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News Letter

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Editorial Board

Message from Director

Dr. Masaaki Terashi

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My deep involvement in the IPA activities started sometime in 2014 when the IPA decided to compile "Design and Construction Manual of the Press-in Method" in order to meet strong demand of a comprehensive material from the Japanese market, which was published in May 2015 in Japanese language. The manual was then revised extensively to meet international expectations and was published as "Press-in retaining structures: a handbook (First edition 2016)" in English language. I hope my personal experience of code writing in Japan, collaboration in drafting Eurocode on special geotechnical works, and co-authoring US FHWA manual on ground improvement might have helped to some extent in the editorial works of these IPA publications.

I am currently chairing the IPA Award Committee, one of the standing committees of the International Press-in Association. The committee was established in 2017. With the strong support of Dr. Andrew McNamara, Co-chair, and the other members of the committee, following five IPA Awards were established.

Outstanding Project Award: The IPA recognizes and honors a project that exemplifies superiority of a pile group, embedded structures and/or embedded walls in meeting the project requirements and public expectations. The project may either be small or large in terms of scale or budget as far as the project exemplifies the superiority of a group of piles or embedded wall from a variety of viewpoints including but not limited to the maximum use of limited land space, effective use of underground space, reduction of adverse environmental impact, effective reinforcement of aged or historic structures, resiliency of the structure under extreme actions such as earthquake or Tsunamis.

Innovative Technology Award: The IPA recognizes and honors innovative technologies that significantly contributed to the advancement of press-in engineering. The innovative technologies include but are not limited to efficient pile installation machinery, auxiliary equipment to cope with spatial and environmental restrictions, new prefabricated piles and attachments, instrumentation to monitor the pile behavior and/or the ground condition, and a system to guarantee the performance of the piles and embedded walls.

Distinguished Research Award: The IPA recognizes and honors distinguished research outcome published in the scientific/academic journals, engineering magazines or conferences/symposia proceedings that contributed to the advancement of the press-in engineering significantly.

Life-long contribution to Press-in Engineering: The IPA recognizes and honors individuals who have made great contributions to the advancement of the press-in engineering for a long period of time. Contributions may be through scientific research, planning, design, construction, development of machinery and materials, development of innovative application of embedded structures, and leadership in IPA activities.

ICPE Best Paper Award: The Organizing Committee of ICPE* and IPA jointly honor the best paper(s) submitted and included in the ICPE proceedings. Because of the multi-disciplinary nature of Press-in Engineering, the best paper awards may be selected from various disciplines.

* ICPE is the triennial International Conference on Press-in Engineering

The award committee encourages IPA members and non-members who are involved in the press-in engineering to submit your own contribution or to nominate your colleagues. The call for nominations will be posted on IPA website at an appropriate timing.

A Brief CV of Dr. Masaaki Terashi

Dr Masaaki TERASHI has led a career as a researcher, professor and consultant in geotechnical engineering. After the completion of post graduate course at Tokyo Tech, he started his career in 1970 as a researcher at the Port and Harbour Research Institute and was involved in the R&D of a variety of ground improvement technologies especially of deep mixing. He was awarded a special prize on the outstanding research contribution from the Science and Technology Agency in 1988. In 1992 he moved to a leading consulting firm in Japan and worked for real life projects covering wide range of infrastructures, domestic and overseas until the end of 2009. Around 10 years during those days, he taught students at Tokyo Tech as a visiting professor. He has been active in professional and academic societies. He delivered State of the Art, key note lectures and invited lectures at international conferences and symposia. He edited, authored and co-authored several books and book chapters and published more than two hundred conference and journal papers on various subjects associated with soft ground and ground improvement. Dr Terashi is a technical adviser of Giken Ltd since 2010.

Announcement

The General Assembly of the year of 2018, held in June, endorsed the change of the Board Members. The list below gives the outgoing and the incoming members of IPA Board Members. Many thanks go to the outgoing Board Members for their great contributions during the terms. Very warm welcome goes to the new Board Members.

Incoming Directors

Mr. Yang Lei (China)
Vice President, Shanghai Tunnel Engineering Co., Ltd.

Dr. Pastsakorn Kitiyodom (Thailand)
Deputy Managing Director, Geotechnical & Foundation Engineering Co., Ltd., Thailand

Outgoing Directors

1. Prof. Fang-Le Peng **2. Mr. Peter Cali**

Special Contribution

Seismic Response Analysis of Ground/Geo-structures using Geo-Analysis Integration Code

Prof. Akira ASAOKA[1] and Prof. Toshihiro NODA[2]

[1]Senior Research Advisor, Professor Emeritus, Nagoya University, Association for the Development of Earthquake Prediction, Japan
[2]Professor, Nagoya University

1. Introduction

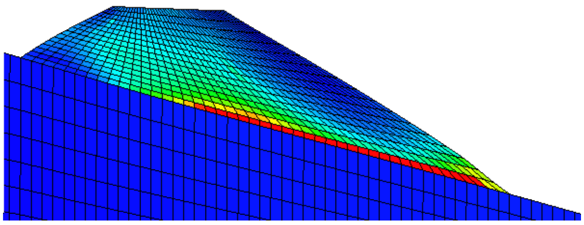
In the past, geo-analysis codes have been dedicated ones that have been used after deciding in advance what is expected to occur in the ground. For this reason, the inputs of the physical properties of the soils and the codes that were employed for the analysis differed depending on the engineering problem to be solved. For example, when a ground composed of alternating sand and clay layers was the target of analysis, the consolidation behavior of the ground was analyzed using a static code dedicated to consolidation of clay, with sand being treated as an elastic body. On the other hand, for analyzing the ground's seismic behavior, another code dedicated to liquefaction of sand was employed, with clay being treated as an elastic body. In order to newly establish soil mechanics by doing away with such provisional or makeshift measures, the Soil Mechanics Group of Nagoya University has been pursuing the development of an analysis code that would be capable of describing what would happen in the ground when it is subjected to a given form of external force by simply inputting at the beginning the initial conditions and the material constants of the ground. As a result of such development, we have proposed the SYS Cam-clay model (Asaoka et al., 2002) by incorporating the concept of sub-loading and super-loading surfaces into the Cam-clay model. This allows the constitutive equation of the soil skeleton to describe within a single theoretical framework the mechanical behavior of a wide spectrum of soils ranging from sand to clay as well as the infinite number of intermediate soils that exist in states between those of sand and clay (ALL SOILS). In addition, through further development in recent years, it has become possible to describe the combined loading state of the above model and the Drucker-Prager model (Drucker and Prager, 1952) through a "combined loading" elasto-plastic equation(Yamada and Noda, 2015) that we have proposed. Simultaneously, we have been developing the analysis code GEOASIA (Noda et al., 2008), which is based on finite deformation theory and is capable of handling problems of deformation and failure without distinguishing between the two (ALL STATES). This code is also capable of dealing with inertial forces, which allows handling of static and dynamic problems en bloc (ALL ROUND). Furthermore, following our studies on soil skeleton-water coupled analysis (2-phase analysis) of saturated soils (or soils assumed to be saturated), we have been extending the analysis code (Noda and Yoshikawa, 2015) to allow seamless handling of soil skeleton-water-air coupled 3-phase systems in states between unsaturated and saturated soils.

In Sections 2 and 3 of this paper, we introduce examples of analyses that have been or are currently being carried out on the seismic responses of grounds and various structures using the analysis codes for 2-phase systems and 3-phase systems. Using these codes to simulate fault movements, our group is also pursuing integrated analysis of the stages of earthquake occurrence and propagation as well as the effect of ground surface tremors on civil structures, considering these to be continuous mechanical phenomena. Although still at its initial stage, an example of analysis of strike-slip fault formation is introduced in Section 4. As for details of the elasto-plastic equation and analysis codes, please see references Asaoka et al.(2002), Yamada and Noda(2015) and Noda et al.(2008), Noda and Yoshikawa(2015).

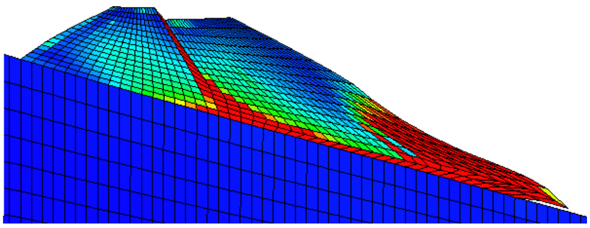
2. Seismic response analyses of ground considered as being saturated

2.1 Embankment collapse due to the 2007 Noto Peninsula Earthquake (Sakai and Nakano, 2012)

The 2007 *Noto* Peninsula Earthquake caused large-scale collapse of embankments built on sloped bedrock along the Noto Satoyama Expressway. Figure 1 is an example of analysis of one of the collapsed embankments. The material constants of the soil were determined by carrying out tests for determining the physical and mechanical properties of samples taken from the embankment slope, which was composed of tuff breccia. The earthquake motion that was observed at the K-NET Anamizu observation point was referred to when inputting the seismic wave to the bottom face of the sloped bedrock. The embankment was a relatively well consolidated one. During the earthquake, the embankment does not collapse because an increase in the mean effective stress and generation of negative excess pore water pressure occur within it simultaneously due to positive dilatancy behavior (i.e., hardening by plastic expansion), which results from the rapidly repeated large shear forces. After the earthquake, however, dissipation of the negative excess water pressure leads to water absorption, and collapse of the embankment occurs as a result of the softening behavior of the soil near the slip planes. The above is not just a singular case—there have been many other examples of delayed embankment collapse occurring a few hours or a few days after an earthquake.



(a) Immediately after earthquake occurrence

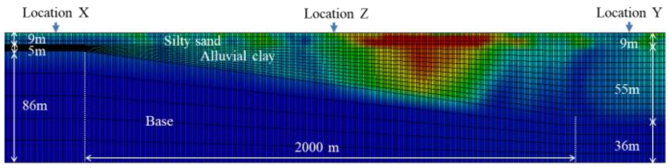


(b) 45 days after earthquake occurrence

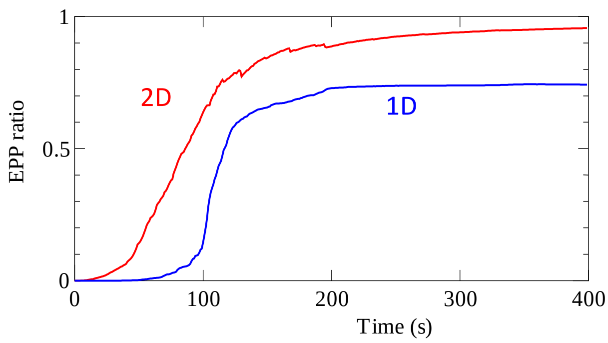
Figure 1 Delayed post-seismic collapse of an embankment built on inclined ground, Shear strain distribution

2.2 Extended ground liquefaction damage at Urayasu City caused by surface waves generated from the edge of sloped bedrock during the Great East Japan Earthquake (Nakai et al., 2015)

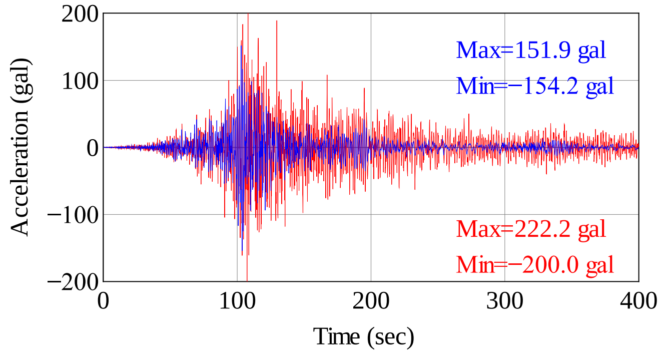
The off the Pacific coast of Tohoku Earthquake caused massive liquefaction damage over wide areas of landfill grounds along the coast of Tokyo Bay, including Urayasu City. Figure 2 shows an example of 2-dimensional plane strain analysis of a ground in Urayasu. The ground consists of a surface sandy soil layer and an alluvial clay layer below it, followed by bedrock (a diluvial layer), which slopes down from northwest (Location X, near Motomachi) to southeast (Location Y, near Shinmachi). The thickness of the clay layer is seen to increase as the bedrock slopes downward, and the analysis focused attention on this irregularity of the ground. The material constants and the initial conditions of the soils were determined from sand and clay test specimens sampled independently from the site and from the structure of the shear wave. The cross section for the analysis was modeled as a sloped diluvial stratum with a 5 m to 55 m thick layer of sedimented clay above it. The seismic wave that was input was 1/2 of that observed at a depth of about GL-36 m in Shinagawa. It was input as a rising wave to the bottom face of the diluvial stratum at approximately GL-100 m. Analysis using 1-dimensional modeling indicated that during the earthquake, the existence of the clay layer amplifies the seismic wave, particularly its long-period components. Although this causes the excess pore water pressure in the sandy layer to increase, liquefaction does not occur (Figure 2b). In contrast, 2-dimensional analysis showed that the seismic wave (body wave), the long-period components of which had become slightly amplified in the clay layer, interfere with the propagating surface wave (Rayleigh wave) (Figure 2d) that had been generated at the edge of the sloped bedrock (edge effect). In addition, aftershocks continued after the main tremor ceased (Figure 2c). For this reason, even in the surface layer that had been assumed to be a homogeneous material, non-uniform shear strain distributions are generated (Figure 2a), and liquefaction occurs over wide areas from Location Z (near Nakamachi) up to Location Y. The above computational results agree with the actual conditions of liquefaction damage that occurred in the Nakamachi and Shinmachi areas of Urayasu City.



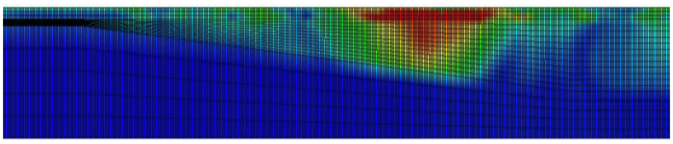
(a) Shear strain distribution 200 s after earthquake occurrence



(b) Excess pore water change at Location Z



(c) Acceleration response at Location



(d) Velocity vector diagram 50 s after earthquake occurrence

Figure 2 Seismic response analysis of ground on sloped bedrock in Urayasu City

2.3 Application of the Sand Compaction Pile (SCP) Method (Noda et al., 2011)

The SCP method is a well-known measure against liquefaction, and Figure 3 is an example of analysis of the mechanism of the resistance to earthquakes (suppression of deformation) obtained through SCP. The target of analysis was a ground of loose sand. First, the sand pile cavity expansion stage was simulated under the condition of axial symmetry, with consideration for the compaction of the ground around the pile. Following this, seismic response analysis focused on the characteristics of the composite ground was carried out using an SCP improved ground model containing the sand pile and the ground around the pile. In the SCP-improved ground, rapid undrained cyclic shearing occurs during the earthquake. This results in positive dilatancy behavior in the dense pile, which causes stress to concentrate in the sand pile, thus suppressing deformation of the ground. In the case of large earthquake movement (L2 movement), in addition to the above phenomena, even the sand between the sand piles that had been compacted at the time of construction of the sand piles exhibits positive dilatancy behavior, leading to dramatic suppression of ground deformation (Figure 3b).

