Composite Damage Administration Federal Aviation Tolerance

This program was conducted by Vought Aircraft Company, Dallas, Texas, to perform technical studies to aid in the development of a probabilistic design methodology. The foundation of the probabilistic design approach, applied to composite structure, is to base design criteria and objectives on reliability targets instead of factors of safety. Control of the process, in terms of how much it differs from the traditional approach, is maintained by the "Probability of Structural Failure." The key technical issues addressed in this contract were the overall assessment of the accuracy of the methodology, current reliability experience, definition of appropriate goals, and database development. The overall assessment of the accuracy of the methodology was done by reviewing current published documents and papers in the probabilistic design field. This review focused on similarities and differences between approaches. The database development was done by visiting airline maintenance depots and naval aviation depots to collect data on structural failures. The analyses of such data produced historical values for aircraft structural reliability. Current structural reliability issues and reliability goals were addressed by analyzing the wing box of the Lear Fan aircraft using Vought's Probabilistic Design Model. Measures of structural reliability such as single flight hour probability of failure for the whole wing box, including upper skin, lower skin, and substructure were produced.

This standardization handbook has been developed and is being maintained as a joint effort of the Department of Defense and the Federal Aviation Administration. It provides guidelines and material properties for polymer (organic) and metal matrix composite materials. This handbook aims to provide a standard source of statistically-based mechanical property data, procedures, and overall materials guidelines for characterization of composite material systems. This volume provides methodologies and lessons learned for the design, manufacture, and analysis of composite structures and for utilization of the material data provided in Volume II consistent with the guidance provided in Volume I. It covers processes and effects of variability; quality control of production materials; design and analysis; structural behavior of joints and reliability; thick section composites; and supportability.

Damage Tolerance and Fatigue Evaluation of Composite Rotorcraft Structures (US Federal Aviation Administration Regulation) (FAA) (2018 Edition) The Law Library presents the complete text of the Damage Tolerance and Fatigue Evaluation of Composite Rotorcraft Structures (US Federal Aviation Administration Regulation) (FAA) (2018 Edition). Updated as of May 29, 2018 This proposal would revise airworthiness standards for type certification requirements of normal and transport category rotorcraft. The amendment would require evaluation of fatigue and residual static strength of composite rotorcraft structures using a damage tolerance evaluation, or a fatigue evaluation, if the applicant establishes that a damage tolerance evaluation is impractical. The amendment would address advances in composite structures technology and provide internationally harmonized standards. This book contains: - The complete text of the Damage Tolerance and Fatigue Evaluation of Composite Rotorcraft Structures (US Federal Aviation Administration Regulation) (FAA) (2018 Edition) - A table of contents with the page number of each section

The use of composite sandwich construction is rapidly increasing in current and future airframe designs. Typically, these sandwich constructions use thin gage composite facesheets (0.020" to 0.045") which are co-cured to honeycomb and foam cores. Due to the nature of these structures, damage tolerance is more complex than conventional laminated structures. Besides typical damage concerns such as through penetration and delamination, additional modes including core crushing and facesheet debonding must also be addressed. This complicates the certification process by introducing undefined Allowable Damage Limits (ADL) and Critical Damage Thresholds (CDT) as related to the ultimate and limit load carrying capability of the structure. In this report, the preliminary results of the damage resistance and tolerance experiments on sandwich panels are presented. The testing capabilities developed at the Wichita State University to support this program are presented in detail. The effect of impactor size on the impact resistance and residual strength properties was investigated. The effectiveness of traditional nondestructive inspection (NDI) methods in detecting and quantifying the damage distribution in the sandwich panels was studied and the salient results were presented. The damage metrics used for quantifying the damage distributions are planar damage area and residual indentation depth. The use of residual indentation in conjunction with a typical visual inspection protocol for preliminary damage detection was appraised. The characteristic damage states due to different impactor sizes were identified using destructive inspection and further correlated with the NDI damage metrics. The effects of different damage states were quantified by conducting uniaxial edgewise-compressive tests on the impacted specimens. The failure mechanisms governing the sandwich panels with different damage modes were identified and reported.

"This document, originally published as Federal Aviation Administration (FAA) technical report DOT/FAA/CT-85/6 ... has been revised to include significant advancements in the s[t]ate of the art in the design of composite structures as well as in the mechanics analysis of composites"--Technical report documentation p.

The behavior of sandwich panels with open holes subjected to in-plane tensile and compressive loads were investigated experimentally. The objective of this study was to establish whether the open-hole damage was more severe compared to an impact damage of equal planar size. The experimental results indicated that the open holes are more severe when compared to impact damage created with different impactor sizes. Comparison with past data revealed that residual strengths of impact damaged sandwich panels tend to approach that of the open hole with increasing residual indentation depth.

