A New Fatigue Analysis Procedure For Composite Wind

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Fatigue Testing and Analysis Springer Science & Business Media
Understand why fatigue happens and how to model, simulate, design and test for it with this practical, industry-focused reference Written to bridge the technology gap between academia and industry, the Metal Fatigue Analysis Handbook presents state-of-the-art fatigue theories and technologies alongside more commonly used practices, with working examples included to provide an informative, practical, complete toolkit of fatigue analysis. Prepared by an expert team with extensive industrial, research and professorial experience, the book will help you to understand: Critical factors that cause and affect fatigue in the materials and structures relating to your work Load and stress analysis in addition to fatigue damage-the latter being the sole focus of many books on the topic How to design with fatigue in mind to meet durability requirements How to model, simulate and test with different materials in different fatigue scenarios The importance and limitations of different models for cost effective and efficient testing Whilst the book focuses on theories commonly used in the automotive industry, it is also an ideal resource for engineers and analysts in other disciplines such as aerospace engineering, civil engineering, offshore engineering, and industrial engineering. The only book on the market to address state-of-the-art technologies in load, stress and fatigue damage analyses and their application to engineering design for durability Intended to bridge the technology gap between academia and industry - written by an expert team with extensive industrial, research and professorial experience in fatigue analysis and testing An advanced mechanical engineering design handbook focused on the needs of professional engineers within automotive, aerospace and related industrial disciplines
Cyclic Deformation and Fatigue of Metals Editora Dialética
This book is devoted to the high-cycle fatigue behaviour of metal components, thus covering essential needs of current industrial design. The new developments included in the book rely on the use of the mesoscopic scale approach in metal fatigue and allow the specific handling of such difficult fatigue problems as multiaxial, non-proportional loading conditions.
Fatigue Design of Marine Structures Springer Science & Business Media
This monograph examines the theoretical foundations of the spectral method for fatigue life determination. The authors discuss a rule of description of random loading states with the matrix of power spectral density functions of the stress/strain tensor components. Some chosen criteria of multiaxial fatigue failure are analyzed. The formula proposed in this book enables readers to determine power spectral density of the equivalent history directly from the components of the power spectral density matrix of the multidimensional stochastic process.
Modern Metal Fatigue Analysis Woodhead Publishing
This book provides practicing engineers, researchers, and students with a working knowledge of the fatigue design process and models under multiaxial states of stress and strain. Readers are introduced to the important considerations of multiaxial fatigue that differentiate it from uniaxial fatigue.
Non-Gaussian Random Vibration Fatigue Analysis and Accelerated Test Elsevier
Applied Optimal Design Mechanical and Structural Systems Edward J. Haug & Jasbir S. Arora This computer-aided design text presents and illustrates techniques for optimizing the design of a wide variety of mechanical and structural systems through the use of nonlinear programming and optimal control theory. A state space method is adopted that incorporates the system model as an integral part of the design formulations. Step-by-step numerical algorithms are given for each method of optimal design. Basic properties of the equations of mechanics are used to carry out design sensitivity analysis and optimization, with numerical efficiency and generality that is in most cases an order of magnitude faster in digital computation than applications using standard nonlinear programming methods. 1979 Optimum Design of Mechanical Elements, 2nd Ed. Ray C. Johnson The two basic optimization techniques, the method of optimal design (MOD) and automated optimal design (AOD), discussed in this valuable work can be applied to the optimal design of mechanical elements commonly found in machinery, mechanisms, mechanical assemblages, products, and structures. The many illustrative examples used to explicate these techniques include such topics as tensile bars, torsion bars, shafts in combined loading, helical and spur gears, helical springs, and hydrostatic journal bearings. The author covers curve fitting, equation simplification, material properties, and failure theories, as well as the effects of manufacturing errors on product performance and the need for a factor of safety in design work. 1980 Globally Optimal Design Douglass J. Wilde Here are new analytic optimization procedures effective where numerical methods either take too long or do not provide correct answers. This book uses mathematics sparingly, proving only results generated by examples. It defines simple design methods guaranteed to give the global, rather than any local, optimum through computations easy enough to be done on a manual calculator. The author confronts realistic situations: determining critical constraints; dealing with negative contributions; handling power function; tackling logarithmic and exponential nonlinearities; coping with standard sizes and indivisible components; and resolving conflicting objectives and logical restrictions. Special mathematical structures are exposed and used to solve design problems. 1978
