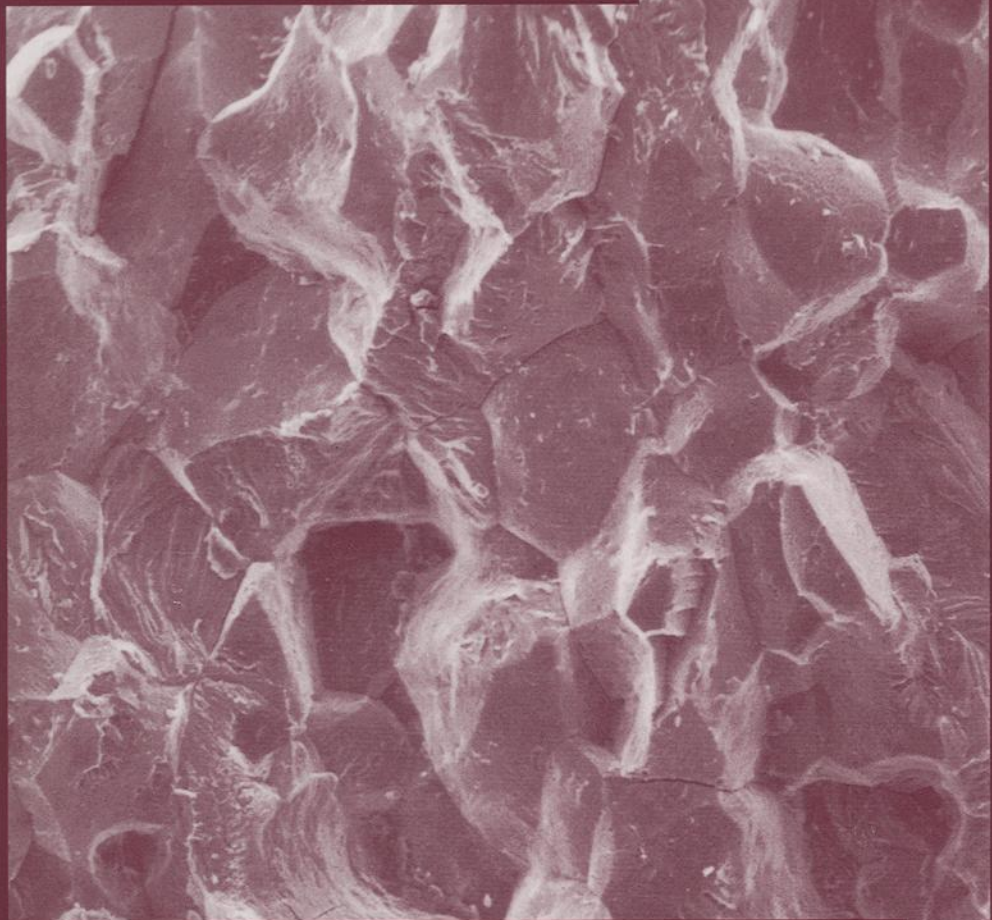


Advances in



Fatigue Lifetime Predictive Techniques

Mitchell/Landgraf, editors



STP 1122

STP 1122

*Advances in
Fatigue Lifetime
Predictive Techniques*

M. R. Mitchell and R. W. Landgraf, editors

ASTM Publication Code Number (PCN):
04-011220-30



ASTM
1916 Race Street
Philadelphia, PA 19103

Library of Congress Cataloging-in-Publication Data

Advances in fatigue lifetime predictive techniques/M. R. Mitchell
and R. W. Landgraf, editors.

p. cm.—(STP; 1122)

Includes bibliographical references and index.

ISBN 0-8031-1423-0

1. Materials—Fatigue. 2. Fracture mechanics. 3. Service life
(Engineering) I. Mitchell, M. R. (Michael R.), 1941–
II. Landgraf, R. W. III. Series: ASTM special technical
publications; 1122.

TA409.A39 1991

620.1'126—dc20

91-36055

CIP

Copyright © 1992 AMERICAN SOCIETY FOR TESTING AND MATERIALS, Philadelphia, PA. All rights reserved. This material may not be reproduced or copied, in whole or in part, in any printed, mechanical, electronic, film, or other distribution and storage media, without the written consent of the publisher.

Photocopy Rights

Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by the AMERICAN SOCIETY FOR TESTING AND MATERIALS for users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$2.50 per copy, plus \$0.50 per page is paid directly to CCC, 27 Congress St., Salem, MA 01970; (508) 744-3350. For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transactional Reporting Service is 0-8031-1423-0 92 \$2.50 + .50.

Peer Review Policy

Each paper published in this volume was evaluated by three peer reviewers. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM Committee on Publications.

The quality of the papers in this publication reflects not only the obvious efforts of the authors and the technical editor(s), but also the work of these peer reviewers. The ASTM Committee on Publications acknowledges with appreciation their dedication and contribution to time and effort on behalf of ASTM.

Printed in Baltimore, Md.

