

Unsaturated Soil Mechanics from Theory to Practice

Editors

Zhenghan Chen, Changfu Wei, De'an Sun & Yongfu Xu



Unsaturated Soil Mechanics

Ryosuke Kitamura, Kazunari Sako

A red circular graphic with a gradient, appearing as a stylized arrow or a partial circle, located to the right of the authors' names.

Unsaturated Soil Mechanics:

The Emergence of Unsaturated Soil Mechanics National Research Council Canada, 1999 This publication is an assemblage of selected papers that have been authored or co authored by D G Fredlund The substance of these papers documents the milestones of both the science of unsaturated soil mechanics and the career of the author during his tenure as a faculty member in the Department of Civil Engineering at the University of Saskatchewan Saskatoon Canada

Advanced Unsaturated Soil Mechanics and Engineering Charles W. W. Ng, Bruce Menzies, 2007-10-23 Analytical and comprehensive this state of the art book examines the mechanics and engineering of unsaturated soils as well as explaining the laboratory and field testing and research that are the logical basis of this modern approach to safe construction in these hazardous geomaterials putting them into a logical framework for civil engineering and design The book illustrates the importance of state dependent soil water characteristic curves highlights modern soil testing of unsaturated soil behaviour including accurate measurement of total volume changes and the measurement of anisotropic soil stiffness at very small strains introduces an advanced state dependent elasto plastic constitutive model for both saturated and unsaturated soil demonstrates the power of numerical analysis which is at the heart of modern soil mechanics studies and simulates the behaviour of loose fills from unsaturated to saturated states explains the difference between strain softening and static liquefaction and describes real applications in unsaturated soil slope engineering includes purpose designed field trials to capture the effects of two independent stress variables and reports comprehensive measurements of soil suction water contents stress changes and ground deformations in both bare and grassed slopes introduces a new conjunctive surface and subsurface transient flow model for realistically analysing rainfall infiltration in unsaturated soil slopes and illustrates the importance of the flow model in slope engineering Including constitutive and numerical modelling this volume will interest students and professionals studying or working in the areas of geotechnical engineering and the built environment

Unsaturated Soils, Two Volume Set Eduardo Alonso, Antonio Gens, 2010-09-02 In recent decades the development of unsaturated soil mechanics has been remarkable resulting in momentous advances in fundamental knowledge testing techniques computational procedures prediction methodologies and geotechnical practice The advances have spanned the full spectrum of theory and practice In addition unsaturated materials exhibiting complex behaviour such as residual soils swelling soils compacted soils collapsing soils tropical soils and solid wastes have been integrated in a common understanding of shared behaviour features It is also noteworthy that unsaturated soil mechanics has proved surprisingly fruitful in expanding to other neighbouring areas such as swelling rocks rockfill mechanics and freezing soils As a consequence geotechnical engineering involving unsaturated soils can be now approached from a more rational and systematic perspective leading towards an improved and more effective practice Unsaturated Soils contains the papers presented at the 5th International Conference on Unsaturated Soil Barcelona Spain 6 8 September 2010 They report

significant advances in the areas of unsaturated soil behaviour testing techniques constitutive and numerical modelling and applications The areas of application include soil atmosphere interaction foundations slopes embankments pavements geoenvironmental problems and emerging topics They are complemented by three keynote lectures and three general reports covering general issues of modelling testing and applications Unsaturated Soils is a comprehensive record of the state of the art in unsaturated soil mechanics and a sound basis for further progress in the future The two volumes will serve as an essential reference for academics researchers and practitioners interested in unsaturated soils

Unsaturated Soils: Research & Applications Nasser Khalili, Adrian Russell, Arman Khoshghalb, 2014-06-05 Unsaturated Soils Research and Applications contains 247 papers presented at 6th International Conference on Unsaturated Soils UNSAT2014 Sydney Australia 2-4 July 2014 The two volumes provide an overview of recent experimental and theoretical advances in a wide variety of topics related to unsaturated soil mechanics

