Simulation Of A Centrifuge Model Test Of Pile Foundations | 07a1c232703d7da0a2f75751d980a5e0

Model Tests and Numerical Simulations of Liquefaction and Lateral Spreading
Centrifugal Modeling of the Response of Tunnels to Blast Loading
Gas Centrifuge Enrichment Plant Safeguards System Modeling
Soils and Foundations Drum Centrifuge Modeling of Overconsolidated Clay Slopes
Centrifuge Modelling for Civil Engineers
Centrifuge Model Simulation of Upheaval Buckling of Pipelines
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Gas Centrifuge Enrichment Plant Safeguards System Modeling

This book results from the 7th ICPMG meeting in Zurich 2010 and covers a broad range of aspects of physical modelling in geotechnics, linking across to other modelling techniques to consider the entire spectrum required in providing innovative geotechnical engineering solutions. Topics presented at the conference: Soil – Structure – Interaction; Natural Hazards; Earthquake Engineering: Soft Soil Engineering; New Geotechnical Physical; Modelling Facilities; Advanced Experimental Techniques; Comparisons between Physical and Numerical Modelling Specific Topics: Offshore Engineering; Ground Improvement and Foundations; Tunnelling, Excavations and Retaining Structures; Dams and slopes; Process Modelling; Goenvironmental Modelling; Education

Soils and Foundations

Drum Centrifuge Modeling of Overconsolidated Clay Slopes

Physical Modelling in Geotechnics collects more than 1500 pages of peer-reviewed papers written by researchers from over 30 countries, and presented at the 9th International Conference on Physical Modelling in Geotechnics 2018 (City, University of London, UK 17-20 July 2018). The ICPMG series has grown such that two volumes of proceedings were required to publish all contributions. The books represent a substantial body of work in four years. Physical Modelling in Geotechnics contains 230 papers, including eight keynote and themed lectures representing the state-of-the-art in physical modelling research in aspects as diverse as fundamental modelling including sensors, imaging, modelling techniques and scaling, onshore and offshore foundations, dams and embankments, retaining walls and deep excavations, ground improvement and environmental engineering, tunnels and geohazards including significant contributions in the area of seismic engineering. ISSMGE TC104 have identified areas for special attention including education in physical modelling and the promotion of physical modelling to industry. With this in mind there is a special themed paper on education, focusing on both undergraduate and postgraduate teaching as well as practicing geotechnical engineers. Physical modelling has entered a new era with the advent of exciting work on real time interfaces between physical and numerical modelling and the growth of facilities and expertise that enable development of so called ‘megafuges’ of 1000gtonne capacity or more; capable of modelling the largest and most complex of geotechnical challenges. Physical Modelling in Geotechnics will be of interest to
professionals, engineers and academics interested or involved in geotechnics, geotechnical engineering and related areas. The 9th International Conference on Physical Modelling in Geotechnics was organised by the Multi Scale Geotechnical Engineering Research Centre at City, University of London under the auspices of Technical Committee 104 of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). City, University of London, are pleased to host the prestigious international conference for the first time having initiated and hosted the first regional conference, Eurofuge, ten years ago in 2008. Quadrennial regional conferences in both Europe and Asia are now well established events giving doctoral researchers, in particular, the opportunity to attend an international conference in this rapidly evolving specialist area. This is volume 2 of a 2-volume set.

