

MECHANICS OF ELASTIC AND INELASTIC SOLIDS

George I.N. Rozvany

Structural Design via Optimality Criteria

The Prager Approach to
Structural Optimization

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J. Herskovits



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Structural Design via Optimality Criteria George I. N. Rozvany, 2012-12-06 During the last two decades research on structural optimization became increasingly concerned with two aspects the application of general numerical methods of optimization to structural design of complex real structures and the analytical derivation of necessary and sufficient conditions for the optimality of broad classes of comparatively simple and more or less idealized structures Both kinds of research are important the first for obvious reasons the second because it furnishes information that is useful in testing the validity accuracy and convergence of numerical methods and in assessing the efficiency of practical designs *quo* Prager and Rozvany 1977a The unexpected death of William Prager in March 1980 marked in a sense the end of an era in structural mechanics but his legacy of ideas will remain a source of inspiration for generations of researchers to come Since his nominal retirement in the early seventies Professor and Mrs Prager lived in Savognin an isolated alpine village and ski resort surrounded by some of Switzerland's highest mountains It was there that the author's close association with Prager developed through annual pilgrimages from Australia and lengthy discussions which pivoted on Prager's favourite topic of structural optimization These exchanges took place in the picturesque setting of Graubünden on the terrace of an alpine restaurant overlooking snow-capped peaks on ski lifts or mountain walks or during evening meals in the cosy hotels of Savognin Parsonz and Riom

Elements of Structural Optimization Raphael T. Haftka, Zafer Gürdal, 2012-12-06 The field of structural optimization is still a relatively new field undergoing rapid changes in methods and focus Until recently there was a severe imbalance between the enormous amount of literature on the subject and the paucity of applications to practical design problems This imbalance is being gradually redressed There is still no shortage of new publications but there are also exciting applications of the methods of structural optimizations in the automotive aerospace civil engineering machine design and other engineering fields As a result of the growing pace of applications research into structural optimization methods is increasingly driven by real life problems Most engineers who design structures employ complex general purpose software packages for structural analysis Often they do not have any access to the source program and even more frequently they have only scant knowledge of the details of the structural analysis algorithms used in this software packages Therefore the major challenge faced by researchers in structural optimization is to develop methods that are suitable for use with such software packages Another major challenge is the high computational cost associated with the analysis of many complex real life problems In many cases the engineer who has the task of designing a structure cannot afford to analyze it more than a handful of times

Optimization of Large Structural Systems G. I. N. Rozvany, 1993 This is the second of two volumes which examine structural optimization of large structural systems Topics covered in these volumes include optimality criteria and topology optimization decomposition methods and approximation concepts neural networks and parallel processing

Shape and Layout Optimization of Structural Systems and Optimality Criteria Methods G.I.N. Rozvany, 2014-05-04 Shape

and layout optimization represent some of the most useful but also most difficult classes of problems in structural design which have been investigated in detail only during the last few years Shape optimization is concerned with the optimal shape of boundaries of continua or of interfaces between two materials in composites Layout optimization deals with the simultaneous optimization of the topology geometry and cross sectional sizes of structural systems In spite of its complexity layout optimization is a very rewarding task because it results in much greater savings than the optimization of cross sectional sizes only Because of their important role in shape and layout optimization the book also covers in detail new optimality criteria methods which are capable of handling many thousand design variables and active design constraints Shape and layout optimization is becoming an indispensable tool in the design of aeroplanes space structures cars ships building and civil engineering structures power stations chemical plants artificial organs sporting equipment and all other solid systems where stresses and deformations play an important role

Fundamentals of Structural Optimization Vladimir Kobelev, 2023-12-01 This book serves as a complementary resource to the courses Advanced structural optimization and Structural optimization in automotive engineering taught by the author at the University of Siegen North Rhine Westphalia Germany since 2001 Focusing on optimization problems in the field of structural engineering this book offers a rigorous and analytical approach to problem solving Each chapter of the book begins with a brief overview of classical results and the derivation of governing equations The solutions to optimization problems are then presented in a closed form with the author guiding readers through several analytical methods for solving stability and contact tasks Throughout the book the author takes care to ensure that even readers without extensive experience in numerical computations can understand the conclusion of each relation The book features several basic optimization problems selected from a large pool of previously solved problems with a particular emphasis on the unique features of optimization problems By presenting analytical solutions readers can better understand other known optimization problems and gain the skills needed to independently set and solve new problems With its comprehensive and rigorous approach to problem solving this book is sure to enhance the reader's understanding of the field and equip them with the skills needed to tackle new challenges

