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Creep-Fatigue Interactions: Test Methods and Models

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Foreword

THIS COMPILATION OF THE JOURNAL OF ASTM INTERNATIONAL (JAI), STP1539, Creep-Fatigue Interactions: Test Methods and Models, contains only the papers published in JAI that were presented at a Symposium on Creep-Fatigue Interactions: Test Methods and Models held during November 17–19, 2010 in San Antonio, TX, USA. The Symposium was sponsored by ASTM International Committee E08 on Fatigue and Fracture in cooperation with ICF and EPRI.

Dr. Ashok Saxena, University of Arkansas, Fayetteville, AR, USA and Dr. Bilal Dogan, EPRI, Charlotte, NC, USA served as the Symposium Co-Chairmen and JAI Guest Editors.
Contents

Overview. ...................................................................................................................... vii

Part I-Creep-fatigue Interactions in Ferritic and Austenitic Steels

Component Assessment Data Requirements from Creep-Fatigue Tests
S. R. Holdsworth ........................................................................................................... 3

ASTM Round-Robin on Creep-Fatigue and Creep Behavior of P91 Steel
V. Kalyanasundaram, A. Saxena, S. Narsimhachary, and B. Dogan .......................... 23

Evaluation of the Testing and Analysis Methods in ASTM E2760-10 Creep-Fatigue
Crack Growth Testing Standard for a Range of Steels
A. Mehmanparast, C. M. Davies, and K. M. Nikbin .................................................. 41

Characterizations of Creep-fatigue Crack Initiation and Growth Life for P92 using
Circular Notched Round Bar Specimen
Y. Hasegawa, and T. Matsuzaki .............................................................................. 67

Creep Fatigue Behavior of Creep Strength Enhanced Ferritic Steels
J. Parker ...................................................................................................................... 87

Advanced Ductility Exhaustion Methods for the Calculation of Creep Damage
During Creep-fatigue Cycling
M. W. Spindler and W. M. Payten ........................................................................... 102

Modeling Creep-Fatigue Behavior of Mod.9Cr-1Mo Steel
M. Li, S. Majumdar, and K. Natesan ......................................................................... 128

Models for Small Crack Growth under Creep-Fatigue in Austenitic Steels
R. P. Skelton .............................................................................................................. 142

Effect of Creep and Oxidation on the Isothermal and Thermomechanical Fatigue
Behavior of an Austenitic Stainless Steel
H.-J. Christ and V. Bauer ........................................................................................... 178

Creep Crack Growth Under Complex Loading
R. A. Ainsworth, D. W. Dean, and P. J. Budden .................................................... 198

Probabilistic Prediction of Crack Growth Based on Creep/Fatigue Damage
Accumulation Mechanism
Z. Wei, F. Yang, H. Cheng, and K. Nikbin .............................................................. 230

Part II-Creep-fatigue Interactions in Ni-base Alloys

Modeling Creep-Fatigue Deformation of Ni-Base Superalloys Using Crystal
Viscoplasticity
R. W. Neu and D. J. Smith ......................................................................................... 255

Influence of Protective Coatings on Damage and Lifetime of Alloy 247 DS in
Thermomechanical Fatigue and Bending Tests
O. Trunova, T. Beck, and L. Singheiser ..................................................................... 278

Effects of the Environment on the Crack Propagation Behavior of IN718 in the
Temperature Range of the Dynamic Embrittlement
K. Wackermann, U. Krupp, and H.-J. Christ .......................................................... 297
<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Effects of Dwell on the LCF Behavior of IN617</td>
<td>S. Shinde and P. Gravett</td>
<td>313</td>
</tr>
<tr>
<td>Creep-Fatigue at High Temperature of Notched Single Crystal Superalloys</td>
<td>M. Filippini</td>
<td>348</td>
</tr>
<tr>
<td>Author Index</td>
<td></td>
<td>375</td>
</tr>
<tr>
<td>Subject Index</td>
<td></td>
<td>377</td>
</tr>
</tbody>
</table>
Overview

Creep-fatigue interaction as a degradation mechanism is a primary design concern in fossil power-plant and nuclear power-plant components, and in land, sea and air based gas turbine hot-section components. The energy conversion efficiency of these plants and turbines is strongly dependent on the operating temperatures and as these temperatures rise to boost efficiency, creep damage and its interaction with fatigue becomes an increasing design and operational concern. This book is intended to describe the latest advances in the understanding of creep-fatigue interaction mechanisms and become an important reference on the topic for several years.

