

Principles Of Composite Materials Mechanics Solutions Manual

Offers information on the fundamental principles, processes, methods and procedures related to fibre-reinforced composites. The book presents a comparative view, and provides design properties of polymeric, metal, ceramic and cement matrix composites. It also gives current test methods, joining techniques and design methodologies.

Over much of the last three decades, the evolution of techniques for characterizing composite materials has struggled to keep up with the advances of composite materials themselves and their broadening areas of application. In recent years, however, much work has been done to consolidate test methods and better understand those being used. Finally,

The main advantages of sandwiches as structural components are now well known and well-established. Due to the progress in polymer science and engineering and advances in manufacturing processes, sandwich structures can blend various functional and structural properties and therefore lead to highly innovating systems. The current difficulty to overcome is to provide designers with proper methodologies and tools that could enable them to design improved sandwich structures. Such dedicated design tools should be efficient, reliable, flexible and user-friendly. They should be based on advanced knowledge of sandwich behaviour at global and local scales. Such approach relies on our capability to test, identify, control and model structure performances. The impressive variety of core and face materials and the rapid developments in forming processes give new opportunities to design components which have more complex shapes and higher integrated functional and structural properties. Interest in sandwiches is permanently growing in industry and refined testing and modelling approaches should be encouraged to set up relevant guidelines to design reliable advanced structures. The European Society for Mechanics sponsored the EUROMECH 360 Colloquium on the 'Mechanics of Sandwich Structures' in Saint-Etienne, France, on 13 - 15 May 1997. The main purpose of EUROMECH 360 was to go into the most recent progresses in sandwich analysis and design, including mechanical modelling and testing. It was expected that the Colloquium should contribute to define new research directions to support development of advanced applications in strategic industrial sectors such as ground transportations or building and civil engineering.

"Extensively revised and maintaining the high standard of the popular original, this book reflects the many recent developments in the mechanics of composite materials. New and up-to-date information throughout the text brings modern engineering students everything they need to advance their knowledge of the ever more common composite materials."--BOOK JACKET.

Volume 5: Structures

Extensively updated and maintaining the high standard of the popular original, Principles of Composite Material Mechanics, Second Edition reflects many of the recent developments in the mechanics of composite materials. It draws on the decades of teaching and research experience of the author and the course material of the senior undergraduate and graduate level classes he has taught. New and up-to-date information throughout the text brings modern engineering students everything they need to advance their knowledge of the evermore common composite materials. The introduction strengthens the book's emphasis on basic principles of mechanics by adding a review of the basic mechanics of materials equations. New appendices cover the derivations of stress equilibrium equations and the strain-displacement relations from elasticity theory. Additional sections address recent applications of composite mechanics to nanocomposites, composite grid structures, and composite sandwich structures. More detailed discussion of elasticity and finite element models have been included along with results from the recent World Wide Failure Exercise. The author takes a phenomenological approach to illustrate linear viscoelastic behavior of composites. Updated information on the nature of fracture and composite testing includes coverage of the finite element implementation of the Virtual Crack Closure technique and new and revised ASTM standard test methods. The author includes updated and expanded material property tables, many more example problems and homework exercises, as well as new reference citations throughout the text. Requiring a solid foundation in materials mechanics, engineering, linear algebra, and differential equations, Principles of Composite Materials Mechanics, Second Edition provides the advanced knowledge in composite materials needed by today's materials scientists and engineers.

Based on 15 years of composites manufacturing instruction, the Principles of the Manufacturing of Composite Materials is the first text to offer both a practical and analytic approach to composite manufacturing processes. It ties together key tools for analyzing the mechanics of composites with the processes whereby composite products are fabricated, whether by hand lay-up or through automated processes. The book outlines the principles of chemistry, physics, materials science and engineering and shows how these are connected to the design and production of a variety of composites, primarily polymeric. It thus provides analytic, quantitative tools to answer the questions of why certain materials are linked with specific processes, and why products are manufactured by one process rather than another. All phases of matrix material formation are explained, as are practical design details for fabrics, autoclaving, filament winding, pultrusion, liquid composite molding, hand techniques, joints and joint bonding, and more. A special section is devoted to nanocomposites. The book includes exercises for university students and practitioners.

