Boundary Element Method For Elasticity Problems

Over the past decades, the Boundary Element Method has emerged as a ver satile and powerful tool for the solution of engineering problems, presenting in many cases an alternative to the more wide Finite Element Method. As with any numerical method, the engineer or scientist who applies it to a practical problem needs to be acquainted with, and understand, its basic principles to be able to appl correctly and be aware of its limitations. It is with this intention that we have endeavoured to write this book: to give the student or practitioner an easy-to-understand introductory course to the method s enable him or her to apply it judiciously. As the title suggests, this book not only serves as an introductory course, but also cov ers some advanced topics that we consider important for the researcher to be up-to-date with new developments. This book is the result of our teaching experiences with the Boundary Element Method, along with research and consulting activities carried out in the field. Its in a graduate course on the Boundary Element Method given by the authors at the university of Stuttgart. The experiences gained from teaching and the remarks and questions of the students have co shaping the 'Introductory course' (Chapters 1-8) to the needs of the stu dents without assuming a background in numerical methods in general or the Boundary Element Method in particular.

The boundary element method is an extremely versatile and powerful tool of computational mechanics which has already become a popular alternative to the well established finite element method. Th presents a comprehensive and up-to-date treatise on the boundary element method (BEM) in its applications to various fields of continuum mechanics such as: elastostatics, elastodynamics, thermoela micropolar elasticity, elastoplasticity, viscoelasticity, theory of plates and stress analysis by hybrid methods. The fundamental solution of governing differential equations, integral representations of the displacement and temperature fields, regularized integral representations of the stress field and heat flux, boundary integral equations and boundary integro-differential equations are derived. Besides mathematical foundations of the boundary integral method, the book deals with practical applications of this method. Most of the applications concentrate mainly on the computational problems of fract mechanics. The method has been found to be very efficient in stress-intensity factor computations. Also included are developments made by the authors in the boundary integral formulation of thermoe micropolar elasticity, viscoelasticity, plate theory, hybrid method in elasticity and solution of crack problems. The solution of boundary-value problems of thermoelasticity and micropolar thermoelasticity formulated for the first time as the solution of pure boundary problems. A new unified formulation of general crack problems is presented by integro-differential equations.

Symmetric Galerkin Boundary Element Method

Boundary Integral Equations in Elasticity Theory

Boundary Element Method for Inverse Problems in Linear Elasticity

Theory and Applications in Engineering

Boundary Element Method

Applications of the Boundary Element Method to Heat Transfer and Elasticity Problems

Past volumes of this series have concentrated on the theoretical and the more formal aspects of the boundary element method. The present book instead stresses the computational aspects of the technique and its applications with the objective of facilitating the implementation of BEM in the engineering industry and its better understanding in the teaching and research environments. The book starts by discussing the topics of convergence of solutions, application to nonlinear problems and numerical integration. This is followed by a long chapter on the computational aspects of the method, discussing the different numerical schemes and the way in which influence functions can be computed. Three separate chapters deal with important techniques which are related to classical boundary elements, namely the edge method, multigrid schemes and the complex variable boundary element approach. The last two chapters are of special interest as they present and explain in detail two FORTRAN codes which have numerous applications in engineering, i.e. a code for the solution of potential problems and another for elastostatics. Each sub routine in the programs is listed and explained. The codes follow the same format as the ones in the classical book "The Boundary Element Method for Engineers" (by C. A. Brebbia, Computational Mechanics Publications, first published in 1978) but are more advanced in terms of elements and capabilities. In particular the new listings deal with symmetry, linear elements for the two dimensional elasticity, some mixed type of boundary conditions and the treatment of infinite regions.

This study investigates the coupling of the finite and boundary element methods in elastostatics where each method is used to model a different portion of the domain. The principal interest is in applying a boundary element method (BEM) to model the infinite domain (assumed to be isotropic linear elastic) while using the finite element method (FEM) to model regions with more complex constitutive relations. The approach taken in this study, referred to as a FEM-hosted coupling, treats each BEM subdomain as a single finite element. Two derivations for an IBEM stiffness matrix are given; the first is a physically intuitive direct derivation while the second is the corresponding variational derivation. Though the emphasis is on the IBEM, the DBEM is also addressed. The inherent incompatibility between the BEM and FEM methods is discussed and explained in terms of the shape function fallacy.

Development and Use of the Boundary Element Method for the Solution of Two-dimensional Problems in Elastostatics

Computational Elasticity

An Introductory Course with Advanced Topics

My Div Grad U (x) + (lambda + My) Grad Div U (x)

New Developments and Applications of the Boundary Element Method for Some Problems in Elasticity and Viscous Flow
A Robust Boundary Element Method for Nearly Incompressible Linear Elasticity

First book on the fast multipole BEM, bringing together classical theory in BEM formulations and the fast multipole method.

