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Recent Advances in Fracture Mechanics

CARLSON LIZETH

Report of NRL Progress Springer
The Mechanics and Thermodynamics of Continua presents a unified treatment of continuum mechanics and thermodynamics that emphasises the universal status of the basic balances and the entropy imbalance. These laws are viewed as fundamental building blocks on which to frame theories of material behaviour. As a valuable reference source, this book presents a detailed and complete treatment of continuum mechanics and thermodynamics for graduates and advanced undergraduates in engineering, physics and mathematics. The chapters on plasticity discuss the standard isotropic theories and, in addition, crystal plasticity and gradient plasticity.
Fracture Mechanics Cambridge University Press
This unique book presents ways to mitigate the disastrous effects of snow/ice accumulation and discusses the mechanisms of new coatings deicing technologies. The strategies currently used to combat ice accumulation problems involve chemical, mechanical or electrical approaches. These are expensive and labor intensive, and the use of chemicals raises serious environmental concerns. The availability of truly icephobic surfaces or coatings will be a big boon in preventing the devastating effects of ice accumulation. Currently, there is tremendous interest in harnessing nanotechnology in rendering surfaces icephobic or in devising icephobic surface materials and coatings, and all signals indicate that such interest will continue unabated in the future. As the key issue regarding icephobic materials or coatings is their durability, much effort is being spent in developing surface materials or coatings which can be effective over a long period. With the tremendous activity in this arena, there is strong hope that in the not too distant future, durable surface materials or coatings will come to fruition. This book contains 20 chapters by subject matter experts and is divided into three parts—Part 1: Fundamentals of Ice Formation and Characterization; Part 2: Ice Adhesion and Its Measurement; and Part 3: Methods to Mitigate Ice Adhesion. The topics covered include: factors influencing the formation, adhesion and friction of ice; ice nucleation on solid surfaces; physics of ice nucleation and growth on a surface; condensation frosting; defrosting properties of structured surfaces; relationship between surface free energy and ice adhesion to surfaces; metrology of ice adhesion; test methods for quantifying ice adhesion strength to surfaces; interlaboratory studies of ice adhesion strength; mechanisms of surface icing and deicing technologies; icephobicities of superhydrophobic surfaces; anti-icing using microstructured surfaces; icephobic surfaces: features and challenges; bio-inspired anti-icing surface materials; durability of anti-icing coatings; durability of icephobic coatings; bio-inspired icephobic coatings; protection from ice accretion on aircraft; and numerical modeling and its application to inflight icing.
Ice Adhesion Cambridge University Press
This book includes materials concepts, so readers fully understand how materials behave mechanically and what options are available to the mechanical designer in terms of material selection and process. The design process is further enhanced by consistently relating the mechanics of materials to the chemistry and microstructure of modern materials.
Cellular Solids Elsevier
The papers in this volume represent a considerable cross-section of the field of fracture mechanics, a testimony to the breadth of interest that Mel and Max Williams' friends share with them. Several are expanded versions of papers that were given in special sessions honoring them at the 1997 Ninth International Conference on Fracture Mechanics in Sydney, Australia. The subjects treated in this volume can be classified as follows: dynamic fracture problems as viewed primarily from a classical continuum point of view; analysis of relatively general crack geometrics; fracture problems of polymers and other relatively ductile materials; scaling rules that allow extension of results obtained at one size to be translated into behavior at different size scales; problems dealing with interactions that produce complex stress fields; fracture problems directly appropriate to composite materials; analysis of stress concentrations in anisotropic, elastic solids; and the problem of cracks in thin plates bending. This volume will be of interest to engineers and scientists working on all aspects of the physics and mechanics of fracture.
Finite Element Modelling of Composite Materials and Structures Oxford University Press
When asked to start teaching a course on engineering fracture mechanics, I realized that a concise textbook, giving a general oversight of the field, did not exist. The explanation is undoubtedly that the subject is still in a stage of early development, and that the methodologies have still a very limited applicability. It is not possible to give rules for general application of fracture mechanics concepts. Yet our comprehension of cracking and fracture beha viour of materials and structures is steadily increasing. Further developments may be expected in the not too distant future, enabling useful prediction of fracture safety and fracture characteristics on the basis of advanced fracture mechanics procedures. The user of such advanced procedures m\lst have a general understanding of the elementary concepts, which are provided by this volume. Emphasis was placed on the practical application of fracture mechanics, but it was aimed to treat the subject in a way that may interest both metallurgists and engineers. For the latter, some general knowledge of fracture mechanisms and fracture criteria is indispensable for an apprecia tion of the limita tions of fracture mechanics. Therefore a general discussion is provided on fracture mechanisms, fracture criteria, and other metal lurgical aspects, without going into much detail. Numerous references are provided to enable a more detailed study of these subjects which are still in a stage of speculative treatment.
Fracture Mechanics Springer Science & Business Media
In 1996, the M.I.T. subject 3.11 Mechanics of Materials in the Department of Materials Science and Engineering began using an experimental new textbook approach by Roylance (Mechanics of Materials, Wiley ISBN 0-471-59399-0), written with a strongly increased emphasis on the materials aspects of the subject. It also included several topics such as finite element methods, fracture mechanics and statistics that are not included in most traditional Mechanics of Materials texts. These nontraditional aspects were designed to fit the curriculum in Materials Science and