Rheology of Particulate Dispersions and Composites provides comprehensive coverage of fundamental principles and equations that govern the rheology for particulate dispersions and two-phase solid composites. The rheological properties of suspensions, emulsions, bubbly liquids (foams) and other dispersions appear alongside those of solid comp

Over the last three decades, the evolution of techniques for the experimental testing of composite materials has struggled to keep up with the advances and broadening areas of application of the composite materials themselves. In recent years, however, much work has been done to consolidate and better understand the test methods being used. Finally, a consensus regarding the best available methods exists, and definitive recommendations can be made. Experimental Characterization of Advanced Composite Materials provides a succinct, authoritative treatment of the best available methods for determining the mechanical properties, thermal expansion coefficients, and fracture and strength data for composite materials. With an emphasis firmly on practical matters, it presents processing techniques, specimen preparation, analyses of test methods, test procedures, and data reduction schemes. Five chapters covering specific aspects of lamina testing are followed by discussions extending those principles to laminate responses. The treatment concludes by exploring composite durability issues with a detailed examination of defects and fracture mechanics. The Fourth Edition is revised to include: New figures, updated ASTM standards, and an expanded index Major additions in processing of thermoset resins, neat resin tests, sandwich structures, cure analyses, damage tolerance tests, single fiber tests, fiber matrix interface tests, interlaminar tension tests, through-thickness tension and compression tests, open-hole compression tests, falling weight impact tests, compression-after-impact tests, sandwich beam and core tests, and more With its concise format, detailed procedures, and expert assessments, this book is an outstanding resource for composites manufacturing and test engineers, lab technicians, and other industry professionals, as well as students, academia, and government research and engineering organizations. It brings together all of the most appropriate and widely accepted test methods developed to date.

The aim of the book is to give a clear picture of some new modern trends in composite mechanics and to give a presentation of the current state-of-the-art of the theory and application of composite laminates. The book addresses the basics as well as recent developments in the theory of laminates and their effective properties, the problem of testing and identification of properties, strength, damage, and failure of composite laminates, lightweight construction principles, optimization techniques, the generation of smart structures, and a number of special technical aspects (e.g. stress localization), their modelling and analysis. The intention of the book is to provide deeper understanding, to give mathematical and algorithmic techniques for analysis, simulation and optimization and to link various aspects of composite mechanics as

necessary to exploit the full potential that is possible for composite structures.

This monograph presents recent research findings on fracture properties and behavior of the composites, and their damage and cracking process under both quasi-static and impact loading conditions. Theoretical treatment, experimental investigation and numerical simulation aspects of the mechanics of composites, including sandwich structures are included.

The use of composite materials in engineering structures continues to increase dramatically, and there have been equally significant advances in modeling for general and composite materials and structures in particular. To reflect these developments, renowned author, educator, and researcher J.N. Reddy created an enhanced second edit

Updated and expanded coverage of the latest trends and developments in fiber composite materials, processes, and applications Analysis and Performance of Fiber Composites, Fourth Edition features updated and expanded coverage of all technical aspects of fiber composites, including the latest trends and developments in materials, manufacturing processes, and materials applications, as well as the latest experimental characterization methods. Fiber reinforced composite materials have become a fundamental part of modern product manufacturing. Routinely used in such high-tech fields as electronics, automobiles, aircraft, and space vehicles, they are also essential to everyday staples of modern life, such as containers, piping, and appliances. Little wonder, when one considers their ease of fabrication, outstanding mechanical properties, design versatility, light weight, corrosion and impact resistance, and excellent fatigue strength. This Fourth Edition of the classic reference the standard text for composite materials courses, worldwide offers an unrivalled review of such an important class of engineering materials. Still the most comprehensive, up-to-date treatment of the mechanics, materials, performance, analysis, fabrication, and characterization of fiber composite materials available, Analysis and Performance of Fiber Composites, Fourth Edition features: Expanded coverage of materials and manufacturing, with additional information on materials, processes, and material applications Updated and expanded information on experimental characterization methods including many industry specific tests Discussions of damage identification techniques using nondestructive evaluation (NDE) Coverage of the influence of moisture on performance of polymer matrix composites, stress corrosion of glass fibers and glass reinforced plastics, and damage due to low-velocity impact New end-of-chapter problems and exercises with solutions found on an accompanying website Computer analysis of laminates No other reference provides such exhaustive coverage of fiber composites with such clarity and depth. Analysis and Performance of Fiber Composites, Fourth Edition is, without a doubt, an indispensable resource for practicing engineers, as well as students of mechanics, mechanical engineering, and aerospace engineering. Visit the Companion Website at: <https://www.wiley.com/WileyCDA/Section/id-830336.html>