"The book presents methods of approximate solution of the basic problem of elasticity for special types of solids. Engineers can apply the approximate methods (Finite Element Method, Boundary Element Method) to solve the problems but the application of the"

Computational Aspects

Application of Boundary Element Method for Some 3-D Elasticity Problems

New Developments in the Boundary Element Method for Planf and Axisymmetric Elasticity

Boundary Element Methods in Elastodynamics

Spline-Interpolation Solution of One Elasticity Theory Problem

Dante Leonelli

This book presents a systematic approach to numerical solution for a wide range of spatial contact problems of geotechnics. On the basis of the boundary element method new techniques and effective computing algorithms are considered. Special attention is given to the formulation and analysis of the spatial contact models for elastic bases. Besides the classical schemes of contact deformation, new contact models are discussed for spatially nonhomogeneous and nonlinearly elastic media properly describing soil properties.

Symmetric Galerkin Boundary Element Method presents an introduction as well as recent developments of this accurate, powerful, and versatile method. The formulation possesses the attractive feature of producing a symmetric coefficient matrix. In addition, the Galerkin approximation allows standard continuous elements to be used for evaluation of hypersingular integrals. FEATURES • Written in a form suitable for a graduate level textbook as well as a self-learning tutorial in the field. • Covers applications in two-dimensional and three-dimensional problems of potential theory and elasticity. Additional basic topics involve axisymmetry, multi-zone and interface formulations. More advanced topics include fluid flow (wave breaking over a sloping beach), non-homogeneous media, functionally graded materials (FGMs), anisotropic elasticity, error estimation, adaptivity, and fracture mechanics. • Presents integral equations as a basis for the formulation of general symmetric Galerkin boundary element methods and their corresponding numerical implementation. • Designed to convey effective unified procedures for the treatment of singular and hypersingular integrals that naturally arise in the method. Symbolic codes using Maple® for singular-type integrations are provided and discussed in detail. • The user-friendly adaptive computer code BEAN (Boundary Element ANalysis), fully written in Matlab®, is available as a companion to the text. The complete source code, including the graphical user-interface (GUI), can be downloaded from the web site http://www.ghpaulino.com/SGBEM_book. The source code can be used as the basis for building new applications, and should also function as an effective teaching tool. To facilitate the use of BEAN, a video tutorial and a library of practical examples are provided.

For Engineers and Scientists

Coupling of the Finite and Boundary Element Methods in Elastostatics

Boundary-Element Method

Theory and Programming

Stress Analysis by Boundary Element Methods

Boundary Element Methods for Engineers and Scientists

The boundary element method (BEM) is a modern numerical technique, which has enjoyed increasing popularity over the last two decades, and is now an established alternative to traditional computational methods o engineering analysis. The main advantage of the BEM is its unique ability to provide a complete solution in terms of boundary values only, with substantial savings in modelling effort. This two-volume book set is desig to provide the readers with a comprehensive and up-to-date account of the boundary element method and its application to solving engineering problems. Each volume is a self-contained book including a substantial amount of material not previously covered by other text books on the subject. Volume 1 covers applications to heat transfer, acoustics, electrochemistry and fluid mechanics problems, while volume 2 concentrates on s and structures, describing applications to elasticity, plasticity, elastodynamics, fracture mechanics and contact analysis. The early chapters are designed as a teaching text for final year undergraduate courses. Both vo reflect the experience of the authors over a period of more than twenty years of boundary element research. This volume, Applications in Solids and Structures, provides a comprehensive presentation of the BEM from fundamentals to advanced engineering applications and encompasses: Elasticity for 2D, 3D and Plates and Shells Non-linear, Transient and Thermal Stress Analysis Crack Growth and Multi-body Contact Mechanics Sensitivity Analysis and Optimisation Analysis of Assembled Structures. An important feature of this book is the in-depth presentation of BEM formulations in all the above fields, including detailed discussions of the ba theory, numerical algorithms and where possible simple examples are included, as well as test results for practical engineering applications of the method. Although most of the methods presented are the latest developments in the field, the author has included some simple techniques, which are helpful in understanding the computer implementation of BEM. Another notable feature is the comprehensive presentation of a ne generation of boundary elements known as the Dual Boundary Element Method. Written by an internationally recognised authority in the field, this is essential reading for postgraduates, researchers and practitioners i Aerospace, Mechanical and Civil Engineering and Applied Mathematics.

by the author to the English edition The book aims to present a powerful new tool of computational mechanics, complex variable boundary integral equations (CV-BIE). The book is conceived as a continuation of the classical monograph by N. I. Muskhelishvili into the computer era. Two years have passed since the Russian edition of the present book. We have seen growing interest in numerical simulation of media with internal structure, and have evidence of the potential of the new methods. The evidence was especially clear in problems relating to multiple grains, blocks, cracks, inclusions and voids. This prompted me, when preparing the English edition, to place more emphasis on such topics. The other change was inspired by Professor Graham Gladwell. It was he who urged me to abridge the chain of formulae and to increase the number of example Now the reader will find more examples showing the potential and advantages of the analysis. The first chapter of the book contains a simple exposition of the theory of real variable potentials, including the hypersingu potential and the hypersingular equations. This makes up for the absence of such exposition in current textbooks, and reveals important links between the real variable BIE and the complex variable counterparts. The chapter may also help readers who are learning or lecturing on the boundary element method.