Optimization of Large Structural Systems George I. N. Rozvany, 2013-11-21 G I N Rozvany ASI Director Professor of Structural Design FB 10 Essen University Essen Germany Structural optimization deals with the optimal design of all systems that consist at least partially of solids and are subject to stresses and deformations This integrated discipline plays an increasingly important role in all branches of technology including aerospace structural mechanical civil and chemical engineering as well as energy generation and building technology In fact the design of most man-made objects ranging from space ships and long span bridges to tennis rackets and artificial organs can be improved considerably if human intuition is enhanced by means of computer-aided systematic decisions In analysing highly complex structural systems in practice discretization is unavoidable because closed form analytical solutions are only available for relatively simple idealized problems To keep discretization

errors to a minimum it is desirable to use a relatively large number of elements Modern computer technology enables us to analyse systems with many thousand degrees of freedom In the optimization of structural systems however most currently available methods are restricted to at most a few hundred variables or a few hundred active constraints Variational Methods for Structural Optimization Andrej Cherkaev,2012-12-06 In recent decades it has become possible to turn the design process into computer algorithms By applying different computer oriented methods the topology and shape of structures can be optimized and thus designs systematically improved These possibilities have stimulated an interest in the mathematical foundations of structural optimization The challenge of this book is to bridge a gap between a rigorous mathematical approach to variational problems and the practical use of algorithms of structural optimization in engineering applications The foundations of structural optimization are presented in a sufficiently simple form to make them available for practical use and to allow their critical appraisal for improving and adapting these results to specific models Special attention is to pay to the description of optimal structures of composites to deal with this problem novel mathematical methods of nonconvex calculus of variation are developed The exposition is accompanied by examples **Computer Aided Optimal Design: Structural and Mechanical Systems** Carlos A. Mota Soares,2012-12-06 This book contains the edited version of lectures and selected papers presented at the NATO ADVANCED STUDY INSTITUTE ON COMPUTER AIDED OPTIMAL DESIGN Structural and Mechanical Systems held in Tr6ia Portugal 29th June to 11th July 1986 and organized by CEMUL Center of Mechanics and Materials of the Technical University of Lisbon The Institute was attended by 120 participants from 21 countries including leading scientists and engineers from universities research institutions and industry and Ph D students Some participants presented invited and contributed papers during the Institute and almost all participated actively in discussions on scientific aspects during the Institute The Advanced Study Institute provided a forum for interaction among eminent scientists and engineers from different schools of thought and young reseachers The Institute addressed the foundations and current state of the art of essential techniques related to computer aided optimal design of structural and mechanical systems namely Vari ational and Finite Element Methods in Optimal Design Numerical Optimization Techniques Design Sensitivity Analysis Shape Optimal Design Adaptive Finite Element Methods in Shape Optimization CAD Technology Software Development Techniques Integrated Computer Aided Design and Knowledge Based Systems Special topics of growing importance were also pre sented Advances in Structural Optimization J. Herskovits,2012-12-06 Advances in Structural Optimization presents the techniques for a wide set of applications ranging from the problems of size and shape optimization historically the first to be studied to topology and material optimization Structural models are considered that use both discrete and finite elements Structural materials can be classical or new Emerging methods are also addressed such as automatic differentiation intelligent structures optimization integration of structural optimization in concurrent engineering environments and multidisciplinary optimization For researchers and designers in industries such as aerospace

automotive mechanical civil nuclear naval and offshore A reference book for advanced undergraduate or graduate courses on structural optimization and optimum design Flow Visualization and Image Analysis F.T. Nieuwstadt, 2012-12-06 Progress in fluid mechanics depends heavily on the availability of good experimental data which can inspire new ideas and concepts but which are also necessary to check and validate theories and numerical calculations With the advent of new recording and image analysis techniques new and promising experimental methods in fluid flows have presented themselves which are rather newly developed techniques such as particle tracking velocimetry PTV particle image velocimetry PIV and laser fluorescence LIF This volume presents state of the art research on these techniques and their application to fluid flow Selected papers from the EUROMECH conference on Image Analysis are published in this volume **The Behaviour of Nonlinear Vibrating Systems** Wanda Szemplinska, 1990-06-30 The purpose of this book is to provide students practicing engineers and scientists with a treatment of nonlinear phenomena occurring in physical systems Although only mechanical models are used the theory applies to all physical systems governed by the same equations so that the book can be used to study nonlinear phenomena in other branches of engineering such as electrical engineering and aerospace engineering as well as in physics The book consists of two volumes Volume I is concerned with single degree of freedom systems and it presents the fundamental concepts of nonlinear analysis Both analytical methods and computer simulations are included The material is presented in such a manner that the book can be used as a graduate as well as an undergraduate textbook Volume II deals with multi degree of freedom systems Following an introduction to linear systems the volume presents fundamental concepts of geometric theory and stability of motion of general nonlinear systems as well as a concise discussion of basic approximate methods for the response of such systems The material represents a generalization of a series of papers on the vibration of nonlinear multi degree of freedom systems some of which were published by me and my associates during the period 1965 1983 and some are not yet published Advanced Multibody System Dynamics Werner Schiehlen, 2013-04-17 The German Research Council DFG decided 1987 to establish a nationwide five year research project devoted to dynamics of multibody systems In this project universities and research centers cooperated with the goal to develop a general purpose multibody system software package This concept provides the opportunity to use a modular structure of the software i.e. different multibody formalisms may be combined with different simulation programmes via standardized interfaces For the DFG project the database RSYST was chosen using standard FORTRAN 77 and an object oriented multibody system datamodel was defined The project included research on the fundamentals of the method of multibody systems concepts for new formalisms of dynamical analysis development of efficient numerical algorithms and realization of a powerful software package of multibody systems These goals required an interdisciplinary cooperation between mathematics computer science mechanics and control theory ix X After a rigorous reviewing process the following research institutions participated in the project under the responsibility of leading scientists Technical University of Aachen