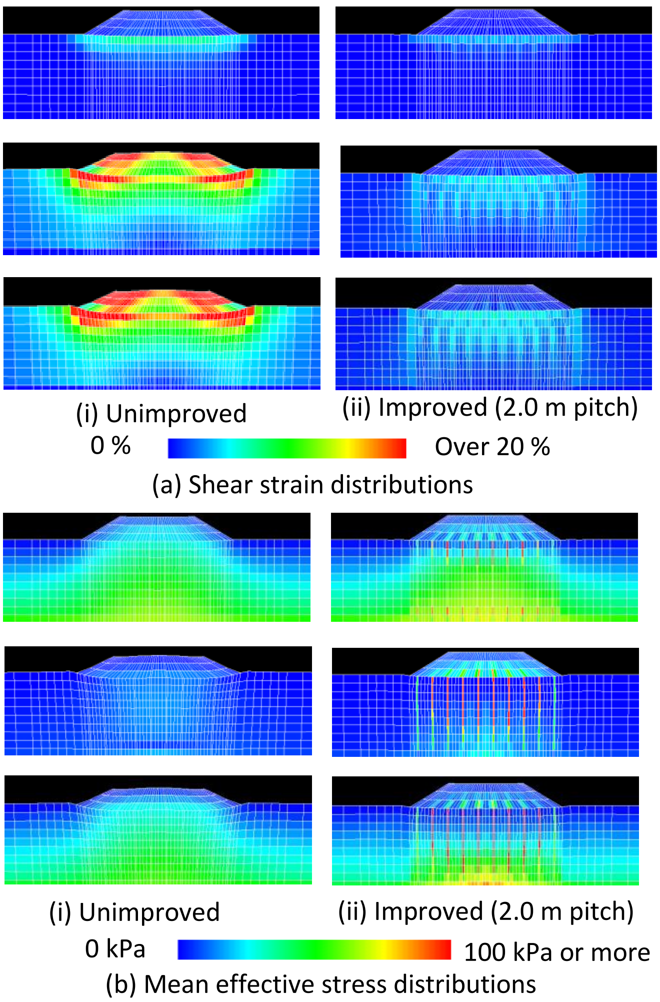


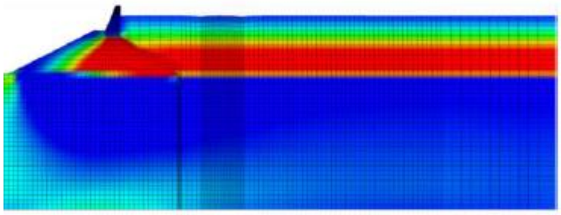
Figure 3 Validation of the SCP method (L2 seismic tremors), Upper: immediately before earthquake, Mid: 300 seconds after earthquake started, Lower: immediately after earthquake

2.4 Application of the Pore Water Pressure Dissipation Method for shore protection structures (Noda et al., 2015; Nonaka et al., 2017)

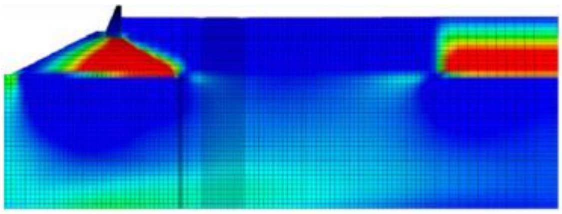
An example of a study on the effect of the Pore Water Dissipation Method as an anti-liquefaction measure with respect to man-made landfill ground with a shore protection structure within Nagoya Port is shown in Fig. 4. In this method, an important issue is the prediction of the amount of deformation due to the compaction that results from the suppression of increases in water pressure by drainage through vertical drains during an earthquake. Therefore, it is necessary for compaction and liquefaction, together with the amount of co-seismic compaction settlement and the amount of consolidation settlement that could occur after liquefaction, to be handled in an integrated manner. In order to avoid the enormous number of mesh partitions needed to represent the innumerable buried vertical drains and the surrounding ground, the macro-element method (Sekiguchi et al., 1986), which is used for analyzing compaction problems, was applied for the first time in this analysis. Furthermore, for evaluating the effect of well resistance, an extended macro-element method, which treats the water pressure in the drains within the soil elements as unknowns, was newly proposed and used (Yamada et al., 2015). It was observed that the increase in excess water pressure during an earthquake is suppressed if this method of improvement is applied to grounds with relatively high water permeability (Figure 4a). As a consequence, in marked contrast to non-improved ground, no liquefaction occurs in the improved ground, and the ground maintains its rigidity, thus suppressing localized settlement of structures built on the landfill. In addition, post-seismic consolidation settlement has been also inhibited because dissipation of excess water pressure has nearly ended immediately after the earthquake (Figure 4b).

2.5 Advanced development of the elasto-plastic constitutive equation of the soil skeleton—the combined hardening elasto-plastic constitutive equation (Yamada and Noda, 2015)

Upgrading the constitutive equation of the soil skeleton is indispensable for describing the behavior of a wide range of soils. In order to allow more accurate descriptions of cyclic mobility and other complex elasto-plastic behavior of soils under cyclic loading, a combined loading elasto-plastic constitutive equation (Yamada and Noda, 2015) was developed. This equation allows the SYS Cam-clay model (Asaoka et al., 2002) and the non-associated Drucker-Prager model (Drucker and Prager, 1952) to express combined loading states. Figure 5 shows the results of hollow cylinder torsional tests (upper figures) of liquefaction tests on Toyoura sand and simulation examples of this model (lower figures). In this figure, a, b, and c represent dense, medium dense, and loosely filled sand (having approximate relative densities Dr = 70%, 60%, and 45%, respectively). Although the set of material constants used consisted of only those of one group, it can be seen that it has been possible to describe the liquefaction tests of materials with differing densities in an integrated manner.

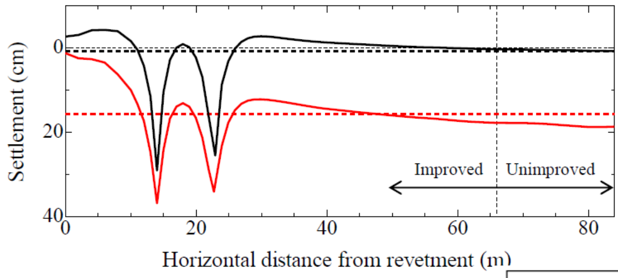


(i) Unimproved

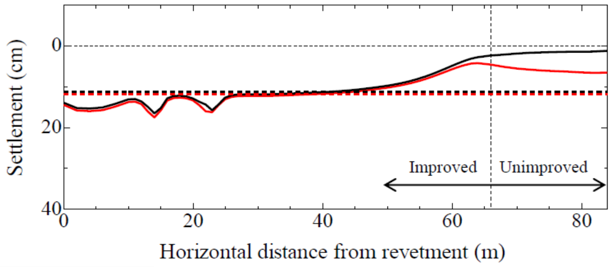


(ii) Improved (1.0 m pitch)

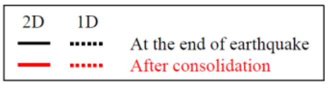
(a) Distribution of excess pore water pressure (when the earthquake ended)



(i) Unimproved

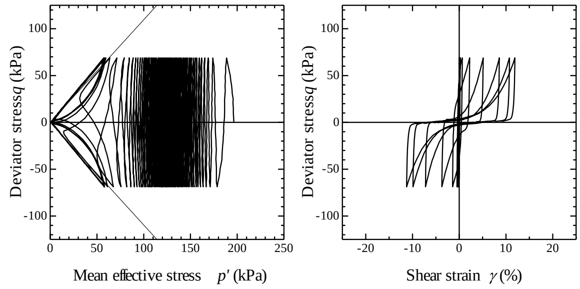


(ii) Improved (1.0 m pitch)

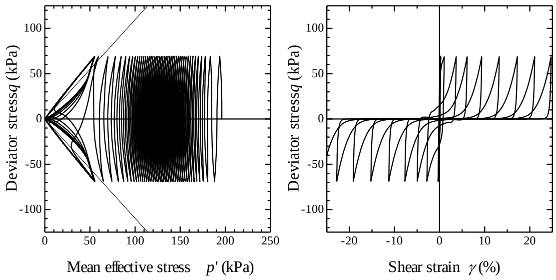


(b) Settlement of ground surface

Figure 4 Validation of the Excess Pore Water Pressure Dissipation Method

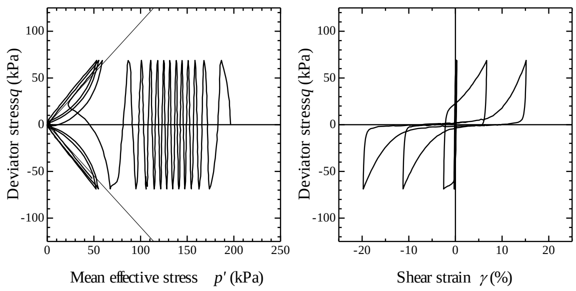


(i) Experiment

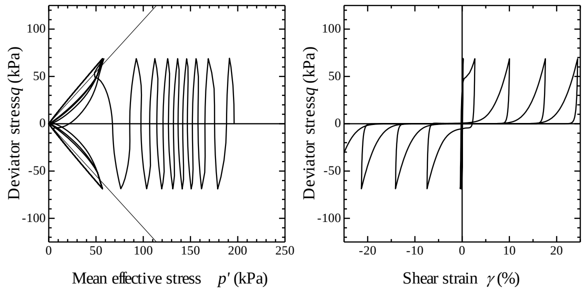


(ii) Simulation

(a) Dense sand (Dr≒70%)

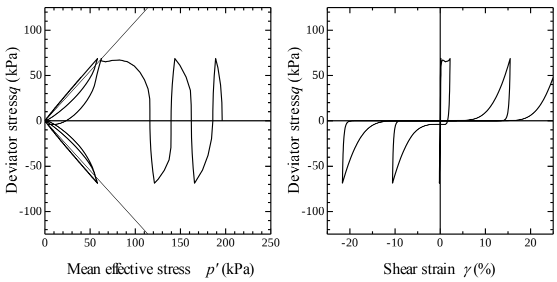


(i) Experiment

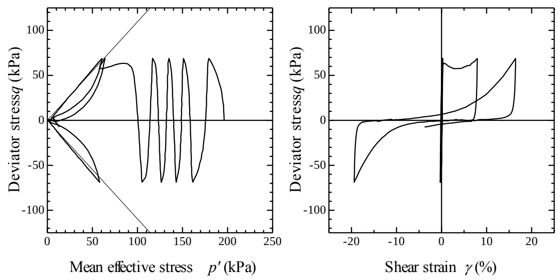


(ii) Simulation

(b) Medium dense sand (Dr≒60%)



(ii) Simulation



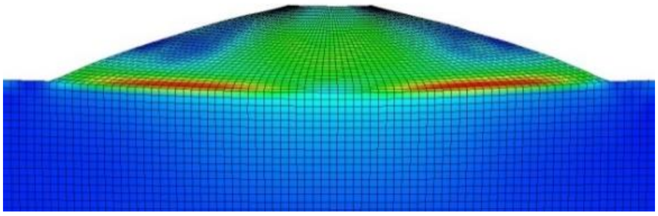
(i) Experiment

(c) Loose sand (Dr≒45%)

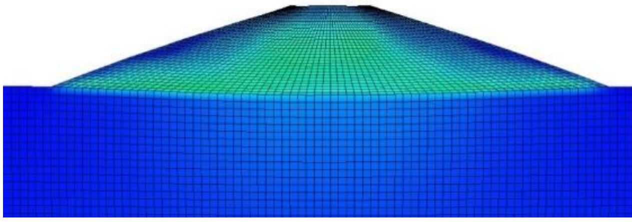
Fig. 5 Simulation of sand liquefaction tests by utilizing the advanced constitutive equation

3. Three-phase seismic response analysis that is also applicable to unsaturated soils

The Great East Japan Earthquake resulted in not only in the collapse/settlement of river embankments due to liquefaction of sandy grounds but also resulted in collapse of river embankments built on clayey grounds. This has been attributed to the liquefaction of an enclosed saturation area created at the lower parts of the embankment as a result of the consolidation settlement that takes place in clayey foundation ground during embankment construction. In addition, it has been confirmed that ground water levels in damaged cross sections were higher compared with those in undamaged ones. An example of the results of a 3-phase analysis study, which was carried out with focus on the effect of ground water level on the continuous behavior of an unsaturated soil embankment built on clayey foundation ground from the time of its construction up to the time of cessation of an earthquake, is shown in Figure 6 (Yoshikawa et al., 2016).



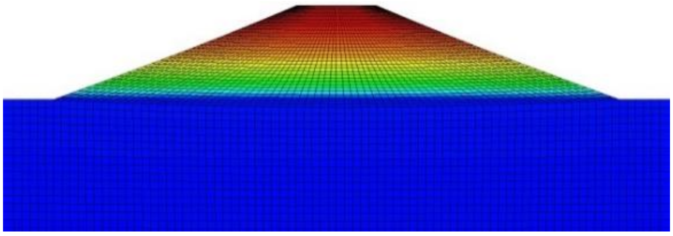
(a) Initial groundwater at the same level as the ground surface



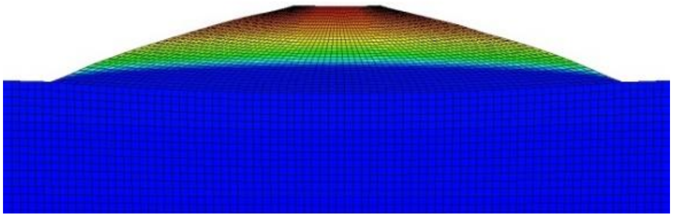
(b) Initial groundwater level at 2 m below the ground surface

Figure 6 Effect of groundwater level on deformation behavior of the river levee, Shear strain distribution (immediately after the earthquake)

The ground was configured on the basis of the results of mechanical tests carried out with undisturbed samples obtained from the disaster-affected Shimonakanome region inland of the Narusegawa River. The seismic wave that was input was a 1/2 wave based on the one that had been recorded at the KiK-NET *Onoda* observation point. The results showed that when the ground water level was high, the degree of saturation in the embankment was high and the skeleton forces (effective stresses) were small, resulting in large co-seismic deformation. Figure 7 illustrates analytical results showing the ground water level rising after the earthquake. If the ground water level is high, a phreatic line forms within the embankment after the earthquake and moves upward. After about a month, it moves down and returns to the original groundwater level. If the ground water level is low, although the phreatic line moves upward, it does not appear within the embankment even after the earthquake (data not shown). The reason for the upward movement of the phreatic line is the post-seismic dissipation of the excess pore water pressure/air pressure generated during the earthquake in the saturation area at the lower parts of the embankment and in the clayey ground.



