



Scaled Boundary Finite Element Method

John P. Wolf



Scaled Boundary Finite Element Method:

The Scaled Boundary Finite Element Method John P. Wolf, 2003-03-14 A novel computational procedure called the scaled boundary finite element method is described which combines the advantages of the finite element and boundary element methods. Of the finite element method that no fundamental solution is required and thus expanding the scope of application for instance to anisotropic material without an increase in complexity and that singular integrals are avoided and that symmetry of the results is automatically satisfied. Of the boundary element method that the spatial dimension is reduced by one as only the boundary is discretized with surface finite elements reducing the data preparation and computational efforts that the boundary conditions at infinity are satisfied exactly and that no approximation other than that of the surface finite elements on the boundary is introduced. In addition the scaled boundary finite element method presents appealing features of its own: an analytical solution inside the domain is achieved permitting for instance accurate stress intensity factors to be determined directly and no spatial discretization of certain free and fixed boundaries and interfaces between different materials is required. In addition the scaled boundary finite element method combines the advantages of the analytical and numerical approaches. In the directions parallel to the boundary where the behaviour is in general smooth the weighted residual approximation of finite elements applies leading to convergence in the finite element sense. In the third radial direction the procedure is analytical permitting e.g. stress intensity factors to be determined directly based on their definition or the boundary conditions at infinity to be satisfied exactly. In a nutshell the scaled boundary finite element method is a semi-analytical fundamental solution-less boundary element method based on finite elements. The best of both worlds is achieved in two ways: with respect to the analytical and numerical methods and with respect to the finite element and boundary element methods within the numerical procedures. The book serves two goals. Part I is an elementary text without any prerequisites, a primer but which using a simple model problem still covers all aspects of the method and Part II presents a detailed derivation of the general case of statics, elastodynamics and diffusion.

The Scaled Boundary Finite Element Method Chongmin Song, 2018-06-19 An informative look at the theory, computer implementation and application of the scaled boundary finite element method. This reliable resource, complete with MATLAB, is an easy-to-understand introduction to the fundamental principles of the scaled boundary finite element method. It establishes the theory of the scaled boundary finite element method systematically as a general numerical procedure, providing the reader with a sound knowledge to expand the applications of this method to a broader scope. The book also presents the applications of the scaled boundary finite element to illustrate its salient features and potentials.

The Scaled Boundary Finite Element Method: Introduction to Theory and Implementation covers the static and dynamic stress analysis of solids in two and three dimensions. The relevant concepts, theory and modelling issues of the scaled boundary finite element method are discussed and the unique features of the method are highlighted. The applications in computational fracture mechanics are detailed.

with numerical examples A unified mesh generation procedure based on quadtree octree algorithm is described It also presents examples of fully automatic stress analysis of geometric models in NURBS STL and digital images Written in lucid and easy to understand language by the co inventor of the scaled boundary element method Provides MATLAB as an integral part of the book with the code cross referenced in the text and the use of the code illustrated by examples Presents new developments in the scaled boundary finite element method with illustrative examples so that readers can appreciate the significant features and potentials of this novel method especially in emerging technologies such as 3D printing virtual reality and digital image based analysis The Scaled Boundary Finite Element Method Introduction to Theory and Implementation is an ideal book for researchers software developers numerical analysts and postgraduate students in many fields of engineering and science

