

Fatigue & Fracture Mechanics

35th Volume

*Richard E. Link
Kamran M. Nikbin
Editors*

STP 1480



STP 1480

Fatigue and Fracture Mechanics: 35th Volume

Richard E. Link and Kamran M. Nikbin, editors

ASTM Stock Number: STP1480



ASTM International
100 Barr Harbor Drive
PO Box C700
West Conshohocken, PA 19428-2959

Printed in the U.S.A.

Library of Congress Cataloging-in-Publication Data
ISBN: 978-0-8031-3406-5
ISBN: 0-8031-3406-1

Copyright © 2007 AMERICAN SOCIETY FOR TESTING AND MATERIALS INTERNATIONAL, West Conshohocken, 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, personal, or educational classroom use, or the internal, personal, or educational classroom use of specific clients, is granted by the American Society for Testing and Materials International (ASTM) provided that the appropriate fee is paid to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923; Tel: 978-750-8400; online: <http://www.copyright.com/>.

Peer Review Policy

Each paper published in this volume was evaluated by two peer reviewers and at least one editor. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM International 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 the peer reviewers. In keeping with long-standing publication practices, ASTM International maintains the anonymity of the peer reviewers. The ASTM International Committee on Publications acknowledges with appreciation their dedication and contribution of time and effort on behalf of ASTM International.

Foreword

The Fifth International ASTM/ESIS Symposium on Fatigue and Fracture (35th ASTM National Symposium on Fatigue and Fracture Mechanics) was held in Reno, Nevada on 18-20 May 2005. ASTM International Committee E08 on Fatigue and Fracture and the European Structural Integrity Society (ESIS) served as sponsors. The symposium chairmen and co-editors of this volume were Richard E. Link, United States Naval Academy, Annapolis, MD and Kamran Nikbin, Imperial College, London, England.

Kamran Nikbin
Imperial College

Richard Link
United States Naval Academy

Contents

Overview	vii
SEDLOW LECTURE	
Trends in High Temperature Structural Integrity Assessment— G. A. WEBSTER	3
CREEP ASSESSMENT	
European Code of Practice for Creep Crack Initiation and Growth Testing of Industrially Relevant Specimens—B. DOGAN, U. CEYHAN, K. M. NIKBIN, B. PETROVSKI, AND D. W. DEAN	23
Creep Crack Growth Predictions in Component Using a Damage Based Approach—M. YATOMI AND K. M. NIKBIN	43
Modelling the Redistribution of Residual Stresses at Elevated Temperature in Components—H. LEE AND K. M. NIKBIN	54
CREEP MODELING	
Probabilistic Analysis of the Creep Crack Growth Rate of Type 316LN Stainless Steel by the Monte Carlo Simulation—W. G. KIM, S. J. KIM, W. S. RYU, AND S. N. YOON	71
Mechanistic Studies of High-Temperature Crack Initiation in Single Crystal Materials—E. P. BUSO, N. P. O'DOWD, AND L. G. ZHAO	81
Creep Crack Growth Analysis of Welded Joints for High Cr Heat Resisting Steel— M. TABUCHI, H. HONGO, T. WATANABE, AND A. T. YOKOBORI, JR.	93

Prediction of Scatter in Creep Crack Growth Data from Creep Failure Strain Properties—K. WASMER, K. M. NIKBIN, AND G. A. WEBSTER	102
Analysis of Creep Crack Initiation and Growth in Different Geometries for 316H and Carbon Maganese Steels—C. M. DAVIES, F. MUELLER, K. M. NIKBIN, N. P. O'DOWD, AND G. A. WEBSTER	115
FATIGUE DAMAGE AND ANALYSIS	
Fatigue Strength in Presence of Inhomogeneities: Influence of Constraint—S. BERETTA, M. CARBONI, AND M. MADIA	137
Detection of Crack Initiation by Observations of Free Surface-Condition—K. GOMI, K. FUKUDA, K. TANIUCHI, AND S. S. YOSHIDA	148
Volumetric and Surface Position Annihilation Studies of Fatigue Damage Accumulation in a Steel Alloy—C. D. GLANCEY AND R. R. STEPHENS	158
Elasto-Viscoplastic Behavior of the Ferritic Stainless Steel AISI 441-EN 1.4509 from Room Temperature to 850 Degree Celsius—P. O. SANTACREU, L. BUCHER, A. KOSTER, AND L. REMY	168
Life Prediction of Fretting Fatigue of Ti-6Al-4V—O. JIN, J. CALCATERRA, AND S. MALL	174
Verification of the Analytical Models in a Fracture Mechanics Based Approach to Modeling Fretting Fatigue—S. A. POST-DOMASKY, L. BROOKS, AND N. YOUNG	185
The Effect of Large Strain Cycling on the Fatigue Strength of Welded Joint—K. OKUYA AND Y. KONDO	195
A Robust Structural Stress Parameter for Evaluation of Multiaxial Fatigue of Weldments—P. DONG AND J. K. HONG	206
FATIGUE CRACK GROWTH	
Observations on Photo-Emission and the Process Zone of a Fatigue Crack—E. A. PATTERSON, F. A. DIAZ, AND J. R. YATES	225
Simulation on the Decrease in Threshold Stress Intensity Factor (SIF) Range due to High Maximum SIF—T. MESHII, K. ISHIHARA, AND T. ASAKURA	234
Anomalous Fatigue Crack Growth Data Generated Using the ASTM Standards—S. C. FORTH, J. C. NEWMAN, JR., AND R. G. FORMAN	244
Development of a Circumferentially Throughwall Cracked Tube Specimen for Fatigue Crack Growth Rate Tests—B. A. YOUNG, W. A. VAN DER SLUYS, AND P. J. KING	256