Engineering, but do not always fit the needs of instructors in other departments and schools. One approach to increasing the flexibility and adaptability of this materials-oriented text is to make discrete and coherent portions of it available as stand-alone modules. Instructors could then pick and choose among topics, and assemble a subject offering in whatever way they choose. It would also be possible for instructors of specialty engineering subjects, for instance bridge or aircraft design, to add modules on mechanics of materials aimed at their own needs. A series of such modules are now being developed under a National Science Foundation Course, Curriculum and Laboratory Improvement (C.C.L.I.) grant aimed at strengthening the links in the engineering curriculum between materials and mechanics. The module development began July 15, 1999 and is planned for completion by June 30, 2001. The modules are pdf versions of LaTeX text files, and require an Acrobat-capable web browser for viewing or printing. The modules are numbered sequentially and ordered logically as in the Roylance text, with those still under construction indicated by trailing asterisks. Each module is intended to be capable of standing alone, so that it will usually be unnecessary to work through other modules in order to use any particular one. However, it is sometimes necessary to refer to earlier modules in order to avoid excessive repetition.

Fiabilité mécanique appliquée : Études de cas concrets MIT Press

Over the past 25 years the field of neutron diffraction for residual stress characterization has grown tremendously, and has matured from the stage of trial demonstrations to provide a practical tool with widespread applications in materials science and engineering. While the literature on the subject has grown commensurately, it has also remained

Elements of Fracture Mechanics John Wiley & Sons

Papers from the 21st National Symposium on Fracture Mechanics, held in Annapolis, Md., June 1988, present new work in elastic-plastic fracture, dynamic fracture, transition fracture in steels, micromechanical aspects of the fracture process, computational mechanics, fracture mechanics testing, and a

Dynamic Fracture Mechanics Springer Science & Business Media

Fracture Mechanics is a graduate level text/professional reference that describes the analytical methods used to derive stress and strain functions related to fracture mechanics. The focus of the book will be on modeling and problem solving as tools to be used in interpreting the meaning of a mathematical solution for a particular engineering problem or situation. Once this is accomplished, the reader should be able to think mathematically, foresee metallurgically the significance of microstructural parameters on properties, analyze the mechanical behavior of materials, and recognize realistically how dangerous a crack is in a stressed structure, which may fail catastrophically. This book differs from others in that the subject matter is organized around the modeling and predicating approaches that are used to explain the detrimental effects of crack growth events. Thus, this book will take a more practical approach and make it especially useful as a basic reference for professional engineers.

