Numerical Methods and Implementation in Geotechnical Engineering – Part 2

Y.M. Cheng, J.H. Wang
L. Liang, W.H. Fung Ivan

Bentham Books

Frontiers in Civil Engineering

(Volume 4)

Numerical Methods and Implementation in Geotechnical Engineering – Part 2

Authored by

Y.M. Cheng

School of Civil Engineering, Qingdao University of Technology, Qingdao, China Department of Civil and Environmental Engineering, Hong Kong, Polytechnic University, Hong Kong

J. H. Wang

National Base of International Science and Technology Cooperation, for Intelligent Manufacturing Service, Chongqing Technology and Business University, Chongqing, China Chongqing South-to-Thais Environmental Protection Technology, Research Institute Co. Ltd., China

Li Liang

School of Civil Engineering, Qingdao University of Technology, Qingdao, China

&

W. H. Fung Ivan

Department of Architecture and Civil Engineering, City University of Hong Kong, Hong Kong

Frontiers in Civil Engineering

Volume # 4

Numerical Methods and Implementation in Geotechnical Engineering ï Part 2

Editors: Y.M. Cheng, J. H. Wang, Li Liang, W. H. Fung Ivan

ISSN (Online): 2468-4708

ISSN (Print): 2468-4694

ISBN (Online): 978-981-14-3742-7

ISBN (Print): 978-981-14-3740-3

ISBN (Paperback): 978-981-14-3741-0

need for a court order if at any point you breach any terms of this License Agreement. In no event will any delay or failure by Bentham Science Publishers in enforcing your compliance with this License Agreement constitute a waiver of any of its rights.

3. You acknowledge that you have read this License Agreement, and agree to be bound by its terms and conditions. To the extent that any other terms and conditions presented on any website of Bentham Science Publishers conflict with, or are inconsistent with, the terms and conditions set out in this License Agreement, you acknowledge that the terms and conditions set out in this License Agreement shall prevail.

Bentham Science Publishers Pte. Ltd.
80 Robinson Road #02-00
Singapore 068898
Singapore
Email: subscriptions@benthamscience.net

BENTHAM SCIENCE

CONTENTS

PREFACE

For most of the geotechnical problems, particularly those related to real life problems, analytical solutions are usually not available. For both research and practical applications, numerical methods and computer programs are required for many cases. In the recent forty years, many numerical methods have evolved for various kinds of engineering problems. Engineers are now well adapted to the uses of different computer programs for the solution of engineering problems. There is however a major drawback in the current engineering practice in that most of the engineers are not familiar with the basics of the numerical methods, the methods of implementations and the limitations of the numerical methods/programs. In fact, to a certain extent, the methods of implementations and the limitations of the numerical methods are related. In many internal studies using different commercial numerical programs, the authors sometimes found noticeable or even completely different results with different programs or the same program with different default setting for a given problem, and this situation is not uncommon. For a problem with unknown solution, how an engineer assess the acceptability of the computer results is a difficult issue that needs serious attention. In several technical meetings in the Hong King Institution of Engineers, the authors have discussed with some engineers about the appreciation of the limitations of the daily-used engineering programs. If two computer programs can produce significantly different results, how an engineer determine the acceptability of the results actually require deeper knowledge about the basics of the numerical methods and implementations. Interestingly, the authors like to ask the students a question “Different answers can be obtained from different commercial programs. Which results should be accepted, and why should those results be accepted?”. In general, the authors challenge the students (undergraduate and graduate students) every year for this question, and virtually this question is never answered properly. The problems in the assessment of the numerical results will also be discussed in this book, which is seldom addressed in other books or research papers.

The authors have participated in different types of geotechnical research and consultancy works in different countries, and has written a book *Frontier in Civil Engineering, Vol.1, Stability Analysis of Geotechnical Structures*, which is well-favored by many students, engineers and researchers. Most of the books on numerical methods seldom address the actual procedures in numerical implementations, but many postgraduates actually need to develop computer programs to consider special constitutive models, loadings, numerical methods, boundary conditions and other effects. In view of the limitations of most of the books at present, the authors would like to write a new book on numerical methods and the implementations based on their previous works, and this new book should be useful for senior undergraduates, postgraduates, engineers as well as researchers.

In this book, finite element method, optimization method, plasticity based slip line method, limit analysis method, distinct element method, Smoothed-Particle Hydrodynamics Method, Spectral Element Method and Material Point Method will be introduced. The present book will not cover dynamic problems which is a big topic, and hopefully this will be covered later by the authors in another book. The authors will also try to explain the methods of implementation for some of these methods through sample computer programs. Sample programs are given and discussed to assist students in developing programs for their own uses. These programs are not meant to be efficient or up-to-date, but will help the students in learning about the implementation of some numerical methods. This book should not be taken as a classical textbook, as the authors do not intend it to be. There are many new contributions to numerical methods in geotechnical engineering over the last 30 years, and many topics can be covered by individual books for detailed discussion. There is also no way for the authors to cover all numerical methods in details in this book. This book is a basic introduction to some more commonly used numerical methods in geotechnical engineering which have been used by the authors for teaching and research, with the discussion of some common commercial program problems, programming techniques and applications.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the support from the Hong Kong Research Grant Council through the project PolyU 5128/13E, the National Natural Science Foundation of China (Grant No. 51778313), the Cooperative Innovation Center of Engineering Construction and Safety in Shangdong Blue Economic Zone. The present book is also partly supported by CityU Strategic Research Grant for unfunded GRF/ECS (SRG-Fd): Enhancement of Building Information Modelling (BIM) in Construction Safety by GIS: 4D Modelling, Geo-spatial Analysis and Topography Modelling (Preliminary Study) (CityU Project No. 7004631).

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

The authors confirm that this chapter contents have no conflict of interest.

Y.M. Cheng
School of Civil Engineering, Qingdao University of Technology,
Qingdao,
China
Department of Civil and Environmental Engineering, Hong Kong,
Polytechnic University,
Hong Kong

CHAPTER 1

Distinct Element Method and Other Numerical Methods

Abstract: In this chapter, the basic formulation of the distinct element method is introduced, which will be followed by more discussions on the blocky and particle formulation of the DEM. This will be followed by some applications of the DEM to several types of problems. As the alternatives to the DEM, DDA and manifold for two-dimensional and three-dimensional problems will be introduced with case studies. There are also many new numerical methods that have evolved in the last twenty years. For example, some recent continuity based methods as such as the SEM, SPH and MPM will also be introduced in this chapter, with applications to some slope failure problems in Hong Kong.

Keywords: DDA, Distinct element, Manifold, Meshless, MPM, Particle flow, SEM, SPH.

1.1. INTRODUCTION TO DISTINCT ELEMENT METHOD

While the finite element is the most popular method adopted by the engineers for practical works, there are some other numerical methods which are under active research by various researchers. These methods are generally not mature enough or difficult to be used for general engineering problems, nevertheless, they can be applied in many geotechnical problems governed by large displacement, discontinuity or even separation of materials. The authors do not aim at introducing all of these special numerical methods, but will discuss some of these methods with applications.

The most commonly used numerical methods for continuous systems are the finite difference method (FDM), the FEM and the boundary element method (BEM). The basic assumption adopted in these numerical methods is that the materials concerned are continuous throughout the physical processes. This assumption of continuity requires that at all points in a problem domain, the material cannot be torn open or broken into pieces. The neighbourhood of all material points will remain unchanged throughout the whole physical process. Some special algorithms have been developed to deal with material fractures in continuum

Y.M. Cheng, J.H. Wang, L. Liang, W.H. Fung Ivan

mechanics based methods, such as the special joint elements by Goodman (1976) and the displacement discontinuity technique in BEM by Crouch and Starfield (1983). However, these methods can only be applied with limitations (Jing *et al*. 1993):

(1) large-scale slip and opening of fracture elements are prevented in order to maintain the macroscopic material continuity;

(2) the amount of fracture elements must be kept to relatively small so that the global stiffness matrix can be maintained well-posed, without causing severe numerical instabilities; and

(3) complete detachment and rotation of elements or groups of elements as a consequence of deformation are either not allowed or treated with special algorithms.

The authors have adopted the zero thickness interface element by Goodman (1976) in developing a soil-structure interaction program. One of the practical problems in using this joint element is the difficulty in mesh generation. Currently, most of the engineers will specify a thin layer of material to simulate the interface instead using the joint element directly in finite element analysis. Rock masses are always dissected by joints, faults, cracks or other discontinuities which control the failure and sliding of the masses. The complicated structure of rock masses and the discontinuities lead to a complicated non-linear mechanical response. Research work in the deformation in jointed rock mass is very important in modeling complicated important geotechnical problems. For such system, the use of the classical continuity based numerical methods will face great difficulty if the deformation is large. The use of the discontinuity based approach will be more appropriate under such condition.

Before a slope starts to collapse, the factor of safety serves as an important index in both the LEM and SRM to assess the stability of the slope. The movement and growth after failure have launched which are also important and in many cases cannot be simulated on the continuum model. This should be analyzed by the discontinuous mechanics. The commonly used discontinuous numerical methods include: Finite Element Method (FEM) with Joints, Discrete Element Method (DEM), Rigid-Block Spring Method (RBSM), Contact-Spring Model, Discontinuous Deformation Analysis (DDA) and Numerical Manifold Method (NMM). Joint element method with zero thickness was proposed by Goodman, Taylor and Brekke in 1968. It is very effective for problems with only few discontinuities and small deformation. The conditions of no penetration and no tension at the interface however cannot be strictly satisfied. Sometimes, it may lead to great errors between computation results and actual measured results.

There was still a major progress in modelling discontinuous problem at that time. The extension of the Goodman joint element to higher order element for improved accuracy has been achieved by many researchers. Desai (1984) also proposed joint element where a small thickness is allowed. Desai's element is easier for programming purpose, but the formulation of the stiffness matrix needs some special treatments as the thickness of the element is very small. A major limitation of the joint element method is that if there are many discontinuities presented in a rock mass, the use of joint element is practically very difficult to be adopted. The separation of elements also cannot be modeled by the use of joint element, as the method of analysis is still based on the continuum finite element method. Besides the blocky structure of rock, masonry and similar structures, discontinuous medium in form of assembly of grains is also commonly found. There are hence, two major discontinuity based numerical approach: blocky and granular. Actually, the granular approach is a special case of the blocky type problem, but due to the shape of the grains, contact detection can be a much easier task, and special techniques are available for the solution which is not possible for the blocky type problem.

In continuum description of soil material, the well-established macro constitutive models and the parameters can be measured experimentally. On the other hand, a discrete element approach will consider the material as distinct grains or particles that interact with each other. The micro-parameters are difficult to be measured directly. The commonly used distinct element method is an explicit method based on the finite difference principles which is originated in the early 1970s by a landmark work on the progressive movements of rock masses as 2D rigid block assemblages (Cundall, 1971). Later, the works by Cundall are developed to the early versions of the UDEC and 3DEC codes (Cundall, 1980; Cundall and Hart, 1985, 1992). The method has also been developed for simulating the mechanical behavior of granular materials (Cundall and Strack, 1979), with an early code BALL (Cundall, 1978) and Trubal (Strack and Cundall 1984) which later evolved into the codes of the PFC group for 2D and 3D problems of particle systems (Itasca, 1995). Lemos (1983) developed a coupled DEM/boundary element formulation. Later, Lorig (1984) developed the pre and post-processor for DEM analysis, and the code is later modified to HYDEBE (Hybrid discrete element boundary element) which is written in Fortran IV. Through continuous developments and extensive applications over the last three decades, a great body of knowledge and a rich field of literature about the distinct element method have been accumulated. The main trend in the development and application of the method in rock engineering is represented by the history and results of the code groups UDEC/3DEC.

Based on Trubal, Thornton and Randall (1988) further developed the contact

CHAPTER 2

Optimization Analysis in Geotechnical Engineering Problems

Abstract: Many engineering problems can be formulated as an equivalent optimization problem. In fact, the popular finite element method is a form of optimization problem, where local interpolation function is used to represent the local effect within an element. In limit equilibrium and limit analysis, the use of global optimization search for the critical slip surfaces and the failure mechanism is required for many slope stability, lateral earth pressure and bearing capacity problems. For pile driving back analysis, the whole analysis is just actually an optimization process. In this chapter, some of the classical gradient type, as well as the modern heuristic optimization methods will be introduced.

Keywords: Control variables, Global optimization, Gradient, Local optimization, Objective function.

2.1. INTRODUCTION

Many engineering problems can be formulated as a form of optimization analysis. In fact, the popular finite element method can be viewed as a special form of optimization problem, where the energy of a system is minimized. There are also many types of problems for which, the optimal solutions have to be evaluated. In the past 30 years, there are tremendous amounts of works in the area of optimization for constrained/unconstrained convex, non-convex, non N-P types of problems, integer problems, multi-criteria problems and others. In this chapter, several types of geotechnical problems will be considered from an optimization point of view, and some of the methods that the authors have used, will be discussed in this chapter. It should be noted that there are over hundreds of method that have evolved for the past 30 years, and they can be grouped accordingly to different criteria. In general, the use of the classical calculus in optimization analysis has only limited uses in geotechnical application, and this chapter will mainly concentrate on the numerical optimization methods.

There are three major methods in geotechnical engineering – the slip line method,

Y.M. Cheng, J.H. Wang, L. Liang, W.H. Fung Ivan

limit analysis method and the limit equilibrium method. A brief introduction about these methods and the relationship of these methods with optimization analysis will be discussed.

At the instant of impending plastic flow, both equilibrium and yield conditions are satisfied. For soils, the Mohr-Coulomb criterion is widely used for the yield condition. Combining the Mohr-Coulomb criterion with the equations of equilibrium will give a set of hyperbolic differential equations of plastic equilibrium. With the known stress boundary conditions, this set of differential equations can be used to obtain the stresses at the ultimate condition. For example, the bearing capacity of footing or the lateral earth pressure behind a retaining wall can be determined by slip line analysis (Cheng 2003, 2005, 2007). To solve the hyperbolic differential equations, this set of equations is transformed to curvilinear coordinates whose directions at every point in this yielded region, coincide with the directions of failure or slip plane. The locus of the failure planes is known as the slip lines while the network of failure planes is called the slip-line field. Kötter (1903) was the first to derive these slip-line equations for the case of plane deformations. Prandtl (1920) was the first to obtain an analytical closed form solution for a footing on a weightless soil. The weight of soil will, however create further complication in the solution of the hyperbolic differential equations, and no analytical solution will be available if the weight of soil is considered. Sokolovskii (1965) adopted a numerical procedure based on a finite difference approximation of the slip-line equations. He solved a number of interesting problems on bearing capacity of footings or slopes, as well as the lateral pressure on the retaining walls, for which it is impossible to find closed form solutions. In a slip-line solution, the domain under consideration is assumed to be completely in the state of plastic equilibrium (Chen 1972), and partial yielding can only be considered with some approximate assumption (Cheng and Au 2005), and this is one of the limitation of the slip-line method.

The limit equilibrium method has traditionally been used to obtain approximate solutions for stability problems in soil mechanics. Currently, most of the engineers still rely on the use of the limit equilibrium method to provide approximate solution to bearing capacity, lateral earth pressure and slope stability problems. Although this method has greatly simplified the stresses at the ultimate limit state and assumptions are required to solve the problems, the concept of this method is simple to be understood by most of the engineers and is hence, a popular tool for normal analysis and design. It has also been demonstrated that this approach can give reasonably acceptable solution for most cases. Based on this approach, the stability problem is reduced to the determination of the most dangerous location for the failure surface, and the use of various optimization methods have been proposed by different authors for such application.

The limit analysis method considers the stress–strain relationship of a soil in an idealized manner. This idealization, termed normality (or the flow rule), establishes the limit theorems on which limit analysis is based. Within the framework of this assumption, the approach is rigorous and the techniques are competitive with those of limit equilibrium, in some instances being much simpler. The plastic limit theorems of Drucker *et al*. (1952) may be used to obtain the upper and lower bounds of the collapse load for stability problems. The conditions required to establish an upper- or lower-bound solution are essentially as follows:

Lower-bound theorem - The loads, determined from a stress distribution that satisfies: (a) the equilibrium equations; (b) stress boundary conditions; and (c) nowhere violates the yield criterion, are not greater than the actual collapse load. The distribution of stress satisfying item (a), (b) and (c) has been termed a statically admissible stress field for the problem under consideration. Hence, the lower-bound theorem is equivalent to the condition that if a statically admissible stress distribution can be found, uncontained plastic flow will not occur at a lower load. Although the lower bound theorem is difficult to be applied except for simple problem, the authors will demonstrate that the use of modern optimization method will help to extend the capability of the lower bound theorem.

Upper-bound theorem - By equating the external rate of work to the internal rate of dissipation according to a prescribed failure mode (or velocity field) that satisfies: (a) velocity boundary conditions; and (b) strain and velocity compatibility conditions, the loads as determined are not less than the actual collapse load. A velocity field satisfying the above conditions has been termed a kinematically admissible velocity field. If a kinematically admissible velocity field can be found, uncontained plastic flow must impend or have taken place previously. The upper-bound technique considers only velocity or failure modes and energy dissipations while the stress distribution need not be in equilibrium, and is only defined in the deforming regions of the mode. Since a prescribed failure mode is required to be defined for the load computation, the critical collapse load is required to be determined from an optimization analysis where different shapes and locations of the failure surface have to be considered.

Both the lower and upper bound methods are useful tools to the engineers, and for practical problems, both methods will become an optimization problem where the solution will be given by the maxima/minima of a functional. Since it is difficult to evaluate the maxima/minima of the functional, the use of modern optimization methods will become particularly attractive for complicated real problems, and the principles and applications of some optimization methods will be discussed in the following sections.