Unsaturated Soil Behavior Advances in Unsaturated Soils Bernardo Caicedo, Carol Murillo, Laureano Hoyos, Julio Esteban Colmenares, Ivan Rafael Berdugo, 2013-01-17 New theories and testing techniques related with Unsaturated Soil Mechanics have proven to be valuable tools to study a broad spectrum of geo materials which includes rocks rock fills frozen soils and domiciliary solid wastes These new theories and testing techniques have permitted the analysis of several traditional problems from a new perspective

Soil Mechanics for Unsaturated Soils Delwyn G. Fredlund, Hendry Rahardjo, 1993-09-06 The principles and concepts for unsaturated soils are developed as extensions of saturated soils Addresses problems where soils have a matric suction or where pore water pressure is negative Covers theory measurement and use of the fundamental properties of unsaturated soils permeability shear strength and volume change Includes a significant amount of case studies

Unsaturated Soils: Experimental Studies Tom Schanz, 2006-03-04 These proceedings document the various papers delivered and partially presented at the International Conference From experimental evidence towards numerical modeling of unsaturated soils which was held in Weimar Germany during 18-19 September 2003 The conference was organized under the auspices of the International Society of Soil Mechanics and Geotechnical Engineering ISSMGE and the National German Geotechnical Society DGGT The need to understand the behavior of unsaturated soils is becoming exclusively essential for the geotechnical engineers and designers In the last three decades many searchers have made significant contribution to the understanding of the unsaturated soil mechanics Nevertheless application of the subject to variety of new problems still requires our attention This International conference is a mere attempt to unite researchers and engineers in geotechnical engineering and to discuss about the problems associated with the unsaturated soils Doing so the objectives of these lecture notes are as follows to promote unsaturated soil mechanics for practical application to exchange experiences in experimental unsaturated soil mechanics and numerical modeling to discuss application of unsaturated soil mechanics to variety of problems In other words we could also name these two volumes as From theory to daily practice I would like to extend my deep sense of appreciation as

the editor and the Head of the organizing committee to many persons who have contributed either directly or indirectly to organize the International conference and to finalize these proceedings

Unsaturated Soil Mechanics in Engineering Practice Delwyn G. Fredlund, Hendry Rahardjo, Murray D. Fredlund, 2012-07-24 The definitive guide to unsaturated soil from the world's experts on the subject This book builds upon and substantially updates Fredlund and Rahardjo's publication *Soil Mechanics for Unsaturated Soils* the current standard in the field of unsaturated soils It provides readers with more thorough coverage of the state of the art of unsaturated soil behavior and better reflects the manner in which practical unsaturated soil engineering problems are solved Retaining the fundamental physics of unsaturated soil behavior presented in the earlier book this new publication places greater emphasis on the importance of the soil water characteristic curve in solving practical engineering problems as well as the quantification of thermal and moisture boundary conditions based on the use of weather data Topics covered include Theory to Practice of Unsaturated Soil Mechanics Nature and Phase Properties of Unsaturated Soil State Variables for Unsaturated Soils Measurement and Estimation of State Variables Soil Water Characteristic Curves for Unsaturated Soils Ground Surface Moisture Flux Boundary Conditions Theory of Water Flow through Unsaturated Soils Solving Saturated Unsaturated Water Flow Problems Air Flow through Unsaturated Soils Heat Flow Analysis for Unsaturated Soils Shear Strength of Unsaturated Soils Shear Strength Applications in Plastic and Limit Equilibrium Stress Deformation Analysis for Unsaturated Soils Solving Stress Deformation Problems with Unsaturated Soils Compressibility and Pore Pressure Parameters Consolidation and Swelling Processes in Unsaturated Soils *Unsaturated Soil Mechanics in Engineering Practice* is essential reading for geotechnical engineers civil engineers and undergraduate and graduate level civil engineering students with a focus on soil mechanics

