STP519-EB/May 1973

Introduction

Modern machinery is required to perform reliably under a variety of operating conditions. Power generation equipment such as nuclear reactors and steam and gas turbines have to respond quickly to the changing power demands of our technological society; aircraft structures and jet engines are to perform reliably under frequent take off, cruise, and landing operations. These are only two examples of the cyclic operating pattern imposed on modern machinery.

The cyclic operating pattern, the increasing demands on reliability imposed by the consumer-oriented society, and the drive for an economic design require sophisticated design methods for critical components subjected to severe cyclic loadings. An essentially static, time-independent viewpoint is no longer feasible in these cases. It will be necessary to calculate the stresses and strains and assess the accumulated damage by following through the operating history of these critical components. Central to this new design approach is the recognition that each severe cycle can cause a permanent damage in the material. During the projected lifetime of the machine the total accumulated damage in highly-stressed components will have to be less than the damage which will lead to mechanical failure. The objective in the development of a modern design approach for critically-stressed components is therefore the accurate assessment of the damage caused by the elements of the operating history.

The Symposium on Cyclic Stress-Strain Behavior—Analysis, Experimentation and Failure Prediction focuses on three vital aspects of the damage assessment in engineering materials. Experimental techniques to determine the cyclic stress-strain behavior and the initiation of cracks in materials are discussed. The importance of time (rate) dependent processes as they affect deformation and crack initiation is delineated in various papers. Notches and their life-reducing effect are examined from an experimental and analytical point of view. In the latter, elasto-plastic computer programs are employed. The crack initiation and crack propagation phase are separated

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and treated individually. The problems of damage definition, damage accumulation, and life prediction under variable amplitude loading receive attention in several papers.

The reader of these papers will realize the interdisciplinary nature of the subject, and he will certainly recognize the contributions made by the metallurgical, materials testing, and analytical disciplines. For the development of reliable damage assessment and life prediction methods to be used in the design of modern machinery, an interdisciplinary approach is absolutely essential. We want to thank the authors for their contributions and their willingness to discuss the subject across the boundaries of classical disciplines. We sincerely hope that this Special Technical Publication will be used by designers and will stimulate further interdisciplinary work towards the development of rational and reliable life prediction methods for realistic operating conditions.

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