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Physical and Numerical Modelling of Pipe/soil Interaction Events for Large Deformation Geohazards - Kenton Patrick Pike 2016
Large deformation, differential ground movement events on buried pipelines involve large strain, nonlinear contact interaction, and soil strain localization and failure mechanisms. This study is focused on advancing finite element modelling procedures through laboratory tests to enhance soil constitutive models, physical models to verify simulation tools and algorithms to improve simulation tools that capture realistic behaviour for cohesive and

cohesionless soils. The outcomes provide a robust framework for improved confidence in predicted outcomes to support engineering design. The large deformation, ice gouge events, in cohesive soil, and pipe/soil interaction events, in cohesive and cohesionless soil, were simulated using the Coupled Eulerian Lagrangian (CEL) formulation within ABAQUS/Explicit modelling framework. For ice gouge events, the numerical simulation was conducted using total stress analysis and the von Mises yield criterion. The numerical modelling procedures are improved by incorporating the distribution of soil properties, including elastic modulus and shear strength, throughout the domain without the need to develop complex user material subroutines. The numerical predictions were in agreement with available data in the literature and exhibited improved accuracy with respect to the keel reaction forces and subgouge soil deformations. The major contribution was to improve the benchmark and state-of-art for the numerical simulation of ice gouge events in cohesive soil. Having developed confidence in the numerical simulation of large deformation events in cohesive soil, the research focused on advancing the modelling procedures for cohesionless soil. Large-scale, physical tests on lateral pipe/soil interaction events in sand investigated the effects of pipe diameter (254 mm, 609.6 mm), burial depth to pipe diameter ratio (1, 3, 7) and soil density (14.7 kN/m3, 15.6 kN/m3). The main objective was to provide a verification basis for the numerical modelling procedures with respect to the force-displacement response and localized soil failure mechanisms. The physical tests contributed to the limited database, for the range of pipe diameters examined, and the first large-scale lateral pipe/soil interaction tests to provide detailed soil deformation and strain fields using particle image velocimetry (PIV) technique. In parallel with the physical testing program, an enhanced constitutive model for cohesionless

soil was advanced through the development of a user-subroutine that accounts for the effects of soil friction angle and dilation angle as a function of plastic shear strain. Laboratory triaxial and direct shear tests were used to characterize the strength parameters. This contribution has practical applications for pipe/soil interaction events in granular soils, particularly at shallow burial depth with low confining pressure, large soil deformations and strains, and dense sand states with strain softening behaviour. Integrating the enhanced constitutive soil models, the numerical modelling procedures, were verified through comparison with the large-scale pipe/soil interaction tests conducted in this study and third-party physical modelling data. An extended study was conducted to assess the verified simulation tool across a range of practical engineering design scenarios. The outcomes from this study illustrated the improved accuracy and confidence in the numerical predictions, based on the tools developed in this study, that provide a significant contribution to the field of buried pipeline design against large deformation ground movement events.
Investigating Soil/pipeline Interaction During Oblique Relative Movements - Nasser Daiyan 2013

Computer Methods and Advances in Geomechanics - Chandra S. Desai 1991

Numerical Methods in Geotechnical Engineering IX - António S. Cardoso 2018-06-19
Numerical Methods in Geotechnical Engineering IX contains 204 technical and scientific papers presented at the 9th European Conference on Numerical Methods in Geotechnical Engineering (NUMGE2018, Porto, Portugal, 25—27 June 2018). The papers cover a wide range of topics in the field of computational geotechnics, providing an overview of recent developments on scientific achievements, innovations and

engineering applications related to or employing numerical methods. They deal with subjects from emerging research to engineering practice, and are grouped under the following themes: Constitutive modelling and numerical implementation Finite element, discrete element and other numerical methods. Coupling of diverse methods Reliability and probability analysis Large deformation – large strain analysis Artificial intelligence and neural networks Ground flow, thermal and coupled analysis Earthquake engineering, soil dynamics and soil-structure interactions Rock mechanics Application of numerical methods in the context of the Eurocodes Shallow and deep foundations Slopes and cuts Supported excavations and retaining walls Embankments and dams Tunnels and caverns (and pipelines) Ground improvement and reinforcement Offshore geotechnical engineering Propagation of vibrations Following the objectives of previous eight thematic conferences, (1986 Stuttgart, Germany; 1990 Santander, Spain; 1994 Manchester, United Kingdom; 1998 Udine, Italy; 2002 Paris, France; 2006 Graz, Austria; 2010 Trondheim, Norway; 2014 Delft, The Netherlands), Numerical Methods in Geotechnical Engineering IX updates the state-of-the-art regarding the application of numerical methods in geotechnics, both in a scientific perspective and in what concerns its application for solving practical boundary value problems. The book will be much of interest to engineers, academics and professionals involved or interested in Geotechnical Engineering.

Investigation of the Pipe-soil Interaction Around Continuous and Jointed Pipes - Müge Balkaya 2010

In this study, the three dimensional response of a rubber-gasketed bell-and-spigot jointed PVC (polyvinyl chloride) pressure pipe is examined to develop an understanding of the effect of gasket modulus, friction coefficient, insertion length and joint rotation on the pipe-joint behavior.

