Elastic Plastic Fracture Mechanics

Grundlegende Prinzipien und Arbeitsmethoden der Bruch- und Mikromechanik: Im Vordergrund steht die mechanische Beschreibung, wobei diese Einführung auch materialspezifische Aspekte diskutiert. Auf kontinuumsmechanische Grundlagen folgt ein Einblick in die klassischen Bruch- und Versagenshypothesen sowie in makro- und mikroskopische Phänomene des Bruchs. Ein umfangreicher Teil ist der linearen und elastisch-plastischen Bruchmechanik gewidmet.

- self-contained and well illustrated - complete and comprehensive derivation of mechanical/mathematical results with enphasis on issues of practical importance - combines classical subjects of fracture mechanics with modern topics such as microheterogeneous materials, piezoelectric materials, thin films, damage - mechanically and mathematically clear and complete derivations of results

The objective of this paper is to present, as simply as possible, an explanation of the J-integral methods of elastic-plastic fracture mechanics. Its rationale as an extension of the linear-elastic fracture mechanics is emphasized. Other methods, such as crack-opening displacement and equivalent-energy methods, are contrasted with the J-integral methods for both analysis and applications to material characterization. Finally, the broad applicability and usefulness of the J-integral methods are also emphasized.

George Irwin, the father of fracture mechanics (FM), is well known for his contributions to linear elastic fracture mechanics, especially the development of the crack-tip field approach and the use of the crack tip stress intensity factor, K. During the early years of FM he was well aware that the limits on the use of K restricted its application to high-strength and low-toughness materials. He encouraged the development of new concepts that would be able to extend the use of FM to the more usual engineering materials, materials that might reach yield stress before fracture toughness on a typical structural component. Concern with that area of FM later led to the development of the technology called elastic-plastic fracture mechanics (EPFM). Besides the encouragement he gave, there are several areas where he contributed technical ideas that helped with the development of the EPFM technology. These ideas include use of crack tip field parameters, the energy and crack tip parameter equivalence, the R-curve approach to fracture toughness evaluation and the concern about constraint effects on fracture behavior.

Fatigue failures invariably start at a surface notch. Crack initiation is due to plasticity while crack propagation can continue in an elastically stressed material due to the crack generating its own crack tip plasticity.

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This book looks at an extension of fracture mechanics to cases where significant plasticity may be associated with the growth of a crack in a material, and how assessments of possible failures are performed in such cases.This book requires the K Calculator available on the CD-ROM (order code T357/CDR01).

The Crack Tip Opening Displacement in Elastic-Plastic Fracture MechanicsProceedings of the Workshop on the CTOD Methodology GKSS-Forschungszentrum Geesthacht, GmbH, Geesthacht, Germany, April 23–25, 1985Springer Science & Business Media

Application of linear elastic and elastic-plastic fracture mechanics parameters to high-temperature fatigue crack growth is examined to determine which parameter provides a better correlation of crack growth data. It is concluded that the J-integral concept is applicable to fatigue, and methods of determination of J for both load-controlled and displacement-controlled fatigue are discussed. The J-integral parameter is shown to be better than the linear elastic parameter K in correlating fatigue crack growth, particularly so in materials that undergo metallurgical changes during test resulting in changes in flow properties. Application of the J-integral concept to time-dependent and combined cycle and time-dependent crack growth is discussed in detail.

Fracture and Fatigue: Elasto-Plasticity, Thin Sheet and Micromechanisms Problems covers the proceedings of the Third Colloquium on Fracture. The book discusses the development and applications of fracture mechanics. The contents of the text are organized according to the areas of concerns. The first part deals with elasto-plastic fracture mechanics, which includes topics such as fracture mechanics in the elastic-plastic regime and sizing of the geometry dependence and significance of maximum load toughness values. Part II covers the micromechanisms of fracture, which includes the aspects of crack growth under monotonic loading and the effect of secondary hardening on the fracture toughness of a bainitic microstructure. Part III concerns itself with thin sheet fracture mechanics, which includes R-curves evaluation for center-cracked panels and use of the R-curve for design with contained yield. The book will be of great interest to researchers and professionals whose work involves fracture mechanics.

Proceedings of the 4th Advanced Seminar on Fracture Mechanics, Joint Research Centre, Ispra, Italy, October 24-28, 1983

NASA's Ares 1 Upper Stage Simulator (USS) is being fabricated from welded A516 steel. In order to insure the structural integrity of these welds it is of interest to calculate the critical initial flaw size (CIFS) to establish rational inspection requirements. The CIFS is in turn dependent on the critical final flaw size (CFS), as well as fatigue flaw growth resulting from transportation, handling and service-induced loading. These calculations were made using linear elastic fracture mechanics (LEFM), which are thought to be conservative because they are based on a lower bound, so called elastic, fracture toughness determined from tests that displayed significant plasticity. Nevertheless, there was still concern that the yield magnitude stresses generated in the flange-to-skin weld by the combination of axial stresses due to axial forces, fit-up stresses, and weld residual stresses, could give rise to significant flaw-tip plasticity, which might render the LEFM results to be non-conservative. The objective of the present study was to employ Elastic Plastic Fracture Mechanics (EPFM) to determine CFS values, and then compare these values to CFS values evaluated using LEFM. CFS values were calculated for twelve cases involving surface and embedded flaws, EPFM analyses with and without plastic shakedown of the stresses, LEFM analyses, and various welding residual stress distributions. For the cases examined, the computed CFS values based on elastic analyses were the smallest in all instances where the failures were predicted to be controlled by the fracture toughness. However, in certain cases, the CFS values predicted by the elastic-plastic analyses were smaller than those predicted by the elastic analyses; in these cases the failure criteria were determined by a breakdown in stress intensity factor validity limits for deep flaws (a greater than 0.90t), rather than by the fracture toughness. Plastic relaxation of stresses accompanying shakedown always increases the calculated CFS values compared to the CFS values determined without shakedown. Thus, it is conservative to ignore shakedown effects. Chell, G. Graham and Hudak, Stephen J., Jr. Langley Research Center ARES 1 UPPER STAGE; FLANGES; WELD STRENGTH; FRACTURE MECHANICS; ELASTIC PROPERTIES; PLASTIC PROPERTIES; CRACKS; STRUCTURAL ENGINEERING; FATIGUE (MATERIALS); MECHANICAL ENGINEERING; AXIAL STRESS; FRACTURE STRENGTH; CRACK INITIATION; CRACK PROPAGATION

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