TC214 General Report; Foundation Engineering for Difficult Soft Soil Conditions

Rapport Général du TC 214 ; Fondations en Conditions Difficiles de Sols Mous

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ABSTRACT: The present TC214 General Report highlights the significant contributions of 33 papers of the Session of the XIX ICSMGE dedicated to the Foundation Engineering for Difficult Soft Soil Conditions. These papers have been tackled according to the topics which were assessed: methods of analysis and design, constructive process, determination of mechanical properties and behavior of soft soils, historical cases, seismic or dynamic response of structures on soft soils. Additionally, others references on the topics discussed are also given in the this report.

RÉSUMÉ : Le présent rapport général met en évidence les contributions significatives des 33 articles de la session « Fondations en Conditions Difficiles de Sols Mous » du 19ème CIMSG. Les documents sont abordés en fonction des sujets évalués : méthodes d'analyse et de conception, procédé de construction, détermination des propriétés mécaniques et comportement des sols mous, cas historiques, réponse sismique ou dynamique des structures sur sols mous, d'autres références sur les sujets abordés sont également présentées dans le rapport.

KEYWORDS: Soft soils, soil improvement, historical cases, characterization of soft soils, analysis, numerical modeling & constructive process.

1 INTRODUCTION

It should not be left aside that urban expansion in many cities around the world, as well as the construction of industrial facilities and associated infrastructure, constantly require to build large projects in very soft soils, where complex foundation solutions may be needed. Moreover, geotechnical engineers all around the world seems to have to face day-to-day geotechnical problems related to the presence of this type of soils.

Currently in Mexico City, a new airport is built in a huge area with problems related to important thicknesses of very soft clays, subsidence, earthquakes and differential behavior between structures, among others issues. Nevertheless, the design and construction of this project undoubtedly will generate valuable knowledge that in a short time could be shared.

Thus, in these 33 papers submitted by 21 countries to the Foundation Engineering for Difficult Soft Soil conditions session, it will be found issues related to soft soil engineering.

2 METHODS OF ANALYSIS AND DESIGN

Bouafia 2017 "Laterally loaded single piles - Construction of P-Y curves from the cone penetration test". P-Y curves-based design offers a powerful tool of analysis of laterally loaded piles. However, there is no practical method available in the literature for constructing the P-Y curves on the basis of the cone penetration test (CPT). This paper aims at suggesting a practical method for the analysis of the load-deflection behavior of a single pile based on the CPT data. This design method was derived from a detailed interpretation of several full-scale lateral loading tests on piles embedded in a variety of soil configurations. It was found the lateral pile/soil stiffness ratio is a key parameter influencing the P-Y curve parameters, namely the lateral reaction modulus and the lateral soil resistance. The methodology of construction of the P-Y curve from the CPT data is presented and the validation of the proposed method by testing it in a small sized database of full-scale loading tests showed a very good predictive capability.

Sakleshpur et al 2017 "Bearing capacity of circular footing on reinforced foundation bed over soft non-homogeneous ground with granular pile". The paper presents a simple method to estimate the ultimate bearing capacity of a circular footing resting on a reinforced foundation bed (RFB) over soft non-homogeneous ground improved by a granular pile. The reinforced bed consists of a single layer of geosynthetic reinforcement embedded within granular fill. Meyerhof's theory for bearing capacity of footings on layered soils along with Madhav et al.'s solution for bearing capacity of granular pile-engineered ground form the basis of the analysis. The non-homogeneity of soft ground is represented by a linear increase of undrained shear strength with depth. The contribution from the frictional resistance mobilized along the planar surfaces of the reinforcement is incorporated in the formulation. Bearing capacity ratios are proposed to quantify the relative contributions of pile, fill and reinforcement towards the ultimate bearing capacity of the footing. Predictions compare fairly well with experimental results in literature.

