

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 *SARCCEP*) 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 Boisserie, 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

A. Jarraya (✉) · F. Dammak · S. Abid · M. Haddar
Mechanics Modelling and Production Research Unit,
Mechanical Engineering Department, National School of
Engineers, BP. W. 3038 Sfax, Tunisia
e-mail: jarraya_alsdeussalem@yahoo.fr

Shape And Thickness Optimization Performance Of A Beam

Puja Mehta



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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 temperature and the numerical simulation algorithms for high strength steel hot stamping is given in combination with the experiments Finally the book presents some application cases of hot stamping technology such as the lightweight car body design using hot stamping components and gradient hardness components and the cooling design of the stamping tool This book is intended for researchers engineers and graduate students in vehicle engineering mechanical engineering especially in the field of advanced manufacturing technology The book also provides a useful reference for other new technology related temperature and phase transformation such as aluminum magnesium alloy hot stamping **Body Design and Engineering 2005** ,2005 This publication contains technical papers presented during the SAE 2005 World Congress held at Cobo Hall Detroit Michigan USA The session included two parts Part I Component Design and Part II Vehicle Design Topics covered in the papers from Part I Component Design include structural design of several subsystems such as automotive door module latch mechanism bumper beam and powered closure system design and simulation and component design concerning motorbike engine block crank case and a swing arm Topics covered under Part II Vehicle Design include development of new vehicle specifications conceptional design and analysis of structural frames for next generation vehicles and occupant protection from cargo in vehicles Proceedings of the ASME Noise Control and Acoustics Division ,1999 *AIAA Journal* American Institute of Aeronautics and Astronautics,2008 NASA Conference Publication ,1987 **Journal of Mechanical Design** ,2008-07 Proceedings of the ASME Aerospace Division American Society of Mechanical Engineers. Aerospace Division,2001 **19th AIAA Advanced Measurement and Ground Testing Technology Conference** ,1996
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 - Chapter 4: Shape And Thickness Optimization Performance Of A Beam in Specific Contexts
 - Chapter 5: Conclusion
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