

LOW-CYCLE FATIGUE AND LIFE PREDICTION

Amzallag/Leis/Rabbe, *editors*

 **STP 770**

LOW-CYCLE FATIGUE AND LIFE PREDICTION

A symposium
sponsored by
French Metallurgical Society
and ASTM
Firminy, France, 23–25 Sept. 1980

ASTM SPECIAL TECHNICAL PUBLICATION 770
C. Amzallag, Creusot-Loire
B. N. Leis, Battelle Columbus Laboratories
P. Rabbe, Creusot-Loire
editors

ASTM Publication Code Number (PCN)
04-770000-30



1916 Race Street, Philadelphia, Pa. 19103

Copyright © by AMERICAN SOCIETY FOR TESTING AND MATERIALS 1982
Library of Congress Catalog Card Number: 81-70264

NOTE

The Society is not responsible, as a body,
for the statements and opinions
advanced in this publication.

Printed in Baltimore, Md. (a)
August 1982

Foreword

The International Symposium on Low Cycle Fatigue and Life Prediction, sponsored by the French Metallurgical Society and ASTM, was held in Firminy, France, on 23–25 September 1980. C. Amzallag and P. Rabbe, Creusot-Loire, served as chairmen. Messrs. Amzallag and Rabbe, and B. N. Leis, Battelle Columbus Laboratories, have edited this publication.

Related ASTM Publications

**Design of Fatigue and Fracture Resistant Structures, STP 761 (1982),
04-761000-30**

**Methods and Models for Predicting Fatigue Crack Growth under Random
Loading, STP 748 (1981), 04-748000-30**

Statistical Analysis of Fatigue Data, STP 744 (1981), 04-744000-30

**Fatigue Crack Growth Measurement and Data Analysis, STP 738 (1981),
04-738000-30**

Tables for Estimating Median Fatigue Limits, STP 731 (1981), 04-731000-30

Fatigue of Fibrous Composite Materials, STP 723 (1981), 04-723000-33

**Effect of Load Variables on Fatigue Crack Initiation and Propagation, STP
714 (1980), 04-714000-30**

Part-Through Crack Fatigue Life Prediction, STP 687 (1979), 04-687000-30

Fatigue Mechanisms, STP 675 (1979), 04-675000-30

**Service Fatigue Loads Monitoring, Simulation, and Analysis, STP 671 (1979),
04-671000-30**

**Cyclic Stress-Strain and Plastic Deformation Aspects of Fatigue Crack
Growth, STP 637 (1977), 04-637000-30**

A Note of Appreciation to Reviewers

This publication is made possible by the authors and, also, the unheralded efforts of the reviewers. This body of technical experts whose dedication, sacrifice of time and effort, and collective wisdom in reviewing the papers must be acknowledged. The quality level of ASTM publications is a direct function of their respected opinions. On behalf of ASTM we acknowledge with appreciation their contribution.

ASTM Committee on Publications

Editorial Staff

Jane B. Wheeler, *Managing Editor*
Helen M. Hoersch, *Senior Associate Editor*
Helen P. Mahy, *Senior Assistant Editor*
Allan S. Kleinberg, *Assistant Editor*
Virginia M. Barishek, *Assistant Editor*

Contents

Introduction	1
RESEARCH	
Influence of Microstructure on Elevated-Temperature Fatigue Resistance of a Titanium Alloy—C. HOFFMANN, D. EYLON, AND A. J. McEVILY	5
Low-Cycle Fatigue Damage Accumulation of Aluminum Alloys—C. BATHIAS, M. GABRA, AND D. ALIAGA	23
Creep and Cyclic Tension Behavior of a Type 316 Stainless Steel at Room Temperature—A. M. NOMINE, D. DUBOIS, D. MIANNAY, P. BALLADON, AND J. HERITIER	45
Evaluation of the Resistance of Type 316 Stainless Steel Against Progressive Deformation—A. PELLISSIER-TANON, J. L. BERNARD, C. AMZALLAG, AND P. RABBE	69
Lifetime Predictions and Cumulative Damage under High-Temperature Conditions—J. L. CHABOCHE	81
An Evaluation of Four Creep-Fatigue Models for a Nickel-Base Superalloy—H. L. BERNSTEIN	105
Damage Accumulation and Fracture Life in High-Temperature Low-Cycle Fatigue—V. M. RADHAKRISHNAN	135
Behavior in Fatigue-Relaxation of a High-Creep Resistant Type 316L Stainless Steel—M. MOTTOT, P. PÉTREQUIN, C. AMZALLAG, P. RABBE, J. GRATTIER, AND S. MASSON	152
Assessment of High-Temperature Low-Cycle Fatigue Life of Austenitic Stainless Steels by Using Intergranular Damage as a Correlating Parameter—C. LEVAILLANT AND A. PINEAU	169
Cumulation of High-Temperature Low-Cycle Fatigue Damage in Two-Temperature Tests—J. REUCHET, M. REGER, F. REZAI-ARIA, AND L. RÉMY	194