CHAPTER 3

Reliability Analysis in Geotechnical Engineering

Abstract: This chapter will give an overview about the application of reliability analysis in geotechnical engineering problems, and slope stability problem will be chosen for the illustration.

Keyword: Finite element, First order reliability method, Monte Carlo simulation, Reliability index, Risk, Response surface method, Second order reliability method.

3.1. INTRODUCTION

In many geotechnical analysis and design works, deterministic methods with suitable factors of safety are used by many engineers with general satisfaction in different countries. In this approach, loads, the strengths, failure modes or collapse mechanisms are assumed to be known or can be approximated with good accuracy, and the difference between the design load and the characteristic strength is large enough to provide adequate factors of safety, which are usually determined based on long term observation and research. Under such condition, the safety level of a system is not explicitly known (Vrijling 1998). For many practical structural and geotechnical problems, this approach is good enough for most of the practical works, and has proved to be acceptable in general.

Traditionally, the geotechnical adequacy is commonly expressed by the concept of safety factor. A safety factor can be expressed as the ratio of capacity to demand. Since there may be different definitions to the meaning of capacity and demand, the safety factor will vary according to the definition, and a unique value may not exist in some cases. The safety factor concept, however, has shortcomings as a measure of the relative reliability of geotechnical structures. A primary deficiency in this factor is that the control parameters (material properties, strengths, loads, *etc.*) must be assigned single precise values, but there are actually various uncertainties associated with these parameters. The use of precisely defined single values in an analysis is required in the *deterministic* approach. The safety factor using this approach will then reflect the engineer's judgment, and the degree of conservatism incorporated into the parameter values.

Y.M. Cheng, J.H. Wang, L. Liang, W.H. Fung Ivan

In general, deterministic approach may be applicable to most of the structural engineering problems, provided that appropriate factor of safety can be defined. On the other hand, geotechnical engineering is different from some engineering disciplines in that the properties of geomaterials and the distribution of the materials are highly uncertain by nature, and the uncertainties are much higher as compared with those in structural engineering. Although the presence of geotechnical uncertainty has long been recognized, most of the geotechnical engineering design works (including slope engineering) are still based on the concept of overall factor of safety, for which the controlling parameters are assumed to be deterministic while the uncertainties are accounted for the use of empirical safety factors which are large enough to cover the uncertainty. The safety factors in geotechnical engineering are hence greater than those in the structural engineering discipline. For example, a factor of safety of 3.0 and 2.0 is applied to shallow foundation and deep foundation in Hong Kong, which are much greater than the safety factor in structural or bridge design. Although the use of partial safety factors concept has appeared in Euro code as well as other design codes which has partially considered the uncertainties of some material properties and applied loadings, such concept is however more appropriate to linear system (typically in structural engineering works) than nonlinear systems in geotechnical engineering works. Also, the spatial variability of the material properties and distribution cannot be reflected by the use of partial safety factors. Safety factors are determined based on experience and long term observation and applications, but do not absolutely guarantee the safety or satisfactory performance under all cases. They also provide no information on how the uncertainties of different parameters influence the safety of the system. Some engineers argue that the classical approach has been used with satisfaction for a long time, as long as an acceptable factor of safety can be defined. This argument is basically correct, except that it is also observed in Hong Kong that about 5% of the stabilized slopes will still eventually fail under the current analysis and design practice. For cases where the appropriate factor of safety cannot be determined due to high uncertainties, engineers tend to use very high factors of safety to cover all these problems (Three Gorge project in China and other cases).

Probabilistic design approach with reliability and risk analysis concepts deal with the uncertainties in the geomaterial parameters, distribution, loadings and even failure mechanism. Such analysis will inevitably be more complicated, and due to a lack of sufficient information available for many practical projects, reliability analysis is not commonly carried out in geotechnical works.

Probabilistic analysis can bring rationality to the consideration of uncertainty in the analysis and design, provides more information about the system behavior, the influence of different uncertain variables on the system performance, and the interaction between different system components (Haldar and Mahadevan 2000a, 2000). Due to the high uncertainty associated with the ground conditions, material properties, ground water conditions, loadings, computational models and other factors, reliability analysis in geotechnical engineering is more important than that in many other disciplines. During the past three decades, there are increasing demand and research works for the probabilistic analysis of the stability of slopes. It is well accepted that the probabilistic methods can play a complementary role to the conventional deterministic factor-of-safety method, and will be useful for some important projects where the consequence of failure can be high.

The following four levels of approach in determination of the safety of a structure is suggested by TAW (1985):

- Level 0: Deterministic approach, for which the design is based on the average situations;

- Level I: Semi-probabilistic approach, for which a characteristic value is used in the design, like the load which is not exceeded in 95% of the cases, or the strength which is available for 95% of the construction material;

- Level II: Probabilistic approach with statistical distributions of all variables are taken into account. Level II comprises a number of approximate methods in which the distribution functions are transformed into standard normal, Gaussian or lognormal distributions.

- Level III: the highest level probabilistic approach and the probability distribution functions of the stochastic variables are fully taken into account.

For practical purposes it is adopted there are three sources of uncertainty (Morgenstern 1995):

I. Parameter uncertainty

II. Model uncertainty

III. Human uncertainty

Parameter uncertainty is readily understood and has received considerable attention in the geotechnical literature. It is concerned with input variables such as the spatial variations of parameters like strength or compressibility and the lack of data for key parameters. Many examples exist in the literature in which the statistical distribution, say, of strength is specified and the traditional Factor of Safety is replaced by a probability of failure. The model, an equation for Factor of Safety based on limit equilibrium assumptions, is taken as certain. However, if,

References

Adami, S. (2014). Modeling and Simulation of Multiphase Phenomena with Smoothed Particle Hydrodynamics.Doktor-Ingenieurs, Technischen Universität München.

Adoko, A.C., Jiao, Y.Y., Wu, L., Wang, H., Wang, Z.H. (2013). Predicting tunnel convergence using multivariate adaptive regression spline and artificial neural network. *Tunn. Undergr. Space Technol, 38*, 368-376.
[http://dx.doi.org/10.1016/j.tust.2013.07.023]

Al-Defae, A.H., Knappett, J.A. (2015). Newmark sliding block model for pile reinforced slopes under earthquake loading. *Soil. Dyn. Earthquake Eng, 75*, 265-278.
[http://dx.doi.org/10.1016/j.soildyn.2015.04.013]

Al-Bittar, T., Soubra, A.H. (2013). Probabilistic Analysis of Strip Footings Resting on Spatially Varying Soils and Subjected to Vertical or Inclined Loads. *J. Geotech. Geoenviron. Eng.*
[http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0001046]

Alonso, E. (1976). Risk analysis of slopes and its application to slopes in Canadian sensitive clays. *Geotechnique, 26*(3), 453-472.
[http://dx.doi.org/10.1680/geot.1976.26.3.453]

Aluru, N. (2000). A point collocation method based on reproducing kernel approximation. *Int. J. Numer. Methods Eng, 47*(6), 1083-1121.
[http://dx.doi.org/10.1002/(SICI)1097-0207(20000228)47:6<1083::AID-NME816>3.0.CO;2-N]

Anderheggen, E., Knopfel, H. (1972). Finite element limit analysis using linear programming. *Int. J. Solids Struct, 8*(12), 1413-1431.
[http://dx.doi.org/10.1016/0020-7683(72)90088-1]

Ang, A.H., Tang, W. (1984). *Probability concepts in engineering planning and design* (Vol. 2). New York: John Wiley and Sons Inc.

Arai, K., Tagyo, K. (1985). Determination of noncircular slip surfaces giving the minimum factor of safety in slope stability analysis. *Soil Found, 25*, 43-51.
[http://dx.doi.org/10.3208/sandf1972.25.43]

Arai, K., Tagyo, K., Barber, J.R. (2010). Determination of noncircular slip surfaces giving the minimum factor of safety in slope stability analysis, Soils and Foundations. *Elasticity* (Vol. 25, pp. 43-51). London: Springer.
[http://dx.doi.org/10.1007/978-90-481-3809-8]

Au, S.K., Beck, J.L. (2001). Estimation of small failure probabilities in high dimensions by subset simulation. *Probab. Eng. Mech, 16*(4), 263-277.
[http://dx.doi.org/10.1016/S0266-8920(01)00019-4]

Au, S.K., Beck, J.L. (2003). Subset simulation and its application to seismic risk based on dynamic analysis. *J. Eng. Mech, 129*(8), 901-917.
[http://dx.doi.org/10.1061/(ASCE)0733-9399(2003)129:8(901)]

Au, S.K., Ching, J., Beck, J.L. (2007). Application of subset simulation methods to reliability benchmark problems. *Struct. Saf, 29*(3), 183-193.

[http://dx.doi.org/10.1016/j.strusafe.2010.03.004]

Au, S.K., Wang, Y. (2014). *Engineering risk assessment with subset simulation.* Singapore: John Wiley & Sons.
[http://dx.doi.org/10.1002/9781118398050]

Baars, S.V. (2018). *100 years of Prandtl's wedge.* IOS Press.

Babuska, I., Melenk, J.M. (1997). The partition of unity method. *Int. J. Numer. Methods Eng, 40*, 727-758.
[http://dx.doi.org/10.1002/(SICI)1097-0207(19970228)40:4<727::AID-NME86>3.0.CO;2-N]

Baker, R., Garber, M. (1978). Theoretical analysis of the stability of slopes. *Geotechnique, 28*, 395-411.
[http://dx.doi.org/10.1680/geot.1978.28.4.395]

Baker, R. (1980). Determination of the critical slip surface in slope stability computations. *Int. J. Numer. Anal. Methods Geomech, 4*, 333-359.
[http://dx.doi.org/10.1002/nag.1610040405]

Baker, R. (2003). Sufficient conditions for existence of physically significant solutions in limiting equilibrium slope stability analysis. *Int. J. Solids Struct, 40*(13-14), 3717-3735.
[http://dx.doi.org/10.1016/S0020-7683(03)00075-1]

Bathe, K.J. (1985). A Four node plate bending element based on Mindlin/Ressiner plate theory and mixed interpolation. *Int. J. Numer. Methods Eng, 21*, 367-383.
[http://dx.doi.org/10.1002/nme.1620210213]

Bathe, K.J. (2014). *Finite element Procedures.* K.J. Bathe.

Bathurst, R., Rothenburg, L. (1989). Investigation of micromechanical features of idealized granular assemblies using DEM *Proceeding of the 1st US Conference on Discrete Element Methods,* Golden, Colo 12.

Bauer, S., Lackner, R. (2015). Gradient-based adaptive discontinuity layout optimization for the prediction of strength properties in matrix-inclusion materials. *Int. J. Solids Struct, 63*, 82-98.
[http://dx.doi.org/10.1016/j.ijsolstr.2015.02.042]

Baecher, G.B., Ingra, T.S. (1981). Stochastic FEM in settlement predictions. *J. Geotech. Eng. Div, 107*(4), 449-463.

Baecher, G.B. (1987). *Statistical analysis of geotechnical data.* Vicksburg, Mississippi: USACE Waterways Experiment Station.

Baecher, G.B., Christian, J.T. (2003). *Reliability and statistics in geotechnical engineering.* John Wiley.

Belytschko, T., Liu, W.K., Moran, B., Elkhodary, K.I. (2014). *Nonlinear finite elements for continua and structures.* John Wiley.

Belytschko, T., Lu, Y.Y., Gu, L. (1994). Element-free Galerkin methods. *Int. J. Numer. Methods Eng, 37*, 229-256.
[http://dx.doi.org/10.1002/nme.1620370205]

Berezantzev, V.G. (1958). Earth pressure on the cylindrical retaining wall. *Proc., Brussels Conf. on Earth Pressure Problems, 2*, 21-27.

Bhattacharya, G., Jana, D., Ojha, S., Chakraborty, S. (2003). Direct search for minimum reliability index of earth slopes. *Comput. Geotech, 30*, 445-462.
[http://dx.doi.org/10.1016/S0266-352X(03)00059-4]

Birolini, A. (2014). *Reliability engineering* Springer.
[http://dx.doi.org/10.1007/978-3-642-39535-2]

Bishop, A.W. (1955). The use of the slip circle in the stability analysis of earth slopes. *Geotechnique, 5*(1), 7-17.
[http://dx.doi.org/10.1680/geot.1955.5.1.7]

Bolton, H.P.J., Heymann, G., Groenwold, A. (2003). Global search for critical failure surface in slope

stability analysis. *Eng. Optim, 35*(1), 51-65.
[http://dx.doi.org/10.1080/0305215031000064749]

Blum, C., Raidl, G.R. (2016). *Hybrid Metaheuristics Powerful Tools for Optimization.* Springer.

Booker, J.R., Zheng, X. (2000). *Application of the theory of classical plasticity to the analysis of the stress distribution in wedges of a perfectly frictional material, Modelling in Geomechanics.* New York: John Wiley.

Bottero, A., Negre, R., Pastor, J., Turgeman, S. (1980). Finite element method and limit analysis theory for soil mechanics problems. *Comput. Methods Appl. Mech. Eng, 22*, 131-149.
[http://dx.doi.org/10.1016/0045-7825(80)90055-9]

Breitung, K. (1984). Asympotic approximations for multinormal integrals. *J. Eng. Mech, 110*(3), 357-366.
[http://dx.doi.org/10.1061/(ASCE)0733-9399(1984)110:3(357)]

Bucher, C.G., Bourgund, U. (1990). A fast and efficient response surface approach for structural reliability problems. *Struct. Saf, 7*(1), 57-66.
[http://dx.doi.org/10.1016/0167-4730(90)90012-E]

Bui, H.H. (2007). Lagrangian Mesh-free Particle Method (SPH) for Large Deformation and Post-failure of Geomaterial using Elasto-plastic Constitutive Models Ph.D. *Dissertation, Ritsumeikan University, Japan,* 170.

Bui, H.H., Fukagawa, R., Sako, K., Ohno, S. (2008). Lagrangian meshfree particles method (SPH) for large deformation and failure flows of geomaterial using elastic-plastic soil constitutive model. *Int. J. Numer. Anal. Methods Geomech, 32*, 1537-1570.
[http://dx.doi.org/10.1002/nag.688]

Busby, D. (2009). Hierarchical adaptive experimental design for Gaussian process emulators. *Reliab. Eng. Syst. Saf, 94*(7), 1183-1193.
[http://dx.doi.org/10.1016/j.ress.2008.07.007]

Cai, Y., Liang, G.P., Shi, G.H., Cook, N.G.W. (1996). Studying an impact problem by using LDDA method. Proceedings of the First International Forum on Discontinuous Analysis (DDA) and Simulations of Discontinuous Media, TSI Press, Berkeley, California, USA, p. 288-294.

Cao, W.G., Shu, B.Y. (2001). A study on techniques of automatically forming of cover system of numerical manifold method. *Chinese Journal of Geotechnical Engineering, 23*(2), 187-190.

Castilo, E., Luceno, A. (1980). Evaluation of variational methods in slope analysis. *Proceedings of International Symposium on Landslides,* New-Delhi, India*1*, 255-258.

Castilo, E., Luceno, A. (1982). A critical analysis of some variational methods in slope stability analysis. *Int. J. Numer. Anal. Methods Geomech, 6*, 195-209.
[http://dx.doi.org/10.1002/nag.1610060206]

Celestino, T.B., Duncan, J.M. (1981). Simplified Search for Non-Circular Slip Surface *Proceedings of 10th International Conference on Soil Mechanics and Foundation Engineering,* Stockholm, Sweden 391-394.

Chang, W.A. (2006). *Advances in Evolutionary Algorithms Theory, Design and Practice.* Springer.

Chapman, S.J. (2007). *Fortran 95/2003 for Scientists & Engineers* McGraw Hill.

Chen, Z. (2003). *Stability analysis of soil slopes: theories, methods and programs.* Beijing: Water Power Press. (in Chinese)

Chen, H., Lee, C.F. (2000). Numerical simulation of debris flows. *Can. Geotech. J, 37*(1), 146-160.
[http://dx.doi.org/10.1139/t99-089]

Chen, W.F., Giger, M.W. (1971). Limit analysis of stability of slopes. Journal of the Soil Mechanics and Foundations Division. *Proc. Am. Soc. Civ. Eng, 97*, 19-26.

Chen, W.F. (1975). *Limit Analysis and Soil Plasticity.* US: Elsevier.

Chen, W.F., Liu, X.L. (1990). *Limit analysis in soil mechanics.* New York: Elsevier.

Chen, Z., Morgenstern, N.R. (1983). Extensions to generalized method of slices for stability analysis. *Can. Geotech. J, 20*(1), 104-109.
[http://dx.doi.org/10.1139/t83-010]

Chen, Z., Shao, C. (1983). Evaluation of minimum factor of safety in slope stability analysis. *Can. Geotech. J, 25*(4), 735-748.
[http://dx.doi.org/10.1139/t88-084]

Chen, Z. (1998). On Pan's principles of rock and soil stability analysis. *Journal of Tsinghua University (Sci & Tech), 38*, 1-4.

Chen, Y.P., Lee, J.D., Eskandarian, A. (2006). *Meshless Methods in Solid Mechanics.* Springer.

Chen, G.Q., Ohnishi, Y., Ito, T. (1997). Development of high order manifold method. *Proceedings of the Second International Conference on Analysis of Discontinuous Deformation,* Kyoto, Japan 132-154.

Chen, G.Q., Ohnishi, Y., Ito, T. (1998). Development of High-order Manifold Method. *Int. J. Numer. Methods Eng, V43*, 685-712.
[http://dx.doi.org/10.1002/(SICI)1097-0207(19981030)43:4<685::AID-NME442>3.0.CO;2-7]

Chen, G.Q., Miki, S., Ohnishi, Y. (1996). Practical improvements on DDA. Proceedings of the First International Forum on Discontinuous Analysis (DDA) and Simulations of Discontinuous Media, TSI Press, Berkeley, California, USA, p. 302-309.