Kyung et all 2017 "Experimental investigation of connected foundation for transmission tower structure using field model load tests in soft clayey soils". The transmission tower structure consists of overhead power lines, steel-tower structure and lower foundation parts at each corner of the tower. Various types of foundations are used to support the upper tower structure depending on local soil condition. Pile foundation is usually adopted in soft clayey soils, as there are issues of instability problems such as insufficient load carrying capacity and large differential settlements. For such cases, connected foundation is an effective option, which can improve overall mechanical performance of transmission tower structure. In the present study, results obtained from a series of model load tests are presented to analyze the improved performance of connected foundation for transmission tower structures. Focus was given to changes in the load carrying capacity and differential settlement. The effects of load direction and connection-beam property were addressed in the analyses. The load carrying capacity and differential settlement noticeably changed with the use of connected foundation. Based on the test results, a methodology for the design application of connected foundation is presented. The validity of the method was checked with field test results.

García and Alhama 2017 "Time-dependent settlements for 3-D scenarios with partially penetrating and regularly distributed vertical strip drains". Reliable numerical solutions for 3-D soil consolidation scenarios with partially or totally penetrating vertical drains have been obtained by using the network method, providing universal curves for the average degree of consolidation. This unknown results to be influenced by the depth of penetration of the drains, as well as the ratio between the vertical and horizontal consolidation coefficients (duly corrected by the form factor 'distance between vertical drains/thickness of the soil'). For the derivation of the independent groups that rule the solution (from the list of relevant variables and using the known rules of dimensional analysis) it has been introduced the concept of discrimination, which allows to consider any of the form factors formed by ratios between horizontal and vertical lengths, as well as the ratio between horizontal and vertical consolidation coefficients, as non-dimensional groups. In fact, any of these form factors join to the ratio of consolidation coefficients to form a real dimensionless 'discriminated' group. As a result, the independent groups are reduced from three to two, a number of groups for which universal representation is relatively easy to carry out with charts obtained, point to point, by numerical simulations.

Madhira and Bandi 2017 "Ultimate Pullout Capacity of Granular Pile Anchors (GPA) in c-ϕ soils by Cavity Expansion Theory". Granular piles efficiency in treating soft soils by reinforcing/densifying resulting in overall increase in shear strength of in-situ soil is well established. The efficiency of granular pile is incremented by provision of anchor at base (either in form of concrete pedestal, a steel plate or geo-grid) connected with a metallic rod or stretched cable. The assembly is termed as Granular Pile Anchor (GPA). The paper presents a method for estimating the pullout capacity of GPA considering cylindrical cavity in soil possessing cohesion and friction as presented by Vesic's (1972) cavity expansion theory. The ultimate capacity shall be least of pile and bulging capacities evaluated as function of various parameters. The results are validated with rigid-plastic analysis for cohesive soils and are in good agreement.

Mendoza et all 2017 "Performance and modelling of a friction-piled embankment on a very soft clayey soil". Construction of linear works on poor ground requires innovative, but reliable solutions. As a possible answer for the runways and platforms of the New International Airport for Mexico City, which is under construction on very soft lacustrine clayey deposits, piled embankments were proposed, among other techniques. All of them were built in a test field. The purpose of this solution is to transmit the embankment loads to deep strata, reducing so the contact vertical stresses on the ground surface. A piled structural embankment has four main components: a competent granular material, piles, pile caps and a basal geosynthetic reinforcement. The embankment loads should be transferred onto the pile caps, through an arching mechanism; and part of the weight falling below the arch is transferred by the reinforcement to the pile caps. The case history of a 2.1 m-height and 30 x 30 m test embankment is described in this paper. It was built on the very soft clayey soils of the ancient Texcoco Lake, near Mexico City. Performance of the system along two years is exposed, including the construction stage, emphasis the arching effect. Numerical modelling of the system is also discussed, comparing their results with those given by analytical solutions and measured values.

Botero et all 2017 "Soft soil pavement foundation system based on the partial mass compensation method". For the construction of roads and runways in the Valley of Mexico, which are primarily situated on soft soils, the evaluation of different construction procedures that enable the identification of a foundation solution to achieve an adequate load transfer and prevent excessive and differential deformations in the soil deposit is important. In this study, the applicability and functionality of the partial mass compensation technique as a possible foundation solution for roads and runways on soft soils are evaluated. To analyze the behavior of this foundation solution, a trial embankment was built on highly compressible soils, and a comparative analysis was performed between the measurements of the instruments installed in the field and the numerical estimations obtained with the finite elements program PLAXIS 2D.

