Computational Plasticity With Emphasis On The Application Of The Unified Strength Theory Advanced Topics In Science And Technology In China

Dislocation Based Crystal Plasticity: Theory and Computation at Micron and Submicron Scale provides a comprehensive introduction to the continuum and discreteness dislocation mechanism-based theories and computational methods of crystal plasticity at the micron and submicron scale. Sections cover the fundamental concept of conventional crystal plasticity theory at the macro-scale without size effect, strain gradient crystal plasticity theory based on Taylar law dislocation, mechanism at the mesoscale, phase-field theory of crystal plasticity, computation at the submicron scale, including single crystal plasticity theory, and the discrete-continuous model of crystal plasticity with three-dimensional discrete dislocation dynamics coupling finite element method (DDD-FEM). Three kinds of plastic deformation mechanisms for submicron pillars are systematically presented. Further sections discuss dislocation nucleation and starvation at high strain rate and temperature effect for dislocation annihilation mechanism. Covers dislocation mechanism-based crystal plasticity theory and computation at the micron and submicron scale Presents crystal plasticity theory without size effect Deals with the 3D discrete-continuous (3D DCM) theoretic and computational model of crystal plasticity with 3D discrete dislocation dynamics (3D DDD) coupling finite element method (FEM) Includes discrete dislocation mechanism-based theory and computation at the submicron scale with single arm source, coating micropillar, lower cyclic loading pillars, and dislocation starvation at the submicron scale

This conference book contains papers presented at the 8th GACM Colloquium on Computational Mechanics for Young Scientists from Academia and Industry. The conference was held from August 28th – 30th, 2019 in Kassel, hosted by the Institute of Mechanics and Dynamics of the department for civil and environmental engineering and by the chair of Engineering Mechanics / Continuum Mechanics of the department for mechanical engineering of the University of Kassel. The aim of the conference is, to bring together young scientits who are engaged in academic and industrial research on Computational Mechanics and Computer Methods in Applied Sciences. It provides a plattform to present and discuss recent results from research efforts and industrial applications. In more than 150 presentations, given by young scientists, current scientific developments and advances in engineering practice in this field are presented and discussed. The contributions of the young researchers are supplemented by a poster session and plenary talks from four senior scientists from academia and industry as well as from the GACM Best PhD Award winners 2017 and 2018.

Limit and shakedown analysis for structures can provide a very useful tool for design and analysis of engineering structures. "Structural Plasticity - Limit, Shakedown and Dynamic Plastic Analyses of Structure" provides more general solutions of limit and shakedown analysis for structures by using a unified strength theory. A series of solutions of plates from circular, annular plates to rhombus plates and square plates, rotating discs and cylinders, pressure vessels are presented. These results encompass the Tresca-Mohr-Coulomb solution of structure as special cases. The unified solution, which cannot be obtained by using a single criterion, is suitable to more materials and structures. Maohong Yu is professor of Department of Civil Engineering at Xi'an Jiaotong University, China. He has authored 12 books including "Unified Strength Theory and Its Applications" and "Generalized Plasticity".

Providing the essential theoretical framework for understanding elastoplastic behaviour, this text develops the subject of small strain elastoplasticity from classical theory to modern computational techniques.

Disorganization occurs in all areas of modern business. This book presents a novel approach to both academics and practitioners on how to break the shackles of rigidity and eliminate our fear of disorganization.

