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Book Reviews

Fracture Mechanics Methodology. Edited by G. C. Sih and L. Faria. Martinus Nijhoff, The Netherlands, 1984. 177 Pages. Price: $45.00.

REVIEWED BY C. H. POPELAR[1]

This book is one in the series on Engineering Application of Fracture Mechanics. The book is a product of lectures prepared for a short course on Fracture Mechanics Methodology in Lisbon from June 1–June 4, 1981. While the main emphasis of the book is the application of fracture mechanics to aircraft structures, many of the principles are applicable to other flawed members. The treatment is essentially confined to linear-elastic fracture mechanics. The fracture mechanics methodology expounded in the first two chapters (constituting over one-half of the book) is based on the strain energy density approach. The remaining chapters deal with the conventional linear-elastic fracture mechanics approach based on a critical stress intensity factor. Each of the book's five chapters is written by a different author.

In Chapter 1, R. Bodaliance treats the subject of fatigue-life predictions in metals and composites using the strain energy density approach. It is demonstrated that good agreement can be obtained between predicted and measured crack growth in metals under mixed-mode loading by integrating cycle by cycle the fatigue crack growth rate as a function of the range of the strain energy density factor deduced from constant amplitude Mode *I* tests. The fatigue life of composites is shown to correlate with a parameter based on the strain energy density modeling microcracks in the laminate matrix.

Chapter 2 by G. C. Sih contains the fundamental hypotheses and the theoretical development of the strain energy density approach. A more logical progression for those unfamiliar with this approach would have this chapter as the first one. The relationship between the strain energy density factor and the stress intensity factors of the three crack tip modes of deformation is established for small scale yielding. With such a relation the critical value of the strain energy density factor can be obtained when the Mode *I* fracture toughness is known. Several examples of the application of the approach within the confines of linear-elastic fracture mechanics are given. The use of the strain energy density in predicting ductile and fatigue crack growth is discussed. The chapter concludes with a comparison of the virtues of the strain energy density approach relative to alternative approaches to ductile fracture such as: the Irwin plastic zone correction, *J*-integral, critical strain, crack opening displacement, and resistance curve.

In Chapter 3 O. Orringer treats failures due to damage modes other than a sharp crack. This chapter contains several case studies of failures in railroad systems. Failure analysis based on spectral analysis of service load data is developed. Life prediction of structural components using linear damage rules and conventional fatigue crack growth methods are discussed.

Chapter 4 by C. M. Branco reviews the flaw acceptance method; i.e., ascertaining whether or not a detected flaw is acceptable for safe performance of a component. The British Standard PD6493 (1980) approach for determining acceptable defect levels is presented. While specifically developed for welded joints, its application to aircraft structures for stress levels below the yield strength is discussed. When significant inelastic behavior exists, the method tends to be overly conservative and an inelastic approach is required.

In Chapter 5, L. Faria reviews briefly the probabilistic approach for assessing the reliability of a structural design.

Whenever chapters of a book are authored by different individuals, there is the risk of inconsistent notation. This book is no exception. For example, *S* has been used in the first two chapters to denote the strain energy density factor whereas it denotes stress in the next two chapters and the factor of safety in the final chapter. To the authors credit, they have been careful to note the different meanings attributed to *S*. Aside from this irritant the book is well written. It is interspersed with application of fracture mechanics to the investigation of real failures. This book should be of interest to those concerned with the evaluation of the structural integrity of components.

Incompressible Flow. By Ronald L. Panton. Wiley, New York, 1984. 780 Pages. Price $44.95.

REVIEWED BY S. A. BERGER[2]

This advanced treatment of the fundamentals of fluid dynamics is designed as a text for graduate students in

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