

SOLID MECHANICS AND ITS APPLICATIONS

José Herskovits (Ed.)

Advances in Structural Optimization



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An Introduction To Structural Optimization Solid Mechanics And Its Applications

Peter W. Christensen, Anders Klarbring



An Introduction To Structural Optimization Solid Mechanics And Its Applications:

An Introduction to Structural Optimization Peter W. Christensen, A. Klarbring, 2008-10-14 This book has grown out of lectures and courses given at Linköping University Sweden over a period of 15 years It gives an introductory treatment of problems and methods of structural optimization The three basic classes of geometrical optimization problems of mechanical structures i.e. size shape and topology optimization are treated The focus is on concrete numerical solution methods for discrete and finite element discretized linear elastic structures The style is explicit and practical mathematical proofs are provided when arguments can be kept elementary but are otherwise only cited while implementation details are frequently provided Moreover since the text has an emphasis on geometrical design problems where the design is represented by continuously varying frequently very many variables so called first order methods are central to the treatment These methods are based on sensitivity analysis i.e. on establishing first order derivatives for objectives and constraints The classical first order methods that we emphasize are CONLIN and MMA which are based on explicit convex and separable approximations It should be remarked that the classical and frequently used so called optimality criteria method is also of this kind It may also be noted in this context that zero order methods such as response surface methods surrogate models neural networks genetic algorithms etc essentially apply to different types of problems than the ones treated here and should be presented elsewhere

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

Structural Optimization with Uncertainties N.V. Banichuk, Pekka Neittaanmäki, 2009-12-01 Structural optimization is currently attracting considerable attention Interest in search in optimal design has grown in connection with the rapid development of aeronautical and space technologies shipbuilding and design of precision machinery A special field in these investigations is devoted to structural optimization with incomplete information incomplete data The importance of these investigations is explained as follows The conventional theory of optimal structural design assumes precise knowledge of material parameters including damage characteristics and loadings applied to the structure In practice such precise knowledge is seldom available Thus it is important to be able to predict the sensitivity of a designed structure to random fluctuations in the environment and to variations in the material properties To design reliable structures it is necessary to apply the so called guaranteed approach based on a worst case scenario or a more optimistic probabilistic approach if we have

additional statistical data Problems of optimal design with incomplete information also have considerable theoretical importance The introduction and investigations into new types of mathematical problems are interesting in themselves Note that some theoretical optimization problems arise for which there are no systematic techniques of investigation This monograph is devoted to the exposition of new ways of formulating and solving problems of structural optimization with incomplete information We recall some research results concerning the optimum shape and structural properties of bodies subjected to external loadings

IUTAM Symposium on Multiscale Modeling and Characterization of Elastic-Inelastic Behavior of Engineering Materials S. Ahzi, M. Cherkaoui, M.A. Khaleel, H.M. Zbib, M.A. Zikry, B. LaMatina, 2013-04-17 The papers in this proceeding are a collection of the works presented at the IUTAM symposium Marrakech 2002 October 20-25 which brought together scientists from various countries These papers cover contemporary topics in multiscale modeling and characterization of materials behavior of engineering materials They were selected to focus on topics related to deformation and failure in metals alloys intermetallics and polymers including experimental techniques deformation and failure mechanisms dislocation based modelling microscopic macroscopic averaging schemes application to forming processes and to phase transformation localization and failure phenomena and computational advances Key areas that are covered by some of the papers include modeling of material deformation at various scales At the atomistic scale results from MD simulations pertaining to deformation mechanisms in nano crystalline materials as well as dislocation defect interactions are presented Advances in modeling of deformation in metals using discrete dislocation analyses are also presented providing an insight into this emerging scientific technique that can be used to model deformation at the microscale These papers address current engineering problems including deformation of thin films dislocation behavior and strength during nanoindentation strength in metal matrix composites dislocation crack interaction development of textures in polycrystals and problems involving twinning and shape memory behavior On Behalf of the organizing committee I would like to thank Professor P

IUTAM Symposium on Physicochemical and Electromechanical Interactions in Porous Media Jacques Huyghe, Peter A.C. Raats, Stephen C. Cowin, 2006-01-28 In the last decades new experimental and numerical techniques have taken many advanced features of porous media mechanics down to practical engineering applications This happened in areas that sometimes were not even suspected to be open to engineering ideas at all The challenge that often faces engineers in the field of geomechanics biomechanics rheology and materials science is the translation of ideas existing in one field to solutions in the other The purpose of the IUTAM symposium from which this proceedings volume has been compiled was to dive deep into the mechanics of those porous media that involve mechanics and chemistry mechanics and electromagnetism mechanics and thermal fluctuations of mechanics and biology The different sections have purposely not been formed according to field interest but on the basis of the physics involved