(a) Immediately before the earthquake



(b) 1 month after the earthquake ended

Figure 7 Rise of the groundwater level after the earthquake

4. Analysis of associated strike-slip fault formation in ground surface layers

4.1 Analysis of associated strike-slip faults resulting from lateral strike-slip fault formation (Toyoda et al., 2019)

It is known that when lateral slip fault displacement occurs deep within a ground, complex slip bands referred to as flower structures (Riedel, 1929) are formed within the sub-surface ground layer immediately above the fault and that an array of echelon mode shear bands called Riedel shear bands appear on the ground surface. In lateral slip faults, it is quite rare for the slip fault lines to be straight lines. Generally, they are curved or include discontinuities (Fossen, 2016) called steps, as shown in Figure 8. The term "jog" refers to such locations that have deviated from the fault lines. Existence of a jog plays an important role in the process of formation of the flower structure. Figure 9 depicts the results of numerical analysis that takes account of the existence of a geometric barrier jog when numerically simulating Riedel shear bands. The solution yields associated strike-slip fault structures that possess the following characteristics:

(a) A fractal slip structure where global Riedel shear (colored green) encompasses localized Riedel shear (colored red)

(b) Secondary shear bands (P-shear) that are inclined to the left and are formed in between the right-inclined Riedel shear bands

(c) High-angle and low-angle shear bands (R-shear・R'-shear)

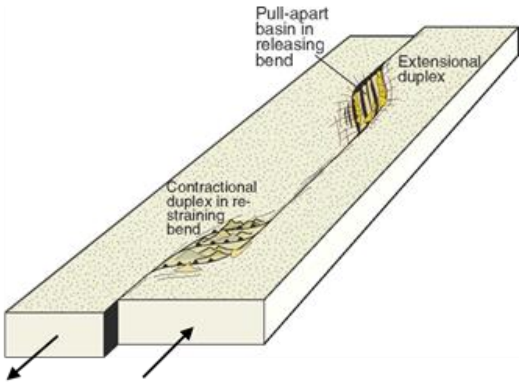


Figure 8 Left lateral strike-slip fault with step (Fossen, 2016)

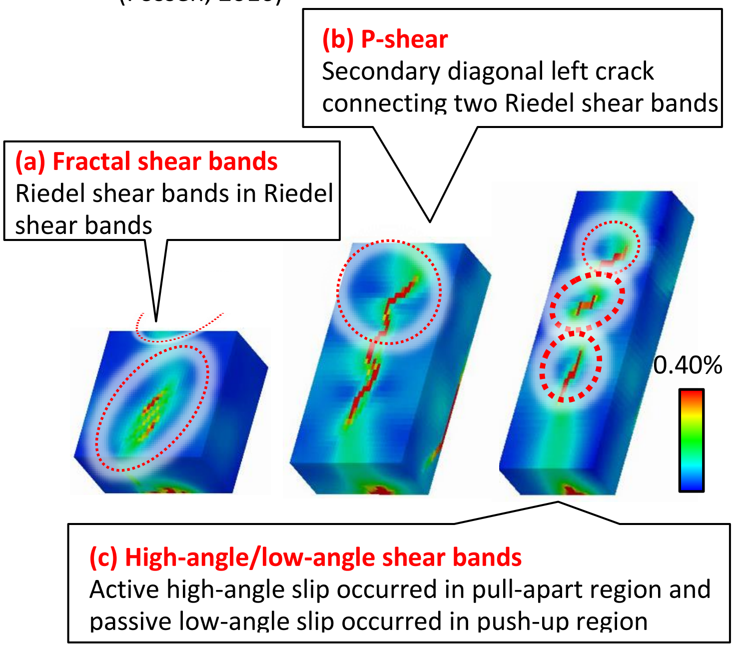


Figure 9 Characteristic associated strike-slip fault structures appearing at the ground surface, Shear strain distributions

5. Conclusion

We have endeavored to introduce, within the limited space available here, recent examples of seismic response analysis of grounds and earth structures using computational methods that are capable of describing in a consistent manner the behavior of the structures from their construction process before earthquake occurrence until after cessation of the tremors. Some of the new developments in tectonic geomorphology analysis have also been introduced.

In the field of strong motion seismology, analysis based on geomechanics of the trampoline effect (Asaoka et al., 2012) has gained a certain measure of recognition. However, there are still several issues, such as clarification of strong motion characteristics of unsaturated ground and pursuant analysis of the co-seismic and post-seismic behavior of natural/man-made slopes, the problem of water (torrential rain/tsunami) and earth structure interactions (Kodaka et al., 2015) that may lead to complex disasters, and the effects of aftershocks, that remain to be studied further. In order to elucidate these mechanisms, further deepening of geodynamics by embracing knowledge from related academic fields would be required.

As for the accuracy of analysis, it is needless to mention the importance of careful investigations through tests on models in which the boundary conditions and initial conditions are relatively well defined. In the case of actual problems, however, in addition to the heterogeneity of the ground, there is uncertainty about the seismic wave that is input as the external force, and there is no choice but to replace many of the 3-dimensional geomechanics phenomena with 2-dimensional problems. As a consequence, there are limits to accuracy, and wavering between optimism and despair just because of a few centimeters or a few tens of centimeters of quantitative accuracy would be a worthless effort. We believe that our immediate aim should be the development of analysis codes capable of extracting and giving us information on specific qualitative issues such as determination of the events that will take place in ground as a result of assumed external forces and determination of whether or not we have overlooked something in our designs.

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Special Contribution

Optimizing the design of foundations on soils reinforced by columns

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Abstract. Recent rational methodology is presented, in brief, for the design of column-reinforced foundations. Optimizing the design of this type of foundations constitutes the focal point of this paper. The optimization of design is addressed for two reinforcement scenarios: end-bearing and floating columns. For the first scenario, it is shown up that the improvement area ratio can be optimized when the improvement of initial soil stiffness is considered, particularly when the stone column technique is practiced. For the second scenario, the length of floating columns is also optimized considering the admissible rate of consolidation of sub-layers underneath the reinforced soil. Worth mentioning that the recent methodology of design also provides an optimized design, when the improvement of initial soil is not considered and regardless of the column type. Discussion of selected case histories-studies made it possible to sort out the inherent highlights regarding the design of foundations on soils reinforced by columns.

1. Introduction

Several techniques are nowadays practiced to reinforce soft and/or highly compressible deposits. Stone columns, sand-compaction piles and deep soil mixing are among the most popular techniques enabling the increase of bearing capacity (BC), the reduction in settlement and the acceleration of consolidation. Mitigation of liquefaction is also another benefit which can be targeted by using vibro-compaction and stone column techniques.

Recently, a rational design methodology of column-reinforced foundations was suggested, then, implemented for several case studies (Bouassida, 2016a & b). Bouassida & Carter (2014) detailed the inherent methodology of design considering the optimization of area ratio in cases of end-bearing columns. The installation of stone columns enables the improvement of soft clays, namely the modulus of deformation and undrained shear strength, as pointed out by Guetif et al., 2007 and Ellouze et al., 2017. Such an improvement contributes in the reduction of optimized improvement area ratio (IAR) previously determined.

Optimizing the design of column-reinforced foundation can be foreseen into two scenarios. First optimization is related to the improvement area ratio after verification of the BC and settlement criteria (Bouassida & Carter, 2014) for the reinforced soil zone. The merit of proposed methodology relies on the prediction of an optimized area ratio associated to an allowable settlement. Bouassida et al. (2017) checked on the conservative side compared to existing methods of design.

Considering the end-bearing type of columns two cases should be considered depending on the column installation technique. This latter can affect the properties of surrounding initial soil. Indeed, when the stone columns and/or the vibro-compaction are adopted, the installation of column material by lateral expansion induces the consolidation of surrounding soil from which the modulus of deformation and strength resistance are enhanced (Guetif et al., 2007 & Frikha et al., 2013). At less extent, the sand compaction technique also moderately affects the properties of surrounding soil. Contrarily, the equipment of deep soil mixing technique essentially dedicated to very soft clays does not actually affect their parameters (Bouassida, 2016 a & b). Therefore, the optimized area ratio can be reduced when the initial soil properties are enhanced due to the stone column installation technique.

Numerical simulation conducted by Ellouze et al. (2017) highlighted the increase in Young modulus of soft soil after the installation of model comprising seven stone columns in triangular pattern. It is understood that predicting such an improvement is depending on the constitutive model adopted for the soft initial soil (Mohr-Coulomb, Hardening Soil Model or Soft Soil Model).

Second scenario is related to the reinforcement by floating columns which can be considered in cases the stratum layer is very deep. During the last decade; several contributions were dedicated to the analysis of reinforcement by floating columns. Published contributions addressed the determination of bearing capacity, Bouassida et al. (2009) and Fattah et al. (2017), the settlement prediction and the behavior of foundations on soil reinforced by floating columns, Ng & Tan (2014), Shahu & Reddy (2014) and Tabchouche et al (2018). Meanwhile the design oriented to optimized length of floating columns still remains with little interest.

The optimization of columns' length depends on the dimensions of loaded foundation and the parameters of unreinforced layers (Bouassida & Hazzar, 2015). Optimized length of floating columns relies on the admissible long-term settlement of compressible layers underneath the reinforced soil. Based on this criterion, Bouassida & Ellouze (2018) recently reported on the optimization of length of floating stone columns for a Tunisian case study.

This paper aims to give an insight about the optimization of design of foundations on soil reinforced by columns through detailed discussion of case studies including the reinforcement by end-bearing and floating columns as well.

2. Reinforcement using end-bearing columns

2.1 Case history n°1: Oil tank at Zarzis terminal (Tunisia)

This case shows up the optimization of area ratio (AR) without consideration of the improvement of surrounding initial soil, and when such improvement is also considered. Figure 1 displays the oil tank diameter, initial soil properties and stone columns' characteristics.

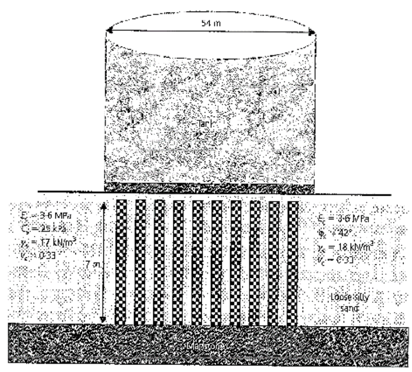

Figure 1 Data of oil tank at Zarzis terminal (Bouassida & Hazzar, 2012)

The practiced AR of 35% was highly conservative because the adopted design method only considered the settlement verification based on the French standard which considers the unit cell model. Bouassida & Hazzar (2012) discussed this case history by implementing the methodology embodied in Columns 1.01 software. Using the project data (Figure 1), it resulted that a significant reduction of area ratio was possible to only install stone columns with an optimized area ratio equals to 30.64 % complying with allowable uniform settlement of 6 cm. This design using the group of columns modelling obviously does not consider the improvement of initial soil (loose silt sand) properties.

Further, settlement gauges installed at the periphery of tank assured the follow up of settlement evolution during tank construction. Recorded averaged settlement, assumed as uniform component, was nearby 4 cm. From this observation it is understood that the reduction of settlement of 2 cm (from predicted to that recorded) can only be attributed to the effect of stone columns installation in the loose silt sand layer. Back calculation of the homogenized Young modulus of reinforced soil (Bouassida 2016a) considering the observed settlement of reinforced soil equals to 4 cm leads to conclude that the Young modulus of loose silt sand layer increased by 40 %. Hence, if the actual admissible settlement of tank foundation was 4 cm, the improvement area ratio can be reduced more than the initially optimized value of 30.64%. The second optimized area ratio can be determined by using Columns 1.01 software. Worth mentioning that predictions by Columns 1.01 software, obtained in linear elastic framework, were in fair agreement with numerical predictions obtained by FLAC3D code (Bouassida et al., 2017). The behavior of rigid raft resting on soft soil reinforced by group of end-bearing stone columns was simulated by FLAC 3D code. From obtained results, the induced bugling effect by lateral deformation surrounding the reinforced soil was explained (Tabchouche et al., 2018).

Guetif et al. (2007) used the data of Damiette project (Naama Engineering and consulting, 2001) and implemented the composite cell model, shown in Figure 2. Implementing numerical 2D computations by Plaxis software those authors proposed predictions confirming such quantification of increased Young modulus of soft clay and the extent of improved zone. Laterally expanded stone column was simulated by the "dummy material" procedure detailed by Debats et al. (2003) including the horizontal consolidation of soft clay. From this latter, the average estimated increase in Young modulus was by 1.3 times, the extent of improved soft clay approximated three times the radius of SC. This case study well illustrates how the design of foundation on soil reinforced by SC can be optimized, first, by implementing the

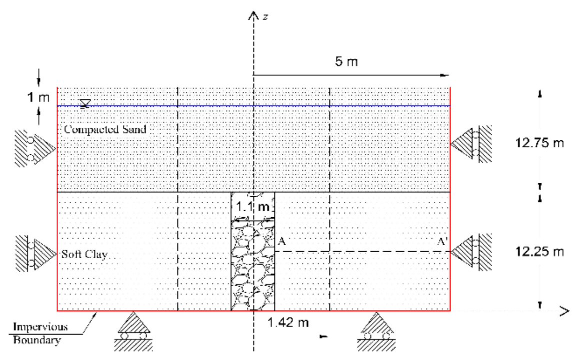

Figure 2 Composite cell model (Guetif et al., 2007)

recent methodology, and, second, by considering the improvement due to the primary consolidation of soft clay which resulted from the installation of stone column by lateral expansion.

2.2 Case study n°2: Damiette project

Ellouze et al. (2017) recently investigated the improvement of Young modulus of soft soil by implementing numerically the "Dummy material" procedure for the reinforcement by a group of end-bearing columns. The numerical model, shown in Figure 3, comprises central column surrounded by six columns installed in triangular pattern (Ellouze & Bouassida, 2009). Those six columns, reduced to an equivalent circular crown, have the same reinforcing area, so that the axisymmetric condition to run Plaxis 2D numerical computations is applicable, as for the case of the composite cell model. The benefit of this model is to look for the optimized spacing between the columns which is determined from the profile of horizontal displacement (outward for the central column; inward for the equivalent crown) induced by the simulated lateral expansion of soft clay. Numerical computations were run by adopting the Mohr-Coulomb and hardening soil modelling for soft clay, and the Mohr-Coulomb constitutive model for the columns material.