Jaja and Ejezie 2017 "Probabilistic model for settlement prediction of cohesive soils in the Niger Delta region of Nigeria". Settlement of building foundations on cohesive soils has been a major problem hindering infrastructure development in the Niger Delta region of Nigeria. An attempt is made in this research to develop probabilistic models for settlement prediction in order to aide preliminary analyses and design of foundations on the cohesive soils. Compressibility tests were done to determine settlement parameters and the Pearson's method was used to determine the appropriate distribution models. The beta distribution was found to be an appropriate distribution model for the behavior of Niger Delta clays with thickness greater than 3.5m, while the normal distribution proved to be the model for clays of thickness less than 3.5m. The beta distribution was also found to be an appropriate model for the unit settlement (cm/m) of Niger Delta clays. The mean unit settlement which can be used as a recommended design value for geotechnical works on Niger Delta clays was found to be 22.64 cm/m with a range of 5.11 to 51.31 cm/m.

3 CONSTRUCTIVE PROCESS

Panchal et all 2017 "Minimizing base heave from deep excavations in soft soil conditions using underwater construction methods". There is a desire to be able construct very deep basements in soft soils without damaging adjacent buildings. Minimizing the magnitude of ground movements arising from such excavations can be achieved by increasing the base stability. This paper will investigate the effectiveness of underwater excavation practices to maintain base stability of deep excavations and minimize surface settlements. Centrifuge modelling at 160g was used to observe the soil response to excavations to determine whether a raised water level on the excavation side of the retaining wall significantly reduces base heave. The model used a 'rigid wall' which eliminates lateral displacements associated with wall bending, thus focusing on the success of this method of construction. The results show that long term movements appear negligible within a year at prototype scale and surcharging the formation limits movements to 50% at distance H behind the wall.

Vynnykov et all 2017 "Innovative projects in difficult soil conditions using artificial foundation and base, arranged without soil excavation". Projects with application of bases and foundations, arranged without soil excavation are presented below: cast-in-situ piles in the punched holes (CPPH), compacted arrays, soil-cement elements (SCE) and piles (SCP). For those projects a whole range of the engineering problems were solved: calculation, design, numerical modeling, construction, supervision over the objects settlements (up to 35 years). For the loessial strata up to 12 m the CPPH is the most efficient solution. CPPH has high level of the foundations bearing capacity using, which caused through the formation of

compacted zone. SCE and SCP are performing by drilling-mixing technology. They are efficient in the soft soils strata with thickness up to 30 m. Paper presents an experience of the SCP application for the: fixing of the deep excavation sides with depth up to 15 m, SCE and SCP as artificial base or foundation.

4 DETERMINATION OF MECHANICAL PROPERTIES AND BEHAVIOR OF SOFT SOILS

Poon and Chan 2017 "1-D consolidation model with stress dependent recompression index and coefficient of consolidation" A new 1-D soil compressibility curve consisting of a stress dependent recompression index cr at the over-consolidated stress range has been developed. This compressibility model, when used in conjunction with a log-linear void-ratio – permeability function, is able to capture implicitly the trend of reduction of cv with σ'v at the over-consolidated stress range, which has been verified with high quality CRS odometer test results. Conversely, the conventional compressibility model with constant cr will give an opposite trend of increasing cv with σ'v at the over-consolidated stress range. Furthermore, the newly proposed soil model will capture slightly more settlement than that of the conventional model at the transition from OC to NC soil states. The predictive capability of the proposed soil model has been demonstrated by numerical simulation of settlement and excess pore water pressure monitored during the staged loading and 3 years of subsequent consolidation for a trial embankment constructed over Ballina Clay treated with PVD.