**Centrifuge Modelling for Civil Engineers**

The increasing shift towards performance-based geotechnical earthquake engineering design requires an improved understanding of soil-structure interaction (SSI) for buildings on liquefiable deposits. While a number of authors have used centrifuge tests and numerical modelling to study this phenomena, a limited number of studies have been undertaken where numerical models have been validated against well-instrumented centrifuge tests. The focus of this research is to validate numerical simulations of ‘free-field’ conditions and numerical simulations of soil-structure interaction response of isolated buildings on liquefiable deposits against measurements from a centrifuge experiment. The 1D simulations for this study have been developed using the PM4Sand constitutive soil model as implemented in FLAC and the PDMY02 constitutive soil model as implemented in OpenSEES. The consideration of two soil models is one of the distinctive features of this study, as one of the objectives of this research is to compare the relative performance of the two constitutive soil models. The 2D numerical simulations to assess the soil-structure interaction response of isolated structures were developed using the PM4Sand constitutive soil model as implemented in FLAC. The 1D validation that was undertaken in this study show relatively good agreement between the simulated and measured accelerations and excess pore pressures using PM4Sand and PDMY02 for up to moderate levels of earthquake shaking. At high levels of earthquake shaking, good results were obtained using PM4Sand but a poor match with measured values was obtained using the PDMY02 model. The centrifuge experiment results appeared to show that the ground motion properties such as duration and the presence of ‘pulse-like’ qualities have an influence on the measured acceleration and excess pore pressure response even if the intensity of shaking is relatively similar. However, this distinction was generally not captured by the two constitutive soil models considered in this study. Additionally, both of the constitutive soil models significantly underestimated volumetric settlements in the ‘free-field’. The 2D validation undertaken in this study showed that, while the numerical simulations were not able to capture volumetric settlements well, the simulations using PM4Sand generally provided good estimates of total settlement of the structure. The numerical simulations also provided relatively comparable acceleration response in the soil beneath the structures and the ii acceleration response at the base and top of the structure. However, more variability between the
measured and simulated excess pore pressure response in the liquefiable soils was noted. The research undertaken in this study shows that numerical simulations are generally able to capture important mechanisms due to liquefaction. In this study, a better response was obtained using the PM4Sand constitutive soil model when simulating ‘free-field’ conditions. However, it should be noted that this observation is based on comparisons against one centrifuge experiment and for the soil parameters adopted in this study.

**Centrifuge Model Simulation of Upheaval Buckling of Pipelines**

**Centrifuge Modeling of Permeability and Pinning Reinforcement Effects on Pile Response to Lateral Spreading**

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**Physical Modelling in Geotechnics, Volume 2**

**Centrifuge modeling of LNAPL movement in the vadose zone**

**Validating Numerical Simulation of Soil- Structure Interaction for Building on Liquefiable Deposits Using Centrifuge Experiments**

This report describes the completion of a new major centrifuge based earthquake simulation facility and a series of model tests that were conducted using the facility. The model tests used centrifuge modeling to investigate remediation of liquefaction at a bridge site. The tests were designed to help evaluate the extent of soil improvement required to mitigate the consequences of liquefaction.
Application of Centrifuge Modelling to Geotechnical Design

The 68 papers in this volume are the proceedings of the International Conference on Simulation.

Model Tests and Numerical Simulations of Liquefaction and Lateral Spreading

The Joslyn steam release incident in 2006 has significantly influenced the approval process for steam assisted gravity drainage (SAGD) projects, which now require rigorous caprock integrity assessment to be conducted. In the past, most of the research efforts have been devoted to reservoir geomechanical simulation studies of caprock integrity. Physical modeling is conducted to a lesser extent, as it is difficult to carry out physical modeling of prototypes at such a scale as SAGD projects. Within the Geotechnical Centrifuge Experimental Research Facility (GeoCERF) at University of Alberta, research is ongoing to utilize the newly built 50g-ton beam centrifuge for physical modeling study of caprock failure mechanisms at high gravitational fields. The centrifuge model will be spun at 100g. According to the scaling law, a 20m thick caprock formation can be simulated using only 20cm thick test material, which makes scaled physical modeling of caprock failure possible. Prototype, reservoir geomechanical simulation and centrifuge modeling are closely integrated in this research. Caprock is deemed as homogeneous material without any pre-existing faults or weak planes. Thus, shear failure and tensile failure are the two major failure modes of caprock to be explored. In reservoir geomechanical simulations, caprock behaviour is described using the elasto-perfectly plastic model with Mohr-Coulomb failure criterion. The development of shearing zones in caprock is analyzed along with displacement profile evolutions at the base of caprock. According to parametric analysis, caprock shearing failure is commonly observed for caprock with different mechanical properties and the shearing patterns of caprock at failure are the same with the vertical displacement at the base of caprock being the main driving force regardless of material property differences. In addition, the vertical displacement profiles at caprock shearing failure also share the same characteristics. A custom-designed electromechanical device named Geomechanical Caprock Deflection Mechanism (GeoCDM) was successfully built and commissioned within GeoCERF to fail the caprock at 100g. In this research, over-consolidated Speswhite kaolin with consistent properties is employed to mimic the caprock in the centrifuge models for the purpose of eliminating the influences of property variability of in-situ materials. Consolidated-drained triaxial tests are conducted on samples cored from the kaolin block and the test results reveal that there are significant property differences between the caprock shale and the over-consolidated Speswhite kaolin in terms of material stiffness, strength and dilation behaviour after shearing. This research is focused on the feasibility study of centrifuge modeling of caprock integrity; however, for future studies, creating synthetic materials with close properties to caprock shale should be a research focus. Through an image-based displacement measurement technique of particle image velocimetry (PIV), the deformation of the kaolin block can be directly captured. Two Kulite miniature pore pressure transducers are installed inside the
overconsolidated Speswhite kaolin block for observation of the internal pore pressure changes and an external pore pressure transducer is connected to the base of the kaolin block. Mariotte Bottle is employed to maintain the hydrostatic pressure inside the centrifuge model. Two preliminary tests were conducted to test the GeoCDM setup. Pore pressure transducers are proven to be working well within the GeoCDM setup and the PIV system can effectively track the soil deformation during centrifuge spinning. However, the PIV analysis results had been compromised due to the faulty hydro-mechanical sealing at the base of the kaolin block, which are now being modified for future tests. For future studies, the results of the centrifuge testing should be compared to those of numerical simulations to verify and modify the numerical tools for SAGD caprock integrity study.