Statistical Analysis of Fatigue Data ASTM International
The analysis of the fatigue behavior of metallic materials and components under variable amplitude multiaxial cyclic loading conditions is of great interest to many industries. These loading conditions represent the loading histories to which many parts are subjected throughout their service lives. This type of analysis requires some key steps. These key steps include understanding the deformation behavior of the material including the cyclic behavior under proportional and non-proportional loading conditions, modeling the fatigue behavior of the material under constant amplitude cyclic loading, cycle counting procedures, damage parameters which can represent the damage mechanisms of the material under multiaxial loading conditions, and damage accumulation methods. In this study a methodology for the analysis of fatigue behavior under multiaxial variable amplitude loading conditions is employed which accounts for the aforementioned issues. This methodology consists of several steps of analysis, each of which is developed to address some of the challenges. At its core, the applied methodology uses critical plane analysis based on the failure behavior of each material to assess the fatigue damage under cyclic loading conditions. In order to evaluate the performance of the analysis method, axial, torsional, and combined axial-torsional variable amplitude tests were performed on one ductile and one brittle behaving steel and the experimental results were compared with those estimated from the analysis. The applied methodology resulted in close estimation of fatigue life for both ductile and brittle behaving steels. Furthermore, interactions between different components of stress such as normal and shear stresses play an important role in multiaxial fatigue damage. The main aim of this study was to investigate this interactions effect on fatigue behavior of shear failure mode materials under multiaxial loading conditions. In order to model the influence of normal stress on fatigue damage, the present study introduces a method based on the idea that the normal stress acting on the critical plane orientation causes two types of influence, first by affecting roughness induced closure, and second, by a fluctuating normal stress affecting the growth of small cracks in mode II. The summation of these terms could then be used in shear-based critical plane damage models, for example FS damage model, which use normal stress as a secondary input. In order to investigate the effect of the modification, constant amplitude load paths with different levels of interaction between the normal and shear stresses, as well as variable amplitude tests with histories both taken from service loading conditions, and generated using random numbers were designed for an experimental program. The proposed modification was observed to result in improved fatigue life estimations where significant interactions between normal and shear stresses exist. In addition, since shear fatigue properties are key properties in the analysis of fatigue behavior of ductile metallic materials, this study evaluated the accuracy of different methods in estimating shear fatigue behavior of steels and titanium alloys from properties which are easier to obtain such as monotonic properties and hardness. In order to achieve this goal, test results of 23 types of carbon steel, Inconel 718, and three types of titanium alloys commonly used in industry were found in the literature. In addition, two types of steel and a Ti-6Al-4V titanium alloy were subjected to axial monotonic and fatigue tests as well as torsion fatigue tests. The results of these tests were used along with the data from literature. A reasonable correlation between uniaxial fatigue properties and shear fatigue properties of ductile and brittle behaving materials were found using von Mises and maximum principal strain criteria, respectively. Estimations from the experimentally obtained uniaxial fatigue properties were compared to those from uniaxial fatigue properties which were calculated from the Roessle-Fatemi hardness estimation method. It was observed from the comparison that for steels and Inconel 718 obtaining shear fatigue properties from uniaxial fatigue properties, which were in turn calculated from Roessle-Fatemi hardness estimation method, resulted in reasonable estimations. The performance of shear fatigue properties estimated from the Roessle-Fatemi hardness method was also used for the analysis of variable amplitude axial-torsion fatigue tests performed on three types of ductile steel. Reasonable predictions of fatigue life were observed for the analyzed variable amplitude tests, as most of the predictions fell within a factor of 3 of the experimental data. Furthermore, in order to use the Roessle-Fatemi hardness method for estimating the shear fatigue behavior of titanium alloys, this method was modified based on the uniaxial fatigue properties of titanium alloys.