Introduction to Boundary Elements Gruppo Italiano Frattura

"Analytical Fracture Mechanics should prove to be a valuable resource to both the new student and the experienced researcher in fracture mechanics. It is recommended." — Applied Mechanics Review

One of the central concerns of engineering is the failure of materials. Addressing this concern, fracture mechanics — an interdisciplinary subject spanning mechanical, civil, and materials engineering, applied mathematics, and physics — predicts the conditions under which such failure will occur due to crack growth. This valuable self-contained text by an expert in the field supplements standard fracture mechanics texts by focusing on analytical methods for determining crack-tip stress and strain fields. Following a comprehensive 120-page introduction — which provides all the background necessary for understanding the remaining chapters — the book is organized around a series of elastoplastic and hydrogen-assisted crack-tip problems and their solutions. The first chapter presents the only proven solution technique for the second order nonlinear partial differential equation governing a mode I elastoplastic crack problem. Other chapters deal with plastic zone transitions, environmental cracking, and small-scale yielding versus exact linear elastic solutions. One of the excellent features of this book is the clarity with which groups of problems are presented and related to each other. Another is the careful attention it gives to the various modes of fracture (I, II, and III) and to showing the circumstances under which information from a solution for one mode may be used to infer information in another mode. For this edition, the author has added a new appendix, "Stress Across an Elastoplastic Boundary of a Mode I Crack: Parabolic to Hyperbolic Plasticity Transition."

Introduction to the Characterization of Residual Stress by Neutron Diffraction Oxford University Press

Introduction to Mechanics of Solid Materials is concerned with the deformation, flow, and fracture of solid materials. This textbook offers a unified presentation of the major concepts in Solid Mechanics for junior/senior-level undergraduate students in the many branches of engineering - mechanical, materials, civil, and aeronautical engineering among others. The book begins by covering the basics of kinematics and strain, and stress and equilibrium, followed by a coverage of the small deformation theories for different types of material response: (i) Elasticity; (ii) Plasticity and Creep; (iii) Fracture and Fatigue; and (iv) Viscoelasticity. The book has additional chapters covering the important material classes of: (v) Rubber Elasticity, and (vi) Continuous-fiber laminated composites. The text includes numerous examples to aid the student. A substantial companion volume with example problems is available free of charge on the book's companion website.

Fatigue Design of Marine Structures William Andrew

to Boundary Elements Theory and Applications With 194 Figures Springer-Verlag Berlin Heidelberg New York London Paris Tokyo Hong Kong Dr.-Ing. Friedel Hartmann University of Dortmund Department of Civil Engineering 4600 Dortmund 50 FRG ISBN-13: 978-3-642-48875-7 e-ISBN-13: 978-3-642-48873-3 001: 10.1007/978-3-642-48873-3 Library of Congress Cataloging-in-Publication Data Hartmann, F. (Friedel) Introduction to boundary elements: theory and applications/Friedel Hartmann. ISBN-13: 978-3-642-48875-7 1. Boundary value problems. I. Title. TA347.B69H371989 515.3'5--dc19 89-4160 This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in other ways, and storage in data banks. Duplication of this publication or parts thereof is only permitted under the provision of the German Copyright Law of September 9,1965, in its version of June 24,1985, and a copyright fee must always be paid. Violations fall under the prosecution act of the German Copyright Law. ©

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Thermoforming of Single and Multilayer Laminates ASTM International

This second book of a 3-volume set on Fracture Mechanics completes the first volume through the analysis of adjustment tests suited to correctly validating the justified use of the laws conforming to the behavior of the materials and structures under study. This volume focuses on the vast range of statistical distributions encountered in reliability. Its aim is to run statistical measurements, to present a report on enhanced measures in mechanical reliability and to evaluate the reliability of repairable or unrepairable systems. To achieve this, the author presents a theoretical and practice-based approach on the following themes: criteria of failures; Bayesian applied probability; Markov chains; Monte Carlo simulation as well as many other solved case studies. This book distinguishes itself from other works in the field through its originality in presenting an educational approach which aims at helping practitioners both in academia and industry. It is intended for technicians, engineers, designers, students, and teachers working in the fields of engineering and vocational education. The main objective of the author is to provide an assessment of indicators of quality and reliability to aid in decision-making. To this end, an intuitive and practical approach, based on mathematical rigor, is recommended.