This book is based on lectures held at the faculty of mechanical engineering at the Technical University of Kaiserslautern. The focus is on the central theme of societies overall aircraft requirements to specific material requirements and highlights the most important advantages and challenges of carbon fiber reinforced plastics (CFRP) compared to conventional materials. As it is fundamental to decide on the right material at the right place early on the main activities

and milestones of the development and certification process and the systematic of defining clear requirements are discussed. The process of material qualification - verifying material requirements is explained in detail. All state-of-the-art composite manufacturing technologies are described, including changes and complemented by examples, and their improvement potential for future applications is discussed. Tangible case studies of high lift and wing structures emphasize the specific advantages and challenges of composite technology. Finally, latest R&D results are discussed, providing possible future solutions for key challenges such as low cost high performance materials, electrical function integration and morphing structures.

Composite materials, with their higher exposure to dynamic loads, have increasingly been used in aerospace, naval, automotive, sports and other sectors over the last few decades. Dynamic Deformation, Damage and Fracture in Composite Materials and Structures reviews various aspects of dynamic deformation, damage and fracture, mostly in composite laminates and sandwich structures, in a broad range of application fields including aerospace, automotive, defense and sports engineering. As the mechanical behavior and performance of composites varies under different dynamic loading regimes and velocities, the book is divided into sections that examine the different loading regimes and velocities. Part one examine low-velocity loading and part two looks at high-velocity loading. Part three then assesses shock and blast (i.e. contactless) events and the final part focuses on impact (contact) events. As sports applications of composites are linked to a specific subset of dynamic loading regimes, these applications are reviewed in the final part. Examines dynamic deformation and fracture of composite materials Covers experimental, analytical and numerical aspects Addresses important application areas such as aerospace, automotive, wind energy and defence, with a special section on sport applications

Long-Term Durability of Polymeric Matrix Composites presents a comprehensive knowledge-set of matrix, fiber and interphase behavior under long-term aging conditions, theoretical modeling and experimental methods. This book covers long-term constituent behavior, predictive methodologies, experimental validation and design practice. Readers will also find a discussion of various applications, including aging air craft structures, aging civil infrastructure, in addition to engines and high temperature applications.

Presents the latest strategies in the development and use of composite materials for large structures and the effects of defects Practical Design and Validation of Composites Structures: Effects of Defects offers an important guide to the use of fiber-reinforced composites and how they affect the durability and safety of engineering structures such as aircraft, ships, bridges, wind turbines as well as sporting equipment. The text draws on the authors' direct experience in industry and academia to cover the most recent strategies in the development of composite structures and uniquely integrates the assessment of the effects of defects introduced during production. This comprehensive resource builds on an essential introduction to the characteristics of composites and the most common types of defects encountered in production. The authors review the recent manufacturing methods and technologies used for inspecting composite structures and the design issues related to an analysis of their failure and strength incorporating the variability of processing. The text also contains information on the latest regulatory requirements and the relevant standards associated with the testing and design within a robust design philosophy and approach. This important resource: Offers a comprehensive review of the most current regulatory developments in the use of composites for the construction of complex composite structures Presents information on the basic characteristics of composites Includes testing strategies for determining the impacts of production defects Reviews the most current manufacturing methods and inspection technologies in the field Contains methods for statistical analysis and processing of experimental effects of defects test data Written for professional engineers in mechanical engineering, automotive engineering, aerospace engineering, civil engineering, and energy engineering as well as industry and academic researchers, Practical Design and Validation of Composites Structures: Effects of Defects is the hands-on text that covers the essential information needed to understand the use of composites and how they affect complex engineering projects using composites.

A state-of-the-art review on composite material fatigue/damage tolerance was conducted to investigate the literature for fatigue life prediction methodologies including stress-based methodologies, strength degradation models, and damage growth models. A critical review was made of each methodology and its commensurate basic equations of importance. Experimental data were reviewed and the behavior of specimens was correlated with that of civil aircraft components. The report also examined the six recognized methods for the non-destructive testing of fibrous composite materials and identified the most effective methods. Keywords: Composite Civil Aircraft.

This report summarizes work that quantifies the benefits of composite patch repairs on cracked metallic aircraft structures. The first chapter describes a data base on bonding methods and repair materials that can be used in design and analysis. In the second chapter, analytical models are derived for the stress intensity factor of cracks in metallic sheets with bonded orthotropic repairs. Specific configurations included through-the-thickness center cracks, through-the-thickness cracks at a loaded fastener hole, surface cracks, and surface cracks at a hole. These analyses can be used in calculations of crack growth life extension resulting from the bonded repairs. Four types of specimens were tested in fatigue to verify the increase in fatigue life. The four configurations were edge crack specimens, surface specimens with multiple site damage (MSD).