Fatigue of Fiber-reinforced Composites Pergamon
Fatigue Testing and Analysis of Results discusses fundamental concepts of fatigue testing and results analysis. The book begins with a description of the symbols and nomenclature selected for the present book, mainly those proposed by the ASTM Committee E-9 on Fatigue. Fatigue testing methods are then discussed including routine tests, short-life and long-life tests, cumulative-damage tests, and abbreviated and accelerated tests. Separate chapters cover fatigue testing machines and equipment; instruments and measuring devices; and test pieces used in fatigue testing. The factors affecting tes.
Stress Determination for Fatigue Analysis of Welded Components Springer
Fatigue Testing and Analysis: Theory and Practice presents the latest, proven techniques for fatigue data acquisition, data analysis, and test planning and practice. More specifically, it covers the most comprehensive methods to capture the component load, to characterize the scatter of product fatigue resistance and loading, to perform the fatigue damage assessment of a product, and to develop an accelerated life test plan for reliability target demonstration. This book is most useful for test and design engineers in the ground vehicle industry. Fatigue Testing and Analysis introduces the methods to account for variability of loads and statistical fatigue properties that are useful for further probabilistic fatigue analysis. The text incorporates and demonstrates approaches that account for randomness of loading and materials, and covers the applications and demonstrations of both linear and double-linear damage rules. The reader will benefit from summaries of load transducer designs and data acquisition techniques, applications of both linear and non-linear damage rules and methods, and techniques to determine the statistical fatigue properties for the nominal stress-life and the local strain-life methods. Covers the useful techniques for component load measurement and data acquisition, fatigue properties determination, fatigue analysis, and accelerated life test criteria development, and, most importantly, test plans for reliability demonstrations Written from a practical point of view, based on the authors' industrial and academic experience in automotive engineering design Extensive practical examples are used to illustrate the main concepts in all chapters

Fatigue Design Elsevier
It is often difficult to become familiar with the field of metal fatigue analysis. Among other reasons, statistics being an important one. Therefore this book focuses on the basics of statistics for metal fatigue analysis. It is written for engineers in the fields of simulation, testing and design who look for a quick introduction to the statistics of metal fatigue. This book enables you - to understand and apply the statistics for metal fatigue in engeneering - to evaluate metal fatigue test data (S-N curves and endurance limits) statistically using probability net and regression - to evaluate endurance limits with the stair case method or the probit method - to calculate safety factors for your components - to assess the impact of small sample sizes - to find and evaluate outliers statistically and - to compare samples with statistic tests like the t-Test. In order to ensure a quick understanding, this book focuses on the most important methods and is limited to the downright necessary mathematics. In addition, you will find helpful tips and experiences for a significant improvement of our learning efficiency. For a comprehensible arrangement of the content many illustrations are utilized, which represents the text. In addition to it, a simple, clear language is consciously used. In order to consolidate the understanding, the theory is also supplemented by extensive job relevant exercises. For easy application of the methods of metal fatigue in engeneering you will find useful Excel tools for your own analysis. These cover the basics of the important methods of this book and can be downloaded for free.
Vibration Fatigue by Spectral Methods ASTM International
It is commonly assumed in analysing fatigue data that there is a definite functional relationship between life in number of cycles and stress level. However, as has been pointed out several times (1, 2), an examination of the data shows considerable scatter. Even with carefully prepared smooth specimens, all from the same heat of steel, treated in the same manner and tested in the same laboratory, a range of 2 to 1 in number of cycles for failure at the same stress level is normal (1) and a range of 10 to 1 is not unusual (2). If the specimens are tested by different laboratories, slightly varying techniques will introduce further scatter (3).