The steady increase in computational power induces an equally steady increase in the complexity of the engineering models and associated computer codes. This particularly affects the modeling of the mechanical response of materials. Material behavior is nowadays modeled in the strongly nonlinear range by tak ing into account finite strains, complex hysteresis effects, fracture phenomena and multiscale features. Progress in this field is of fundamental importance for many engineering disciplines, especially those concerned with material testing, safety, reliability and serviceability analyses of engineering structures. In recent years many important achievements have been made in the field of the theoretical formulation, the mathematical analysis and the numerical im plementation of deformation processes in solids. Computational methods and simulation techniques today play a central role in advancing the understanding of complex material behavior. Research in the field of "ComputationalMechan ics of Materials" is concerned with the development of mathematical models and numerical solution techniques for the simulation of material response. It is a very broad interdisciplinary field of science with inputs from traditional fields such as Applied Mechanics, Applied Mathematics, Materials Science, Solid State Physics and Information Technology. The intention of the IUTAM Symposium "Computational Mechanics of Solid Materials at Large Strains", held at the University of Stuttgart, Germany, from August 20-24, 200I, was to give a state of the art and a survey about recent developments in this field and to create perspectives for future research trends.

Computational Methods in Elasticity and Plasticity: Solids and Porous Media presents the latest developments in the area of elastic and elasto-plastic finite element modeling of solids, porous media and pressure-dependent materials and structures. The book covers the following topics in depth: the mathematical foundations of solid mechanics, the finite element method for solids and porous media, the theory of plasticity and the finite element implementation of elasto-plastic constitutive models. The book also includes: -A detailed coverage of elasticity for isotropic and anisotropic solids. -A detailed treatment of nonlinear iterative methods that could be used for nonlinear elastic and elasto-plastic analyses. -A detailed treatment of a kinematic hardening von Mises model that could be used to simulate cyclic behavior of solids. -Discussion of recent advances in the analysis of porous media and pressure-dependent materials in more detail than other books currently available. Computational Methods in Elasticity and Plasticity: Solids and Porous Media also contains problem sets, worked examples and a solutions manual for instructors.

This volume demonstrates the use of FORTRAN for numerical computing in the context of the finite element method. FORTRAN is still an important programming language for computational mechanics and all classical finite element codes are written in this language, some of them even offer an interface to link user-code to the main program. This feature is especially important for the development and investigation of new engineering structures or materials. Thus, this volume gives a simple introduction to programming of elasto-plastic material behavior, which is, for example, the prerequisite for implementing new constitutive laws into a commercial finite element program.

This book addresses the need for a fundamental understanding of the physical origin, the mathematical behavior and the numerical treatment of models which include microstructure. Leading scientists present their efforts involving mathematical analysis, numerical analysis, computational mechanics, material modelling and experiment. The mathematical analyses are based on methods from the calculus of variations, while in the numerical implementation global optimization algorithms play a central role. The modeling covers all length scales, from the atomic structure up to macroscopic samples. The development of the models ware guided by experiments on single and polycrystals and results will be checked against experimental data.

This conference proceedings brings together the work of researchers and practising engineers concerned with computational modelling of complex concrete, reinforced concrete and prestressed concrete structures in engineering practice. The subjects considered include computational mechanics of concrete and other cementitious materials, including masonry. Advanced discretisation methods and microstructural aspects within multi-field and multi-scale settings are discussed, as well as modelling formulations and constitutive modelling frameworks and novel experimental programmes. The conference also considered the need for reliable, high-quality analysis and design of concrete structures in regard to safety-critical structures, with a view to adopting these in codes of practice or recommendations. The book is of special interest to researchers in computational mechanics, and industry experts in complex nonlinear simulations of concrete structures.

Offering a well-balanced blend of theory and hands-on applications, this book presents a unified framework for the main dissipative phenomena in metallic materials: plasticity and damage. Based on representation theory for tensor functions and scale-bridging theorems, this framework enables the development of constitutive models that account for the influence of crystallographic structures and deformation mechanisms on the macroscopic behavior. It allows readers to develop a clear understanding of the range of applicability of any given model, as well as its capabilities and limitations, and provides procedures for parameter identification along with key concepts necessary to solve boundary value problems, making it useful to both researchers and engineering practitioners. Although the book focuses on new contributions to modeling anisotropic materials, the review of the foundations of plasticity and models for isotropic materials, completed with detailed mathematical proofs mean that it is self-consistent and accessible to graduate students in engineering mechanics and material sciences.