Chen, G.Q., Ohnishi, Y., Zhen, L., Sasaki, T. (2013). Frontiers of Discontinuous Numerical Methods and Practical Simulations in Engineering and Disaster Prevention *Proceedings of the 11th International Conference on analysis of Discontinuous Deformation, ICADD11.* Fukuoka, Japan27-29 August
[http://dx.doi.org/10.1201/b15791]

Chen, G.Q., Ohnishi, Y. (1999). A non-liner model for discontinuous in DDA. *The Third International Conference on Analysis of Discontinuous Deformation from Theory to Practice,* Vail, Colorado, USA 57-64.

Chen, W., Qiu, T. (2011). Numerical Simulations of Granular Materials Using Smoothed Particle Hydrodynamics Method. *Int. J. Geomech, 12*(2), 157-164.

Cheng, Y.P., Nakata, Y., Bolton, M.D. (2003). Distinct element simulation of crushable soil. *Geotechnique, 53*(7), 633-641.
[http://dx.doi.org/10.1680/geot.2003.53.7.633]

Cheng, Y.M. (1989). An Efficient and Flexible Out-of-Core Equation Solver. *Microcomputers in Civil Engineering, 4*, 297-306.
[http://dx.doi.org/10.1111/j.1467-8667.1989.tb00031.x]

Cheng, Y.M., Tsui, Y. (1993). A Simple and Flexible Finite Element Mesh Graphics Program. *Comput. Struc, 48*, 555-574.

Cheng, Y.M. (1993). An Effective Storage Minimizer Program. *J. Struct. Eng, 20*, 103-110.

Cheng, Y.M. (1996). Iterative Solution using Sparse Matrix Storage in Finite Element Analysis *International Conference on Computing & Information Technology for Architecture, Engineering,* Construction, Singapore16-17 May93-96.

Cheng, Y.M., Tsui, Y. (1996). Discontinuous Deformation Analysis vs Discrete Element Analysis, The Ninth International Conference of the Association for Computer Methods and Advances in Geomechanics, Nov., Wuhan, 479-482.

Cheng, Y.M., Tsui, Y. (1997). Use of Discrete Element Analysis in Geotechnical Engineering *The Second International Symposium on Structures and Foundations in Civil Engineering,* Jan. 7-10153-156.

Cheng, Y.M. (1997). Application of Discrete Element Method/Discontinuous Deformation Analysis, The International Symposium on Rock Mechanics and Environmental Geotechnology, April, Chongqing, p. 214-218.

Cheng, Y.M. (1998). Advancement and Improvements in Discontinuous Deformation Analysis. *Comput.*

Geotech, 22(2), 153-163.
[http://dx.doi.org/10.1016/S0266-352X(98)00002-0]

Cheng, Y.M., Zhang, Y.H. (1998). The Extension and Application of DDA Method. *Chinese Journal of Geotechnical Engineering, 20*(3), 109-111. a

Cheng, Y.M., Zhang, Y.H. (1998). Block Rotation in DDA and Its Application to Rolling Stone. *Chinese Journal of Rock Mechanics and Engineering, 17*, 834-839. b

Cheng, Y.M., Zhang, Y.H. (2000). Rigid Body Rotation and Internal Block Discretization in DDA Analysis. *Int. J. Numer. Anal. Methods Geomech, 24*, 567-578.
[http://dx.doi.org/10.1002/(SICI)1096-9853(200005)24:6<567::AID-NAG83>3.0.CO;2-N]

Cheng, Y.M., Zhang, Y.H., Wang, K.J. (2000). Coupling of Fem and DDA methods in engineering. *J. Geotech. Eng, 22*, 727-730.

Cheng, Y.M. (2002). Slip Line Solution and Limit Analysis for Lateral Earth Pressure Problem, the Ninth Conference on Computing in Civil and Building Engineering, April 3-5, Taipei, Taiwan, p.311-314.

Cheng, Y.M. (2003). Seismic lateral earth pressure coefficients by slip line method. *Comput. Geotech, 30*(8), 661-670.
[http://dx.doi.org/10.1016/j.compgeo.2003.07.003]

Cheng, Y.M., Zhang, Y.H., Chen, W.S. (2002). Wilson non-conforming Element in Numerical Manifold Method. *Commun. Numer. Methods Eng, 18*, 877-884.
[http://dx.doi.org/10.1002/cnm.545]

Cheng, Y.M., Chen, W.S., Guo, X.R. (2002). Distinct Element Analysis of Ground Deformation arising from Underground Mining. *Chinese Journal of Rock Mechanics and Engineering, 21*(8), 1130-1135.

Cheng, Y.M., Zhang, Y.H. (2002). Coupling of FEM and DDA Methods. *Int. J. Geomech, 2*(4), 503-517.
[http://dx.doi.org/10.1061/(ASCE)1532-3641(2002)2:4(503)]

Procedure to the detect of three-dimensional blocks using penetration edges method Cheng, Y.M., Chen, W.S., Guo, X.R. (2002). Geotechnical Special PublicationASCE.

Cheng, Y.M. (2003). Locations of Critical Failure Surface and some Further Studies on Slope Stability Analysis. *Comput. Geotech, 30*, 255-267.
[http://dx.doi.org/10.1016/S0266-352X(03)00012-0]

Cheng, Y.M., Zhang, Y.H. (2003). Application of NMM in Underground excavation *Proceedings of Geo Eng 2003,* Beijing 1159-1164.

Cheng, Y.M., Zhang, Y.H. (2004). Application and discussion of three dimensional numerical manifold method based on hexahedron element. *Chinese Journal of Rock Mechanics and Engineering,* 1745-1754.

Cheng, Y.M., Chen, W.S., Zheng, H., Zhang, Y.H. (2004). Detection of 3D block contacts by penetration edges. *Chinese Journal of Rock mechanics and engineering, 23*(4), 565-571.

Cheng, Y.M., Zhu, L.J. (2004). Unified Formulation for Two Dimensional Slope Stability Analysis and Limitations in Factor of Safety Determination. *Soils and Foundations, 44*(6), 121-128.

Cheng, Y.M., Chen, W.S., Zhang, Y.H. (2006). A robust method for the detection of contacts for three-dimensional blocks. *Int. J. Geomech, 6*(5), 303-310.
[http://dx.doi.org/10.1061/(ASCE)1532-3641(2006)6:5(303)]

Cheng, Y.M., Au, S.K. (2005). Slip line solution of bearing capacity problems with inclined ground. *Can. Geotech. J, 42*, 1232-1241.
[http://dx.doi.org/10.1139/t05-037]

Cheng, Y.M., Liu, H.T., Wei, W.B., Au, S.K. (2005). Location of critical three- dimensional non-spherical failure surface by NURBS functions and ellipsoid with applications to highway slopes. *Comput. Geotech, 32*(6), 387-399.
[http://dx.doi.org/10.1016/j.compgeo.2005.07.004]

Cheng, Y.M., Yip, C.J. (2007). Three-dimensional asymmetrical slope stability analysis – Extension of Bishop's, Janbu's, and Morgenstern–Price's techniques. *J. Geotech. Geoenviron. Eng, 133*(12), 1544-1555. [http://dx.doi.org/10.1061/(ASCE)1090-0241(2007)133:12(1544)]

Cheng, Y.M., Hu, Y.Y., Wei, W.B. (2007). General Axi-symmetric active earth pressure by Methods of Characteristics – Theory and Numerical Formulation. *International Journal on Geomechanics, ASCE, 7*(1), 1-15.

Cheng, Y.M., Li, L. (2007). Particle swarm optimization algorithm for non-circular failure surface in two dimensional lope stability analysis. *Comput. Geotech, 34*(2), 92-103. [http://dx.doi.org/10.1016/j.compgeo.2006.10.012]

Cheng, Y.M. (2007). Global optimization analysis of slope stability by simulated annealing with dynamic bounds and Dirac function. *Eng. Optim, 39*(1), 17-32. [http://dx.doi.org/10.1080/03052150600916294]

Cheng, Y.M., Li, L., Chi, S.C. (2007). Studies on six heuristic global optimization methods in the location of critical slip surface for soil slopes. *Comput. Geotech, 34*, 462-484. [http://dx.doi.org/10.1016/j.compgeo.2007.01.004]

Cheng, Y.M., Lansivaara, T., Wei, W.B. (2007). Two-dimensional Slope Stability Analysis by Limit Equilibrium and Strength Reduction Methods. *Comput. Geotech, 34*, 137-150. [http://dx.doi.org/10.1016/j.compgeo.2006.10.011]

Cheng, Y.M., Zhang, Y.H. (2008). Three-dimensional Numerical Manifold Method - Tetrahedron and Hexahedron Mesh. *International for Rock Mechanics and Rock Engineering, 41*(4), 601-628. [http://dx.doi.org/10.1007/s00603-006-0120-9]

Cheng, Y.M., Hu, Y.Y., Au, S.K., Wei, W.B. (2008). Active pressure for circular cut with Berezantzev's and Prater's Theories. *Soil Found, 48*(5), 621-632. [http://dx.doi.org/10.3208/sandf.48.621]

Cheng, Y.M., Lansivaara, T., Siu, J. (2008). Impact of Convergence on Slope Stability Analysis and Design. *Comput. Geotech, 35*(1), 105-115. [http://dx.doi.org/10.1016/j.compgeo.2007.02.011]

Cheng, Y.M., Li, L., Chi, S.C., Wei, W.B. (2008). Determination of critical slip surface using artificial fish swarms algorithm. *J. Geotech. Geoenviron. Eng, 134*(2), 244-251. [http://dx.doi.org/10.1061/(ASCE)1090-0241(2008)134:2(244)]

Cheng, Y.M., Li, L., Lansivaara, T., Chi, S.C., Sun, Y.J. (2008). Minimization of factor of safety using different slip surface generation methods and an improved harmony search minimization algorithm. *Eng. Optim, 40*(2), 95-115. [http://dx.doi.org/10.1080/03052150701618153]

Cheng, Y.M., Law, C.W. (2008). Development of a New and Efficient Thick Plate Element. *Struct. Eng. Mech, 29*(3), 327-354. [http://dx.doi.org/10.12989/sem.2008.29.3.327]

Cheng, Y.M., Liu, Z.N., Song, W.D., Au, S.K. (2009). Laboratory test and Particle Flow Simulation of Silos problem with nonhomogeneous materials. *J. Geotech. Geoenviron. Eng, 135*, 1754-1761. [http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0000125]

Cheng, Y.M., Chau, K.T., Xiao, L.J., Li, N. (2010). Flow pattern for silo with two layers of materials with single and double openings. *Journal of Geotechnical and Geoenvironmental Engineering, ASCE, 136*(9), 1278-1286.

Cheng, Y.M., Zhao, Z.H., Sun, Y.J. (2010). Evaluation of interslice force function and discussion on convergence in slope stability analysis by the lower bound method. *J. Geotech. Geoenviron. Eng, 136*(8), 1103-1113. [http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0000317]

Cheng, Y.M., Li, D.Z., Li, L., Sun, Y.J., Baker, R., Yang, Y. (2011). Limit equilibrium method based on approximate lower bound method with variable factor of safety that can consider residual strength. *Comput. Geotech, 38*, 628-637.
[http://dx.doi.org/10.1016/j.compgeo.2011.02.010]

Cheng, Y.M., Li, L., Sun, Y.J., Au, S.K. (2012). A coupled particle swarm and harmony search optimization algorithm for difficult geotechnical problems. *Struct. Multidiscipl. Optim, 45*, 489-501.
[http://dx.doi.org/10.1007/s00158-011-0694-z]

Cheng, Y.M., Lansivaara, T., Baker, R., Li, N. (2013). The use of internal and external variables and extremum principle in limit equilibrium formulations with application to bearing capacity and slope stability problems. *Soil Found, 53*(1), 130-143.
[http://dx.doi.org/10.1016/j.sandf.2012.12.009]

Cheng, Y.M., Li, D.Z., Li, N., Li, Y.Y., Au, S.K. (2013). Solution of some engineering partial differential equations governed by the minimal of a functional by global optimization method. *J. Mech, 29*(3), 493-506.

Cheng, Y.M., Lau, C.K. (2014). *Soil Slope stability analysis and stabilization - new methods and insights* Spon Press.
[http://dx.doi.org/10.1201/b17015]

Cheng, Y.M., Li, L., Liu, L.L. (2015). Simplified Approach for Locating the Critical Probabilistic Slip Surface in Limit Equilibrium Analysis. *Nat. Hazards Earth Syst. Sci, 15*, 2241-2256.
[http://dx.doi.org/10.5194/nhess-15-2241-2015]

Cheng, Y.M., Li, N. (2017). Equivalence between Bearing Capacity, Lateral Earth Pressure and Slope Stability Problems by Slip-line and Extremum Limit Equilibrium Methods. *International Journal of Geomechanics, 17*(12) ASCE, 04017113.

Cheng, Y.M., Li, N., Fung, W.H., Li, L. (2019). Laboratory and Field Test and Distinct Element Analysis of Debris Flow. *Nat. Hazards Earth Syst. Sci, 19*, 181-199.
[http://dx.doi.org/10.5194/nhess-19-181-2019]

Cheng, Y.M., Au, S.K., Wong, H. (2019). *Fracture Grouting and Geonails for Soft Soil Tunnelling.* Geomechanics and Geoengineering.
[http://dx.doi.org/10.1080/17486025.2019.1573321]

Ching, J.Y., Phoon, K.K., Hu, Y.G. (2009). Efficient evaluation of reliability for slopes with circular slip surfaces using importance sampling. *J. Geotech. Geoenviron. Eng, 135*(6), 768-777.
[http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0000035]

Ching, J.Y., Phoon, K.K. (2013). Effect of element sizes in random field finite element simulations of soil shear strength. *Comput. Struc, 126*, 120-134.
[http://dx.doi.org/10.1016/j.compstruc.2012.11.008]

Chiou, Y.J., Tsay, R.J., Chuang, W.L. (1997). Crack propagation using manifold method. *Proceedings of the Second International Conference on Analysis of Discontinuous Deformation,* Kyoto, Japan 298-308.

Chiou, Y.J., Tsay, R.J. (2000). Nonlinear analysis of low-rise reinforced concrete shear walls by manifold method. *Zhongguo Gongcheng Xuekan, 23*(6), 721-729.
[http://dx.doi.org/10.1080/02533839.2000.9670593]

Chiou, Y.J., Lee, Y.M., Tsay, R.J. (2002). Mixed mode fracture propagation by manifold method. *Int. J. Fract, 114*(4), 327-347.
[http://dx.doi.org/10.1023/A:1015713428989]

Cho, S.E. (2009). Probabilistic stability analyses of slopes using the ANN-based response surface. *Comput. Geotech, 36*, 787-797.
[http://dx.doi.org/10.1016/j.compgeo.2009.01.003]

Cho, S.E. (2010). Probabilistic assessment of slope stability that considers the spatial variability of soil properties. *J. Geotech. Geoenviron. Eng, 136*(7), 10.

[http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0000309]

Cho, S.E. (2013). First-order reliability analysis of slope considering multiple failure Modes. *Eng. Geol, 154*, 98-105.
[http://dx.doi.org/10.1016/j.enggeo.2012.12.014]

Chowdhury, R.N., Xu, D.W. (1995). Geotechnical system reliability of slopes. *Reliab. Eng. Syst. Saf, 47*, 141-151.
[http://dx.doi.org/10.1016/0951-8320(94)00063-T]

Christian, J.T., Ladd, C.C., Bolcher, G.B. Reliability and probability in stability analysis. In Stability and Performance of Slopes and Embankments - II, ed. by R.B. Seed and R.W. Boulanger, Geotechnical Special Publication No. 31, p. 1071-1111, ASCE.

Christian, J.T., Ladd, C., Baecher, G.B. (1994). Reliability applied to slope stability analysis. *J. Geotech. Eng, 120*(12), 2180-2207.
[http://dx.doi.org/10.1061/(ASCE)0733-9410(1994)120:12(2180)]

Clarke, S.D., Smith, C.C., Gilbert, M. (2013). Modelling discrete soil reinforcement in numerical limit analysis. *Can. Geotech. J, 50*, 705-715.
[http://dx.doi.org/10.1139/cgj-2012-0387]

Cornell, C.A. (1969). A probability based structural code. *J. Am. Concr. Inst, 66*(12), 974-985.

Coley, D.A. (1999). *An Introduction to Genetic Algorithms for Scientists and Engineers.* World Scientific.
[http://dx.doi.org/10.1142/3904]

Collins, I.F. (1974). A note on the interpretation of Coulomb's analysis of the thrust on a rough retaining wall in terms of the limit theorems of limit plasticity. *Geotechnique, 24*, 106-108.
[http://dx.doi.org/10.1680/geot.1974.24.1.106]

Cornell, C.A. (1969). A probability-based structural code. *J. Am. Concr. Inst, 66*(12), 974-985.

Cressie, N. (1993). *Statistics for spatial data.* John Wiley & Sons.

Crouch, S.L., Starfield, A.M. (1983). *Boundary element methods in solid mechanics, S. L. Crouch and A. M. Starfield.* London: George Allen & Unwin.

Cuevas, E., Zaldívar, D., Cisneros, M.P. (2018). *Advances in Metaheuristics Algorithms: Methods and Applications.* Springer.
[http://dx.doi.org/10.1007/978-3-319-89309-9]

Cundall, P.A. (1971). A computer model for simulating progressive, large-scale movements in blocky rock systems. In: Proceedings of the International Symposium on Rock Mechanics. Nancy, France, 1971: 129–136.