Fatigue and Fracture Mechanics John Wiley & Sons
Fatigue of structures and materials covers a wide scope of different topics. The purpose of the present book is to explain these topics, to indicate how they can be analyzed, and how this can contribute to the designing of fatigue resistant structures and to prevent structural fatigue problems in service. Chapter 1 gives a general survey of the topic with brief comments on the signi?cance of the aspects involved. This serves as a kind of a program for the following chapters. The central issues in this book are predictions of fatigue properties and designing against fatigue. These objectives cannot be realized without a physical and mechanical understanding of all relevant conditions. In Chapter 2 the book starts with basic concepts of what happens in the material of a structure under cyclic loads. It illustrates the large number of variables which can affect fatigue properties and it provides the essential background knowledge for subsequent chapters. Different subjects are presented in the following main parts: • Basic chapters on fatigue properties and predictions (Chapters 2–8) • Load spectra and fatigue under variable-amplitude loading (Chapters 9–11) • Fatigue tests and scatter (Chapters 12 and 13) • Special fatigue conditions (Chapters 14–17) • Fatigue of joints and structures (Chapters 18–20) • Fiber-metal laminates (Chapter 21) Each chapter presents a discussion of a speci?c subject.
Fatigue Design Springer Science & Business Media
Fatigue Design Procedures presents the full text of the papers presented at the 4th Symposium of the International Committee on Aeronautical Fatigue held in Munich, Germany on June 16-18, 1965, and summaries of the discussion held about them. The papers featured in the volume covers different aspects of fatigue design. These include fail-safe design for a jet transport airplane, the weapon systems fatigue certification program of the U.S. Air Force, the role of variable amplitude or constant amplitude tests in design studies, the evaluation of allowable design stress and corresponding fatigue life, and the importance of fatigue design testing. This book will be of interest to persons dealing with studies on fatigue design methods.
Fundamentals of Metal Fatigue Analysis Elsevier
Vibration Fatigue by Spectral Methods relates the structural dynamics theory to the high-cycle vibration fatigue. The book begins with structural dynamics theory and relates the uniaxial and multiaxial vibration fatigue to the underlying structural dynamics and signal processing theory. Organized in two parts, part I gives the theoretical background and part II the selected experimental research. The time- and frequency- domain aspects of signal processing in general, related to structural dynamics and counting methods are covered in detail. It also covers all the underlying theory in structural dynamics, signal processing, uniaxial & multiaxial fatigue; including non-Gaussianity and non-stationarity. Finally, it provides the latest research on multiaxial vibration fatigue and the non-stationarity and non-Gaussianity effects. This book is for engineers, graduate students, researchers and industry professionals working in the field of structural durability under random loading and vibrations and also those dealing with fatigue of materials and constructions. Introduces generalized structural dynamics theory of multiaxial vibration fatigue Maximizes understanding of structural dynamics theory in relation to frequency domain fatigue Illustrates connections between experimental work and theory with case studies, cross-referencing, and parallels to accelerated vibration testing
Spectral method for fatigue damage estimation with non-zero mean stress Springer Science & Business Media
Abstract: This dissertation presents a new finite element procedure for fatigue life prediction and high strain rate assessment of cold worked Advanced High Strength Steel (AHSS). The first part of this research is related to the development of a new finite element procedure from an energy-based fatigue life prediction framework previously developed for prediction of axial, bending and multi-axial fatigue life. The framework for the prediction of fatigue life via energy analysis consists of constitutive laws which correlate the cyclic energy to the amount of energy required to fracture a material. In this study, the energy expressions that construct the new constitutive laws are integrated into a minimum potential energy formulation to develop new finite elements for fatigue life prediction for structural components subjected to axial, bending and multi-axial cyclic loads. The comparison of finite element method (FEM) results to the existing experimental fatigue data verifies the new finite element method for fatigue life prediction. The final output of this finite element analysis is in the form of number of cycles to failure for each element. The performance of the fatigue finite element is demonstrated by the fatigue life predictions from Al 6061-T6 and Ti-6Al-4V. In addition to developing new fatigue finite elements, a new equivalent stress expression and a new finite element procedure for multiaxail fatigue life prediction are also proposed. The new procedure is applicable to biaxial as well as multiaxial fatigue applications. The second part of this research is related to the development of LSDYNA material model for vehicle crash simulation based on high strain rate assessment of cold worked AHSS. In order to simulate actual crash using software like LSDYNA, it is desirable to have accurate stress/strain data for materials. The material models available in the literature ignore the effect of cold working on the material and present data only for flat sheets. In this research, the cold worked AHSS with curved cross-section is tested at strain rates of 1000 (in/in)/s and the data is used to develop a corresponding LSDYNA material model for vehicle crash simulation.
