

COMPUTATIONAL METHODS FOR PLASTICITY

THEORY AND APPLICATIONS



EA de Souza Neto
D Perić
DRJ Owen

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Computational Methods For Plasticity Theory And Applications

Andreas Öchsner



Computational Methods For Plasticity Theory And Applications:

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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

Plasticity Theory Andreas Öchsner, 2024-05-30 This book provides a comprehensive exploration of the fundamentals experimental techniques and simulation methodologies related to advanced engineering materials It addresses the challenges posed by these materials introduces the concept of stress invariants and demonstrates their implementation in finite element programs for accurate simulations The book serves as a valuable resource for researchers engineers and students interested in the cutting edge developments in materials science and engineering

Computational Methods in Elasticity and Plasticity A. Anandarajah, 2011-01-04 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

Elements of Classical Plasticity Theory Andreas Öchsner, 2022-11-08 This monograph provides a compact introduction into the classical i e rate independent plasticity theory Starting from the engineering stress strain diagram the concept of elastic and elasto plastic material behavior is introduced as well as the concept of uniaxial and multiaxial stress states Continuum mechanical modeling in the elasto plastic range requires in regards to the constitutive equation in addition to the elastic law e g Hooke s law a yield condition a flow rule and a hardening rule These basic equations are thoroughly introduced and explained for one dimensional stress states Considering three dimensional plasticity different sets of stress invariants to characterize the stress matrix and the decomposition of the stress matrix in its hydrostatic and deviatoric part are introduced Furthermore the concept of the yield condition flow rule and hardening rule is generalized for multiaxial stress states Some typical yield conditions are introduced and their graphical representation in different stress spaces is discussed in detail The book concludes with an introduction in the elasto plastic finite element simulation of mechanical structures In the context of numerical approximation methods the so called predictor corrector methods are used to integrate the constitutive equations This is again introduced in detail based on one dimensional stress states and afterwards generalized to the three dimensional case Test your knowledge with questions and answers about the book in the Springer Nature Flashcards app

The Catalogue of Computational Material

Models Paul Steinmann, Kenneth Runesson, 2021-02-16 This book gives a comprehensive account of the formulation and computational treatment of basic geometrically linear models in 1D To set the stage it assembles some preliminaries regarding necessary modelling computational and mathematical tools Thereafter the remaining parts are concerned with the actual catalogue of computational material models To this end after starting out with elasticity as a reference further 15 different basic variants of material models 5 x each of visco elasticity plasticity visco plasticity respectively are systematically explored The presentation for each of these basic material models is a stand alone account and follows in each case the same structure On the one hand this allows in the true sense of a catalogue to consult each of the basic material models separately without the need to refer to other basic material models On the other hand even though this somewhat repetitious concept may seem tedious it allows to compare the formulation and resulting algorithmic setting of the various basic material models and thereby to uncover in detail similarities and differences In particular the response of each basic material model is analysed for the identical histories Zig Zag Sine Ramp of prescribed strain and stress so as to clearly showcase and to contrast to each other the characteristics of the various modelling options **One-Dimensional Finite Elements** Andreas Öchsner, Markus Merkel, 2018-04-25 This textbook presents finite element methods using exclusively one dimensional elements It presents the complex methodology in an easily understandable but mathematically correct fashion The approach of one dimensional elements enables the reader to focus on the understanding of the principles of basic and advanced mechanical problems The reader will easily understand the assumptions and limitations of mechanical modeling as well as the underlying physics without struggling with complex mathematics Although the description is easy it remains scientifically correct The approach using only one dimensional elements covers not only standard problems but allows also for advanced topics such as plasticity or the mechanics of composite materials Many examples illustrate the concepts and problems at the end of every chapter help to familiarize with the topics Each chapter also includes a few exercise problems with short answers provided at the end of the book The second edition appears with a complete revision of all figures It also presents a complete new chapter special elements and added the thermal conduction into the analysis of rod elements The principle of virtual work has also been introduced for the derivation of the finite element principal equation Plasticity of Metallic Materials Oana Cazacu, Benoit Revil-Baudard, 2020-11-23 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 *Plasticity* Weimin Han, B. Daya Reddy, 2012-11-19 This book focuses on the theoretical aspects of small strain theory of elastoplasticity with hardening assumptions It provides a comprehensive and unified treatment of the mathematical theory and numerical analysis It is divided into three parts with the first part providing a detailed introduction to plasticity the second part covering the mathematical analysis of the elasticity problem and the third part devoted to error analysis of various semi discrete and fully discrete approximations for variational formulations of the elastoplasticity This revised and expanded edition includes material on single crystal and strain gradient plasticity In addition the entire book has been revised to make it more accessible to readers who are actively involved in computations but less so in numerical analysis Reviews of earlier edition The authors have written an excellent book which can be recommended for specialists in plasticity who wish to know more about the mathematical theory as well as those with a background in the mathematical sciences who seek a self contained account of the mechanics and mathematics of plasticity theory ZAMM 2002 In summary the book represents an impressive comprehensive overview of the mathematical approach to the theory and numerics of plasticity Scientists as well as lecturers and graduate students will find the book very useful as a reference for research or for preparing courses in this field Technische Mechanik The book is professionally written and will be a useful reference to researchers and students interested in mathematical and numerical problems of plasticity It represents a major contribution in the area of continuum mechanics and numerical analysis Math Reviews *Automation of Finite Element Methods* Jože Korelc, Peter Wriggers, 2016-06-08 New finite elements are needed as well in research as in industry environments for the development of virtual prediction techniques The design and implementation of novel finite elements for specific purposes is a tedious and time consuming task especially for nonlinear formulations The automation of this process can help to speed up this process considerably since the generation of the final computer code can be accelerated by order of several magnitudes This book provides the reader with the required knowledge needed to employ modern automatic tools like AceGen within solid mechanics in a successful way It covers the range from the theoretical background algorithmic treatments to many different applications The book is written for advanced students in the engineering field and for researchers in educational and industrial environments **One-Dimensional Finite Elements** Markus Merkel, Andreas Öchsner, 2023-12-28 The basic idea of this introduction to the finite element method is based on the concept of explaining the complex method using only one dimensional elements Thus the mathematical description remains largely simple and straightforward The emphasis in each chapter is on explaining the method and understanding it itself The reader learns to understand the assumptions and derivations in various physical problems in structural mechanics and to critically assess the possibilities and limitations of the finite element method The restriction to one dimensional elements thus enables the methodical understanding of important topics e.g. plasticity or composite materials which a prospective computational engineer encounters in professional practice but which are rarely treated in this form at universities Thus an easy entry also

