

Introduction

Interest in elastic-plastic fracture mechanics grew as a natural extension of linear elastic fracture mechanics (LEFM) concepts when it became obvious that LEFM methods were not adequate to handle many problems in the design and reliability analysis of structural components. Some of the early elastic-plastic fracture parameters and crack-tip analyses were developed in the 1960's; in the early 1970's, however, work on elastic-plastic fracture characterization was greatly expanded. Many new parameters and methods of fracture prediction were introduced and interest in this topic became widespread.

This publication represents papers presented at the ASTM Committee E-24 sponsored Symposium on Elastic-Plastic Fracture held in Atlanta, Ga., in November 1977. The symposium was organized to provide a forum for presenting current work in this rapidly developing field. No single approach was taken in the papers presented; rather, a variety of parameters and methodologies was presented. For the most part the papers presented new approaches and new data; some of the papers presented summaries and applications of existing approaches.

The symposium was very successful in that a good cross section of workers presently engaged in elastic-plastic fracture studies was represented. Most of the methods presently being used were discussed. The work presented herein is a fairly accurate account of the present status of the elastic-plastic fracture field, which status is that work is progressing at a fairly rapid pace, new ideas are frequently introduced, different approaches are being attempted, and to date no single method has been adopted by all of the workers in this field.

The contents of this publication will be particularly useful to persons working in the elastic-plastic fracture field. This would include researchers involved in material property studies and structural analysis, designers, and persons concerned with safety and licensing. The contents of the book do not so much represent an end product in the development of elastic-plastic fracture; rather, they represent a step in the development of this field which should be followed by other important publications on the subject. Some of the papers may become dated as the technology advances and present techniques are discarded for new ones, while other papers may have more permanent value, marking the first introduction of a significant new concept.

Three major areas were covered in the symposium: fracture criteria and analysis; experimental evaluation and toughness testing; and applications

of elastic-plastic methodology, including the application of elastic-plastic fracture concepts to fatigue crack growth analysis. The analysis papers dealt mainly with the assessment of new and existing criteria. The present emphasis is on extending fracture prediction based on an initiation criterion to include the characterization of stable crack growth and ductile instability in the fracture process. Some of the criteria are mainly empirical while others are based on the postulation of a fracture mechanism. Finite-element analysis remains the most popular method for evaluating crack-tip behavior in the elastic-plastic regime.

Fracture toughness test results were directed at determining properties of materials for specific applications and at evaluating present fracture criteria. Many of the materials evaluated were steels used in the nuclear industry. Of particular interest were pressure vessel steels tested under dynamic loading and stainless steels. Experimental evaluation of existing fracture criteria dealt with the evaluation of test specimen size, the evaluation of analysis methods, and the use of advanced testing methods such as computer-based data acquisition and reduction systems.

The application of elastic-plastic techniques to the evaluation of structural components is directed toward fracture problems in pressure vessels, pipelines, and other structural members. Specific areas of given structures were often considered, generally areas of high stress concentration such as nozzle corners and notches. Special note was given to the application of elastic-plastic techniques to fatigue crack growth studies, particularly in the high-strain low-cycle regime.

The variety of topics covered should be of interest to a large number of researchers working in the elastic-plastic area. This publication represents the first major collection of papers devoted solely to the topic of elastic-plastic fracture.

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