Numerical analyses are performed using ABAQUS. In addition to studying joints using finite element analysis, the jointed pipe specimens are tested in the laboratory to investigate the behavior of the pipe-joint assembly during insertion and bending. Furthermore, parametric studies using three-dimensional finite element analyses are also reported, where continuous and jointed PVC and CI (cast iron) water pipes buried under overburden soil are examined. The primary purpose of this study was to develop a better understanding of longitudinal bending as a result of voids under the invert of buried pipes, a condition used to characterize the effect of poor construction practice or loss of support during service (say as a result of erosion caused by water leakage). All numerical analyses were performed using ABAQUS.

Advances in Civil Engineering and Building Materials IV - Shuenn-Yih Chang 2015-05-06

Covering a wide range of topics, Advances in Civil Engineering and Building Materials IV presents the latest developments in:- Structural Engineering- Road & Bridge Engineering- Geotechnical Engineering- Architecture & Urban Planning- Transportation Engineering- Hydraulic Engineering- Engineering Management- Computational Mechanics- Constru

Guidelines for the Seismic Design of Oil and Gas Pipeline Systems - 1984

Issues in Land and Water Engineering: 2011 Edition - 2012-01-09

Issues in Land and Water Engineering / 2011 Edition is a ScholarlyEditions™ eBook that delivers timely, authoritative, and comprehensive information about Land and Water Engineering. The editors have built Issues in Land and Water Engineering: 2011 Edition on the vast information databases of ScholarlyNews.™ You can expect the information about Land and Water Engineering in this eBook to be deeper than what you can

access anywhere else, as well as consistently reliable, authoritative, informed, and relevant. The content of Issues in Land and Water Engineering: 2011 Edition has been produced by the world's leading scientists, engineers, analysts, research institutions, and companies. All of the content is from peer-reviewed sources, and all of it is written, assembled, and edited by the editors at ScholarlyEditions™ and available exclusively from us. You now have a source you can cite with authority, confidence, and credibility. More information is available at http://www.ScholarlyEditions.com/.

Ground Improvement and Earth Structures - Mounir Bouassida 2017-07-11

This volume contains research articles that cover a wide range of topics related to ground improvement and subsurface structures. Selected papers represent the state-of-the-art in the analysis and design of reinforced retaining walls, diaphragm walls and buried pipes. In addition, topics related to ground improvement using vacuum consolidation and deep mixing techniques are also included. This volume is part of the proceedings of the 1st GeoMEast International Congress and Exhibition on Sustainable Civil Infrastructures, Egypt 2017.

Unsaturated Soil Mechanics - from Theory to Practice - Zhenghan Chen 2015-10-14

In the past decades advances have been made in the research and practice on unsaturated soil mechanics. In 2000 the first Asia-Pacific Conferences on Unsaturated Soils was organized in Singapore. Since then, four conferences have been held under the continued support of the Technical Committee on Unsaturated Soils (TC106) of the International Socie

Understanding and Reducing Landslide Disaster Risk - Željko Arbanas 2020-12-20

This book is a part of ICL new book series "ICL Contribution to Landslide Disaster Risk Reduction" founded in 2019. Peer-reviewed papers submitted to the Fifth World Landslide Forum were published in six volumes of this

book series. This book contains the following parts: • Impact of Large Ground Deformations near Seismic Faults on Critically Important Civil Infrastructures• Recent Progress in the Landslide Initiating Science• Earth Observation and Machine Learning in Landslide Science• General Landslide Studies Professor Željko Arbanas is the Vice President of International Consortium on Landslides. He is a Professor of Faculty of Civil Engineering, University of Rijeka, Croatia. He is the Assistant Editor-in-Chief of International Journal Landslides. Professor Peter Bobrowsky is the President of International Consortium on Landslides. He is a Senior Scientist of Geological Survey of Canada, Ottawa, Canada. Professor Kazuo Konagai is Professor Emeritus at the University of Tokyo and Principal Researcher at the ICL Headquarters. He serves as the Secretary-General of the Fifth World Landslide Forum. Professor Kyoji Sassa is the Founding President and the Secretary-General of the International Consortium on Landslides (ICL). He has been the Editor-in-Chief of International Journal Landslides since its foundation in 2004. Professor Kaoru Takara is the Executive Director of International Consortium on Landslides. He is a Professor and Dean of Graduate School of Advanced Integrated Studies (GSAIS) in Human Survivability (Shishu-Kan), Kyoto University.

Soil Dynamics and Soil-Structure Interaction for Resilient Infrastructure - Tarek Abdoun 2017-07-11

Infrastructure is the key to creating a sustainable community. It affects our future well-being as well as the economic climate. Indeed, the infrastructure we are building today will shape tomorrow's communities. GeoMEast 2017 created a venue for researchers and practitioners from all over the world to share their expertise to advance the role of innovative geotechnology in developing sustainable infrastructure. This volume focuses on the role of soil-structure-interaction and soil dynamics. It

discusses case studies as well as physical and numerical models of geo-structures. It covers: Soil-Structure-Interaction under static and dynamic loads, dynamic behavior of soils, and soil liquefaction. It is hoped that this volume will contribute to further advance the state-of-the-art for the next generation infrastructure. This volume is part of the proceedings of the 1st GeoMEast International Congress and Exhibition on Sustainable Civil Infrastructures, Egypt 2017.