Size Effects in Plasticity: From Macro to Nano provides concise explanations of all available methods in this area, from atomistic simulation, to non-local continuum models to capture size effects. It then compares their applicability to a wide range of research scenarios. This essential guide addresses basic principles, numerical issues and computation, applications and provides code which readers can use in their own modeling projects. Researchers in the fields of computational mechanics, materials science and engineering will find this to be an ideal resource when they address the size effects observed in deformation mechanisms and strengths of various materials. Provides a comprehensive reference on the field of size effects and a review of mechanics of materials research in all scales Explains all major methods of size effects simulation, including non-local continuum models, non-local crystal plasticity, discrete dislocation methods and molecular dynamics Includes source codes that readers can use in their own projects

Plasticity of Metallic Materials presents a rigorous framework for description of plasticity phenomena, classic and recent models for isotropic and anisotropic materials, new original analytical solutions to various elastic/plastic boundary value problems and new interpretations of mechanical data based on these recent models. The book covers models for metals with both cubic and hexagonal crystal structures, presents the mechanical tests required to determine the model parameters, various identification procedures, verification, and validation tests, and numerous applications to metal forming. Outlines latest research on plastic anisotropy and its role in metal forming Presents characterization and validation tests for metals with various crystal structures Compares the predictive capabilities of various models for a variety of loadings

This book thoroughly describes a theory concerning the yield and failure of materials under multi-axial stresses – the Unified Strength Theory, which was first proposed by the author and has been frequently quoted since. It provides a system of yield and failure criteria adopted for most materials, from metals to rocks, concretes, soils, and polymers. This new edition includes six additional chapters: General behavior of Strength theory function; Visualization of the Unified Strength Theory; Equivalent Stress of the UST and Comparisons with other criteria; Economic Signification of the UST; General form of failure criterion; Beauty of Strength Theories. It is intended for researchers and graduate students in various fields, including engineering mechanics, material mechanics, plasticity, soil mechanics, rock mechanics, mechanics of metallic materials and civil engineering, hydraulic engineering, geotechnical engineering, mechanical engineering and military engineering.

There have been many excellent books written on the subject of plastic deformation in solids, but rarely can one find a textbook on this subject. “Plasticity Modeling & Computation” is a textbook written specifically for students who want to learn the theoretical, mathematical, and computational aspects of inelastic deformation in solids. It adopts a simple narrative style that is not mathematically overbearing, and has been written to emulate a professor giving a lecture on this subject inside a classroom. Each section is written to provide a balance between the relevant equations and the explanations behind them. Where relevant, sections end with one or more exercises designed to reinforce the understanding of the “lecture.” Color figures enhance the presentation and make the book very pleasant to read. For professors planning to use this textbook for their classes, the contents are sufficient for Parts A and B that can be taught in sequence over a period of two semesters or quarters.

This book gives an introduction to computational plasticity and includes the kinematics of large deformations, together with relevant continuum mechanics. Central to the book is its focus on computational plasticity, and we cover an introduction to the finite element method which includes both quasi-static and dynamic problems. We then go on to describe explicit and implicit implementations of plasticity models in to finite element software. Throughout the book, we describe thegeneral, multiaxial form of the theory but uniquely, wherever possible, reduce the equations to their simplest, uniaxial form to develop understanding of the general theory and, we hope, physical insight. We provide several examples of implicit and explicit implementations of von Mises time-independentand visco-plasticity in to the commercial code ABAQUS (including the fortran coding), which should prove invaluable to research students and practising engineers developing ABAQUS 'UMATs'. The book bridges the gap between undergraduate material on plasticity and existing advanced texts on nonlinear computational mechanics, which makes it ideal for students and practising engineers alike. It introduces a range of engineering applications, including superplasticity, porous plasticity, cyclicplasticity and thermo-mechanical fatigue, to emphasize the subject's relevance and importance.

