experiences on new technology, we chose our presentation title "Leveraging on Technology: A Way Forward for Sustainable Coastal Monitoring and Preservation in Malaysia".

During the presentation, Press-in technology and drone technology were highlighted as a potential new technology to be considered in coastal protection and preservation work in the near future. For Press-in technology, the attendees were exposed with the basic principles of the technology, the concept of implant structure and a video presentation of coastal levee upgrading work along Kochi coastline to protect the city from future tsunami and coastal erosion. They were also exposed with several Press-in projects mainly for railway infrastructure work in Kuala Lumpur. It is hoped that the attendees will be able to recognize the superiority of Press-in technology as one of the options in preserving the coastline.

In summary, the Seminar was a good opportunity to familiarize the Press-in technology as the applicable state-of-art technology in preserving Malaysia coastline. I believe this should be a great step for the Press-in technology to be more appreciated in the construction industry in Malaysia. It is not only to overcome the coastal erosion problems, moreover to deliver the construction activities in a more sustainable and responsible manner.

Photo 1 A minute before the presentation

Photo 2 Sharing the concept of implant structure by implementing Press-in technology

Photo 3 A part of the attendees attended the symposium

Photo 4 Group photo after the presentation

Event Report

Mr. Akio Kitamura Presented with the Ben C. Gerwick Marine Foundation Innovation Award

Mr. Anthony Bertrams

Executive Director
GIKEN LTD.

During the 2018 International Foundations Conference and Equipment Exhibition (IFCEE) in Orlando Florida Mr. Akio Kitamura, President, Giken Ltd, was awarded the prestigious Ben C. Gerwick Award for Innovation in Marine Structures by the Deep Foundation Institute (DFI). On the 8th of March Mr. Rick A. Ellman, Partner, Mueser Rutledge Consulting Engineers, and Chairman of the DFI Marine Foundations Committee presented the award in front of over 150 international delegates at the IFCEE.

The award was established in 2012 to recognize Ben C. Gerwick's innovative spirit and his phenomenal contribution to the marine foundation industry over his 62 year professional career as a contractor, educator, and construction engineer.

Gerwick helped develop the use of prestressed concrete in bridge piers, foundation pilings and marine structures. His concrete foundation work included North Sea oil platforms, high-rise buildings, the Bay Area Rapid Transit system and bridges such as the San Francisco-Oakland Bay Bridge and San Mateo-Hayward Bridge in California, the Columbia River Bridge in Oregon, and an over-water extension of New York's La Guardia Airport.

Mr. Kitamura was given the Award in recognition of his invention of the Silent piler and continuing work in developing innovative construction methods using press in piling technology. Mr. Kitamura was universally seen as a worthy recipient of the Ben C. Gerwick Award for his 51 year dedication to press in piling an industry where the company he founded in 1967, Giken Ltd, is internationally recognized as the industry leader.

In his reception speech Mr. Kitamura spoke about the immense honor in receiving the Award bearing the name of the man universally accepted as the greatest marine foundation engineer of the 20th century. Connected not only by innovative spirit Mr. Kitamura reflected on the fact that Ben C Gerwick spent significant time in Japan to advise on the design the for the Seto Ohashi Bridge which joins the main island of Japan, Honshu, with the Shikoku islands where Mr. Kitamura was born and established his company in Kochi Prefecture. At 13.1 km it ranks as the world's largest two tier bridge system.

Photo 1 Mr. Kitamura is giving a speech

As part of the award Mr. Kitamura presented the Ben C. Gerwick Lecture which described the ambitions of Giken's innovation development for the next 100 years including disaster prevention structures, artificial intelligence automated press in technology and the future of modular press in construction methodologies.

Included in the lecture was a presentation by Professor Osamu Kusakabe, President of the International Press-in Association, providing a detailed introduction to press in technology and construction. Dr. Kusakabe, an internationally recognized leading proponent on press in construction highlighted the success of press in construction around the world where high quality, environmentally and commercially sustainable projects have been completed using the more than 3,350 silent pilers and gyro press produced at Giken.