Unsaturated Soil Mechanics - from Theory to Practice Zhenghan Chen, Changfu Wei, De'an Sun, Xongfu Xu, 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 Society of Soil Mechanics and Geotechnical Engineering

Unsaturated Soil Mechanics in Geotechnical Practice Geoffrey E. Blight, 2013-07-11 There are other books on unsaturated soil mechanics but this book is different Unsaturated soil mechanics is only one aspect of a continuous range of soil mechanics studies that extends from the rheology of high water content soil slurries to the mechanics of soft soils to stiff saturated soils to unsaturated soils and at the far end of the range

Unsaturated Soils: Research and Applications Claudio Mancuso, Cristina Jommi, Francesca D'Onza, 2012-06-23 These volumes contain the contributions to the Second European Conference on Unsaturated Soils E UNSAT 2012 held in Napoli Italy in June 2012 The event is the second of a series of European conferences and follows the first successful one organised in Durham UK in 2008 The conference series is supported by Technical Committee 106 of the International Society of Soil Mechanics and Geotechnical Engineering on Unsaturated Soils The published contributions were selected after a careful peer review

process A collection of more than one hundred papers is included addressing the three thematic areas experimental including advances in testing techniques and soil behaviour modelling covering theoretical and constitutive issues together with numerical and physical modelling and engineering focusing on approaches case histories and geo environmental themes The areas of application of the papers embrace most of the geotechnical problems related to unsaturated soils Increasing interest in geo environmental problems including chemical coupling marks new perspectives in unsaturated soil mechanics This book will provide a valuable up to date reference across the subject for both researchers and practitioners

Unsaturated Soils: Research and Applications Claudio Mancuso, Cristina Jommi, Francesca D'Onza, 2012-06-26 These volumes contain the contributions to the Second European Conference on Unsaturated Soils E UNSAT 2012 held in Napoli Italy in June 2012 The event is the second of a series of European conferences and follows the first successful one organised in Durham UK in 2008 The conference series is supported by Technical Committee 106 of the International Society of Soil Mechanics and Geotechnical Engineering on Unsaturated Soils The published contributions were selected after a careful peer review process A collection of more than one hundred papers is included addressing the three thematic areas experimental including advances in testing techniques and soil behaviour modelling covering theoretical and constitutive issues together with numerical and physical modelling and engineering focusing on approaches case histories and geo environmental themes The areas of application of the papers embrace most of the geotechnical problems related to unsaturated soils Increasing interest in geo environmental problems including chemical coupling marks new perspectives in unsaturated soil mechanics This book will provide a valuable up to date reference across the subject for both researchers and practitioners

Unsaturated Soils Eduardo E Alonso, 2010 In recent decades the development of unsaturated soil mechanics has been remarkable resulting in momentous advances in fundamental knowledge testing techniques computational procedures prediction methodologies and geotechnical practice The advances have spanned the full spectrum of theory and practice In addition unsaturated materials exhibiting complex behaviour such as residual soils swelling soils compacted soils collapsing soils tropical soils and solid wastes have been integrated in a common understanding of shared behaviour features It is also noteworthy that unsaturated soil mechanics has proved surprisingly fruitful in expanding to other neighbouring areas such as swelling rocks rockfill mechanics and freezing soils As a consequence geotechnical engineering involving unsaturated soils can be now approached from a more rational and systematic perspective leading towards an improved and more effective practice Unsaturated Soils contains the papers presented at the 5th International Conference on Unsaturated Soil Barcelona Spain 6-8 September 2010 They report significant advances in the areas of unsaturated soil behaviour testing techniques constitutive and numerical modelling and applications The areas of application include soil atmosphere interaction foundations slopes embankments pavements geoenviromental problems and emerging topics They are complemented by three keynote lectures and three general reports covering general issues of modelling