The Scaled Boundary Finite Element Method Chongmin Song, 2018-09-04 An informative look at the theory computer implementation and application of the scaled boundary finite element method This reliable resource complete with MATLAB is an easy to understand introduction to the fundamental principles of the scaled boundary finite element method It establishes the theory of the scaled boundary finite element method systematically as a general numerical procedure providing the reader with a sound knowledge to expand the applications of this method to a broader scope The book also presents the applications of the scaled boundary finite element to illustrate its salient features and potentials The Scaled Boundary Finite Element Method Introduction to Theory and Implementation covers the static and dynamic stress analysis of solids in two and three dimensions The relevant concepts theory and modelling issues of the scaled boundary finite element method are discussed and the unique features of the method are highlighted The applications in computational fracture mechanics are detailed with numerical examples A unified mesh generation procedure based on quadtree octree algorithm is described It also presents examples of fully automatic stress analysis of geometric models in NURBS STL and digital images Written in lucid and easy to understand language by the co inventor of the scaled boundary element method Provides MATLAB as an integral part of the book with the code cross referenced in the text and the use of the code illustrated by examples Presents new developments in the scaled boundary finite element method with illustrative examples so that readers can appreciate the significant features and potentials of this novel method especially in emerging technologies such as 3D printing virtual reality and digital image based analysis The Scaled Boundary Finite Element Method Introduction to Theory and Implementation is an ideal book for researchers software developers numerical analysts and postgraduate students in many fields of engineering and science

The Scaled Boundary Finite Element Method for Plate Bending Problems Siriporn Thongpaknum, 2016 This thesis presents an efficient and accurate semi analytical solution procedure based upon the scaled boundary finite element method SBFEM for modeling thin plates under transverse loadings and different types of boundary conditions The key formulation is established within the framework of Kirchhoff's plate bending theory A standard weighted residual technique is then applied together with the discretization along the scaled

boundary direction to derive the scaled boundary finite element equations Standard implementations including the numerical integration the determination of eigenvalues and eigenvectors a procedure for solving a system of linear ordinary differential equations and a linear solver are adopted to construct all involved unknown functions An h hierarchical adaptive procedure with the moment recovery error estimator is also integrated into the present implementation to further enhance its computational performance and reduce meshing effort A selected set of results is reported to demonstrate the accuracy and convergence of computed solutions and the computational performance of the developed technique

Development of the Scaled Boundary Finite-element Method for Applications in Geomechanics James Peter Doherty, 2004

Enhancing the Scaled Boundary Finite Element Method Thu Hang Vu, 2006

Truncated abstract The scaled boundary finite element method is a novel computational method developed by Wolf and Song which reduces partial differential equations to a set of ordinary linear differential equations The method which is semi analytical is suitable for solving linear elliptic parabolic and hyperbolic partial differential equations The method has proved to be very efficient in solving various types of problems including problems of potential flow and diffusion The method out performs the finite element method when solving unbounded domain problems and problems involving stress singularities and discontinuities The scaled boundary finite element method involves solution of a quadratic eigenproblem the computational expense of which increases rapidly as the number of degrees of freedom increases Consequently to a greater extent than the finite element method it is desirable to obtain solutions at a specified level of accuracy while using the minimum number of degrees of freedom necessary In previous work no systematic study had been performed so far into the use of elements of higher order and no consideration made of p adaptivity The primal problem is solved normally using the basic scaled boundary finite element method The dual problem is solved by the new technique using the fundamental solution A guaranteed upper error bound based on the Cauchy Schwarz inequality is derived A p goal oriented p hierarchical adaptive procedure is proposed and implemented efficiently in the scaled boundary finite element method

Acoustic-structure interaction in the Scaled Boundary Finite Element Method for prismatic geometries Paul Wasmer, Jannis Bulling, H. Gravenkamp, Jens Prager, 2019

Extending the Scaled Boundary Finite-element Method to Wave Diffraction Problems Boning Li, 2007

Truncated abstract The study reported in this thesis extends the scaled boundary finite element method to first order and second order wave diffraction problems The scaled boundary finite element method is a newly developed semi analytical technique to solve systems of partial differential equations It works by employing a special local coordinate system called scaled boundary coordinate system to define the computational field and then weakening the partial differential equation in the circumferential direction with the standard finite elements whilst keeping the equation strong in the radial direction finally analytically solving the resulting system of equations termed the scaled boundary finite element equation This unique feature of the scaled boundary finite element method enables it to combine many of advantages of the finite element method and the boundary element