January 1992

Foreword

The ASTM Symposium on Advances in Fatigue Lifetime Predictive Techniques was held on 24 April 1990 in San Francisco, California. ASTM Committee E-9 on Fatigue sponsored the event.

The symposium chairmen and editors of this volume were M. R. Mitchell, Rockwell International, Science Center, Thousand Oaks, California, and R. W. Landgraf, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Contents

Overview	1
-----------------	---

GENERAL APPROACHES

Fatigue Mechanics: An Assessment of a Unified Approach to Life Prediction— J. C. NEWMAN, JR., E. P. PHILLIPS, M. H. SWAIN, AND R. A. EVERETT, JR.	5
A Fracture Mechanics Based Model for Cumulative Damage Assessment As Part of Fatigue Life Prediction— M. VORMWALD, P. HEULER, AND T. SEEGER	28

ELEVATED TEMPERATURE PHENOMENA

Thermo-Mechanical Fatigue Life Prediction Methods— H. SEHITOGLU	47
Evaluation of the Effect of Creep and Mean Stress on Fatigue Life Using a Damage Mechanics Approach— N. M. ABUELFOUTOUH	77
Cumulative Creep-Fatigue Damage Evolution in an Austenitic Stainless Steel— M. A. MCGAW	84
Application of a Thermal Fatigue Life Prediction Model to High-Temperature Aerospace Alloys B1900 + Hf and Haynes 188— G. R. HALFORD, J. F. SALTSMAN, M. J. VERRILLI, AND V. ARYA	107
Thermomechanical and Bithermal Fatigue Behavior of Cast B1900 + Hf and Wrought Haynes 188— G. R. HALFORD, M. J. VERRILLI, S. KALLURI, F. J. RITZERT, R. E. DUCKERT, AND F. A. HOLLAND	120
Elevated Temperature Crack Growth in Aircraft Engine Materials— T. NICHOLAS AND S. MALL	143

SPECTRUM LOADING

Near-Threshold Fatigue Crack Growth Prediction under Spectrum Loading— R. SUNDER	161
Contribution of Individual Load Cycles to Crack Growth under Aircraft Spectrum Loading— R. SUNDER	176
Fatigue Crack Growth from Narrow-Band Gaussian Spectrum Loading in 6063 Aluminum Alloy— P. S. VEERS AND J. A. VAN DEN AVYLE	191

Modeling High Crack Growth Rates under Variable Amplitude Loading—
D. J. DOUGHERTY, A. U. DE KONING, AND B. M. HILLBERRY 214

**A Probabilistic Fracture Mechanics Approach for Structural Reliability Assessment
of Space Flight Systems—**S. SUTHARSHANA, M. CREAGER, D. EBBELER, AND
N. MOORE 234

MULTIAXIAL BEHAVIOR

A Multiaxial Fatigue Life Estimation Technique—J. A. BANNANTINE AND
D. F. SOCIE 249

Small Crack Growth in Multiaxial Fatigue—S. C. REDDY AND A. FATEMI 276

Failure Modes in a Type 316 Stainless Steel under Biaxial Strain Cycling—
S. Y. ZAMRIK, D. C. DAVIS, AND P. J. KULOWITCH 299

Nonproportional Fatigue of Welded Structures—A. SILJANDER, P. KURATH, AND
F. V. LAWRENCE, JR. 319

APPLICATIONS

**Damage Evaluation in Composite Materials Using Thermographic
Stress Analysis—**D. ZHANG AND B. I. SANDOR 341

**Fatigue Life Prediction and Experimental Verification for an Automotive
Suspension Component Using Dynamic Simulation and Finite Element
Analysis—**W. K. BAEK AND R. I. STEPHENS 354

Plasticity and Fatigue Damage Modeling of Severely Loaded Tubing—S. M. TIPTON
AND D. A. NEWBURN 369

**Electric-Potential-Drop Studies of Fatigue Crack Development in Tensile-Shear Spot
Welds—**M. H. SWELLAM, P. KURATH, AND F. V. LAWRENCE 383

**Life Prediction of Circumferentially Grooved Components under Low-Cycle
Fatigue—**K. HATANAKA, T. FUJIMITSU, S. SHIRAISHI, AND J. OMORI 402

**Reliability Centered Maintenance for Metallic Airframes Based on a Stochastic
Crack Growth Approach—**S. D. MANNING, J. N. YANG, F. L. PRETZER, AND
J. E. MARLER 422

On the Prediction of the Fatigue Propagation of Semi-Elliptical Defects—
W. O. SOBOYEJO 435

Analytical and Experimental Investigation of Fatigue in Lap Joints—
D. V. SWENSON, C. CHIH-CHIEN, AND T. G. DERBER 449

Fatigue Lifetime Monitoring in Power Plants—P. C. RICCARDELLA, A. F. DEARDORFF, AND T. J. GRIESBACH	460
Fatigue Analysis Techniques for Vintage Steam Turbine/Generator Components—H. R. JHANSALE AND D. R. McCANN	474
Author Index	491
Subject Index	493

