

Shape and Thickness Optimization Performance of a Beam Structure by Sequential Quadratic Programming Method

A. Jarraya · F. Dammak · S. Abid · M. Haddar

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Abstract Successful performance of beam structures is critical to failure prevention, and beam performance can be optimized by careful consideration of beam shape and thickness. Shape and thickness optimization of beam structures having linear behaviour is treated. The first problem considered is the thickness distribution of the beam where the optimization variable is the thickness of the control points. The second problem is the shape optimization where the optimization variables are the ordinates of the control points. The optimization criterion (function objective to be minimized) is defined starting with the Von Mises criterion expressed in plane constraints. The resolution of the mechanical problem is made by the finite element method, and the optimization algorithm is the sequential quadratic programming (SQP) method.

Keywords Finite elements · Beams element · Parameterization · Optimization · Sequential quadratic programming method

Introduction

The optimization of structures with linear mechanical behaviour (small displacement) was widely treated over the last two decades. Powerful methods were developed to treat a large variety of problems. Gill [1] and various

commercial software (such as *ANSYS*, *NASTRAN*, *IDEAS*, and *SAMCEF*) contain structural optimization modules. Dimensioning problems (in particular the optimization of thickness or shape) have been treated by several investigators, for example the works of Boissarie, Glowinski [2], Fleury [3], Abid [4] and Vanderplaats and Moses [5]. The variables treated were the nodes and sections of bars. Zienkiewicz and Campbell [6], Kechoi and Duan [7], and Vinot et al. [8] generalized the concept by systematically using the finite element method. The approach described in this work is based on a discrete finite-element analysis considering the effect of membrane, bending, and transverse shear in isotropic materials. Parameterization is achieved by B-Spline of orders three and four and by the points of Bezier. A formulation of the optimization problem is made using an objective function, which considers both the mechanical constraints and the volume of the structure. The constraints are represented by the Von Mises criteria for isotropic material. For all examples treated, the selected objective function allowed the simultaneous reduction in the total state of the structural constraints and an estimate of the gradients of the objective function. The numerical technique used is based on the finite differences method. The steps followed in this article are: (1) formulation of the beam element, (2) choice of the objective function, (3) implementation of parameterization techniques, (4) resolution of the optimization problem, and finally some examples and applications.

Formulation of the Beam Element

The relations presented characterize the theory of the beams in bending by taking into account the influence of

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Shape And Thickness Optimization Performance Of A Beam

Michal Rosen-Zvi



Shape And Thickness Optimization Performance Of A Beam:

Advanced Engineering Optimization Through Intelligent Techniques Ravipudi Venkata Rao, Jan Taler, 2023-04-07

This book comprises peer reviewed papers presented at the International Conference on Advanced Engineering Optimization Through Intelligent Techniques AEOTIT 2022 The book combines contributions from academics and industry professionals and covers advanced optimization techniques across all major engineering disciplines like mechanical manufacturing civil automobile electrical chemical computer and electronics engineering The book discusses different optimization techniques and algorithms such as genetic algorithm non dominated sorting genetic algorithm II and III differential search particle swarm optimization fruit fly algorithm cuckoo search teaching learning based optimization algorithm grey wolf optimization Jaya algorithm Rao algorithms and many other latest meta heuristic techniques and their applications Various multi attribute decision making methods such as AHP TOPSIS ELECTRE PROMETHEE DEMATEL R method fuzzy logic and their applications are also discussed This book serves as a valuable reference for students researchers and practitioners and helps them in solving a wide range of optimization problems

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Advances in Machinery, Materials Science and Engineering Application IX Min Chen, Marco Giorgetti, Bo

Jin, Ramesh K. Agarwal, 2023-11-15 New engineering materials techniques and applications are constantly being researched and developed and keeping up to speed with the latest advances is crucial for engineers if they are to successfully address the challenges they face in their work This book presents the selected proceedings of MMSE2023 the 9th International Conference on Advances in Machinery Materials Science and Engineering Applications jointly organized by the SAE Supmeca France and China University of Geosciences Wuhan and held on 22 and 23 July 2023 in Wuhan China For the past 12 years this annual conference has collated recent advances and experiences identified emerging trends and provided a platform for participants from academia and industry to exchange information and views helping to address the world's machinery and engineering challenges The book contains 4 sections mechanical engineering material science and manufacturing technology electrical engineering automation and control modeling simulation and optimization techniques in engineering and advanced engineering technologies and applications A total of 241 submissions were received for MMSE2023 of which 151 papers were selected for the conference and for publication by means of a rigorous international peer review process These papers present exciting ideas and methods that will open novel research directions for different communities Offering a current overview of the latest research and applications in machinery and materials science engineering the book will be of interest to all those working in the field