“Computational Plasticity with Emphasis on the Application of the Unified Strength Theory” explores a new and important branch of computational mechanics and is the third book in a plasticity series published by Springer. The other two are: Generalized Plasticity, Springer: Berlin, 2006; and Structural Plasticity, Springer and Zhejiang University Press: Hangzhou, 2009. This monograph describes the unified strength theory and associated flow rule, the implementation of these basic theories in computational programs, and shows how a series of results can be obtained by using them. The unified strength theory has been implemented in several special nonlinear finite-element programs and commercial Finite Element Codes by individual users and corporations. Many new and interesting findings for beams, plates, underground caves, excavations, strip foundations, circular foundations, slop, underground structures of hydraulic power stations, pumped-storage power stations, underground mining, high-velocity penetration of concrete structures, ancient structures, and rocket components, along with relevant computational results, are presented. This book is intended for graduate students, researchers and engineers working in solid mechanics, engineering and materials science. The theories and methods provided in this book can also be used for other computer codes and different structures. More results can be obtained, which put the potential strength of the material to better use, thus offering material-saving and energy-saving solutions. Mao-Hong Yu is a professor at the Department of Civil Engineering at Xi'an Jiaotong University, Xi'an, China.

Plasticity is now an established area of study within materials science and engineering mechanics. The proceedings of the Second International Symposium on Plasticity and its Current Applications brings together papers on all current areas of research into the plastic behaviour of solids. The main emphasis is on dynamic plasticity and study of deformation at crystal level but there are also papers on plasticity in particular materials such as superalloys and metal-matrix composites, the mechanics of damage, and the applications of plastic theory in metal-forming processes.

The subject of computational plasticity encapsulates the numerical methods used for the finite element simulation of the behaviour of a wide range of engineering materials considered to be plastic – i.e. those that undergo a permanent change of shape in response to an applied force. Computational Methods for Plasticity: Theory and Applications describes the theory of the associated numerical methods for the simulation of a wide range of plastic engineering materials; from the simplest infinitesimal plasticity theory to more complex damage mechanics and finite strain crystal plasticity models. It is split into three parts - basic concepts, small strains and large strains. Beginning with elementary theory and progressing to advanced, complex theory and computer implementation, it is suitable for use at both introductory and advanced levels. The book: Offers a self-contained text that allows the reader to learn computational plasticity theory and its implementation from one volume. Includes many numerical examples that illustrate the application of the methodologies described. Provides introductory material on related disciplines and procedures such as tensor analysis, continuum mechanics and finite elements for non-linear solid mechanics. Is accompanied by purpose-developed finite element software that illustrates many of the techniques discussed in the text, downloadable from the book’s companion website. This comprehensive text will appeal to postgraduate and graduate students of civil, mechanical, aerospace and materials engineering as well as applied mathematics and courses with computational mechanics components. It will also be of interest to research engineers, scientists and software developers working in the field of computational solid mechanics.

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Comprehensive introduction to finite elastoplasticity,addressing various analytical and numerical analyses &including state-of-the-art theories Introduction to Finite Elastoplasticity presentsintroductory explanations that can be readily understood by readerswith only a basic knowledge of elastoplasticity, showing physicalbackgrounds of concepts in detail and derivation processes ofalmost all equations. The authors address various analytical andnumerical finite strain analyses, including new theories developedin recent years, and explain fundamentals including thepush-forward and pull-back operations and the Lie derivatives oftensors. As a foundation to finite strain theory, the authors begin byaddressing the advanced mathematical and physical properties ofcontinuum mechanics. They progress to explain a finiteelastoplastic constitutive model, discuss numerical issues onstress computation, implement the numerical algorithms for stresscomputation into large-deformation finite element analysis andillustrate several numerical examples of boundary-value problems.Programs for the stress computation of finite elastoplastic modelsexplained in this book are included in an appendix, and the codecan be downloaded from an accompanying website.