**Centrifuge Modeling of Liquefaction Remediation at Bridge Sites**

This thesis describes centrifuge model tests and numerical analyses of tunnels in liquefiable soil. The prototype of the centrifuge tests was the Bay Area Rapid Transit (BART) Transbay Tube (TBT) that connects Oakland to San Francisco, CA, USA. During the tunnel construction, much of the gravelly backfill material around this tunnel was placed loosely under water at a relative density less than 50%. Because of the low relative density of the backfill material around the tube and low unit weight of the tube, there were concerns that tube might suffer large deformation due to buoyancy forces if the backfill material liquefied in an earthquake. BART engaged Fugro West Inc., Oakland, CA to assess the need for ground improvement to mitigate seismically-induced deformations of the tunnel, in particular, the deformations due to uplift of the tunnel in the liquefied backfill. Fugro recommended that their numerical analyses and deformation mechanisms should be further verified using centrifuge model tests. Centrifuge model tests were performed (1) to assess the stability of the BART Transbay Tube, (2) to confirm the uplift mechanisms of the BART Transbay Tube and (3) to verify numerical methods. Test results indicated that the anticipated uplift during the design earthquake would be acceptable (less than about 0.25 m). Three uplift mechanisms were observed in the centrifuge model tests: (1) a cyclic ratcheting mechanism of sand moving under the tunnel associated with cyclic lateral deformations of the tunnel, (2) seepage of water under the tunnel, and (3) heave of soft clay around the trench. Flow of the sand as a viscous liquid was not observed. Two approaches were used to record subsurface movements in the centrifuge experiments. The traditional approach used data from accelerometers and displacement transducers to determine the trajectory of the tunnel. A new approach, Electric Field Displacement Sensors (EFDS), involves installation of source and ground electrodes in the specimen through which well defined multi-directional electric fields can be set up in the specimen. The movement of measurement electrode (which can be attached to an object of interest) can then be determined simply by measuring its voltage. Li (2006) was the first to use this approach, but she used an electrode switching system to sequentially excite multidirectional electric fields. A new contribution of this thesis was the idea that independent electric fields data from different sources can be excited simultaneously at different frequencies; elimination of the need for the switching system has saved a lot of complexity in the equipment and also
allowed much improved temporal resolution. After comparing the processed data from the EFDS and traditional approaches, the EFDS can capture the dynamic response pretty well but the EFDS has its limitations. The change of soil resistivity and the heterogeneities of the soil resistivity affect the estimated movements greatly but the change of the soil resistivity can not be captured from the voltage data in the current implementation. With continued work on solving its limitation, the EFDS could become a fairly inexpensive tool for tracking movements. A parametric study was performed using a finite difference program, FLAC 2D. In the numerical simulation, the UBC Sand model (Beatty and Byrne 1998) was used to model the behavior of liquefiable soils. A mesh sensitivity study was performed to decide the appropriate number of nodes for the simulations and how to best model sliding at interfaces between the soil and tunnel. In the parametric study, effects of different geometry characteristics and soil properties on the seismic behavior of the tunnel were explored and the results are summarized in a few dimensionless plots. After effects of various factors on the tunnel performance were understood, suggestions for the future tunnel design were made: (1) densify the liquefiable soils to reduce the cyclic mobility associated with liquefaction, (2) minimize the volume of the liquefiable soils and the thickness of the liquefiable soils underneath the tunnel to reduce the volume of pore water expelled and the space through which water and soil may flow under the tunnel, (3) make the elevation of the interface between high and low permeability materials shallow enough so that high pore pressures are not trapped near the base of the tunnel, (4) make the liquefiable soils as permeable as possible to drain high pore pressures away from the base of the tunnel, and (5) make the unit weight of the tunnel as close as to the surrounding soil.