Attendees of the lecture included academics, consulting engineers and piling contractors. The presentations by Mr. Kitamura and Dr. Kusakabe generated a great deal of discussion and interest in press in construction. Several major collaborations were established over the two days Giken and the IPA were in Orlando for the ICFEE.

The awarding of the Ben C. Gerwick Awrd to Mr. Akio Kitamura is a wonderful recognition of his life work and the value of press in foundation construction methodologies. Such recognition is a significant boost to international awareness of the benefits that can be derived by this construction technology. The momentum generated by this event will be carried forward by the IPA in expanding our membership and activities internationally.

Photo 2 Mr. Rick A. Ellman presents the Ben C. Gerwik Award to Mr. Akio Kitamura

Photo 3 The presentation of Press-in Technology by Dr. Kusakabe, President of IPA

Photo 4 Group Photo

Announcement

Technical material was finalized by TC2

Yukihiro Ishihara

Giken Ltd. / IPA Director

'Technical material on the use of piling data in the Press-in Method. I. Estimation of subsurface information (in Japanese)' was finalized by IPA Technical Committee 2 (Technical Committee on Estimation of Subsurface Information using Press-in Data, chaired by Dr. Osamu Kusakabe) in November 2017, as shown in **Fig. 1**. The material consists of 63 pages, and summarizes methods to estimate subsurface information from data obtained in three press-in techniques: standard press-in, press-in with augering and rotary cutting press-in. For standard press-in, CPT q_c and soil type are firstly estimated from the press-in piling data, based on the analogy in the penetration mechanism between CPT and press-in, and then SPT *N* is obtained by CPT-SPT conversion. For press-in with augering and rotary cutting press-in, SPT *N* is estimated from the press-in piling data based on Specific Energy, the energy required for penetrating a pile by a specific volume into the ground.

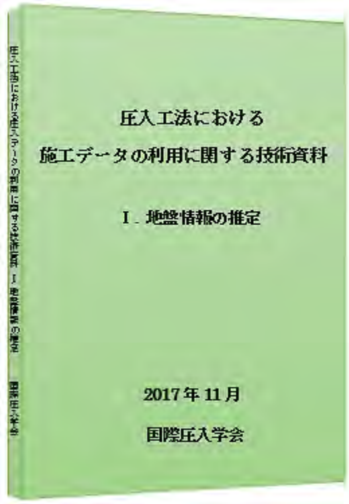


Fig. 1

The use of piling data in the Press-in Method has been recognized as being helpful in design and construction of structures with piles, as shown in **Fig. 2**, for more than a decade. An automatic operation of press-in machines that can automatically cope with transient situations in piling work is one typical example, in which a current piling status is estimated from the piling data and fed back to the machine so that parameters necessary for its operation can be adequately modified if necessary in response to the estimated information. The estimation of subsurface information, on the other hand, has been expected to be a solution for improving the validity of the design and construction of structures with piles in some cases, as it can fill the gap between the existing information and the reality related to the ground, which results from the nature of locality of the ground and the interpolation of limited numbers of site investigation results. At this moment, as stated in this technical material, the estimated information based on the methods in this technical material is recommended to be used as a reference in termination control or in judging the alteration of piling techniques. Accumulating the opportunities of its practical use will ensure the reliability of this estimation technique further, and make this technique a basis for estimating the performance of the piles to judge the necessity of alteration of design or to carry out construction when subsurface information is not precisely known in advance.

