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Advances in Applied Mechanics Gruppo Italiano Frattura
BASIC Fracture Mechanics: Including an Introduction to Fatigue discusses the fundamentals of fracture and fatigue. The book presents a series of Beginner's All-purpose Symbolic Instruction Code (BASIC) programs that implement fracture and fatigue methods. The first chapter reviews the BASIC, while the second chapter covers elastic fracture. Chapter 3 deals with the stress intensity factors. The book also tackles the crack tip plasticity and covers crack growth. The last chapter in the text discusses some applications in fracture mechanics. The book will be of great use to engineers who want to get acquainted with fracture mechanics.

Extended Finite Element Method: Tsinghua University Press Computational Mechanics Series ASTM International
Papers of the June 1990 meeting held in Atlanta, Ga. The first volume (47 papers) concentrates on experimental and theoretical aspects of fracture mechanics. Volume two (26 papers) covers numerical and computational approaches. Topics include: ductile fracture, high-temperature and time-dependent fr

The Practical Use of Fracture Mechanics kassel university press GmbH
This important textbook provides an introduction to the concepts of the newly developed extended finite element method (XFEM) for fracture analysis of structures, as well as for other related engineering applications. One of the main advantages of the method is that it avoids any need for remeshing or geometric crack modelling in numerical simulation, while generating discontinuous fields along a crack and around its tip. The second major advantage of the method is that by a small increase in

number of degrees of freedom, far more accurate solutions can be obtained. The method has recently been extended to nonlinear materials and other disciplines such as modelling contact and interface, simulation of inclusions and holes, moving and changing phase problems, and even to multiscale analyses. The book is self contained, with summaries of both classical and modern computational techniques. The main chapters include a comprehensive range of numerical examples describing various features of XFEM.

Fracture Mechanics ASTM International

Modern Applied Fracture Mechanics presents a practical, accessible guide to understanding and applying basic linear elastic fracture mechanics (LEFM) techniques to problems commonly seen in industry, including fatigue analysis, failure analysis, and damage tolerance. Including applications for several software programs, AFGROW, MATLAB®, ABAQUS, and a web-based FM calculator, the book discusses appropriate models, assumptions, and typical input/output parameters. It provides a framework that will enable readers to quickly learn and use fracture mechanics (FM) software packages and/or write their own code to solve unique or standard FM problems. The book covers the fundamental concepts needed to successfully execute routine applications or conduct experimental investigations. End-of-chapter problems are included, along with real-world examples to enhance student understanding. The textbook is appropriate for undergraduate students, preparing them for the industry, and for advanced studies in fracture mechanics at the graduate level. Industry professionals and researchers will find this book a valuable resource for understanding basic fracture mechanics principles and methods. Features include: Provides broad, accessible coverage of common fracture mechanics concepts and applications. Focuses on applications, real-world examples, and numerical methods in fracture analysis. Integrates and explains current end-user software coverage for fracture mechanics. Includes numerous sample problems, software examples, and end-of-chapter problems. Includes a Solutions Manual for adopting instructors.

Extended Finite Element and Meshfree Methods John Wiley & Sons

This book presents recent advances related to the following two topics: how mechanical fields close to material or geometrical singularities such as cracks can be determined; how failure criteria can be established according to the singularity degrees related to these discontinuities. Concerning the determination of mechanical fields close to a crack tip, the first part of the book presents most of the traditional methods in order to classify them into two major categories. The first is based on the stress field, such as the Airy function, and the second resolves the problem from functions related to displacement fields. Following this, a new method based on the Hamiltonian system is presented in great detail. Local and energetic approaches to fracture are used in order to determine the fracture parameters such as stress intensity factor and energy release rate. The second part of the book describes methodologies to establish the critical fracture loads and the crack growth criteria. Singular fields for homogeneous and non-homogeneous problems near crack tips, v-notches, interfaces, etc. associated with the crack initiation and propagation laws in elastic and elastic-plastic media, allow us to determine the basis of failure criteria. Each phenomenon studied is dealt with according to its conceptual and theoretical modeling, to its use in the criteria of fracture resistance; and finally to its implementation in terms of feasibility and numerical application. Contents 1. Introduction. Part 1: Stress Field Analysis Close to the Crack Tip 2. Review of Continuum Mechanics and the Behavior Laws. 3. Overview of Fracture Mechanics. 4. Fracture Mechanics. 5. Introduction to the Finite Element Analysis of Cracked Structures. Part 2: Crack Growth Criteria 6. Crack Propagation. 7. Crack Growth Prediction in Elements of Steel Structures Submitted to Fatigue. 8. Potential Use of Crack Propagation Laws in Fatigue Life Design.