**Centrifuge Modeling of Settlement and Lateral Spreading with Comparisons to Numerical Analysis**

This open access book presents work collected through the Liquefaction Experiments and Analysis Projects (LEAP) in 2017. It addresses the repeatability, variability, and sensitivity of lateral spreading observed in twenty-four centrifuge model tests on mildly sloping liquefiable sand. The centrifuge tests were conducted at nine different centrifuge facilities around the world. For the first time, a sufficient number of experiments were conducted to enable assessment of variability of centrifuge test results. The experimental data provided a unique basis for assessing the capabilities of twelve different simulation platforms for numerical simulation of soil liquefaction. The results of the experiments and the numerical simulations are presented and discussed in papers submitted by the project participants. The work presented in this book was followed by LEAP-Asia that included assessment of a generalized scaling law and culminated in a workshop in Osaka, Japan in March 2019. LEAP-2020, ongoing at the time of printing, is addressing the validation of soil-structure interaction analyses of retaining walls involving a liquefiable soil. A workshop is planned at RPI, USA in 2020. This work was published by Saint Philip Street Press pursuant to a Creative Commons license permitting commercial use. All rights not granted by the work's license are retained by the
Geotechnical Centrifuge Technology

This book provides a thorough review of this powerful and sophisticated technique for modelling soil structure interactions. It has been written by an international team of authors.

Centrifugal and Analytical Modeling of Soft Soil Sites Subjected to Seismic Shaking

Numerical and Dynamic Centrifuge Modeling of Initiation of Flow Failure and Interface Behavior

Modelling Sand Production in a Geotechnical Centrifuge

Centrifuge Model Simulation of Impact Loading on Footing

River dyke failure modeling under transient water conditions

Centrifugal Modeling of Collapse of Underground Cavities in Sands

Submarine Landslide Flows Simulation Through Centrifuge Modelling

Like New, No Highlights, No Markup, all pages are intact.
Access Free Simulation Of A Centrifuge Model Test Of Pile Foundations

**Centrifugal Modeling Techniques**

Knowledge of the performance of river dykes during flooding is necessary when designing governmental assistance plans aimed to reduce both casualties and material damage. This is especially relevant when floods have increased in their frequency during the last decades, together with the resulting material damage and life costs. Most of previous attempts for analyzing dyke breaching during flooding have neglected to consider the soil mechanics component and the influence of infiltration and saturation changes on the failure mechanisms developed in the river dyke. This research project aimed to fill that gap in knowledge by analyzing, in a comprehensive manner, the effect of transient water conditions, represented by successive flood cycles, on the seepage conditions and subsequent breaching of dykes. Therefore, three key sub-projects were carried out: • the analysis of the results from an overflow field test, • the physical modeling of small-scaled models under an enhanced gravity field, • the numerical modeling of the flow response and the resulting stability of both the air- and water-side slopes. The results from the numerical simulations matched accurately with the results obtained with the centrifuge modeling, including the prediction of local instabilities during the flood cycles for those dykes that did not include a toe filter.