Elements of Structural Optimization Raphael T. Haftka, Zafer Gürdal, M.P. Kamat, 2013-03-14 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 now 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 the details of program and even more frequently they have only scant knowledge 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

Multiscale Fatigue Crack Initiation and Propagation of Engineering Materials: Structural Integrity and Microstructural Worthiness

George C. Sih, 2008-06-01 What can be added to the fracture mechanics of metal fatigue that has not already been said since the 1900s From the view point of the material and structure engineer there are many aspects of failure by fatigue that are in need of attention particularly when the size and time of the working components are changed by orders of magnitude from those considered by st traditional means The 21 century marks an era of technology transition where structures are made larger and devices are made smaller rendering the method of destructive testing unpractical While health monitoring entered the field of science and engineering the practitioners are discovering that the correlation between the signal and the location of interest depends on a priori knowledge of where failure may initiate This information is not easy to find because the integrity of the physical system will change with time Required is software that can self adjust in time according to the monitored data In this connection effective application of health monitoring can use a predictive model of fatigue crack growth Earlier fatigue crack growth models assumed functional dependence on the maximum stress and the size of the pre existing crack or defect Various possibilities were examined in the hope that the data could be grouped such that linear interpolation would apply

Optimization Methods in Structural Design Alan Rothwell, 2017-03-27 This book offers an introduction to numerical optimization methods in structural design Employing a readily accessible and compact format the book presents an overview of optimization methods and equips readers to properly set up optimization problems and interpret the results A how to do it approach is followed throughout with less emphasis at this stage on mathematical derivations The book features spreadsheet programs provided in Microsoft Excel which allow readers to experience optimization hands on Examples covered include truss structures columns beams reinforced shell structures stiffened panels and composite laminates For the last three a review of relevant analysis methods is included Exercises with solutions where

appropriate are also included with each chapter The book offers a valuable resource for engineering students at the upper undergraduate and postgraduate level as well as others in the industry and elsewhere who are new to these highly practical techniques While the specific application is to structural design the principles involved can be applied far more widely

Design-Oriented Analysis of Structures Uri Kirsch, 2006-04-11 This book was developed while I was teaching graduate courses on analysis design and optimization of structures in the United States Europe and Israel Structural analysis is a main part of any design problem and the analysis often must be repeated many times during the design process Much work has been done on design oriented analysis of structures recently and many studies have been published The purpose of the book is to collect together selected topics of this literature and to present them in a unified approach It meets the need for a general text covering the basic concepts and methods as well as recent developments in this area This should prove useful to students researchers consultants and practicing engineers involved in analysis and design of structures Previous books on structural analysis do not cover most of the material presented in the book The book deals with the problem of multiple repeated analyses reanalysis of structures that is common to numerous analysis and design tasks Reanalysis is needed in many areas such as structural optimization analysis of damaged structures nonlinear analysis probabilistic analysis controlled structures smart structures and adaptive structures It is related to a wide range of applications in such fields as Aerospace Engineering Civil Engineering Mechanical Engineering and Naval Architecture Thin-Walled Composite Beams

Liviu Librescu, Ohseop Song, 2006-01-15 Annotation This is the first monograph devoted to the foundation of the theory of composite anisotropic thin walled beams and to its applications in various problems involving the aeronautical aerospace helicopter naval and mechanical structures Throughout the theoretical part an effort was made to provide the treatment of the subject by using the equations of the 3 D elasticity theory Non classical effects such as transverse shear warping constraint anisotropy of constituent materials yielding the coupling of twist bending lateral bending transversal extension have been included and their implications have been thoroughly analyzed Thermal effects have been included and in order to be able to circumvent their deleterious effects functionally graded materials have been considered in their construction Implications of the application of the tailoring technique and of the active feedback control on free vibration dynamic response instability and aeroelasticity of such structures have been amply investigated Special care was exercised throughout this work to address and validate the adopted solution methodologies and the obtained results against those available in the literature and obtained via numerical or experimental means *Optimal Control from Theory to Computer Programs* Viorel Arnăutu, Pekka Neittaanmäki, 2013-04-17 The aim of this book is to present the mathematical theory and the know how to make computer programs for the numerical approximation of Optimal Control of PDE s The computer programs are presented in a straightforward generic language As a consequence they are well structured clearly explained and can be translated easily into any high level programming language Applications and corresponding numerical tests are also given

and discussed To our knowledge this is the first book to put together mathematics and computer programs for Optimal Control in order to bridge the gap between mathematical abstract algorithms and concrete numerical ones The text is addressed to students and graduates in Mathematics Mechanics Applied Mathematics Numerical Software Information Technology and Engineering It can also be used for Master and Ph D programs