Nonlinear Mechanics for Composite Heterogeneous Structures CRC Press

This book contains two sections: Chapters 1-7 deal with contact mechanics, and Chapters 8-13 deal with fracture mechanics. The different contributions of this book will cover the various advanced topics of research. It provides some needed background with respect to contact mechanics, fracture mechanics and the use of finite element methods in both. All the covered chapters of this book are of a theoretical and applied nature, suitable for the researchers of engineering, physics, applied mathematics and mechanics with an interest in computer simulation of contact and fracture problems.

Fracture Mechanics WIT Press

PARTITION OF UNITY METHODS Master the latest tool in computational mechanics with this brand-new resource from distinguished leaders in the field While it is the number one tool for computer aided design and engineering, the finite element method (FEM) has difficulties with discontinuities, singularities, and moving boundaries. Partition of unity methods addresses these challenges and is now increasingly implemented in commercially available software. Partition of Unity Methods delivers a detailed overview of its fundamentals, in particular the extended finite element method for applications in solving moving boundary problems. The distinguished academics and authors introduce the XFEM as a natural extension of the traditional finite element method (FEM), through straightforward one-dimensional examples which form the basis for the subsequent introduction of higher dimensional problems. This book allows readers to fully understand and utilize XFEM just as it becomes ever more crucial to industry practice. Partition of Unity Methods explores all essential topics on this key new technology, including: Coverage of the difficulties faced by the finite element method and the impetus behind the development of XFEM The basics of the finite element method, with discussions of finite element formulation of linear elasticity and the calculation of the force vector An introduction to the fundamentals of enrichment A revisitation of the partition of unity enrichment A description of the geometry of enrichment features, with discussions of level sets for stationary interfaces Application of XFEM to bio-film, gradient theories, and three dimensional crack propagation Perfect for researchers and postdoctoral candidates working in the field of computational mechanics, Partition of Unity Methods also has a place in the libraries of senior undergraduate and graduate students working in the field. Finite element and CFD analysts and developers in private industry will also greatly benefit from this book.

The EXtended Finite Element Method (XFEM) with Adaptive Mesh Refinement for Fracture Mechanics John Wiley & Sons
"Extended Finite Element Method" provides an introduction to the extended finite element method (XFEM), a novel computational method which has been proposed to solve complex crack propagation problems. The book helps readers understand the method and make effective use of the XFEM code and software plugins now available to model and simulate these complex problems. The book explores the governing equation behind XFEM, including level set method and enrichment shape function. The authors outline a new XFEM algorithm based on the continuum-based shell and consider numerous practical problems, including planar discontinuities, arbitrary crack propagation in shells and dynamic response in 3D composite materials. Authored by an expert team from one of China's leading academic and research institutionsOffers complete coverage of XFEM, from fundamentals to applications, with numerous examplesProvides the understanding needed to effectively use the latest XFEM code and software tools to model and simulate dynamic crack problems
Fracture Mechanics John Wiley & Sons
The key objective of this research is to study fracture with a meshfree method, local maximum entropy approximations, and model fracture in thin shell structures with complex geometry and topology. This topic is of high relevance for real-world applications, for example in the automotive industry and in aerospace engineering. The shell structure can be described efficiently by meshless methods which are capable of describing complex shapes as a collection of points instead of a structured mesh. In order to find the appropriate numerical method to achieve this goal, the first part of the work was development of a method based on local maximum entropy (LME) shape functions together with enrichment functions used in partition of unity methods to discretize problems in linear elastic fracture mechanics. We obtain improved accuracy relative to the standard extended finite element method (XFEM) at a comparable computational cost. In addition, we keep the advantages of the LME shape functions,such as smoothness and non-negativity. We show numerically that optimal convergence (same as in FEM) for energy norm and stress intensity factors can be obtained through the use of geometric (fixed area) enrichment with no special treatment of the nodes near the crack such as blending or shifting. As extension of this method to three dimensional problems and complex thin shell structures with arbitrary crack growth is cumbersome, we developed a phase field model for fracture using LME. Phase field models provide a powerful tool to tackle moving interface problems, and have been extensively used in physics and materials science. Phase methods are gaining popularity in a wide set of applications in applied science and engineering, recently a second order phase field approximation for brittle fracture has gathered significant interest in computational fracture such that sharp cracks discontinuities are modeled by a diffusive crack. By minimizing the system energy with respect to the mechanical displacements and the phase-field, subject to an irreversibility condition to avoid crack healing, this model can describe crack nucleation, propagation, branching and merging. One of the main advantages of the phase field modeling of fractures is the unified treatment of the