**Bureau of Mines Geotechnical Centrifuge Research--a Review**

**Model Tests and Numerical Simulations of Liquefaction and Lateral Spreading**

This research effort explored the feasibility of using a centrifuge as an experimental simulator to measure free-field blast parameters very near the explosive charge. A series of experimental blast events was conducted in the 30 g to 80 g range using the centrifuge test facility located at Kirtland AFB New Mexico. The results of these tests concluded that the use of a centrifuge simulator is a workable concept for the determination of blast parameters. The simulation of high-explosive effects through gravity scaling permits the use of small charges in the centrifuge simulator and it can easily be refurbished after each test. More importantly, the use of the centrifuge simulator preserves the gravity scaling relationships which are usually distorted during replica model testing. (Author).

**Centrifuge Modeling of the BART Transbay Tube and Numerical Simulation of Tunnels in Liquefying Ground**

The U.S. Department of Energy (DOE) is interested in developing tools and methods for potential U.S. use in designing and
evaluating safeguards systems used in enrichment facilities. This research focuses on analyzing the effectiveness of the safeguards in protecting against the range of safeguards concerns for enrichment plants, including diversion of attractive material and unauthorized modes of use. We developed an Extend simulation model for a generic medium-sized centrifuge enrichment plant. We modeled the material flow in normal operation, plant operational upset modes, and selected diversion scenarios, for selected safeguards systems. Simulation modeling is used to analyze both authorized and unauthorized use of a plant and the flow of safeguards information. Simulation tracks the movement of materials and isotopes, identifies the signatures of unauthorized use, tracks the flow and compilation of safeguards data, and evaluates the effectiveness of the safeguards system in detecting misuse signatures. The simulation model developed could be of use to the International Atomic Energy Agency IAEA, enabling the IAEA to observe and draw conclusions that uranium enrichment facilities are being used only within authorized limits for peaceful uses of nuclear energy. It will evaluate improved approaches to nonproliferation concerns, facilitating deployment of enhanced and cost-effective safeguards systems for an important part of the nuclear power fuel cycle.

Physical Modeling of Tailings Dams Using Centrifuge Simulation Techniques

This open access book presents work collected through the Liquefaction Experiments and Analysis Projects (LEAP) in 2017. It addresses the repeatability, variability, and sensitivity of lateral spreading observed in twenty-four centrifuge model tests on mildly sloping liquefiable sand. The centrifuge tests were conducted at nine different centrifuge facilities around the world. For the first time, a sufficient number of experiments were conducted to enable assessment of variability of centrifuge test results. The experimental data provided a unique basis for assessing the capabilities of twelve different simulation platforms for numerical simulation of soil liquefaction. The results of the experiments and the numerical simulations are presented and discussed in papers submitted by the project participants. The work presented in this book was followed by LEAP-Asia that included assessment of a generalized scaling law and culminated in a workshop in Osaka, Japan in March 2019. LEAP-2020, ongoing at the time of printing, is addressing the validation of soil-structure interaction analyses of retaining walls involving a liquefiable soil. A workshop is planned at RPI, USA in 2020.

Centrifuge Modeling for Soil-pile-bridge Systems with Numerical Simulations Accounting for Soil-container-shaker Interaction

Centrifuge Modeling of Liquefaction in Layered Soils
Model Tests and Numerical Simulations of Liquefaction and Lateral Spreading

Landslides occur both onshore and offshore. However, little attention has been given to offshore landslides (submarine landslides). Submarine landslides have significant impacts and consequences on offshore and coastal facilities. The unique characteristics of submarine landslides include large mass movements and long travel distances at very gentle slopes. This thesis is concerned with developing centrifuge scaling laws for submarine landslide flows through the study of modelling submarine landslide flows in a mini-drum centrifuge. A series of tests are conducted at different gravity fields in order to understand the scaling laws involved in the simulation of submarine landslide flows. The model slope is instrumented with miniature sensors for measurements of pore pressures at different locations beneath the landslide flow. A series of digital cameras are used to capture the landslide flow in flight. Numerical studies are also carried out in order to compare the results obtained with the data from the centrifuge tests. The Depth Averaged Material Point Method (DAMPM) is used in the numerical simulations to deal with large deformation (such as the long runout of submarine landslide flows). Parametric studies are performed to investigate the validity of the developed centrifuge scaling laws under the initial and boundary conditions given in the centrifuge tests. Both the results from the centrifuge tests and numerical simulations appear to follow the proposed centrifuge scaling laws, which differ from the conventional centrifuge scaling laws. The results provide a better understanding of the centrifuge scaling laws that need to be adopted for centrifuge experiments involving submarine landslide flows, as well as giving an insight into the flow mechanism involved in submarine landslide flows.