Large Deformation Finite Element Analysis of Partially Embedded Offshore Pipelines for Vertical and Lateral Motion at Seabed - Sujan Dutta 2012

The Integrated Stability Analysis of Offshore Pipelines - Bassem Samir Hassan Youssef 2011

[Truncated abstract] Pipelines are the main conduits in offshore hydrocarbon developments and for economical and environmental reasons must be designed to safely operate in remote locations and under harsh environments. For pipelines laid directly on the seabed, pipeline on-bottom stability is critical and analysis techniques should accurately simulate the real offshore processes occurring. This thesis is concerned with the on-bottom stability analysis of offshore pipelines under the action of wave and current loading. It details how hydrodynamic load modeling, pipe-soil interaction modeling and the coupling effect between the hydrodynamic load and the pipe-soil interaction can be properly considered. The motivation is to develop an integrated pipeline on-bottom stability analysis program and design methodology, and to use it to achieve a better understanding of hydrodynamicpipe- soil interaction. A hydrodynamic modeling program that generates a 3-D ocean surface, estimates the wave kinematics at the pipeline level and calculates the hydrodynamic loads on the pipeline was coded in FORTRAN. It has been named UWAHYDRO. Pipe-soil interaction is

modeled using plasticity based techniques, again coded in FORTRAN in the UWAPIPE program. A unique pipeline on-bottom stability simulation program was developed by integrating UWAHYDRO and UWAPIPE with the commercial finite element program ABAQUS. The developed modeling program can efficiently evaluate the movement of a long pipeline under storm conditions, as shown by a parametric study of 1250 m of pipeline under one-hour of storm characteristic of the Australian North West Shelf region. Probabilistic methods are also discussed in this thesis and are used to develop further understanding of the pipeline on-bottom stability and to estimate the reliability of the pipeline under different design conditions. A sensitivity study using realistic uncertainty in the input basic random variables was conducted to inform engineers of which are the most critical parameters in the pipeline on-bottom stability design. A set of pipe centrifuge tests was carried out using the beam centrifuge facility at the University of Western Australia. The tests were designed to investigate the pipe-soil interaction behavior under the action of complex load paths similar to the hydrodynamic loads conditions offshore. This subjected the pipe-soil model, for the first time, to loading conditions different to those used to derive its parameters. The applied loads were designed to be gradually increasing to allow examination of different pipe-soil interaction stages with different loads intensity. Results showed that the pipe embeds itself during the earlier stages of cyclic loads and also shapes the side berms. Larger cyclic loads were required to lift the pipe from its embedment zone and to break out of the berms created. However, the centrifuge tests confirmed that basic pipe-soil behavior could still be numerically modeled, but with conservative predictions of sliding/uplift failure at cyclic loads smaller than the experimental limits...

Numerical Modelling of Pipe-soil Interactions - Santiram Chatterjee 2012

[Truncated abstract] This thesis described research into the pipe-soil interaction forces during large movements of deep-water pipelines, using numerical methods. Vertical penetration, lateral break-out and steady-state lateral resistances were investigated with the help of numerical models using a large deformation approach implemented within the ABAQUS finite element software and sophisticated soil constitutive models. The large deformation finite element methodology is based on a periodic remeshing and interpolation technique which was developed for this research to incorporate the effects of changes in the strength and geometry of the seabed during large movements of the pipelines. Soil constitutive model that accounts for strain rate effects and remoulding were implemented to simulate realistic behaviour. Coupled pore-fluid stress analyses were also carried out using the modified Cam Clay plasticity model to investigate the effects of drainage and consolidation on interaction forces. The initial vertical penetration of a seabed pipeline is an important parameter for design of these pipes against lateral buckling and other design conditions. The penetration rate and strain softening have marked effects on the resistance experienced during vertical penetration. A simple elastic perfectly plastic soil constitutive model was modified to incorporate these effects to identify the equivalent shear strength of the soil. A parametric study considering wide range of parameters was conducted and the results were unified when the vertical penetration resistance was normalised using this equivalent shear strength. Simplified equations are presented for ease of application. Lateral pipe-soil interactions were also studied to observe the effects of the initial embedment and different pipe weights. Two stages of lateral interaction are dealt in this research. Firstly, the initial breakout resistance was investigated through large deformation finite element analyses and also limit analysis

using the software OxLim. Results were presented in terms of plastic failure envelopes in the V-H load space for different initial embedments. The steady state lateral residual resistance was then studied using large deformation analyses and an appropriate soil constitutive model. It was found that steady state resistance is achieved after a lateral displacement of typically three times the pipe diameter or less, even if the soil berm continues to grow in size. The increase in berm size is counteracted by a reduction in the soil strength due to accumulation of plastic strain. The steady state residual friction factor was linked to a new history parameter termed the effective embedment in a simple manner, regardless of the other soil and pipeline parameters. Finally, coupled consolidation analyses using the modified Cam Clay plasticity model was carried out to explore the effects of consolidation on penetration and breakout resistances. Elastoplastic modelling of consolidation beneath partially embedded pipes was first done to study the pore pressure dissipation time history, allowing the rate of build-up of pipe-soil resistance to be assessed. The effects of penetration rate on the vertical resistance were examined and backbone-type curves showing drained, undrained and partially drained behaviour were presented...