into more advanced application areas is ensured by the concept of a introduction to the basics b exact derivation with restriction to one dimensional elements and in many cases also to one dimensional problems c extensive examples and advanced tasks with short solution in the appendix For illustration purposes each chapter is deepened with extensively calculated and commented examples as well as with further tasks including short solutions

Equilibrium Finite Element Formulations J. P. Moitinho de Almeida, Edward A. Maunders, 2017-03-20 A comprehensive treatment of the theory and practice of equilibrium finite element analysis in the context of solid and structural mechanics Equilibrium Finite Element Formulations is an up to date exposition on hybrid equilibrium finite elements which are based on the direct approximation of the stress fields The focus is on their derivation and on the advantages that strong forms of equilibrium can have either when used independently or together with the more conventional displacement based elements These elements solve two important problems of concern to computational structural mechanics a rational basis for error estimation which leads to bounds on quantities of interest that are vital for verification of the output and provision of outputs immediately useful to the engineer for structural design and assessment Key features Unique in its coverage of equilibrium an essential reference work for those seeking solutions that are strongly equilibrated The approach is not widely known and should be of benefit to structural design and assessment Thorough explanations of the formulations for 2D and 3D continua thick and thin bending of plates and potential problems covering mainly linear aspects of behaviour but also with some excursions into non linearity Highly relevant to the verification of numerical solutions the basis for obtaining bounds of the errors is explained in detail Simple illustrative examples are given together with their physical interpretations The most relevant issues regarding the computational implementation of this approach are presented When strong equilibrium and finite elements are to be combined the book is a must have reference for postgraduate students researchers in software development or numerical analysis and industrial practitioners who want to keep up to date with progress in simulation tools

Computational Solid Mechanics Marco L. Bittencourt, 2014-09-19 Presents a Systematic Approach for Modeling Mechanical Models Using Variational Formulation Uses Real World Examples and Applications of Mechanical Models Utilizing material developed in a classroom setting and tested over a 12 year period Computational Solid Mechanics Variational Formulation and High Order Approximation details an approach that e