Pineda et all 2017 "Modifications in soil fabric due to tube sampling in soft clay "This paper analyses the effects of tube sampling in soft clay with particular emphasis on the modifications that occur in the clay fabric for tube specimens retrieved using open samplers (Shelby) as well as a fixed-piston sampler relative to a Sherbrooke block sampler. Tube specimens of an estuarine soft clay are analyzed in this study. Mercury intrusion porosimetry (MIP) tests are carried out to infer the pore size density function (PSD) of specimens trimmed at different locations along the tube and these are compared against those performed on undisturbed clay, obtained from Sherbrooke specimens, to estimate variations in the natural soil fabric due to tube sampling.

Wang et al 2017 "Quasi-static RTM method and its application to the asymmetric consolidation of a layered transversely isotropic saturated soil "The reflection-transmission matrix (RTM) method was originally developed for addressing the wave propagation in the layered elastic medium. In this study, the quasi-static RTM method for the layered transversely isotropic saturated soil (TISS) undergoing asymmetric consolidation is developed. To this aim, a partial differential equation system is established using the governing equations for the TISS first. Applying the Hankel-Laplace transform to the partial differential equation system furnishes the corresponding ordinary differential equation system. By using the general solution of the ordinary differential equation system, the RTM method for the layered TISS is established. To show the capacity of the proposed model, one numerical example for the consolidation of the layered TISS subjected to a horizontal force is presented.

Hamed et all 2017 "Geotechnical Characterization of Port-Said Clay". The physical and mechanical engineering behaviors of the clay deposits encountered in the East of Port-Said governorate, North East of Egypt, were investigated. Geologically, Port-Said region is part of El-Tina plain, which is composed of very soft to firm clays extending to depths exceeding 50 m. The geological history of the area suggests that "Port-Said Clay" was deposited in a marine environment. Field and laboratory tests were carried out on Port-Said Clay as part of this study. Results from previous investigations were also compiled. The results have enabled a better characterization of Port-Said Clay and confirmed its marine nature. The outcome of this study is compared with published results on soft marine clays in other parts of the world. The results have also enabled developing the required parameters to numerically simulate Port-Said Clay utilizing the Hardening Soil Model.

Forsman et all 2017 "Utilization of mass stabilized dredged mud and clay as fill and embankment construction material, case City of Helsinki". The technical and environmental properties of stabilized dredged soft sediments have been studied thoroughly at the laboratory scale and in situ in different phases of construction - in the basin before and after stabilization and in the structure after transport and construction. The studied properties are e.g. shear strength, modulus of elasticity, hydraulic conductivity, leaching of contaminants, etc. Mass stabilization has been applied to improve the technical and environmental properties of the dredged sediment in order to be utilized as earth construction material. The high price and carbon footprint of cement binder have encouraged the use of alternative binders such as fly ash from the combustion of coal and oil shale as well as flue gas desulphurization residue. The results of the leaching tests show that the leaching of heavy metals is very low with all the binder materials tested. These stabilized sediments have been utilized as earth construction material in various construction sites such as noise barriers in the Helsinki city area.

Watabe et all 2017 "Soil parameters governing mechanical properties of coral gravel soils". Coral gravel soils are composite soils comprising of finger coral fragments and silt matrix, often found at coastal regions of sub-tropical islands, particularly in Okinawa Islands, Japan. In this study, a series of triaxial CD tests was conducted for undisturbed coral gravel soils collected at four different sites to investigate the mechanical properties of coral gravel soils. The test results were compared to the authors' previous test results obtained for the reconstituted coral gravel soils with different volumetric percentage of coral fragments, and then soil parameter governing the mechanical properties such as the maximum principal stress difference and shear resistance angle was discussed. It was found out that granular void ratio corresponding to 0.075 mm, in which particles finer than a grain-size of 0.075 mm are regarded as void, is very useful as a governing parameter for shear strength of both the reconstituted and undisturbed coral gravel soils.

Tan Manh Do et all 2017 "Stabilization of marine dredged sediment using lime-fly ash-red mud-gypsum binder". The aim of this study is to evaluate the strength characteristics of marine dredged sediment (MDS) and stabilized with cement less binder. In this study, the new cement less binder, tentatively named Fa-RmLG, derived from a cementitious mixture composed of fly ash (Fa), red mud (Rm), lime (L) and gypsum (G) is proposed and employed. For the stage of MDS stabilization, a pilot experimental program was first performed to find the optimum water content in mixtures. Various mixtures of MDS were then prepared with different proportions of Fa-RmLG. The settlement, pH values, leaching of heavy metals and the most important property unconfined compressive strength, were evaluated on the MDS mixtures. As a result, an extremely large increase in strength was obtained from the stabilized MDS mixtures when comparing to the unstabilized MDS ones. The

proposed Fa-RmLG binder was found to be feasible to solidify MDS.