Deepwater Foundations and Pipeline Geomechanics - William O. McCarron 2011-09-15

Practicing engineers in the offshore and reservoir engineering industry will find this timely volume filled with practical advice and expert information on current oil field development from oil exploration to production.

Proceedings of the ... International Conference on Offshore Mechanics and Arctic Engineering - 2006

Computational Methods of Multi-Physics Problems - Timon Rabczuk 2019-08-20

This book offers a collection of six papers addressing problems associated with the computational modeling of multi-field problems. Some of the proposed contributions present novel computational techniques, while other topics focus on applying state-of-the-art techniques in order to solve coupled problems in various areas including the prediction of material failure during the lithiation process, which is of major importance in batteries; efficient models for flexoelectricity, which require higher-order continuity; the prediction of composite pipes under thermomechanical conditions; material failure in rock; and computational materials design. The latter exploits nano-scale modeling in order to predict various material properties for two-dimensional materials with applications in, for example, semiconductors. In summary, this book provides a good overview of the computational modeling of different multi-field problems.

Applied Soil Mechanics with ABAQUS Applications - Sam Helwany 2007-03-16

A simplified approach to applying the Finite Element Method to geotechnical problems Predicting soil behavior by constitutive equations that are based on experimental findings and embodied in numerical methods, such as the finite element method, is a significant aspect of soil mechanics. Engineers are able to solve a wide range of geotechnical engineering problems, especially inherently complex ones that resist traditional analysis. Applied Soil Mechanics with ABAQUS® Applications provides civil engineering students and practitioners with a simple, basic introduction to applying the finite element method to soil mechanics problems. Accessible to someone with little background in soil mechanics and finite element analysis, Applied Soil Mechanics with ABAQUS® Applications explains the basic concepts of soil mechanics and then prepares the reader for solving geotechnical engineering problems using both

traditional engineering solutions and the more versatile, finite element solutions. Topics covered include: Properties of Soil Elasticity and Plasticity Stresses in Soil Consolidation Shear Strength of Soil Shallow Foundations Lateral Earth Pressure and Retaining Walls Piles and Pile Groups Seepage Taking a unique approach, the author describes the general soil mechanics for each topic, shows traditional applications of these principles with longhand solutions, and then presents finite element solutions for the same applications, comparing both. The book is prepared with ABAQUS® software applications to enable a range of readers to experiment firsthand with the principles described in the book (the software application files are available under "student resources" at www.wiley.com/college/helwany). By presenting both the traditional solutions alongside the FEM solutions, Applied Soil Mechanics with ABAQUS® Applications is an ideal introduction to traditional soil mechanics and a guide to alternative solutions and emergent methods. Dr. Helwany also has an online course based on the book available at www.geomilwaukee.com.
ABAQUS/Standard - 2001

Numerical Modelling of Pipeline and Riser Seabed Interaction - Xiaoyu Dong 2020
Subsea risers and pipelines are widely used in offshore industries especially for the production of oil and gas resources. Due to complex subsea environment, a variety of risks are challenging the operation or serviceability life of subsea pipelines and risers. Subsea riser and pipeline-seabed interaction are proven to have significant effect on its performance. This interaction can be modeled by two main approaches, beam-spring, and continuum approach. Beam-spring model provided the most efficient and economical way to estimate the response of soil. While with more explorations in fields, more sophisticated and accurate models are required and thus continuum models are developed to

give more details on the soil behavior around the pipe. Two challenging topics in pipeline and riser seabed interaction were selected, 1- the effect of riser-seabed interaction on fatigue life in touchdown zone, 2- the effect of trenching/backfilling on lateral response of buried pipelines. The first one was modelled by beam-spring approach and the second one investigated by continuum approach. The abstracts of the conducted research works are independently discussed below: A.1. Part I Pipeline-Seabed Interaction Subsea pipelines are often protected by burying in the subsea trenches to mitigate the effects of the functional and environmental loads. Depending on the trenching methodology (pre-lay or post-lay trenching), trenching and laying the pipeline may take place at the same time or in a different period of time. Using the excavated material for backfilling of the pipeline is a common practice and a cost-effective solution. Depending on trenching methodology, construction strategy, and environmental loads, the backfilling material may experience different degrees of remolding resulting in a softer material with a range of shear strengths. The difference between the stiffness of the backfill and native material affects the soil failure mechanisms under the lateral pipeline displacement. The relative displacement between the pipeline and the surrounding soil that may occur due to the ground movements, faults, slope instabilities, ice gouging, etc. exerts forces on the pipeline. The amplitude of these forces on the pipeline depends on several parameters, including the submerged weight of the mobilized backfilling and native soil, the horizontal component of shearing resistance offered by interacted soil, and the suction behind the pipe. And the load-displacement curve becomes important in terms of the design of the embedded pipelines. Under different circumstances, trenched pipelines might be displaced at different velocities (could be from millimeters per year to very high),