Polymer Composites in the Aerospace Industry, Second Edition, summarizes the latest research and developments on the design, manufacture and performance of composite components for aerospace structures. Sections cover the modeling, structure and behavior of 2D and 3D woven composites, the manufacture processes used for composite materials and components, buckling and compressive strength of laminates and manufacturing defects in composite materials, aspects of composite performance in aerospace structural design, including chapters on modeling stiffness and strength of structural elements, fatigue under uniaxial and multiaxial loads, fracture mechanics, impact strength and fatigue, crashworthiness, design and failure analysis of bolted joints, and much more. This updated edition is an essential reference resource for engineers, scientists and designers working in the development of composite materials in aerospace applications. Presents detailed discussions on the design, modeling and

analysis of conventional and advanced polymer composites used in aerospace applications Provides an in-depth understanding of the performance parameters of aerospace composites, such as strength, stiffness and fatigue, impact and blast resistance Includes significant developments that have occurred since 2015 (in production and manufacturing, fatigue modeling, test standards, adhesive bonding and repair and service techniques) Features a brand new section on design applications, including helicopter components, fixed wing landing gear, aircraft wings and fuselage

Repair of Polymer Composites: Methodology, Techniques, and Challenges discusses fundamental issues related to the repair of composites and their suitability in various industrial sectors, such as aerospace, automotive, marine and construction, etc. The repair of composites is complex and requires a thorough understanding of the various types of damage mechanisms in order to apply the appropriate NDT techniques. This book explores these issues in significant detail and presents systematic procedures and methods, thus serving as a useful reference for both undergraduate and postgraduate students, academic researchers, engineers and other professionals who are interested in this exciting field of research. Discusses fundamental issues related to the repair of composites and their suitability in various industrial sectors, including aerospace, automotive, marine and construction, etc. Provides comprehensive coverage, from the fundamental aspects, to real applications Serves as a useful reference for both undergraduate and postgraduate students, academic researchers, engineers and other professionals Presents different types of repair techniques by correlating different parameters and challenges

This book provides a state-of-the-art review of the fail-safe and damage tolerance approaches, allowing weight savings and increasing aircraft reliability and structural integrity. The application of the damage tolerance approach requires extensive know-how of the fatigue and fracture properties, corrosion strength, potential failure modes and non-destructive inspection techniques, particularly minimum detectable defect and inspection intervals. In parallel, engineering practice involving damage tolerance requires numerical techniques for stress analysis of cracked structures. These evolved from basic mode I evaluations using rough finite element approaches, to current 3D modeling based on energetic approaches as the VCCT, or simulation of joining processes. This book provides a concise introduction to this subject.

The availability of efficient and cost-effective technologies to repair or extend the life of aging military airframes is becoming a critical requirement in most countries around the world, as new aircraft becoming prohibitively expensive and defence budgets shrink. To a lesser extent a similar situation is arising with civil aircraft, with falling revenues and the high cost of replacement aircraft. This book looks at repair/reinforcement technology, which is based on the use of adhesively bonded fibre composite patches or doublers and can provide cost-effective life extension in many situations. From the scientific and engineering viewpoint, whilst simple in concept, this technology can be quite challenging particularly when used to repair primary structure. This is due to it being based on interrelated inputs from the fields of aircraft design, solid mechanics, fibre composites, structural adhesive bonding, fracture mechanics and metal fatigue. The technologies of non-destructive inspection (NDI) and, more recently smart materials, are also included. Operational issues are equally critical, including airworthiness certification, application technology (including health and safety issues), and training. Including contributions from leading experts in Canada, UK, USA and Australia, this book discusses most of these issues and the latest developments. Most importantly, it contains real histories of application of this technology to both military and civil aircraft.

Engineered Repairs of Composite Structures provides a detailed discussion, analysis, and procedures for effective and efficient repair design of advanced composite structures. It discusses the identification of damage types and the effect on structural integrity in composite structures, leading to the design of a repair scheme that focusses on the restoration of the structural integrity and damage tolerance. This book teaches the reader to better understand effective and efficient repair design, allowing for more structurally effective repairs of damaged composite structures. It also discusses the application of the repair and what is needed in the forming of the composite repair to meet the engineering design requirements. Aimed at materials engineers, mechanical engineers, aerospace engineers, and civil engineers, this practical work is a must have for any industry professional working with composite structures.