Prof G Sedlacek Technical University of Darmstadt Prof P Hagedorn University of Duisburg M Hiller Prof Methods of Fracture Mechanics: Solid Matter Physics G.P. Cherepanov, 2013-03-09 Modern fracture mechanics considers phenomena at many levels macro and micro it is therefore inextricably linked to methods of theoretical and mathematical physics This book introduces these sophisticated methods in a straightforward manner The methods are applied to several important phenomena of solid state physics which impinge on fracture mechanics adhesion defect nucleation and growth dislocation emission sintering the electron beam effect and fractal cracks The book shows how the mathematical models for such processes may be set up and how the equations so formulated may be solved and interpreted The many open problems which are encountered will provide topics for MSc and PhD theses in fracture mechanics and in theoretical and experimental physics As a supplementary text the book can be used in graduate level courses on fracture mechanics solid matter physics and mechanics of solids or in a special course on the application of fracture mechanics methods in solid matter physics

Dynamic Structure of Detonation in Gaseous and Dispersed Media A.A. Borissov, 2012-12-06 Of late the demands of industry in creating new composite and functional materials with present properties stimulated an increased interest to the investigation of processes which occur in the detonation technologies of complex chemical composition with an additive of disperse particles The collection includes a series of papers presented at the 3d International Conference Lavrentyev Readings on Mathematics Mechanics and Physics Novosibirsk 1990 was held by the Hydrodynamics Institute under the support of the Presidium of the Siberian Branch of the USSR Academy of Sciences to stimulate the international cooperation of the leading international centers In the framework of this Conference the Round Table seminar was held by Prof A Borissov and Prof V Mi trofanov devoted to Dynamic Structure of Detonation in Gaseous and Dispersed Media The idea to hold such Round Table was supported by Chairman of Organizing Committee academician Prof V Titov from Hydrodynamics Institute and academician Prof V Nakoryakov and also his Institute of Thermophysics The main ideas discussed at the Round Table were presented in the form of papers which reflected present situation of the problem of dynamic structure of the detonation waves in gaseous and dispersed media The basic experimental facts concerning of complicated mul ti dimensional non stationary structure both of the detonation wave and its front surface generation of the cell structure the effect of transverse waves obstacles channel geometry etc on the transition from dynamic regime to stationary structure are represented in the fist three papers Computational Methods in Solid Mechanics A. Curnier, 2012-12-06 This volume presents an introduction to the three numerical methods most commonly used in the mechanical analysis of deformable solids viz the finite element method FEM the linear iteration method LIM and the finite difference method FDM The book has been written from the point of view of simplicity and unity its originality lies in the comparable emphasis given to the spatial temporal and nonlinear dimensions of problem solving This leads to a neat global algorithm Chapter 1 addresses the problem of a one dimensional bar with emphasis being given to the virtual work principle Chapters 2 4 present the three numerical

methods Although the discussion relates to a one dimensional model the formalism used is extendable to two dimensional situations Chapter 5 is devoted to a detailed discussion of the compact combination of the three methods and contains several sections concerning their computer implementation Finally Chapter 6 gives a generalization to two and three dimensions of both the mechanical and numerical aspects For graduate students and researchers whose work involves the theory and application of computational solid mechanics