resulting in different drainage conditions (including undrained condition, partially drained condition, and drained condition). Partially drainage condition in pipe-soil interaction has been a very challenging topic since it requires a coupled analysis with the pore fluid pressure to explore the induced excess pore pressure which affects the responses of the pipe, internal soil deformation, and also the failure mechanism in the soil. However, most of the published works only explored the undrained condition of soil. These parameters in turn depend on several parameters such as the properties of the backfill and the native soil, trench geometry, burial depth and confining pressure, pipeline roughness, pipeline size, loading rate (drained/undrained), soil stress history, the backfill extent of consolidation, and the over-consolidation ratio (OCR) of native soil . In this thesis, a coupled large deformation finite element (LDFE) model using re-meshing and interpolation technique with small strain (RITSS) was developed to give prediction of the pipeline force-displacement response together with the computation of the induced excess pore pressure within large deformations. This coupled LDFE model was proven to have advantages in modelling pipe-soil interaction under drained and partially drained conditions using the ABAQUS built-in coupled pore fluid pressure method, which cannot work with the popular existing LDFE method such as Coupled Eulerian Lagrangian (CEL) method. And the LDFE model was proved to be a strong tool for comprehensive investigation of the progressive failure mechanisms around the pipeline considering the varying pipeline-backfill-trench interaction effects. A.2. Part II Riser-Seabed Interaction Steel catenary risers (SCR) are popular amongst the riser families because of their lower cost and technical advantages such as applicability in a wider range of sizes and water depths. The survey results obtained by remote operating vehicles (ROV) have proved

the complex non-linear seabed response to riser fluctuations in the touchdown zone (TDZ), where SCR penetrates into the seabed and cyclically creates trenches often with several diameters deep. The oscillatory motions of SCR in the touchdown zone result in a complex riser interaction mechanism with surrounding media including fluid and soil. Some of the influential parameters contributing to these non-linear hysteretic interactions are: soil stiffness degradation under cyclic loads and riser penetration into the seabed, mobilization of suction force within uplift motions of riser, trench base softening and damping, erosive mechanism by water velocity field around the SCR in TDZ and consequent variation of flow pattern of displaced water, the riser dynamics influenced by internal multi-phase flow regimes and also vessel motions (velocity and frequencies), and vortex-induced vibration (VIV). The existing non-linear hysteretic riser-seabed interaction models have been verified in wave-induced fatigue assessment. However, the effect of non-linear seabed interaction on the riser fatigue under riser vibrations has never been examined. In this work, the performance of the non-linear hysteretic models was investigated in slug-induced fatigue damages in touchdown zone which is a key contributor to fatigue damage. For this purpose, first the nodal and global performance of the most popular models was comprehensively examined, and its pros and cons were thus explored. Then an advanced and novel model was developed to simulate the riser slugging and slug-induced fatigue, which has never been done in the past due to extreme complexity. This model was incorporated into slug-induced fatigue analysis and it was indicated that the model was applicable to these type of analysis with acceptable level of accuracies. The research work showed that the slug-induced vibrations can combine with the wave-induced oscillations and create critical case scenarios. Therefore, it is critical to

consider the combined effects of slugging and wave in riser fatigue analysis and fill the knowledge gap.
Canadian Geotechnical Conference - 1999

Earthquakes and Structures - T. G. Sitharam 2021-11-19
This volume presents select papers presented at the 7th International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics. The papers discuss advances in the fields of earthquake engineering connected with structures. Some of the themes include soil structure interaction, dynamic analysis, underground structures, vibration isolation, seismic response of buildings etc. A strong emphasis is placed on connecting academic research and field practice, with many examples, case studies, and best practices. This volume will be of interest to researchers and practicing engineers alike.

Numerical Modeling of Large Deformation Behaviour of Offshore Pipelines and Risers in Soft Clay Seabeds - Sujan Dutta 2017
Deepwater oil and gas development activities have increased significantly in the last few decades to meet the global demand for energy. One of the key components of these developments is the oil and gas transportation pipeline. Deepwater pipelines are often laid on the seabed and may vertically penetrate into the seabed sediment (primarily clay) or remain suspended in the case of uneven seabed profiles. Partially embedded pipelines might displace laterally during operation due to changes in internal pressure and temperature. The displacement of the pipeline depends on soil resistance, which is also related to the initial embedment. The suspended pipelines might also be impacted by soil blocks moving out from submarine landslides. Moreover, in deepwater, steel catenary risers (SCR)-a long pipe of 150-600 mm typical diameter-are often used to transport hydrocarbon from the seabed

production system to floating production facilities. The interaction between soil, water and pipes (partially embedded, suspended or SCR) involves significant large deformations, which cannot be modeled properly using traditional Lagrangian-based finite element (FE) techniques and therefore improved numerical modeling is required for safe and economic design. In the present study, simulations of the large deformation behaviour of deepwater pipelines and SCRs are performed using two numerical approaches. First, simulation is performed using the Coupled Eulerian-Lagrangian (CEL) approach available in the Abaqus FE software. In CEL, the soil is modeled as an Eulerian material that flows through the fixed mesh and therefore numerical issues related to mesh distortion at large displacements are avoided. Simulations are performed for undrained loading conditions implementing a strain-rate and strain-softening dependent undrained shear strength model for clay in Abaqus CEL through user subroutines. For partially embedded pipelines, numerical simulations are performed for vertical penetration and subsequent lateral displacements. In addition, dynamic penetration of the pipeline into a deepwater soft clay seabed is simulated. The penetration and lateral resistances are compared with the results of previous physical model tests, and numerical and analytical solutions. Recognizing the limitations of Abaqus CEL and other FE modeling techniques to simulate the role of water, ANSYS CFX-a finite volume software-is used in the second approach for numerical modeling. A technique is developed to implement strain-rate and strain-softening dependent undrained shear strength of clay in ANSYS CFX. The comparison between penetration resistances obtained from CEL and CFX shows that the latter approach can simulate the effect of water in the cavity formed behind the pipe when it penetrates to a sufficiently