Lechowicz and Wrzesiński 2017 "Evaluation of undrained shear modulus Gu of cohesive soils in a Hollow Cylinder Apparatus". The paper presents test results in a Hollow Cylinder Apparatus to determine the shear modulus Gu in undrained conditions. Values of the undrained shear modulus Gu were determined at shear strain 0.1% and 0.5%. Laboratory tests were performed on lightly over consolidated clay (Cl) and sandy silty clay (sasiCl) with an over consolidation ratio OCR about 3.5 and 2.7 and a plasticity index Ip equal to 77.6% and 34.7%, respectively. HCA tests were carried out with anisotropic consolidation and shearing in undrained conditions. The obtained results have allowed to assess the influence of rotation of the principal stress directions on the value of the shear modulus Gu in undrained conditions.

Gouw 2017 "Consolidation parameters – alternative to Casagrande and Taylor methods". For decades, consolidation parameters are derived graphically. Pre-consolidation pressure is derived by Casagrande method where technician has to pick the point of smallest curvature from e-log σ' curve. Coefficient of consolidations is derived by Taylor's method where technician has to draw a linear line from deformation vs square root of time curve. Both graphical methods can lead to different results depending on the technician's judgment. Given the same e-log σ' curve, pre-consolidation pressure determined by different interpreters easily varies by three folds. Great variations also obtained in determining coefficient of consolidation through Taylor's method. As soil compresses, void ratio reduces and so does permeability, hence the higher consolidation pressure the lower coefficient of consolidation should be. However, it is often found that plot of coefficient of consolidation vs consolidation pressures goes up and down irregularly. The author tries to derive pre-consolidation pressure by 'Parallel Rebound Method', that is: first line is drawn through unloading part of e-log σ' plot, second line is drawn tangent through initial part of e-log σ' curve parallel to the first line, third line is the normal consolidation line. The intersection of the third line with the second line is the pre-consolidation pressure. With regard to coefficient of consolidation, Asaoka's method is employed to determine 100% consolidation under constant load, certain degree of consolidation time is then decided to derive coefficient of consolidation. It was found that the resulted coefficient of consolidation curve reduces consistently with higher consolidation pressures. With the help of computer spreadsheet program and mathematical formulation, both methods appear to give consistent results. It was concluded 'Parallel Rebound Method' and Asaoka's method lead to better results in deriving pre-consolidation pressure and coefficient of consolidation, respectively.

Shahien et all 2017 "Stress history profiling of Nile delta clay deposits: Determination and challenges". Stress history of geo-material is one of the most important parameters required for both geotechnical analysis and design. Stress history is often expressed in terms of OCR that is defined as the ratio of pre-consolidation pressure to effective overburden pressure. The OCR is usually determined using one dimensional consolidation tests carried out on "undisturbed" samples in the Oedometer. One of the major challenges in determination of the OCR is sample disturbance during and after sampling. This paper shall show the challenges in OCR determination in a conventional manner, and discuss all other alternative approaches used to complement and confirm the determination of stress history of clay deposits. These approaches include in-situ and laboratory tests. This will be demonstrated through examples from two sites of major projects in Egypt during the last 15 years.

5 CASE HISTORIES

Sadaoui et al 2017 "Experimental and numerical study of the impact of heavy structures settlement founded on soft ground improved by stone floating columns". The paper discusses the experience feedback of the behavior of storage silo 80000 t and two towers founded on a compressible soil improvement by floating stone columns in the harbor of Bejaia city, Algeria. The stone columns of 18m depth, 1.6 x 1.6 (m^2) meshes have not reached the substratum located at 39m depth. The stresses transmitted to the service limit state (SLS) are variable 73 to 376 kPa. After the loading of the silo in 2010, settlement occurred affecting the stability of the towers due to excessive differential settlements. Consequently, the towers were inclined and the damaged transporter. A rigorous and ongoing monitoring of the evolution of loads in the silo and settlements of the soil was carried out during 1400 days that is from the construction of foundations in 2008 to 2012. Numerical calculations by finite elements have been carried and the results obtained are compared with the measurements.