The JUT AMIIACM Symposium on Discretization Methods in Structural Mechanics was nd th held in Vienna, Austria, from 2 to 6 June 1997. The site of the Symposium was the "Theatersaal" of the Austrian Academy of Sciences. The Symposium was attended by 71 persons from 23 countries. In addition, several Austrian graduate students and research associates participated in the meeting. In the 5-day Symposium a total of 48 papers were presented. All of them were invited and accorded equal weight in the programme. The following topics were covered: • Error-controlled adaptivity of finite element methods • Large deformations and buckling, including inelastic deformations • Inelastic brittle or ductile localization, phase transition and system failure, resulting from monotonic, cyclic or impact loading • Sensitivity analysis and inverse problems with special emphasis on identification of material parameters • Development of linear and nonlinear finite element methods for thin-walled structures and composites • Implicit integration schemes for nonlinear dynamics • Coupling of rigid and deformable structures; fluid-structures and acoustic-structure interaction • Competitive numerical methods (finite element methods, boundary element methods, coupling ofthese two methods)

• Identification of material and structural data. Comments on details of the treatment of these topics are contained in the Concluding Remarks. The Editors would like to express their appreciation to E. Stein who has prepared these Concluding Remarks.

The powder forming process is an extremely effective method of manufacturing structural metal components with high-dimensional accuracy on a mass production basis. The process is applicable to nearly all industry sectors. It offers competitive engineering solutions in terms of technical performance and manufacturing costs. For these reasons, powder metallurgy is developing faster than other metal forming technology. Computational Plasticity in Powder Forming Proceses takes a specific look at the application of computer-aided engineering in modern powder forming technologies, with particular attention given to the Finite Element Method (FEM). FEM analysis provides detailed information on conditions within the processed material, which is often more complete than can be obtained even from elaborate physical experiments, and the numerical simulation makes it possible to examine a range of designs, or operating conditions economically. * Describes the mechanical behavior of powder materials using classical and modern constitutive theories. * Devoted to the application of adaptive FEM strategy in the analysis of powder forming processes. * 2D and 3D numerical modeling of powder forming processes are presented, using advanced plasticity models.

This book brings together some 20 chapters on state-of-the-art research in the broad field of computational plasticity with applications in civil and mechanical engineering, metal forming processes, geomechanics, nonlinear structural analysis, composites, biomechanics and multi-scale analysis of materials, among others. The chapters are written by world leaders in the different fields of computational plasticity.

This book contains 14 invited contributions written by distinguished authors who participated in the VIII International Conference on Computational Plasticity held at CIMNE/UPC (www.cimne.com) from 5-8 September 2005, in Barcelona, Spain. The chapters present recent progress and future research directions in the field of computational plasticity.

A description of the theoretical foundations of inelasticity, its numerical formulation and implementation, constituting a representative sample of state-of-the-art methodology currently used in inelastic calculations. Among the numerous topics covered are small deformation plasticity and viscoplasticity, convex optimisation theory, integration algorithms for the constitutive equation of plasticity and viscoplasticity, the variational setting of boundary value problems and discretization by finite element methods. Also addressed are the generalisation of the theory to non-smooth yield surface, mathematical numerical analysis issues of general return mapping algorithms, the generalisation to finite-strain inelasticity theory, objective integration algorithms for rate constitutive equations, the theory of hyperelastic-based plasticity models and small and large deformation viscoelasticity. Of great interest to researchers and graduate students in various branches of engineering, especially civil, aeronautical and mechanical, and applied mathematics.

Strength theory deals with the yield or failure of materials under complex stress state. It is very important in mechanics of materials, strength of structures, and mechanical and civil engineering. Unified strength theory is a series of yield criteria and failure criteria other than a single strength theory. The unified strength theory can be adopted for various kinds of materials, such as metallic materials, geomaterials, polymers etc. It is the solution to the Voigt-Timoshenko Conundrum. Its limit surfaces cover all regions of the convex strength theory from the lower bound to the upper bound. This book gives a clear and brief description about the unified strength theory both in figures and text. Some applications of unified strength theory are also given in this book. This book is suitable for undergraduate students, who are studying the mechanics of materials and engineering mechanics, as well as for graduate students who are interested in this field. Researchers and engineers can also benefit from this book.