large depth into the clay seabed, with a transition between shallow and deep failure mechanisms. In the SCR-seabed-water interaction modeling, in addition to undrained remoulding, the reduction of undrained shear strength due to other factors such as water entrainment is considered using "shear wetting". Cyclic degradation of penetration and uplift resistance, development of suction under the riser during uplift, and the formation of a trench are successfully simulated for a large number of cyclic motions near the seabed, where a significant shear strength reduction occurs, as reported from physical model tests. The impact force on suspended offshore pipelines by submarine landsides is also simulated using both Abaqus CEL and ANSYS CFX. The development of forces on the pipe with its penetration into the soil block shows that the trapped water behind the pipe influences the failure mechanisms and magnitude of force. The suction in the trapped water and flow of free water through the channel formed behind the pipe is simulated using ANSYS CFX. Based on a comprehensive parametric study with calibration against a series of centrifuge test results, a set of empirical equations are proposed to calculate the impact force on suspended pipelines.

Subsea Pipeline Design, Analysis, and Installation - Qiang Bai 2014-02-18

As deepwater wells are drilled to greater depths, pipeline engineers and designers are confronted with new problems such as water depth, weather conditions, ocean currents, equipment reliability, and well accessibility. Subsea Pipeline Design, Analysis and Installation is based on the authors' 30 years of experience in offshore. The authors provide rigorous coverage of the entire spectrum of subjects in the discipline, from pipe installation and routing selection and planning to design, construction, and installation of pipelines in some of the harshest underwater environments around the world. All-inclusive, this must-have handbook covers the latest

breakthroughs in subjects such as corrosion prevention, pipeline inspection, and welding, while offering an easy-to-understand guide to new design codes currently followed in the United States, United Kingdom, Norway, and other countries. Gain expert coverage of international design codes Understand how to design pipelines and risers for today's deepwater oil and gas Master critical equipment such as subsea control systems and pressure piping

Nonlinear Finite Element-based Investigation of the Effect of Bedding Thickness on Underground Pipe - Anupong Kararam 2006

The pipe-soil interaction is studied by using the finite element software, ABAQUS/CAE Version 6.5-1 as a symmetric model of embankment installation to study the effect of bedding property and thickness on pipe-soil interaction with increase in the height of fill. A three-dimensional finite element model (FEM) of the concrete pipe and surrounding soil is developed. The FEM is capable of simulating material, geometric, and contact nonlinearities which employs a nonlinear incremental solution algorithm. Several different element types and mesh size were tested to obtain the optimum converged mesh. These elements were eight-noded linear brick (C3D8R) and six-noded linear triangular prism (C3D6) for modeling of the concrete pipe and surrounding soil. The behavior of the 3-D model is investigated by varying the pipe diameter, backfill height, bedding thickness, and bedding material. Three material constitutive relationships of soil involving in the model are gravelly sand (Sn), sandy silt (Si), and silty clay (CL). To study the effect of bedding thickness on the pipe wall, due to the increment of backfill soil depth, contact elements were employed in the interface between each two regions. (Abstract shortened by UMI.).

Physical Modelling in Geotechnics - P. Guo 2022-11-22

Papers cover topics including: physical

modelling facilities; experimental advances; seismic experimental advances; education; soil behaviour; offshore systems; cold regions; geo-environment; dynamics; earthquake effects; and strategies for disaster reduction.

Geohazards and Pipelines - Spyros A. Karamanos 2020-10-31

This book presents state-of-the-art methodologies for the design and analysis of buried steel pipelines subjected to severe ground-induced action, including tectonic (quasi-static) effects, slope movements (landslides), liquefaction-induced actions or excavation-induced settlements. The text is an amended version of the final deliverables of the GIPIPE project, sponsored by the European Commission (Research Fund for Coal and Steel programme, 2011-2014). Geohazards and Pipelines presents an integrated investigation of this subject, using advanced and innovative experimental techniques, high-performance numerical simulations and novel analytical methodologies, which account for the particularities of buried steel pipelines with an emphasis on soil-pipeline interaction. Geohazards and Pipelines will be of use to professionals working in the field of pipeline engineering, including design consultants and industrial practitioners involved in projects related to pipeline infrastructure. Structural engineers, mechanical engineers, geotechnical engineers, geologists and seismologists may also find this book of interest, as may graduate students and researchers in these areas.

Analytical Methods in Petroleum Upstream Applications - Cesar Ovalles 2015-04-02

Effective measurement of the composition and properties of petroleum is essential for its exploration, production, and refining; however, new technologies and methodologies are not adequately documented in much of the current literature. Analytical Methods in Petroleum Upstream Applications explores advances in the analytical methods and instrumentation that

allow more accurate determination of the components, classes of compounds, properties, and features of petroleum and its fractions. Recognized experts explore a host of topics, including: A petroleum molecular composition continuity model as a context for other analytical measurements A modern modular sampling system for use in the lab or the process area to collect and control samples for subsequent analysis The importance of oil-in-water measurements and monitoring The chemical and physical properties of heavy oils, their fractions, and products from their upgrading Analytical measurements using gas chromatography and nuclear magnetic resonance (NMR) applications Asphaltene and heavy ends analysis Chemometrics and modeling approaches for understanding petroleum composition and properties to improve upstream, midstream, and downstream operations Due to the renaissance of gas and oil production in North America, interest has grown in analytical methods for a wide range of applications. The understanding provided in this text is designed to help chemists, geologists, and chemical and petroleum engineers make more accurate estimates of the crude value to specific refinery configurations, providing insight into optimum development and extraction schemes.