method with the features of its own In this thesis both first order and second order solutions of wave diffraction problems are presented in the context of scaled boundary finite element analysis In the first order wave diffraction analysis the boundary value problems governed by the Laplace equation or by the Helmholtz equation are considered The solution methods for bounded domains and unbounded domains are described in detail The solution process is implemented and validated by practical numerical examples The numerical examples examined include well benchmarked problems such as wave reflection and transmission by a single horizontal structure and by two structures with a small gap wave radiation induced by oscillating bodies in heave sway and roll motions wave diffraction by vertical structures with circular elliptical rectangular cross sections and harbour oscillation problems The numerical results are compared with the available analytical solutions numerical solutions with other conventional numerical methods and experimental results to demonstrate the accuracy and efficiency of the scaled boundary finite element method The computed results show that the scaled boundary finite element method is able to accurately model the singularity of velocity field near sharp corners and to satisfy the radiation condition with ease It is worth noting that the scaled boundary finite element method is completely free of irregular frequency problem that the Green's function methods often suffer from For the second order wave diffraction problem this thesis develops solution schemes for both monochromatic wave and bichromatic wave cases based on the analytical expression of first order solution in the radial direction It is found that the scaled boundary finite element method can produce accurate results of second order wave loads due to its high accuracy in calculating the first order velocity field

The Coupled Dual Boundary Element-scaled Boundary Finite Element Method for Efficient Fracture Mechanics Gareth Edward Bird, 2012

Abstract A novel numerical method is presented for applications to general fracture mechanics problems in engineering The coupled dual boundary element scaled boundary finite element method DBE SBFEM incorporates the numerical accuracy of the SBFEM and the geometric versatility of the DBEM Background theory detailed derivations and literature reviews accompany the extensions made to the methods constituents necessary for their coupling as part of the present work The coupled DBE SBFEM its constituent components and their application to linear elastic fracture mechanics are critically assessed and presented with numerical examples to demonstrate both method convergence and improvements over previous work Further a proof of concept demonstrates an alternative formulation of the DBEM that both negates the need for hyper singular integration and lends itself to a wider variety of imposed boundary conditions Conclusions to this work are drawn and further recommendations for research in this area are made

Structural Integrity and Fracture A.V. Dyskin, Hu Xiaozhi, E. Sahouryeh, 2002-01-01 Topics covered in this title include the fracturing and damage of composite materials ceramics metals and concretes and rocks at different scales in both monotonic and cyclic loading

Earthquake Engineering P. Bisch, P. Labbe, A. Pecker, 1998-01-01 This text details the proceedings of the 11th European Conference on Earthquake Engineering CD ROM contains full text of the 650 papers in printed form This would have been 6 volumes of

1000 pages each Topics covered are Engineering seismology Experimental aspects for soils rocks and construction material Computational aspects for materials structures and soil structure interaction Civil engineering projects Active and passive isolation Industrial facilities lifelines and equipment Vulnerability seismic risk and strengthening Site effects and spatial variability of seismic motions Reliability analyses and probabilistic aspects Design criteria codes and standards Eurocode 8 and national applications Seismic risk in the Mediterranean basin Post earthquake investigations

Mechanics of Structures and Materials M.A. Bradford,R.Q. Bridge,S.J. Foster,1999-01-01 Structural mechanics in Australasia is the focus of the some 100 papers but among them are also contributions from North America Japan Britain Asia and southeast Asia *Mechanics of Structures and Materials XXIV* Hong Hao,Chunwei Zhang,2019-08-08 Mechanics of Structures and Materials Advancements and Challenges is a collection of peer reviewed papers presented at the 24th Australasian Conference on the Mechanics of Structures and Materials ACMSM24 Curtin University Perth Western Australia 6 9 December 2016 The contributions from academics researchers and practising engineers from Australasian Asia pacific region and around the world cover a wide range of topics including Structural mechanics Computational mechanics Reinforced and prestressed concrete structures Steel structures Composite structures Civil engineering materials Fire engineering Coastal and offshore structures Dynamic analysis of structures Structural health monitoring and damage identification Structural reliability analysis and design Structural optimization Fracture and damage mechanics Soil mechanics and foundation engineering Pavement materials and technology Shock and impact loading Earthquake loading Traffic and other man made loadings Wave and wind loading Thermal effects Design codes Mechanics of Structures and Materials Advancements and Challenges will be of interest to academics and professionals involved in Structural Engineering and Materials Science