testing and applications Unsaturated Soils is a comprehensive record of the state of the art in unsaturated soil mechanics and a sound basis for further progress in the future The two volumes will serve as an essential reference for academics researchers and practitioners interested in unsaturated soils *Unsaturated Soils, Two Volume Set* Olivier Buzzi, S. Fityus, D. Sheng, 2009-11-02 Unsaturated soil mechanics is now increasingly recognized as an integral part of mainstream soil mechanics and the importance and relevance of unsaturated soil mechanics for the broad field of geotechnical engineering no longer needs to be emphasized The two volumes making up Unsaturated soils include papers from the 4th Asia Pacific Confere **Unsaturated Soil Mechanics with Probability and Statistics** Ryosuke Kitamura, Kazunari Sako, 2019-08-09 Soil is fundamentally a multi phase material consisting of solid particles water and air In soil mechanics and geotechnical engineering it is widely treated as an elastic elastoplastic or visco elastoplastic material and consequently regarded as a continuum body However this book explores an alternative approach considering soil as a multi phase and discrete material and applying basic Newtonian mechanics rather than analytical mechanics It applies microscopic models to the solid phase and fluid phases and then introduces probability theory and statistics to derive average physical quantities which correspond to the soil's macroscopic physical properties such as void ratio and water content This book is particularly focused on the mechanical behaviour of dry partially saturated and full saturated sandy soil as much of the physicochemical microscopic characteristic of clayey soil is still not clear It explores the inter particle forces at the point of contact of soil particles and the resultant inter particle stresses instead of the total stress and effective stress which are studied in mainstream soil mechanics Deformation and strength behaviour soil water characteristic curves and permeability coefficients of water and air are then derived simply from grain size distribution soil particle density void ratio and water content A useful reference for consultants professional engineers researchers and public sector organisations involved in unsaturated soil tests Advanced undergraduate and postgraduate students on Unsaturated Soil Mechanics courses will also find it a valuable text to study

Experimental Unsaturated Soil Mechanics Tom Schanz, 2007-06-02 These proceedings are a continuation of the series of International Conferences in Germany entitled Mechanics of Unsaturated Soils The objective is to discuss and understand unsaturated soil behaviour so that engineered activities are improved in terms of judgement and quality In addition to knowledge of classical concepts it is a challenge to adapt convincing new concepts and present them in such a way that they can be used in engineering practices **Unsaturated Soils** E. J. Murray, V. Sivakumar, 2010-06-17 An understanding of the mechanical properties of unsaturated soils is crucial for geotechnical engineers worldwide as well as to those concerned with the interaction of structures with the ground This book deals principally with fine grained clays and silts or soils containing coarser sand and gravel particles but with a significant percentage of fines The study of unsaturated soil is a practical subject linking fundamental science to nature Soils in general are inherently variable and their behaviour is not easy to analyse or predict and unsaturated soils raise the complexity to a higher level Even amongst practicing engineers there is often lack of

awareness of the intricacies of the subject This book offers a perspective of unsaturated soils based on recent research and demonstrates how this dovetails with the general discipline of soil mechanics Following an introduction to the basic soil variables the phases the phase interactions and the relevance of soil structure an up to date review of laboratory testing techniques is presented This includes suction measurement and control techniques triaxial cell testing This is followed by an introduction to stress state variables critical state and theoretical models in unsaturated soils A detailed description of the thermodynamic principles as applied to multi phase materials under equilibrium conditions follows These principles are then used to explore and develop a fundamental theoretical basis for analysing unsaturated soils Soil structure is broken down into its component parts to develop equations describing the dual stress regime The critical state strength and compression characteristics of unsaturated soils are examined and it is shown how the behaviour may be viewed as a three dimensional model in dimensionless stress volume space The analysis is then extended to the work input into unsaturated soils and the development of conjugate stress volumetric and strain increment variables These are used to examine the micromechanical behaviour of kaolin specimens subjected to triaxial shear strength tests and lead to observations not detectable by other means