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Artificial Intelligence and Online Engineering Michael E. Auer,Samir A. El-Seoud,Omar H. Karam,2022-10-14 Nowadays online technologies are the core of most fields of engineering and the whole society and are inseparable connected for example with Internet of Things Industrial Internet of Things Industry 4 0 Online Biomedical Engineering Data Science Machine Learning and Artificial Intelligence Cross Mixed Reality and Remote Working Environments to name only a few Since the first REV conference in 2004 we tried to focus on the upcoming use of the Internet for engineering tasks and the opportunities as well as challenges around it Consequently the motto of this year s REV2022 was Artificial Intelligence and Online Engineering In a globally connected world the interest in online collaboration teleworking remote services and other digital working environments is rapidly increasing In response to that the general objective of this conference is to contribute and discuss fundamentals applications and experiences in the field of Online and Remote Engineering Virtual Instrumentation and other related new technologies like Cross Reality Data Science Big Data Internet of Things Industrial Internet of Things Industry 4 0 Cyber Security and M2M Smart Objects Another objective of the conference is to discuss guidelines and new concepts for engineering education in higher and vocational education institutions including emerging technologies in learning MOOCs MOOLs and Open Resources REV2022 was the 19th in a series of annual events concerning the area of Online Engineering It has been organized in cooperation with The British University in Egypt BUE Cairo as a hybrid event from February 28 until March 02 2022 **Topics in Modal Analysis & Testing, Volume 10** Michael Mains,2016-05-26 Topics in Modal Analysis Testing Volume 10 Proceedings of the 34th IMAC A Conference and Exposition on Dynamics of Multiphysical Systems From Active Materials to Vibroacoustics 2016 the tenth volume of ten from the Conference brings together contributions to this important area of research and engineering The collection presents early findings and case studies on fundamental and applied aspects of Structural Dynamics including papers on Modal Analysis Measurements Parameter Estimation Basics of Modal Analysis Additive Manufacturing Modal Testing of Printed Parts Modal Analysis Model Updating Modal Testing Methods **58th Shock and Vibration Symposium** ,1987 **Hot Stamping Advanced Manufacturing Technology of Lightweight Car Body** Ping Hu,Liang Ying,Bin He,2016-10-14 This book summarizes the advanced manufacturing technology of original innovations in hot stamping of lightweight car body A detailed description of the technical system and basic knowledge of sheet metal forming is given which helps readers quickly understand the relevant knowledge in the field Emphasis has been placed on the independently developed hot stamping process and equipment which help describe the theoretical and experimental research on key problems involving stress field thermal field and phase transformation field in hot stamping process Also a description of the formability at elevated

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Engineers and Scientists, Third Edition Adrian A. Hopgood,2011-12-12 The third edition of this bestseller examines the principles of artificial intelligence and their application to engineering and science as well as techniques for developing intelligent systems to solve practical problems Covering the full spectrum of intelligent systems techniques it incorporates knowledge based systems computational intelligence and their hybrids Using clear and concise language *Intelligent Systems for Engineers and Scientists Third Edition* features updates and improvements throughout all chapters It includes expanded and separated chapters on genetic algorithms and single candidate optimization techniques while the chapter on neural networks now covers spiking networks and a range of recurrent networks The book also provides extended coverage of fuzzy logic including type 2 and fuzzy control systems Example programs using rules and uncertainty are presented in an industry standard format so that you can run them yourself The first part of the book describes key techniques of artificial intelligence including rule based systems Bayesian updating certainty theory fuzzy logic types 1 and 2 frames objects agents symbolic learning case based reasoning genetic algorithms optimization algorithms neural networks hybrids and the Lisp and Prolog languages The second part describes a wide range of practical applications in interpretation and diagnosis design and selection planning and control The author provides sufficient detail to help you develop your own intelligent systems for real applications Whether you are building intelligent systems or you simply want to know more about them this book provides you with detailed and up to date guidance Check out the significantly expanded set of free web based resources that support the book at <http://www.adrianhopgood.com/aitoolkit> **Advanced Techniques in Porous Structure Design for Additive**

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