Engineering Design Applications II Andreas Öchsner, Holm Altenbach, 2019-06-27 This book offers an update on recent developments in modern engineering design Different engineering disciplines such as mechanical materials computer and process engineering provide the foundation for the design and development of improved structures materials and processes The modern design cycle is characterized by the interaction between various disciplines and a strong shift to computer based approaches where only a few experiments are conducted for verification purposes A major driver for this development is the increased demand for cost reduction which is also linked to environmental demands In the transportation industry e g automotive or aerospace the demand for higher fuel

efficiency is related to reduced operational costs and less environmental damage One way to fulfil such requirements is lighter structures and or improved processes for energy conversion Another emerging area is the interaction of classical engineering with the health and medical sector

Non-standard Discretisation Methods in Solid Mechanics Jörg Schröder, Peter Wriggers, 2022-04-14 This edited volume summarizes research being pursued within the DFG Priority Programme 1748 Reliable Simulation Methods in Solid Mechanics Development of non standard discretisation methods mechanical and mathematical analysis the aim of which was to develop novel discretisation methods based e g on mixed finite element methods isogeometric approaches as well as discontinuous Galerkin formulations including a sound mathematical analysis for geometrically as well as physically nonlinear problems The Priority Programme has established an international framework for mechanical and applied mathematical research to pursue open challenges on an interdisciplinary level The compiled results can be understood as state of the art in the research field and show promising ways of further research in the respective areas The book is intended for doctoral and post doctoral students in civil engineering mechanical engineering applied mathematics and physics as well as industrial researchers interested in the field

Introduction to Finite Strain Theory for Continuum Elasto-Plasticity Koichi Hashiguchi, Yuki Yamakawa, 2012-10-09 Comprehensive introduction to finite elastoplasticity addressing various analytical and numerical analyses including state of the art theories Introduction to Finite Elastoplasticity presents introductory explanations that can be readily understood by readers with only a basic knowledge of elastoplasticity showing physical backgrounds of concepts in detail and derivation processes of almost all equations The authors address various analytical and numerical finite strain analyses including new theories developed in recent years and explain fundamentals including the push forward and pull back operations and the Lie derivatives of tensors As a foundation to finite strain theory the authors begin by addressing the advanced mathematical and physical properties of continuum mechanics They progress to explain a finite elastoplastic constitutive model discuss numerical issues on stress computation implement the numerical algorithms for stress computation into large deformation finite element analysis and illustrate several numerical examples of boundary value problems Programs for the stress computation of finite elastoplastic models explained in this book are included in an appendix and the code can be downloaded from an accompanying website

Nonlinear Continuum Mechanics Carlos Agelet de Saracibar, 2023-08-22 This textbook on Continuum Mechanics presents 9 chapters Chapters 1 and 2 are devoted to Tensor Algebra and Tensor Analysis Part I of the book includes the next 3 chapters All the content here is valid for both solid and fluid materials At the end of Part I the reader should be able to set up in local spatial material form the fundamental governing equations and inequalities for a Continuum Mechanics problem Part II of the book Chapters 6 to 10 is devoted to presenting some nonlinear constitutive models for Nonlinear Solid Mechanics including Finite Deformation Hyperelasticity Finite Deformation Plasticity Finite Deformation Coupled Thermoplasticity and Finite Deformation Contact Mechanics The constitutive equations are derived

within a thermodynamically consistent framework Finite deformation elastoplasticity models are based on a multiplicative decomposition of the deformation gradient and the notion of an intermediate configuration Different formulations based on the intermediate configuration the current or spatial configuration and the material configuration are considered The last chapter is devoted to Variational Methods in Solid Mechanics a fundamental topic in Computational Mechanics The book may be used as a textbook for an advanced Master s course on Nonlinear Continuum Mechanics for graduate students in Civil Mechanical or Aerospace Engineering Applied Mathematics or Applied Physics with an interest in Continuum Mechanics and Computational Mechanics