Applications in Solids and Structures

Preconditioning of the Boundary Element Method Applied to the Lamé Equation in Elasticity
Elastic Contact Analysis by Boundary Elements
Boundary Element Methods
The Boundary Element Method, Volume 2

This book presents a new formulation of the boundary element method for two-dimensional and axisymmetric contact problems. The solution procedure includes the effects of non-frictional as well as frictional contact between elastic bodies. Following a literature survey of various experimental and analytical approaches for solving elastic contact problems, a comprehensive review of numerical techniques used for analyses of contact problems is presented. The boundary element formulations for two-, three-dimensional and axisymmetric problems in elasticity are derived and numerical implementation using constant and linear elements is described. For analysis of contact problems, boundary elements are employed to compute flexibility matrices representing the relationship between tractions and displacements only at nodes coming into contact. The contact analysis is performed using the flexibility matrices in conjunction with contact boundary conditions. In this approach, only equations corresponding to the node coming into contact are required and consequently very efficient computation is achieved. Furthermore, the boundary element analysis and the contact analysis are performed separately, which makes it easy to implement the contact analysis procedure into boundary element codes. A new contact criterion for nodes coming into contact is proposed. Load incremental and iterative schemes are used to obtain accurate solutions. Some classical Hertz and non-Hertz contact problems are studied and results are found to be in good agreement with analytical and other numerical solutions.

This thorough yet understandable introduction to the boundary element method presents an attractive alternative to the finite element method. It not only explains the theory but also presents the implementation of the theory into computer code, the code in FORTRAN 95 can be freely downloaded. The book also addresses the issue of efficiently using parallel processing hardware in order to considerably speed up the computations for large systems. The applications range from problems of heat and fluid flow to static and dynamic elasto-plastic problems in continuum mechanics.

Coupling of the Finite Element and Boundary Element Methods for the Solution of Plane Problems of Linear Elasticity
Collages
A Novel Boundary Element Method for Linear Elasticity
Fundamentals and Applications
Application of Boundary Element Method to Certain Elasticity Problems
Fast Multipole Boundary Element Method
Stress Analysis by Boundary Element MethodsElsevier
Disk includes versions of BETIS and SERBA programs and input and output files corresponding to the examples that appear in the book.
Numeric and Analytic Integration Techniques Using the Boundary Element Method for 2D Potential and 2D Linear Elasticity
Theory of Elasticity and Finite and Boundary Element Methods
Boundary Element Analysis in Computational Fracture Mechanics
Spatial Contact Problems in Geotechnics
Application of the Boundary Element Method to Finite Elasticity
A boundary element method for two dimensional linear elastic fracture analysis

Boundary Element Analysis: Theory and Programming introduces the theory behind the boundary element method and its computer applications. The author uses Cartesian tensor notation throughout the book and includes the steps involved in deriving many of the equations. The text includes computer programs in Fortran 77 for elastostatic, plate bending, and free and forced vibration problems with detailed descriptions of the code.

The Boundary Integral Equation (BIE) method has occupied me to various degrees for the past twenty-two years. The attraction of BIE analysis has been its unique combination of mathematics and practical application. The EIE method is unforgiving in its requirement for mathe matical care and its requirement for diligence in creating effective numerical algorithms. The EIE method has the ability to provide critical inSight into the mathematics that underlie one of the most powerful and useful modeling approximations ever devised--elasticity. The method has even revealed important new insights into the nature of crack tip plastic strain distributions. I believe that EIE modeling of physical problems is one of the remaining opportunities for challenging and fruitful research by those willing to apply sound mathematical discipline coupled with phys ical insight and a desire to relate the two in new ways. The monograph that follows is the summation of many of the successes of that twenty-two years, supported by the ideas and synergisms that come from working with individuals who share a common interest in engineering mathematics and their application. The focus of the monograph is on the application of EIE modeling to one of the most important of the solid mechanics disciplines--fracture mechanics. The monograph is not a trea tise on fracture mechanics, as there are many others who are far more qualified than I to expound on that topic.

Applications of the Boundary Element Method to Elasticity and Thermoelasticity Problems

Adaptive Boundary Element Methods in Elastostatics

Proceedings of the Third International Seminar, Irvine, California, July 1981

Three-dimensional Boundary Element Method in Linear Elasticity

The Combined Finite Element, Boundary Element Method in Axisymmetric Potential and Elasticity Problems

By M.E. Said Issa