Standardization of Fretting Fatigue Test Methods and Equipment Elsevier
This report introduces definitions of the terminology relevant to stress determination for fatigue analysis of welded components. The various stress concentrations, stress categories and fatigue analysis methods are defined. Fatigue analysis methods considered are nominal stress, hot spot stress, notch stress, notch strain and fracture mechanics approaches. The report also contains comprehensive recommendations concerning the application of finite element methods and experimental methods for stress determination. It is intended for fatigue design of common welded structures, such as cranes, excavators, vehicle frames, bridges, ship hulls, offshore structures etc. fabricated from materials at least 3mm thick. In general, attention is focused on weld details which give rise to fatigue cracking from the surface, notably from the weld toe.
Fatigue and Corrosion in Metals Elsevier
About the Series: This important new series of five volumes has been written with both the professional engineers and the academic in mind. Christian Lalanne explores every aspect of vibration and shock, two fundamental and crucially important areas of mechanical engineering, from both the theoretical and practical standpoints. As all products need to be designed to withstand the environmental conditions to which they are likely to be subjected, prototypes must be verified by calculation and laboratory tests, the latter according to specifications from national or international standards. The concept of tailoring the product to its environment has gradually developed whereby, from the very start of a design project, through the to the standards specifications and testing procedures on th e prototype, the real environment in which the product being tested will be functioning is taken into account. The five volumes of Mechanical Shock and Vibration cover all the issues that need to be addressed in this area of mechanical engineering. The theoretical analyses are placed in the context of the real world and of laboratory tests - essential for the development of specifications. Volume IV: Fatigue Damage Fatigue damage in a system with one degree of freedom is one of the two criteria applied when comparing the severity of vibratory environments. The same criterion is also employed for a specifciation representing the effects produced by the set of vibrations imposed in a real environment. In this volume, which is devoted to the calculation of fatigue damage, the author explores the hypotheses adopted to describe the behavior of material suffering fatigue and the laws of fatigue accumulation. He also considers the methods of counting the response peaks, which are used to establish the histogram when it is impossible to use the probability density of the peaks obtained with a Gaussian signal. The expressions for mean damage and its standard deviation are established and other hypotheses are tested.
Structural Hot-Spot Stress Approach to Fatigue Analysis of Welded Components Springer Science & Business Media
Fatigue has long been recognized as a mechanism that can provoke catastrophic material failure in structural applications and researchers are now turning to the development of prediction tools in order to reduce the cost of determining design criteria for any new material. Fatigue of Fiber-reinforced Composites explains these highly scientific subjects in a simple yet thorough way. Fatigue behavior of fiber-reinforced composite materials and structural components is described through the presentation of numerous experimental results. Many examples help the reader to visualize the failure modes of laminated composite materials and structural adhesively bonded joints. Theoretical models, based on these experimental data, are demonstrated and their capacity for fatigue life modeling and prediction is thoroughly assessed. Fatigue of Fiber-reinforced Composites gives the reader the opportunity to learn about methods for modeling the fatigue behavior of fiber-reinforced composites, about statistical analysis of experimental data, and about theories for life prediction under loading patterns that produce multiaxial fatigue stress states. The authors combine these theories to establish a complete design process that is able to predict fatigue life of fiber-reinforced composites under multiaxial, variable amplitude stress states. A classic design methodology is presented for demonstration and theoretical predictions are compared to experimental data from typical material systems used in the wind turbine rotor blade industry. Fatigue of Fiber-reinforced Composites also presents novel computational methods for modeling fatigue behavior of composite materials, such as artificial neural networks and genetic programming, as a promising alternative to the conventional methods. It is an ideal source of information for researchers and graduate students in mechanical engineering, civil engineering and materials science.