interfacial tracking and mechanics, which potentially leads to simple, robust, scalable computer codes applicable to complex systems. In other words, this approximation reduces considerably the implementation complexity because the numerical tracking of the fracture is not needed, at the expense of a high computational cost. We present a fourth-order phase field model for fracture based on local maximum entropy (LME) approximations. The higher order continuity of the meshfree LME approximation allows to directly solve the fourth-order phase field equations without splitting the fourth-order differential equation into two second order differential equations. Notably, in contrast to previous discretizations that use at least a quadratic basis, only linear completeness is needed in the LME approximation. We show that the crack surface can be captured more accurately in the fourth-order model than the second-order model. Furthermore, less nodes are needed for the fourth-order model to resolve the crack path. Finally, we demonstrate the performance of the proposed meshfree fourth order phase-field formulation for 5 representative numerical examples. Computational results will be compared to analytical solutions within linear elastic fracture mechanics and experimental data for three-dimensional crack propagation. In the last part of this research, we present a phase-field model for fracture in Kirchoff-Love thin shells using the local maximum-entropy (LME) meshfree method. Since the crack is a natural outcome of the analysis it does not require an explicit representation and tracking, which is advantageous over techniques as the extended finite element method that requires tracking of the crack paths. The geometric description of the shell is based on statistical learning techniques that allow dealing with general point set surfaces avoiding a global parametrization, which can be applied to tackle surfaces of complex geometry and topology. We show the flexibility and robustness of the present methodology for two examples: plate in tension and a set of open connected pipes.

Modern Applied Fracture Mechanics Springer Science & Business Media

Advances in Applied Mechanics, Volume 53 in this ongoing series, highlights new advances in the field, with this new volume presenting interesting chapters on Phase field modelling of fracture, Advanced geometry representations and tools for microstructural and multiscale modelling, The material point method: the past and the future, From Experimental Modeling of Shotcrete to Large Scale Numerical Simulations of Tunneling, and Material point method after 25 years: theory, implementation, applications. Provides the authority and expertise of leading contributors from an international board of authors Presents the latest release in the Advances in Applied Mechanics series

High Gradient XFEM for Fracture Mechanics CRC Press

This book is aimed at those in both industry and academic institutions who require a grounding not only in the basic principles of this important field but also in the practical aspects of evaluating fracture mechanics parameters.

Linear Elastic Fracture Mechanics for Engineers: Theory and Applications CRC Press

While the regular Finite Element Method (FEM) is well developed and robust, it is not particularly well suited to model evolving discontinuities, since the construction of a discontinuous space requires the element topology to be aligned with the geometry of

the discontinuity. This in turn requires regeneration of the mesh as the discontinuity evolves, resulting in projection errors and a significant computational cost. The eXtended Finite Element Method (XFEM) is a new technique which was developed recently to account for the evolving discontinuities in the crack growth problems. In XFEM, special functions (discontinuous and near tip functions) are added to the regular FEM to model the discontinuities without regenerating the mesh. Using this property in XFEM, and assuming Linear Elastic Fracture Mechanics (LEFM) concept, the damage tolerance analysis to determine the time or the number of loading cycles required for a smaller pre-existent crack to grow to critical size can be accomplished more efficiently than that in the regular FEM. The derived XFEM-formulation has been effectively implemented and in-house computer code has been developed to find the stress intensity factors and to model the crack growth efficiently without re-meshing the structure. Numerous benchmark 2-D problems with cracks located at different locations and inclined in different angles have been investigated and the results are validated with those available in the literature. Finally, the potential application of XFEM in damage tolerance analysis has been demonstrated.
Fracture Mechanics Academic Press
Extended Finite Element and Meshfree Methods provides an overview of, and investigates, recent developments in extended finite elements with a focus on applications to material failure in statics and dynamics. This class of methods is ideally suited for applications, such as crack propagation, two-phase flow, fluid-structure-interaction, optimization and inverse analysis because they do not require any remeshing. These methods include the original extended finite element method, smoothed extended finite element method (XFEM), phantom node method, extended meshfree methods, numerical manifold method and extended isogeometric analysis. This book also addresses their implementation and provides small MATLAB codes on each sub-topic. Also discussed are the challenges and efficient algorithms for tracking the crack path which plays an important role for complex engineering applications. Explains all the important theory behind XFEM and meshfree methods Provides advice on how to implement XFEM for a range of practical purposes, along with helpful MATLAB codes Draws on the latest research to explore new topics, such as the applications of XFEM to shell formulations, and extended meshfree and extended isogeometric methods Introduces alternative modeling methods to help readers decide what is most appropriate for their work
Fracture Mechanics ASTM International
- self-contained and well illustrated - complete and comprehensive derivation of mechanical/mathematical results with enphasis on issues of practical importance - combines classical subjects of fracture mechanics with modern topics such as microheterogeneous materials, piezoelectric materials, thin films, damage - mechanically and mathematically clear and complete derivations of results
XFEM Fracture Analysis of Composites ASTM International
Nonlinear Mechanics for Composite Heterogeneous Structures applies both classical and multi-scale finite element analysis to the non-linear, failure response of composite structures. These traditional and modern computational approaches are holistically presented, providing insight into a range of non-linear structural