This is a comprehensive, reader-friendly treatment of the theory behind modern elastic composite materials. The treatment includes recently developed results and methods drawn from research papers published in Eastern Europe that until now were unavailable in many western countries. Among the book's many notable features is the inclusion of more th

This book is an attempt to present an integrated and unified approach to the analysis of FRP composite materials which have a wide range of applications in various engineering structures- offshore, maritime, aerospace and civil engineering; machine components; chemical engineering applications, and so on.

Composite materials are increasingly used in many applications because they offer the engineer a range of advantages over traditional materials. They are often used in situations where a specified level of performance is required, but where the cost of testing the materials under the extremes of those specifications is very high. In order to solve this problem, engineers are turning to computer Modelling to evaluate the materials under the range of conditions they are likely to encounter. Many of these analyses are carried out in isolation, and yet the evaluation of a range of composites can be carried out using the same basic principles. In this new book the editor has brought together an international panel of authors, each of whom is working on the analysis and Modelling of composite materials. The overage of the book is deliberately wide; to illustrate that similar principles and methods can be used to model and evaluate a wide range of materials. It is also hoped that, by bringing together this range of topics, the insight gained in the study of one composite can be recognized and utilized in the study of others. Professional engineers involved in the specification and testing of composite material structures will find this book an invaluable resource in the course of their work. It will also be of interest to those industrial and academic engineers involved in the design, development, manufacture and applications of composite materials.

· Technical explanation of composite materials in vehicle design and manufacture · Covers all phases of composites design, formulation, fabrication, and testing · Features hundreds of case studies and hard-to-find formulas and analytical data · Detailed information on resins, preforms, lightweighting, biobased materials ----- This technical book provides a comprehensive explanation of how advanced composite materials, including FRPs, reinforced thermoplastics, carbon-based composites and many others are designed, processed and utilized in exterior, interior, under-the-hood, structural, semi-structural and non-structural components in passenger cars, performance cars, trucks, motorbikes, and mass transit vehicles. The book clarifies how the material properties of composites can be optimized to decrease weight, expand design options, improve crashworthiness, and reduce fuel consumption in response to CAFE and other regulations. The many case studies and equation-based analyses in this book are intended to assist engineers and others in the selection of materials and the fabrication of vehicle parts. Table of Contents: CHAPTER 1: INTRODUCTION 1.1 Introduction 1.2 History and Legislative Actions 1.3 The Case for Lightweighting 1.4 Technological Barriers 1.5 Advantages and Opportunities 1.6 Integral Factors 1.7 Summary 1.8 References CHAPTER 2: POLYMER RESINS, ADDITIVES AND SANDWICH CORES FOR AUTOMOTIVE, MASS TRANSIT AND HEAVY TRUCKS 2.1 Introduction 2.2 Polymer Resins: Thermoset and Thermoplastic 2.3 Thermoset Polymer Composites 2.4 Thermoplastic Resins 2.5 Additives 2.6 Structural Foams and Core Materials 2.7 Summary 2.8 References CHAPTER 3: REINFORCEMENTS FOR AUTOMOTIVE AND TRANSPORTATION APPLICATIONS 3.1 Reinforcing Fibers 3.2 Reinforcement Length Scales and Forms 3.3 Glass Fibers 3.4 Carbon or Graphite Fibers 3.5 Aramid (Kevlar") Fibers 3.6 High-Strength Polyolefin Fibers 3.7 Basalt Fibers 3.8 Summary 3.9 References CHAPTER 4: MATERIAL FORMS FOR AUTOMOTIVE, HEAVY TRUCKS AND MASS TRANSIT 4.1 Need for Intermediate Material Forms 4.2 Preforming 4.3 Intermediate Material Form for Thermoplastic Composites 4.4 Summary 4.5 References CHAPTER 5: DISCONTINUOUS REINFORCEMENT-BASED PROCESSES FOR AUTOMOTIVE AND TRANSPORTATION APPLICATIONS 5.1 Discontinuous Forms 5.2 Glass Mat Thermoplastic Composites (GMT) 5.3 Long Fiber Thermoplastics (LFT) 5.4 Sheet Molding Compound (SMC) 5.5 Compression Molding 5.6 Programmable Powdered Preform Process (P4) 5.7 Structural Foam Molding 5.8 Other Application Case Studies with Discontinuous Fiber Composites 5.9 Exterior 5.10 Interior 5.11 Lightweighting Fuel Cells 5.12 Summary 5.13 References CHAPTER 6: CONTINUOUS FIBER REINFORCEMENT BASED PROCESSES FOR AUTOMOTIVE, HEAVY TRUCKS AND MASS TRANSIT 6.1 Continuous Fiber Composites 6.2 Preforming 6.3 Continuous Fiber Processes for Automotive and Transportation Applications 6.4 Application Case Studies with Continuous Fiber Reinforcements 6.5 Summary 6.6 References CHAPTER 7: MECHANICS AND DESIGN TIPS 7.1 Test Methods and Specific Properties 7.2 Conversion Between Volume and Weight Fractions 7.3 Stiffness and Strength Prediction of Discontinuous and Continuous Fiber Composites 7.4 Stiffness Equivalency 7.5 Sandwich Composites 7.6 Ribbed LFT and Tape Reinforced LFT 7.7 Summary 7.8 References CHAPTER 8: COMPOSITE MANUFACTURING PROCESS ANALYSIS FOR AUTOMOTIVE PARTS 8.1 Background 8.2 Production Requirements 8.3 Representative Part 8.4 Cost Analysis 8.5 Economic Benefit for the Material Supplier 8.6 Summary 8.7 References CHAPTER 9: CARBON FIBER 9.1 Background 9.2 Challenges 9.3 Typical Properties of Automotive Carbon Fiber Composites 9.4 Carbon Fibers in Cars 9.5 Summary 9.6 References CHAPTER 10: PERFORMANCE CARS 10.1 Background 10.2 Performance Cars 10.3 Hypercar 10.4 Futuristic