Srithar and Paul 2017 "Settlement Behavior of a Quarried, Waste Backfilled Soft Clay Site" Sites comprising soft clay deposits, uncontrolled fill and waste materials are prone to long term settlements and there could be considerable uncertainty about the magnitude and timing of the long term settlement. This paper presents the settlement assessment of a site where both waste materials and soft clays were present. Instrumented embankments were constructed in two areas of the site to assess the settlement behavior of different parts of the site and to provide measures to reduce the risks associated with settlement. The instrumentation included settlement plates and magnetic extensometers. This paper describes the subsurface conditions encountered at the site, details of the instrumented trial embankments, assessment of the monitoring results and the risk reduction measures.

Manea and Ciortan 2017 "Foundation solutions for cereal silos in Romania". The development of the grain industry resulted in the construction of numerous silos, located mainly in plain, rural, areas but also in harbours. Geotechnical and groundwater conditions vary and dictate diverse foundation solutions depending on the loads transmitted to the soil and the specific site conditions. Site located in plain areas are characterized by difficult foundation soils including soils sensitive to water (collapsible soils – loess); in these cases are necessary special foundation solution or consolidation of soil. For silos constructed on waterfront, it is necessary to evaluate overall stability when adopting the foundation system – this results in additional verifications. Multiple situations require placing the silos in the immediate vicinity of existing operating quays and imply foundation solutions by witch the new efforts must not affect the bearing capacity and stability of such quays. The paper presents various case studies regarding this type of works, as well as specific computation aspects for the adopted foundation systems.

Lillis et all 2017 "Reclamation of a containment area: measurements and back analysis of the height of dredged mud". The expansion project of the Port of Gaeta (Italy) included a 6 Ha diked containment area to be reclaimed and developed into container depot using fine-grained materials dredged from Gaeta's gulf. A system of prefabricated vertical drains, horizontal drainage pipes combined with vacuum pressure and surcharge preloading was designed to ensure both the feasibility

of the project and the future serviceability of the area. A well-structured sequence of operations was devised to increase storage capacity during hydraulic filling. The height of the dredged mud was monitored at all stages. The paper compares Class A numerical prediction, modified to consider the real filling procedure and construction timeline, back-analyses and field monitoring data. The study emphasizes the importance of modelling every phase of the sedimentation-consolidation process to accurately account for the change in volume of the dredged material, and shows that even a relatively simple numerical model can be used to this aim.

Ohta et all 2017 "Three trial embankments placed on a soft foundation deeper than 100 meters". Three trial embankments for expressway construction were placed on a soft foundation deeper than 100 meters aiming at evaluating the performance of three types of vacuum consolidation. Performance of the trial embankments are simulated by employing a visco-plastic constitutive model called the Extended Sekiguchi-Ohta model incorporated into a soil/water coupled finite element software called DACSAR. The procedures how to specify the soil parameters of each soil layer forming the soft foundation are fully described in this paper. The computer simulation of the three trial embankments is found to be good in estimating the settlement observed at the sites during the period of applying the vacuum pressure. This suggests that the parameter specification procedures adopted in this investigation are satisfyingly reliable from the viewpoint of engineering practice.

Zhussupbekov et all "Analysis results of static and dynamic loads tests of pile foundations in constructions site of Expo-2017, Astana, Kazakhstan". Traditionally, pile load tests in Kazakhstan are carried out using static and dynamic load test methods. Static pile load test is the most reliable method to obtain the load-settlement relation of piles. Most of the static pile load tests are performed using reaction systems. Furthermore, cost and time for the static pile load test are relatively high compared to the dynamic pile load testing. This paper includes the short summary about dynamic and static tests by pile foundations. The methodologies of definition bearing capacity of the pile by aforementioned methods were also given. According to the results of tests were determined the possible depth of penetration and bearing capacity of piles, as well as recommendations on the device of working. Experienced driving piles with lengths of 4,38 m,6 m, 7,5 m, and 8.5 m cross section 30x30 cm. This geotechnical investigation is important for understanding of soil-structures interaction on difficult soil ground conditions of construction sites of Expo -2017.

