

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

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

Submitted: 15 August 2006 / in revised form: 9 December 2006
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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

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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 *Recent Advances in Multidisciplinary Analysis and Optimization*, 1989 *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 **Proceedings of China SAE Congress 2019: Selected Papers** China Society of Automotive Engineers, 2020-11-04 These proceedings gather outstanding papers presented at the China SAE Congress 2019 Featuring contributions mainly from China the biggest carmaker as well as most dynamic car market in the world the book covers a wide range of automotive topics and the latest technical advances in the industry Many of the approaches included

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Paul, 2010-05-28 MEMS are rapidly moving from the research laboratory to the marketplace Many market studies indicate not only a tremendous market potential of MEMS devices year by year we see the actual market grow as the technology matures In fact these days many large silicon foundries have a MEMS group exploring this promising technology including such giants as INTEL and Motorola Yet MEMS are fundamentally different from microelectronics This means that companies with an established track record in these branches need to adapt their skills whereas companies that want to enter the miniaturization market need to establish an entirely new set of capabilities The same can be said of engineers with classical training who will also need to be educated toward their future professional activity in the MEMS field Here are some questions that a company or technologist may ask I have an existing product with miniaturization market potential Which technology should I adopt What are the manufacturing options available for miniaturization What are the qualitative differences How do we maintain market lead for products based on MEMS Is there CAD support Can we outsource manufacturing Which skills in our current capability need only adaptation What skills need to be added Professors Jan Korvink and Oliver Paul have set out to answer these questions in a form that addresses the needs of companies commercial practitioners and technologists *Recent Advances in Multidisciplinary Analysis and Optimization, Part 1*, 1989

Engineering Design Reliability Handbook Efstratios Nikolaidis, Dan M. Ghiocel, Suren Singhal, 2004-12-22 Researchers in the engineering industry and academia are making important advances on reliability based design and modeling of uncertainty when data is limited Non deterministic approaches have enabled industries to save billions by reducing design and warranty costs and by improving quality Considering the lack of comprehensive and definitive presentations on the

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Table of Contents Shape And Thickness Optimization Performance Of A Beam

1. Understanding the eBook Shape And Thickness Optimization Performance Of A Beam
 - The Rise of Digital Reading Shape And Thickness Optimization Performance Of A Beam
 - Advantages of eBooks Over Traditional Books
2. Identifying Shape And Thickness Optimization Performance Of A Beam
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Shape And Thickness Optimization Performance Of A Beam
 - User-Friendly Interface
4. Exploring eBook Recommendations from Shape And Thickness Optimization Performance Of A Beam
 - Personalized Recommendations
 - Shape And Thickness Optimization Performance Of A Beam User Reviews and Ratings
 - Shape And Thickness Optimization Performance Of A Beam and Bestseller Lists
5. Accessing Shape And Thickness Optimization Performance Of A Beam Free and Paid eBooks
 - Shape And Thickness Optimization Performance Of A Beam Public Domain eBooks
 - Shape And Thickness Optimization Performance Of A Beam eBook Subscription Services
 - Shape And Thickness Optimization Performance Of A Beam Budget-Friendly Options

6. Navigating Shape And Thickness Optimization Performance Of A Beam eBook Formats
 - ePub, PDF, MOBI, and More
 - Shape And Thickness Optimization Performance Of A Beam Compatibility with Devices
 - Shape And Thickness Optimization Performance Of A Beam Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Shape And Thickness Optimization Performance Of A Beam
 - Highlighting and Note-Taking Shape And Thickness Optimization Performance Of A Beam
 - Interactive Elements Shape And Thickness Optimization Performance Of A Beam
8. Staying Engaged with Shape And Thickness Optimization Performance Of A Beam
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Shape And Thickness Optimization Performance Of A Beam
9. Balancing eBooks and Physical Books Shape And Thickness Optimization Performance Of A Beam
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Shape And Thickness Optimization Performance Of A Beam
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Shape And Thickness Optimization Performance Of A Beam
 - Setting Reading Goals Shape And Thickness Optimization Performance Of A Beam
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Shape And Thickness Optimization Performance Of A Beam
 - Fact-Checking eBook Content of Shape And Thickness Optimization Performance Of A Beam
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements

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