Rock Fracture Mechanics Courier Corporation

Thermoforming of Single and Multilayer Laminates explains the fundamentals of lamination and plastics thermoforming technologies along with current and new developments. It focuses on properties and thermoforming mechanics of plastic films and in particular single and multilayered laminates, including barrier films. For environmental and economic reasons, laminates are becoming increasingly important as a replacement for solid sheets and paint finishes in many industries, including transportation, packaging, and construction. Yet the processes of film formability during the extensive deformation and elevated temperatures experienced in conventional processing technologies, such as thermoforming, are poorly understood by most engineers. This book covers production processes, such as extrusion, calendaring, and casting, as well as mechanical and impact testing methods. It also describes how testing protocols developed for metals can be leveraged for plastic films and laminates, and includes a thorough discussion on methods for performing optical strain analysis. Applications in transportation vehicles and packaging, including packaging for food, medical and electronics applications, sports equipment, and household appliances, are discussed. Safety, recycling and environmental aspects of thermoforming and its products complete the book. First comprehensive source of information and hands-on guide for the thermoforming of multilayered laminates Covers applications across such sectors as automotive, packaging, home goods, and construction Introduces new testing methods leveraging protocols used for metals

Introduction to the Mechanics of Composite Materials CRC Press

The public debate over civilian use of drones is intensifying. Variously called "unmanned aircraft systems", "unmanned aerial vehicles", "remotely piloted aircraft", or simply "drones", they are available for purchase by anyone for a few hundred to a few thousand dollars. They have strikingly useful capabilities. They can carry high-definition video cameras, infrared imaging equipment, sensors for aerial surveying and mapping. They can stream their video in real time. They have GPS, inertial guidance, magnetic compasses, altimeters, and sonic ground sensors that permit them to fly a preprogrammed flightplan, take off and land autonomously, hover and orbit autonomously with the flick of a switch on the DRone Operator’s ("DROPs") console. The benefits they can confer on law enforcement, journalism, land-use planning, real estate sales, critical infrastructure protection and environmental preservation activities are obvious. However, their proliferation in response to these demands will present substantial risks to aviation safety. How to ensure the safety of drone operations perplexes aviation regulators around the world. They are inexpensive consumer products, unsuited for traditional requirements for manned aircraft costing hundreds of thousands or millions of dollars and flown only by licensed pilots who have dedicated significant parts of their lives and their wealth to obtaining licenses. Regulatory agencies in Europe and Asia are ahead of US regulators in creating spaces for commercial use. Over the next several years, legal requirements must be crystallized, existing operators of helicopter and airplanes must refine their policy positions and their business plans to take the new technologies into account, and all businesses from the smallest entrepreneur to large conglomerates must decide whether and how to use them. Domesticating Drones offers rigorous engineering, economics, legal and policy theory and doctrine on this important and far-reaching development within aviation.

Domesticating Drones CRC Press

Continuum Mechanics of Solids is an introductory text for graduate students in the many branches of engineering, covering the basics of kinematics, equilibrium, and material response. As an introductory book, most of the emphasis is upon the kinematically linear theories of elasticity, plasticity, and viscoelasticity, with two additional chapters devoted to topics in finite elasticity. Further chapters cover topics in fracture and fatigue and coupled field problems, such as thermoelasticity, chemoelasticity, poroelasticity, and piezoelectricity. There is ample material for a two semester course, or by selecting only topics of interest for a one-semester offering. The text includes numerous examples to aid the student. A companion text with over 180 fully worked problems is also available.