Cundall, P.A. (1978). *Ball - A computer program to model granular medium using the distinct element method, Technical note TN-LN-13* (pp. 129-163). London: Advanced Technology Group, Dames and Moore.

Cundall, P.A., Strack, O.D.L. (1979). A discrete model for granular assemblies. *Geotechnique, 29*(1), 47-65.
[http://dx.doi.org/10.1680/geot.1979.29.1.47]

Cundall, P.A., Strack, O.D.L. (1979). A discrete model for granular assemblies. *Geotechnique, 29*(1), 47-65.

Cundall, P.A., Hart, R.D. (1985). *Development of generalized 2-D and 3-D distinct element programs for modeling jointed rock, Misc. Paper SL-85-1.* US Army Corps of Engineers.

Cundall, P.A. (1987). Distinct Element Models of Rock and Soil structure. *Analytical and Computational Methods in Engineering Rock Mechanics* (pp. 129-163). London: George Allen and Unwin.

Cundall, P.A. (1988). Formulation of a 3-D distinct element model-Part I. A scheme to detect and represent contacts in system composed of many polyhedral blocks. *Int. J. Rock Mech. Min. Sci. Geomech. Abstr, 25*(3), 107-116.
[http://dx.doi.org/10.1016/0148-9062(88)92293-0]

Cundall, P.A., Hart, D.H. (1992). Numerical Modelling of Discontinua. *Eng. Comput, 9*, 101-111. [http://dx.doi.org/10.1108/eb023851]

Dasaka, S.M., Zhang, L. (2012). Spatial variability of in situ weathered soil. *Geotechnique, 49*(6), 835-840. [http://dx.doi.org/10.1680/geot.8.P.151.3786]

Davis, R.O., Selvadurai, A.P.S. *Cambridge University Press.*

De Jong, D.J.G. (1957). Graphical method for the determination of slip-line fields in soil mechanics. *Ingenior, 69*, 61-65.

De Jong, D.J.G. (1980). Application of calculus of variation to the vertical cut-off in cohesive frictionless soil. *Geotechnique, 30*(1), 1-16. [http://dx.doi.org/10.1680/geot.1980.30.1.1]

De Jong, D.J.G. (1981). Variational fallacy. *Geotechnique, 31*(4), 289-290. [http://dx.doi.org/10.1680/geot.1981.31.2.289]

DeGroot, D.J., Baecher, G.B. (1993). Estimating autocovariance of insitu soil properties. *J. Geotech. Eng, 119*(1), 147-166. [http://dx.doi.org/10.1061/(ASCE)0733-9410(1993)119:1(147)]

Der Kiureghian, A., Ke, J.B. (1988). The stochastic finite element method in structural reliability. *Probab. Eng. Mech, 3*(2), 83-91. [http://dx.doi.org/10.1016/0266-8920(88)90019-7]

Der Kiureghian, A., Dakessian, T. (1998). Multiple design points in first and second order reliability. *Struct. Saf, 20*(1), 37-49. [http://dx.doi.org/10.1016/S0167-4730(97)00026-X]

Desai, C.S., Zaman, M.M., Lightner, J.G., Siriwardane, H.J. (1984). Thin-layer element for interfaces and joints. *Int. J. Numer. Anal. Methods Geomech.* [http://dx.doi.org/10.1002/nag.1610080103]

Diaby, M., Karwan, M.H. (2016). *Advances in combinatorial optimization.* World Scientific Publishing. [http://dx.doi.org/10.1142/9725]

Dinis, L.M.J.S., Jorge, R.M.N., Belinha, J. (2007). Analysis of 3D solids using the natural neighbor radial point interpolation method. *Comput. Methods Appl. Mech. Eng, 196*(13-16), 2009-2028. [http://dx.doi.org/10.1016/j.cma.2006.11.002]

Dolinski, K. (1983). First order second moment approximation in reliability of structural systems -critical review and alternative approach. *Struct. Saf, 1*(3), 211-231. [http://dx.doi.org/10.1016/0167-4730(82)90027-3]

Donald, I.B., Chen, Z. (1997). Slope stability analysis by the upper bound approach: fundamentals and methods. *Can. Geotech. J, 34*, 853-862. [http://dx.doi.org/10.1139/t97-061]

Doss, L.J.T., Arathi, P. (2016). A constructive bandwidth reduction algorithm-A variant of GPS algorithm. *AKCE International Journal of Graphs and Combinatorics, 13*, 241-254. [http://dx.doi.org/10.1016/j.akcej.2016.06.014]

Ditlevsen, O. (1979). Generalized second moment reliability index. *Journal of Structural Mechanics, 7*(4), 435-451. [http://dx.doi.org/10.1080/03601217908905328]

Dow, J.O. (2015). *A concise overview of the finite element method.* Momentum Press.

Drescher, A. (1983). Limit plasticity approach to piping in bins. *ASME Trans. J. Appl. Mech, 50*, 549-553. [http://dx.doi.org/10.1115/1.3167089]

Drescher, A. (1986). Kinematics of axisymmetric vertical slopes at collapse. *Int. J. Numer. Anal. Methods Geomech, 10*, 431-444.

[http://dx.doi.org/10.1002/nag.1610100407]

Drescher, A., Detournay, E. (1993). Limit load in translational failure mechanisms for associative and non-associative materials. *Geotechnique, 43*(3), 443-456.
[http://dx.doi.org/10.1680/geot.1993.43.3.443]

Drucker, D.C., Prager, W. (1952). Soil mechanics and plastic analysis or limit design. *Q. Appl. Math, 10*, 157-165.
[http://dx.doi.org/10.1090/qam/48291]

Drucker, D.C., Greenberg, W., Prager, W. (1951). The safety factor of an elastic plastic body in plane strain, Transactions of the ASME. *J. Appl. Mech, 73*, 371.

Duarte, C.A., Oden, J.T. (1996). h-p clouds - an h-p meshless method. *Numer. Methods Partial Differ. Equ, 12*(6), 673-705.
[http://dx.doi.org/10.1002/(SICI)1098-2426(199611)12:6<673::AID-NUM3>3.0.CO;2-P]

Duncan, J.M. (1996). State of the art: Limit equilibrium and finite element analysis of slopes. *J. Geotech. Eng, 122*(7), 577-596.
[http://dx.doi.org/10.1061/(ASCE)0733-9410(1996)122:7(577)]

Duncan, J.M. (2000). Factors of safety and reliability in geotechnical engineering. *J. Geotech. Geoenviron. Eng, 126*(4), 307-316.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(2000)126:4(307)]

Ellingwood, B.R., Galambos, T.V., MacGregor, J.G., Cornell, C.A. (1980). Development of probability-based load criterion for American National Standard A58. *Special Publication 577, National Bureau of Standards, Washington.*
[http://dx.doi.org/10.6028/NBS.SP.577]

Fan, K., Fredlund, D.G., Wilson, G.W. (1986). An interslice force function for limit equilibrium slope stability analysis. *Can. Geotech. J, 23*(3), 287-296.
[http://dx.doi.org/10.1139/t86-042]

Fellin, W., Lessmann, H., Oberguggenberger, M., Vieider, R. (2005). *Analyzing Uncertainty in Civil Engineering.* Springer.
[http://dx.doi.org/10.1007/b138177]

Fenton, G.A. (1999). Random field modeling of CPT data. *J. Geotech. Eng, 125*(6), 486-498.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(1999)125:6(486)]

Fenton, G.A., Vanmarcke, E.H. (1998). Spatial variation in liquefaction risk. *Geotechnique, 48*(6), 819-831.
[http://dx.doi.org/10.1680/geot.1998.48.6.819]

Fenton, G.A., Griffiths, D.V. (2002). Probabilistic foundation settlement on spatially random soil. *J. Geotech. Geoenviron. Eng, 128*(5), 381-390.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(2002)128:5(381)]

Fenton, G.A., Griffiths, D.V. (2003). Bearing-capacity prediction of spatially random c-phi soils. *Can. Geotech. J, 40*(1), 54-65.
[http://dx.doi.org/10.1139/t02-086]

Fenton, G.A., Griffiths, D.V. (2005). Three-dimensional probabilistic foundation settlement. *J. Geotech. Geoenviron. Eng, 131*(2), 232-239.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(2005)131:2(232)]

Fenton, G.A. (2007). Data analysis/geostatistics. *Probabilistic methods in geotechnical engineering* (pp. 51-73). New York: Springer.

Fiessler, B., Neumann, H.J., Rackwitz, R. (1979). Quadratic limit states in structural reliability. *J. Eng. Mech, 105*(4), 661-676.

Fleming, K., Weltman, A., Randolph, M., Elson, K. (2009). *Piling engineering* Taylors and Francis. Flibs.http://flibs.sourceforge.net/

Floudas, C.A., Pardalos, P.M. (2009). *Encyclopedia of Optimization.* Springer.
[http://dx.doi.org/10.1007/978-0-387-74759-0]

Fredlund, D.G., Krahn, J. (1984). Analytical methods for slope analysis *International Symposium on Landslides,* 229-250.

Freudenthal, A.M. (1947). Safety of Structures. *Trans. Am. Soc. Civ. Eng, 112*, 125-159.

Frey, P.L., George, P.J. (2000). *Mesh generation* John Wiley.

Friedman, J.H. (1991). Multivariate adaptive regression splines. *Ann. Stat, 19*(1), 1-67.
[http://dx.doi.org/10.1214/aos/1176347963]

Ganesan, S., Tobiska, L. (2017). *Finite elements theory and algorithms.* Cambridge University Press.
[http://dx.doi.org/10.1017/9781108235013]

Ghanem, R., Saad, G., Doostan, A. (2007). Efficient solution of stochastic systems: application to the embankment dam problem. *Struct. Saf, 29*(3), 238-251.
[http://dx.doi.org/10.1016/j.strusafe.2006.07.015]

Gharti, H.N., Komatitsch, D., Oye, V., Martin, R., Tromp, J. (2012). Application of an elastoplastic spectral-element method to 3D slope stability analysis. *Int. J. Numer. Methods Eng, 91*(1), 1-26.
[http://dx.doi.org/10.1002/nme.3374]

Gharti, H.N., Tromp, J. (2017). A spectral-infinite-element solution of Poisson's equation: an application to self gravity, arXiv preprint arXiv:1706.00855.

Gilbert, M., Smith, C., Pritchard, T. (2010). Masonry arch analysis using discontinuity layout optimisation. *Proc. Instn Civ. Engrs - Engng. Comput. Mech, 163*(3), 155-166.

Gingold, R.A., Monaghan, J.J. (1977). Smoothed particle hydrodynamics: theory and application to non-spherical stars. *Mon. Not. R. Astron. Soc, 181*, 375-389.
[http://dx.doi.org/10.1093/mnras/181.3.375]

Glover, F., Laguna, M. (1996). *Tabu Search.* Dordrecht, Netherlands: Kluwer.

Goh, A.T.C. ((1984)). Genetic algorithm search for critical slip surface in multiple-wedge stability analysis. In: Graham , J., (Ed.), *Canadian Geotechnical Journal, 36(2), 382–391. Graham J* Slope Instability, John Wiley & Sons.36(2),

Goldreich, O.P. (2010). *NP, and NP-Completeness.* Cambridge University Press.
[http://dx.doi.org/10.1017/CBO9780511761355]

Gong, W.P., Wang, L., Khoshnevisan, S., Juang, C.H., Huang, H.W., Zhang, J. (2015). Robust geotechnical design of earth slopes using fuzzy sets. *J. Geotech. Geoenviron. Eng, 141*(1), 1-9.
[http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0001196]

Goodman, R.E. (1976). *Methods of geological engineering in discontinuous rocks.* San Francisco, CA, USA: West Publishing Company.

Greco, V.R. (1996). Efficient Monte Carlo technique for locating critical slip surface. *J. Geotech. Eng, 122*, 517-525.
[http://dx.doi.org/10.1061/(ASCE)0733-9410(1996)122:7(517)]

Gregory, B. B., John, T. C. (2005). Reliability and Statistics in Geotechnical Engineering. .Wiley Press, Baecher Christian.

Griffiths, D.V., Fenton, G.A. (2000). Influence of soil strength spatial variability on the stability of an undrained clay slope by finite element, Slope stability 2000. *GSP, 101*, 184-193.

Griffiths, D.V., Fenton, G.A. (2001). Bearing capacity of spatially random soil:The undrained clay Prandtl problem revisited. *Geotechnique, 51*(4), 351-359.
[http://dx.doi.org/10.1680/geot.2001.51.4.351]

Griffiths, D.V., Fenton, G.A. (2004). Probabilistic slope stability analysis by Finite element methods. *J.*

Geotech. Geoenviron. Eng, 130(5), 507-518.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(2004)130:5(507)]

Griffiths, D.V., Fenton, G.A. (2007). Probabilistic slope stability analysis by Finite element methods. *J. Geotech. Geoenviron. Eng, 130*(5), 507-518.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(2004)130:5(507)]

Griffiths, D.V., Fenton, G.A. (2009). Probabilistic Settlement Analysis by Stochastic and Random Finite element methods. *J. Geotech. Geoenviron. Eng, 135*(11), 1629-1637.
[http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0000126]

Griffiths, D.V., Huang, J., Fenton, G.A. (2011). Probabilistic infinite slope analysis. *Comput. Geotech, 38*, 577-584.
[http://dx.doi.org/10.1016/j.compgeo.2011.03.006]

Guenin, B., Konemann, J., Tuncel, L. (2014). *A Gentle Introduction to Optimization.* Cambridge University Press.
[http://dx.doi.org/10.1017/CBO9781107282094]

Haddad, O.B. (2018). *Advanced Optimization by Nature-Inspired Algorithms.* Springer.

Haldar, A., Mahadevan, S. (2000). *Reliability assessment using stochastic finite Reliability assessment using stochastic finite Reliability assessment using stochastic finite analysis.* John Wiley.

Haldar, A., Mahadevan, S. (2000). *Probability, reliability and statistical methods in engineering design.* John Wiley. a

Haldar, A., Mahadevan, S. (2000). *Reliability assessment using stochastic finite Reliability assessment using stochastic finite Reliability assessment using stochastic finite analysis.* John Wiley. b

Halsey, T., Mehta, A. (2002). *Challenges in Granular Physics.* World Scientific.

Hansen, J.B. (1970). A revised and extended formula for bearing capacity, Danish Geotechnical Institute. *Bulletin,* 28. [Copenhagen.].

Harr, M.E. (1977). *Mechanics of particulate media: A probabilistic approach.* New York: McGraw Hill.

Hartmann, F., Katz, C. (2004). *Structural Analysis with Finite Elements.* Springer.
[http://dx.doi.org/10.1007/978-3-662-05423-9]

Hasofer, A.M., Lind, N.C. (1974). Exact and invariant second-moment code format. *J. Eng. Mech. Div, 100*(EM1), 111-121.

Hassan, A.M., Wolff, T.F. (1999). Search algorithm for minimum reliability index of earth slopes. *J. Geotech. Geoenviron. Eng, 125*(4), 301-308.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(1999)125:4(301)]

Henderson, C.R. (1975). Best linear unbiased estimation and prediction under a selection model. *Biometrics, 31*(2), 423-447.
[http://dx.doi.org/10.2307/2529430]

Hertz, H. (1881). Ueber die Berührung fester elastischer Körper. *J. Reine Angew. Math, 92*, 156-171.

Hicks, M.A., Spencer, W. (2010). Influence of heterogeneity on the reliability and failure of a long 3D slopes. *Comput. Geotech, 37*(7-8), 948-955.
[http://dx.doi.org/10.1016/j.compgeo.2010.08.001]

Hilbert, L.B., Yi, W., Cook, N.G.W., Cai, Y., Liang, G.P. (1994). A new discontinuous finite element method for interaction of many deformable bodies in geomechanics. Proceedings of the Eighth International Conference Computer Methods and Advances in Geomechanics, Morgantown, Virginia, V1, p. 831-836.

Hill, R. (1950). *Mathematical theory of plasticity.* Oxford University Press.

Hill, J.M., Cox, G.M. (2000). Cylindrical cavities and classical rat-hole theory occurring in bulk materials. *Int. J. Numer. Anal. Methods Geomech, 24*, 971-990.

[http://dx.doi.org/10.1002/1096-9853(200010)24:12<971::AID-NAG107>3.0.CO;2-G]

Hinton, E., Owen, D.R.J. (1977). *Programming the finite element method.* Academic Press.

Homayouni, S.M., Tang, S.H., Motlagh, O. (2014). A genetic algorithm for optimization of integrated scheduling of cranes, vehicles, and storage platforms at automated container terminals. *J. Comput. Appl. Math, 270*, 545-556.
[http://dx.doi.org/10.1016/j.cam.2013.11.021]

Hohenbichler, M., Rackwitz, R. (1988). First order concept in system reliability. *Struct. Saf, 1*(3), 177-188.
[http://dx.doi.org/10.1016/0167-4730(82)90024-8]

Hong, H.P. (1999). Simple approximations for improving second-order reliability estimates. *J. Eng. Mech, 125*(5), 592-595.
[http://dx.doi.org/10.1061/(ASCE)0733-9399(1999)125:5(592)]

Hong, H.P., Roh, G. (2008). Reliability evaluation of earth slopes. *J. Geotech. Geoenviron. Eng, 134*(12), 1700-1705.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(2008)134:12(1700)]

Honjo, Y., Kuroda, K.A. (1991). New look at fluctuating geotechnical data for reliability design. *Soil Found, 31*(01), 110-120.
[http://dx.doi.org/10.3208/sandf1972.31.110]

Houlsby, G.T., Wroth, C.P. (1982). Direct solution of plasticity problems in soils by the method of characteristics *Proc., 4th Int. Conf. on Numerical Methods in Geomechancis,* Edmonton, Alta., Canada 1059-1071.