Fatigue Design Procedures ASTM International
Modern analytical theories of fatigue coupled with a knowledge of processing effects on metals make up the sound basis for designing machine parts that are free from unexpected failure. Fatigue Design: Life Expectancy of Machine Parts provides the information and the tools needed for optimal design. It highlights practical approaches for effectively solving fatigue problems, including minimizing the risk of hidden perils that may arise during production processes or from exposure to the environment.The material is presented with a dual approach: the excellent coverage of the theoretical aspects is accented by practical illustrations of the behavior of machine parts. The theoretical approach combines the fundamentals of solid mechanics, fatigue analysis, and crack propagation. The chapters covering fatigue theories are given special emphasis, starting with the basics and progressing to complicated multiaxial nonlinear problems.The practical approach concentrates on the effects of surface processing on fatigue life and it illustrates many faceted fatigue problems taken from case studies. The solutions demonstrate the authors' detailed analyses of failure and are intended to be used as preventive guidelines. The cases are a unique feature of the book. The numerical method used is the finite element method, and is presented with clear explanations and illustrations.Fatigue Design: Life Expectancy of Machine Parts is an extremely valuable tool for both practicing design engineers and engineering students.
Fatigue of Structures and Materials Cambridge University Press
This book is an attempt to provide a uni?ed methodology to derive models for fatigue life. This includes S-N, ?-N and crack propagation models. This is not a conventional book aimed at describing the fatigue fundamentals, but rather a book in which the basic models of the three main fatigue approaches, the stress-based, the strain-based and the fracture mechanics approaches, are contemplated from a novel and integrated point of view. On the other hand, as an alternative to the preferential attention paid to deterministic models based on the physical, phenomenological and empirical description of fatigue, their probabilistic nature is emphasized in this book, in which stochastic fatigue and crack growth models are presented. This book is the result of a long period

of close collaborationbetween its two authors who, although of di?erent backgrounds, mathematical and mechanical, both have a strong sense of engineering with respect to the fatigue problem. When the authors of this book ?rst approached the fatigue ?eld in 1982 (twenty six years ago), they found the following scenario: 1. Linear, bilinear or trilinear models were frequently proposed by relevant laboratoriesandacademiccenterstoreproducetheW˙ ohler?eld. Thiswas the case of well known institutions, which justi?ed these models based on clientrequirementsorpreferences. Thisledtotheinclusionofsuchmodels and methods as, for example, the up-and-down, in standards and o?cial practical directives (ASTM, Euronorm, etc.), which have proved to be unfortunate.

A New Finite Element Procedure for Fatigue Life Prediction and High Strain Rate Assessment of Cold Worked Advanced High Strength Steel SAE International

This book discusses the theory, method and application of non-Gaussian random vibration fatigue analysis and test. The main contents include statistical analysis method of non-Gaussian random vibration, modeling and simulation of non-Gaussian/non-stationary random vibration, response analysis under non-Gaussian base excitation, non-Gaussian random vibration fatigue life analysis, fatigue reliability evaluation of structural components under Gaussian/non-Gaussian random loadings, non-Gaussian random vibration accelerated test method and application cases. From this book, the readers can not only learn how to reproduce the non-Gaussian vibration environment actually experienced by the product, but also know how to evaluate the fatigue life and reliability of the structure under non-Gaussian random excitation.