analysis problems. The classical methods include geometric and material non-linearity, plasticity, damage and contact mechanics. The cutting-edge formulations include cohesive zone models, the Extended Finite Element Method (XFEM), multi-scale computational homogenization, localization of damage, neural networks and data-driven techniques. This presentation is simple but efficient, enabling the reader to understand, select and apply appropriate methods through programming code or commercial finite element software. The book is suitable for undergraduate studies as a final year textbook and for MSc and PhD studies in structural, mechanical, aerospace engineering and material science, among others. Professionals in these fields will also be strongly benefited. An accompanying website provides MATLAB codes for two-dimensional finite element problems with contact, multi-scale (FE2) and non-linear XFEM analysis, data-driven and machine learning simulations.

Partition of Unity Methods Academic Press

The main scope of this Cargese NATO Advanced Study Institute (June 5-17 2000) was to bring together a number of international experts, covering a large spectrum of the various Physical Aspects of Fracture. As a matter of fact, lecturers as well as participants were coming from various scientific communities: mechanics, physics, materials science, with the common objective of progressing towards a multi-scale description of fracture. This volume includes papers on most materials of practical interest: from concrete to ceramics through metallic alloys, glasses, polymers and composite materials. The classical fields of damage and fracture mechanisms are addressed (critical and sub-critical quasi-static crack propagation, stress corrosion, fatigue, fatigue-corrosion . . . . as well as dynamic fracture). Brittle and ductile fractures are considered and a balance has been carefully kept between experiments, simulations and theoretical models, and between the contributions of the various communities. New topics in damage and fracture mechanics - the effect of disorder and statistical aspects, dynamic fracture, friction and fracture of interfaces - were also explored. This large overview on the Physical Aspects of Fracture shows that the old barriers built between the different scales will soon "fracture". It is no more unrealistic to imagine that a crack initiated through a molecular dynamics description could be propagated at the grain level thanks to dislocation dynamics included in a crystal plasticity model, itself implemented in a finite element code. Linking what happens at the atomic scale to fracture of structures as large as a dam is the new emerging challenge.

Physical Aspects of Fracture ASTM International

This book illustrates how MATLAB compact and powerful programming framework can be very useful in the finite element analysis of solids and structures. The book shortly introduces finite element concepts and an extensive list of MATLAB codes for readers to use and modify. The book areas range from very simple springs and bars to more complex beams and plates in static bending, free vibrations, buckling and time transient problems. Moreover, laminated and functionally graded material structures are introduced and solved.

Boundary Element Analysis in Computational Fracture Mechanics Sudwestdeutscher Verlag Fur Hochschulschriften AG

Extended Finite Element Method provides an introduction to the extended finite element method (XFEM), a novel computational method which has been proposed to solve complex crack propagation problems. The book helps readers understand the method and make effective use of the XFEM code and software plugins now available to model and simulate these complex problems. The book explores the governing equation behind XFEM, including level set method and enrichment shape function. The authors outline a new XFEM algorithm based on the continuum-based shell and consider numerous practical problems, including planar discontinuities, arbitrary crack propagation in shells and dynamic response in 3D composite materials.

Fracture Mechanics and Crack Growth Springer Science & Business Media

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.

Damage Tolerance Analysis Using the EXtended Finite Element Method CRC Press

The aim of this thesis is the simulation of progressive damage in brittle materials due to cracking. With this aim, the mathematical crack model will be solved using the eXtended Finite Element Method for the spatial discretization and time integration schemes for the numerical integration in the time domain. The time integration schemes considered are the Generalized-? method, the continuous GALERKIN method and the discontinuous GALERKIN method.