Hovland, H.J. (1977). Three-Dimensional Slope Stability analysis method. *J. Geotech. Eng. Div, 103*, 971-986.

Huang, C.C., Tsai, C.C. (2000). New method for 3D and asymmetrical slope stability analysis. *J. Geotech. Geoenviron. Eng, 126*(10), 917-927.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(2000)126:10(917)]

Huang, C.C., Tsai, C.C., Chen, Y.H. (2002). Generalized method for three- dimensional slope stability analysis. *J. Geotech. Geoenviron. Eng, 128*(10), 836-848.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(2002)128:10(836)]

Huang, J.S., Griffiths, D.V., Fenton, G.A. (2010). Probabilistic analysis of coupled soil consolidation. *J. Geotech. Geoenviron. Eng, 136*(3), 417-430. a
[http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0000238]

Huang, J.S., Griffiths, D.V., Fenton, G.A. (2010). System reliability of slopes by RFEM. *Soil Found, 50*(3), 345-355. b
[http://dx.doi.org/10.3208/sandf.50.343]

Hughes, T.J.R., Hinton, E. (1986). *Finite Element Methods for Plates and Shell Structures* Pineridge Press.

Ibrahimbegovic, A. (1993). Quadrilateral Finite Elements for Analysis of Thick and Thin Plates. *Comput. Methods Appl. Mech. Eng, 10*, 195-209.
[http://dx.doi.org/10.1016/0045-7825(93)90160-Y]

Irfan, T.Y. (1986). *Mode and mechanism of a complex failure at Tin Wan Hill, Special Projects Report 2/86.* Hong Kong: Geotechnical Control Office.

Irfan, T.Y. (1998). Structurally controlled landslides in saprolitic soils in Hong Kong. *Geotech. Geol. Eng, 16*, 215-238.
[http://dx.doi.org/10.1023/A:1008805827178]

Isukapalli, S.S., Roy, A., Georgopoulos, P.G. (1998). Stochastic response surface methods for uncertainty propagation: application to environmental and biological systems. *Risk Anal, 18*(3), 351-363.
[http://dx.doi.org/10.1111/j.1539-6924.1998.tb01301.x]

Itasca Consulting Group Inc. (1995). PFC3D 1.0, User Guide.

Itasca Consulting Group Inc. (2004). PFC3D 3.1, User Guide.

Iwashita, K., Oda, M. (1998). Rolling resistance at contacts in simulation of shear band development by DEM. *J. Eng. Mech, 124*(3), 285-292.
[http://dx.doi.org/10.1061/(ASCE)0733-9399(1998)124:3(285)]

Izbicki, R.J. (1981). Limit plasticity approach to slope stability problems, Journal of the Geotechnical Engineering Division. *Proc. Am. Soc. Civ. Eng, 107*, 228-233.

Janbu, N. (1957). Earth pressure and bearing capacity by generalized procedure of slices *Proc. 4th International Conference on Soil Mechanics,* 207-212.

Janbu, N. (1973). Slope stability computations. *Embankment-Dam Engineering* John Wiley.

Jaksa, M.B., Kaggwa, W.S., Brooker, P.I. (1999). Experimental evaluation of the scale of fluctuation of a stiff clay, Proc. 8th Int. Conf. on the Application of Statistics and Probability 1, 415-422.

Jaksa, M.B., Fenton, G.A. (2000). Random field modeling of CPT data. *J. Geotech. Geoenviron. Eng, 126*(12), 1212-1216.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(2000)126:12(1212)]

Jebahi, M., André, D., Terreros, I., Iordanoff, I. (2015). *Discrete Element Method to Model 3D Continuous Materials.* John Wiley.
[http://dx.doi.org/10.1002/9781119103042]

Jenike, A.J., Yen, B.C. (1962). Slope stability in axial symmetry *Proc., 5th Symp. on Rock Mechanics,* Univ. of Minnesota, Pergamon.New York: 689-711.

Jha, S.K., Ching, J.Y. (2013). Simplified reliability method for spatially variable undrained engineered slopes. *Soil Found, 53*(5), 708-719.
[http://dx.doi.org/10.1016/j.sandf.2013.08.008]

Ji, J., Low, B.K. (2012). Stratified response surfaces for system probabilistic evaluation 781 of slopes. *J. Geotech. Geoenviron. Eng, 138*(11), 1398-1406.
[http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0000711]

Ji, J., Liao, H.J., Low, B.K. (2012). Modeling 2-D spatial variation in slope reliability analysis using interpolated autocorrelations. *Comput. Geotech, 40*, 135-146.
[http://dx.doi.org/10.1016/j.compgeo.2011.11.002]

Jing, L.R., Stephansson, O., Erling, N. (1993). Study of rock joints under cyclic loading conditions. *Rock Mech. Rock Eng, 26*(3), 215-232.
[http://dx.doi.org/10.1007/BF01040116]

Jiang, Q.H. (2000). Research on three dimensional discontinuous deformation analysis method, Ph.D. Thesis, Wuhan Institute of Rock & Soil Mechanics, Wuhan, China.

Jiang, M.J., Yu, H.S., Harris, D. (2005). A novel discrete model for granular material incorporating rolling resistance. *Comput. Geotech, 32*, 340-357.
[http://dx.doi.org/10.1016/j.compgeo.2005.05.001]

Jiao, Y.Y. (1998). *Three dimension DDA and its application. Ph.D. Thesisi.* Wuhan, China: Wuhan Institute of Rock & Soil Mechanics.

Jing, R.J. (2007). *Fundamentals of Discrete Element Methods for Rock Engineering: Theory and Applications.* Elsevier.

Jiang, S.H., Huang, J.S. (2016). Efficient slope reliability analysis at low-probability levels in spatially variable soils. *Comput. Geotech, 75*, 18-27.
[http://dx.doi.org/10.1016/j.compgeo.2016.01.016]

Jiang, S.H., Li, D.Q., Zhang, L.M., Zhou, C.B. (2014). Slope reliability analysis considering spatially variable shear strength parameters using a non-intrusive stochastic finite element method. *Eng. Geol, 168*, 120-128. [http://dx.doi.org/10.1016/j.enggeo.2013.11.006]

Jiang, S.H., Qi, X.H., Cao, Z.J., Li, D.Q. (2015). System reliability analysis of slope with stochastic response surface method. *Chin J Rock Soil Mech, 36*(3), 809-818.

Jirousek, J., Wroblewski, A., Szybinski, B. (1995). A new 12 d.o.f. Quadrilateral element for analysis of thick and thin plates. *Int. J. Numer. Methods Eng, 38*, 2619-2638. [http://dx.doi.org/10.1002/nme.1620381508]

Juang, C.H., Rosowsky, D.V., Tang, W.H. (1999). Reliability-based method for assessing liquefaction potential of soils. *J. Geotech. Geoenviron. Eng, 128*(8), 684-689. [http://dx.doi.org/10.1061/(ASCE)1090-0241(1999)125:8(684)]

Kang, F., Han, S.X., Salgado, R., Li, J.J. (2015). System probabilistic stability analysis of soil slopes using Gaussian process regression with Latin hypercube sampling. *Computers and Geotechnics, 63:13:25.*

Kang, F., Li, J. (2015). Artificial bee colony algorithm optimized support vector regression for system reliability analysis of slopes. *J. Comput. Civ. Eng.*04015040.

Karel, K. (1977). Application of energy method, Journal of the Geotechnical Engineering Division. *Proc. Am. Soc. Civ. Eng, 103*, 381-397. a

Karel, K. (1977). Energy method for soil stability analyses, Journal of the Geotechnical Engineering Division. *Proc. Am. Soc. Civ. Eng, 103*, 431-445. b

Kaymaz, I. (2005). Application of kriging method to structural reliability problems. *Struct. Saf, 27*(2), 133-151. [http://dx.doi.org/10.1016/j.strusafe.2004.09.001]

Ke, T.C. (1995). Modification of DDA with respect to rigid-body rotation. *Proceedings of the First International Conference on Analysis of Discontinuous Deformation,* Chungli, Taiwan 260-273.

Ke, T.C., Thapa, B., Goodman, R.E. (1994). Stability analysis of a penstock slope. *Proceedings of the First North American Rock Mechanics Symposium,* Austin, TX, USA 1109-1116.

Ke, T.C., Tang, J.H. (1996). Modeling of solid-fluid Interactions using the manifold method. *Proceedings of the Second North American Rock Mechanics Symposium,* Montreal, Quebec, Canada 1815-1822.

Kennedy, J., Eberhart, R. (1995). Particle Swarm Optimization *International Conference on Neural Networks,* Perth, Australia 1942-1948.

Kerisel, J., Absi, E. (1990). *Active and passive earth pressure tables.* U.K.: Taylor and Francis.

Khoei, A.R. (2015). *Extended finite element method.* John Wiley.

Kim, J.M., Sitar, N. (2013). Reliability approach to slope stability analysis with spatially correlated soilproperties. *Soil Found, 53*(1), 1-10. [http://dx.doi.org/10.1016/j.sandf.2012.12.001]

Kirk, P.A., Campbell, S.D.G., Fletcher, C.J.N., Merriman, R.J. (1997). The significance of primary volcanic fabrics and clay distributions in landslides in Hong Kong. *J. Geol. Soc. London, 154*, 1009-1019. [http://dx.doi.org/10.1144/gsjgs.154.6.1009]

Knill, J. (2006). *Report on Shum Wan Road Landslide of 13 August 1995.* Geotechnical Engineering Office, Hong Kong SAR Government.

Knill and GEO (2006). Report on the Fei Tsui road landslide of 13 August 1995, Hong Kong SAR Government.

Krige, D.G. (1994). A statistical approach to some basic mine valuation problems on the witwatersrand. *J. S. Afr. Inst. Min. Metall, 94*(3), 95-112.

Komzsik l. (2009). *Applied Calculus of Variations for Engineers.* CRC Press.

Koo, C.Y., Chern, J.C., Chen, S. (1995). The development of the second-order displacement function for discontinuous deformation analysis. *Proceedings of the Sixth Conference on Geotechnical Engineering,* Taiwan 665-674.

Koo, C.Y., Chern, J.C. (1996). *The development of DDA with third displacement function. DDA and Simulations of Discontinuous Media* TSI press.

Konietzky, H. (2004). Numerical Modelling of Discrete Materials in Geotechnical Engineering, Civil Engineering and Earth Sciences: Proceedings of the First International UDEC/3DEC Symposium, Bochum, Germany, 29 September - 1 October 2004, CRC Press.

Korte, B., Vygen, J. (2018). *Combinatorial Optimization Theory and Algorithms6th edition.* Springer. [http://dx.doi.org/10.1007/978-3-662-56039-6]

Kosinski, W. (2008). *Advances in Evolutionary algorithms, AvE4EvA.*

Kotter, F. (1903). *Die Bestimmung des Druckes an gekrmmten Gleitflchen, eine Aufgabe aus der Lehre vom Erddruck, Berlin Akad* (pp. 229-233). Berlin: Wiss.

Koutromanos, I. (2018). *Fundamentals of Finite Element Analysis, Linear Finite Element Analysis.* John Wiley.

Koyluoglu, H.U., Nielsen, S.R.K. (1994). New approximations for SORM integrals. *Struct. Saf, 13*(4), 235-246.
[http://dx.doi.org/10.1016/0167-4730(94)90031-0]

Krahn, J., Fredlund, D.G. (1997). Evaluation of the University of Saskatchewan slope stability program." R.T.A.C Forum, Roads and Transportation Association of Canada, Quebec City, Canada, 69–76.

Kulhawy, F.H., Mayne, P.W. (1990). *Manual on estimating soil properties for foundation design.* Ithaca, NY, USA: Cornell Univ.

Kumar, J. (2001). Seismic passive earth pressure coefficients for sands. *Can. Geotech. J, 38*, 876-881.
[http://dx.doi.org/10.1139/t01-004]

Kumar, J., Chitikela, S. (2002). Seismic passive earth pressure coefficients using the method of characteristics. *Can. Geotech. J, 39*, 463-471.
[http://dx.doi.org/10.1139/t01-103]

Lasdon, L.S., Warren, A.D., Jain, A., Ratner, M. (1978). Design and testing of a generalized reduced gradient code for nonlinear programming. *ACM Trans.Math, 4*(1), 34-50.
[http://dx.doi.org/10.1145/355769.355773]

Lam, L., Fredlund, D.G., Barbour, S.L. (1987). Transient Seepage Model for Saturated-Unsaturated Soil Systems: a Geotechnical Engineering Approach. *Can. Geotech. J, 24*, 565-580.
[http://dx.doi.org/10.1139/t87-071]

Lam, L., Fredlund, D.G. (1993). A general limit equilibrium model for three-dimensional slope stability analysis. *Can. Geotech. J, 30*(6), 905-919.
[http://dx.doi.org/10.1139/t93-089]

Lawrence, C.T., Tits, A.L. (1996). Nonlinear equality constraints in feasible sequential quadratic programming. *Optim. Methods Softw, 6*, 265-282.
[http://dx.doi.org/10.1080/10556789608805638]

Lawrence, S. (1984). *Resource constrained project scheduling: An experimental investigation of heuristic scheduling techniques, Pittsburgh: School of industrial Administration, Carnegie.* USA: Mellon University.

Lemos, J.V. (1983). A Hybrid Distinct Element-Boundary Element Computational Model for the Half-Plane. M.S. Thesis, University of Minnesota.

Leshchinsky, B. (2015). Bearing Capacity of Footings Placed Adjacent to c′-ϕ′ Slopes. *J. Geotech. Geoenviron. Eng, 141*(6)04015022.
[http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0001306]

Leshchinsky, B., Ambauen, S. (2015). Limit Equilibrium and Limit Analysis: Comparison of Benchmark

Slope Stability Problems. *J. Geotech. Geoenviron. Eng, 141*(10)04015043.
[http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0001347]

Li, K.S., Lee, I.K. (1991). The assessment of geotechnical safety. *Selected Topics in Geotechnical Engineering, The Lumb Volume* (pp. 195-229). Canberra: University College, University of New South Wales.

Li, K.S., Lumb, P. (1987). Probabilistic design of slopes. *Can. Geotech. J, 24*(4), 520-535.
[http://dx.doi.org/10.1139/t87-068]

Li, L., Chu, X.S. (2015). Multiple response surfaces for slope reliability analysis. *Int. J. Numer. Anal. Methods Geomech, 39*(2), 175-192.
[http://dx.doi.org/10.1002/nag.2304]

Li, D.Q., Jiang, S.H., Cao, Z.J., Zhou, W., Zhou, C.B., Zhang, L.M. (2015). A multiple response surface method for slope reliability analysis considering spatial variability of soil properties. *Eng. Geol, 187*, 60-72.
[http://dx.doi.org/10.1016/j.enggeo.2014.12.003]

Li, S.F., Liu, W.K. (2007). *Meshfree Particle Methods.*. Springer.

Li, X.K., Feng, Y.T., Mustoe, G. (2017). *Proceedings of the 7th International Conference on Discrete Element Methods.* Springer.

Li, D.Z., Cheng, Y.M. (2012). Lower Bound Limit Analysis Using Nonlinear Failure Criteria, 2012 International Conference on Structural Computation and Geotechnical Mechanics. Procedia Earth and Planetary Science City: Kun Ming China, pp. 170-174.

Li, D.Z., Cheng, Y.M., Wang, J.A., Yang, Y., Li, N. (2013). Application of finite-element-based limit analysis with mesh adaptation in geotechnical engineering, Chinese. *J. Geotech. Eng, 35*(5), 922-929.

Li, N., Cheng, Y.M. (2015). Laboratory and 3D-Distinct Element Analysis of Failure Mechanism of Slope under External Surcharge. *Nat. Hazards Earth Syst. Sci, 15*, 35-43.
[http://dx.doi.org/10.5194/nhess-15-35-2015]

Li, N., Cheng, Y.M., Fung, W.H. (2018). Transition Zone in Bearing Capacity Problem from Plasticity Method, Discrete Element Method and Laboratory Tests. *Adv. Geosci, 2*(1), 1-21.

Li, H., Mulay, S.S. (2013). *Meshless methods and their numerical properties.* CRC Press.
[http://dx.doi.org/10.1201/b14492]

Li, L., Chu, X.S. (2016). Locating the Multiple Failure Surfaces for Slope Stability Using Monte Carlo Technique. *Geotech. Geol. Eng, 34*(5), 1475-1486.
[http://dx.doi.org/10.1007/s10706-016-0055-1]

Li, X.Y., Zhang, L.M., Gao, L., Zhu, H. (2016). Simplified slope reliability analysis considering spatial soil variability. *Eng. Geol.*
[http://dx.doi.org/10.1016/j.enggeo.2016.11.013]

Libersky, L.D., Petschek, A.G., Carney, T.C., Hipp, J.R., Allahdadi, F.A. (1993). High strain lagrangian hydrodynamics: A three-dimensional SPH code for dynamic material response. *J. Comput. Phys, 109*(1), 67-75.
[http://dx.doi.org/10.1006/jcph.1993.1199]

Lind, N.C. (1971). Consistent partial safety factors. *J. Struct. Div, 97*(ST6), 1651-1669.

Lin, J.S., Lee, D.H. (1996). Manifold method using polynomial basis function of any order, Proceedings of the First International Forum on Discontinuous Analysis (DDA) and Simulations of Discontinuous Media, TSI Press, Berkeley, California, USA, p. 365-372.

Lin, D.Z., Mo, H.H. (1994). *Manifold method of material analysis.* The University of Oklahoma.

