

Overview

In the past four decades, the field of fracture mechanics has transitioned from a fundamental research topic to a mature, engineering discipline. Begun with the work by Griffith on glass and later extended to metals by Irwin, engineers today are equipped with the tools and techniques to characterize the behavior of cracks for a majority of structural materials and service conditions. Methodologies have been developed by researchers to model fracture in linear-elastic, elastic-plastic, and viscoelastic/viscoplastic materials and conditions. Regardless of the method used, however, the fundamental ingredients required to properly characterize fracture behavior are the stress state and crack size. With the increasing availability of analytical tools such as finite element analysis, engineers can describe the stress on a component with excellent accuracy. Likewise for the experimentalist tasked with empirically characterizing fracture related properties of materials, test equipment has matured to the point that loading conditions on a component or specimen can be determined accurately and maintained to well within a percentage of desired conditions. However, the ability to accurately measure crack size and similarly crack extensions in the range of tens of microns often remains a formidable task, even for the most experienced researcher.

Historically, crack size measurements for most test applications began with visual examination of the specimen under test. Situations quickly arose, however, where such visual measurements were either inaccurate or impractical, forcing researchers to develop nonvisual means for determining crack size. Refinements in automated crack size methodology have evolved over the years to include the now commonly employed compliance and electric potential difference techniques. These methods, though pioneered years ago, have been incorporated eventually into the ASTM standards for crack size determination under fatigue (E 647), static (E 1457), and quasi-static (E 813 and E 1152) loading conditions, just to name a few. Though such procedures are carefully outlined for a majority of standardized tests, unique situations or materials or both often require the experimentalist to modify or devise new procedures for the precise measurement of crack size.

Sensing the need of researchers to keep abreast of continual improvements, as well as providing a better understanding of existing methods for crack measurement techniques, the ASTM Committee on Fatigue and Fracture (E8) sponsored a one-day symposium in Atlanta, Georgia, on 19 May 1993 to review a number of unique applications and advanced techniques that researchers are currently employing for crack size determination. Information presented at the symposium and included in this volume should prove useful to the most experienced experimentalist as well as those less familiar with such nonvisual approaches. Methods are described for the measurement of surface crack size, multiple site cracking, and cracking under nonisothermal conditions using AC potential difference procedures. Influences of crack deflection and crack splitting on DC potential calibrations are discussed. Compliance techniques using a laser micrometer, as well as a load-ratio method for predicting crack size, are described for standard laboratory test specimens. Ultrasonic methods for crack measurement are presented for situations involving specimens containing large closure regions, metal matrix composites, and the in situ measurement of crack size and crack opening parameters during actual testing conditions. Finally, a novel approach using an AC magnetic bridge device for quantifying crack size in aluminum specimens is described in detail.

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