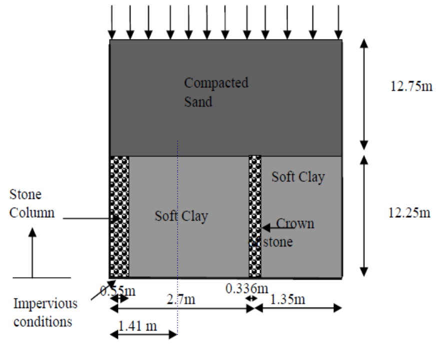

Figure 3 Numerical model of group of stone columns

The main insight from the study by Ellouze et al. (2017) was to estimate the reduction of area ratio by comparing the two cases: without improvement of soft clay and when this improvement was considered. Figure 4 displays the reduction of area ratio when modeling the soft clay by the Hardening Soil Model. From this figure, one can note how significant the reduction of the initially optimized area ratio is when the improvement of soft soil is considered. In this regard, learned lesson from a French case history reported by Debats et al. (1999), was, after stone columns installation, a rest time revealed necessary to make possible the improvement of initial soil by laterally expanded stone columns.

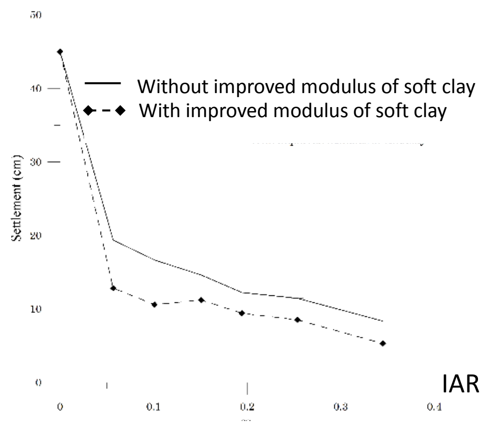

Figure 4 Variation of settlement versus improvement area ratio

Presently, at the National Engineering School of Tunis, the investigation on this subject is oriented to analytical prediction of the reduction in area ratio when considering a given rate of improvement of soft soil.

3. Reinforcement using floating columns

This second alternative of reinforcement by columns prevails when the rigid stratum is located a high depth (equals or exceeds 30 m). To proceed for the design in such soil conditions it is worth noticing, as first step, to estimate the depth on which the loaded foundation will induce non-negligible settlement as explained in Figure 5 (Bouassida & Hazzar, 2015). Beyond the settlement depth H_{sett}, induced vertical stress by the loaded foundation are negligible, hence induced settlement are almost zero at higher depth. In other terms, there is no need to extend the length of reinforcing columns beyond depth equals to H_{sett}. Therefore, the maximum length of floating columns equals to H_{sett}.

In addition to the determination of optimized area ratio explained in the above, the design of foundations on soil reinforced by floating columns involves, in second step, the optimization of columns' length. Indeed, the length of floating columns might be lesser than Hs depending on the agreed allowable settlement of unreinforced layers located underneath the reinforced soil over depth H_c that corresponds to the length of columns.

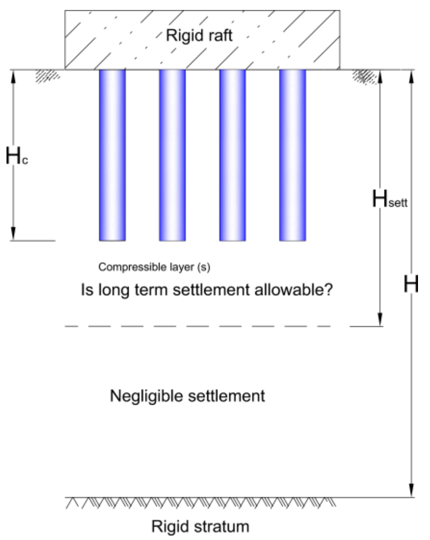

Figure 5 Reinforcement by floating columns

Based on the suggested methodology of design (Bouassida & Carter, 2014), the verification of bearing capacity (first step of the design) is carried out identically to the end-bearing columns reinforcement case. The second verification is related to the settlement. Total settlement δ_{tot} of the foundation is the sum of settlement of reinforced soil, which is assumed to occur in short term conditions due to enhanced drainage of column materials like stone columns, and the settlement of unreinforced layers. Hence:

$$\delta_{tot} = \delta_{rs} + \delta_{ur} \tag{1}$$

δ_{rs} and δ_{ur} denote the settlement of reinforced soil over length H_c and the settlement of unreinforced layer(s) of thickness (H_{sett} - H_c), respectively.

Settlement of unreinforced layer(s) represents the key issue since it often occurs in compressible layer(s), therefore a consolidation problem should be solved based on allowable residual long-term settlement. The length of floating columns should be optimized in this way: Bouassida & Debats, (2017) and Bouassida & Ellouze (2018). Two case histories are presented to show up the feasibility and efficiency of reinforcement using floating columns.

3.1 Case study n°3: Oil tank foundation on homogeneous Tunis soft clay

Collected data were from the Tunisian case history investigated by Bouassida & Hazzar (2012) and Bouassida & Carter (2014). Uniform vertical load of 80 kPa is subjected, at the surface of soft ground, by the oil tank of 20 m diameter. Tables 1 and 2 summarize the properties of Tunis soft clay layer (resting on rigid stratum) of total thickness *H* = 20 m, and columns material, respectively. The admissible total short-term settlement equals to 25 cm.

Table 1. Properties of soil layers

Depth (m)	c_u (kPa)	*E* (kPa)	γ (kN/m^3)	ν	φ (degree)	*Compression index*	*Initial void ratio*
0 – H_c	24	2000	18	0.4	0	0.6	0.9
H_c - 20	24	2000	18	0.4	0	0.6	0.9

H_c denotes the columns' length which coincides with the thickness of first sub-layer of homogeneous soft clay.

Table 2. Properties of columns material

Columns material	C_c (kPa)	E_c (kPa)	γ_c (kN/m^3)	ν_c	φ_c(deg)
Stone	0	20000	20	0.33	38
Lime-cement treated soil	150	90000	22	0.33	0

Using Columns 1.01 software, the prediction of short term settlement of foundation resting on homogeneous compressible soil, of total thickness *H*, reinforced by floating columns of length H_c requires a soil profile composed of two sub-layers having the same properties of thickness H_c and (H - H_c), respectively.

After Eq (1), total settlement of oil tank is the sum of two components: first component corresponds to reinforced soil over thickness H_c and, second is for the unreinforced soil over thickness ($H – H_c$).

Consider the two reinforcement techniques using floating either stone columns or soil treated lime-cement columns. Following the methodology of design of Columns 1.01 software, it has revealed that minimum length of floating columns is 12 m in the case of lime-cement treatment and 14 m in the case of stone columns.

Figure 6 illustrates the evolution of optimized improvement area ratio, IAR_{opt}, according to predictions by Columns 1.01 software as function of length of floating columns. From this figure it is clear that predicted decrease in IAR_{opt} is much more significant with stone columns reinforcement compared to that predicted for the deep mixing treatment. Indeed, in the range H_c = 14 m to 20 m IAR_{opt} decreases from 39 % to 14 % and from 8 to 3% for stone columns and deep mixing reinforcement, respectively.

Figure 7 shows the variations of consolidation (long term) settlement, short term settlement and residual consolidation settlement of the unreinforced soil layer in function of columns length H_c. Long term settlement is predicted by Terzaghi's one dimensional consolidation theory as detailed by Bouassida & Ellouze (2018).

From Figure 7 the length of floating columns is decided for an agreed admissible residual settlement. The residual settlement becomes negligible (i.e. less than 2 cm) from H_c = 16.5 m; hence the optimized length of columns might be chosen in the range 14 to 16 m assuming that admissible residual settlement does not exceed 5 cm in unreinforced compressible layer. Note that the French method (2005) only applies for the design (viz. settlement estimation) of stone columns, therefore the settlement of reinforced soil by the deep mixing technique is estimated using the methods proposed by Balaam & Booker (1981) and Bouassida et al. (2003) which adopt the unit cell and the group of columns modelling, respectively.

In the case of stone columns reinforcement, predictions by Bouassida et al. (2003) method provide conservative design compared to predictions by the French method (2005). The same trend is observed in the case of the deep mixing method (DMM) is considered. Indeed, Figure 8 shows that Bouassida et al. (2003) method predicts more secured design in term of settlement than prediction by Balaam & Booker's (1981) method.

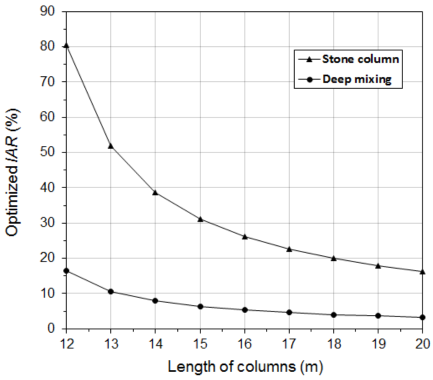

Figure 6 Variation of optimized improvement area ratio vs length of columns, case study n°3

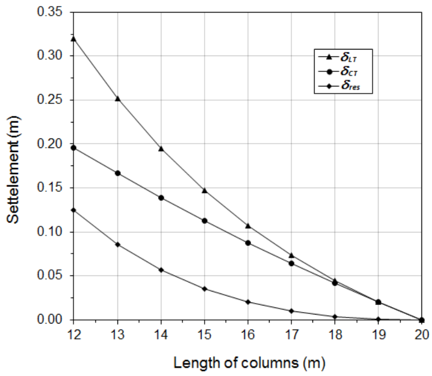

Figure 7 Variation of settlements of unreinforced soil vs length of columns, case study n°3

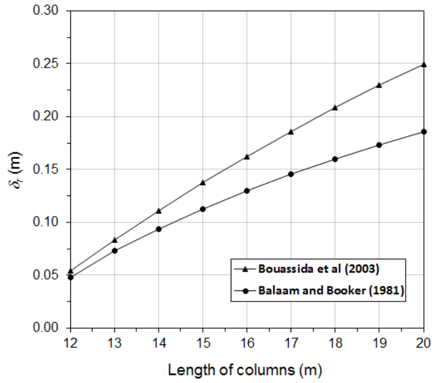

Figure 8 Estimations of settlement of reinforced soil vs length of columns, case study n°3

3.2 Case history n°4: Oil storage facility at Ghannouche (Tunisia)

The storage facility comprises two bullets of butane and five bullets of propane protected in mounded banks. Figure 9 schematizes the cross section of completely integrated embankment. Geotechnical properties of soil layers are obtained from measured CPT values during soil investigation and laboratory tests results conducted for the project. Reinforcement by stone column is suitable to reduce unallowable settlement as predicted under applied embankment load of 120 kPa. The required stability for an allowable settlement of 4 cm, over 15 years in post construction of storage facility, was agreed (Bouassida & Ellouze, 2018). Hence, significant reduction of settlement associated to the prescribed margin of security has led to the installation of floating stone columns of 11 m length, embedded in medium sand layer. Stone columns with 0.9 m in diameter were installed in triangular pattern of 1.9 x 2.2 m with IAR = 16%.

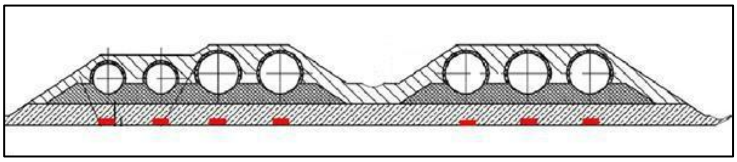

Figure 9 Cross section of whole integrated embankment

Table 3 summarizes the predictions of linear elastic settlement obtained by Columns 1.01 software for the unreinforced soil and the reinforced soil, Bouassida and Hazzar (2012). Table 3 shows quite similar predictions of total settlement by the French method (2005) and Balaam and Booker's (1981) one. Although these two methods do not take account of the improvement of the initial soil, settlement reduction closes one third by the installation of floating stone columns. Further, the use of Columns 1.01 software has confirmed that the optimized IAR, which verifies the allowable settlement of 4 cm, is 15.39 %. This prediction is close to the practiced reinforcement for the project that was 16%.

Table 3. Predictions of linear elastic settlement of embankment on reinforced soil (Bouassida, 2016a)

Layers	Thickness (m)	Settlement of unreinforced soil (cm)	Settlement of reinforced soil (cm)	
			Balaam & Booker (1981)	French method (2005)
Gypsums sand	2.5	0.5	0.26	0.25
Silt sand	6.5	6.83	1.34	1.53
Medium cemented sand (1)	5.5	0.54	0.37	0.41
Medium cemented sand (2)	7.5	3.58	1.18	1.35
Compacted fine sand	6.0	0.41	0.41	0.41

Numerical simulation of embankment behavior was carried out by Plaxis 2D software. Built plane strain model comprises a 6 m height embankment founded on the soil profile shown in Figure 10. After project data, 46 stone columns were installed along the horizontal direction, with axis to axis spacing of 1.9 m, and 30 stone columns were installed, along the perpendicular direction, with axis to axis spacing by 2.2 m, over 64 m length. The group of stone columns is modelled by a group of equivalent trenches to simulate the behavior of reinforced ground in plane strain condition, (Klai et al., 2015). Then, the equivalent thickness of a trench, b_{tr}, is determined from Eq. (2):

$$b_{tr} = \frac{30}{64}\pi a^2 \qquad (2)$$

“a” denotes stone column’s radius

Forty-one trenches of stone material are considered in the numerical model with dimensions: thickness: b_{tr} = 0.3 m; length: H_c = 11 m; spacing between edges of trenches: s’ = 1.9 m (Klai et al., 2015). The behavior of soil layers is described by the elastic perfect plastic Mohr-Coulomb constitutive law with parameters given in Table 4 (Bouassida, 2016a). Adopted characteristics of column material are: γ_c = 20 kN/m^3, ν_c = 0.33, E_c = 60,000 kPa; φ_c = 40°; C_c = 0.005 kPa.

Table 4. Geometrical parameters of soil layers and embankment material

Layers	Height / Thickness [m]	Young Modulus [MPa]	Cohesion [kPa]	Friction angle [°]	Total unit weight [kN/ m^3]
Backfill material	6	10	1	30	20
Fine sand	2.5	30	5	30	19
Soft silt clay	6.5	5.7	2	24	18
Firm clay	5.5	60	2	24	19
Silt clay 1	7.5	12	15	10	18
Stiff clay 2	6	80	2	24	20

The numerical simulation of embankment with staged construction comprises four phases. The first phase consists of 30 days consolidation analysis that occurs upon the installation of stone columns within the compressible layers. Then, a partial horizontal consolidation is triggered that dissipates the induced excess pore pressure and leads to uniform consolidation settlement within the compressible layers. The second and third phases of numerical staged construction also consist of consolidation analysis which corresponds to loadings applied upon the execution of first and second embankment layers, respectively. A consolidation analysis is run for each loading embankment layer during 120 days and 270 days, respectively.