IUTAM Symposium on Microstructure-Property Interactions in Composite Materials R. Pyrz, 2012-12-06 The IUT AM Symposium on Microstructure Property Interactions in Composite Materials was held during the dates 22nd to 25th August 1994 in Rebild Bakker Conference Centre situated in the heart of one of Denmark's most beautiful natural areas Participation in the Symposium was reserved for invited participants suggested by members of the Scientific Committee The cooperation with the Scientific Committee is highly appreciated The Symposium brought together 76 researchers from 15 countries representing a broad range of backgrounds relevant to the topic of the meeting The participants represented the disciplines of materials science and engineering applied mechanics applied mathematics and scientific computations The Symposium comprehensively addressed the analytical numerical and experimental methods that provide an estimation of the overall effective properties from microstructural data The 41 contributions emphasized the significance of the microstructure morphology in understanding the nature and origin of a multitude of properties such as viscoelasticity plasticity strength and fracture for a variety of polymer metal and ceramic based composite materials Specifically the Symposium examined and reviewed the current state of the art of micromechanical modelling experimental investigations and morphological quantification of composite materials microstructure The volume contains 35 papers published in an alphabetic order after the name of the first author Much to regret of the Scientific Committee some manuscripts were not submitted The financial support of the IUT AM the Obels Family Foundation and the Institute of Mechanical Engineering Aalborg University is gratefully acknowledged

Moving Loads on Ice Plates V.A. Squire, Roger J. Hosking, Arnold D. Kerr, Patricia J. Langhorne, 2012-12-06 Moving Loads on Ice Plates is a unique study into the effect of vehicles and aircraft travelling across floating ice sheets It synthesizes in a single volume with a coherent theme and nomenclature the diverse literature on the topic hitherto available only as research journal articles Chapters on the nature of fresh water ice and sea ice and on applied continuum mechanics are included as is a chapter on the subject's venerable history in related areas of engineering and science The most recent theories and data are discussed in great depth demonstrating the advanced state of the modelling and experimental field programmes that have taken place Finally results are interpreted in the context of engineering questions faced by agencies operating in the polar and subpolar regions Although the book necessarily contains some graduate level applied mathematics it is written to allow engineers physicists and mathematicians to extract the information they need without becoming preoccupied with details Structural environmental civil and offshore engineers and groups who support these industries particularly within the

Arctic and Antarctic will find the book timely and relevant

Recent Developments in Turbulence Management K.-S.

Choi, 2012-12-06 The European Drag Reduction Meeting has been held on 15th and 16th November 1990 in London This was the fifth of the annual European meetings on drag reduction in engineering flows The main objective of this meeting was to discuss up to date results of drag reduction research carried out in Europe The organiser has adopted the philosophy of discussing the yesterday s results rather than the last year s results No written material has therefore been requested for the meeting It was only after the meeting the submission of papers was requested to the participants from which 16 papers were selected for this proceedings volume The meeting has attracted a record number of participants with a total of 52 researchers from seven European countries U K France Germany the Netherlands Italy Switzerland and U S S R as well as from Japan Canada and Australia The subjects covered in this proceedings volume include riblets LEBUs Large Eddy Break Up device surface roughness compliant surfaces and polymer additives Riblets seem to be one of the most extensively studied devices in the past years Reflecting this situation in the European community there are six papers on riblets covering their practical applications to aircraft and to a model ship near wall coherent structure of the boundary layer and effects of flow three dimensionality Possibility of heat transfer enhancement with riblets and potential use in the laminar flow are also investigated An analytical model is developed for the boundary layer with a LEBU device

Finite Element Analysis of

Composite Laminates O.O. Ochoa, J.N. Reddy, 2013-06-29 Composite materials are increasingly used in aerospace underwater and automotive structures To take advantage of the full potential of composite materials structural analysts and designers must have accurate mathematical models and design methods at their disposal The objective of this monograph is to present the laminated plate theories and their finite element models to study the deformation strength and failure of composite structures Emphasis is placed on engineering aspects such as the analytical descriptions effective analysis tools modeling of physical features and evaluation of approaches used to formulate and predict the response of composite structures The first chapter presents an overview of the text Chapter 2 is devoted to the introduction of the definitions and terminology used in composite materials and structures Anisotropic constitutive relations and laminate plate theories are also reviewed Finite element models of laminated composite plates are presented in Chapter 3 Numerical evaluation of element coefficient matrices post computation of strains and stresses and sample examples of laminated plates in bending and vibration are discussed Chapter 4 introduces damage and failure criteria in composite laminates Finally Chapter 5 is dedicated to case studies involving various aspects and types of composite structures Joints cutouts woven composites environmental effects postbuckling response and failure of composite laminates are discussed by considering specific examples

Mechanics of Composite Materials J.N. Reddy, 2013-04-18 Everyone involved with the mechanics of composite materials and structures must have come across the works of Dr N J Pagano in their research His research papers are among the most referenced of all existing literature in the field of mechanics of composite materials This monograph makes

available in one volume all Dr Pagano's major technical papers Most of the papers included in this volume have been published in the open literature but there are a few exceptions a few key unpublished reports have been included for continuity The topics are some basic studies of anisotropic behavior exact solutions for elastic response role of micromechanics and some carbon carbon spinoffs The volume can be used as a reference book by researchers in academia industry and government laboratories and it can be used as a reference text for a graduate course on the mechanics of composite materials

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