Lind, N.C. (1983). Modelling uncertainty in discrete dynamical systems. *Appl. Math. Model, 7*(3), 146-152.
[http://dx.doi.org/10.1016/0307-904X(83)90001-X]

Liu, H.P. (2009). *Taylor kriging metamodeling for simulation interpolation, sensitivity analysis and* *optimization.*

Liu, H.P., Shi, J., Erdem, E. (2010). Prediction of wind speed time series using modified taylor kriging method. *Energy, 35*(12), 4870-4879.
[http://dx.doi.org/10.1016/j.energy.2010.09.001]

Liu, G.R. (2010). *Meshfree methods Moving Beyond the Finite Element Method.* CRC Press.

Liu, M.B., Liu, G.R. (2016). *Particle methods for multi-scale and multi-physics.* World Scientific Publishing.
[http://dx.doi.org/10.1142/9017]

Liu, L.L., Cheng, Y.M. (2016). Efficient system reliability analysis of soil slopes using multivariate adaptive regression splines-based Monte Carlo simulation. *Comput. Geotech, 79*, 41-54.
[http://dx.doi.org/10.1016/j.compgeo.2016.05.001]

Liu, L.L., Cheng, Y.M., Wang, X.M. (2017). Genetic algorithm optimized Taylor Kriging surrogate model for system reliability analysis of soil slopes. *Journal of Landslides, 14*, 535-546.
[http://dx.doi.org/10.1007/s10346-016-0736-0]

Liu, L.L., Cheng, Y.M. (2017). Conditional random field reliability analysis of a cohesion-frictional slope. *Comput. Geotech, 82*, 173-186.
[http://dx.doi.org/10.1016/j.compgeo.2016.10.014]

Liu, L.L., Cheng, Y.M., Wang, X.M., Zhang, S.H., Wu, Z.H. (2017). System reliability analysis and risk assessment of a layered slope in spatially variable soils considering stratigraphic boundary uncertainty. *Comput. Geotech, 89*, 213-225.
[http://dx.doi.org/10.1016/j.compgeo.2017.05.014]

Liu, L.L., Deng, Z., Zhang, S.H., Cheng, Y.M. (2018). Simplified framework for system reliability analysis of slopes in spatially variable soils. *Eng. Geol, 239*, 330-343.
[http://dx.doi.org/10.1016/j.enggeo.2018.04.009]

Liu, L.L., Cheng, Y.M., Zhang, S.H, Z., Deng (2018). Simplified framework for system reliability analysis of slopes in spatially variable soils. *Engineering Geology, 239*, 330-343.

Liu, L.L., Zhang, S.H., Cheng, Y.M. (2018). Advanced reliability analysis of slopes in spatially variable soils using multivariate adaptive regression splines. *Geoscience Frontiers.*
[http://dx.doi.org/10.1016/j.gsf.2018.03.013]

Liu, W.K., Jun, S., Zhang, Y. (1995). Reproducing kernel particle methods. *Int. J. Numer. Methods Eng, 20*, 1081-1106.
[http://dx.doi.org/10.1002/fld.1650200824]

Liu, W.K., Li, S., Belytschko, T. (1997). Moving least square reproducing kernel methods part i: Methodology and convergence. *Comput. Methods Appl. Mech. Eng, 143*(1-2), 113-154.
[http://dx.doi.org/10.1016/S0045-7825(96)01132-2]

Liu, Y.X., Zheng, Y.R. (2019). *Plastic Mechanics of Geomaterial.* Science Press and Springer.
[http://dx.doi.org/10.1007/978-981-13-3753-6]

Liu, G.R., Liu, M.B. (2003). *Smoothed Particle Hydrodynamics: A Meshfree Particle Method.* Singapore: World Scientific Publishing.
[http://dx.doi.org/10.1142/5340]

Livesley, R.K., Sabin, M.A. (1991). Algorithms for numbering the nodes of finite-element meshes. *Comput. Syst. Eng, 2*(1), 103-114.
[http://dx.doi.org/10.1016/0956-0521(91)90042-4]

Lloret-Cabot, M., Fenton, G.A., Hicks, M.A. (2014). On the estimation of scale of fluctuation in geostatistics. Georisk. *Assessment and Management of Risk for Engineered Systems and Geohazards, 8*(2), 129-140.
[http://dx.doi.org/10.1080/17499518.2013.871189]

Lo, S.H. (2015). *Finite element mesh generation.* CRC Press.

Lophaven, S.N., Nielsen, H.B., Søndergaard, J. (2002). *Dace, a matlab kriging toolbox.*

Lorig, L.J. (1984). *A Hybrid Computational Model for Excavation and Support Design in Jointed Media.*

Low, B.K., Tang, W.H. (1997). Reliability analysis of reinforced embankments on soft ground. *Can. Geotech. J, 34*, 672-685. a
[http://dx.doi.org/10.1139/t97-032]

Low, B.K., Tang, W.H. (1997). Probabilistic slope analysis using Janbu's generalized procedure of slices. *Comput. Geotech, 21*(2), 121-142. b
[http://dx.doi.org/10.1016/S0266-352X(97)00019-0]

Low, B.K. (2003). Practical probabilistic slope stability analysis.

Low, B.K., Lacasse, S., Nadim, F. (2007). Slope reliability analysis accounting for low spatial variation. *Georisk, 1*(4), 177-189.

Low, B.K., Zhang, J., Tang, W.H. (2011). Efficient system reliability analysis illustrated for a retaining wall and a soil slope. *Comput. Geotech, 38*(2), 196-204.
[http://dx.doi.org/10.1016/j.compgeo.2010.11.005]

Lowe, J., Karafiath, L. (1960). Stability of Earth Dams Upon Drawdown *Proceedings of the 1st Pan-American Conference on Soil Mechanics and Foundation Engineering,* Mexico*2*, 537-552.

Lu, Z.M., Zhang, D.X. (2007). Stochastic simulations for flow in nonstationary randomly heterogeneous porous media using a KL-based moment-equation approach. *Multiscale Model. Simul, 6*(1), 228-245.
[http://dx.doi.org/10.1137/060665282]

Lucy, L.B. (1977).)A numerical approach to the testing of the fission hypothesis. *The Astronomical Journal, 82*(1977), 1024.

Lumb, P., Lee, C.F. (1975). Clay mineralogy of the Hong Kong soils. *Proceedings 4th South East Asian Conference on Soil Engineering,* Kuala Lumpur, Malaysia 1-41.

Lumb, P. (1970). Safety factors and the probability distribution of soil strength. *Can. Geotech. J, 7*(3), 225-242.
[http://dx.doi.org/10.1139/t70-032]

Lumb, P., Lee, C.F. (1975). Clay mineralogy of the Hong Kong soils. Proceedings 4th South East Asian Conference on Soil Engineering.(pp. 1-41). Kuala Lumpur, Malaysia,.

Luo, S.M., Zhang, X.W., Cai, Y.C. (2000). The variational principle and application of nonlinear numerical manifold method. *Chinese Journal of Applied Mathematics and Mechanics, 21*(12), 1265-1270.

Luo, S.M., Zhang, X.W., Cai, Y.C. (2001). The variational principle and application of numerical manifold method. *Chinese Journal of Applied Mathematics and Mechanics, 22*(6), 587-592.

Luo, X.F., Li, X., Zhou, J., Cheng, T. (2012). A Kriging-based hybrid optimization algorithm for slope reliability analysis. *Struct. Saf, 34*(1), 401-406.
[http://dx.doi.org/10.1016/j.strusafe.2011.09.004]

Luo, X.F., Li, X., Zhou, J., Cheng, T. (2012). A kriging-based hybrid optimization algorithm for slope reliability analysis. *Struct. Saf, 34*(1), 401-406. b
[http://dx.doi.org/10.1016/j.strusafe.2011.09.004]

Lyamin, A.V., Sloan, S.W. (1997). A comparison of linear and nonlinear programming formulations for lower bound limit analysis In: Pietruszczak, S., Pande, G.N., (Eds.), *Proceedings of the 6th International Symposium on Numerical Models in Geomechanics,* 367-373.Balkema.Rotterdam:

Lysmer, J. (1970). Limit analysis of plane problems in soil mechanics. *J. Soil Mech. Found. Div, 96*(SM4), 1311-1334.

Ma, S., Zhang, X., Qiu, X.M. (2009). Comparison study of MPM and SPH in modeling hypervelocity impact problems. *Int. J. Impact Eng, 36*(2), 272-282.

[http://dx.doi.org/10.1016/j.ijimpeng.2008.07.001]

Maclaughlin, M.M., Sitar, N. (1996). Rigid-body rotations in DDA Proceedings of the First International Forum on Discontinuous Analysis(DDA) and Simulations of Discontinuous Media, TSI Press, Berkeley, California, USA, p. 620-636.

Maday, Y., Patera, A.T. (1989). Spectral element methods for the incompressible Navier-Stokes equations. *State-of-the-Art surveys on computational mechanics.* New York: ASME.

Malkawi, A.I.H., Hassan, W.F., Sarma, S.K. (2001). Global search method for locating general slip surface using Monte Carlo techniques. *J. Geotech. Geoenviron. Eng, 127*, 688-698.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(2001)127:8(688)]

Mao, Z., Liu, G.R., Dong, X. (2017). A comprehensive study on the parameters setting in smoothed particle hydrodynamics (SPH) method applied to hydrodynamics problems. *Comput. Geotech, 92*, 77-95.
[http://dx.doi.org/10.1016/j.compgeo.2017.07.024]

Martin, C.M. (2004). *User Guide for ABC - Analysis of Bearing Capacity (v1.0).* Department of Engineering Science, University of Oxford.

Matsuo, M., Kuroda, K. (1974). Probabilistic approach to design of embankments. *Soil Found, 14*(2), 1-17.
[http://dx.doi.org/10.3208/sandf1972.14.2_1]

Matuttis, H.G., Chen, J. (2014). *Understanding the discrete element method.* John Wiley.
[http://dx.doi.org/10.1002/9781118567210]

Mayne, D.Q., Polak, E. (1976). Feasible directions algorithms for optimization problems with equality and inequality constraints. *Math. Program, 11*, 67-80.
[http://dx.doi.org/10.1007/BF01580371]

Mester, D., Ronin, D., Frenkel, M., Korol, A., Braysy, Z., Dullaert, O., Raa, W. (2010). *Discrete optimization for TSP-Like genome mapping problems.* Nova Science Publishers.

Meyerhof, G.G. (1963). Some recent research on the bearing capacity of foundations. *Can. Geotech. J, 1*, 16-26.
[http://dx.doi.org/10.1139/t63-003]

Michalowski, R.L. (1989). Three-dimensional analysis of locally loaded slopes. *Geotechnique, 39*(1), 27-38.
[http://dx.doi.org/10.1680/geot.1989.39.1.27]

Michalowski, R.L. (1995). Slope stability analysis: A kinematical approach. *Geotechnique, 45*(2), 283-293.
[http://dx.doi.org/10.1680/geot.1995.45.2.283]

Michalowski, R.L. (1997). An estimate of the influence of soil weight on bearing capacity using limit analysis. *Soil Found, 37*(4), 57-64.
[http://dx.doi.org/10.3208/sandf.37.4_57]

Mohammadi, S. (2003). *Discontinuous mechanics Using finite and discrete elements.* WIT Press.

Monaghan, J.J., Lattanzio, J.C. (1985). A refined particle method for astrophysical problems. *Astron. Astrophys, 149*, 135-143.

Mononobe, N., Matsuo, H. (1929). On the determination of earth pressure during earthquakes *Proceeding of the World Engineering Congress,* Tokyo*Vol.9*, 179-187.

Morgenstern, N.R., Price, V.E. (1965). The analysis of stability of general slip surface. *Geotechnique, 15*(1), 79-93.
[http://dx.doi.org/10.1680/geot.1965.15.1.79]

The Evaluation of Slope Stability - A 25-Year Perspective, Stability and Performance of Slopes and Embankments - II Morgenstern, N.R. (1992). Geotechnical Special PublicationASCE.

Morgenstern, N.R. (1994). *Report on Kwun Lung Lau Landslide of 23 July, 1994; Causes of the Landslide and Adequacy of Slope Safety Practice in Hong Kong.* Hong Kong: Civil Engineering Department.

Morgenstern, N.R. (1995). Managing risk in geotechnical engineering. *Proceedings 10th Pan-American Conference on Soil Mechanics and Foundation Engineering,* Guadalajara *4*, 102-126.

Morrison, E.E., Jr, Ebeling, R.M. (1995). Limit equilibrium computation of dynamic passive earth pressure. *Can. Geotech. J, 32*, 481-487.
[http://dx.doi.org/10.1139/t95-050]

Mroz, Z., Drescher, A. (1969). Limit plasticity approach to some cases of flow of bulk solids, Journal of Engineering for Industry. *Trans. Am. Soc. Mech. Eng, 51*, 357-364.

Munjiza, A.A., Knight, E.E., Rougier, E. (2012). *Computational mechanics of discontinua.* John Wiley.

Munjiza, A. (2004). *The Combined Finite-Discrete Element Method.* John Wiley.
[http://dx.doi.org/10.1002/0470020180]

Nash, D. (1987). A comparative review of limit equilibrium methods of stability analysis. *Slope Stability* (pp. 11-75). New York: John Wiley & Sons.

Nayroles, B., Touzot, G., Villon, P. (1992). Generalizing the finite element method: diffuse approximation and diffuse elements. *Comput. Mech, 10*, 307-318.
[http://dx.doi.org/10.1007/BF00364252]

Nayyar, A., Le, D.N., Nguyen, N.G. (2019). *Advances in Swarm Intelligence for Optimizing Problems in Computer Science.* CRC Press.

Nedjah, N., Alba, E. (2006). Parallel Evolutionary Computations, Springer.

Nedderman, R.M. (1992). Statistics and kinematics of granular materials, Cambridge University Press.

Nguyen, V.U. (1985). Determination of critical slope failure surfaces. *J. Geotech. Eng, 111*(2), 238-250.
[http://dx.doi.org/10.1061/(ASCE)0733-9410(1985)111:2(238)]

Nithiarasu, P., Lewis, R.W., Seetharamu, K.N. (2016). *Fundamentals of the Finite Element Method for Heat and Mass Transfer* John Wiley.

Nocedal, J., Wright, S.J. (2006). *Numerical Optimization.* Springer.

Norouzi, H.R., Zarghami, R., Sotudeh-Gharebagh, R., Mostoufi, N. (2016). *Coupled CFD-DEM Modeling.* John Wiley.
[http://dx.doi.org/10.1002/9781119005315]

Novotortsev, V.I. (1938). Experience with the application of the theory of plasticity to problems of determination of the bearing capacity of foundation beds of structures, Izv. Nauchno-Issled. *Inst. Anzh. Geol, 22*, 115-128.

Oka, Y., Wu, T.H. (1990). System reliability of slope stability, Journal of Geotechnical Engineering, ASCE. *Geotech. Eng, 116*(8), 1185-1189.
[http://dx.doi.org/10.1061/(ASCE)0733-9410(1990)116:8(1185)]

Ohnishi, Y., Tanaka, M., Sasaki, T. (1995). Modification of DDA for elasto-plastic analysis with illustrative generic problems. *Proceedings of the 35th U.S. Symposium On Rock Mechanics,* Lake Tahoe, California 45-50.

Ohnishi, Y., Miki, S. (1996). Development of circular and elliptic disc elements for DDA. Proceedings of the First International Forum on Discontinuous Analysis (DDA) and Simulations of Discontinuous Media, TSI Press, Berkeley, California, USA, p. 44-51.

Ohtsubo, H., Suzuki, K., Terada, K., Nakanishi, K. (1997). Utilization of finite covers in the manifold method for accuracy control. *Proceedings of the Second International Conference on Analysis of Discontinuous Deformation,* Kyoto, Japan 317-322.

Ohnishi, Y., Tanaka, R., Koyama, T. (1999). Manifold method in saturated-unsaturated groundwater flow analysis.

Okereke, M., Keates, S. (2018). *Finite Element Applications A Practical Guide to the FEM Process.*

Springer.
[http://dx.doi.org/10.1007/978-3-319-67125-3]

Oñate, E., Idelsohn, S. (1998). A mesh-free finite point method for advective-diffusive transport and fluid flow problems. *Comput. Mech, 21*(4-5), 283-292.

Oñate, E., Owen, D.R.J. (2011). *Particle-Based Methods.* Springer. a
[http://dx.doi.org/10.1007/978-94-007-0735-1]

Oñate, E., Owen, D.R.J. (2011). *Particle-based Methods II Fundamentals and Applications, International Center for Numerical Methods in Engineering.* CIMNE. b

Onwubolu, G., Davendra, D. (2009). *Differential Evolution: A Handbook for Global Permutation-Based Combinatorial Optimization.* Springer.
[http://dx.doi.org/10.1007/978-3-540-92151-6]

O'Sullivan, C. (2002). *The application of discrete element modelling to finite deformation problems in geomechanics.*

O Sullivan, C. (2011). *Particulate Discrete Element Modelling.* Spon Press.

Ourique, C.O., Biscaia, E.C., Pinto, J.C. (2002). The use of particle swarm optimization for dynamic analysis in chemical processes. *Comput. Chem. Eng, 26*, 1783-1793.
[http://dx.doi.org/10.1016/S0098-1354(02)00153-9]

Owen, D.R.J., Hinton, E. (1980). *Finite element in Plasticity.* Pineridge Press Limited.

Paice, G.M., Griffiths, D.V., Fenton, A. (1996). Finite element modeling of settlements on spatially random soil. *J. Geotech. Eng, 122*(9), 777-779.
[http://dx.doi.org/10.1061/(ASCE)0733-9410(1996)122:9(777)]

Pan, J. (1980). *Analysis of Stability and Landslide for Structures* (pp. 25-28). Beijing: Hydraulic Press. (in Chinese)

Paradalos, P.M. (1993). *Complexity in numerical optimization.* Utopia Press.
[http://dx.doi.org/10.1142/2041]

Pardalos, P.M., Du, D.Z., Graham, R.L. (2005). *Handbook of Combinatorial Optimization.* Springer.