Proceedings of International conference on Antenna Technologies ,2005 **Futures in Mechanics of Structures and Materials** Thiru Aravinthan,Warna (Karu) Karunasena,Hao Wang,2008-11-20 Futures in Mechanics of Structures and Materials is a collection of peer reviewed papers presented at the 20th Australasian Conference on the Mechanics of Structures and Materials ACMSM20 University of Southern Queensland Toowoomba Queensland Australia 2 5 December 2008 by academics researchers and practicing engineers mainly from Austral

American Environmentalism J. Michael Martinez,2013-06-20 Protecting the natural environment and promoting sustainability have become important objectives but achieving such goals presents myriad challenges for even the most committed environmentalist American Environmentalism Philosophy History and Public Policy examines whether competing interests can be reconciled while developing consistent coherent effective public policy to regulate uses and protection of the natural environment without destroying the national economy It then reviews a range of possible solutions The book delves into key normative concepts that undergird American perspectives on nature by providing an overview of philosophical concepts found in the western intellectual tradition the presuppositions inherent in neoclassical economics and anthropocentric human

centered and biocentric earth centered positions on sustainability It traces the evolution of attitudes about nature from the time of the Ancient Greeks through Europeans in the Middle Ages and the Renaissance the Enlightenment and the American Founders the nineteenth and twentieth centuries and up to the present Building on this foundation the author examines the political landscape as non governmental organizations NGOs industry leaders and government officials struggle to balance industrial development with environmental concerns Outrageous claims silly misrepresentations bogus arguments absurd contentions and overblown prophesies of impending calamities are bandied about by many parties on all sides of the debate industry spokespeople elected representatives unelected regulators concerned citizens and environmental NGOs alike In lieu of descending into this morass the author circumvents the silliness to explore the crucial issues through a more focused disciplined approach Rather than engage in acrimonious debate over minutiae as so often occurs in the context of green claims he recasts the issue in a way that provides a cohesive look at all sides This effort may be quixotic but how else to cut the Gordian knot

Wave Propagation in Infinite Domains Lutz Lehmann, 2007-05-24 This book presents theoretical fundamentals and applications of a new numerical model that has the ability to simulate wave propagation Coverage examines linear waves in ideal fluids and elastic domains In addition the book includes a numerical simulation of wave propagation based on scalar and vector wave equations as well as fluid structure interaction and soil structure interaction

Progress in Industrial and Civil Engineering III Jian Guo Liang, Xun Wu, Wei Jun Yang, Wei Zhen Chen, 2014-09-19 Selected peer reviewed papers from the 2014 3rd International Conference on Civil Architectural and Hydraulic Engineering ICCAHE 2014 July 30 31 2014 Hangzhou China Selected peer reviewed papers from the 2014 3rd International Conference on Civil Architectural and Hydraulic Engineering ICCAHE 2014 July 30 31 2014 Hangzhou China

Computational Intelligence Methods for Green Technology and Sustainable Development Yo-Ping Huang, Wen-June Wang, Hoang An Quoc, Hieu-Giang Le, Hoai-Nam Quach, 2022-12-14 This book provides readers with peer reviewed research papers presented at the 6th International Conference on Green Technology and Sustainable Development GTSD held in Nha Trang City Vietnam from July 29 to 30 2022 The book is original work of researchers from academia and industry focusing on the theme Green technology and sustainable development in Industrial Revolution 4.0 not only to raise awareness of the vital importance of sustainability in education technology and economic development but also to highlight the essential roles of technology innovation for the green future The book presents a wide range of research aspects including energy engineering electric power systems renewable energy systems automatic control engineering robotics vehicle engineering material engineering construction engineering mechanical engineering vibrations computational analysis numerical investigation system failure technological solutions in health care and so on Through thorough research basing on both experimental and numerical methods the authors feature either solutions for existing problems or optimization and improvement for performance of existing methods The collected research results could be useful alternatives and implications for industry

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