

Preface

From time to time in technical practice, damages occur due to mechanical loading. Reasons are often small defects or cracks that are already in the component or initiate during the operation. Under service load—time variable loading—cracks can grow. In general the crack growth is initially stable, i.e., the crack grows a small amount with each cycle. This is known as fatigue crack growth. Depending on the manner of the loading, the geometry of the component and the material, a fatigue crack can grow over thousands of cycles without becoming unstable. If the loading or the crack length reaches a critical limit, unstable crack growth occurs and the component or the whole structure fails.

This book deals with the fatigue crack growth process. Therefore, at first the dimensioning of components and structures in accordance with current approaches of the classical strength of materials is described. After the description of many cases of damage caused by the crack growth as well as the principles of damage analyses and non-destructive testing, the basics of fracture mechanics and fatigue crack growth for mode I, mode II, mode III as well as mixed mode are presented. The experimental determination of fracture-mechanical material parameters, e.g., the fracture toughness, the threshold value, or the fatigue crack growth curve is described afterwards. The previously mentioned concepts and material parameters are valid for cyclic loading with constant amplitude. However, constant amplitude loading is very rare in practice, so that the fatigue crack growth under service loading and its influence on the residual lifetime is discussed in detail in the next chapter. Subsequently, the calculation of the residual lifetime using analytical and numerical simulation tools is in the focus. The book concludes with practical examples such as a leak in a pipeline, an investigation of fatigue crack growth in a high-speed train tire or a simulation of the fatigue crack growth in a press frame.

The authors hope that readers will find here a solid basis for further study on fatigue crack growth and subsequent application of the described concepts and methods. Moreover, they hope these readers will enjoy studying the variety of examples contained in the book. Let the study of this book lead to a smaller number of damage cases caused by fatigue crack growth.

The book is translation from the third edition of the German language book “Ermüdungsrisse – Erkennen, Sicher beurteilen, Vermeiden” published by Springer Vieweg in 2012. In this context we thank all persons who contributed to the German edition, especially Dr.-Ing. Andre Riemer (University of Paderborn) as well as Thomas Zipsner and Imke Zander (Editorial Office Springer Vieweg).

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Fatigue Crack Growth

Detect - Assess - Avoid

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