ENVIRONMENTAL FRACTURE

- Effect of Microstructure on Pit-to-Crack Transition of 7075-T6 Aluminum Alloy—**
K. JONES AND D. HOEPFNER 271
- The Role of Applied Potential on Environment-Assisted Cracking of Zirconium**
Alloys—A. K. ROY, U. VALLIYIL, AND E. GOVINDARAJ 281

FRACTURE MECHANICS ANALYSIS

- Elastic T-Stress Solutions of Embedded Elliptical Cracks Subjected to Uniaxial**
and Biaxial Loadings—J. QU AND X. WANG 295
- Asymptotic Stress Fields for Thermomechanically Loaded Cracks in FGMs—**
N. JAIN, R. CHONA, AND A. SHUKLA 309
- Experimental Evaluation of the J or C Parameter for a Range of Crack Geometries—**
C. M. DAVIES, M. KOURMPETIS, N. P. O'DOWD, AND K. M. NIKBIN 321

FRACTURE TOUGHNESS AND CONSTRAINT

- An Experimental and Numerical Study on the Fracture Strength Of Welded Structural**
Hollow Section X-Joints—T. BJORK, G. MARQUIS, V. PELLIKKA, AND R. ILVONEN 343
- Constraint Corrected J-R Curve and Its Application to Fracture Assessment for X80**
Pipelines—X. K. ZHU AND B. N. LEIS 357
- Use of Miniaturized Compact Tension Specimens for Fracture Toughness**
Measurements in the Upper Shelf Regime—E. LUCON, M. SCIBETTA, R. CHAOUADI, AND
E. VAN WALLE, 374
- An Investigation of Specimen Geometry Effects on the Fracture Behavior of a**
Polytetrafluoroethylene Polymer—J. A. JOYCE AND P. J. JOYCE 390
- Surface Roughness, Quasi-Static Fracture, and Cyclic Fatigue Effects on GFRP**
and CFRP-Concrete Bonded Interfaces—T. O. LAWRENCE AND D. BOYAJIAN 407

DUCTILE-BRITTLE TRANSITION

- Temperature Dependence and Variability of Fracture Toughness in the Transition**
Regime for A508 Grade 4N Pressure Vessel Steel—T. R. LEAX 425
- Application of the Reference Temperature to the Evaluation of Cleavage Fracture**
in HSLA-100 Steel—S. M. GRAHAM, G. P. MERCIER, AND B. P. L'HEUREUX 445
- Prediction of the Shape of the K_J Ductile-to-Ductile Transition Temperature Curve**
for Ferritic Pressure Vessel Steels Using the Material's Resistance to
Crack Extension K_J versus Δa Curve—G. WARDLE AND W. GEARY 457

DYNAMIC FRACTURE

Finite Element Simulation of Dynamic Crack Propagation for Complex Geometries without Remeshing—F. R. BIGLARI, A. REZAEINASAB, K. NIKBIN, AND I. SATTARIFAR	469
Analysis of Dynamic Fracture and Crack Arrest of an HSLA Steel in an SE(T) Specimen—R. E. LINK	485
Application of the Normalization Method to Dynamic Fracture Toughness Testing of Alloy 718—S. M. GRAHAM	511

Overview

This book is a presentation of work of several authors at the Fifth International ASTM/ESIS Symposium on Fatigue and Fracture, May 18–20, 2005, Reno, NV. Fatigue and fracture methodologies depend upon robust and accurate models of the damage accumulation and failure mechanisms that operate within the structures as well as an accurate characterization of the material response to the combined effects of loading, loading rate and environmental conditions. The combination of competing failure mechanisms and varying environmental conditions during the operational life of a component can make it a challenge to accurately predict its life. Hence the scope for this symposium captures the latest research covering state of the art work on fracture mechanics related topics such as fracture, fatigue, residual stress, creep, creep/fatigue, constraint and stress corrosion and links them to concepts used in structural integrity assessment. Furthermore the subject does not restrict itself to metallic materials but is applicable to polymers, composites as well as inhomogeneous materials. Papers and presentations delivered by nationally and internationally recognized authors were chosen to cover the general areas of modelling, testing and validation in crack dominant related research. It is felt that improvements in life assessment methods will only come about when validated fracture mechanics models are developed to produce verifiable predictions. Hence an emphasis on linking experimental and modelling techniques in the papers published in this volume should lead to the development of more accurate life assessment methods.

The papers contained in this publication represent the commitment of the ASTM Committee E-08 to providing the latest research information in the wide-ranging fracture mechanics field. The themes in the papers cover experimental results coupled to modelling techniques of linear, non-linear, time independent and dependant behaviour of cracked geometries of a range of materials. Papers relating to residual stress, crack tip constraint and probabilistic methods of analyses also highlight the importance of developing these fields for future improvements in life assessment methods.

Kamran Nikbin
Imperial College

Richard Link
United States Naval Academy

www.astm.org

Stock # STP1480
ISBN 978-0-8031-3406-5