

SPRINGER BRIEFS IN APPLIED SCIENCES
AND TECHNOLOGY · CONTINUUM MECHANICS

Andreas Öchsner

Micromechanics of Fiber-Reinforced Laminae



Springer

SpringerBriefs in Applied Sciences and Technology

SpringerBriefs in Continuum Mechanics

Series Editors

Holm Altenbach, Institut für Mechanik, Lehrstuhl für Technische Mechanik, Otto von Guericke University Magdeburg, Magdeburg, Sachsen-Anhalt, Germany

Andreas Öchsner, Faculty of Mechanical Engineering, Esslingen University of Applied Sciences, Esslingen am Neckar, Germany

These SpringerBriefs publish concise summaries of cutting-edge research and practical applications on any subject of Continuum Mechanics and Generalized Continua, including the theory of elasticity, heat conduction, thermodynamics, electromagnetic continua, as well as applied mathematics.

SpringerBriefs in Continuum Mechanics are devoted to the publication of fundamentals and applications, presenting concise summaries of cutting-edge research and practical applications across a wide spectrum of fields. Featuring compact volumes of 50 to 125 pages, the series covers a range of content from professional to academic.

More information about this subseries at <https://link.springer.com/bookseries/10528>

Andreas Öchsner

Micromechanics of Fiber-Reinforced Laminae

 Springer

Andreas Öchsner
Faculty of Mechanical Engineering
Esslingen University Applied Sciences
Esslingen, Germany

ISSN 2191-530X ISSN 2191-5318 (electronic)
SpringerBriefs in Applied Sciences and Technology
ISSN 2625-1329 ISSN 2625-1337 (electronic)
SpringerBriefs in Continuum Mechanics
ISBN 978-3-030-94090-4 ISBN 978-3-030-94091-1 (eBook)
<https://doi.org/10.1007/978-3-030-94091-1>

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2022

This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Composite materials, especially fiber-reinforced composites, are gaining increasing importance since they can overcome the limits of many structures based on classical metals. Particularly, the combination of a matrix with fibers provides far better properties than the components alone. Despite their importance, many engineering degree programs do not treat the mechanical behavior of this class of advanced structured materials in detail, at least on the Bachelor degree level. Thus, some engineers are not able to thoroughly apply and introduce these modern engineering materials in their design process.

This SpringerBriefs volume provides the first introduction to the micromechanics of fiber-reinforced laminae, which deals with the prediction of the macroscopic mechanical lamina properties based on the mechanical properties of the constituents, i.e., fibers and matrix. The focus is on unidirectional lamina which can be described based on orthotropic constitutive equations. Three classical approaches to predict the elastic properties, i.e., the mechanics of materials approach, the elasticity solutions with contiguity after Tsai, and the Halpin-Tsai relationships, are presented. The quality of each prediction is benchmarked based on two different sets of experimental values. The volume concludes with optimized representations, which were obtained based on the least squares approach for the used experimental data sets.

Esslingen, Germany
November 2021

Andreas Öchsner