Unsaturated Soils A fundamental interpretation of soil behaviour covers a rapidly advancing area of study research and engineering practice and offers a deeper appreciation of the key characteristics of unsaturated soil It provides students and researchers with a framework for understanding soil behaviour and demonstrates how to interpret experimental strength and compression data provides engineers with a deeper appreciation of key characteristics of unsaturated soils covers a rapidly advancing area of study research and engineering practice provides students and researchers a framework for understanding soil behaviour shows how to interpret experimental data on strength and compression the limited number of books on the subject are all out of date

Introducing Unsaturated Soil Mechanics to Undergraduate Students Through the Net Stress Concepts Eddy F. Ramirez, 2013 The purpose of this research was to introduce unsaturated soil mechanics to the undergraduate geotechnical engineering course in a concise and easy to understand manner Also it was essential to develop unsaturated soil mechanics teaching material that merges smoothly into current undergraduate curriculum and with sufficient flexibility for broad adaptation by faculty The learning material consists of three lecture modules and a laboratory module The lecture modules introduced soil mechanics for the general 3 phase medium condition with the saturated soil as a special case The three lecture modules that were developed are 1 the stress state variables for unsaturated soils 2 soil water characteristic curves and 3 axis translation A PowerPoint presentation was created to present each module in an easy to understand manner so that the students will enjoy the learning material Along with the lecture modules a laboratory module was developed that reinforced the key aspects and concepts for unsaturated soil behavior A laboratory manual was created for the Tempe Pressure Cell and Fredlund SWC 150 device one dimensional oedometer pressure plate device in order to give the instructor and institution a choice of which testing equipment best fits their

program Along with the laboratory manuals an analysis guide was created to help students with constructing SWCCs from their laboratory A soil type recommendation was also researched for use in the laboratory module The soil ensured acceptably short equilibrium times along with a wide range or suction values controllable by both testing equipment Tempe Pressure Cell and Fredlund SWC 150 A silt type soil material was recommended for the laboratory module As a part of this research a smooth transition from unsaturated to saturated condition was demonstrated through laboratory volume change experiments using a silt soil tested in an oedometer type pressure plate device Three different experiments were conducted 1 volume change for unsaturated soils in response to suction and net normal stress change 2 volume change for saturated soils in response to effective stress change as determined using unsaturated soils testing equipment and 3 traditional consolidation tests on saturated soil using a conventional consolidometer device

Advanced Unsaturated Soil

Mechanics Charles W.W. Ng,Chao Zhou,Junjun Ni,2024-10-24 Unsaturated soil is a three phase material that is ubiquitous on the Earth s surface and exhibits complex behaviour which becomes more complex in response to the Earth s changing climate and increasing engineering activities This is because the former affects its moisture and temperature conditions significantly and the latter governs its stress state and suction condition This book is designed to meet the increasing challenges of climate change and engineering activities by covering the mechanics and engineering of unsaturated soil in a logical manner It comprises four major parts Water retention and flow characteristics Shear strength and stiffness at various temperatures State dependent elasto plastic constitutive modelling Field monitoring and engineering applications This second edition uniquely covers fundamental topics on unsaturated soil that are not covered in other similar books including the state dependency of soil water retention behaviour and water permeability functions such as dependence on engineering activities small strain stiffness considering the influence of wetting drying cycles and recent suction history such as that due to climate change suction effects on dilatancy and peak shear strength cyclic thermal effects on soil behaviour state dependent elastoplastic constitutive modelling of monotonic and cyclic behaviour engineering applications such as the South to North Water Transfer Project an earthen landfill cover system devoid of geomembrane in the Xiaping landfill Shenzhen and a 15 m deep multi propped excavation in Tianjin China

Laboratory and Field Testing of Unsaturated Soils

Alessandro Tarantino,Enrique Romero,Yu-Jin Cui,2008-12-28 This volume details recent global advances in laboratory and field testing of unsaturated soils Coverage includes mechanical hydraulic and geo environmental testing and applications of unsaturated soil monitoring to engineering behavior of geo structures

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