Patera, A. T. (1984).), A spectral element method for fluid dynamics: laminar flow in a channel expansion. *J. Comput. Phys,* 468-488.

Pearce, C., Bicanic, N., Thavalingham, A., Liao, Z.H. (1999). On the DDA framework for modelling concrete fracture.

Peck, R.B. (1973). Influence of non-technical factors on the quality of embankment dams. *Embankment Dam Engineering, Casagrande Volume* John Wiley.

Pepper, D.W., Heinrich, J.C. (2006). *The Finite Element Method Basic Concepts and Applications* CRC Press.

Phoon, K., Kulhawy, F.H. (1999). Characterization of geotechnical variability. *Can. Geotech. J, 36*(4), 612-624. a
[http://dx.doi.org/10.1139/t99-038]

Phoon, K., Kulhawy, F.H. (1999). Evaluation of geotechnical property variability. *Can. Geotech. J, 36*(4), 625-639. b
[http://dx.doi.org/10.1139/t99-039]

Phoon, K.K., Ching, J. (2015). *Risk and reliability in geotechnical engineering.* CRC Press.

Pillo, G.D., Roma, M. (2006). *Large scale nonlinear optimization.* Springer.
[http://dx.doi.org/10.1007/0-387-30065-1]

Plewa, T., Linde, T., Weirs, V.G. (2003). Adaptive mesh refinement - theory and applications *Proceedings of the Chicago Workshop on Adaptive Mesh Refinement Methods.*Sept. 3-5, 2003

Polidori, D.C., Beck, J.L., Papadimitriou, C. (1999). New approximations for reliability integrals. *J. Eng. Mech, 125*(4), 466-475.
[http://dx.doi.org/10.1061/(ASCE)0733-9399(1999)125:4(466)]

Pozrikidis, C. (2014). *Introduction to Finite and Spectral Element Methods Using MATLAB* Chapman and Hall.

Prandtl, L. (1920). Uber die Harte plasticher Korper, Nachrichten von der Koniglichen Gesellschaften, Gottingen, Math.-phys. Klasse, p.74-85.

Prater, E.G. (1977). An examination of some theories of earth pressure on shaft lining. *Can. Geotech. J, 14*(1), 91-106.
[http://dx.doi.org/10.1139/t77-007]

Press, W.H., Teukolsky, S.A., Vetterling, W.T., Flannery, B.P. Numerical recipes in Fortran 90. .Cambridge University Press.

Pugsley, A. (1955). Report on structural safety. *Struct. Eng, 33*(5), 141-149.

Qiu, X.J. (1996). Manifold method without use of penalty springs. Proceedings of the First International Forum on Discontinuous Analysis (DDA) and Simulations of Discontinuous Media, TSI Press, Berkeley, California, USA, p. 205-249.

Rackwitz, R., Fiessler, B. (1978). Structural reliability under combined random load sequences. *Comp. & Struct, 9*, 484-494.
[http://dx.doi.org/10.1016/0045-7949(78)90046-9]

Rackwitz, R. (2001). Reliability analysis: A review and some perspectives. *Struct. Saf, 23*(4), 365-395.
[http://dx.doi.org/10.1016/S0167-4730(02)00009-7]

Rao, S.S. (2018). *The finite element method in engineering* (6th ed.). London: Butterworth Heinemann.

Rao, S.S. (2009). *Engineering Optimization.* Wiley.
[http://dx.doi.org/10.1002/9780470549124]

Rassam, D.W., Williams, D.J. (1999). 3-dimensional effects on slope stability of high waste rock dumps. *International Journal of Surface Mining, 13*, 19-24.
[http://dx.doi.org/10.1080/09208119908944197]

Ravindra, M.K., Galambos, T.V. (1978). Load and resistance factor design for steel. *J. Struct. Div, 104*(ST9), 1427-1441.

Reale, C., Xue, J.F., Pan, Z.M., Gavin, K. (2015). Deterministic and probabilistic multi-modal analysis of slope stability. *Comput. Geotech, 66*, 172-179.
[http://dx.doi.org/10.1016/j.compgeo.2015.01.017]

Reddy, J.N. (2000). *Theory and Analysis of Elastic Plates.* Taylor and Francis.

Reddy, J.N. (2015). *An Introduction to Nonlinear Finite Element Analysis.* Oxford University Press.

Rees, D.W.A. (2006). *Basic engineering plasticity.* Elsevier.

Reissner, H. (1924). Zum Erddruckproblem In: Biezeno, C.B., Burgers, J.M., (Eds.), *Proc. 1st Int. Congress for Applied Mechanics,* Delft 295-311.

Revilla, J., Castillo, E. (1977). The calculus of variations applied to stability of slopes. *Geotechnique, 27*, 1-11.
[http://dx.doi.org/10.1680/geot.1977.27.1.1]

Rodriguez, R.J., Sitar, N., Chacon, J. (2006). System reliability approach to rock slope stability. *Int. J. Rock Mech. Min. Sci.*
[http://dx.doi.org/10.1016/j.ijrmms.2005.11.011]

Rosenblueth, E. (1981). Two-point estimates in probabilities. *Appl. Math. Model, 5*(2), 329-335.

[http://dx.doi.org/10.1016/S0307-904X(81)80054-6]

Rourke, J. Computational Geometry in C, 2nd edition, Cambridge University Press.
[http://dx.doi.org/10.1017/CBO9780511804120]

Sarhosis, V., Bagi, K., Lemos, J.V., Milani, G. (2016). *Computational Modeling of Masonry Structures Using the Discrete Element Method.* Engineering Science Reference.
[http://dx.doi.org/10.4018/978-1-5225-0231-9]

Sarma, S.K., Tan, D. (2006). Determination of critical slip surface in slope analysis. *Geotechnique, 56*(8), 539-550.
[http://dx.doi.org/10.1680/geot.2006.56.8.539]

Schultze, E. (1975). Some aspects concerning the application of statistics and probability to foundation structures *Proceedings of the 2nd International Conference on Applications of Statistics and Probability in Soil and Structural Engineering,* Aachen 457-494.

Senders, J.W., Moray, N.P. (1991). *Human Error: Cause, Prediction and Reduction.* New Jersey: Lawrence Erlbaum Associates.

Sherali, H.D., Terlaky, T., Ye, Y. (2016). *Advances in Stochastic and Deterministic Global Optimization.* Springer.

Shi, G.H., Goodman, R.E. (1985). Two dimensional discontinuous deformation analysis. *Int. J. Numer. Anal. Methods Geomech, 39*, 541-556.
[http://dx.doi.org/10.1002/nag.1610090604]

Shi, G.H. (1988). *DDA-a new numerical model for the static and dynamics of block system.*

Sh, G.H. (1993). Block system modelling by discontinuous deformation analysis. *Comput. Mech,* 11.

Shinozuka, M., Deodatis, G. (1988). Response variability of stochastic finite-element systems. *J. Eng. Mech, 114*(3), 499-519.
[http://dx.doi.org/10.1061/(ASCE)0733-9399(1988)114:3(499)]

Shooman, M. (1968). *Probabilistic Reliability an Engineering Approach.* McGraw Hill.

Shyu, K., Salami, M.R. (1995). Manifold with four-node isoparametric finite element method. *Work Forum on Manifold Method of Material, California, USA, V1*, 165-182.

Silvestrini, R.T., Montgomery, D.C., Jones, B. (2013). Comparing computer experiments for the Gaussian process model using integrated prediction variance. *Qual. Eng, 25*(2), 164-174.
[http://dx.doi.org/10.1080/08982112.2012.758284]

Sloan, S.W. (1988). Lower bound limit analysis using finite elements and linear programming. *Int. J. Numer. Anal. Methods Geomech, 12*(1), 61-77.
[http://dx.doi.org/10.1002/nag.1610120105]

Sloan, S.W. (1989). Upper bound limit analysis using finite-elements and linear-programming. *Int. J. Numer. Anal. Methods Geomech, 13*(3), 263-282.
[http://dx.doi.org/10.1002/nag.1610130304]

Sloan, S.W., Randolph, M.F. (1983). Automatic element reordering for finite element analysis with frontal solution schemes. *Int. J. Numer. Methods Eng, 19*, 1153-1181.
[http://dx.doi.org/10.1002/nme.1620190805]

Sloan, S.W. (1989). A Fortran program for profile and wavefront reduction. *Int. J. Numer. Methods Eng, 28*, 2651-2679.
[http://dx.doi.org/10.1002/nme.1620281111]

Smith, I.M., Griffiths, D.V., Margetts, L. (2014). *Programming the Finite Element Method* John Wiley.

Smith, C., Gilbert, M. (2007). Application of discontinuity layout optimization to plane plasticity problems. *Proc. R. Soc. A, 463*(2086), 2461-2484.

[http://dx.doi.org/10.1098/rspa.2006.1788]

Stuedlein, A., Kramer, S., Arduino, P., Holtz, R. (2012). Geotechnical characterization and random field modeling of desiccated clay. *J. Geotech. Geoenviron. Eng, 138*(11), 1301-1313.
[http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0000723]

Sokolovskii, V.V. (1965). *Statics of Granular Media.* Pergamon Press.

Solnon, C. (2010). *Ant Colony Optimization and Constraint Programming.* ISTE Ltd.

Soubra, A.H. (2000). Static and seismic passive earth pressure coefficients on rigid retaining structures. *Can. Geotech. J, 37*, 463-478.
[http://dx.doi.org/10.1139/t99-117]

Sowers, G.F. (1991). *The human factor in failures.* Civil Engineering, ASCE, March, p. 72-73.

Spanos, P.D., Ghanem, R. (1989). Stochastic finite element expansion for random medium. *J. Eng. Mech, 115*(5), 1035-1053.
[http://dx.doi.org/10.1061/(ASCE)0733-9399(1989)115:5(1035)]

Spencer, E. (1967). A method of analysis of the stability of embankments assuming parallel inter-slice forces. *Geotechnique, 17*, 11-26.
[http://dx.doi.org/10.1680/geot.1967.17.1.11]

Strack, O.D.L., Cundall, P.A. (1984). *Fundamental studies of fabrics in granular materials, Interim report to National Science Foundation, NSF CEE-8310729.* Department of Civil and Mineral Engineering, University of Minnesota.

Suchomel, R., Masin, D. (2010). Comparison of different probabilistic methods for predicting stability of a slope in spatially variable c- soil. *Comput. Geotech, 37*(1), 132-140.
[http://dx.doi.org/10.1016/j.compgeo.2009.08.005]

Sudret, B., Der Kiureghian, A. (2002). Comparison of finite element reliability methods. *Probab. Eng. Mech, 17*, 337-348.
[http://dx.doi.org/10.1016/S0266-8920(02)00031-0]

Sukumar, N., Moran, B. (2001). Natural neighbour Galerkin Methods. *Int. J. Numer. Methods Eng, 50*, 1-27.
[http://dx.doi.org/10.1002/1097-0207(20010110)50:1<1::AID-NME14>3.0.CO;2-P]

Sulsky, D., Chen, Z., Schreyer, H. (1994). A particle method for history-dependent materials. *Comput. Methods Appl. Mech. Eng, 118*(1-2), 179-196.
[http://dx.doi.org/10.1016/0045-7825(94)90112-0]

Sze, K.Y. (2002). Three-dimensional continuum finite element models for plate/shell analysis. *Prog. Struct. Eng. Mater, 4*, 400-407.
[http://dx.doi.org/10.1002/pse.133]

Szilard, R. (2004). *Theory and Applications of Plates Analysis of Plates.* John Wiley.
[http://dx.doi.org/10.1002/9780470172872]

Talbi, E.G., Nakib, A. (2019). *Bioinspired Heuristics for Optimization.* Springer.
[http://dx.doi.org/10.1007/978-3-319-95104-1]

(1985). Some considerations of an acceptable level of risk in the Netherlands. Report by TAW workgroup 10, "Probabilistic methods".

Temme, Y., Goh, C.K. (2010). *Computational Intelligence in Expensive Optimization Problems.* Springer.

Thapa, B. (1996). Joint shear displacement-dilation analysis using in-situ opposing profiles. *Proceedings of 35^{th} U.S. Symposium on Rock Mechanics,* Lake Tahoe, CA, USA 44-51.

Thornton, C. (2015). *Granular Dynamics, Contact Mechanics and Particle System Simulations.* Springer.
[http://dx.doi.org/10.1007/978-3-319-18711-2]

Thornton, C., Randall, C.W. (1988). *Applications of theoretical contact mechanics to solid particle system* *simulations, Mechanics of granular materials.* Elsevier Science Publishing.

Timoshenko, S., Krieger, W. (1959). *Theory of Plates and Shells.* McGraw-Hill.

Ting, J.M., Corkum, B.T., Kauffman, C.R. (1989). Discrete element model for soil mechanics. *J. Geotech. Eng, 115*(3), 379-398.
[http://dx.doi.org/10.1061/(ASCE)0733-9410(1989)115:3(379)]

Tiwari, R.C., Bhandary, N.P., Yatabe, R. (2014). Spectral element analysis to evaluate the stability of long and steep slopes. *Acta Geotech, 2014*(9), 753-770.
[http://dx.doi.org/10.1007/s11440-013-0292-x]

Tiwari, R.C., Bhandary, N.P., Yatabe, R. (2015). 3-D elasto-plastic spectral element application to evaluate the stability of large-scale landslides. *Geomechanics and Geoengineering, 10*(4), 271-289.
[http://dx.doi.org/10.1080/17486025.2014.985337]

Tiwari, R.C. (2015). *3D Slope Stability Modeling: Numerical Methods and Applications: Slope stability, Prog. Failure, Finite-element method, Spectral-element method, Vegetation, Stability charts, Excavation.* LAP LAMBERT Academic Publishing.

Tsay, R.J., Chiou, Y.J., Chuang, W.L. (1999). Crack growth prediction by manifold method. *J. Eng. Mech, 125*, 884-890.
[http://dx.doi.org/10.1061/(ASCE)0733-9399(1999)125:8(884)]

Tuy, H. (1998). *Convex analysis and global optimization.* Kluwer Academic Publishers.
[http://dx.doi.org/10.1007/978-1-4757-2809-5]

Tvedt, L. (1990). Distribution of quadratic forms in normal space: Application to structural reliability. *J. Eng. Mech, 116*(6), 1183-1197.
[http://dx.doi.org/10.1061/(ASCE)0733-9399(1990)116:6(1183)]

Ugai, K. (1988). 3-D Slope Stability Analysis by Slice Methods *Proceedings of the 6th International Conference on Numerical Methods in Geomechanics,* Innsbruck, Austria 1369-1374.

Ugai, K., Leshchinsky, D. (1995). Three-dimensional limit equilibrium and finite element analysis: a comparison of results. *Soil Found, 35*(4), 1-7.
[http://dx.doi.org/10.3208/sandf.35.4_1]

Urugal, A.C. (1999). *Stress in Plates and Shells* McGraw-Hill.

Vahedifard, F., Leshchinsky, B., Sehat, S., Leshchinsky, D. (2014). Impact of Cohesion on Seismic Design of Geosynthetic-Reinforced Earth Structures. *J. Geotech. Geoenviron. Eng, 140*(6)04014016.
[http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0001099]

Vanmarcke, E.H. (1977). Probabilistic modeling of soil profiles. *J. Geotech. Eng, 103*(11), 1227-1246. a

Vanmarcke, E.H. (1977). Reliability of earth slopes. *J. Geotech. Eng, 103*(11), 1247-1265. b

Vanmarcke, E., Grigoriu, M. (1983). Stochastic finite element analysis of simple beams. *J. Eng. Mech, 109*(5), 1203-1214.
[http://dx.doi.org/10.1061/(ASCE)0733-9399(1983)109:5(1203)]

Vanmarcke, E.H. (2010). *Random Fields: Analysis and Synthesis (revised and expanded).* New ed. World Scientific Publishing Co. Pte. Ltd. Singapore.

Vesic, A.S. (1973). Analysis of ultimate loads for shallow foundations. *Journal of Soil Mechanics and Foundations Division, ACSE, 99*(SM1), 45-73.

Verlet, L. (1967). Computer "Experiments" on Classical Fluids. I. Thermodynamical Properties of Lennard-Jones Molecules'. *Phys. Rev, 159*, 98-103.
[http://dx.doi.org/10.1103/PhysRev.159.98]

Vick, S.G. (1995). *Geotechnical risk and reliability - from theory to practice in dam safety.* In The Earth, Engineers and Education - Whitman Symposium, Massachusetts Institute of Technology, p. 45-58.

Vrijling, J.K., van Hengel, W., Houben, R.J. (1998). *Acceptable risk as a basic for design. Journal of Reliability Engineering and System Safety* Elsevier.

Walton, O.R. (1982). Explicit particle dynamics model for granular materials, The 4th International Conference on Numerical Methods in Geomechanics, p.1261-1268.

Wang, S.F. (2000). *Research on numerical manifold method of discontinuous and nonlinear deformation analysis for rockmass.*

Wang, Y. (2012). Uncertain parameter sensitivity in Monte Carlo simulation by sample Reassembling. *Comput. Geotech, 46*, 39-47.
[http://dx.doi.org/10.1016/j.compgeo.2012.05.014]

Wang, Y. (2013). Mcs-based probabilistic design of embedded sheet pile walls. *Georisk, 7*(3), 151-162.
[http://dx.doi.org/10.1080/17499518.2013.765286]

Wang, Y., Cao, Z.J., Au, S.K. (2010). Efficient Monte Carlo simulation of parameter sensitivity in probabilistic slope stability analysis. *Comput. Geotech, 37*(7-8), 1015-1022.
[http://dx.doi.org/10.1016/j.compgeo.2010.08.010]

Wang, Y., Cao, Z.J., Au, S.K. (2011). Practical reliability analysis of slope stability by advanced Monte Carlo simulations in a spreadsheet. *Can. Geotech. J, 48*, 162-172.
[http://dx.doi.org/10.1139/T10-044]

Wang, C.Y., Sheng, J., Chen, M.H., Chuang, C.C. (1995). Approximation theories for the manifold method. *Work Forum on Manifold Method of Material, California, USA, 1*, 61-86.