FSI Methodology for Analyzing VIV on Subsea Pipeline Free Spans with Practical Boundary Conditions - Marcus Aaron Gamino 2013

The objective of this thesis is to develop a more realistic numerical model than current methodologies for free span stability of submarine pipelines based on fatigue analysis. A general assumption in performing vortex-induced vibration (VIV) analysis of pipeline free spans is that both ends of the free span are fixed and/or pinned in order to simplify computational simulations; however, Det Norske Veritas (DNV - translation to The Norwegian Truth) Recommended Practice F105 states that these

boundary conditions must adequately represent the pipe-soil interaction and the continuality of the pipeline. To adequately simulate the free span's response to VIV, three-dimensional fluid-structure interaction (FSI) simulations are performed by coupling the computational fluid dynamics (CFD) codes from STAR-CCM+ with the finite element (FE) codes from ABAQUS. These FSI simulations in combination with separate coupled Eulerian-Lagrangian (CEL) simulations are modeled to mimic real world conditions by setting up the boundary conditions to factor in the effects of pipe-soil interaction at the ends of the span. Computational design of experiments (DOE) is utilized to determine the sensitivity of several input variables on the maximum stress response of the free span from VIV. The variables considered in this investigation include the soil density (1700-2000 kg/m3), length of pipe contact with the soil (20-200 inches), and the pipe embedment depth within the soil (0-10 inches). A Box-Behnken surface response design was used to capture the non-linear responses throughout the design space. These simulations show a mitigation of overall stresses to the free spans; as a result, the integration of pipe-soil interaction in free span assessment may aid in the prevention of unnecessary corrective action.

Subsea Pipelines and Risers - Yong Bai 2005-12-05

Marine pipelines for the transportation of oil and gas have become a safe and reliable part of the expanding infrastructure put in place for the development of the valuable resources below the world's seas and oceans. The design of these pipelines is a relatively new technology and continues to evolve as the design of more cost effective pipelines becomes a priority and applications move into deeper waters and more hostile environments. This updated edition of a best selling title provides the reader with a scope and depth of detail related to the design of offshore pipelines and risers not seen before in a

textbook format. With over 25years experience, Professor Yong Bai has been able to assimilate the essence of the applied mechanics aspects of offshore pipeline system design in a form of value to students and designers alike. It represents an excellent source of up to date practices and knowledge to help equip those who wish to be part of the exciting future of this industry.

Finite Element and Centrifuge Modeling of Frost Heave and Thaw Consolidation Settlement of Pipelines in Cold Regions - Rajith Dayarathne 2021

Frost heave and thaw settlement are two main issues that need to be considered in the design of pipelines in cold regions. Operating a chilled gas pipeline in unfrozen ground or a warm oil pipeline in frozen ground could create a frost or thaw bulb in the soils around the pipeline, which could cause significant ground movement that may impose unacceptable loads on the pipeline, especially in the proximity of thermal interfaces. Modelling of such ground movement and corresponding pipeline-soil interaction may become more complex due to seasonal variation of air temperatures and operating conditions of the pipeline (e.g., pressure and temperature at the compressor stations), which may induce freeze-thaw cycles in the soils downstream areas. The frost heave and thaw settlement around the pipeline under constant and cyclic temperatures at the pipeline and ground surfaces are the focus of the present study. An experimental investigation of displacement of pipelines buried in frost susceptible soils subjected to freeze-thaw cycles is presented first. The effectiveness of cyclic variation of pipeline operating temperatures as a frost heave mitigation measure is evaluated by analyzing 14 model pipes' tests in a geotechnical centrifuge. Based on the experimental results, five types of possible freeze-thaw induced vertical displacement responses of the pipeline during operation have been identified. The cyclic

pipeline operation (sub-zero in the winter and above-zero in the summer months) could reduce the heave rate and total heave compared to those observed in the tests operated under continuous sub-zero pipe temperatures. Secondly, a two-dimensional fully coupled thermo-mechanical finite element (FE) model is developed using Abaqus FE software for simulating the frost heave around chilled gas pipelines buried in frost susceptible soil. The mechanical behaviour of frozen and unfrozen soils is defined using elastic-plastic models that recognize the key influencing factors, including temperature and volumetric ice content in the frozen soil. The Konrad-Morgenstern segregation potential model and the mechanical behaviour of soil are implemented in Abaqus using user subroutines. The FE calculated results are compared with the Calgary full-scale experimental results of two pipe sections buried at different depths, namely control and deep-burial sections. The FE calculated frost front penetration, frost heave, and moisture growth agree well with the experimental results, which indicates that the present FE model can successfully simulate the frost heave around buried pipelines. The long-term frost heave (up to 20 years) is simulated. The decrease of heave rate after the formation of the final ice lens and associated warming at its leading edge is highlighted. The effects of key factors on frost heave and challenges in FE modelling of such large displacements are evaluated. The factors include the water migration modelling approach, soil properties, seasonal ground surface temperatures and operating conditions. Finally, a large-strain coupled thermo-hydro-mechanical FE model is developed using Abaqus FE software to simulate thaw consolidation. The variations of hydraulic conductivity, compressibility, and thermal properties of thawed soils during consolidation are implemented. One-dimensional FE simulations are performed first to verify the FE modelling