Experimental Mechanics of Composite, Hybrid, and Multifunctional Materials, Volume 4: Proceedings of the 2014 Annual Conference on Experimental and Applied Mechanics, the fourth volume of eight from the Conference, brings together contributions to this important area of research and engineering. The collection presents early findings and case studies on a wide range of areas, including: Composites for Energy Applications Novel/Bio Composites NDE of Composites Mechanical Testing of Composites Strain Measurements Using Digital Image Correlation Digital Image Correlation for Composite Structures Particulate Composites Nanocomposites

An improved certification methodology for composite structures was developed. The methodology permits certification of bonded and concurred composite structures with the same level of confidence as bolted structures. This methodology also ensures that the threat of in service low velocity impact is adequately addressed. The methodology was demonstrated on actual composite aircraft structures to evaluate the damage tolerance capability of these structures. The F/A-18A upper wing skin was used for methodology demonstration. Sensitivity studies were conducted to determine the influence of impact damage threat scenarios and damage tolerance design requirements on the reliability of composite structures.

A through review of the existing impact test data and analysis methods was conducted and the results were used to identify a reliability prediction methodology for further development. The integrated residual strength/reliability method developed by Northrop Grumman under a Navy/Federal Aviation Administration sponsored program was selected and modified. The modification was primarily in reducing the number of empirical constants required in the model. In addition, a cutoff energy level and a threshold energy level were also established analytically for the strength prediction. A structural damage tolerance evaluation was conducted using the modified model and the results compared to those obtained from the existing model.

The Federal Aviation Administration (FAA) is working with the European Aviation Safety Agency to determine the certification base for proposed new engines that would not have a containment structure on large commercial aircraft. Equivalent safety to the current fleet is desired by the regulators, which means that loss of a single fan blade will not cause hazard to the aircraft. NASA Glenn and Naval Air Warfare Center (NAWC) China Lake collaborated with the FAA Aircraft Catastrophic Failure Prevention Program to design and test a shield that would protect the aircraft passengers and critical systems from a released blade that could impact the fuselage. This report documents the live-fire test from a full-scale rig at NAWC China Lake. NASA provided manpower and photogrammetry expertise to document the impact and damage to the shields. The test was successful: the blade was stopped from penetrating the shield, which validates the design analysis method and the parameters used in the analysis. Additional work is required to implement the shielding into the aircraft. Seng, Silvia and Frankenberger, Charles and Ruggeri, Charles R. and Revilock, Duane M. and Pereira, J. Michael and Carney, Kelly S. and Emmerling, William C. Glenn Research Center COMMERCIAL AIRCRAFT; PROP-FAN TECHNOLOGY; ROTORS; FAN BLADES; FRAGMENTATION; SHRAPNEL; SHIELDING; PANELS; COMPOSITE STRUCTURES; FULL SCALE TESTS; IMPACT TESTS; FAILURE ANALYSIS; DAMAGE ASSESSMENT; PHOTOGRAMMETRY

Numerical Modelling of Failure in Advanced Composite Materials comprehensively examines the most recent analysis techniques for advanced composite materials. Advanced composite materials are becoming increasingly important for lightweight design in aerospace, wind energy, and mechanical and civil engineering. Essential for exploiting their potential is the ability to reliably predict their mechanical behaviour, particularly the onset and propagation of failure. Part One investigates numerical modeling approaches to interlaminar failure in advanced composite materials. Part Two considers numerical modelling approaches to intralaminar failure. Part Three presents new and emerging advanced numerical algorithms for modeling and simulation of failure. Part Four closes by examining the various engineering and scientific applications of numerical modeling for analysis of failure in advanced composite materials, such as prediction of impact damage, failure in textile composites, and fracture behavior in through-thickness reinforced laminates. Examines the most recent analysis models for advanced composite materials in a coherent and comprehensive manner Investigates numerical modelling approaches to interlaminar failure and intralaminar failure in advanced composite materials Reviews advanced numerical algorithms for modeling and simulation of failure Examines various engineering and scientific applications of numerical modelling for analysis of failure in advanced composite materials

The Pilot’s Handbook of Aeronautical Knowledge is an official Federal Aviation Administration (FAA) Handbook that provides basic knowledge that is essential for pilots. This updated handbook introduces pilots to the broad spectrum of knowledge that will be needed as they progress in their pilot training. Written for the pilot preparing for a Remote, Sport, Private, Commercial, or Flight Instructor Pilot Certificate, it is a key reference for all the information necessary to operate an aircraft and to pass the FAA Knowledge Exam and Practical Test. This handbook introduces readers to flying and a history of flight, then explores the role of the FAA, criteria for earning the various pilot certificates, how to plan their flight education, and the examinations associated with earning a pilot certificate. With covered topics ranging from aeronautical decision-making to flight instrument use to weather theory, beginners and advanced pilots alike will find the Pilot's Handbook of Aeronautical Knowledge to be their primary resources for all things aviation. In addition the most current FAA information, this 2016 edition features full-color drawings and photographs, an index, a glossary, and appendices of common acronyms, abbreviations and NOTAM contractions, and airport signs.