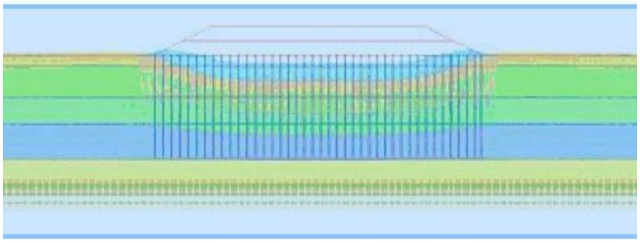

Figure 10 Geometry of numerical plane strain modelling of reinforced soil

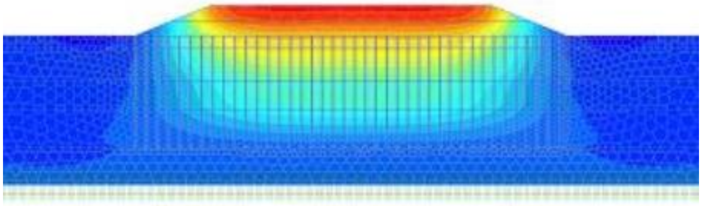

Figure 11 Contours of vertical displacements of the embankment facility on reinforced soil by stone columns subjected to a uniform load of 120 kPa.

Figure 11 shows the contours of vertical displacement with maximum value of settlement equals 8 cm at upper crest of embankment facility. Whilst, at the surface of reinforced soil, the predicted settlement is almost uniform of value 6 cm over the width of upper crest beneath the embankment. Consolidation settlement of magnitude 6.5 cm was predicted to occur in four years.

The follow up of behavior of storage facility built on reinforced ground by floating stone columns was performed by means of data acquisition unit connecting the pressure sensors, to record the evolution of settlements, located at the surface of reinforced ground (Bouassida, 2016a).

The first measured settlements induced by the acquisition unit data occurred in post construction of the backfill, and, then, stabilized when the data acquisition measurements started.

The evolution of measured settlement in function of time at profile PR02 are plotted in Figure 12. The recorded settlement after the installation of the first backfill layer varied between 1.0 and 1.7 cm and, then, were stabilized after a period of 30 days. After the completion of the entire embankment the magnitude of measured settlements was less than 3.0 cm. Based on this observation it is confirmed that the stone columns reinforcement experienced at Gannouche' site fulfilled the requirement of admissible consolidation settlement that was less than 3.5 cm.

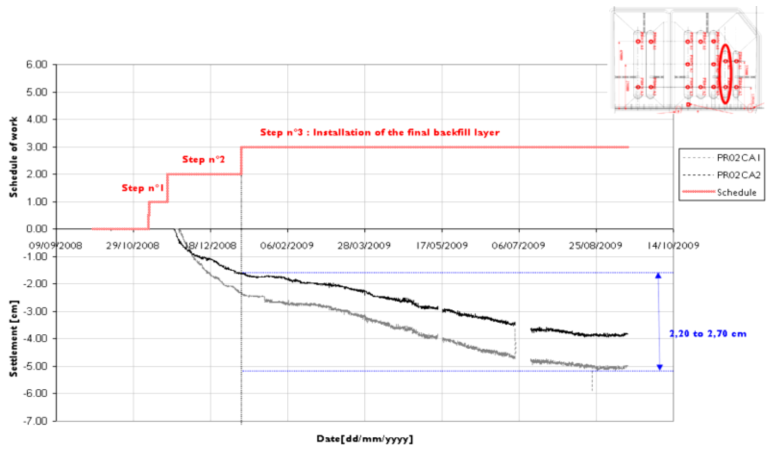

Figure 12 Evolution of measured settlement vs. time at location PR02 (Bouassida, 2016a)

The last phase of numerical staged construction also included consolidation analysis which corresponds to the final height of embankment. This phase simulates the long-term behavior fifteen years after the construction of storage facility. It is noted during the progress of stage construction of embankment, the settlement significantly increases in different locations and, then, it becomes almost uniform within the allowable limit of settlement that is 4 cm. This long-term settlement corresponds to the induced deformation within unreinforced sub-layers. After Bouassida & Hazzar (2015), the settlement of reinforced layer which depends on the length of columns, is accelerated by the drained columns' material, hence it is completed at the end of embankment construction.

Investigation of Ghannouche case history well demonstrated the usefulness of floating stone columns reinforcement as no residual consolidation settlement, occurred in the unreinforced sub-layers.

It is, then, concluded that the design of foundation of bullets of butane and propane integrated into an embankment on compressible layers reinforced by stone columns was successful. Indeed, this design permitted to comply with the allowable settlement of the foundation over fifteen years as predicted by the numerical computations. Those predictions revealed in acceptable agreement with the measured settlement that remained under 4 cm over 15 years.

4. Concluding remarks

This paper addressed the optimization of design of foundations built on soil reinforced by columns. Two reinforcement options were studied; first, for end-bearing columns, and, second, for floating columns. On the basis of recent methodology of design considering the group of columns modelling and combining verifications of BC and settlement, four case histories were investigated. Main findings from the obtained results led to the following insights.

1. In the case of end-bearing columns, based on allowable settlement of reinforced soil, the unique optimization is restricted to the IAR that can be predicted for two cases. First case, when the properties of initial soil are not affected by the installed columns, and the second case is concerned with the improvement of initial soil characteristics, like for the stone columns technique. Analysis of oil tank case history well illustrated that recent methodology of design enables to significantly reduce the IAR, compared to existing methods. Further, recorded settlements permitted to estimate the rate of improved Young modulus of loose silt sand from which another gain on IAR is potential.
2. Simulation of stone columns installation by lateral expansion was implemented by Plaxis 2D software. The use of composite cell model and reduced group of stone columns for two case histories showed up how the Young modulus of soft clay is enhanced after running horizontal consolidation implemented by the numerical "dummy material" procedure. The extent of improved zone in soft clay was estimated from which the IAR can be optimized.
3. The behavior of oil tank case study on Tunis soft clay layer of 20 m thickness reinforced by floating columns was analyzed. For prescribed allowable short settlement a minimum length (equal to 12 m) of floating columns is identified. Further, for prescribed residual (long-term) settlement of 3 cm it was proven that reinforcement by floating stone columns of length 15.5 m well complies with tank stability.
4. Fourth case history was dedicated to the reinforcement by floating stone columns of compressible layers at Ghannouche site (Tunisia). Stage construction of storage facility, comprising two bullets of butane and five bullets of propane protected in mounded banks, was simulated by Plaxis software in four phases. Using an equivalent 2D modelling of reinforced ground by floating columns of length 11 m the study of behavior of storage facility showed up that the prescribed residual settlement, occurring after the end of stage construction, did not exceed 3.5 cm as observed from recorded settlements. This prediction fulfilled the required value of residual settlement equals to 4 cm over fifteen years.

   Throughout investigated case histories it is concluded that optimizing the design of foundations on soils reinforced by columns is necessary to provide cost-effective ground improvement solutions, however the related techniques are considered cost-effective when compared, for instance, to the classical pile foundations.

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Abbreviations

BC: bearing capacity**,** IAR: improvement area ratio**,** SC: stone column(s)**,** HSM: hardening soil model

◆ A Brief CV of Prof. Mounir Bouassida

M. Bouassida is a professor at the National Engineering School of Tunis of the University of Tunis El Manar where he earned his B.S., M.S., Ph.D., and doctorate of sciences in civil engineering. He is the director of the Geotechnical Engineering Research Laboratory, focusing on soil improvement techniques and behavior of soft clays. Dr Bouassida elaborated a novel methodology for the design of foundations on reinforced soil by columns. He was awarded the 2006 Prakash Prize for Excellence in the practice of geotechnical engineering. Dr Bouassida is the advisor of consulting office, SIMPRO he founded in 2008. He is a co-developer of the software Columns 1.01 used for the design of column-reinforced foundations. Prof. Bouassida held the office of the vice president of ISSMGE for Africa (2005–2009). He is an appointed member of the ISSMGE (2017-2021).

IPA News Letter Volume 3, Issue 3 September 2018

Report
The worst water-related disaster in Japan since 1982

Masafumi Yamaguchi, IPA Secretariat
Takamasa Takeuchi, GIKEN LTD.

Severe torrential rain has continued over wide areas of western and central Japan, as well as Hokkaido, during the period of June 28 to July 8, triggered by Typhoon No.7 and the activated Bai-u front (seasonal rain front). Heavy rain has caused devastating flooding and mudslides, killing 220 people and missing 11 people, spreading over 14 prefectures as of August 5 (Figure 1). In all, two million people were evacuated. This is the Japan's worst water-related disaster since 1982 in Japan, when a great water-related disaster occurred in Nagasaki Prefecture, Kyushu, where nearly 300 people were killed or lost.

The most devastated regions are in western Japan: Chugoku and Shikoku regions. Accumulated amount of the precipitation over those 11 days has reached as high as 1,800 mm in the Shikoku region, and 1,200 mm in the Chugoku region, while many meteorological observation stations recorded the highest precipitation per 48 hours or per 72 hours ever in their observational histories. This unprecedented torrential rain caused damage to 48,250 houses, sediment-related disaster to 1518 locations, and river levee failures due to overflow in many places.

The Japanese Geotechnical Society (JGS), of which President is Professor Jun Otani, IPA Director and Chair of TC3, immediately responded by sending their members to the affected areas in order to investigate each situation and their possible causes, in particular, related to geotechnical disasters; landslide, debris flow and river bank failure. At the Annual Meeting of the JGS on July 25, the JGS called for an urgent meeting to report the information gathered by the various investigating teams. The conference room, with a capacity of more than 800, was almost full of the audience (Photo 1). During the meeting, participants were apprised of the serious damage and learned some technical information (i.e. case studies, countermeasures). At the end of the meeting, Professor Otani told those present that the JGS will conduct further investigations and determine a course of action to this disaster.

Note: The second JGS meeting is scheduled to be held in Tokyo on September 12, 2018.

Disaster mitigation is also one of the International Press-inn Association (IPA) missions, so we must cooperate with the JGS, and re-consider traditional concepts of suitable countermeasures for torrential rain.

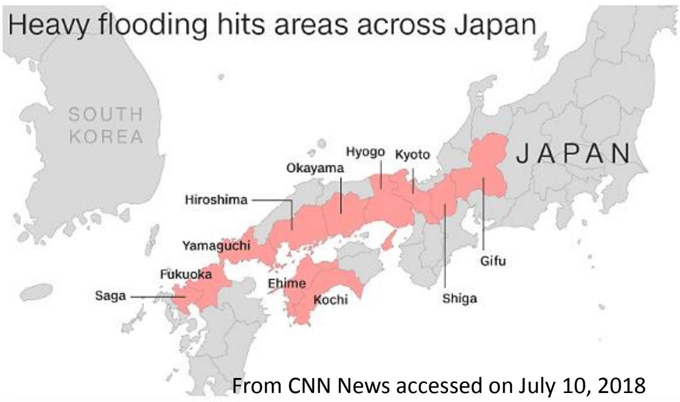

Figure 1 Fourteen prefectures suffered in Japan

Photo 1 The conference room was almost full of over 800participants.

The Investigation Report by the GIKEN Team

GIKEN LTD., which is an IPA corporate member, sent a team to examine the damage in Okayama and Hiroshima Prefectures, and to find out the possibility of utilizing Press-in Technology to be used in the restoration works related to the failure of river levees. They investigated fourteen damaged areas for three days from July 18 to 20 and reported on them in detail. Hereafter, some of them are introduced.

1. Saka-cho Nishi, Aki-gun, Hiroshima Prefecture (Ohshiro-ike Reservoir) … Figure 2

The reservoir dike, which is located upstream, collapsed. After the dike collapsed, debris, driftwood flowed into the lower basin. In the lower basin, driftwoods were caught on a bridge and at river curves, and the damage extended because the debris overflowed (Photo 2 & Photo 3).

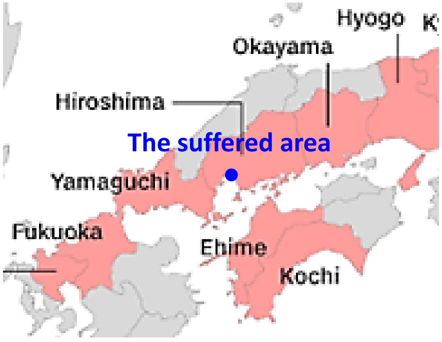

Figure 2 Saka-cho Nishi, Aki-gun, Hiroshima prefectures

Photo 2 Driftwoods were caught on a bridge

Photo 3 The situation after the flood and mudslide

2. Mabi-cho, Kurashiki-shi, Okayama Pref. (Oda River, Suemasa River) … Figure 3

The water of the Oda River, which is a side stream, was dammed up when it joined up with the Takahashi River, which is the main stream, and a "backwater phenomenon" occurred. Because the water level suddenly rose, the Oda River embankment collapsed near the place where the both rivers join, which caused serious inundation damage to the whole area of Mabi-cho. In addition, there was a collapse of the embankment of Suemasa River, which is a sidestream of the Oda River. It was inferred that the embankments were scoured by the overflow due to the heavy rain. Removal and recovery work by the the Ministry of Land Infrastructure, Transport and Tourism (MLIT) and the Self Defense Forces of Japan (SDF) was carried out (Photo 4). At the collapsed embankments, tentative recovery work with the double steel sheet pile structure was done (Photo 5).

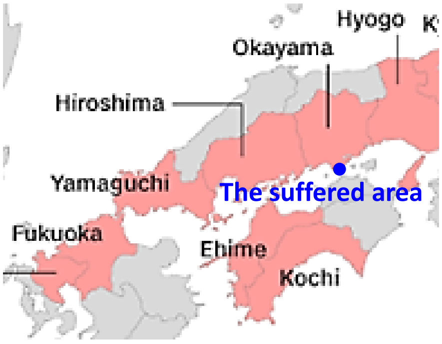

Figure 3 Mabi-cho, Kurashiki-shi, Okayama Pref.

Photo 4 Removal activity by SDF

Photo 5 Tentative recovery work with steel sheet piles structure

Report Summary

- A lot of bridges were washed away, which is assumed to have been caused by debris flow.
- It was confirmed that there were failures of back slopes which were not caused by overflows in reservoirs and river banks. Due to heavy rain over a short period, it is inferred that they were in a condition where the erosion of the bank body and seepage failures were likely.
- There were many places which presented problems of access as the road was either too narrow or there was only one way. Furthermore, main roads such as national roads or prefectural roads were also severely damaged by debris flow. It was made clear that, in the case of a large-scale disaster like this one, how to secure roads for carrying machinery and materials at the time is a major problem.
- We found that, at the places where river banks collapsed, not only the restoration work, but also improvement work with double steel sheet piles were carried out. It is assumed that the countermeasures were prepared in advance, from the fact that the period from failure to restoration was very short, approx.10 days. There is a possibility that a similar structure will be adopted in places where there are high risks of future flood disaster.
- In the case of proposing restoration work to the implant structure, a significant concern is the speed of supplying materials. The above-mentioned concern might be mitigated by concluding disaster agreements (including methodology, materials) with the national and local governments in advance.