Nonlinear and Stochastic Dynamics of Compliant Offshore Structures Seon Mi Han, Haym Benaroya, 2013-04-17 The purpose of this monograph is to show how a compliant offshore structure in an ocean environment can be modeled in two and three dimensions The monograph is divided into five parts Chapter 1 provides the engineering motivation for this work that is offshore structures These are very complex structures used for a variety of applications It is possible to use beam models to initially study their dynamics Chapter 2 is a review of variational methods and thus includes the topics principle of virtual work D'Alembert's principle Lagrange's equation Hamilton's principle and the extended Hamilton's principle These methods are used to derive the equations of motion throughout this monograph Chapter 3 is a review of existing transverse beam models They are the Euler Bernoulli Rayleigh shear and Timoshenko models The equations of motion are derived and solved analytically using the extended Hamilton's principle as outlined in Chapter 2 For engineering purposes the natural frequencies of the beam models are presented graphically as functions of normalized wave number and geometrical and physical parameters Beam models are useful as representations of complex structures In Chapter 4 a fluid force that is representative of those that act on offshore structures is formulated The environmental load due to ocean current and random waves is obtained using Morison's equation The random waves are formulated using the Pierson Moskowitz spectrum with the Airy linear wave theory

An Introduction to Structural Optimization Peter W. Christensen, Anders Klarbring, 2009-08-29 This book has grown out of lectures and courses given at Linköping University Sweden over a period of 15 years It gives an introductory treatment of problems and methods of structural optimization The three basic classes of geometrical optimization problems of mechanical structures i.e. size shape and topology optimization are treated The focus is on concrete numerical solution methods for discrete and finite element discretized linear elastic structures The style is explicit and practical mathematical proofs are provided when arguments can be kept elementary but are otherwise only cited while implementation details are frequently provided Moreover since the text has an emphasis on geometrical design problems where the design is represented by continuously varying frequently very many variables so called first order methods are central to the treatment These methods are based on sensitivity analysis i.e. on establishing first order derivatives for objectives and constraints The classical first order methods that we emphasize are CONLIN and MMA which are based on explicit convex and separable approximations It should be remarked that the classical and frequently used so called optimality criteria method is also of this kind It may also be noted in this context that zero order methods such as response surface methods surrogate models neural networks genetic algorithms etc essentially apply to different types of problems than the ones treated here and should be presented elsewhere

Journal of the Engineering Mechanics Division American Society of Civil Engineers. Engineering Mechanics Division, 1971 Three-Dimensional Contact Problems A.M. Alexandrov, D.A. Pozharskii, 2001-11-30 A systematic treatment based on Green's functions and integral equations is given to the analytical and numerical methods and results for a great number of 3 D contact problems for elastic bodies Semi bounded elastic bodies layer cylinder space with cylindrical or spherical cavity 3 D wedge special cases of which are half and quarter spaces cone and finite elastic bodies circular plate finite cylinder spherical layer spherical lens sphere are considered Methods introduced in the book can also be applied in fracture mechanics hydrodynamics electrostatics thermodynamics and diffusion theory continuum mechanics and mathematical physics as well as by engineers and students in mathematics mechanics and physics 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 t Jost 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 **Whitaker's Books in Print** , 1998 **Structural Safety Studies** James Tsu-ping Yao, 1985 Proceedings of a Symposium on Structural Safety Studies at the ASCE Convention held in Denver Colorado May 1 2 1985 Sponsored by the Committee on Structural Safety and Reliability of the Structural Engineering Division of ASCE This collection contains 14 papers focusing on safety aspect of structures The complexities of many current projects and the increasing attention to existing infrastructures often require reevaluation of structural safety during the lifetime of a particular structure In so doing it is necessary to idealize complex natural phenomena Such idealized models require frequent updating and improvement These papers introduce relatively new concepts and methods to the structural engineering community Topics include human errors random vibration structural damage finite element methods structural optimization evaluation of structures earthquake and wind effects elastic foundations design loads risk assessment and bridge inspection *Astrodynamics 2003* , 2004 IUTAM Symposium on Discretization Methods in Structural Mechanics H.A. Mang, F.G. Rammerstorfer, 1999-03-31 Proceedings of the IUTAM

Symposium held in Vienna Austria 2 6 June 1997

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