Centrifuge Modeling of the Effects of Aggradation and Progradation on Syndepositional Salt Structures

This book contains technical papers, presented in a discussion session at the XI International Conference on Soil Mechanics and Foundation Engineering held in San Francisco in 1985, on the role of centrifuge in geotechnical testing, with descriptions of test facilities.

Centrifuge Modeling of Soil Liquefaction

This open access book presents work collected through the Liquefaction Experiments and Analysis Projects (LEAP) in 2017. It addresses the repeatability, variability, and sensitivity of lateral spreading observed in twenty-four centrifuge model tests on mildly sloping liquefiable sand. The centrifuge tests were conducted at nine different centrifuge facilities around the world. For the first time, a sufficient number of experiments were conducted to enable assessment of variability of centrifuge test
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**Centrifuges in Soil Mechanics**

**International Conference on Simulation '98**

**Centrifuge Modeling for Dynamic Response of Foundations**

This SBIR 2 final report covers three areas: (1) current state of the art of the human factors effects of flying thrust vectored, or supermaneuverable, aircraft, (2) the development and validation of a model of the 3 axis Dynamic Environment Simulator (DES) centrifuge, and (3) potential upgrades to the 30 year old DES to enhance its performance. The F-22 will be the first production thrust vectored aircraft in aviation history. Because of its pitch axis thrust vector control, the F-22 can pitch at high rates of angular velocity as it flies. The human factors effects of controlling such an aircraft are unknown. The DES was modeled in order to evaluate its ability to replicate some multi-axis accelerations, or agile maneuvers. The MATLAB model allows researchers the ability to investigate such supermaneuvers as the Cobra, Herbst, and Hook on a PC before using the DES. It appears DES arm onset improvements above 3.5 G/sec will not improve agile flight simulation; however, the addition of a fourth degree of freedom (yaw axis platform for seat) is likely to enhance multi-axis simulation fidelity.

**Centrifuge Modelling for Earthquake Simulation at C-CORE's Geotechnical Engineering Centrifuge Facility**

Solve Complex Ground and Foundation Problems Presenting more than 25 years of teaching and working experience in a wide variety of centrifuge testing, the author of Centrifuge Modelling for Civil Engineers fills a need for information about this field. This text covers all aspects of centrifuge modelling. Expertly explaining the basic principles, the book makes this technique accessible to practicing engineers and researchers. Appeals to Non-Specialists and Specialists Alike Civil engineers
that are new to the industry can refer to this material to solve complex geotechnical problems. The book outlines a
generalized design process employed for civil engineering projects. It begins with the basics, and then moves on to
increasingly complex methods and applications including shallow foundations, retaining walls, pile foundations, tunnelling
beneath existing pile foundations, and assessing the stability of buildings and their foundations following earthquake-
induced soil liquefaction. It addresses the use of modern imaging technique, data acquisition, and modelling techniques. It
explains the necessary signal processing tools that are used to decipher centrifuge test data, and introduces the reader to
the specialist aspects of dynamic centrifuge modelling used to study dynamic problems such as blast, wind, or wave loading
with emphasis on earthquake engineering including soil liquefaction problems. Introduces the equipment and
instrumentation used in centrifuge testing Presents in detail signal processing techniques such as smoothing and filtering
Provides example centrifuge data that can be used for sample analysis and interpretation Centrifuge Modelling for Civil
Engineers effectively describes the equipment, instrumentation, and signal processing techniques required to make the best
use of the centrifuge modelling and test data. This text benefits graduate students, researchers, and practicing civil
engineers involved with geotechnical issues.

Physical Modelling in Geotechnics, Two Volume Set

This open access book presents work collected through the Liquefaction Experiments and Analysis Projects (LEAP) in 2017. It
addresses the repeatability, variability, and sensitivity of lateral spreading observed in twenty-four centrifuge model tests on
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Feasibility Study of Centrifuge Modeling of SAGD Caprock Integrity