Rangel et all "Behavior of an embankment built on a very soft soil deposit with and without rigid inclusions: monitoring and numerical modeling". This paper presents a case history of two test embankments that were built on a very soft soil deposits with and without rigid inclusions in order to calibrate the axisymmetric element finite model using conventional soil models. The soil deposit, 27m thick, is a high plasticity silt, with hard and thin layers of volcanic ash and silty sand, located in the valley of Toluca, Mexico. The stratigraphic soil profile and mechanical characterization of each layer were defined by field testing (CPTu, SDMT, VST, and PMT) and conventional geotechnical laboratory testing. Concrete inclusions, 0.3m and 9m in diameter and length, were placed in a regular array with a spacing of 2.5m using a construction procedure which generates low soil alteration. Monitoring before, during and just after embankment construction, with topographic levelling, push-in pressure cells and total earth pressure cells placed in the ground, short time ground and embankment behavior were observed. Results indicate that superficial settlements are reduced just 13% when spacing of inclusion are 2.5m (eight times the inclusion diameter). This result was verified by using a calibrated FEM model element.

Świdziński et all 2017 "Assessment of load bearing capacity of tailings deposited in a wet disposal dump required for paste deposition". One of ways to reduce the capacity of tailings being deposited into a disposal is change of deposition technology aiming at discharging denser material with reduced amount of water. It may be executed by preliminary thickening of tailings up to the form of paste. However, discharging denser material and its deposition on top of tailings which were previously spigotted requires an assessments of its bearing capacity. In order to verify this issue in situ model tests in TSF Żelazny Most, Poland have been performed. The response of saturated tailings to additional surcharge corresponding to deposition of paste material has been modelled by trial inward embankment 1100 long constructed on the surface of spigotted tailings. Consolidation and deformation conditions were identified based on SCPTU, SDMT, FVT tests accompanied by embankment settlement measurements supplemented by laboratory testing of tailings samples. The results of tests have revealed variety of tailings responses depending on its location and deposition conditions.

Szerző and Batali 2017 "Numerical modelling of piled raft foundations. Modelling particularities and comparison with field measurements". The calculations presented in this paper are based on a real-life project, a circular gas tank situated in Northern France, subjected to a full-scale filed test by filling up with water, with the maximum load exceeding the service load.
The geotechnical investigations were based on CPT and pressuremeter tests, according to French practice. They identified a relatively homogeneous stratigraphy formed of 5 characteristic strata, characterized by an alternation of weaker and harder soils. This particular situation allows the comparison of different calculation methods for a complex project.
The foundation was subjected to a full-scale vertical load tests and settlements were measured using two horizontal inclinometers, in order to check the initial design, but also to perform a primary consolidation of the soil. The settlement limit imposed in the initial design was 50 mm in every load case. The maximum settlement was measured in the center of the foundation, one month after the application of the final load increment. Its value is 38.5 mm, compared to 31.0 mm estimated in the design. It needs to be mentioned that there are no available load test results for the single pile. For this case study both the single pile and the entire foundation was modelled with several the methods available for the author, out of which all the numerical calculations (Finite Element Method using the software Plaxis 2D and 3D, Midas GTS NX 3D) were presented, along with two simplified methods. The research focused on the comparison of overall settlements obtained using different methods, and the influence of specific details of numerical modelling (soil constitutive model and pile-soil interface) on results. According to the results, the numerical calculations presented a wide range of results for overall settlements, all of them overestimating settlements, especially at the margin of the foundation, where a large percentage of the load was concentrated. As a general trend, the Plaxis calculations using the Mohr-Coulomb constitutive model produced the largest settlements, while the results obtained using Hardening Soil model are in better agreement with field measurements.
The calculations present some aspects of the complexity of numerical modelling for large foundations in difficult soil

conditions. The wide dispersion of results confirm that the numerical modelling of such foundations require careful choice of model parameters, which can be best obtained using physical modelling, such as instrumented pile load tests.
Also, the results show that simplified methods can be successfully used for preliminary design (and in some cases even detailed design), although the designer needs to take into account the uncertainties resulting from the various simplifying assumptions of these methods.

