Preface

The book in hand presents advanced methods of brittle fracture and fatigue assessment. It continues the expositions of two well-known reference works for designers of machines and constructions, structural analysts, testing engineers and code-responsible experts. The one book in English language with the title 'Fatigue assessment of welded joints by local approaches' is authored by Radaj et al. ([2]2006). The other book in German language with the title 'Ermüdungsfestigkeit—Grundlagen für Ingenieure' ('Fatigue strength—fundamentals for engineers') is authored by Radaj and Vormwald ([3]2007).

A further separate new book was found necessary after the two works mentioned above had reached a certain limit size. The second edition of the application-related English book has 639 pages based on 997 references. The third edition of the fundamentals-related German book consists of 688 pages with 1761 references.

This new book is conceived to review and explain advanced methods of brittle fracture and fatigue assessment which are not sufficiently well represented in the two books mentioned above, especially in respect of the major steps in methods development and application which have taken place in the recent few years.

The authors do not claim that the addressed scientific fields are the only ones in which major advance has been achieved. The personal involvement in actual research efforts was also decisive for the selection of the fields. Nonetheless, the authors believe that these fields will remain most influential on the methods development in the future. The following comments may elucidate the significance of the selected fields.

In Chap. 1 headed 'Generalised Neuber Concept of Fictitious Notch Rounding' and authored by Radaj, this analytically demanding approach is brought to a completion by extending it to three new areas, to in-plane shear loading with out-of-bisector crack propagation, to varying notch opening angles and to V-notches with root hole as an alternative to blunt V-notches. The reference notch concept for the fatigue assessment of welded joints is based on the above approach.

In Chap. 2 headed 'Extended Stress Intensity Factor Concepts' and authored by Radaj, the stress intensity factor approach which is well known from fracture

mechanics is extended in two directions. One extension refers to pointed V-notches whose singular notch stress field is described by mode-related and angle-dependent notch stress intensity factors. The other extension is related to rounded V-notches (blunt shape or root hole shape) whose non-singular notch stress field is governed by generalised notch stress intensity factors. Additionally, the extension into the elastic-plastic range is performed. Rigid inclusion problems are treated in a similar way as the open notch problems, defining the corresponding stress intensity factors.

In Chap. 3 headed 'Local Strain Energy Density Concept' and authored by Radaj, the stress intensity factor approaches just mentioned are transferred into a local energy concept which is well suited for the assessment of the brittle fracture or fatigue failure limit of sharply notched structural members. The local energy concept is more appropriate for strength assessments than the conventional stress concentration concept, because the local average strain energy density, based on stress intensity factors, characterises the strength-relevant field as opposed to stress concentration factors which are related to strength-irrelevant point stresses. The size effect in strength assessments is naturally included in the local strain energy density concept. Most important for applications is the fact that finite element procedures based on extremely coarse meshes can be used without a major loss in accuracy of the results.

In Chap. 4 headed 'Elastic-Plastic Fatigue Crack Growth' and authored by Vormwald, the various implications of cyclic plasticity with regard to the fatigue crack growth are explained. Conventional fatigue crack propagation approaches rely on similitude arguments and relationships between the stress intensity factor range and the crack growth rate. The application limit of this approach is specified by small-scale yielding conditions. Still within these limits, an explanation and straightforward modelling of the mean stress influence and the influence of variable amplitudes requires consideration of cyclic plasticity. Plasticity-induced crack closure is of great influence on the crack growth rate. Modelling tools and algorithms are presented. Outside the small-scale yielding limits, the stress intensity factor range must be substituted by a crack driving force parameter of elastic-plastic fracture mechanics. Various proposals are presented and discussed with a focus on the J-integral. Together with an adequate consideration of crack closure, advances in simulating fatigue crack growth in this regime more realistically are presented. Multiaxial and mixed mode loading are a continuing challenge for actual research. These topics are discussed against the background of current expertise and available computational resources.

The following formal aspects of the presentation in the book is important to know. Each of the four chapters above is a separate unit within the book with its own abstract at the beginning and its own reference list, symbol list and list of contents at the end. The reason for this is that the book is offered by the publisher not only in the printed, but also in the electronic version inclusive of a pay-per-chapter option. It is also introduced for the reader's convenience.

Our colleagues from the University of Padova in Vicenza, Paolo Lazzarin together with Filippo Berto and Michele Zappalorto, have immensely contributed

to the first three chapters of the book. They are the original developers of the advanced concepts of stress intensity factors and local strain energy density leading to successful applications. They were available for discussing some intriguing scientific problems associated with their methods development. They have patiently answered innumerable questions related to their original publications. They have contributed about one-half of the large number of figures in the book, which were only slightly modified for a uniform appearance. We hope that the unequalled scientific merit of these persons will become apparent to the readers of the book. The authors acknowledge the received support with deep respect.

Additionally, the first author appreciates 10 years of challenging cooperation with the eminent personalities mentioned above. These years with nearly daily contacts have become an especially valuable final phase of his scientific career. He wants to express his thanks and his respect by presenting this book, summarising and elucidating the achievements of his colleagues in Vicenza.

Other colleagues have given support to special items of the book contents. Dietmar Gross from the Technical University of Darmstadt has provided a curve plot illustrating the Ramberg–Osgood material law. Mikkel Pedersen from the Aalberg University in Denmark has supplied a plot of fatigue test data supporting the notch stress design curve for fatigue-loaded welded joints. We appreciate the kindness of these two persons.

The manuscript of the first three chapters of this book was put into well-executed typescript by Claudia Raschke whose commitment to this task facilitated the first author's work substantially. This person has also prepared the graphical artwork, mainly based on plots provided by the original authors. It was a tremendous task to keep track with the great bulk of written or drawn material delivered by the author for further electronic processing. This support given to the book cannot be overrated. Any less qualified person would have brought the project to a breakdown. The first author pays his respects to Claudia's contribution to the project.

Both authors express their thanks to Kerstin Breidenbach for helping to bring the fourth chapter into its final form.

Finally, we express our thanks to the publishing house Springer-Verlag, who has agreed to publish this work and has supported our efforts in every respect.

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