Report
New president of Japanese Geotechnical Society (JGS), Professor Jun Otani

Associate Professor Kiyonobu Kasama
Kyushu University

Prof. Jun Otani has designated as the 35th president of the Japanese Geotechnical society JGS since June 6th in 2018. He is a Professor of Soil Mechanics and Geotechnical Engineering at Kumamoto University Japan and also a Vice Director of International Research Organization for Advanced Science and Technology (IROAST). He is also the Director of IPA and chair of TC-3 (Expansion of Applicability and Assessment of Seismic Performance of PFS Method).

After he received Master Degree in Geotechnical Engineering at Nagoya University, Japan in 1983, he moved to the USA as a Ph.D. student at the University of Houston in 1984 and later, received his Ph.D. from the University of Houston. His research career started as a postdoctoral fellow at the Scripps Institution of Oceanography, the University of California, San Diego in 1987. Then, he moved back to Japan and got the position of the research associate at Kyushu University in the same year. Later in 1993, he moved to Kumamoto University as the Associate Professor at the Department of Civil and Environmental Engineering and in 2001, he became a full professor at Kumamoto University. In fact, he was a Director of International Student Office and also the Dean of Graduate School of Science and Technology at the same university. And now, he is not only the professor but also a Vice Director of International Research Organization for Advanced Science and Technology.

His research interest is firstly pile foundation which is his Ph.D. topic at the University of Houston. Later when he was at Kyushu University, he started to work on soil reinforcement. In fact, he was a core member of so called "IS Kyushu" which is the earth reinforcement conference from 1988 to 2007 for 5 times. Then, he started a new research topic in geotechnical engineering which is the application of X-ray CT in geomechanics and geotechnical engineering in 1996. He had a unique international workshop on the application of X-ray CT for Goematerials for the first time ever in geotechnical engineering.

He has done some works under the International Society for Soil Mechanics and Geotechnical Engineering ISSMGE, in which he was the Secretary of Asian technical committee ATC and technical committee TC9 (topic on Earth Reinforcement) whose chair was Emeritus Professor of Kyushu University, Prof. Hidetoshi Ochiai from 1995 to 2005. Recently, he was a Chair of the 15th Asian Regional Conference on Soil Mechanics and Geotechnical Engineering in Fukuoka 2015 and this was a great success having total of 1000 participants in ARC history.

Picture 1 Meeting of IPA TC3

As his career of the president of JGS, he has pointed out following terms of reference:

1. To internationalize the JGS and those members as one of the members society under ISSMGE with sustainability of human resources;
2. To promote the development of new technology and to take care of disaster prevention and reduction; and
3. To pursue the social contribution as a Public Interest Incorporated Association in Japan.

On-site Interview

Construction of underground bicycle parking (Eco Cycle) in Sumida ward, Tokyo

Ms. Hongjuan He

IPA Secretariat

I visited the construction site of the underground bicycle parking system at the vicinity of the JR Kinshicho Station on August 2, 2018. I met Messrs. Yohei Nakayama and Mizuho Yokoyama of GIKEN SEKO CO., LTD. there and interviewed them. I sincerely appreciated that they shared a very valuable information with me.

Illustration 1 - Illustration 4 are the images of completion

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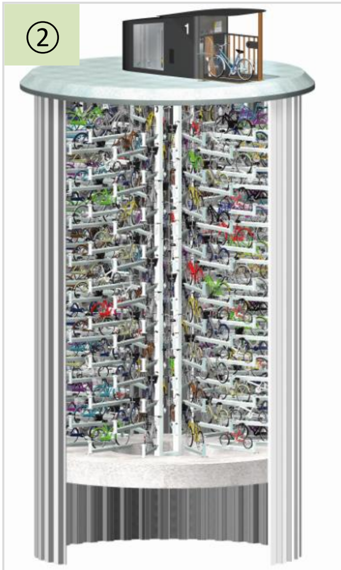

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Construction Sequence

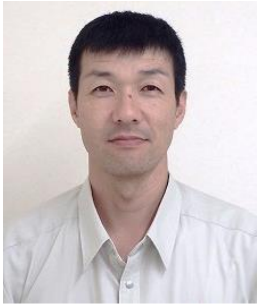
1. Installing piles to form the cylindrical wall

2. Excavation of soil from the cylinder

3. Installation of the Parking Machinery

4. Fixing the entrance booth

Profile of Mr. Yohei Nakayama, Assistant Manager of GIKEN SEKO CO., LTD.



Mr. Nakayama Joined GIKEN Group in April 1996 and have worked on the Press-in construction projects including Hard Ground Press-in Method and Gyropress Method for 19 years. This is his 13th experience on the underground bicycle parking project and he is assigned as the operational manager.

Qualifications: The certified First-class Civil Engineering works Execution managing engineer and the Supervising Engineer in construction

Profile of Mr. Mizuho Yokoyama, Assistant Manager of GIKEN SEKO CO., LTD.

Mr. Yokoyama Joined GIKEN Group in April 1997 and has worked on the Press-in construction projects including Hard Ground Press-in Method and Gyropress Method for 19 years. This is his 12th experience on the underground bicycle parking project and he is assigned as the Chief Operator.

Qualifications: The certified Second-class Civil Engineering works Execution managing engineer and the First-class Press-in technician

Q1. Please explain me about the background and overview of this project.

Mr. Nakayama: Many illegal parking bicycles have found in the vicinity of JR Kinshicho station. Those are not only interfering pedestrians and emergency vehicles traffic but also causing social problems by impairing town's landscape. This area is congested with many commercial facilities and residential houses around the station so that it is difficult to build parking facilities above ground. These are main reasons why the underground mechanical bicycle parking system (ECO Cycle) was adopted. This underground bicycle parking system will accommodate 456 bicycles in two units. Construction period is scheduled in 8 months between June 2018 and February 2019. We hope this project will contribute to decrease the number of illegal parking bicycles substantially and a safe and comfortable walking space will be secured upon completion.

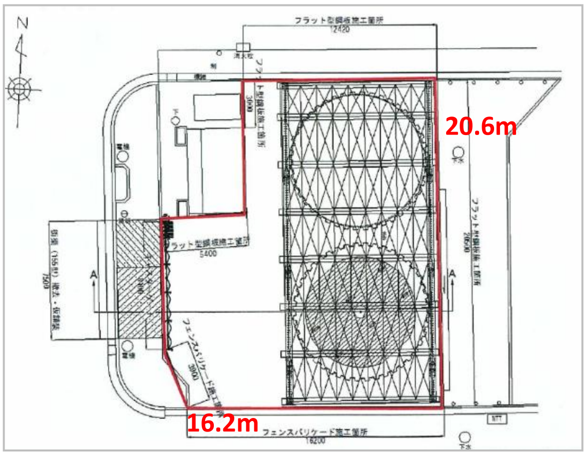


Figure 1: Site plan

Q2. What are the features on this project?

Mr. Yokoyama: There are two remarkable features. Firstly, the construction is carried out in a tight space with 20.6 m by 16.2 m surrounded by commercial facilities, residentials and roads (Figure 1 and Photo 1). 640mm width of Hat-shaped steel sheet piles in 18.2m long are installed in the project. The length of the steel sheet piles is almost equivalent to the width of the construction site, therefore placement of construction materials and equipment have to be properly arranged on the site with the progress of the project. Secondly, the sheet pile installation is carried out in a circular shape by utilizing a special made press-in machine. This special made press-in machine is the only one our company owns and the angles of the clamp and the chuck are adjusted along the arc of the circular installation, and the piling is carried out in a clockwise direction (Photo 2).

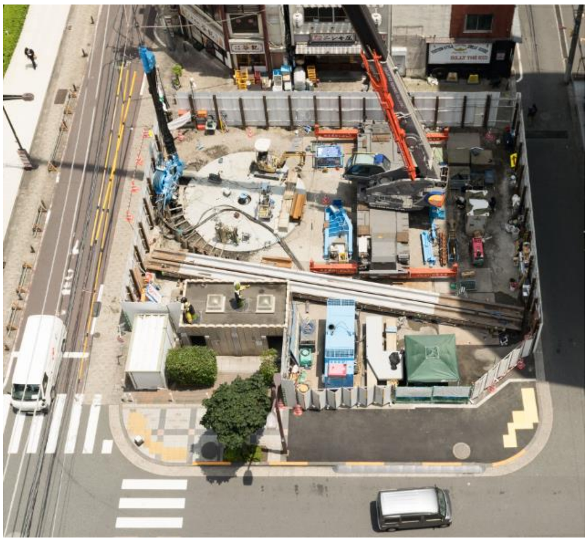


Photo 1 A view of Construction

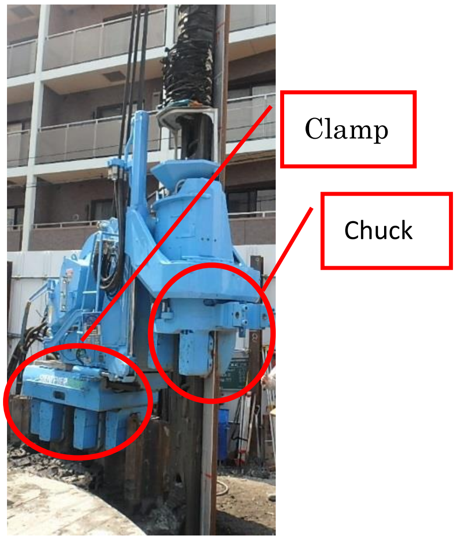


Photo 2 Silent Piler for Eco Cycle

Q3. Looking at the soil boring log, the site does not seem a stiff ground. Why is the augering system adopted?

Mr. Nakayama: There are two reasons. Firstly, the steel sheet piles in 18.2 m length are used in the project. With the repeated up-and-down stroke motions in the press-in operation, the longer sheet pile toe has tendency to be distorted during installation. Generally, there is the difficulty to manage the pile toe in a right position by dealing with the longer pile. The distortion of sheet piles is suppressed when the Pressing-in operation is assisted with the simultaneous augering, so that the position of the pile toe can be well controlled accurately (Photo 3). Secondly, we encountered underground obstacles which are not reflected in the SPT N-value in the soil boring log. Those obstacles have been left over in the ground due to the Great Kanto Earthquake in 1923. To protect pile materials from being damaged and to ensure accuracy in piling, the Press-in Method assisted with augering was adopted.

Photo 3 Checking distortion and verticality

Q4. What kind of measures did you take to prevent groundwater seepage from the interlocking of the steel sheet piles?

Mr. Nakayama: Expansive rubber water cut-off seal is securely mounted on the interlocking joint of the sheet pile at the factory in advance (Photo 4). To prevent water cut-off seal absorbing water like rain water prior to installation, the sheet piles are properly wrapped with waterproof materials and transported to the site. The rubber water cut-off seal expands by absorbing groundwater after the installation, then it prevents groundwater seepage thereafter. This measure is a unique application steel sheet pile to interlockings developed by our group company, GIKEN LTD.

Photo 4 rubber water cut-off seal

Q5. What was the most difficult problem in this project? How did you solve it?

Mr. Yokoyama: The most difficult thing was to control the curved sheet piles alignment. Forty-four (44) sheet piles are installed as a unit of bicycle parking system. All of the 44 sheet piles are installed with different angles due to a circular shape. Further, the actual products are not accurately uniformed with 640 mm width as the catalogue data because of the product dimensional error. To make a circular enclosed coffer dam with 44 sheet piles, it is necessary to decide the placement of each sheet pile one by one for a resultant radius of the circle. In other words, angle and position of each 44 sheet pile are determined by the measured width, then the radius and circumference of a circle shall be determined accurately. At the site, a pile laser and a steel wire with a length of the radius are set up on the control platform located at the center of the circle, and the laser is radiated on the point measured by the steel wire. The forward angle and location of each sheet pile are determined with this way, and the press-in operation is carried out, putting emphasis on the construction accuracy (Photos 5 & 6). Placement of materials and equipment are also decided from the planning stage, while a construction plan is made, including how the piles used should be stuck up.

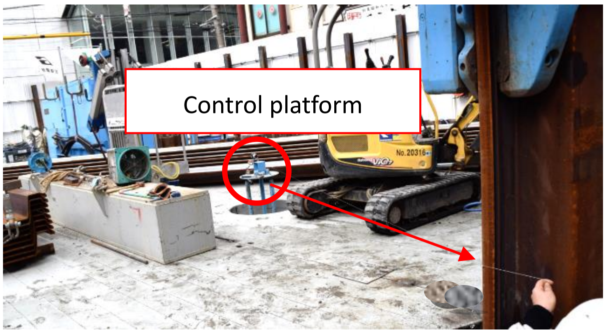


Photo 5 Control platform

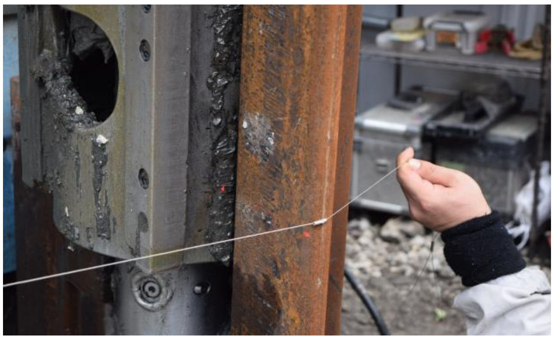


Photo 6 Checking sheet pile position with the Piler laser

Q6. What was the most difficult and challenging site for you through your career?

Mr. Yokoyama: One-third of the Miyako-city in Iwate prefecture experienced serious disaster, due to the gigantic tsunamis occurred by the Great East Japan Earthquake in 2011. I was assigned to the site in Miyako-city in 2013 and took charge of a foundation construction of the disaster restoration work to build the 165 m wide flood control gate at the mouth of a river. The existing bedrock was found in shallower depth than expected during construction, and piles with a prescribed length had to be penetrated in to the bedrock. This seriously affected the progress of the construction duration. I was an under the extreme pressure to penetrate piles into stiff rock with very tight construction schedule. The issue has been studied and the prime contractor finally confirmed that "As long as enough bearing capacity is ensured, it is not necessary to embed the piles into ground with planned length." As the conclusion, we ceased piling by ensuring an appropriate embedded length after the piles reached the bedrock. We have learned that the making a right decision in a timely manner is very essential as well as the improvement of construction understandings and skills for a disaster restoration work in particular.

Mr. Nakayama: I worked on the underground bicycle parking system like this project in front of the JR Chiba station in 2008. It was my first experience to conduct duties on site management. Since our company was the prime contractor for the project, I was in a position to assist the construction management. I could get to learn how to manage construction site little by little through valuable advices from experienced seniors parallel to daily work. There was the restaurant belowground next to the construction site. The restaurant owner filed complaints with respect to noise and vibration during the construction. I negotiated with him as the site administrative manager and took some measures including adjustment of construction time schedule to minimize the effect to restaurant's business. I strongly felt, as the site administrative manager that it was very important to have a good site management programme to carry out a safe and smooth construction together with a good technical skill required in construction.