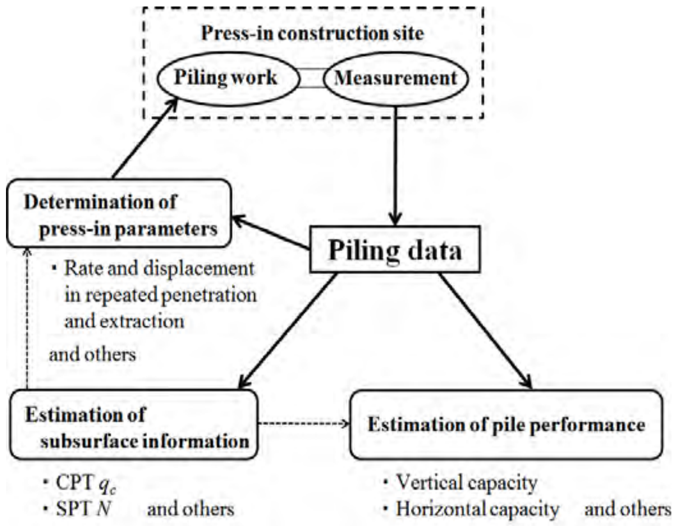


Fig. 2

Plenty of important comments were provided by the members of TC2 to finalize this technical material. In addition, many of the test data in this material were obtained in field tests carried out by Giken engineers, some of which were under the scheme of the joint research with the University of Cambridge supervised by Dr. Malcolm Bolton and Dr. Stuart Haigh. I am grateful to all these specialists.

The English version of this material will be prepared in two or three years.

Event Diary

Title	Date	Venue
■ **IPA Events** https://www.press-in.org/en/event		
IPA Seminar on Press-in Technology	May 18, 2018	Bangkok, Thailand
IPA Seminar on Press-in Technology	May 21, 2018	Manila, Philippine
International Conference on Press-in Engineering (ICPE) 2018, Kochi	September 19-20, 2018	Kochi, Japan
International Society for Soil Mechanics and Geotechnical Engineering http://www.issmge.org/events		
International Symposium on Geotechnics for Transportation Infrastructure	April 7-8, 2018	New Delhi, India
EUROROCK 2018 Geomechanics and Geodynamics of Rock Masses	May 22-26, 2018	Saint-Petersburg , Russia
4th GeoShanghai International Conference	May 27-30, 2018	Shanghai, China
micro to MACRO mathematical modelling in soil mechanics	May 29 - June 1, 2018	Reggio Calabria, Italy
Geotechnical Earthquake Engineering and Soil Dynamics V	June 10-13, 2018	Austin, USA
■ **Deep Foundations Institute** http://www.dfi.org/dfievents.asp		
DFI-CAIT Deep Mixing and Sand Compaction Piles Technical Seminar	April 24, 2018	New Jersey, USA
International Conference on Deep Foundations and Ground Improvement	June 5-8, 2018	Rome, Italy
SuperPile 2018	June 27-29, 2018	New York, United States
■ **Construction Machinery Events**		
The Big 5 Heavy 2018 http://www.thebig5heavy.com/	March 26-28, 2018	Dubai, UAE
8th Dredging & Land Reclamation Summit 2018 http://www.equip-global.com/dredging-and-land-reclamation-summit-2018	April 23-26, 2018	London, UK
■ **International Geosynthetics Society** http://www.geosyntheticssociety.org/calendar/		
5th International Conference on Geofoam	May 9-11, 2018	Kyrenia , Northern Cyprus
Geotechnical Construction of Civil Engineering & Transport Structures of the Asian-Pacific Region	Jul 4-17, 2018	Yuzhno-Sakhalinsk, Russia
■ **Others**		
ICDEM 2018 (International Conference on Disaster Management) http://seminar.unand.ac.id/index.php/icdm/2018	May 1-4, 2018	Andalas University Padang, Indonesia

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Editorial Remarks

The Editorial Board is pleased to publish Volume 3, Issue 1 on schedule. This issue contains message from Prof. Kenichi Soga, vice president of IPA, a report for activities of JASPP (Japanese Association for Steel Pie Piles), and event reports from Ukraine, Malaysia and IFCEE 2018 on Orland. It is 4rd time to publish the On-site interview. This time is a disaster recovery project in Kagoshima Prefecture in Japan with Gyropress (Rotary Cutting Press-in) Method. IPA will hold the Seminar on Press-in Technology in Thailand and Philippines, please read on the event dairy.

This issue also includes a special contribution about “Potential Damage to Steel Pipe Piles during Installation” written by Prof. M.F. Randolph, The university of Western Australia, to which The Editorial Board is most grateful.

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