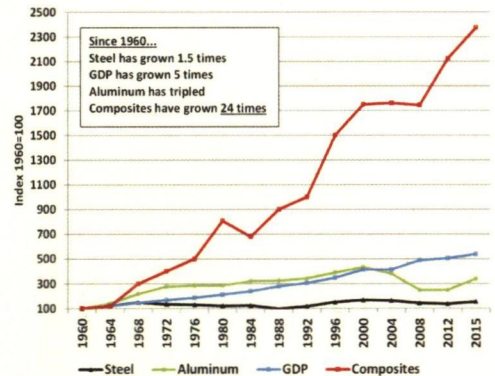
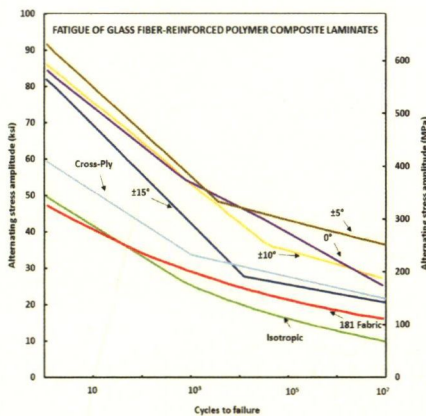


- |                    |                 |                           |
|--------------------|-----------------|---------------------------|
| ■ Carbon laminate  | } 50% by weight | ■ Titanium, 15%           |
| ■ Carbon sandwich  |                 | ■ Titanium/Steel/Aluminum |
| ■ Other composites |                 | ■ Steel, 10%              |
| ■ Aluminum, 20%    |                 | ■ Other, 5%               |

Bhagwan D. Agarwal | Lawrence J. Broutman | K. Chandrashekhara

# ANALYSIS AND PERFORMANCE OF FIBER COMPOSITES

FOURTH EDITION



WILEY

# UPDATED AND EXPANDED COVERAGE OF THE LATEST TRENDS AND DEVELOPMENTS IN FIBER COMPOSITE MATERIALS, PROCESSES, AND APPLICATIONS

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- 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.

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Agarwal  
Broutman  
Chandrashekhara

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FOURTH EDITION

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# ANALYSIS AND PERFORMANCE OF FIBER COMPOSITES

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# PREFACE

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The need to include composite materials courses in engineering and science curricula at colleges and universities has been steadily increasing over the past 40 years. This need is caused by the growing worldwide usage of composite materials. The advantages of fiber composites in structural applications include outstanding mechanical properties, design versatility, light weight, corrosion and impact resistance, and excellent fatigue strength. In addition, their strength and stiffness properties are easily controlled by their fiber and layer composition. No wonder that these materials are now a major player in the universe of materials available to the design engineer. Thus, engineering and science students, particularly civil, materials, mechanical, and aerospace engineers need to be educated on all aspects of composites from the materials science to the engineering design of products manufactured from composites. The inclusion of new courses into a curriculum is greatly aided by the availability of suitable textbooks. This also lessens the need for the teacher to be an expert in the specific field. Prior editions of the book have well served the needs of colleges and universities for over three decades. The revised edition, with updates and extensive rewrites and reorganization, provides an improved teaching tool and is better focused for students and practicing engineers using the book for reference. The new edition was substantially developed from the feedback of students who used previous editions in their composites courses.

The book retains its complete coverage of the subject, with chapters on materials and manufacturing, micro- and macromechanics analyses, structural analysis, and test methods. Additional examples are presented of polymer composites used in demanding applications such as the Boeing Dreamliner passenger jet, the Bell-Boeing V-22, and the Ford Raptor truck.

A very useful structural analysis software, MATLAB, has been described in a new appendix and its use demonstrated by example problems in chapters 5, 6, and 7. The MATLAB code for exercise problems is provided in a solutions manual for instructors.

The authors would like to acknowledge the help of Zhen Huo, Sudharshan Anandan, Gurjot S. Dhaliwal, Bo Wang, Cheng Yan, and Shouvik Ganguly, all graduate students at the Missouri University of Science and Technology, Rolla. They provided useful suggestions, aided in typing the manuscript,



prepared many new figures, and developed MATLAB codes for the solution of example and exercise problems. The authors also thank Dr. Sanjay Mazumdar for providing several updated as well as new figures.

BHAGWAN D. AGARWAL  
LAWRENCE J. BROUTMAN  
K. CHANDRASHEKHARA  
May 2017

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# ABOUT THE COMPANION WEBSITE

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This book is accompanied by a companion website:

[www.wiley.com/go/agarwal/fiber](http://www.wiley.com/go/agarwal/fiber)

Password: industry

The website includes a solutions manual.



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