Foreword

This book, along with the forthcoming publication *Fatigue of Materials and Structures: Application to Damage and Design* (edited by C. Bathias), is the most comprehensive compilation of current approaches in the field of fatigue of materials and structures under repeated loads/loadings of various types. Historic methods, as well as the most recent approaches and current research, are included. Professors Claude Bathias and André Pineau have selected a group of outstanding experts on the various topics in the field for each chapter and have themselves contributed to some chapters dealing with their specialties. These books are great references for anyone wishing to be up-to-date on any topic in this field.

Although the fatigue of materials has been studied for over 150 years, many significant approaches have been developed in the past 100 years. The Coffin-Manson "plastic strain cycling approach" for low cycle failures and later the beginning of the "damage tolerance approach" through the fracture mechanics correlation of crack growth rates were suggested in the 1950s. Indeed these methods were shown to be applicable in the late 1950s but were frequently ignored until the failure of an F-111 aircraft in December 1969. This crash convinced the US Air Force to develop and use damage tolerance methods on every aircraft. The US Federal Aviation Agency was soon applying similar methods to ensure a sufficient crack-growth life in order to set up adequate inspection intervals for critical structural parts. Earlier in the 1960s Westinghouse and others used/applied fatigue crack-growth testing to ensure sufficient life in the case of various power generating systems. Since then, many novel applications of these newer methods have been developed.

More recently, Bathias and others have shown that the "traditional fatigue limit stress", below which failures were regarded as not occurring, are unsafe for "very high cycle fatigue" of the order ranging from 10^8 to 10^{10} loading cycles. This evidence was determined using ultrasonic testing at 20 to 30 kHz. This field is still

rapidly developing but is thoroughly covered in this book. Further discussion dealing with the historical aspects of fatigue are detailed in the introduction in Chapter of this book.

Each chapter is self-contained on the topic of interest. Each chapter is well referenced in order to provide the reader with a thorough background and to act as a source for deeper study on the topics covered in this book. As a consequence, readers can use this book as a guide to further information on the topics they are interested in. In some cases, the chapters focus on similar topics as they belong to the same general category but are written from different points of view and with different emphasis.

Chapters 2, 3, 4, 5 and 9 present the approach of failure cycles from low cycle plastic fatigue to very high cycle behavior, including the effects of notches, hardening mechanisms, etc., with many other variables involved. Within Chapter 9 fatigue crack growth mechanisms are also discussed.

Chapters 6, 7, 8 and 9 (again) deal with fatigue crack growth from small to long cracks with various models. They cover growth laws and their mechanisms. Chapters 10 and 11 provide a thorough overview of environmental factors, from aggressive to vacuum effects, leading to the initiation and growth of cracks. While Chapter 12 discusses loading interaction effects for a wide variety of structural applications and the counting methods for these various loading programs and types.

As a veteran of this field, allow me to point out the excellence of the work of some of the outstanding young stars of this field, such as Sylvie Pommier and Thierry Palin-Luc, who contributed to the writing of Chapters 9 and 12. Although these volumes present the current state of understanding, this field has many other outstanding young researchers who will develop new approaches as time goes by. However, these volumes stand as a full picture of the current “state of the art” in understanding fatigue phenomena.

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