Numerical Methods in Geotechnical Engineering IX António S. Cardoso, José L. Borges, Pedro A. Costa, António T. Gomes, José C. Marques, Castorina S. Vieira, 2018-06-19 Numerical Methods in Geotechnical Engineering IX contains 204 technical and scientific papers presented at the 9th European Conference on Numerical Methods in Geotechnical Engineering NUMGE2018 Porto Portugal 25-27 June 2018 The papers cover a wide range of topics in the field of computational geotechnics providing an overview of recent developments on scientific achievements innovations and engineering applications related to or employing numerical methods They deal with subjects from emerging research to engineering practice and are grouped under the following themes Constitutive modelling and numerical implementation Finite element discrete element and other numerical methods Coupling of diverse methods Reliability and probability analysis Large deformation large strain analysis Artificial intelligence and neural networks Ground flow thermal and coupled analysis Earthquake engineering soil dynamics and soil structure interactions Rock mechanics Application of numerical methods in the context of the Eurocodes Shallow and deep foundations Slopes and cuts Supported excavations and retaining walls Embankments and dams Tunnels and caverns and pipelines Ground improvement and reinforcement Offshore geotechnical engineering Propagation of vibrations Following the objectives of previous eight thematic conferences 1986 Stuttgart Germany 1990 Santander Spain 1994 Manchester United Kingdom 1998 Udine Italy 2002 Paris France 2006 Graz Austria 2010 Trondheim Norway 2014 Delft The Netherlands Numerical Methods in Geotechnical Engineering IX updates the state of the art regarding the application of numerical methods in geotechnics both in a scientific perspective and in what concerns its application for solving practical boundary value problems The book will be much of interest to engineers academics and professionals involved or interested in Geotechnical Engineering

Nonlinear Finite Elements for Continua and Structures Ted Belytschko, Wing Kam Liu, Brian Moran, Khalil Elkhodary, 2014-01-07 Nonlinear Finite Elements for Continua and Structures p Nonlinear Finite Elements for Continua and Structures This updated and expanded edition of the bestselling textbook provides a comprehensive introduction to the methods and theory of nonlinear finite element analysis New material provides a concise introduction to some of the cutting edge methods that have evolved in recent years in the field of nonlinear finite element modeling and includes the eXtended Finite Element Method XFEM multiresolution continuum theory for multiscale microstructures and dislocation density based crystalline plasticity Nonlinear

Finite Elements for Continua and Structures Second Edition focuses on the formulation and solution of discrete equations for various classes of problems that are of principal interest in applications to solid and structural mechanics Topics covered include the discretization by finite elements of continua in one dimension and in multi dimensions the formulation of constitutive equations for nonlinear materials and large deformations procedures for the solution of the discrete equations including considerations of both numerical and multiscale physical instabilities and the treatment of structural and contact impact problems Key features Presents a detailed and rigorous treatment of nonlinear solid mechanics and how it can be implemented in finite element analysis Covers many of the material laws used in today s software and research Introduces advanced topics in nonlinear finite element modelling of continua Introduction of multiresolution continuum theory and XFEM Accompanied by a website hosting a solution manual and MATLAB and FORTRAN code Nonlinear Finite Elements for Continua and Structures Second Edition is a must have textbook for graduate students in mechanical engineering civil engineering applied mathematics engineering mechanics and materials science and is also an excellent source of information for researchers and practitioners

Virtual Element Methods in Engineering Sciences Peter Wriggers,Fadi Aldakheel,Blaž Hudobivnik,2023-10-28 This book provides a comprehensive treatment of the virtual element method VEM for engineering applications focusing on its application in solid mechanics Starting with a continuum mechanics background the book establishes the necessary foundation for understanding the subsequent chapters It then delves into the VEM s Ansatz functions and projection techniques both for solids and the Poisson equation which are fundamental to the method The book explores the virtual element formulation for elasticity problems offering insights into its advantages and capabilities Moving beyond elasticity the VEM is extended to problems in dynamics enabling the analysis of dynamic systems with accuracy and efficiency The book also covers the virtual element formulation for finite plasticity providing a framework for simulating the behavior of materials undergoing plastic deformation Furthermore the VEM is applied to thermo mechanical problems where it allows for the investigation of coupled thermal and mechanical effects The book dedicates a significant portion to the virtual elements for fracture processes presenting techniques to model and analyze fractures in engineering structures It also addresses contact problems showcasing the VEM s effectiveness in dealing with contact phenomena The virtual element method s versatility is further demonstrated through its application in homogenization offering a means to understand the effective behavior of composite materials and heterogeneous structures Finally the book concludes with the virtual elements for beams and plates exploring their application in these specific structural elements Throughout the book the authors emphasize the advantages of the virtual element method over traditional finite element discretization schemes highlighting its accuracy flexibility and computational efficiency in various engineering contexts

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