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Principles of Composite Material Mechanics, Third Edition presents a unique blend of classical and contemporary mechanics of composites technologies. While continuing to cover classical methods, this edition also includes frequent references to current state-of-the-art composites technology and research findings. New to the Third Edition Many new worked-out example problems, homework problems, figures, and references An appendix on matrix concepts and operations Coverage of particle composites, nanocomposites, nanoenhancement of conventional fiber composites, and hybrid multiscale composites Expanded coverage of finite element modeling and test methods Easily accessible to students, this popular bestseller incorporates the most worked-out example problems and exercises of any available textbook on mechanics of composite materials. It offers a rich, comprehensive, and up-to-date foundation for students to begin their work in composite materials science and engineering. A solutions manual and PowerPoint presentations are available for qualifying instructors.

Comprehensive Composite Materials II, Second Edition is a one-stop reference work spanning the whole composites science field, covering such topics as fiber reinforcements and general theory of composites, polymer matrix composites, metal matrix composites, test methods, nondestructive evaluation and smart composites, design and application, and nanocomposites, multifunctional materials and smart materials. Detailed coverage is also given to the development and application of the principles of multi-scale mechanics and physical model-based design methods and the incorporation of mechanisms of deformation and fracture into predictive design equations that are useful for the design engineer. Extensive coverage of topics related to nanocomposites, including nanoscale reinforcements, such as single-wall and multi-wall nanotubes, graphene nanoplatelets, and nanodiamonds are also covered. Includes up-to-date coverage of important commercial, consumer and aerospace/defense applications, including structural, mechanical, electronic, and medical uses of composites Covers new technologies with a special focus on nanocomposites and multifunctional materials, important for many areas, including structures and electronics Contains approximately 85% newly commissioned articles, with 15% of articles updated from the previous edition

Introduction to Composite Materials; Review of stress, Strain and Material Behavior; Lamina Analysis; Mechanical Test Methods for Lamina Failure Theories; Laminate Analysis; Appendix A, B, C, D; Glossary.