Q7. What is your view on how the young engineers and technicians should be trained?

Mr. Yokoyama: I feel some gap between young engineers and my generation now a days. However, I think it is important to train people for their needs, in a way goes with the times. We always tell them that the most important thing on site is safety, and we should carry out a risk prediction activity every day prior to the start of the daily work. We instruct them to predict risks in advance and carry out construction activities safely. It is important to train them in the technical parts, but the first priority is always safety.

Q8. What is your view on the future of the press-in technology?

Mr. Nakayama: As Japan heads for an aging society, the number of workers is gradually decreasing. I think the complete automation of the construction machinery could solve the problem of manpower shortage. In particular, the construction of ECO Cycle in which a high construction accuracy is required has high potential to be automated. To obtain accuracy required for coffer dams built in a circular shape, construction accuracy with high precision of positioning is required. I think automated operation of machinery will surely be helpful.

Mr. Yokoyama: Japan is a country with lots of natural disasters such as earthquakes and tsunamis. Very dangerous in sites after a disaster, since it is unknown when the secondary disaster will take place. Safe construction is considered possible, with remotely-controlled operations in a place away from the disaster area. I am hoping that if remote-control operation becomes possible, we can secure safety of the operators in the positive applications of press-in technology in disaster restoration works.

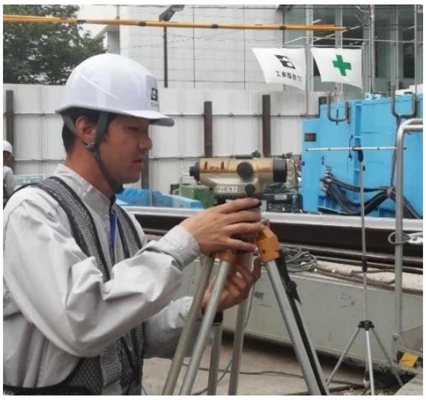


Photo 8 Mr. Nakayama is checking alignment with laser.

Photo 9 Mr. Yokoyama is operating the Piler.

★ Editorial notes：

Prior to the interview, we had paid attention to the function and convenience of the underground mechanical bicycle parking system from the users' point of view. But we found out through the interview that a high accurate planning and execution were required on actual construction sites.

We would like to thank the two persons we interviewed and other staff members for their cooperation.

Report

History of Cambridge – GIKEN collaboration research (Part3)

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 2010 to 2018 are presented.

[2010-2011]

Project title	:	Reduction of penetration resistance during rotary press-in
Outline of tests in Kochi	:	Two types of piles were used in this project: a closed-ended tubular pile with an outside diameter of 318.5 mm and an open-ended tubular pile with an outside diameter of 500mm. The closed-ended pile was installed by standard press-in and rotary press-in at different penetration rates and rotation rates. It was found that the base resistance was reduced by increasing the penetration rate, showing a trend explained based on Finnie factor, in which the rate effect is attributed to the drainage condition. The rotation was confirmed to reduce the shaft resistance significantly but have little influence on the base resistance. The reduction of the shaft resistance was greater at larger velocity ratio (the ratio of the rotation rate to the penetration rate). This was attributed to a more horizontal direction of friction mobilized at the pile-soil interface. On the other hand, the extent of plugging was not mitigated by rotation; the length of the soil column inside a pile installed by rotary press-in was not shorter than that installed by standard press-in. This was concluded to be due to the difference in the ground condition.
Main students	:	Thomas Bond and Travis Winstanley
Related publications	:	Bond, T. 2011. Rotary jacking of tubular piles. M.Eng. Project Report, Cambridge University Department of Engineering, 50p. Nishigawa, M., Okada, K., Bond, T., Yamane, T., Ishihara, Y. and Kitamura, A. 2011. Reduction of friction in rotary jacking. Proceedings of the 3rd IPA International Workshop in Shanghai, Press-in Engineering 2011, pp. 107-113.

[2011-2012]

Project title	:	Spatial distribution of pore water pressure during press-in
Outline of tests in Kochi	:	Three closed-ended piles with the outside diameter of 318.5mm were used in this project. Each pile was equipped with a load cell on its base, 5 pore water pressure transducers and 5 earth pressure transducers on its shaft. Two of the piles were used as measurement piles while the other one was pressed-in as a test pile, as shown in Figure 1. The distance between the test pile and the measurement piles were maintained either as 1, 2, 3 or 5 times the outside diameter of the piles. During press-in, the pore water pressure measured by the measurement piles increased to its peak value until the pile base passed the depth of the transducers, and then started to decrease to a residual value. It was confirmed that the spherical cavity expansion analysis provides a lower bound of the peak values of pore water pressure during press-in.
Main students	:	Travis Winstanley and Ewa Hazla
Related publications	:	Winstanley, T., 2012. The significance of pore water pressures on press-in piles. M.Eng. Project Report, Cambridge University Department of Engineering, 50p.

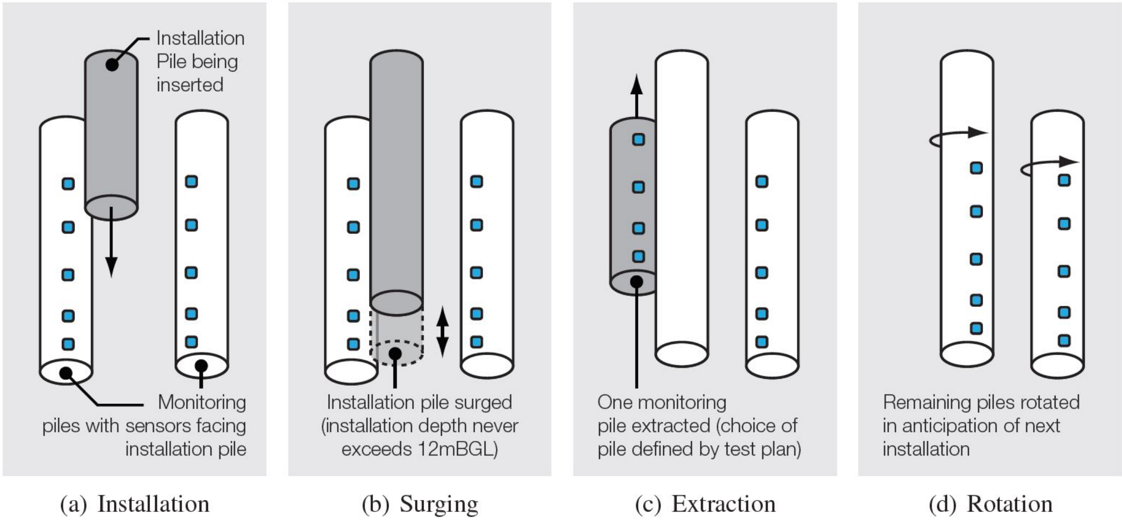


Figure 1 (from Winstanley (2012))

[2012-2013]

Project title	:	Reduction of friction during rotary cutting press-in of an open-ended tubular pile in sand
Outline of tests in Kochi	:	Open-ended tubular piles with the outside diameter of 800mm were used in this project. The piles were installed into a dense sandy ground by rotary cutting press-in method. When the pile was processed to have surface projections, which had been expected to be effective in reducing the shaft resistance, the penetration resistance was greater than when the pile did not have the surface projections, which was contrary to the expectation. When the non-processed pile was continuously rotated at a constant depth, the rotational torque did not keep decreasing with an increasing rotational displacement. This result was in contrast with the results confirmed in the previous year that the rotational torque decreased by around 50% with an increasing rotational displacement when a pile with the outside diameter of 318.5mm embedded in a soft alluvial ground was rotated at a constant depth.
Main students	:	Ewa Hazla and Gongyan Gao
Related publications	:	Hazla, E., 2013. Rotary press-in piling in hard ground. M.Eng. Project Report, Cambridge University Department of Engineering, 50p.

[2013-2014]

Project title	:	Performance of steel sheet pile walls
Outline of tests in Kochi	:	Three types of cantilevered sheet pile walls were dealt with in this project. One was the 'Normal wall' in which sheet piles were embedded vertically. Another was the 'Slanting wall' where sheet piles were embedded with the inclination angle of 5 degrees. The other was the 'Implant preload wall' in which sheet piles were embedded with the inclination angle at their base of 5 degrees and were elastically deflected toward the excavation side, as shown in Figure 2. When the backside surcharge was applied to the wall, the horizontal displacement of the walls was the largest in the Normal wall and the smallest in the Implant preload wall. Two underlying mechanisms were inferred. One was that the horizontal loading history on the soil in the excavated bottom associated with the horizontal displacement of the wall due to the preload increased the stiffness of the soil when it responded to the second loading process associated with the backside surcharge. The other was that the shear strength of the soil behind the wall was enhanced due to the increased confinement stress associated with the elastic deflection of the wall.
Main students	:	Gongyan Gao and Glyn Stevens
Related publications	:	Gao, G., 2014. Comparing performance of different sheet pile walls. M.Eng. Project Report, Cambridge University Department of Engineering, 50p.

Ishihara, Y., Ogawa, N., Okada, K. and Kitamura, A., 2015. Implant Preload Wall: a novel self-retaining wall with high performance against backside surcharge. Proceedings of the 5th IPA International Workshop in Ho Chi Minh, Press-in Engineering 2015, pp. 68-82.

Ogawa, N., Ishihara, Y. and Kitamura, A., 2017. Experimental study on deformation of self-retaining sheet pile wall due to excavation and backside surcharge. Journal of Japan Society of Civil Engineers, Division C: Geotechnics, pp. 62-75. (in Japanese)

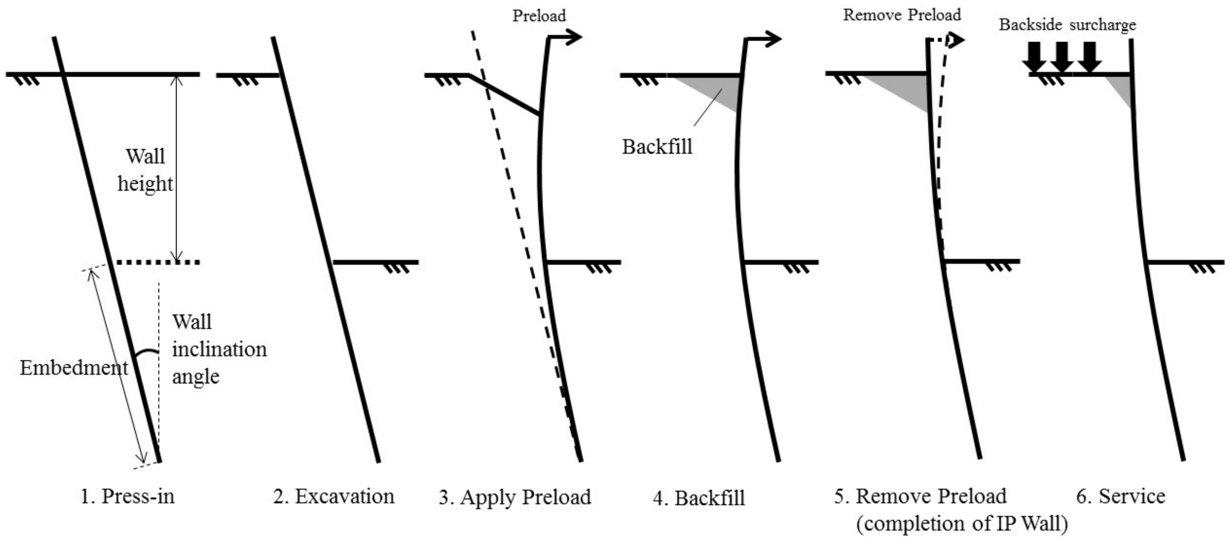


Figure 2

[2014-2015]

Project title : Mechanism of water-binding during rotary press-in in dense sand

Outline of tests in Kochi : Water-binding is a phenomena that is sometimes encountered when installing a pile in sand assisted with water injection. Muddy water coming up to the ground surface along the pile shaft, which will be observed when a pile is being installed smoothly, is lost and the penetration resistance suddenly increases. To investigate into the mechanism of water-binding, a circular and a semi-circular model piles with the outside diameter of 48.6mm and a soil tank with the width and the horizontal depth of 1000mm and the depth of 1200mm were used in this project. The soil tank had an acrylic plate on one of its four sides, and a saturated model ground was prepared inside the soil tank by mixing a saturated silica sand #7 using a stirring bar. The semi-circular pile was pressed-in assisted by water injection against the acrylic plate, so that the penetration process can be visualized. The circular pile was installed by rotary press-in assisted by water injection at the center of the model ground, with different penetration rates, rotational rates and flowrates to confirm the conditions on which the water-binding is triggered. From the tests using the semi-circular piles, the process of the creation of 'interface liquefaction' and the disappearance of it (i.e. water-binding) was observed, and the three parameters were identified as critical for sustaining the interface liquefaction: the water pressure at the pile shoulder, the water pressure required to sustain the interface liquefaction and the flowrate available for interface liquefaction. An analytical model was proposed by assuming that the cause of water-binding is the sufficient pressure in the liquefied region to transmit all water though the pores, and was confirmed to be able to predict the depth of water-binding correctly for saturated sand.

Main students : Glyn Stevens and Andrei Dobrisan

Related publications : Stevens, G., 2015. Mechanism of water binding during press-in in sand. M.Eng. Project Report, Cambridge University Department of Engineering, 50p.

[2015-2016]

Project title : Verification of the resilience of Implant levees against tsunami

Outline of tests in Kochi : Two sets of experiments were carried out in this project. One was to investigate the horizontal load imposed by tsunami on a wall in an overflowing condition, by means of model tests using an experimental facility called the Tsunami Simulator, as shown in Figure 3. The other was a static horizontal load tests on two piles with the same outside diameter of 1000mm and different thicknesses of 12mm and 24mm, to observe the deformation characteristics of piles embedded in dense sand beyond its elastic limit. The results of the model tests showed that the tsunami load in an overflowing condition can be safely estimated by an existing estimation method, excluding instantaneous loads measured when the model tsunami hit the wall. Based on the results of the load tests, it was confirmed that the stiffness and bending moment profile of the pile were well estimated by DNV (1992). On the other hand, the horizontal capacity of the pile was confirmed to be underestimated by a factor of 2 by the p-y method, which has been pointed out by many researchers.

Main students : Andrei Dobrisan and Yan Zhuang

Related publications : Dobrisan, A., 2016. Suitability of jacked-in steel piles as tsunami defences. M.Eng. Project Report, Cambridge University Department of Engineering, 48p.

Dobrisan, A., Haigh, S. K. and Ishihara, Y. 2018. Evaluating the efficiency of jacked-in piles as tsunami defences. Proceedings of the First International Conference on Press-in Engineering.