The papers in this Special Technical Publication (STP) were presented in a two and half day ASTM International symposium on Creep-Fatigue Interactions: Test Methods and Models held in San Antonio, Texas, during November 17–19, 2010. The symposium was co-sponsored by the Electric Power Research Institute (EPRI) and was also billed as an Inter-quadrennial of the International Congress on Fracture, ICF. The symposium addressed the latest research in the area of creep-fatigue crack formation and crack growth in high temperature materials and structures. Thirty-four papers on recent developments in experimental techniques, models for representing the data and applications to structures were presented in a single session format. The presentations included six plenary presentations, four keynote presentations and contributed papers. Eventually 17 papers were submitted and accepted for publication in the STP.

Over the past few years, this area of research has seen some major advances in technology. In just the past two years, ASTM has published two standards for conducting creep-fatigue testing; the first E 2714-2009 addresses test methods for characterizing the creep-fatigue crack formation properties while the other E 2714-2010 addresses the creep-fatigue crack growth properties. This progress has happened largely with international level cooperation between several research groups from Europe, Asia, and America facilitated by EPRI. Therefore, the time was right to document this progress by holding an international symposium and collecting the papers into this book.

The first part of the STP addresses creep-fatigue interaction behavior of ferritic steels and in austenitic stainless steels. The emphasis among the ferritic steels was entirely on the relatively new class of materials with high chromium content designated by ASTM as P91 and P92 class of steels. These materials are being used extensively in advanced, high efficiency fossil power plants. The papers in this STP on this topic deal with properties, test methods and the latest models for applying the test data to components. The
austenitic stainless-steels continue to be the favored materials in nuclear power-plants. The topics of papers presented on austenitic stainless-steel cover the same range as the papers on the ferritics.

The second part of the STP covers creep-fatigue interactions in Nickel-base superalloys being considered for use or already in use in advanced nuclear plants and in gas turbines. The materials covered are IN 617, IN 718 and directionally solidified alloy 247. One paper also addresses creep-fatigue interaction in single crystal materials. A few papers also deal with thermal-mechanical fatigue and with the behavior of protective thermal barrier coatings that enhance the creep-fatigue performance of the components.

The Organizing Committee consisted of Ashok Saxena, University of Arkansas (Co-chair) and Bilal Dogan, EPRI, (Co-chair), Kamran Nikbin, Imperial College; Jeff Evans, University of Alabama at Huntsville; Andrew Rosenberger, Air Force Research Laboratory, Wright Patterson Air Force Base; Andre Pineau, Ecole de Mines; Peter Skelton, Consultant; Yukio Takahashi, CREIPI, Japan; Stuart Holdsworth, EMPA, Switzerland; A.T. Yokobori, Sendai University, Japan; S. Kalluri, OAI/NASA-GRC; R. Ainsworth, British Energy- part of EDF Energy; Laura Carroll, INEL, Idaho, S.D. Antolovich, Washington State University; Richard Neu, Georgia Tech; David Taplin, ICF; Alberto Carpinteri, Politecnico di Torino; F. Masuyama, Kyushu Institute of Technology, Jonathan Parker, Structural Integrity Associates, Karl Maile, MPA Stuttgart; Helmuth Klingelhoffer, BAM, Berlin. Their invaluable contributions are very much appreciated. We also wish to acknowledge the contributions of all the authors and reviewers. The contributions of the ASTM Meetings staff and their publication Department staff are also gratefully acknowledged.

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