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Editorial

Fatigue Damage

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1. Introduction and Scope

Prevention of unexpected failures is a fundamental design objective in any engineering structure or system subjected to fatigue. Nevertheless, the complexity of modern structures and the interactivity among engineering systems, coupled with human fallibility, means that failure and its consequences can only be avoided to a statistical probability. Hence, occasional catastrophic failures will occur, with some of them involving the loss of human lives. Within the last few decades, a dramatic advancement has been achieved in many of the necessary technologies to either avoid or mitigate the consequences of failure. This advancement is associated with ever-increasing performance objectives for materials, structures, and machines, an increased complexity of engineered products and processes. Alongside this, catastrophic failure and its consequences are considered less tolerable in society as a whole; this ensures that efforts to prevent unexpected failures are now a cornerstone in modern engineering design and, simultaneously, a technological and scientific challenge. There is an increasing acknowledgement in the engineering community that the response to this challenge, that is, prevention of catastrophic failure, generally requires a systems approach and necessitates engagement of a large pool of multidisciplinary expertise and the deployment of tools for systems analysis. This multidisciplinary pool includes materials science, structural analysis, manufacturing technologies, quality control and evaluation, mathematics, physics, and probability and reliability. Furthermore, from the scientific point of view, there is also an increasing acknowledgement that addressing the complex engineering problems of today requires the use of concepts and approaches that can account for size- and time-scaling effects. The Special Issue scope embraces interdisciplinary work aimed at understanding and deploying physics of fatigue and failure techniques, advancing experimental and theoretical failure analysis, modelling of the structural response with respect to both local and global failures, and structural design that accounts for scale and time effects in preventing engineering failures.

2. Contributions

Fourteen articles have been published in the present Special Issue of *Metals*, encompassing the fields of fatigue damage, high-cycle fatigue, fatigue and creep interaction, and fatigue in aggressive corrosive media. This grouping is not hard-bound, and thematic links can be established beyond them, which shall be emphasized in the following presentation.

2.1. High-Cycle Fatigue

High-cycle fatigue is a traditional topic, but still offers many challenges, as is well described in some of the present contributions. In particular, it becomes increasingly critical if large-scale effects occur in a full-scale component, increasing the presence of defects [1]. Aspects related to microstructure and interaction between fatigue properties and metallurgical properties are also very important for the fatigue design [2]. The special issue treats this topic in a comprehensive way, providing an overview of the state of the art of recent developments useful for the readers of *Metals*.

2.2. Fatigue and Creep Interaction

The interest in fatigue assessment of steels and different alloys at high temperature has increased continuously in recent years. The applications in which the fatigue phenomenon is affected by high temperature are of considerable interest, and involve various industrial sectors, such as transportation, energy, and metal-manufacturing (e.g., jet engine components, nuclear power plant, pressure vessel, hot rolling of metal). To provide as optimal a performance as possible in these highly demanding conditions, it is necessary to be aware of the application and of the proper tools for performing the fatigue assessment, including at high temperatures. Interaction between creep and fatigue is a crucial point for the design, and it is well treated in some contributions to the present Special Issue (see, for example Ref. [3]).

2.3. Fatigue in Corrosive Media

An aggressive environment can be extremely critical for the fatigue life of a structure working in an aggressive environment, and protection against corrosion is necessary to maintain adequate fatigue properties and warrant the safety of the component. Designers must consider corrosion in service for a proper design against fatigue loadings. Corrosion is also undesirable for reasons related to a safe and economic use of a structure during its service life. Some recent advances in this area are well presented in [4], providing a useful and up-to-date overview of the problem in connection with fatigue damage of structural materials.

3. Conclusions and Outlook

A variety of connected topics have been compiled in the present Special Issue of *Metals*, providing a wide overview of recent developments on different aspects of fatigue damage. Hopefully, this special issue will be a starting point for future discussions and scientific debate on challenging topics related to fatigue damage and fatigue design. The topic, in fact, remains current, with a high and relevant impact for many applications. The selected papers touch on a variety of important topics related to fatigue and fracture in structural materials. Scale effect and multiscaling approaches are a fundamental part of these topics, and allow a better understanding of the fatigue damage at different scale levels.

As guest editor of this special issue, I am very happy with the final result, and hope that the present papers will be useful to researchers and designers, working towards the demanding objective of failure prevention in presence cyclic loadings. I would like to warmly thank all the authors for their contributions, and all of the reviewers for their efforts in ensuring a high-quality publication. At the same time, I would like to thank the many anonymous reviewers who assisted me in the reviewing process. Sincere thanks also to Editors of *Metals* for their continuous help, and to the *Metals* Editorial Assistants for the valuable and inexhaustible engagement and support during the preparation of this volume. In particular, my sincere thanks to Natalie Sun for her help and support.

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