Low-Cycle Fatigue Damage Mechanisms in Body-Centered-Cubic Materials—T. MAGNIN AND J. H. DRIVER	212
Effect of Discontinuities on Low-Cycle Fatigue Behavior of NiMoV Rotor Forging Steel—G. A. MILLER, T-T. SHIH, H. S. REEMSNYDER, AND C. E. SWENSON	227
Application of Low-Cycle Fatigue Test Results to Crack Initiation from Notches—M. TRUCHON	254
Prediction Capability and Improvements of the Numerical Notch Analysis for Fatigue Loaded Aircraft and Automotive Components—H. NOWACK, D. HANSCHMANN, J. FOTH, G. LÜTJERING, AND G. JACOBY	269
Low-Cycle Fatigue Behavior of Thick High-Strength Steel Plates for Pressure Vessels—R. D'HAEYER AND P. SIMON	296
Low-Cycle Fatigue Behavior of Welded Joints in High-Strength Steels—H.-P. LIEURADE AND C. MAILLARD-SALIN	311
Growth of Short Cracks During High Strain Fatigue and Thermal Cycling—R. P. SKELTON	337
Prediction of Fatigue Life of Smooth Specimens of SG Iron by Using a Fracture Mechanics Approach—M. S. STARKEY AND P. E. IRVING	382
Growth of Physically Short Corner Cracks at Circular Notches—B. N. LEIS AND R. D. GALLIHER	399
Fatigue Crack Initiation of Cr-Mo-V Steel in High-Temperature Environment—KAORU WADA, YUTAKA IINO, AND MASAHIKO SUZUKI	422
Fatigue Behavior of Carbon Steel Components in High-Temperature Water Environments—S. RANGANATH, J. N. KASS, AND J. D. HEALD	436
Effect of Light-Water Reactor Environments on Fatigue Crack Growth Rate in Reactor Pressure Vessel Steels—KARI TÖRRÖNEN AND W. H. CULLEN, JR.	460
Two Decades of Progress in the Assessment of Multiaxial Low-Cycle Fatigue Life—M. W. BROWN AND K. J. MILLER	482
Multiaxial Nonproportional Cyclic Deformation—D. L. McDOWELL, D. F. SOCIE, AND H. S. LAMBA	500

Low-Cycle Fatigue under Biaxial Strain—A. MOGUEROU, R. VASSAL, G. VESSIERE, AND J. BAHUAUD	519
---	------------

APPLICATIONS

The Concept of Uniform Scatter Bands for Analyzing <i>S-N</i> Curves of Unnotched and Notched Specimens in Structural Steel— E. HAIBACH AND C. MATSCHKE	549
Fatigue Life Evaluation of the A-7E Arresting Gear Hook Shank— D. J. WHITE, J. R. ELLIS, C. E. DUMESNIL, AND T. D. GRAY	572
Use of Low-Cycle Fatigue Data for Pressure Vessel Design—C. W. LAWTON	585
Materials-Data Needs for Fatigue Design of Pressure Vessel Systems— C. E. JASKE	600
Influence of Local Strain Distribution on Low-Cycle Fatigue Behavior of Thick-Walled Structures—VATROSLAV GRUBISIC AND C. M. SONSINO	612

SUMMARY

Summary	633
Index	639

