Introduction

Since the development of fracture mechanics, the materials scientists and design engineers have had an extremely useful concept with which to describe quantitatively the fracture behavior of solids. The use of fracture mechanics has permitted the materials scientists to conduct meaningful comparisons between materials on the influence of microstructure, stress state, and crack size on the fracture process. To the design engineer, fracture mechanics has provided a methodology to use laboratory fracture data (such as tests on compact specimens) to predict the fracture behavior of flawed structural components.

Many of the engineering applications of fracture mechanics have been centered around linear-elastic fracture mechanics (LEFM). This concept has proved to be invaluable for the analysis of brittle high-strength materials. LEFM concepts, however, become inappropriate when ductile low-strength materials are used. LEFM methods also become inadequate in the design and reliability analysis of many structural components. To meet this need, much experimental and analytical effort has been devoted to the development of elastic-plastic fracture mechanics (EPFM) concepts. Over the past two decades, many EPFM methods have been developed to assess the toughness of metallic materials and to predict failure of cracked structural components. However, for materials that exhibit large amounts of plasticity and stable crack growth prior to failure, there is no consensus of opinion on the most satisfactory method. To assess the accuracy and usefulness of many of these methods, an experimental and predictive round robin was conducted in 1979–1980 by Task Group E24.06.02 under the Applications Subcommittee of the ASTM Committee E-24 on Fracture Testing. The objective of the round robin was to verify experimentally whether the fracture analysis methods currently used could predict failure (maximum load or instability load) of complex structural components containing cracks from results of laboratory fracture toughness test specimens (such as the compact specimen) for commonly used engineering materials and thicknesses.

The ASTM Task Group E24.06.02 had also undertaken the task of organizing the documentation of various elastic-plastic fracture mechanics methods to assess flawed structural component behavior. The task group co-chairmen asked for the participation of interested members and, thus, six groups representing different methods were formed. These groups and corresponding chairmen were: (1) K_R-Resistance Curve Method, Chairmen D. E. McCabe and K. H. Schwalbe; (2)

Deformation Plasticity Failure Assessment Diagram (R-6), Chairman J. M. Bloom; (3) Dugdale Strip Yield Model with K_R-Resistance Curve Method, Chairman R. deWit, which is Appendix X of the first paper in this publication; (4) J_R-Resistance Curve Method, Chairmen H. A. Ernst and J. D. Landes; and (5) Crack-Tip-Opening Displacement (CTOD/CTOA) Approach, Chairman J. C. Newman, Jr. The chairmen were assigned the task of producing a written document explaining in detail a particular method following a common outline. The major objectives of these documents were to explain what laboratory tests were needed to determine the appropriate fracture parameter(s) and to demonstrate how the method is used to predict failure of cracked structural components.

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