This second edition of the textbook presents a systematic introduction to the structural mechanics of composite components. The book focusses on modeling and calculation of sandwiches and laminated composites i.e. anisotropic material. The new edition includes an additional chapter covering the latest advances in both research and applications, which are highly relevant for readers. The textbook is written for use not only in engineering curricula of aerospace, civil and mechanical engineering, but also for materials science and applied mechanics. Furthermore, it addresses practicing engineers and researchers. No prior knowledge of composite materials and structures is required for the understanding of its content. The book is close to classical courses of "Strength of Materials" and "Theory of Beams, Plates and Shells" but it extends the classic content on two topics: the linear elastic material behavior of isotropic and non-isotropic structural elements, and inhomogeneous material properties in the thickness direction. The Finite Element Analysis of laminate and sandwich structures is briefly presented. Many solved examples illustrate the application of the techniques learned.

The principles of mechanics are utilized for the description of the behavior of fiber-reinforced composites. Principal components of elastic moduli and strength for an orthotropic material are established as the intrinsic macromechanical properties.

Micromechanics analyses provide a rational design basis of these properties from the material and geometric properties of the constituent materials. A bridge between the properties of the constituent materials and the structural behavior of a laminated anisotropic composite can then be established. Combined materials and structural design become feasible. Finally, test methods of composite materials are evaluated. The principles of mechanics can be used to select the material properties to be tested and the appropriate test procedures to be followed.

This book presents the principles of composite laminate sizing widely used for composite structures. The focus is on aeronautics in particular, including the concepts of limit loads and ultimate loads. After a brief overview of the main composite materials used in aeronautics, the basic theory of laminated plates and the associated rupture criteria are given. The author presents two fundamental cases of the sizing of aeronautical composite structures: the calculation of the holed structures and their subsequent multi-bolt joints, and the calculation of the buckling. The concept of damage tolerance is also explored, with a focus on its application for tolerance to impact damage. These notions are fundamental for understanding the specificities of the sizing of aeronautical composite structures. The book also contains corrected exercises for the reader to test their understanding of the different topics covered.

The IUT AM Symposium on Microstructure Property Interactions in Composite Materials was held during the dates 22nd to 25th August 1994 in Rebild Bakker Conference Centre, situated in the heart of one of Denmark's most beautiful natural areas. Participation in the Symposium was reserved for invited participants, suggested by members of the Scientific Committee. The cooperation with the Scientific Committee is highly appreciated. The Symposium brought together 76 researchers from 15 countries representing a broad range of backgrounds relevant to the topic of the meeting. The participants represented the disciplines of materials science and engineering, applied mechanics, applied mathematics and scientific computations. The Symposium comprehensively addressed the analytical, numerical and experimental methods that provide an estimation of the overall, effective properties from microstructural data. The 41 contributions emphasized the significance of the microstructure morphology in understanding the nature and origin of a multitude of properties such as viscoelasticity, plasticity, strength and fracture for a variety of polymer, metal and ceramic based composite materials. Specifically, the Symposium examined and reviewed the current state of the art of micromechanical modelling, experimental investigations and morphological quantification of composite materials' microstructure. The volume contains 35 papers published in an alphabetic order after the name of the first author. Much to regret of the Scientific Committee some manuscripts were not submitted. The financial support of the IUT AM, the Obels Family Foundation and the Institute of Mechanical Engineering, Aalborg University, is gratefully acknowledged.

Engineering Design with Polymers and Composites, Second Edition continues to provide one of the only textbooks on the analysis and design of mechanical components made from polymer materials. It explains how to create polymer materials to meet design

specifications. After tracing the history of polymers and composites, the text describes modern design concepts, such as weight-to-strength ratio and cost-to-strength ratio, for selecting polymers and composites for design applications. It also presents computer methods for choosing polymer materials from a database, for optimal design, and for laminated plate design. New to the Second Edition This edition rearranges many chapters and adds a significant amount of new material. Composites are now covered in two chapters, instead of one. This edition also includes entirely new chapters on polymer fusing and other assembly techniques, rapid prototyping, and piezoelectric polymers. Suitable for mechanical and civil engineering students as well as practicing engineers, this book helps readers get an edge in the rapidly changing electromechanical industry. It gives them a fundamental foundation for understanding phenomena that they will encounter in real-life applications or through subsequent study and research.