Karunawardena et all 2017 "Improvement of Sri Lankan Peaty Clay using the Gravel Compaction Pile Method for the Construction of a Highway Embankment". Gravel Compaction Pile method was applied as a ground improvement technique in improving the soft ground for a highway construction project in Sri Lanka. The embankment foundation soil consisted of a 5 m -12 m thick soft layer which consisted of peat, organic clay and silty clay. The vibrating compaction technique was used in the construction of Gravel Compaction Piles. Using this method, compacted gravel piles with an average diameter of 0.7 m were formed through the soft soil down to the identified bearing stratum. The spacing of the gravel piles were determined based on the stability and the settlement requirements. The average height of the embankment was around 10m and an additional surcharge load was placed to have sufficient over consolidation ratio to control the residual settlement as required in the Technical Specification. The effectiveness of the ground improvement was evaluated by comparing the field and laboratory tests conducted before and after the ground improvement and the data obtained from the field monitoring program. The results indicate that the Gravel compaction pile method is very effective for the construction of high embankments over deep peaty deposits to reduce the settlement, to increase the stability and to accelerate the consolidation.

Papadopoulou and Gazetas 2017 "Leaning instability of the Tower of Pisa, re-examined by 3D F.E. analyses". Several important issues regarding the stability of the Pisa tower are investigated by 3D F.E. analyses, as the time dependent bearing capacity, the potential leaning instability and the interpretation of the time-tilt observations and differential settlements. The soil behavior is simulated by the SSCModel in most of 3D analyses. The potential leaning instability is examined through the modified safety factor SF=sinω/sinωs, where ω is the developed tilt at any time and ωs the presumed inclination of the annular foundation, which might be caused by the overturning moment, M. The analyses are focused on the topics: i) The bearing capacity factors in relation with the actual tilt, ω. ii) The relationship between eccentricity, e and tilt ratio, sinω/sinωs. iii) The significance of the preconsolidation stresses and the creep characteristics.

6. SEISMIC OR DYNAMIC RESPONSE OF STRUCTURES ON SOFT SOILS

Tomisawa et al 2017 "Seismic strengthening technique for existing pile foundations in soft ground and liquefiable ground". Seismic reinforcement of existing pile foundations is not often conducted because it is difficult to apply seismic reinforcement on many construction sites, and required seismic performance and seismic diagnosis method of existing pile foundations has not been clarified. However, it is essential for existing pile foundations to implement seismic strengthening work, as well as the superstructures and substructures. In particular, large deformation of pile foundations in soft and liquefiable ground during earthquakes is a concern. In this research, seismic strengthening technique for the existing pile foundations, in which seismic resistance is improved by applying ground improvement around the existing pile foundations (hereinafter called "Composite pile method"), is examined. Composite pile method is an effective reasonable technique under limiting condition for construction. A patent for the method has been obtained and registered in "New Technology Information System" in Japan. In this paper, usefulness on a practical level is verified by reviewing the typical dynamic excitation experiment results on this method.

Huicochea and Belli 2017 "Foundations analysis in difficult ground conditions for Wind Turbine Generator". The traditional analysis for Wind Turbine Foundations is, in idealized conditions, enough to develop all the analytical checks such as: overall stability, bearing capacity, settlements, overturning moments, sliding and dynamic actions: rotational stiffness, gap forces, maximum ground pressure all that is generally enough to get an acceptable solution for geotechnical foundation design. Nonetheless, when Engineers have to face some of geotechnical issues such as: soft high compressible soils, rock masses with sinkholes, seepage or very fractured rock with weak layers below, good rock layers and so on, they should perform extra or complementary analysis with other technical tools as soil-structure interaction, dynamic wind analysis, seismic and cyclic vibrations coupled analysis.