Fundamentals of Fracture Mechanics Springer Science & Business Media

In this new edition of their classic work on Cellular Solids, the authors have brought the book completely up to date, including new work on processing of metallic and ceramic foams and on the mechanical, electrical and acoustic properties of cellular solids. Data for commercially available foams are presented on material property charts; two new case studies show how the charts are used for selection of foams in engineering design. Over 150 references appearing in the literature since the publication of the first edition are cited. The text summarises current understanding of the structure and mechanical behaviour of cellular materials, and the ways in which they can be exploited in engineering design. Cellular solids include engineering honeycombs and foams (which can now be made from polymers, metals, ceramics and composites) as well as natural materials, such as wood, cork and cancellous bone.

Introduction to Fracture Mechanics Linköping University Electronic Press

This Licentiate of Engineering thesis is a product of the results generated in the research project

KME-702, which comprises modelling, microstructure investigations and material testing of cast nickel-base superalloys. The main objective of this work is to model the fatigue crack propagation behaviour in single-crystal nickel-base superalloys. To achieve this, the influence of the crystal orientations on the cracking behaviour is assessed. The results show that the crystal orientation is strongly affecting the material response and must be accounted for. Furthermore, a linear elastic crack driving force parameter suitable for describing crystallographic cracking has been developed. This parameter is based on resolved anisotropic stress intensity factors and is able to predict the correct crystallographic cracking plane after a transition from a Mode I crack. Finally, a method to account for inelastic deformations in a linear elastic fracture mechanics context was investigated. A residual stress field is extracted from an uncracked finite-element model with a perfectly plastic material model and superimposed on the stress field from the cracked model with a linear elastic material model to account for the inelastic deformations during the determination of the crack driving force. The modelling work is validated by material testing on two different specimen geometries at different temperatures. This Licentiate of Engineering thesis consists of two parts, where Part I gives an introduction and background to the research area, while Part II consists of three papers. Denna licentiatavhandling är en produkt av resultat som genererats i forskningsprojektet KME-702, och omfattar modellering, mikrostrukturundersökningar och materialprovning av gjutna nickelbaserade superlegeringar. Huvudsyftet med detta arbete är att modellera sprickförloppet under utmattning i enkristallina nickelbaserade superlegeringar. För att uppnå detta har kristallorienteringens inverkan på sprickbeteendet utvärderats. Resultaten visar att kristallorienteringen har en stark inverkan på materialbeteendet, således måste hänsyn till denna tas. Dessutom har en linjär-elastisk sprickdrivkraftsparameter lämplig att beskriva kristallografisk sprickbildning utvecklats. Denna parameter är baserad på anisotropa spänningsintensitetsfaktorer på kristallplan och kan prediktera det korrekta kristallografiska sprickplanet efter övergång från Modus I spricka. Slutligen har undersökts en metod för att ta hand om inelastiska deformationer i en linjär-elastisk brottmekanikskontext. Ett restspänningsfält extraherades från en osprucken finita element modell med en ideal plastisk materialmodell. Denna överlagrades på spänningsfältet från den spruckna modellen, som analyserades med en linjär-elastisk materialmodell, för att ta hänsyn till de inelastiska deformationerna vid bestämning av sprickdrivkraften. Modelleringsarbetet validerades genom materialprovning på två olika provgeometrier vid olika temperaturer. Licentiatavhandlingen består av två delar, där del I ger en introduktion och bakgrund till forskningsområdet medan del II består av tre papper. Dieses Lizentiat der Ingenieurwissenschaften ist im Rahmen des Forschungsprojekts KME-702 entstanden, welches Modellierung, Mikrostrukturuntersuchungen und Materialtests von gegossenen nickelbasierten Superlegierungen umfasst. Das Hauptziel dieser Arbeit ist die Modellierung der Ermüdungsrissausbreitung in einkristallinen nickelbasierten Superlegierungen. Um dieses zu erreichen, wurde der Einfluss der Kristallorientierungen auf das Rissverhalten untersucht. Die Ergebnisse zeigen, dass die Kristallorientierung das Materialverhalten stark beeinflusst und daher berücksichtigt werden muss. Darüber hinaus wurde ein linear elastischer Rissantriebskraftparameter entwickelt, der zum Beschreiben von kristallographischen Rissen geeignet ist. Dieser Parameter basiert auf aufgelösten anisotropen Spannungsintensitätsfaktoren und ist in der Lage, die korrekte kristallographische Rissebene nach einem Übergang von einem Modus I Riss vorherzusagen. Abschließend wird in einem linear-elastisch bruchmechanischen Kontext eine Methode untersucht, die nichtelastischen Deformationen bei der Bestimmung der Rissantriebskraft zu berücksichtigen. Dazu wird aus einem Finite-Elemente Modell, welches keinen Riss aufweist und mit einem perfekt plastischen Materialmodell beschrieben wird, das Restspannungsfeld extrahiert und dem Spannungsfeld überlagert, welches aus dem Modell mit Riss unter Verwendung eines linear elastischen Materialmodells erzeugt wurde. Die Modellierung wird durch Materialtests an zwei verschiedenen Probengeometrien bei unterschiedlichen Temperaturen validiert. Dieses Lizentiat der Ingenieurwissenschaften besteht aus zwei Teilen, wobei Teil I eine Einführung und einen Hintergrund in das Forschungsgebiet gibt, während Teil II aus drei Forschungsartikeln besteht.