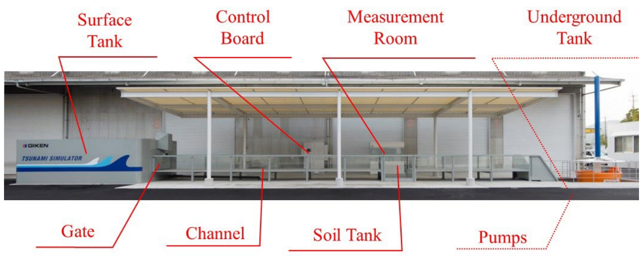


Figure 3

[2016-2017]

Project title : Design and construction of sheet pile retaining wall with and without the stabilization of excavation base

Outline of tests in Kochi : Two types of sheet pile pits were designed and constructed One was a square pit No.1 with a horizontal length of 8.4m, an embedment depth of 10m and an excavated depth of 5m. The other was a rectangular pit No.2 with a horizontal length of 8.4m and 6m, an embedment depth of 16.5m and an excavated depth of 9.5m. The excavation base in the pit No.2 was stabilized by a number of concrete columns before the excavation, as shown in Figure 4. The deformation of the wall due to the stabilization and the excavation was measured manually by an inclinometer. The wall was pushed outwards due to the stabilization and then pushed inwards due to the excavation. Together with the results of FEM analysis in which the stabilization process was modelled by thermal expansion, the effectiveness of the stabilization was discussed qualitatively.

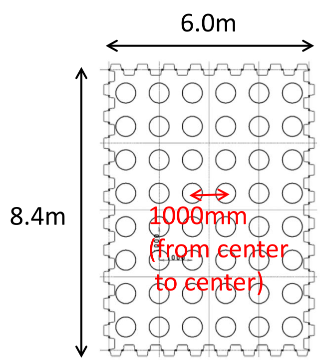


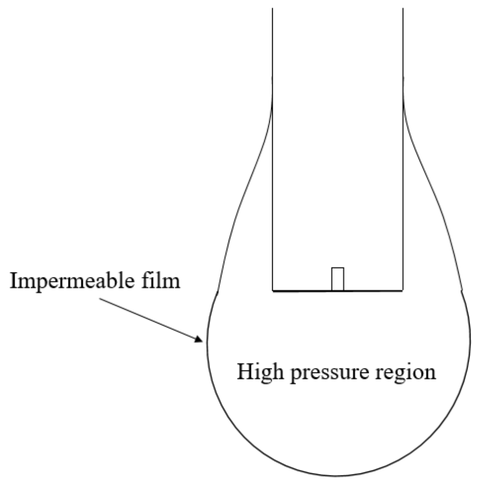
Figure 4

Main students : Yan Zhuang and Marla Gillow

Related publications : Zhuang, Y., 2017. The effect of bottom stabilisation on sheet pile pit. M.Eng. Project Report, Cambridge University Department of Engineering, 46p.

[2017-2018]

Project title	:	Mechanism of water jetting
Outline of tests in Kochi	:	Two sets of sheet piles equipped with pore pressure transducers were used in this project. One pile was installed prior to the installation of another, so that the pore water pressure not only on the shaft of the pile being installed but also in the ground at a certain distance from the pile being installed can be measured. Results of detailed analysis of the data suggested that a high stress region near the base of the sheet pile caused a build-up of base resistance, preventing further penetration of the pile, until enough water pressure was built up at the pile base to reduce the stress of the high stress region. The high water pressure was able to be built-up around the pile base even in relatively permeable soils, presumably because the repeated penetration and extraction at a constant depth range caused crushing of sand particles, forming an impermeable film in the pile base as shown in Figure 5.



Fiure 5 (from Gillow (2018))

Main students	:	Marla Gillow, Jennifer Chambers
Related publications	:	Gillow, M. 2018. Water jetting for sheet piling in sandy soils. M.Eng. Project Report, Cambridge University Department of Engineering, 49p. Gillow, M., Haigh, S. K., Ishihara, Y., Ogawa, N. and Okada, K. 2018. Water jetting for sheet piling. Proceedings of the First International Conference on Press-in Engineering.

Serial Report

Terminologies in Press-in Engineering (Part 3)

IPA Editorial Committee

Following Terminologies Press-in Engineering (Part 2) in Volume 2, Issue 3, Part 3 presents "Press-in data" as follows:

Press-in data

press-in data	an equivalent term to monitoring data obtained during pile installation, such as actual press-in force, extraction force, penetration and extraction speed, and etc. Depending on the ground condition, they may/may not be different from those determined in advance for operation
monitoring data	items displayed and recorded on Press-in Data Monitoring System, such as press-in speed and to be used for proper piling control
press-in force	a static force generated by the in hydraulic pressure by the main cylinders of Silent Piler to press-in pile/sheet pile. The maximum value is determined as press-in parameter to control the operation. Actual data obtained as the press-in data are displayed on a monitor and recorded by Press-in Data Monitoring System
penetration resistance	force acting as resistance during press-in mainly due to toe resistance of piles/sheet piles, shaft friction and friction along the sheet pile interlocking
reaction force	a force required to either press-in or extract piles/sheet piles
penetration length [ℓp]	penetration length of pile/sheet pile during penetration and extraction operation
penetration speed	the speed of a pile/sheet pile penetration. One of the important press-in parameters to control pile installation efficiency. Actual data obtained as press-in data are displayed on a monitor then recorded by the Press-in Data Monitoring System
extraction force	static force generated by the hydraulic pressure in the main cylinders of Silent Piler to extract pile/sheet pile. One of the press-in data to be displayed on a monitor and recorded by Press-in Data Monitoring System
extraction length [ℓe]	extracted length of pile/sheet pile during a cycle penetration and extraction operation
extraction speed	the speed of a pile/sheet pile extraction. One of the important press-in parameters to control pile installation efficiency. Actual data obtained as press-in data are displayed on a monitor and recorded by Press-in Data Monitoring System
repeated penetration and extraction	an operation to repeat "penetration" and "extraction" of the pile/sheet piles during press-in operation, in the case where the penetration resistance is large. This will reduce shaft friction and toe resistance
net pressed-in length [ℓp - ℓe]	net pressed-in length of pile/sheet pile per single penetration and extraction operation
Pile Penetration Test	one of the systems to make the better use of the press-in data. The Pile Penetration Test analyzes monitored data and evaluates the ground condition. The term may be used as an equivalent term to Press-in Data Monitoring System

(to be continued on Part 4)

Event Report

IPA Seminar on Press-in Technology in the Philippines

JAIME ANGELO S. VICTOR
Secretary of Local Organizing Committee
Assistant Professor, UP Institute of Civil Engineering

The IPA Seminar on Press-in Technology was successfully held last May 21, 2018 at the David M. Consunji Theater, Institute of Civil Engineering (ICE), University of the Philippines (UP) Diliman, Quezon City, Philippines. The seminar was jointly organized by IPA Organizing Committee, Philippine Society of Soil Mechanics and Geotechnical Engineering (PSSMGE) and UP ICE. The event was sponsored by GIKEN LTD. and Nippon Steel & Sumikin Bussan Corporation, and has received local support from AMH Philippines Inc.

Local Organizing Committee

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President, PSSMGE
Professor, UP ICE

Co-Chair: Roy Anthony Luna
Secretary, PSSMGE
Vice Chairman, AMH Philippines, Inc.

Co-Chair: Dr. Maria Antonia N. Tanchuling
Director and Professor, UP ICE

The seminar was formally opened by the Dr. Mark Albert Zarco, Vice President of PSSMGE and Professor at UP ICE. The event was also graced by Dr. Robert. Licup, 1st Vice President of the Philippine Institute of Civil Engineers (PICE) - the recognized professional organization for civil engineers in the Philippines. Dr. Licup has echoed the call for Filipino civil engineers to participate and significantly contribute to the Philippine Government's ambitious "Build Build Build" infrastructure development program.

Dr. Mark Albert Zarco

SEMINAR OUTLINE and RESOURCE SPEAKERS

State of Practice of Pile Foundation Analysis, Design, Construction and Testing in the Philippines
Engr. Roy Anthony Luna
Geotechnical Engineer and Vice Chairman, AMH Philippines

Application of Physical Modeling to Retaining Structure
Dr. Jiro Takemura
Associate Professor at Tokyo Institute of Technology, IPA Director

Study of End-Bearing Steel Screw Pile Embedded In Guadalupe Tuff Formation
Engr. David Dennis Sta. Rosa
Geotechnical Engineer, PNS Advanced Steel Technology, Inc.

Press-in Retaining Structures: A handbook (Design)
Dr. Jiro Takemura
Associate Professor at Tokyo Institute of Technology, IPA Director

Press-in Retaining Structures: A handbook (Construction)
Mr. Kazuo Hamada
General Manager, GIKEN SEISAKUSHO ASIA PTE., LTD

Recent Experiences with Bi-directional Static Load Testing in the Philippines
Engr. Richard C. Tan
Geotechnical Engineer and President, AGES Philippines

The Best Practice Notes for Water Jetting
Mr. Tsunenobu Nozaki
GIKEN LTD.

E-site visit (Introduction of the Press-in applications)
Mr. Tomotaka Hirose
GIKEN LTD.

The IPA Seminar was attended by local geotechnical engineering practitioners, contractors and members of the academe. Graduate students and senior undergraduate students from several Philippine universities also participated in the event. After all the presentations, an open forum was conducted to further discuss the advantages of using press-in technology.

IPA President Dr. Osamu Kusakabe delivered the concluding remarks of the event, expressing his appreciation to all participants, organizers and sponsors. He reiterated that the application of press-in technology in the Philippines is timely and IPA is looking forward to more collaborations in the near future.

Participants of the IPA Seminar on Press-in Technology in the Philippines
Photo Credits: Mr. Tsunenobu Nozaki

Event Report

9th International Conference on Physical Modelling in Geotechnics, (ICPMG 2018)

Andrew McNamara
Director of IPA
Senior Lecture, City University of London

Introduction

The 9th International Conference in Physical Modelling in Geotechnics (ICPMG 2018) was held at City, University of London, UK, between 17th – 20th July and attracted over 250 practicing engineers, academics and students from over 35 countries. 230 papers were published in the proceedings and 140 oral presentations were given whilst around 90 posters were presented. The conference disseminated research on foundations and retaining structures as well as a wide range of other topics such as dams, embankments, slopes, offshore and seismic modelling and tunneling. Many of the papers bridged the gap between physical and numerical modelling.

Notable events

The fourth Schofield Lecture was given by Professor R. Neil Taylor of City, University of London on 17th July 2018. Professor Andrew Schofield attended the lecture to support his former PhD student. Professor Taylor briefly described his contribution to physical modelling and emphasized the importance of enjoying research.

An industry themed day, opened by Professor Lord Robert Mair, the President of the Institution of Civil Engineers, presented important aspects of physical modelling research to invited members of industry where the techniques offered are sometimes overlooked. The sessions included a well-received presentation on the possibilities offered by steel sheet piles as permanent hybrid foundations. The event promoted the best of physical modelling techniques and many of the applications to industry.

Photo 1 Session

Laboratory tours

Delegates were invited to visit the Schofield Centre at Cambridge University whilst tours of the Geotechnical Centrifuge facility and laboratories at City, University of London were also available during the conference with over 120 delegates in attendance.

Conference activities

Over the course of the conference, delegates were treated to a number of social activities organised by the ICPMG 2018 local organising committee. Events included a Welcome Reception at Skinners' Hall; a drinks reception following the Schofield lecture, a gala dinner held at Middle Temple Hall and a casual afternoon in Greenwich.

Future physical modelling events

・ICPMG 2022 will be held in Daejeon, Korea
・Eurofuge 2020 will be hosted in Lulea, Sweden
・Asiafuge 2020 will be hosted by NUS Singapore

A Brief CV of Dr. Andrew McNamara

Andrew McNamara is a Senior Lecturer at the School of Mathematics, Computer Science and Engineering of City, University of London since 2004. In 2005 he was awarded a Diploma of the Henry Adams Award, jointly with Professor RN Taylor, by the Institution of Structural Engineers for a paper on his doctoral work and also a Telford Prize, jointly with Dr PRJ Morrison and Dr TOL Roberts by the Institution of Civil Engineers for a paper on the design and construction of a deep shaft for Crossrail. He is currently chair of I SSMGE TC104 for Physical Modelling in Geotechnics.

Event Diary

Title	Date	Venue
■ **IPA Events** https://www.press-in.org/en/event		
IPA Seminar on Press-in Technology in VietNam	December 6, 2018	Hanoi, Vietnam
International Society for Soil Mechanics and Geotechnical Engineering http://www.issmge.org/events		
8th International Symposium on Environmental Vibration and Transportation Geodynamics	October 26-28, 2018	Changsha, China
The 8th International Congress on Environmental Geotechnics	October 28- November 1, 2018	Hangzhou, China
THE FIRST VIETNAM SYMPOSIUM ON ADVANCES IN OFFSHORE ENGINEERING	November 1-3, 2018	Hanoi, Vietnam
16th World Conference of the Associated Research Centers for the Urban Underground Space	November 5 -7, 2018	Hong Kong, Hong Kong
International Seminar on Roads, Bridges, and Tunnels: Challenges and Innovation (ISRBT2018)	November 9 -15, 2018	Thessaloniki, Greece
6th African Young Geotechnical Engineering Conference (6th AYGEC)	November 24 -17, 2018	Khartoum, Sudan
■ **Deep Foundations Institute** http://www.dfi.org/dfievents.asp		
DFI 43rd Annual Conference on Deep Foundations	October 24-27 , 2018	New York, United States
8th Conference on Deep Foundation Technologies for Infrastructure Development in India	November 15-17, 2018	Gujarat, India
■ **Construction Machinery Events**		
APEX Asia https://apexasiashow.com/	October 23-26, 2018	Shanghai, China
■ **International Geosynthetics Society** http://www.geosyntheticssociety.org/calendar/		
GeoMEast 2018 International Congress and Exhibition	November 24-28, 2018	Giza Governorate, Egypt
■ **Others**		
International Conference on Urban Infrastructure & Management (ICIM 2018) http://www.icim.net.cn/	October 18-19, 2018	Hangzhou, China

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Editorial Remarks

The Editorial Board is pleased to publish Volume 3, No.3 issue on schedule. Dr. Terashi, IPA Director, describes in his message the detailed structure of IPA Award. Some of the Awards were presented on the occasion of the first International Conference on Press-in Engineering (ICPE) held in September 2018. Details of the ICPE will be reported in December issue.

This issue contains two important special contributions, one is the advanced numerical analysis and other the design and application of soil reinforcement technique. The contribution by Professors A. Asaoka, and T. Noda describes seismic response analysis of ground/geo-structures using Geo-Analysis integration code, which is considered to be the most advanced powerful computer code in the world at present time. The contribution by Prof. Bouassida describes the design of foundations on soft soil reinforced by columns and introduces interesting case histories mostly in Africa. This issue also contains various reports, including disaster, conference, IPA seminar and others. On site interview is also included.

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.