Built upon the two original books by Mike Crisfield and theirown lecture notes, renowned scientist René de Borst and histeam offer a thoroughly updated yet condensed edition that retainsand builds upon the excellent reputation and appeal amongststudents and engineers alike for which Crisfield's first edition isacclaimed. Together with numerous additions and updates, the new authorshave retained the core content of the original publication, whilebringing an improved focus on new developments and ideas. Thisedition offers the latest insights in non-linear finite elementtechnology, including non-linear solution strategies, computationalplasticity, damage mechanics, time-dependent effects,hyperelasticity and large-strain elasto-plasticity. The authors' integrated and consistent style and unrivalledengineering approach assures this book's unique position within thecomputational mechanics literature. Key features: Combines the two previous volumes into one heavily revised textwith obsolete material removed, an improved layout and updatedreferences and notations Extensive new material on more recent developments incomputational mechanics Easily readable, engineering oriented, with no more details inthe main text than necessary to understand the concepts. Pseudo-code throughout makes the link between theory andalgorithms, and the actual implementation. Accompanied by a website (www.wiley.com/go/deborst) with aPython code, based on the pseudo-code within the book and suitablefor solving small-size problems. Non-linear Finite Element Analysis of Solids and Structures, 2ndEdition is an essential reference for practising engineers andresearchers that can also be used as a text for undergraduate andgraduate students within computational mechanics.

Computational structural mechanics (CSM) and computational fluid dynamics (CFD) have emerged in the last two decades as new disciplines combining structural mechanics and fluid dynamics with approximation theory, numerical analysis and computer science. Their use has transformed much of theoretical mechanics and abstract science into practical and essential tools for a multitude of technological developments which affect many facets of our life. This collection of over 40 papers provides an authoritative documentation of major advances in both CSM and CFD, helping to identify future directions of development in these rapidly changing fields. Key areas covered are fluid structure interaction and aeroelasticity, CFD technology and reacting flows, micromechanics, stability and eigenproblems, probabilistic methods and chaotic dynamics, perturbation and spectral methods, element technology (finite volume, finite elements and boundary elements), adaptive methods, parallel processing machines and applications, and visualization, mesh generation and artificial intelligence interfaces.

Researchers in the fields of computational mechanics, materials science and engineering need to address the size effects observed in deformation mechanisms and strengths of various materials. To solve this problem, this book provides concise explanations of all available methods, from atomistic simulation to non-local continuum models to capture size effects, and compares their applicability to a wide range of research scenarios. This essential guide addresses basic principles, numerical issues and computation, applications, and provides code which readers can use in their own modeling projects. Provides a comprehensive reference on the field of size effects and a review of mechanics of materials research in all scales Explains all major methods of size effects simulation including non-local continuum models, non-local crystal plasticity, discrete dislocation methods, and molecular dynamics Includes source codes that readers can use in their own projects

Inelastic Analysis of Solids and Structures presents in a unified manner the physical and theoretical background of inelastic material models and computational methods, and illustrates the behavior of the models in typical engineering conditions. The book describes experimental observations and principles of mechanics, and efficient computational algorithms for stress calculations as typically performed in finite element analysis. The theoretical background is given to an extent necessary to describe the commonly employed material models in metal isotropic and orthotropic plasticity, thermoplasticity and viscoplasticity, and the plasticity of geological materials. The computational algorithms are developed in a unified manner with some detailed derivations of the algorithmic relations. Many solved examples are presented, which are designed to give insight into the material behavior in various engineering conditions, and to demonstrate the application of the computational algorithms.