Introduction to Mechanics of Solid Materials Springer

La fiabilité anticipe et prévoit le futur en vue d'améliorer les performances et le niveau de sûreté par l'optimisation des stratégies d'exploitation. Elle a fait preuve d'une évolution notable au niveau des matériaux et des structures. Largement inspiré des modèles de la mécanique de rupture, cet ouvrage présente les cas les plus significatifs dont l'encadrement de la probabilité de rupture par les bornes simples, la méthode Bayésienne appliquée, les chaînes de Markov, les indices de fiabilité de Cornell et de Hasofer-Lind ou l'intégrale indicatrice du dommage et de la simulation de Monte Carlo. Ce volume insiste sur le calcul des incertitudes au sens de la méthode GUM (Guide to the expression of Uncertainty in Measurement) en respectant le vocabulaire international de métrologie. Destiné aux universitaires et aux professionnels, Fiabilité mécanique appliquée se caractérise par son approche pédagogique des méthodes statistiques, structurées autour de cas concrets et illustrées d'applications corrigées et commentées. Ce volume apportera une aide précieuse aux concepteurs et aux décideurs.

Applications of Differential Equations in Engineering and Mechanics Springer

Mixing scientific, historic and socio-economic vision, this unique book complements two previously published volumes on the history of continuum mechanics from this distinguished author. In this volume, Gérard A. Maugin looks at the period from the renaissance to the twentieth century and he includes an appraisal of the ever enduring competition between molecular and continuum modelling views. Chapters trace early works in hydraulics and fluid mechanics not covered in the other volumes and the author investigates experimental approaches, essentially before the introduction of a true concept of stress tensor. The treatment of such topics as the viscoelasticity of solids and plasticity, fracture theory, and the role of geometry as a cornerstone of the field, are all explored. Readers will find a kind of socio-historical appraisal of the seminal contributions by our direct masters in the second half of the twentieth century. The analysis of the teaching and research texts by Duhem, Poincaré and Hilbert on continuum mechanics is key: these provide the most valuable documentary basis on which a revival of continuum mechanics and its formalization were offered in the late twentieth century. Altogether, the three volumes offer a generous conspectus of the developments of continuum mechanics between the sixteenth century and the dawn of the twenty-first century. Mechanical engineers, applied mathematicians and physicists alike will all be interested in this work which appeals to all curious scientists for whom continuum mechanics as a vividly evolving science still has its own mysteries.