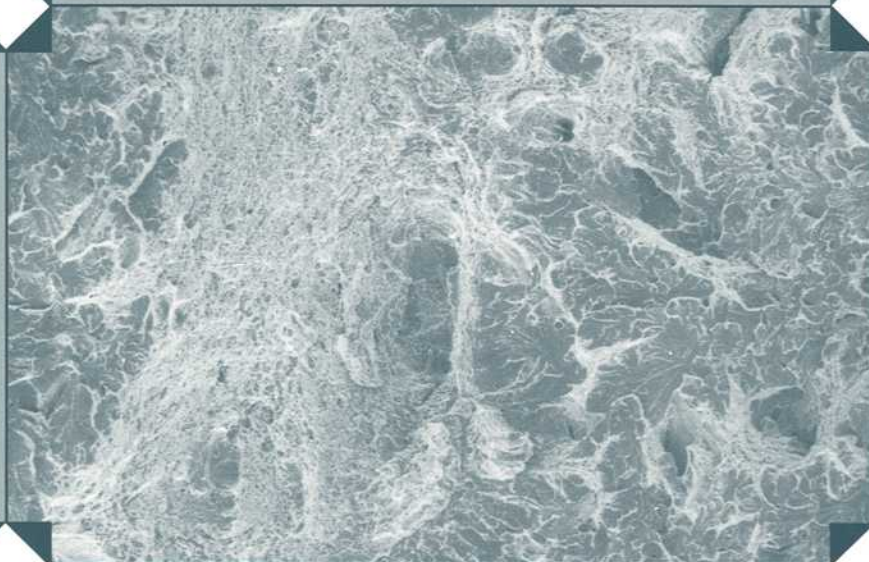


Rapid Load Fracture Testing



Chona/Corwin, editors



STP 1130

STP 1130

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ASTM Publication Code Number (PCN)
04-011300-30



ASTM
1916 Race Street
Philadelphia, PA 19103

Library of Congress Cataloging-in-Publication Data

Rapid load fracture testing/Ravinder Chona and William R. Corwin, editors.

(ASTM STP; 1130)

"ASTM publication code number (PCN) 04-011300-30."

Includes bibliographical references and index.

ISBN 0-8031-1429-X

1. Steel—Testing. 2. Metals—Impact testing. 3. Steel—Fracture. I. Chona, Ravinder.

II. Corwin, W. R. III. Series: ASTM special technical publication; 1130.

TA465.R37 1992

620.1'76—dc20

91-45387

CIP

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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.

Foreword

The symposium on Rapid Load Fracture Testing was presented in San Francisco, California, on 23 April 1990. ASTM Committee E-24 on Fracture Testing sponsored the symposium. Ravinder Chona, Texas A&M Univeristy, and William R. Corwin, Oak Ridge National Laboratory, served as chairmen of the symposium and editors of the resulting publication.

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Overview

The Symposium on Rapid Load Fracture Testing was organized by ASTM Task Group E-24.01.06 on Dynamic Fracture Toughness and Crack Arrest and was held in April 1990 in conjunction with the semiannual standards development meetings of ASTM Committee E 24 on Fracture Testing. The aim of the symposium was to review the state of the art with regard to the use of rapid loading to determine the fracture toughness behavior of ferritic steels in the ductile-to-brittle transition region. In particular, the symposium focused on test methods that could: reduce the amount of data scatter; illustrate or establish any relationships between K_{Ic} , K_{Ia} , and/or K_{Ja} ; provide lower-bound measures of fracture toughness; and improve the efficiency of testing with material of limited availability.

The papers presented at the symposium, and published in this volume following the usual ASTM peer-review process, described a variety of test techniques, specimen geometries, and data acquisition, analysis, and interpretation methods, all generally suited to loading times to failure of the order of 1 to 2 milliseconds or less. This may, at first, be somewhat puzzling to the reader, since it is generally recognized that the structural applications of interest would be unlikely to involve loadings at comparable rates. The rationale is, however, as follows. It has been demonstrated that, within the ductile-to-brittle transition region, the crack arrest fracture toughness, K_{Ia} , for a given temperature, is consistently below the initiation toughness, K_{Ic} , of the material, and can potentially serve as a conservative, lower-bound estimate of K_{Ic} . It has also been demonstrated that, at temperatures close to and below the nil ductility temperature, NDT, the values of K_{Ic} obtained from tests conducted with rapid loading times, following Annex A-7 of the ASTM Test for Plane-Strain Fracture Toughness of Metallic Materials (E 399) provide close estimates of K_{Ia} , with the required loading time being of the order of 5 milliseconds at temperatures close to the NDT. The usefulness of rapid loading in transition region testing, therefore, lies more in the increased probability for initiating a rapid, unstable, cleavage-type fracture, with little or no prior stable crack extension, when performing material characterization tests with small, laboratory-sized specimens. A brief summary of the contents of this volume follows.

A major area of interest from an applications standpoint is the establishment of safe operating pressure-temperature relationships for nuclear reactor pressure vessels. The paper by Server and Mager, which leads off this volume, provides an overall perspective of how the information obtained from this type of testing might be used and summarizes the current thinking regarding operating regulations from the viewpoint of the nuclear industry.

The next group of seven papers discusses a variety of loading techniques and specimen geometries as well as various methods for interpreting dynamically recorded signals to obtain fracture parameters. The first subgroup of three papers, by Irwin et al., Couque et al., and Homma et al., describe three rather different techniques for achieving cleavage fracture using short duration stress wave loading, while the second subgroup of four papers, by Kirk et al., KarisAllen and Morrison, Böhme, and McConnell, all address various aspects of testing using impact-loaded bend bars.

A somewhat different topic is addressed in the next paper by Tregoning et al., which describes an optical technique for monitoring the CTOD before and following initiation of a dynamically loaded, stationary crack.

The next two papers both use the ASTM Test for Determining the Plane-Strain Crack Arrest Fracture Toughness K_{Ia} of Ferritic Steels (E 1221): Varga and Schneeweiss describe crack-arrest toughness measurements using instrumented Charpy V-notch specimens and compare their results to those obtained with standard K_{Ia} specimens, while Underwood et al., discuss the application of ASTM Test E 1221 to a ship steel and compare the results for K_{Ia} to the values of K_{Ic} for the same material.

The final paper, by McGillivray and Cannon, describes a test method under development in the United Kingdom for determining the dynamic fracture toughness of metallic materials at loading rates that can be achieved using an impact-loading arrangement.

The overall goal of the symposium was to bring together a group of active researchers addressing the various aspects of using rapid-loading techniques when performing fracture toughness evaluations and to see if the presentations and subsequent discussions would indicate that a standardization effort was warranted at the present time. Considerable interest in the topic was evident, but more time is clearly needed before a consensus can be established on the most suitable methods for standardization activities. The potential usefulness of rapid loading for achieving the goal of reliable, lower-bound, transition region fracture toughness measurements is felt to be well documented by the contents of this volume, and it is hoped that this collection of papers will be the first in an ongoing series that will benchmark progress towards a useful and necessary standard.

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ISBN 0-8031-1429-X