There are many books available on polymer chemistry, properties, and processing, but they do not focus on the practicalities of selecting and using them correctly in the design of structures. Engineering students require an understanding of polymers and composites as well as viscoelasticity, adhesion, damping applications, and tribology in order to successfully integrate these materials into their designs. Based on more than twenty years of classroom experience, *Engineering Design with Polymers and Composites* is the first textbook to unite these topics in a single source. The authors take a bottom-up functional approach rather than a top-down analytical approach to design. This unique perspective enables students to select the proper materials for the application rather than force the design to suit the materials. The text begins with an introduction to polymers and composites, including historical background. Detailed coverage of mechanical properties, viscoelastic behavior of polymers, composite materials, creep and fatigue failure, impact, and related properties follows. Discussion then turns to selection of materials, design applications of polymers, polymer processing, adhesion, tribology, and damping and isolation. Abundant examples, homework problems, tables, and illustrations reinforce the concepts. Accompanied by a CD-ROM containing materials databases, examples in Excel®, and a laminate analysis program, *Engineering Design with Polymers and Composites* builds a strong background in the underlying concepts necessary for engineering students to successfully incorporate polymers and composites into their designs. Fiber-reinforced polymer (FRP) composites have become an integral part of the construction industry because of their versatility, enhanced durability and resistance to fatigue and corrosion, high strength-to-weight ratio, accelerated construction, and lower maintenance and life-cycle costs. Advanced FRP composite materials are also emerging for a wide range of civil infrastructure applications. These include everything from bridge decks, bridge strengthening and repairs, and seismic retrofit to marine waterfront structures and sustainable, energy-efficient housing. *The International Handbook of FRP Composites in Civil Engineering* brings together a wealth of information on advances in materials, techniques, practices, nondestructive testing, and structural health monitoring of FRP composites, specifically for civil infrastructure. With a focus on professional applications, the handbook supplies design guidelines and standards of practice from around the world. It also includes helpful design formulas, tables, and charts to provide immediate answers to common questions. Organized into seven parts, the handbook covers: FRP fundamentals, including history, codes and standards, manufacturing, materials, mechanics, and life-cycle costs Bridge deck applications and the critical topic of connection design for FRP structural members External reinforcement for rehabilitation, including the strengthening of reinforced concrete, masonry, wood, and metallic structures FRP composites for the reinforcement of concrete structures, including material characteristics, design procedures, and quality assurance—quality control (QA/QC) issues Hybrid FRP composite systems, with an emphasis on design, construction, QA/QC, and repair Quality control, quality assurance, and evaluation using nondestructive testing, and in-service monitoring using structural health monitoring of FRP composites, including smart composites that can actively sense and respond to the environment and internal states FRP-related books, journals, conference proceedings, organizations, and research sources Comprehensive yet concise, this is an invaluable reference for practicing engineers and construction professionals, as well as researchers and students. It offers ready-to-use information on how FRP composites can be more effectively utilized in new construction, repair and reconstruction, and architectural engineering. This book balances introduction to the basic concepts of the mechanical behavior of composite materials and laminated composite structures. It covers topics from micromechanics and macromechanics to lamination theory and plate bending, buckling, and vibration, clarifying the physical significance of composite materials. In addition to the materials covered in the first edition, this book includes more theory-experiment comparisons and updated information on the design of composite materials.

Structural Analysis of Polymeric Composite Materials, Second Edition introduces the mechanics of composite materials and structures and combines classical lamination theory with macromechanical failure principles for prediction and optimization of composite structural performance. It addresses topics such as high-strength fibers, manufacturing techniques, commercially available compounds, and the behavior of anisotropic, orthotropic, and transversely isotropic materials and structures subjected to complex loading. Emphasizing the macromechanical (structural) level over micromechanical issues and analyses, this unique book integrates effects of environment at the outset to establish a coherent and updated knowledge base. In addition, each chapter includes example problems to illustrate the concepts presented.

This book explores damage growth and fracture processes in cementitious, ceramic, polymer and metal matrix composites, integrating properties like stiffness and strength with observation at below macroscopic scale. Advances in multiscale modelling and analysis pertain directly to materials which either have a range of relevant microstructural scales, like metals, or do not have a well-defined microstructure, like cementitious or ceramic composites.

This book provides a systematic and thorough introduction to the classical laminate theory based on the theory for plane elasticity elements and classical (shear-rigid) plate elements. It focus on unidirectional lamina which can be described based on orthotropic constitutive equations and their composition to layered laminates. In addition to the elastic behavior, failure is investigated based on the maximum stress, maximum strain, Tsai-Hill and the Tsai-Wu criteria.

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