approach and to show the limitations of the existing small-strain linear thaw consolidation model. Nonlinear variation of void ratio-effective stress-hydraulic conductivity is then considered for improved modelling of thaw consolidation. Finally, a two-dimensional FE modelling of thaw consolidation around a warm pipeline buried in permafrost is presented. The highly nonlinear void ratio-effective stress and void ratio-hydraulic conductivity relationships, specifically the high hydraulic conductivity at large void ratios and low effective stresses after thawing, cause pore water flow along the thaw front, instead of vertical flow in simplified one-dimensional thaw consolidation models, as assumed in previous studies.

Frontiers in Offshore Geotechnics II - Susan Gourvenec 2010-10-04

Frontiers in Offshore Geotechnics II comprises the Proceedings of the Second International Symposium on Frontiers in Offshore Geotechnics (ISFOG), organised by the Centre for Offshore Foundation Systems (COFS) and held at the University of Western Australia (UWA), Perth from 8 10 November 2010. The volume addresses current and emerging challenges

Numerical Methods in Geotechnical Engineering IX, Volume 1 - Manuel de Matos Fernandes 2018-06-22

NUMGE 2018 is the ninth in a series of conferences on Numerical Methods in Geotechnical Engineering organized by the ERTC7 under the auspices of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). The first conference was held in 1986 in Stuttgart, Germany and the series continued every four years (1990 Santander, Spain; 1994 Manchester, United Kingdom; 1998 Udine, Italy; 2002 Paris, France; 2006 Graz, Austria; 2010 Trondheim, Norway; 2014 Delft, The Netherlands). The conference provides a forum for exchange of ideas and discussion on topics related to numerical modelling in geotechnical engineering. Both

senior and young researchers, as well as scientists and engineers from Europe and overseas, are invited to attend this conference to share and exchange their knowledge and experiences. This work is the first volume of NUMGE 2018.

Advances in Frontier Research on Engineering Structures Volume 1 - Yang Yang 2023-01-13

Advances in Frontier Research on Engineering Structures focuses on the research of advanced structures and anti-seismic design in civil engineering. The proceedings present the most cutting-edge research directions and achievements related to civil and structural engineering. Topics covered in the proceedings include: · Engineering Structure and Seismic Resistance · Structural Mechanics Analysis · Components and Materials · Structural Seismic Design · 3D Printing Concrete · Other Related Topics The works of this proceedings will promote development of civil and structural engineering, resource sharing, flexibility and high efficiency. Thereby, promote scientific information interchange between scholars from the top universities, research centers and high-tech enterprises working all around the world.

Pipelines and Risers - Yong Bai 2001-02-07

Pipelines and Risers

ABAQUS Keywords Manual - 2000

Failure Analysis - Jose Luis Otegui 2014-01-02

This book addresses the failures of structural elements, i.e. those components whose primary mission is to withstand mechanical loads. The book is intended as a self-contained source for those with different technical grades, engineers and scientists but also technicians in the field can benefit from its reading.

Challenges and Innovations in Geomechanics - Marco Barla 2022-08-31

This book gathers the latest advances, innovations, and applications in the field of computational geomechanics, as presented by international researchers and engineers at the

16th International Conference of the International Association for Computer Methods and Advances in Geomechanics (IACMAG), held in Turin, Italy on August 30 - September 2, 2022. Contributions include a wide range of topics in geomechanics such as: laboratory and field testing, constitutive modelling, monitoring and remote sensing, multiphase modelling, reliability and risk analysis, surface structures, deep structures, dams and earth structures, natural slopes, mining engineering, earthquake and dynamics, soil-atmosphere interaction, ice mechanics, landfills and waste disposal, gas and petroleum engineering, geothermal energy, offshore technology, energy geostructures and computational rail geotechnics.

Proceedings of the 4th International Conference on Performance Based Design in Earthquake Geotechnical Engineering (Beijing 2022) - Lanmin Wang 2022-10-21

The 4th International Conference on Performance-based Design in Earthquake Geotechnical Engineering (PBD-IV) is held in Beijing, China. The PBD-IV Conference is organized under the auspices of the International Society of Soil Mechanics and Geotechnical Engineering - Technical Committee TC203 on Earthquake Geotechnical Engineering and Associated Problems (ISSMGE-TC203). The PBD-I, PBD-II, and PBD-III events in Japan (2009), Italy (2012), and Canada (2017) respectively, were highly successful events for the international earthquake geotechnical engineering community. The PBD events have been excellent companions to the International Conference on Earthquake Geotechnical Engineering (ICEGE) series that TC203 has held in Japan (1995), Portugal (1999), USA (2004), Greece (2007), Chile (2011), New Zealand (2015), and Italy (2019). The goal of PBD-IV is to provide an open forum for delegates to interact with their international colleagues and advance performance-based design research and practices for earthquake geotechnical

engineering.