Wang, Q., Shi, X.W. (2009). An improved algorithm for matrix bandwidth and profile reduction in finite element analysis. *Progress In Electromagnetics Research Letters, 9*, 29-38.
[http://dx.doi.org/10.2528/PIERL09042305]

Wang, S.L., Ge, X.R., Zhang, G. (1999). Manifold method with four physical covers forming an element and its application. *The Third International Conference on Analysis of Discontinuous Deformation from Theory to Practice,* Vail, Colorado, USA 193-201.

Wang, S.F., Zhu, W.S., Li, S.C., Qiu, X.B. (2001). Numerical manifold method considering lateral effect and its application. *Chinese Journal of Rock Mechanics and Engineering, 20*(3), 297-300.

Wang, S.F., Zhu, W.S., Li, S.C., Chen, S.H. (2002). Numerical manifold method of elastoplastic analysis for rockmass. *Chinese Journal of Rock Mechanics and Engineering, 21*(6), 900-904. a

Wang, S.F., Zhu, W.S., Li, S.C., Chen, S.H. (2002). Numerical manifold method of deformation analysis for bolt supported rockmass. *Chinese Journal of Rock Mechanics and Engineering, 21*(8), 1120-1123. b

Wang, Z.Y., Wang, S.J., Yang, Z.F. (1997). Manifold method in analysis of large deformation for rock. *Chinese Journal of Rock Mechanics and Engineering, 16*(5), 513-516.

Wang, C.M., Reddy, J.N., Lee, K.H. (2000). *Shear deformable beams and plates.* Elsevier.

Wang, L., Liu, B. (2008). *Particle swarm optimization and scheduling algorithms.* China: Tsinghua University Press.

Wei, W.B., Cheng, Y.M., Li, L. (2009). Three-dimensional slope failure by strength reduction and limit equilibrium methods. *Comput. Geotech, 36*, 70-80.
[http://dx.doi.org/10.1016/j.compgeo.2008.03.003]

Wei, W.B., Cheng, Y.M. (2009). Soil nailed slope by strength reduction and limit equilibrium methods. *Comput. Geotech, 37*, 602-618.
[http://dx.doi.org/10.1016/j.compgeo.2010.03.008]

Wei, W.B., Cheng, Y.M. (2009). Strength reduction analysis for slope reinforced with one row of piles. *Comput. Geotech, 36*, 1176-1185.
[http://dx.doi.org/10.1016/j.compgeo.2009.05.004]

Wei, W.B., Cheng, Y.M. (2010). Stability analysis of slope with water flow by strength reduction method. *Soil Found, 50*(1), 83-92.
[http://dx.doi.org/10.3208/sandf.50.83]

Wilson, E.L., Taylor, R.L., Doherty, W., Ghaboussi, J. (1973). *Incompatible Displacement Models, Numerical and Computer Methods in Structural Mechanics.* Academic press.

Wolff, T.F. (1985). Analysis and design of embankment dam slopes: A probabilistic approach, PhD Thesis, Purdue University.

Wolff, T.F. (1991). Embankment reliability versus factor of safety - Before and after slide repair. *Int. J. Numer. Anal. Methods Geomech, 15*(1), 41-50.
[http://dx.doi.org/10.1002/nag.1610150104]

Wriggers, P., Panagiotopoulos, P. (1999). *New developments in contact problems.* Springer.
[http://dx.doi.org/10.1007/978-3-7091-2496-3]

Wu, H.Y. (2012). *Discrete Element Modelling of Particulate Media.* RSC Publishing.
[http://dx.doi.org/10.1039/9781849735032]

Wu, T.H. (2008). *Reliability analysis of slopes, Reliability based design in geotechnical engineering: Computations and Applications* (pp. 413-447). London: Taylor and Francis.

Wu, L.Y., Tsai, Y.F. (2004). Analysis of Earth Pressure for Retaining Wall and Ultimate Bearing Capacity for Shallow Foundation by Variational method. *J. Mech, 20*, 45-55.

Wu, LY, Tsai, YF (2005). Variational Stability Analysis of Cohesive Slope by Applying Boundary integral Equation Method. *Journal of Mechanics, 21*, 187-195.

Wu, Z.J., Wang, S.L., Ge, X.R. (2009). Slope reliability analysis by random FEM under constraint random field. *Chincese Journal of Rock and Soil Mechanics, 30*(10), 3086-3092.

Xing, Y.F., Liu, B.O., Liu, G. (2010). A differential quadrature finite element method. *Int. J. Appl. Mech, 02*, 207.
[http://dx.doi.org/10.1142/S1758825110000470]

Xu, B., Low, B.K. (2006). Probabilistic stability analyses of embankments based on finite-element method. *J. Geotech. Geoenviron. Eng, 132*(11), 1444-1454.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(2006)132:11(1444)]

Xue, J.F., Gavin, K. (2007). Simultaneous Determination of Critical Slip Surface and Reliability Index for Slopes. *J. Geotech. Geoenviron. Eng, 133*(7), 878-886.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(2007)133:7(878)]

Yang, Y., Huang, R.Q., Cheng, Y.M., Wang, J.F. (2014). Investigation of the Deformable Behavior of Loose and Dense Sand through DEM. *Adv. Mat. Res, 871*, 124-128.

Yang, Y., Cheng, Y.M. (2014). The fractal features of contact force chains for crushable granular materials under confined compression. *Proceedings of ASCE Engineering Mechanics Institute International Conference,* Hong Kong 7-9.

Yang, Y., Cheng, Y.M. (2015). A fractal model of contact force distribution and the unified coordination distribution for crushable granular materials under confined compression. *Powder Technol, 279*, 1-9.
[http://dx.doi.org/10.1016/j.powtec.2015.03.006]

Yang, Y., Cheng, Y.M. (2016). Quantified evaluation of particle shape effects from micro-to-macro scales for non-convex grains. *Particuology, 25*, 23-35.
[http://dx.doi.org/10.1016/j.partic.2015.01.008]

Yang, Y., Cheng, Y.M. (2016). Exploring the contact types within mixtures of different shapes at the steady state by DEM. *Powder Technol, 301*, 440-448.
[http://dx.doi.org/10.1016/j.powtec.2016.06.016]

Yang, Y., Cheng, Y.M. (2017). The effects of rolling resistance and non-convex particle on the mechanics of

the undrained granular assembles in 2D. *Powder Technol, 318*, 528-542.
[http://dx.doi.org/10.1016/j.powtec.2017.06.027]

Yang, Y., Cheng, Y.M., Sun, Q.C. (2018). Revisiting the confined comminution of granular materials with the consideration of the initial particle size distributions and repetitive loadings. *Powder Technol, 329*, 149-157.
[http://dx.doi.org/10.1016/j.powtec.2018.01.045]

Yang, Y.S. (2010). *Engineering Optimization An Introduction with Metaheuristic Applications.* Wiley.
[http://dx.doi.org/10.1002/9780470640425]

Yeung, M., Klein, S.J., Max, M. (1994). Application of the discontinuous deformation analysis to the evaluation of rock reinforcement for tunnel stabilization. *Proceedings of the First North American Rock Mechanics Symposium,* Austin, TX 607-614.

Yi, P., Wei, K.T., Kong, X.J., Zhu, Z. (2015). Cumulative PSO-Kriging model for slope reliability analysis. *Probab. Eng. Mech, 39*, 39-45.
[http://dx.doi.org/10.1016/j.probengmech.2014.12.001]

Yim, S.C. (2007). *3-D Wave-Structure Interaction with Coastal Sediments-A Multi-Physics/Multi-Soluti-n-Techniques Approach.* Corvallis: Defense Technical Information Center.

Yin, P.Y. (2004). A discrete particle swarm algorithm for optimal polygonal approximation of digital curves. *J. Vis. Commun. Image Represent, 15*, 241-260.
[http://dx.doi.org/10.1016/j.jvcir.2003.12.001]

Yu, H.S., Salgado, R., Sloan, S.W., Kim, J.M. (1998). Limit analysis versus limit equilibrium for slope stability. *J. Geotech. Geoenviron. Eng, 124*(1), 1-11.
[http://dx.doi.org/10.1061/(ASCE)1090-0241(1998)124:1(1)]

Yu, H.S. (2006). *Plasticity and geotechnics.* Springer.

Yu, X.J., Gen, M.S. (2010). *Introduction to Evolutionary Algorithms.* Springer.
[http://dx.doi.org/10.1007/978-1-84996-129-5]

Yuan, X., Lu, Z., Zhou, C., Yue, Z. (2013). A novel adaptive importance sampling algorithm based on markov chain and low-discrepancy sequence. *Aerosp. Sci. Technol, 29*(1), 253-261.
[http://dx.doi.org/10.1016/j.ast.2013.03.008]

Zelinka, I., Snasel, V., Abraham, A. (2013). *Handbook of Optimization From Classical to Modern Approach.* Springer.
[http://dx.doi.org/10.1007/978-3-642-30504-7]

Zhang, X. (1988). Three-dimensional stability analysis of concave slopes in plan view. *J. Geotech. Eng, 114*(6), 658-671.
[http://dx.doi.org/10.1061/(ASCE)0733-9410(1988)114:6(658)]

Zhang, X. (1999). Slope stability analysis based on the rigid finite element method. *Geotechnique, 49*(5), 585-593.
[http://dx.doi.org/10.1680/geot.1999.49.5.585]

Zhang, Y.H., Zhu, W.S., Qiu, X.B., Li, S.C. (1998). The application of DDA method on the excavation of the ground factory of Xiledu hydropower station. *Chinese Journal of Rock Mechanics and Engineering, 18*, 945-947.

Zhang, X.W., Cai, Y.C., Liao, L.C. (2000). Auto mesh algorithm of the finite cover system in the numerical manifold method. *Chinese Journal of Chongqing University, 23*(1), 28-31. [Natural Science Edition].

Zhang, X., Sanderson, D.J. (2002). *Numerical Modelling and Analysis of Fluid Flow and Deformation of Fractured Rock Masses.* Elsevier.

Zhang, G.X., Sigiura, Y., Hasegawa, H. (1997). Crack propagation and thermal fracture analysis by manifold method. *Proceedings of the Second International Conference on Analysis of Discontinuous Deformation,* Kyoto, Japan 282-297.

Zhang, G.X., Sugiura, Y., Saito, K. (1999). Application of manifold method to jointed dam foundation. *The Third International Conference on Analysis of Discontinuous Deformation from Theory to Practice,* Vail, Colorado, USA 211-220.

Zhang, J., Huang, H.W., Phoon, K.K. (2013). Application of the Kriging-Based Response Surface Method to the System Reliability of Soil Slopes. *J. Geotech. Geoenviron. Eng, 139*(4), 651-655. [http://dx.doi.org/10.1061/(ASCE)GT.1943-5606.0000801]

Zhang, X., Chen, Z., Liu, Y. (2017). *The Material Point Method: A Continuum-Based Particle Method for Extreme Loading Cases.* Tsinghua University Press Computational Mechanics Series. [http://dx.doi.org/10.1016/B978-0-12-407716-4.00003-X]

Zhang, J., Zhang, L.M., Tang, W.H. (2011). New methods for system reliability analysis of soil slopes. *Can. Geotech. J, 48*(7), 1138-1148. [http://dx.doi.org/10.1139/t11-009]

Zhang, J., Huang, H.W., Juang, C.H., Li, D.Q. (2013). Extension of Hassan and Wolff method for system reliability analysis of soil slopes. *Eng. Geol, 60*, 81-88. [http://dx.doi.org/10.1016/j.enggeo.2013.03.029]

Zhang, W.G., Goh, A.T.C. (2013). Multivariate adaptive regression splines for analysis of geotechnical engineering systems. *Comput. Geotech, 48*, 82-95. [http://dx.doi.org/10.1016/j.compgeo.2012.09.016]

Zhao, J., Ohnishi, Y., Zhao, G.F., Sasaki, T. (2011). Advances in Discontinuous Numerical Methods and Applications in Geomechanics and Geoengineering *Proceedings of the 10th International Conference on advances in Discontinuous numerical methods and applications in geomechanics and geoengineering, ICADD 10.*Honolulu, Hawaii6 8 Dec.

Zhao, H.B. (2008). Slope reliability analysis using a support vector machine. *Comput. Geotech, 35*(3), 459-467. [http://dx.doi.org/10.1016/j.compgeo.2007.08.002]

Zhao, W., Wang, W., Dai, H., Xue, G. (2010). Structural reliability analysis based on the cokriging technique. *IOP Conf. Series Mater. Sci. Eng, 10*012204. [http://dx.doi.org/10.1088/1757-899X/10/1/012204]

Zhao, Y.G., Ono, T. (1999). New approximations for SORM: Part 1. *J. Eng. Mech, 125*(1), 79-85. a [http://dx.doi.org/10.1061/(ASCE)0733-9399(1999)125:1(79)]

Zhao, W., Wang, W. (2011). Application of cokriging technique to structural reliability analysis. *2011 International Conference,* 170-174. [http://dx.doi.org/10.1109/ICFCSA.2011.46]

Zhao, Y.G., Ono, T. (1999). New approximations for SORM: Part 2. *J. Eng. Mech, 125*(1), 86-93. b [http://dx.doi.org/10.1061/(ASCE)0733-9399(1999)125:1(86)]

Zheng, H., Zhou, C.B., Liu, D.F. (2009). A robust solution procedure for the rigorous methods of slices. *Soil Found, 49*(4), 537-544. [http://dx.doi.org/10.3208/sandf.49.537]

Zhou, J.L., Tits, A.L. (1992). *User's Guide for FSQP Version 3.0c: A FORTRAN Code for Solving Constrained Nonlinear (Minimax) Optimization Problems, Generating Iterates Satisfying All Inequality and Linear Constraints, Technical research report.* University of Maryland.

Zhou, W.Y., Yang, Q., Kou, X.D. (1997). Development of high order manifold method. *Proceedings of the Second International Conference on Analysis of Discontinuous Deformation,* Kyoto, Japan 274-281.

Zhou, W.Y., Kou, X.D., Yang, R.Q. (1999). Crack propagation by manifold method coupled with element free method. *The Third International Conference on Analysis of Discontinuous Deformation from Theory to Practice,* Vail, Colorado, USA 283-289.

Zhu, Y.W. (1999). Augment manifold method in big deformation of rock. *Chinese Journal of Rock*

Mechanics and Engineering, 18(1), 1-5.

Zhu, B.F. (2018). *The Finite Element Method, Fundamentals and Applications in Civil, Hydraulic, Mechanical and Aeronautical Engineering.* Tsinghua University Press.

Zhu, D.Y., Lee, C.F., Qian, Q.H., Zou, Z.S., Sun, F. (2001). A new procedure for computing the factor of safety using the Morgenstern–Price's method. *Can. Geotech. J, 38*(4), 882-888. [http://dx.doi.org/10.1139/t01-002]

Zhu, D.Y., Lee, C.F., Jiang, H.D. (2003). Generalised framework of limit equilibrium methods for slope stability analysis. *Geotechnique, 53*(4), 377-395. [http://dx.doi.org/10.1680/geot.2003.53.4.377]

Zhu, T., Atluri, S.N. (1998). A modified collocation method and a penalty formulation for enforcing the essential boundary conditions in the element free Galerkin method. *Comput. Mech, 21*(3), 211-222. [http://dx.doi.org/10.1007/s004660050296]

Zolfaghari, A.R., Heath, A.C., McCombie, P.F. (2005). Simple genetic algorithm search for critical non-circular failure surface in slope stability analysis. *Comput. Geotech, 32*(3), 139-152. [http://dx.doi.org/10.1016/j.compgeo.2005.02.001]

Zoyama, A.Y. (2006). *Handbook of nature-inspired and innovative computing.* Springer. [http://dx.doi.org/10.1007/0-387-27705-6]

Zienkiewicz, O.C., Taylor, R.L., Zhu, J.Z. (2011). *The finite element method: Its basis and fundamentals* (6th ed.). London: Butterworth Heinemann.

SUBJECT INDEX

A

B

C

Y.M. Cheng, J. H. Wang, L. Liang, W. H. Fung Ivan (Eds.)

D

E

F

G

H

I

K

L

M

N

O

P

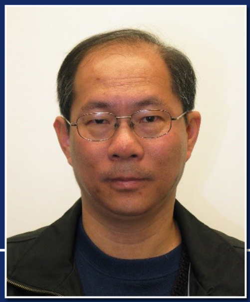
Q

R

S

T

V



Y. M. Cheng

Prof. Cheng has worked in various design and construction works in soft ground tunneling, rock tunneling, various types of bridges, deep excavation and lateral supports, soil stabilization, ground treatment works and other geotechnical works before joining the university. His research interests include geotechnical engineering, structural engineering, numerical methods and monitoring system.

Prof. Cheng has participated in the Foundation Code 2017 in Hong Kong as well as the Foundation Handbook in Hong Kong. Besides that, he is also one of the members of various professional bodies as well as one of the advisors to several government departments. Besides research, Prof. Cheng has also participated in various large scale construction works in Hong Kong, Macau, China, Taiwan, Europe, Egypt and Australia.

To date, Prof. Cheng has published 7 books and has received 3 Best Paper Awards from different journals. Prof. Cheng has also developed several patents which include SLOPE 2000, SLOPE3D, PLATE, GeoSuite and IOT monitoring system.